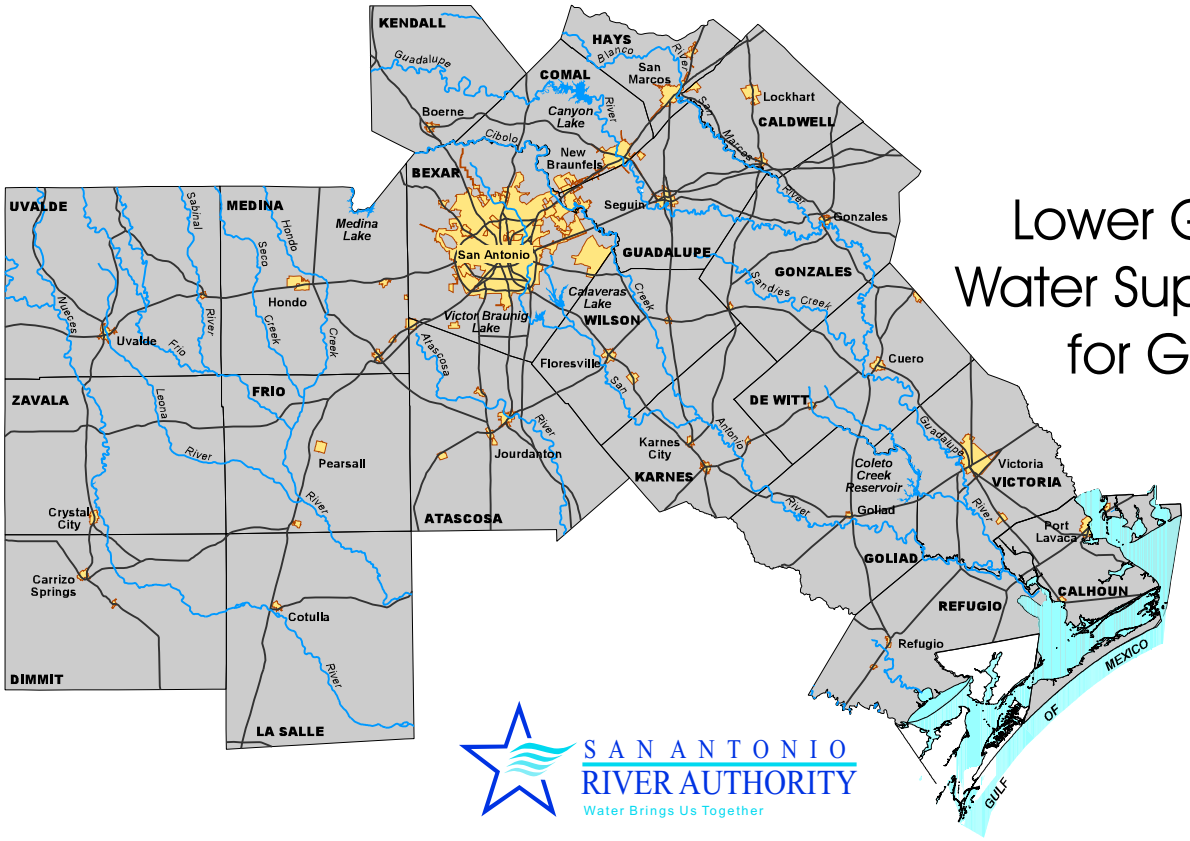
Region L

South Central Texas Regional Water Planning Group

2011 Regional Water Plan

Study 1
Lower Guadalupe Water Supply Project for GBRA Needs



SAN ANTONIO RIVER AUTHORITY
Water Brings Us Together

April 2009

Prepared by:

South Central Texas Regional Water Planning Group

With administration by:

San Antonio River Authority

With technical assistance by:

HDR Engineering, Inc.
Laura Raun Public Relations
Ximenez & Associates

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South Central Texas Regional Water Planning Area

2011 Regional Water Plan

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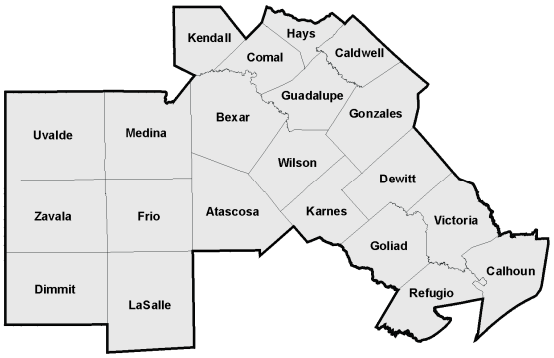

With technical assistance by:

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Table of Contents

List of Figures

List of Tables

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Executive Summary

ES.1 Introduction

The purpose of Study 1 is to further analyze and refine the Lower Guadalupe Water Supply Project for GBRA Needs (LGWSP for GBRA Needs), a water management strategy recommended to meet projected needs in the 2006 South Central Texas Regional Water Plan (SCTRWP). Further analyses were precipitated by issues that arose during final preparation of the 2006 SCTRWP and interpretation of language in House Bill 3776 of the 80th Texas Legislature. The results of Study 1 provide information of relevance to SCTRWPG consideration of the possibilities of amending the 2006 SCTRWP and/or recommending a refined LGWSP for GBRA Needs for implementation in the 2011 SCTRWP.

The LGWSP for GBRA Needs scenarios presented herein involve the diversion of water from the Guadalupe-Blanco River Authority (GBRA) Calhoun Canal System, transmission to water treatment plants at Luling, Lake Dunlap and/or San Marcos, New Braunfels, and the Western Canyon Project, and integration into municipal water supply systems (Figure ES-1).

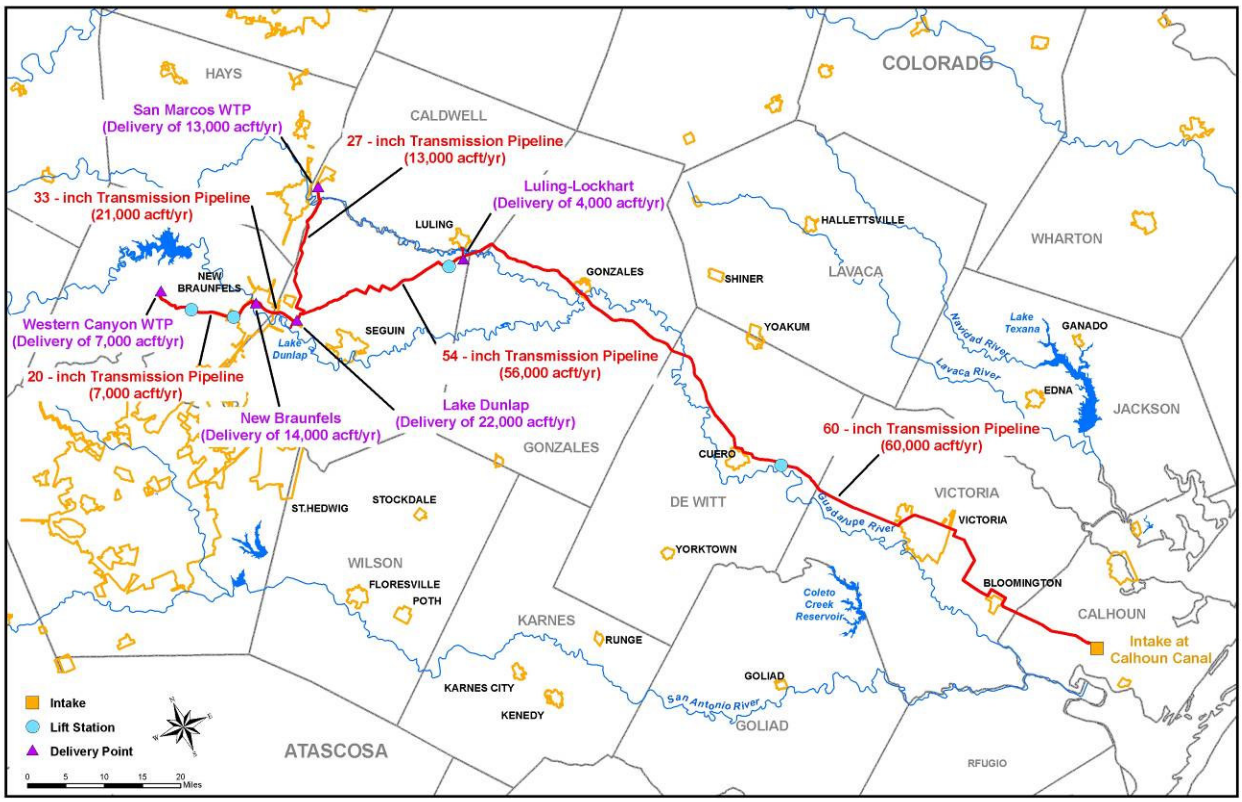


Figure ES-1. LGWSP for GBRA Needs — Location Map

The three scenarios evaluated in this study (Study 1), as defined by the SCTRWPG, are as follows:

Scenario 1: GBRA Preferred Alternative

1. Assumptions:
    a. Diversion of up to 75,000 acft/yr under GBRA water rights without the application of Consensus Criteria for Environmental Flow Needs (CCEFN).
    b. Edwards Aquifer pumpage consistent with SB3 (80th Texas Legislature).
    c. Off-channel storage as necessary.
    d. Delivery amount of 60,000 acft/yr.
2. Calculations – Off-channel storage capacity necessary to obtain firm yield of 60,000 acft/yr.
3. Cost estimate includes:
    a. Diversion pump station at existing GBRA Relift #1 Pump Station site on Calhoun Canal System.
    b. Off-channel storage in Lower Basin.
    c. Transmission through GBRA District and delivery to Luling, Lake Dunlap, New Braunfels, and the Western Canyon Project in the amounts shown Figure ES-1.
    d. Treatment and integration facilities.

Scenario 2: Alternative Interpretation of HB3776 with Groundwater

1. Assumptions:
    a. Diversion of up to 75,000 acft/yr under GBRA water rights with the application of CCEFN.
    b. Edwards Aquifer pumpage consistent with SB3 (80th Texas Legislature).
    c. Brackish groundwater from the Gulf Coast Aquifer and fresh water from the Carrizo/Wilcox Aquifer (50-50 split).
    d. Off-channel storage as necessary.
    e. Delivery amount of 60,000 acft/yr.
2. Calculations – Combination of off-channel storage and well field capacities necessary to obtain a firm yield of 60,000 acft/yr.
3. Cost estimate includes:
    a. Diversion pump station at existing GBRA Relift #1 Pump Station site on Calhoun Canal System.
    b. Off-channel storage in Lower Basin.
    c. Two well fields – Calhoun County (brackish Gulf Coast) & Gonzales County (fresh Carrizo-Wilcox).
    d. Transmission through GBRA District and delivery to Luling, Lake Dunlap, New Braunfels, and the Western Canyon Project in the amounts shown Figure ES-1.
    e. Treatment and integration facilities.

Scenario 3: Alternative Interpretation of HB3776 without Groundwater

1. Assumptions:
    a. Diversion of up to 75,000 acft/yr under GBRA water rights with the application of CCEFN.
    b. Edwards Aquifer pumpage consistent with SB3 (80th Texas Legislature).
    c. Off-channel storage as necessary.
    d. Delivery amount of 60,000 acft/yr.

2. Calculations – Off-channel storage capacity necessary to obtain a firm yield of 60,000 acft/yr.
3. Cost estimate includes:
    a. Diversion pump station at existing GBRA Relift #1 Pump Station site on Calhoun Canal System.
    b. Off-channel storage in Lower Basin.
    c. Transmission through GBRA District and delivery to Luling, Lake Dunlap, New Braunfels, and the Western Canyon Project in the amounts shown Figure ES-1.
    d. Treatment and integration facilities.

ES.2 Water Availability

The Guadalupe-San Antonio River Basin Water Availability Model (GSAWAM, as modified for regional water planning purposes) was used to quantify water available for diversion under CA# 18-5178. Hydrologic simulations and calculations were performed subject to the General Assumptions for Applications of Hydrologic Models, as adopted by the SCTRWPG for the 2006 Regional Water Plan, with a modification to include the latest Edwards Aquifer permitted pumping cap and critical period provisions as set forth in SB3 of the 80th Texas Legislature. A specifically-designed MS Excel model was then used to simulate off-channel storage operations, while meeting the 60,000 acft/yr delivery to GBRA customers. Results obtained using both the GSAWAM and the Excel model to evaluate each of three scenarios are presented in the following paragraphs.

ES.2.1 Scenario 1 – GBRA Preferred Alternative

Application of the GSAWAM demonstrates that water availability from the Guadalupe River, via the Calhoun Canal System, is very reliable under Scenario 1. A maximum diversion rate of 187 cfs (the pro-rata share of the maximum diversion rate in CA# 18-5178 or [264.35 cfs * 75,000 acft / 106,000 acft] = 187.0 cfs) was used in all scenarios. Subject to a uniform seasonal diversion pattern, the full monthly portion of 75,000 acft/yr is available in about 96 percent of the months simulated. Water available from the Calhoun Canal System was used in the Excel model to maintain storage in the off-channel storage facility and sized to the specified 60,000 acft/yr delivery requirement.

During relatively short periods during the 1934 – 1989 period of record, water is not available under CA# 18-5178, and diversions must be made from storage. It was determined that the storage necessary to sustain uniform delivery of 60,000 acft/yr is approximately 19,000 acft, based on a ring dike type structure limited to 20-feet deep. An off-channel storage reservoir of

this size would inundate approximately 950 acres. The maximum annual diversion under CA# 18-5178 is 64,198 acft/yr in this scenario.

It is noted that GBRA could provide most, if not all, of the 60,000 acft/yr delivery amount using firm senior water rights, rather than the junior portion of CA# 18-5178. This option would substantially reduce or eliminate off-channel requirements, but would require occasional suspension of water rights used for irrigation.

ES.2.2 Scenario 2 – Alternative Interpretation of HB3776 with Groundwater

Scenario 2 differs from Scenario 1 in that GBRA's CA# 18-5178 is assumed to be subject to the application of CCEFN for instream flows and freshwater inflows to the Guadalupe Estuary. CA# 18-5178 includes no specific conditions limiting diversions for maintenance of environmental flows. Under CCEFN, diversions cannot be made unless the streamflow passing the Guadalupe River Saltwater Barrier is 742 cfs or greater.

Groundwater is available under Scenario 2 as a secondary supply source to the LGWSP for GBRA Needs. Pursuant to SCTRWPG direction, groundwater use associated with the project is split evenly between brackish groundwater from the Gulf Coast Aquifer and fresh groundwater from the Carrizo/Wilcox Aquifer. For the purposes of this study, it is assumed that brackish groundwater from the Gulf Coast Aquifer would be developed in Calhoun County and fresh groundwater from the Carrizo/Wilcox Aquifer would be developed in Gonzales County.

Application of CCEFN to GBRA's existing water rights significantly decreases water available to the project. Subject to a maximum diversion rate of 187 cfs and a uniform seasonal diversion pattern, the full monthly portion of 75,000 acft/yr is available in about 41 percent of the months simulated. Water available from the Calhoun Canal System was used in the Excel model to maintain storage in the off-channel storage facility and meet the specified 60,000 acft/yr delivery requirement.

Various combinations of off-channel storage capacities and well field capacities were evaluated, and it was decided to strike a balance between off-channel storage and well field capacity. The resulting combination is one which attempts to minimize well field capacity, while maintaining a relatively small off-channel storage facility. Through an iterative process in the Excel model, it was determined that the storage necessary to sustain uniform delivery of 60,000 acft/yr is approximately 51,500 acft, based on a ring dike type structure limited to 20-feet deep,

and total groundwater pumping capacity of 52,500 acft/yr (26,250 acft/yr in each of Calhoun and Gonzales Counties).

ES.2.3 Scenario 3 – Alternative Interpretation of HB3776 without Groundwater

Scenario 3 differs from Scenario 2 in that groundwater is eliminated as a secondary supply source for the project. Because application of CCEFN to GBRA's existing water rights significantly limits water available and groundwater sources are eliminated, simulations demonstrate that it is not possible to meet the 60,000 acft/yr delivery requirement during drought with any reasonably-sized off-channel storage facility and diversions limited to 75,000 acft/yr.

In an attempt to assess the feasibility of a project (that delivers firm water less than the desired 60,000 acft/yr to GBRA customers), an off-channel storage facility of 250,000 acft capacity was assumed, and the firm yield calculated. Under Scenario 3, with a 250,000 acft storage facility, the firm yield is about 4,250 acft/yr, an amount substantially less than projected water supply needs in the middle and upper Guadalupe River Basin.

ES.3 Environmental Issues

The LGWSP for GBRA Needs project area is located primarily in the Gulf Coastal Plains of Texas Physiographic Province. This area is locally characterized as a nearly flat prairie which terminates at the Gulf of Mexico, and includes topography changes of less than one foot per mile. Elevation levels in this area range from 0 to 300 feet above mean sea level. Vegetation types found within the pipeline corridor are primarily live oak and post oak woodlands, with crops as the second largest type and the remaining portions containing grasslands and urban areas.

In Calhoun, Victoria, De Witt, Guadalupe, Gonzales, Caldwell, and Comal Counties, 41 state-listed endangered or threatened species and 22 federally-listed endangered or threatened wildlife species, may occur according to the county lists of rare species published by Texas Parks and Wildlife Department (TPWD). The potential occurrence of such species within a county does not mean that they will be affected by the water management strategy, just that consideration should be given to the possibility.

The scenarios selected rely on existing surface water rights and exclude any new surface water right appropriations. Therefore, freshwater inflows to the Guadalupe Estuary would be essentially the same as the "full water rights use" baseline that is used when calculating surface water supply and evaluating the cumulative effects of regional water plan implementation.

ES.4 Engineering and Costing

The canal intake and pump station are sized to deliver up to 187 cfs through a 3-mile, 96-inch diameter pipeline to an off-channel storage facility in Calhoun County. While a specific off-channel storage facility site has not been selected, it is assumed that an off-channel storage site could be located within three miles of the Calhoun Canal System.

The estimated cost of the LGWSP for GBRA Needs Scenario 1, including contingencies, is $804,679,000 in Second Quarter 2007 dollars. With a total annual cost of $90,332,000 and an available project yield of 60,000 acft/yr, the resulting unit cost is $1,506 per acft.

If GBRA chose to meet the yield of the project from the more senior, firm portions of their existing water rights in the lower basin, high capacity diversion facilities from the Calhoun Canal System and an off-channel storage facility might not be necessary. The resulting unit cost would be $1,423 per acft, or about $83 less than that presented above for Scenario 1.

The estimated costs of the LGWSP for GBRA Needs Scenario 2 is $962,282,000 in Second Quarter 2007 dollars. With a total annual cost of $105,966,000 and an available project yield of 60,000 acft/yr, the resulting unit cost is $1,766 per acft.

The LGWSP for GBRA Needs is unable to produce a firm yield of 60,000 acft/yr under Scenario 3. Even with off-channel storage of 250,000 acft, the resulting firm yield with a maximum annual diversion of 75,000 acft/yr is only 4,250 acft/yr, far below the desired 60,000 acft/yr. In discussions with GBRA staff and the Region L Staff Workgroup, it was decided that preparing a cost estimate for Scenario 3 would be futile, as Scenario 3 does not provide for a viable project. Therefore, costs for Scenario 3 were not prepared.

ES.5 Implementation Issues

Project implementation would include various permits from both state and federal agencies, land acquisition, and relocation of existing roads, utilities, pipelines, and power transmission lines.

ES.6 Potential Economic Benefits

An estimate of the potential economic impact of the LGWSP for GBRA Needs was performed to determine direct and indirect benefits in the terminus area, in the source area, and along the construction route. The total direct, indirect and induced economic benefit of construction of the LGWSP is estimated at $172,034,000, of which $52,131,000 or 30 percent is expected to occur in the Calhoun and Victoria Counties source area.

1.0 Description of Water Management Strategy Scenarios

The Lower Guadalupe Water Supply Project (LGWSP) for GBRA Needs water management strategy scenarios presented herein involve the diversion of water from the Guadalupe-Blanco River Authority (GBRA) Calhoun Canal System, transmission to water treatment plants at Luling, Lake Dunlap and/or San Marcos, New Braunfels, and the Western Canyon Project, and integration into municipal water supply systems (Figure 1-1). Potential sources of water for this strategy include up to 75,000 acft/yr of presently underutilized surface water rights from GBRA, brackish groundwater supplies from the Gulf Coast Aquifer, and fresh groundwater from the Carrizo/Wilcox Aquifer. As other sources of water become available near the end of the current planning horizon (e.g., seawater desalination), they could be used to supplement or replace supplies from GBRA surface water rights.

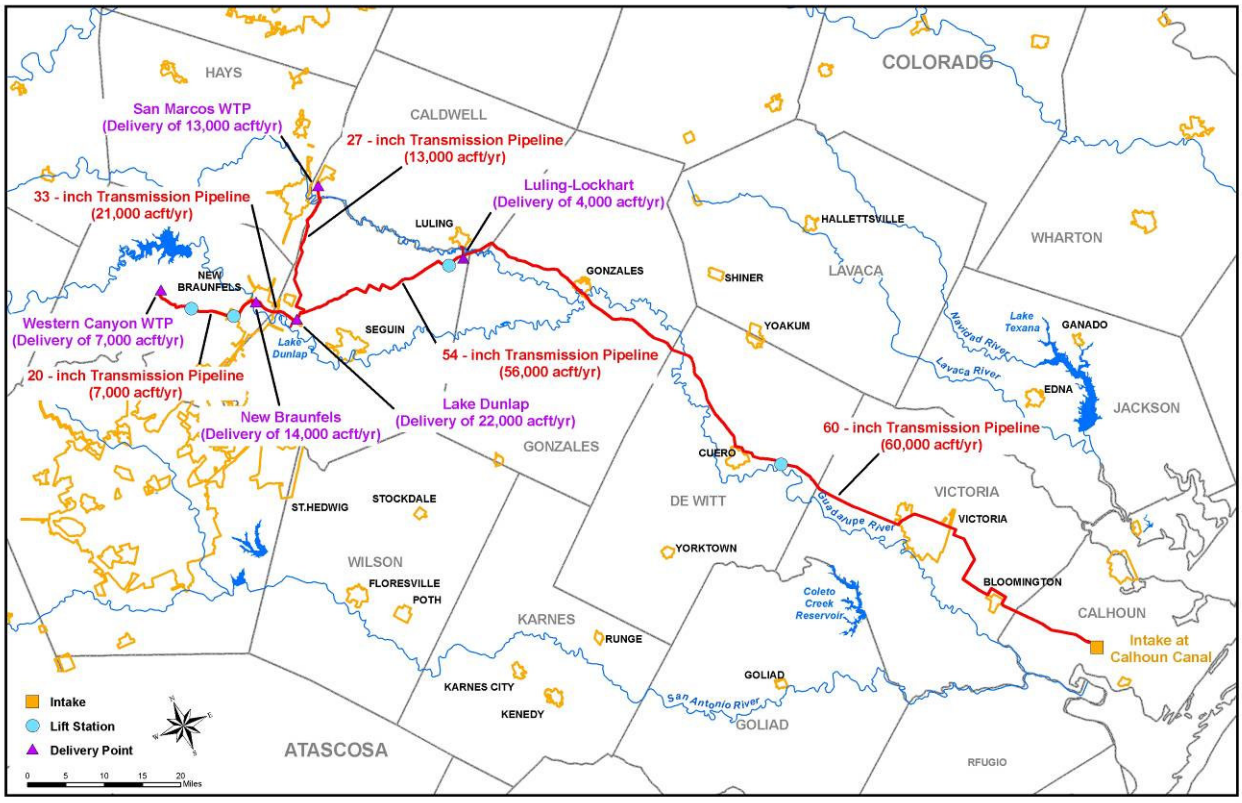


Figure 1-1. LGWSP for GBRA Needs — Location Map

The GBRA lower basin water rights total 175,501 acft/yr and represent about 30 percent of all surface water rights in the Guadalupe-San Antonio River Basin authorized for consumptive use. A majority of these rights are jointly held with the Dow Chemical Company/Union Carbide Corporation. These GBRA water rights are quite reliable, as the upstream watershed encompasses approximately 10,128 square miles and includes the two largest springs in Texas. In addition, substantial volumes of treated effluent are discharged upstream of the proposed diversion point. In all years, there is unappropriated streamflow passing the Guadalupe River Saltwater Barrier and entering the Guadalupe Estuary. However, junior portions of the GBRA rights committed to the LGWSP may not be "firm" (i.e., 100 percent reliable) during each month of a repeat of the most severe drought on record. Hence, this strategy includes off-channel storage facilities that serve to "firm-up" (increase the reliability of) run-of-river diversions to be used for municipal and industrial purposes.

The three water management strategy scenarios presented herein differ from those presented in the 2006 South Central Texas Regional Water Plan (SCTRWP) in that they are in response to legislation set forth in HB 3776 of the 80th Texas Legislature. A sub-section of HB 3776 includes provisions for approving the 2006 SCTRWP so long as the LGWSP for GBRA Needs water management strategy is revised to include the following conditions:

1. Include a transmission pipeline for the diversion of up to 60,000 acre-feet per year of surface water available under water rights held by the Guadalupe-Blanco River Authority as of December 31, 2006;
2. At least 100,000 acre-feet per year of surface water must be reserved for lower basin needs;
3. Prohibit use of fresh groundwater for the project;
4. Require the consent of appropriate property owner(s) before off-channel storage or an off-channel reservoir may be developed as part of the project; and
5. Require freshwater inflows in an amount sufficient to meet the Texas Parks and Wildlife Department, Texas Commission on Environmental Quality, and Texas Water Development Board's environmental consensus criteria for San Antonio Bay to be identified and included in the project.

Interpretation of the language in HB 3776 has been debated, as the bill references only the 2006 SCTRWP, and not any future Regional Water Plans. The South Central Texas Regional Water Planning Group (SCTRWPG) has chosen to evaluate the LGWSP for GBRA Needs under three

scenarios. Each of these scenarios, or formulations of the LGWSP for GBRA Needs, serves to ensure that long-term, reliable, and renewable surface water supplies will be available throughout the GBRA statutory district.

The three scenarios evaluated in this study (Study 1), as defined by the SCTRWPG, are as follows:

Scenario 1: GBRA Preferred Alternative

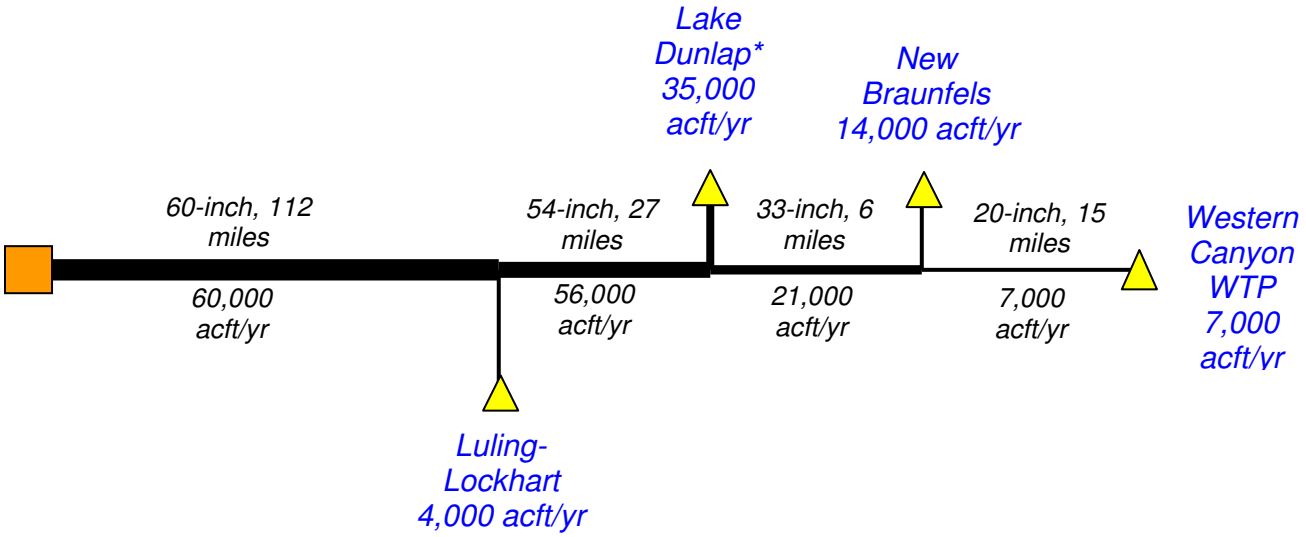
1. Assumptions:
    a. Diversion of up to 75,000 acft/yr under GBRA water rights without the application of Consensus Criteria for Environmental Flow Needs (CCEFN).
    b. Edwards Aquifer pumpage consistent with SB3 (80th Texas Legislature).
    c. Off-channel storage as necessary.
    d. Delivery amount of 60,000 acft/yr.
2. Calculations – Off-channel storage capacity necessary to obtain firm yield of 60,000 acft/yr.
3. Cost estimate includes:
    a. Diversion pump station at existing GBRA Relift #1 Pump Station site on Calhoun Canal System.
    b. Off-channel storage in Lower Basin.
    c. Transmission through GBRA District and delivery to Luling, Lake Dunlap, New Braunfels, and the Western Canyon Project in the amounts shown Figure ES-1.
    d. Treatment and integration facilities.

Scenario 2: Alternative Interpretation of HB3776 with Groundwater

1. Assumptions:
    a. Diversion of up to 75,000 acft/yr under GBRA water rights with the application of CCEFN.
    b. Edwards Aquifer pumpage consistent with SB3 (80th Texas Legislature).
    c. Brackish groundwater from the Gulf Coast Aquifer and fresh water from the Carrizo/Wilcox Aquifer (50-50 split).
    d. Off-channel storage as necessary.
    e. Delivery amount of 60,000 acft/yr.
2. Calculations – Combination of off-channel storage and well field capacities necessary to obtain a firm yield of 60,000 acft/yr.
3. Cost estimate includes:
    a. Diversion pump station at existing GBRA Relift #1 Pump Station site on Calhoun Canal System.
    b. Off-channel storage in Lower Basin.
    c. Two well fields – Calhoun County (brackish Gulf Coast) & Gonzales County (fresh Carrizo-Wilcox).
    d. Transmission through GBRA District and delivery to Luling, Lake Dunlap, New Braunfels, and the Western Canyon Project in the amounts shown Figure ES-1.
    e. Treatment and integration facilities.

Scenario 3: Alternative Interpretation of HB3776 without Groundwater

1. Assumptions:
    a. Diversion of up to 75,000 acft/yr under GBRA water rights with the application of CCEFN.
    b. Edwards Aquifer pumpage consistent with SB3 (80th Texas Legislature).
    c. Off-channel storage as necessary.
    d. Delivery amount of 60,000 acft/yr.
2. Calculations – Off-channel storage capacity necessary to obtain a firm yield of 60,000 acft/yr.
3. Cost estimate includes:
    a. Diversion pump station at existing GBRA Relift #1 Pump Station site on Calhoun Canal System.
    b. Off-channel storage in Lower Basin.
    c. Transmission through GBRA District and delivery to Luling, Lake Dunlap, New Braunfels, and the Western Canyon Project in the amounts shown Figure ES-1.
    d. Treatment and integration facilities.



** Approximately 13,000 acft/yr is needed for the IH35 Corridor (Including San Marcos)*

Figure 1-2. LGWSP for GBRA Needs — Schematic of Delivery Amounts

Inclusion of off-channel storage has certain operational advantages in addition to increasing firm water availability. These advantages include the capability of suspending river diversions to avoid poor water quality during flood events and/or facilitate maintenance of diversion facilities without curtailing deliveries from the reservoir.

2.0 Water Availability

The Guadalupe River Saltwater Barrier was constructed in the early 1960s at a location immediately downstream of the San Antonio River confluence and creates a reservoir pool extending some distance up both rivers. Diversions from this reservoir pool, under existing rights, flow into GBRA's Calhoun Canal System and are dependent upon waters originating in both the Guadalupe and San Antonio Rivers and their respective tributaries. Since the end users of the LGWSP for GBRA Needs are customers within the 10-county GBRA statutory district and part of each of the 10 counties is with in the Guadalupe River Basin, this version of the LGWSP is not subject to many provisions of Section 11.085 of the Texas Water Code regarding inter-basin transfers.

Maximum reported water use under the GBRA lower basin water rights totaling 175,501 acft/yr at the Guadalupe River Saltwater Barrier did not exceed 63,000 acft/yr during the 1991 through 2006 historical period[1]. It is estimated by GBRA that up to 75,000 acft/yr under one or more of these rights is available for periods of time into the future. Certificate of Adjudication (CA) #18-5178 is the least senior of GBRA's lower basin water rights and it has a priority date of January 7, 1952. Authorized annual diversions under CA# 18-5178 total 106,000 acft for municipal, industrial, and irrigation uses.

The Guadalupe-San Antonio River Basin Water Availability Model (GSAWAM, as modified for regional water planning purposes) was used to quantify water available for diversion under CA# 18-5178. Hydrologic simulations and calculations were performed subject to the General Assumptions for Applications of Hydrologic Models, as adopted by the SCTRWPG for the 2006 Regional Water Plan, with a modification to include the latest Edwards Aquifer permitted pumping capacity and Critical Period provisions as set forth in SB3. A maximum diversion rate of 187 cfs (the pro-rata share of the maximum diversion rate in CA# 18-5178 or [264.35 cfs * 75,000 acft / 106,000 acft] = 187.0 cfs) was used in all scenarios. A specifically-designed MS Excel model was then used to simulate off-channel storage operations, while meeting the 60,000 acft/yr delivery to GBRA customers. Results obtained using both the GSAWAM and the Excel model to evaluate each of three scenarios are presented in the following paragraphs.

[1] GBRA, Personal Communication, 2007.

2.1 Scenario 1 – GBRA Preferred Alternative

Application of the GSAWAM, with a period of record from January 1934 to December 1989, demonstrates that water availability from the Guadalupe River, via the Calhoun Canal System, is very reliable under Scenario 1. Figure 2-1 shows the water available for diversion under the junior 75,000 acft/yr portion of CA# 18-5178 on an annual basis, limited only by a maximum diversion rate of 187 cfs. Actual diversions from the Guadalupe River to the off-channel reservoir are further limited by the annual diversion maximum (70,000 acft/yr) and/or by amounts necessary to keep the reservoir full. Subject to a uniform seasonal diversion pattern, the full monthly portion of 75,000 acft/yr is available in about 96 percent of the months simulated. Water available from the Calhoun Canal System was used in the Excel model to maintain storage in the off-channel storage facility sized to meet the specified 60,000 acft/yr delivery requirement.

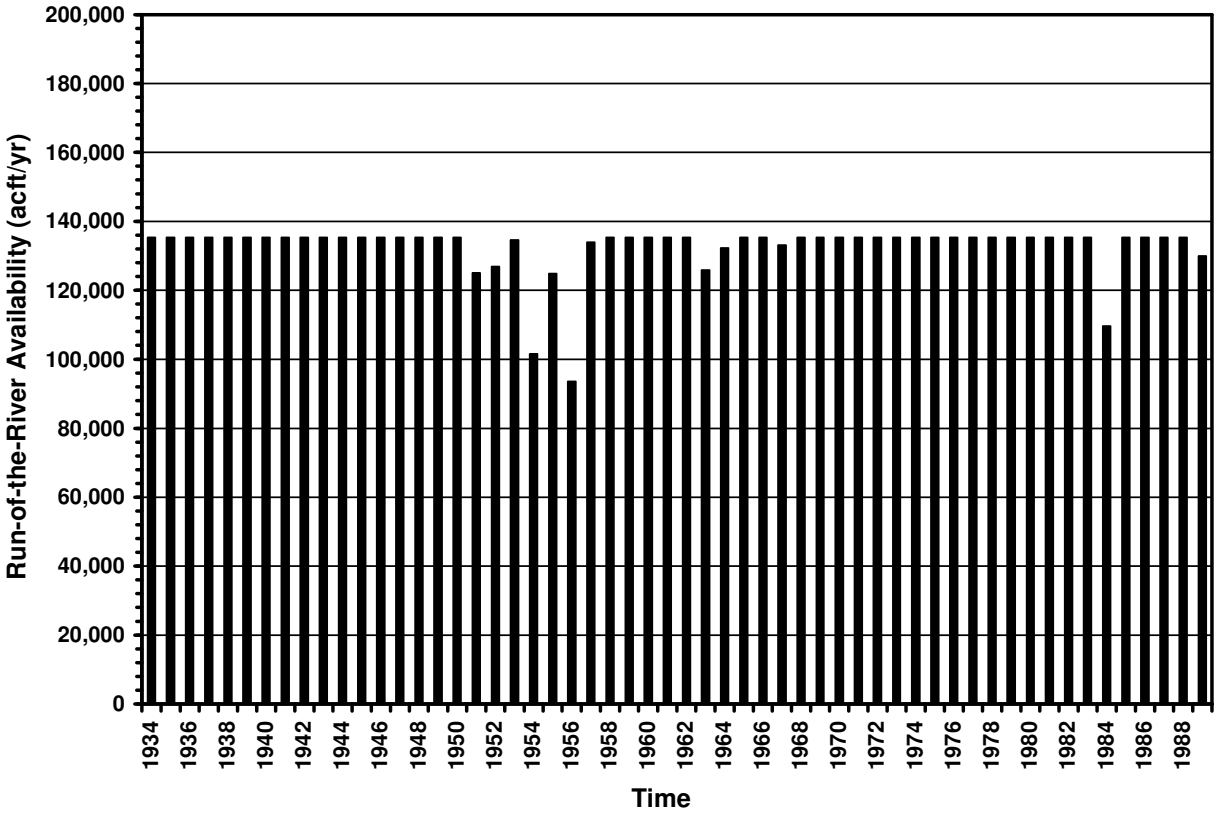


Figure 2-1. Scenario 1 – Availability from Guadalupe River under Junior Portion of CA# 18-5178, Limited by Maximum Diversion Rate of 187 cfs

During relatively short periods during the 1934 – 1989 period of record, water is not available under CA# 18-5178, and diversions must be made from storage. It is assumed that the off-channel storage facility for all scenarios would be located in Calhoun County. Through an

iterative process in the Excel model, it was determined that the storage necessary to sustain uniform delivery of 60,000 acft/yr is approximately 19,000 acft, based on a ring dike type structure limited to about 20-feet deep. An off-channel storage reservoir of this size would inundate approximately 950 acres. The long-term average net evaporative loss associated with a reservoir of this size in the lower Guadalupe River Basin is expected to be 2,160 acft/yr (3.6 percent of firm yield). The maximum annual diversion under CA# 18-5178 is 64,198 acft/yr in this scenario.

It is noted that GBRA could provide most, if not all, of the 60,000 acft/yr delivery amount using firm senior water rights, rather than the junior portion of CA# 18-5178. This option would substantially reduce or eliminate off-channel requirements, but would require occasional suspension of water rights used for irrigation.

2.2 Scenario 2 – Alternative Interpretation of HB3776 with Groundwater

Scenario 2 differs from Scenario 1 in that GBRA's CA# 18-5178 is assumed to be subject to the application of CCEFN for instream flows and freshwater inflows to the Guadalupe Estuary. CA# 18-5178 includes no specific conditions limiting diversions for maintenance of environmental flows. Table 2-1 lists the associated instream flow values for the application of CCEFN at the Guadalupe River Saltwater Barrier. Under CCEFN, diversions cannot be made unless the streamflow passing the Guadalupe River Saltwater Barrier is 742 cfs or greater.

Application of CCEFN for diversions from the Guadalupe River at the Saltwater Barrier includes consideration of the recommended monthly inflow needs of the Guadalupe Estuary associated with the maximum harvest (MaxH) of selected species[2] as a minimum amount to pass when flows exceed the monthly natural daily median. When flows fall below the median, the monthly instream flow provisions in the CCEFN are assumed to apply. It is important to note that two significant research studies are under way which will result in site-specific environmental flow requirements and modification of the estimates of water availability and firm yield reported herein. Texas A&M University is conducting a multi-faceted research project involving extensive collection of field data seeking to better define potential linkage of freshwater inflows and marsh community dynamics in San Antonio Bay to whooping crane populations. The Texas A&M University research project is presented in Study 4B under separate cover. In addition, the Center for Research in Water Resources at the University of

Texas at Austin is engaged in a research effort focusing upon the influence of freshwater inflows on the ecological health of San Antonio Bay.

Groundwater is available under Scenario 2 as a secondary supply source to the LGWSP for GBRA Needs. Pursuant to SCTRWPG direction, groundwater use associated with the project is split equally between brackish groundwater from the Gulf Coast Aquifer and fresh groundwater from the Carrizo/Wilcox Aquifer. For the purposes of this study, it is assumed that brackish groundwater from the Gulf Coast Aquifer would be developed in Calhoun County and fresh groundwater from the Carrizo/Wilcox Aquifer would be developed in Gonzales County.

Application of CCEFN to GBRA's existing water rights significantly decreases water available to the project, as shown in Figure 2-2. Subject to a maximum diversion rate of 187 cfs and a uniform seasonal diversion pattern, the full monthly portion of 75,000 acft/yr is available in about 41 percent of the months simulated. Water available from the Calhoun Canal System was used in the Excel model to maintain storage in the off-channel storage facility and meet the specified 60,000 acft/yr delivery requirement.

Table 2-1.
Daily Naturalized Streamflow Statistics for
Lower Guadalupe Water Supply Project for GBRA Needs

Month	*Median Flows — Zone 1 Pass-Through Requirement (cfs)*	*25th Percentile Flows — Zone 2 Pass-Through Requirement (cfs)*
January	1476.7	899.4
February	1670.3	998.7
March	1483.2	927.1
April	1513.0	913.5
May	1962.7	1038.1
June	1814.5	961.9
July	1278.5	742.1*
August	1002.3	742.1*
September	1223.6	742.1*
October	1360.7	745.7
November	1364.8	861.1
December	1355.7	836.9
Zone 3 Pass-Through Requirement (cfs)		742.1
** Zone 3 Pass-Through Requirement exceeds 25th Percentile Flow.*		

[2] TPWD and TWDB, "Freshwater Inflow Recommendation for the Guadalupe Estuary of Texas," Coastal Studies Technical Report No. 98-1, December 1998.

During relatively long periods during the 1934 – 1989 period of record, there are multiple years when water available under CA# 18-5178 is very limited and diversions must draw on storage and/or groundwater from one or both of the two well fields. There are multiple combinations of off-channel storage capacities and well field capacities that could be sized to ensure delivery of the 60,000 acft/yr. Various combinations were evaluated, and it was decided to strike a balance between off-channel storage and well field capacity. The resulting combination is one which attempts to minimize well field capacity, while maintaining a relatively small off-channel storage facility. Through an iterative process in the Excel model, it was determined that the storage necessary to sustain uniform delivery of 60,000 acft/yr is approximately 51,500 acft, based on a ring dike type structure limited to 20-feet deep, and total groundwater pumping capacity of 52,500 acft/yr (26,250 acft/yr in each of Calhoun and Gonzales Counties). An off-channel storage reservoir of this size would inundate approximately 2,575 acres. The long-term average net evaporative loss associated with a reservoir of this size in the lower Guadalupe River Basin is expected to be 5,844 acft/yr (9.7 percent of firm yield). The maximum annual diversion under CA# 18-5178 is 64,358 acft/yr, while the long-term average groundwater pumpage would be about 33,534 acft/yr in this scenario.

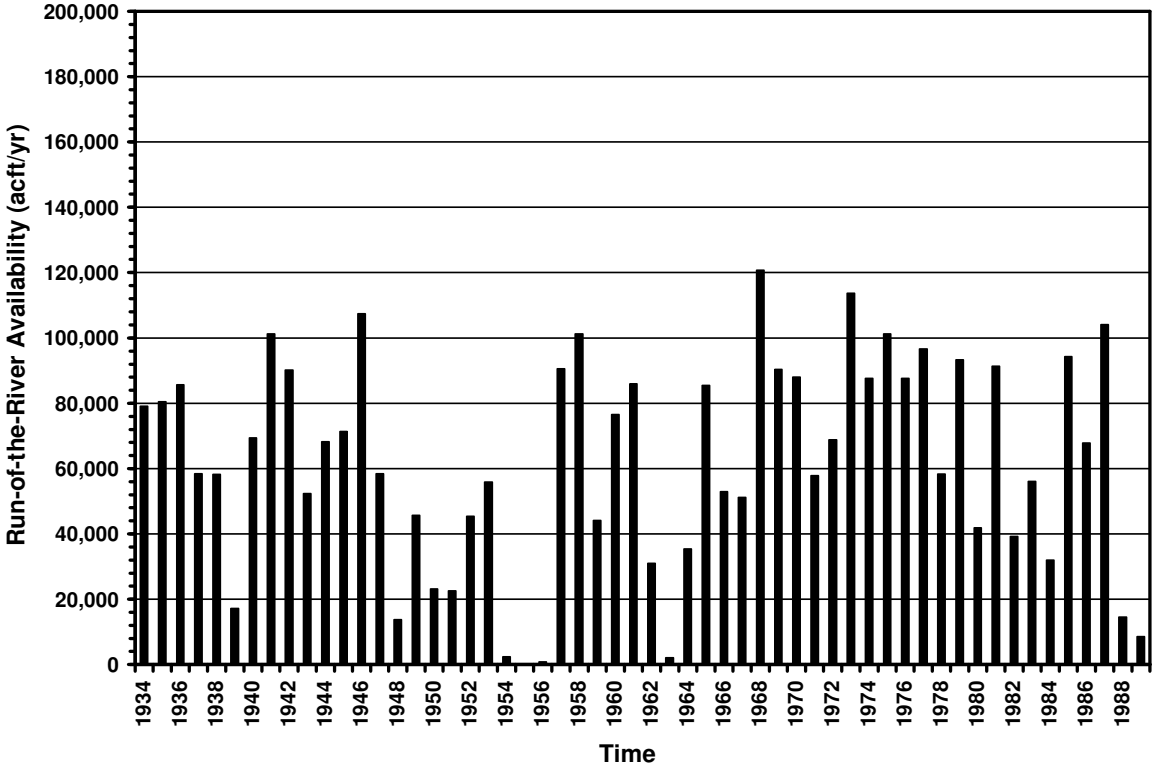


Figure 2-2. Scenario 2 – Availability from Guadalupe River under Junior Portion of CA# 18-5178 Subject to CCEFN, Limited by Maximum Diversion Rate of 187 cfs

2.3 Scenario 3 – Alternative Interpretation of HB3776 without Groundwater

Scenario 3 differs from Scenario 2 in that groundwater is eliminated as a secondary supply source for the project. Because application of CCEFN to GBRA's existing water rights significantly limits water available (Figure 2-2) and groundwater sources are eliminated, simulations demonstrate that it is not possible to meet the 60,000 acft/yr delivery requirement during drought with any reasonably-sized off-channel storage facility and diversions limited to 75,000 acft/yr.

In an attempt to assess the feasibility of a project (that delivers firm water less than the desired 60,000 acft/yr to GBRA customers), an off-channel storage facility of 250,000 acft was chosen, and the firm yield calculated. The long-term average net evaporative loss associated with a reservoir of this size in the lower Guadalupe River Basin is expected to be 28,356 acft/yr. Under Scenario 3, with a 250,000 acft storage facility, the firm yield is about 4,250 acft/yr, an amount substantially less than projected water supply needs in the middle and upper Guadalupe River Basin.

3.0 Environmental Issues

The LGWSP for GBRA Needs includes a 3-mile diversion pipeline from the GBRA Calhoun Canal System to an off-channel storage facility in Calhoun County and a single 160-mile long transmission pipeline from the off-channel storage facility to delivery points in the middle and upper Guadalupe River Basin originates in Calhoun County and runs in a northwesterly direction through portions of Calhoun, Victoria, De Witt, Gonzales, Caldwell, Guadalupe, and Comal Counties.

A construction right-of-way approximately 140-feet wide would affect a total area of approximately 2,700 acres. The construction of the pipelines would include the clearing and removal of woody vegetation within and maintenance of a 40-foot wide right-of-way free of woody vegetation for the life of the project (1,943 acres of temporarily disturbed construction corridor).

The project area is located primarily in the Gulf Coastal Plains of Texas Physiographic Province. This area is locally characterized as a nearly flat prairie which terminates at the Gulf of Mexico, and includes topography changes of less than one foot per mile. Elevation levels in this area range from 0 to 300 feet above mean sea level. Vegetation types found within the pipeline corridor are primarily live oak and post oak woodlands, with crops as the second largest type and the remaining portions containing grasslands and urban areas.

The pipeline route encompasses four different vegetational areas, The Gulf Prairies and Marshes, Post Oak Savannah, Blackland Prairies, and Edwards Plateau. The portion of the pipeline route found within Calhoun County and the majority of Victoria County crosses the Gulf Prairies and Marshes Vegetational Area. Gulf Prairies have slow surface drainage and elevations that range from sea level to 250 feet. These areas include nearly level and virtually undissected plains. Originally the Gulf Prairies were composed of tallgrass prairie and post oak savannah. However, tree species such as honey mesquite and acacia, along with other trees and shrubs, have increased in this area, forming dense thickets in many places.

Typical oak species found in this area include live oak (Quercus virginiana) and post oak (Q. stellata), in addition to huisache (Acacia smallii), black-brush (A. rigidula), and a dwarf shrub, bushy sea-ox-eye (Borrichia frutescens). Principal climax grasses of the Gulf Prairies include gulf cordgrass (Spartina spartinae), indiangrass (Sorghastrum nutans), and big bluestem (Andropogon gerardii var. gerardii). Prickleypear (Opunita) are common within this area along with forbs including asters (Aster), poppy mallows (Callirhoe), bluebonnets (Lupinus), and

evening primroses (Oenothera). Gulf Marshes range from sea level to a few feet in elevation, and include low, wet marshy coast areas commonly covered with saline water. These salty areas support numerous species of sedges (Carex and Cyperus), bulrushes (Scirpus), rushes (Juncus), and grasses. Aquatic forbs found in these areas generally include pepperweeds (Lepidium), smartweeds (Polygonum), cattails (Typha domingensis) and spiderworts (Tradescantia) among others. Upland game and waterfowl find these low marshy areas to be excellent natural wildlife habitat.

The Post Oak Savannah vegetational area of Texas includes portions of De Witt, Guadalupe, Gonzales, and Caldwell counties. The Post Oak Savannah refers to the gently rolling, moderately dissected, wooded plain that lies to the west of the Pineywoods in east-central Texas and intermingles with the Blackland Prairie in south-central Texas. The elevation in this area ranges from 300-800 feet. This vegetation area includes the entire Claypan land resource area of Texas, which is considered part of the Southern Coastal Plains. Vegetation is typified by post oak (Quercus stellata) and blackjack oak (Quercus marilandica) in association with tallgrasses. Dense thickets may occur within this area in the absence of fire or other methods of woody plant suppression. The Post Oak Savannah was extensively cultivated until the 1940's, but numerous acres have since been restored to native vegetation or converted to tame pastures.

In addition to post oak and blackjack oak, associated trees of the Post Oak Savannah include elms (Ulmus spp.), junipers (Juniperus spp.), hackberries (Celtis spp.), and hickories (Carya spp.). Understory vegetation includes shrubs such as yaupon (Ilex vomitoria), American beautyberry (Callicarpa americana), coralberry (Symphoricarpos orbiculatus), and vines such as greenbriars (Smilax spp.) and grapes (Vitis spp.). Common climax grasses include little bluestem (Schizachyrium scoparium), indiangrass (Sorghastrum nutans), switchgrass (Panicum virgatum), silver bluestem (Bothriochloa laguroides), Texas wintergrass (Nassella leucotricha), brownseed paspalum (Paspalum plicatulum) purpletop (Tridens flavus), narrow leaf woodoats (Chasmanthium laxum), and beaked panicum (Panicum anceps). Forbs occurring in the area include wild indigos (Baptisia spp.), indigobush (Amorpha fruticosa), sennas (Senna spp.), tickclovers (Desmodium spp.), lespedezas (Lespedeza spp.), prairie clovers (Dalea spp.), western ragweed (Ambrosia psilostachya), crotons (Croton spp.), and sneezeweeds (Helenium spp.).

The Blackland Prairies refers to rolling hills of well-dissected prairie in west-central Texas and represents the southern extension of the true prairie that occurs from Texas to Canada. Portions of this type of vegetational area are included in De Witt, Guadalupe, Gonzales, Comal,

and Caldwell counties. The region was once a tallgrass prairie dominated by little bluestem (Schizachyrium scoparium), big bluestem (Andropogon gerardii), indiangrass (Sorghastrum nutans), tall dropseed (Sporobolus compositus), and Silver dropseed (Sporobolus silveanus). Oaks (Quercus spp.), elms (Ulmus spp.), cottonwood (Populus deltoides), and native pecan (Carya illinoinensis) are common along streams in this region. About 98 percent of the Blackland Prairies were cultivated to produce crops such as cotton, corn, and wheat in the late 19th and early 20th centuries. Since the 1950's, the region has been increasingly used for pasture and forage crops for the production of livestock, and now only about 50 percent of the area is used as cropland.

The Edwards Plateau vegetational area occurs within the western portions of Comal and Hays counties. This area includes rapidly drained stony plains with broad flat divides. The original vegetation within this area was grassland or open savannah-type plains with most tree or brushy species found along rocky slopes and stream bottoms. The Edwards plateau is currently primarily rangeland with short grasses. Along rocky outcrops and protected areas with good soil moisture you will still find tallgrasses such as cane bluestem (Bothriochloa barbinodis var. barbinodis), indiangrass (Sorghastrum nutans), and switchgrass (Panicum spp.) Common woody species include live oak (Quercus virginiana), sand shin oak (Quercus havardii), mesquite (Prosopis glandulosa) and ashe juniper (Juniperus ashei).

In Calhoun, Victoria, De Witt, Guadalupe, Gonzales, Caldwell, and Comal Counties, 41 state-listed endangered or threatened species and 22 federally-listed endangered or threatened wildlife species, may occur according to the county lists of rare species published by Texas Parks and Wildlife Department (TPWD). A list of these species is provided in Table 3-1.

Inclusion in Table 3-1 does not imply that a species will occur within the study area, but only acknowledges the potential for occurrence in the study area counties. A more intensive field reconnaissance would be necessary to confirm and identify specific suitable habitat that may be present in the project area. In addition to county lists, HDR also reviewed Texas Natural Diversity Database (TXNDD) map data for known occurrences of listed species within or near the proposed pipeline route. This information indicated that there were reported sightings of Cagle's map turtle (Graptemys caglei), a state listed threatened species; the fountain darter fish (Etheostoma fonticola), listed by both the state and federal government as endangered; the Comal Springs dryopid beetle (Stygoparnus comalensis), which is federally listed as endangered; within a one mile radius of the pipeline area. Two rare species are also documented, the

Guadalupe bass (Micropterus teculii) and the mountain plover (Charadrius montanus). The presence or absence of potential habitat within an area does not confirm the presence or absence of a listed species. No species specific surveys were conducted in the study area for this report.

Many migratory birds are dependent on estuarine environments like those located near Calhoun County in order to complete their foraging and nesting requirements during migration. One of the most well known of these migratory birds is the whooping crane (Grus Americana), which is listed as endangered by both United States Fish and Wildlife Service (USFWS) and TPWD. A growing population of whooping cranes winter in and near the Aransas National Wildlife Refuge, located adjacent to the Mesquite Bay and the southern and western portions of San Antonio Bay. This wintering population has grown from a low of only 16 birds in 1941 to a high of 257 birds in December 2007. Detailed research studies by Texas A&M University are underway at this time to identify and better understand factors affecting whooping crane population. Three other migratory birds known to the San Antonio Bay area are listed as threatened by TPWD: the reddish egret (Egretta rufescens), wood stork (Mycteria Americana), and piping plover (Charadrius melodus). The piping plover is also listed as threatened by USFWS.

Endangered and threatened species listed for Comal County include the Black-capped Vireo, Golden-cheeked Warbler, and four additional migratory bird species, two salamanders, a amphipod, and two beetles. Some care may be necessary should water pipelines traverse preferred habit for these endemic species. Black-capped Vireos are insectivorous songbirds that nest in low shrubland thickets where vegetation extends to ground level. Golden-cheeked Warblers prefer habitat consisting of mature oak-juniper woodlands located along steep escarpments and canyons. The listed invertebrate species (amphipod and beetles) are all endemic to karst features or springs, as is the Cascade Cavers salamander. The listed migratory bird species tend to avoid areas of concentrated human development.

Several species listed as threatened by the state may possibly be affected by the project. These include the Texas horned lizard (Phrynosoma cornutum), Texas scarlet snake (Cemophora coccinea lineri), Texas tortoise (Gopherus berlandieri), and timber/canebrake rattlesnake (Crotalus horridus). Many of these reptile species are dependent on shrubland or riparian habitat.

Habitat studies and surveys for protected species and cultural resources may need to be conducted at the proposed lift station sites and along any pipeline routes. Potential wetland impacts, which are limited to pipeline stream crossings, can be minimized by right-of-way

selection and appropriate construction methods, including horizontal directional drilling, erosion controls, and revegetation procedures. Compensation for net losses of wetlands would be required where impacts are unavoidable.

Table 3-1
Important Species Having Habitat or Known to Occur in
Calhoun, Caldwell, Comal, De Witt, Gonzales, Guadalupe and Victoria Counties

Common Name	*Scientific Name*	*Summary of Habitat Preference*	*Listing Entity*		*Potential Occurrence in Counties*
			USFWS[1]	*TPWD*[1]	
A mayfly	Campsurus decoloratus	TX and MX; possibly clay substrates;			Resident
A mayfly	Tortopus circumfluus	Generally found in shoreline vegetation			Resident
American Eel	*Anguilla rostrata*	Moist aquatic habitats			Resident
Atlantic Hawksbill Sea turtle	*Eretmochelys imbricata*	Gulf and bay systems	LE	E	Migrant
Attwater's Greater Prairie-chicken	*Tympanuchus cupido attwateri*	Endemic, open prairies and coastal plains	LE	E	Resident
Bald Eagle	*Haliaeetus leucocephalus*	Large bodies of water with nearby resting sites	DL	T	Nesting/ Migrant
Big red sage	*Salvia penstemonoides*	Endemic; moist to seasonally wet clay or silt soils in creek beds.			Resident
Black Bear	*Usus americanus*	Mountains, broken country, woods, brushlands, forests	T/SA; NL	T	Historic Resident
Black-capped Vireo	Vireo atricapillus	Semi-open broad-leaved shrublands	LE	E	Nesting/ Migrant
Black-Spotted Newt	*Notophthalmus meridionalis*	Ponds and resacas in south Texas		T	Resident
Blue sucker	Cycleptus elongatus	Larger portions of major rivers in Texas;		T	Resident
Bracted Twistflower	*Streptanthus bracteatus*	Endemic; Shallow clay soils over limestone; rocky slopes			Resident
Brown Pelican	*Pelecanus occidentalis*	Coastal inlands for nesting, shallow gulf and bays for foraging	LE	E	Nesting/Migrant
Canyon mock-orange	*Philadelphus ernestii*	Endemic, outcrops of limestone			Resident
Cagle's map turtle	*Graptemys caglei*	Endemic; Guadalupe River System		T	Resident

Table 3-1 (Continued)

Common Name	Scientific Name	Summary of Habitat Preference	Listing Entity		Potential Occurrence in Counties
			USFWS[1]	TPWD[1]	
Cascade Caverns salamander	*Eurycea latitans complex*	Endemic: subaquatic, springs and caves in Medina and Guadalupe River and Cibolo Creek Watersheds		T	Resident
Cave myotis bat	*Myotis velifer*	Colonial and cave-dwelling;			Resident
Comal Blind Salamander	*Eurycea tridentifera*	Endemic; Semi-troglobitic; Springs and waters of caves		T	Resident
Comal snakewood	*Colubria stricta*	Rock outcrops			Resident
Comal Springs diving beetle	*Comaldessus stygius*	Aquatic, at outflow at Comal Springs			Resident
Comal Springs dryopid beetle	*Stygoparnus comalensis*	Aquatic, cling to objects in streams	LE		Resident
Comal Springs riffle beetle	*Heterelmis comalensis*	Comal and San Marcos Springs	LE		Resident
Comal Springs salamander	*Eurycea* sp. 8	Endemic; Comal Springs			Resident
Creeper (squawfoot)	*Strophitus undulates*	Small to large streams			Resident
Edwards Aquifer diving beetle	*Haideoporus texanus*	Artesian well in Hays County			Resident
Edwards Plateau Spring Salamander	*Eurycea sp. 7*	Endemic; springs and waters of caves within region			Resident
Elmendorf's onion	*Allium elmendorfii*	Endemic, in deep sands			Resident
Eskimo curlew	*Numenius borealis*	Historic; grasslands, pastures	LE	E	Nonbreeding Historic Resident
Ezell's cave amphipod	*Stygobromus flagellatus*	Known from artesian wells			Resident
False spike mussel	*Quincuncina mitchelli*	Substrates of cobble and mud with water lilies present. Rio Grande, Brazos, Colorado and Guadalupe river basins.			Resident
Fountain darter	Etheostoma fonticola	Sam Marcos and Comal Rivers	LE	E	Resident
Golden-Cheeked Warbler	Dendroica chrysoparia	Woodlands with oaks and old juniper	LE	E	Nesting/ Migrant
Golden orb	*Quadrula aurea*	Sand and gravel, Guadalupe, San Antonio, and Nueces river basins			Resident
Green Sea Turtle	*Chelonia mydas*	Gulf and bay system.	LT	T	Migrant

Table 3-1 (Continued)

Common Name	Scientific Name	Summary of Habitat Preference	Listing Entity		Potential Occurrence in Counties
			USFWS[1]	TPWD[1]	
Guadalupe bass	Micropterus treculii	Endemic to perennial streams of the Edward's Plateau region			Resident
Guadalupe darter	Percina sciera apristis	Guadalupe River basin; large streams and rivers			Resident
Gulf Saltmarsh Snake	Nerodia clarkii	Brackish to saline coastal waters			Resident
Henslow's Sparrow	*Ammodramus henslowii*	Weedy fields, cut over areas.			Nesting/ Migrant
Hill County wild-mercury	*Argythamnia aphoroides*	Shallow clays and limestone			Resident
Horseshoe liptooth snail	*Daedalochila hippocrepis*	Snal known only from Landa Park in New Braunfels			Resident
Jaguarundi	*Herpailurus yaguarondi*	South Texas thick brushlands, favors areas near water	LE	E	Resident
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	Gulf and bay system.	LE	E	Migrant
Leonora's dancer damselfly	Argia leonorae	South central and western Texas; small streams and seepages			Resident
Leatherback Sea Turtle	*Dermochelys coriacea*	Gulf and bay system.	LE	E	Migrant
Loggerhead Sea Turtle	*Caretta caretta*	Gulf and bay system.	LT	T	Migrant
Long-legged cave amphipod	*Stygobromus longipes*	Subaquatic obligate			Resident
Louisiana Black Bear	*Ursus americanus luteolus*	Within historical range.	LT	T	Historic Resident
Mountain Plover	*Charadrius montanus*	Non-breeding-shortgrass plains and fields, plowed fields and sandy deserts			Nesting/ Migrant
Ocelot	*Leopardus pardalis*	Dense chaparral thickets; mesquite-thorn scrub and live oak mottes	LE	E	Resident
Opossum Pipefish	*Microphis brachyurus*	Brooding adults found in fresh or low salinity waters.		T	Resident
Palmetto pill snail	Euchemotrema leai cheatumi	One known population, from moist palmetto woodlands of Palmetto State Park;			Resident
Park's jointweed	*Polygonella parksii*	Endemic; deep loose sands of Carrizo and similar Eocene formations.			Resident

Table 3-1 (Continued)

Common Name	Scientific Name	Summary of Habitat Preference	Listing Entity		Potential Occurrence in Counties
			USFWS[1]	TPWD[1]	
Peck's cave amphipod	*Stygobromus pecki*	Aquatic crustacean, Comal Springs and Hueco Springs	LE	E	Resident
Peregrine falcon	*Falco peregrinus anatum (American)*	Open county; cliffs	DL	E	Nesting/ Migrant
	Falco peregrinus tundrius (Arctic)		DL	T	
Pistolgrip	*Tritogonia verrucosa*	Aquatic, stable substrate			Resident
Plains Spotted Skunk	*Spilogale putorius interrupta*	Prefers wooded, brushy areas and tallgrass prairie.			Resident
Rawson's metalmark	*Calephelis rawsoni*	Moist areas in limestone outcrops.			Resident
Red Wolf	*Canis rufus*	Extirpated	LE	E	Historic Resident
Reddish Egret	Egretta rufescens	Coastal inlands for nesting, coastal marshes for foraging		T	Migrant
Rock pocketbook	*Arcidens confragosus*	Mud and sand, Red through Guadalupe river basins			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	Endemic; open areas in deep sands derived from Carrizo and similar Eocene formations			Resident
Sheep Frog	*Hypopachus variolosus*	Deep sandy soils of Southeast Texas		T	Resident
Shinner's sunflower	Helianthus occidentalis ssp plantagineus	Mostly in prairies on the Coastal Plain			Resident
Snowy Plover	*Charadrius alexandrinus*	Wintering Migrant on mud flats			Migrant
Sooty Tern	*Sterna fuscata*	Catches small fish		T	Resident
Southeastern Snowy Plover	*Charadrius alexandrinus tenuirostris*	Texas Gulf Coast beaches and bayside mud or salt flats			Wintering Migrant
Spot-tailed earless lizard	*Holbrookia lacerata*	Moderately open prairie-brushland			Resident
Texas asaphomyian tabanid fly	Asaphomyia texensis	Adults of tabanid spp. found near slow-moving water			Resident
Texas Diamondback Terrapin	*Malaclemys terrapin littoralis*	Bays, coastal marshes of the upper two-thirds of Texas Coast			Resident

Table 3-1 (Continued)

Common Name	Scientific Name	Summary of Habitat Preference	Listing Entity		Potential Occurrence in Counties
			USFWS[1]	TPWD[1]	
Texas fatmucket	*Lampsilis bracteata*	Streams and rivers on sand, mud and gravel, Colorado and Guadalupe River basins			Resident
Texas Garter Snake	*Thamnophis sirtalis annectens*	Wet or moist microhabitats			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	Varied, sparsely vegetated uplands, grass, cactus, brush		T	Resident
Texas mock-orange	*Philadelphus texensis*	Endemic, limestone cliffs and boulders			Resident
Texas pimpleback	*Quadrula petrina*	Mud, gravel and sand substrates, Colorado and Guadalupe river basins			Resident
Texas Scarlet Snake	*Cemophora coccinea lineri*	Mixed hardwood scrub		T	Resident
Texas Tortoise	*Gopherus berlandieri*	Open brush w/ grass understory; open grass/bare ground avoided		T	Resident
Timber/Canebrake Rattlesnake	*Crotalus horridus*	Floodplains, upland pine, deciduous woodlands, riparian zones		T	Resident
Welder machaeranthera	*Psilactis heterocarpa*	Endemic, grasslands and adjacent scrub flats on clay			Resident
West Indian manatee	*Trichechus manatus*	Aquatic	LE	E	Resident
Timber/Canebrake Rattlesnake	*Crotalus horridus*	Floodplains, upland pine, deciduous woodlands, riparian zones		T	Resident
Western Burrowing Owl	*Athene cunicularia hypugaea*	Open grasslands, especially prairie, plains and savanna			Resident
Western Snowy Plover	*Charadrius alexandrinus nivosus*	Winters along coast			Migrant
White-faced Ibis	*Plegadis chihi*	Prefers freshwater marshes		T	Resident
White-nosed coati	*Nasua narica*	Woodlands, riparian corridors		T	Transient
White-tailed Hawk	*Buteo albicaudatus*	Coastal prairies, savannahs and marshes in Gulf coastal plain		T	Nesting/ Migrant
Whooping Crane	*Grus americana*	Potential migrant	LE	E	Migrant

Table 3-1 (Concluded)

Common Name	Scientific Name	Summary of Habitat Preference	Listing Entity		Potential Occurrence in Counties
			USFWS[1]	TPWD[1]	
Wood Stork	*Mycteria americana*	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
Zone-tailed Hawk	*Buteo albonotatus*	Arid open county near watercourse		T	Nesting/ Migrant

- LE/LT=Federally Listed Endangered/Threatened
- E/SA, T/SA=Federally Listed Endangered/Threatened by Similarity of Appearance
- DL, PDL=Federally Delisted/Proposed for Delisting
- E, T=State Listed Endangered/Threatened
- Blank = Rare, but no regulatory listing status

Source: TPWD, Annotated County List of Rare Species, Calhoun County, August 14, 2007, Victoria County November 20, 2007, De Witt County, November 20, 2007, Gonzales County August 8, 2007, Guadalupe County, August 8, 2007, and Caldwell County, November 20, 2007.

All areas to be disturbed during construction would first be surveyed by qualified professionals to determine the presence or absence of significant cultural resources. 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).

A specific site for the off-channel reservoir has not been chosen. In choosing a site, key considerations will include minimizing construction and long-term operations costs and minimizing conflicts with streams, highways/roadways, railroads, transmission facilities (water, product, and power), petroleum production, and environmental/cultural resources (e.g., endangered & threatened species habitat, wetlands, and historical/archaeological sites).

The scenarios selected rely on existing surface water rights and exclude any new surface water right appropriations. Therefore, in Scenario 1, freshwater inflows to the Guadalupe Estuary would be the same as the "full water rights use" baseline that is used when calculating surface water supply and evaluating the cumulative effects of regional water plan implementation. Thus graphics showing median inflow and flow frequency are not necessary, as the median values for both Baseline and Lower Guadalupe Water Supply Project for GBRA needs would be equal in all months. For the scenarios in which Consensus Criteria for Environmental Flow Needs are applied to existing water rights (Scenarios 2 and 3), freshwater inflows to the Guadalupe Estuary would be greater than those of the baseline (full water rights use). Figures 3-1 and 3-2 show the effects of Scenario 2 on freshwater inflow to the Guadalupe

Estuary, and Figures 3-3 and 3-4 show the effects of Scenario 3 on freshwater inflow to the Guadalupe Estuary.

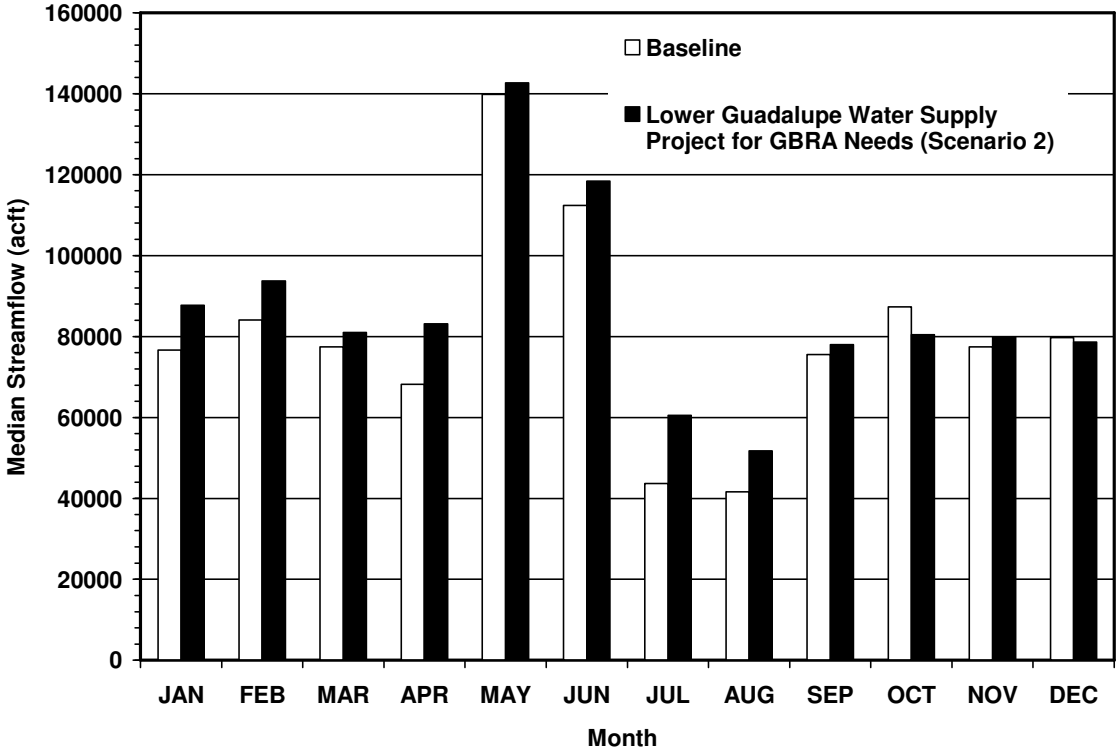


Figure 3-1. Median Freshwater Inflow to the Guadalupe Estuary – Scenario 2

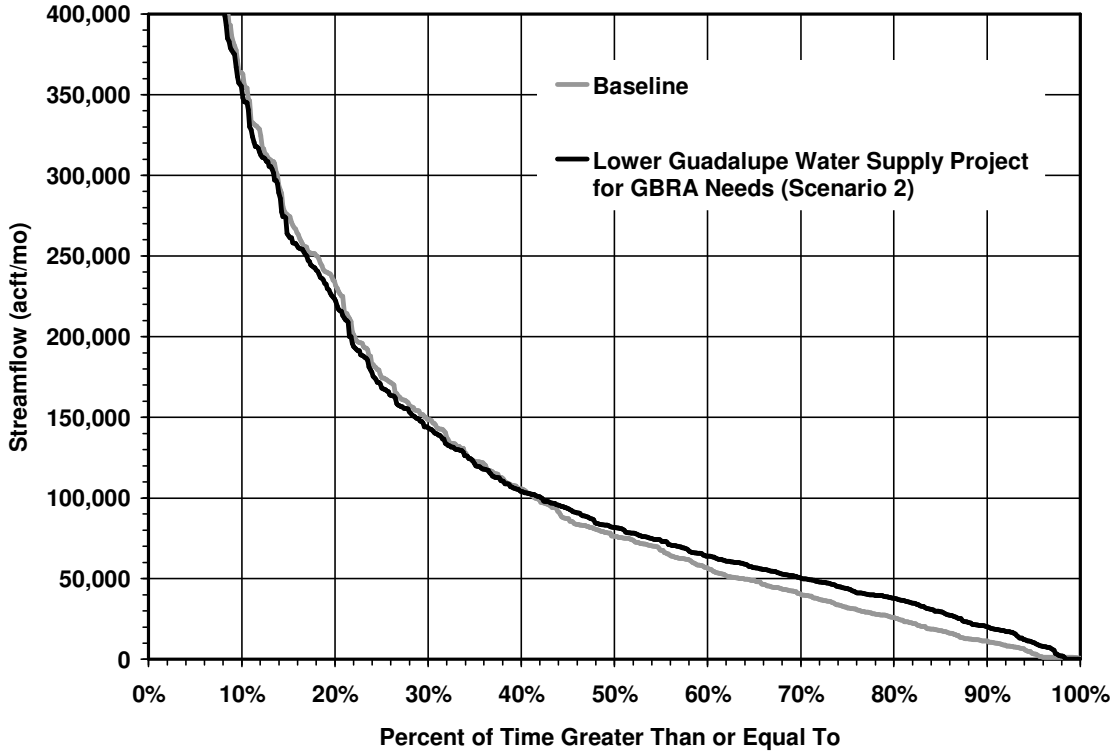


Figure 3-2. Freshwater Inflow Frequency to the Guadalupe Estuary – Scenario 2

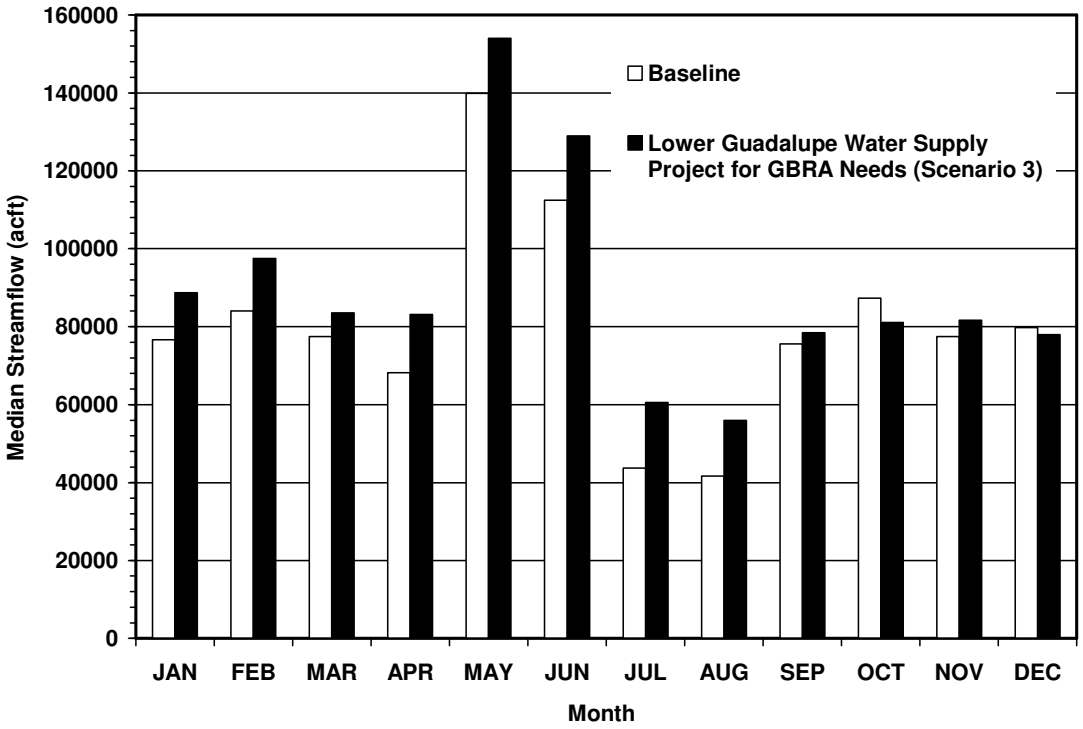


Figure 3-3. Median Freshwater Inflow to the Guadalupe Estuary – Scenario 3

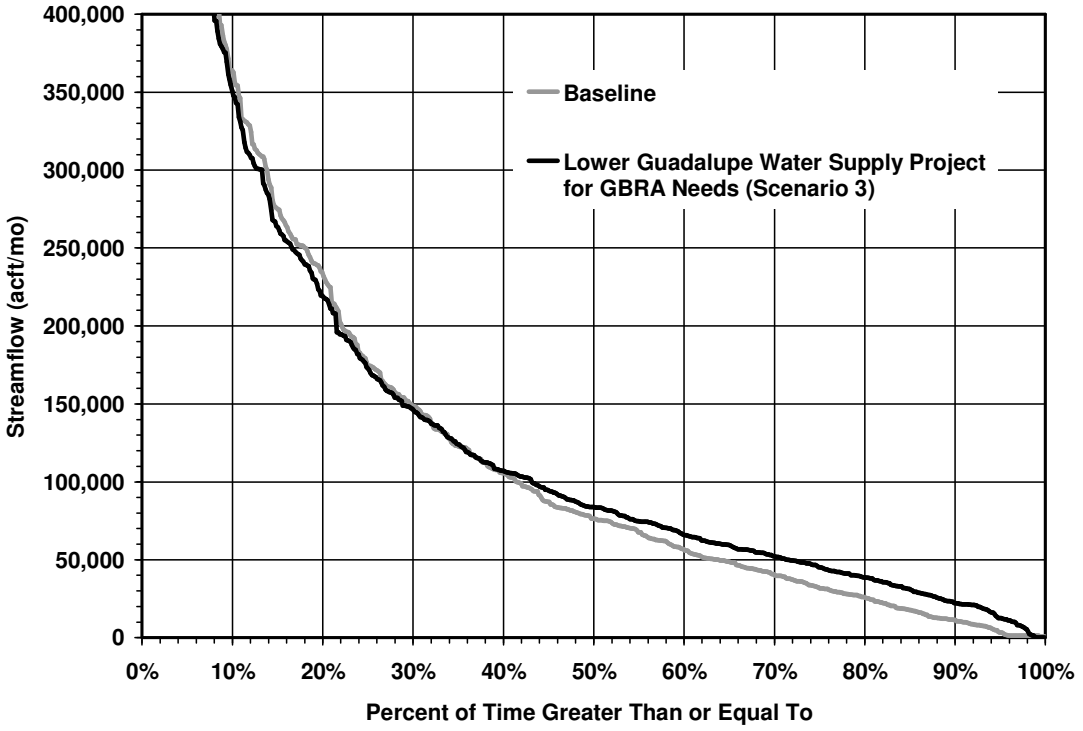


Figure 3-4. Freshwater Inflow Frequency to the Guadalupe Estuary – Scenario 3

4.0 Engineering and Costing

The firm yield diversion from the off-channel reservoir used for costing purposes is assumed to be a uniform rate throughout the year. Major facilities required to implement this water management strategy include:

- Canal Intake and Pump Station;
- Transmission Pipeline to Off-Channel Storage;
- Off-Channel Storage;
- Reservoir Intake and Pump Station at Off-Channel Storage;
- Raw Water Transmission Pipeline to Luling;
- Raw Water Pipeline to Lake Dunlap;
- Raw Water Pipeline to New Braunfels;
- Raw Water Pipeline to Western Canyon Project;
- Transmission Lift Stations;
- New or Expanded Water Treatment Plants (Level 3) at Luling, near Lake Dunlap, near San Marcos, at New Braunfels, and at the Western Canyon Project;
- Treated or Raw Water Pipeline from Lake Dunlap to San Marcos;
- Well Fields in Calhoun and Gonzales Counties (Scenario 2 only);
- Brackish Groundwater Treatment Plant (Scenario 2 only);
- Brine Disposal Pump Station and Pipeline (Scenario 2 only);
- Groundwater (Iron and Manganese Removal) Treatment Plant (Scenario 2 only); and
- Integration.

The canal intake and pump station are sized to deliver up to 187 cfs through a 3-mile, 96-inch diameter pipeline to an off-channel storage facility in Calhoun County. While a specific off-channel storage facility site has not been selected, it is assumed that an off-channel storage site could be located within three miles of the Calhoun Canal System.

It is important to note that, according to the 2006 SCTRWP, Year 2060 water needs in the upper and middle Guadalupe Basin total about 38,000 acft/yr. The LGWSP for GBRA Needs project is sized to meet up to 60,000 acft/yr, approximately 22,000 acft/yr more than the projected needs. This 22,000 acft/yr, delivered as raw water to Lake Dunlap, is held in reserve to meet needs beyond the Year 2060 projected timeline. For consistency, however, cost estimates include treatment and integration costs for this 22,000 acft/yr.

Scenario 2 includes an element of brackish groundwater desalination from Calhoun County. During a peak day of operation, the desalination water treatment plant will produce about 6.86 MGD of brine for disposal with a total dissolved solids (TDS) concentration of about

8,000 mg/L. This concentration is slightly less than the median salinity of about 10,000 mg/L of water in San Antonio Bay near Seadrift, where the brine disposal water would be discharged offshore.

The estimated costs of the LGWSP for GBRA Needs Scenario 1 are presented in Table 4-1. The estimated total project cost, which includes contingencies, is $804,679,000 in Second Quarter 2007 dollars. With a total annual cost of $90,332,000 and an available project yield of 60,000 acft/yr, the resulting unit cost is $1,506 per acft. The long-term, post-debt service cost of the project is $536 per acft.

If GBRA chose to meet the yield of the project from the more senior, firm portions of their existing water rights in the lower basin, high capacity diversion facilities from the Calhoun Canal System and an off-channel storage facility might not be necessary. The resulting unit cost would be $1,423 per acft, or about $83 per acft less than that presented in Table 4-1.

The estimated costs of the LGWSP for GBRA Needs Scenario 2 are presented in Table 4-2. The estimated total project cost, which includes contingencies, is $962,282,000 in Second Quarter 2007 dollars. With a total annual cost of $105,966,000 and an available project yield of 60,000 acft/yr, the resulting unit cost is $1,766 per acft. The long-term, post-debt service cost of the project is $611 per acft.

The LGWSP for GBRA Needs is unable to produce a firm yield of 60,000 acft/yr under Scenario 3. Even with off-channel storage of 250,000 acft, the resulting firm yield with a maximum annual diversion of 75,000 acft/yr is only 4,250 acft/yr, far below the desired 60,000 acft/yr. In discussions with GBRA staff and the Region L Staff Workgroup, it was decided that preparing a cost estimate for Scenario 3 would be futile, as Scenario 3 does not provide for a viable project. Therefore, costs for Scenario 3 were not prepared.

Table 4-1. .
Cost Estimate Summary for
Lower Guadalupe Water Supply Project for GBRA Needs Scenario 1
(Second Quarter 2007 Prices)

Item	*Estimated Costs for Facilities*
Capital Costs	
Canal Intake and Pump Station	$8,766,000
Transmission Pipeline to OCS (96 in dia., 3 miles)	$10,060,000
Off-Channel Storage Reservoir (Conservation Pool 19,000 acft, 950 acres, 52 ft. msl)	$32,450,000
Intake and Pump Station at OCS (56.3 MGD)	$15,566,000
Transmission Pipeline to Luling (60 in dia., 112 miles)	$239,111,000
Transmission Pipeline to Lake Dunlap (54 in dia., 27 miles)	$36,221,000
Transmission Pipeline to New Braunfels (33 in dia., 6 miles)	$5,939,000
Transmission Pipeline to Western Canyon Project (20 in dia., 15 miles)	$9,645,000
Transmission Booster Stations	$35,087,000
Spur Pipeline to Luling WTP (16 in dia., 1 mile)	$393,000
Spur Pipeline to San Marcos WTP (27 in dia., 20 miles)	$9,039,000
Spur Pipeline to New Braunfels WTP (27 in dia., 1 mile)	$555,000
Luling WTP Expansion (4 MGD)	$5,329,000
San Marcos WTP Expansion (11 MGD)	$10,952,000
New Braunfels WTP Expansion (14 MGD)	$14,209,000
Western Canyon WTP Expansion (6 MGD)	$5,772,000
New WTP at Lake Dunlap (20 MGD)*	$25,771,000
Integration (53.6 MGD)	$69,263,000
Total Capital Cost	**$534,128,000**
Engineering, Legal Costs and Contingencies	$171,397,000
Environmental & Archaeology Studies and Mitigation	$6,391,000
Land Acquisition and Surveying (1,817 acres)	$9,924,000
Interest During Construction (3 years)	$82,839,000
Total Project Cost	**$804,679,000**
Annual Costs	
Debt Service (6 percent, 30 years)	$54,887,000
Reservoir Debt Service (6 percent, 40 years)	$3,268,000
Operation and Maintenance	
Intake, Pipeline, Pump Station	$5,162,000
Dam and Reservoir	$487,000
Water Treatment Plant	$7,857,000
Pumping Energy Costs (153,952,955 kW-hr @ 0.09 $/kW-hr)	$13,856,000
Purchase of Water (64,198 acft/yr @ 75 $/acft)	$4,815,000
Total Annual Cost	**$90,332,000**
Available Project Yield (acft/yr)	60,000
Annual Cost of Water ($ per acft)	$1,506
Annual Cost of Water ($ per 1,000 gallons)	$4.62

**The 20 MGD WTP at Dunlap is a placeholder for the treatment plant necessary once the need for the water exists.*

Table 4-2.
Cost Estimate Summary for
Lower Guadalupe Water Supply Project for GBRA Needs Scenario 2
(Second Quarter 2007 Prices)

Item	*Estimated Costs for Facilities*
Capital Costs	
Canal Intake and Pump Station	$8,766,000
Transmission Pipeline to OCS (96 in dia., 3 miles)	$10,060,000
Off-Channel Storage Reservoir (Conservation Pool 51,500 acft, 2,575 acres, 52 ft. msl)	$58,926,000
Intake and Pump Station at OCS (56.3 MGD)	$15,566,000
Transmission Pipeline to Luling (60 in dia., 112 miles)	$239,111,000
Transmission Pipeline to Lake Dunlap (54 in dia., 27 miles)	$36,221,000
Transmission Pipeline to New Braunfels (33 in dia., 6 miles)	$5,939,000
Transmission Pipeline to Western Canyon Project (20 in dia., 15 miles)	$9,645,000
Transmission Booster Stations	$35,087,000
Spur Pipeline to Luling WTP (16 in dia., 1 mile)	$393,000
Spur Pipeline to San Marcos WTP (27 in dia., 20 miles)	$9,039,000
Spur Pipeline to New Braunfels WTP (27 in dia., 1 mile)	$555,000
Well Fields	$40,949,000
Groundwater Treatment	$25,180,000
Brine Disposal Pump Station and Pipeline	$7,553,000
Luling WTP Expansion (4 MGD)	$5,329,000
San Marcos WTP Expansion (11 MGD)	$10,952,000
New Braunfels WTP Expansion (14 MGD)	$14,209,000
Western Canyon WTP Expansion (6 MGD)	$5,772,000
New WTP at Lake Dunlap (20 MGD) *	$25,771,000
Integration (53.6 MGD)	$69,263,000
Total Capital Cost	**$634,286,000**
Engineering, Legal Costs and Contingencies	$205,377,000
Environmental & Archaeology Studies and Mitigation	$10,724,000
Land Acquisition and Surveying (3,527 acres) **	$13,558,000
Interest During Construction (3 years)	$98,337,000
Total Project Cost	**$962,282,000**
Annual Costs	
Debt Service (6 percent, 30 years)	$63,059,000
Reservoir Debt Service (6 percent, 40 years)	$6,266,000
Operation and Maintenance	
Intake, Pipeline, Pump Station	$5,624,000
Dam and Reservoir	$884,000
Water Treatment Plant	$10,687,000
Pumping Energy Costs (160,428,214 kW-hr @ 0.09 $/kW-hr)	$14,619,000
Purchase of Water (64,358 acft/yr @ 75 $/acft) **	$4,827,000
Total Annual Cost	**$105,966,000**
Available Project Yield (acft/yr)	60,000
Annual Cost of Water ($ per acft)	$1,766
Annual Cost of Water ($ per 1,000 gallons)	$5.42

**The 20 MGD WTP at Dunlap is a placeholder for the treatment plant necessary once the need for the water exists.*

***Purchase of water cost for groundwater estimated using the cost necessary to procure land for the well fields.*

5.0 Implementation Issues

Institutional arrangements may be needed to implement the project, potentially including financing on a regional basis.

1. It will be necessary to obtain the following:
   a. TCEQ Storage Permits.
   b. USCE Sections 10 and 404 Dredge and Fill Permits for the reservoir and pipelines.
   c. GLO Sand and Gravel Removal permits.
   d. GLO Easement for use of state-owned land.
   e. Coastal Coordination Council review.
   f. TPWD Sand, Gravel, and Marl permit.
   g. Groundwater production permits in Calhoun and Gonzales Counties (Scenario 2 only).
2. Permitting may require these studies:
   a. Assessment of changes in freshwater inflows to bays and estuaries.
   b. Habitat mitigation plan.
   c. Environmental studies.
   d. Cultural resource studies and mitigation.
3. Land will need to be acquired through either negotiations or condemnation.
4. Relocations for the off-channel storage facilities may include:
   a. County roads.
   b. Other utilities.
   c. Product transmission pipelines.
   d. Power transmission lines.

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6.0 Evaluation of Potential Economic Impacts in the Terminus and Source Areas

The evaluation of potential economic impacts in the terminus and source areas is performed using three calculations:

(1) Calculation of estimates of direct economic values that would be lost as a result of not meeting projected shortages (unmet needs) in the terminus areas of the Lower Guadalupe Water Supply Project for GBRA Needs (LGWSP for GBRA Needs);
(2) Calculation of economy-wide indirect economic values foregone through failure to meet the projected needs of the direct water users (beneficiaries) in the terminus areas of the LGWSP for GBRA Needs;
(3) Calculation of economic impacts in the source area of the LGWSP for GBRA Needs, including direct, indirect, and induced economic impacts of project construction in the source area.

Data for the evaluations are the water needs (shortages) and cost estimates, as presented in Section 4, and from the economic multipliers developed by the TWDB, as expressed for the Water User Groups (WUGs) and construction and associated sectors of the economy.[3] It is important to note that, in accordance with water planning policies of the TWDB and Region L, projected local needs are met from potential local sources of supply, and that only quantities of supply projected to be surplus to the source area projected year 2060 needs are considered for transmission to terminus areas of need.

6.1 Terminus Area Needs to be Met from LGWSP for GBRA Needs

The areas to which LGWSP for GBRA Needs water is to be delivered are located in parts of Caldwell, Comal, Hays (IH-35 Corridor), and Kendall Counties. Long-term needs and economic impacts associated with the 22,000 acft/yr delivered to the Lake Dunlap area in Guadalupe County (but not assigned to ultimate terminus areas) are not included. WUGs of these areas with needs (shortages) are Lockhart and Luling in Caldwell County, New Braunfels in Comal County, Kyle, Buda, Goforth WSC, and Rural areas of Hays County, and customers of the Western Canyon Project, which includes Kendall County Rural areas, Bulverde, and Comal County Rural areas. The needs to be met are municipal water shortages, including commercial and individual household uses, the total of which is projected at 12,250 acft/yr in 2020, increasing to 22,622 acft/yr in 2040, and 34,691 acft/yr in 2060 (Table 6-1).

[3] Economic multipliers used in the calculation of economic and social impacts of not meeting needs are from the 2006 South Central Texas Regional Water Plan, Appendix E, January 2006.

Projected needs in Caldwell County in 2020 are 1,295 acft/yr, and increase to 3,870 acft/yr in 2060, with supplies from the LGWSP for GBRA Needs at 4,000 acft/yr for the period 2020 through 2060. Projected needs in Comal County in 2020 are 1,462 acft/yr, and increase to 14,475 acft/yr in 2060, with supplies from the LGWSP for GBRA Needs at 14,000 acft/yr for the period 2020 through 2060. Projected needs in Hays County in 2020 are 6,740 acft/yr, and increase to 12,379 acft/yr in 2060, with supplies from the LGWSP for GBRA Needs at 13,000 acft/yr for the period 2020 through 2060 (Table 6-1).

Customers of the Western Canyon Project, including Kendall County Rural areas, the City of Bulverde, and Rural areas of Comal County have a projected need of 2,753 acft/yr in 2020, increasing to 3,967 acft/yr in 2060. The LGWSP supply available to the Western Canyon Project is 7,000 acft/yr for the period 2020 through 2060 (Table 6-1).

6.2 Estimates of Direct and Economy-Wide Indirect Economic Values and Water Utility Values of Failure to Meet Projected Needs in the Terminus Area of the LGWSP for GBRA Needs

The projected water needs in the terminus area are for municipal purposes, which includes commercial business establishments and households and institutions that use water to meet human needs. In the case of commercial establishments, water is used for activities such as restaurants, hotels, motels, laundries, nurseries, car washes, and professional offices. In the case of human needs, water is used in homes and institutions for drinking, food preparation, dish washing, clothes washing, bathing, toilets, landscape and lawn watering, swimming pools, hot tubs, fire protection, and public area sanitation. For purposes of this analysis, this water is labeled as "Household Water Use." According to TWDB estimates, 20 percent of municipal water use in the terminus area is for commercial purposes, and 80 percent is for household types of use. In the case of the LGWSP for GBRA Needs terminus area projected needs, the direct

Table 6-1.
Projected Needs by County and WUGS (Shortages) in Terminus Areas and Projected Supplies Available from LGWSP for GBRA Needs by 2020*

	2010 (acft)	*2020 (acft)*	*2030 (acft)*	*2040 (acft)*	*2050 (acft)*	*2060 (acft)*
Caldwell County	NA**					
Lockhart	NA	984	1,519	2,070	2,615	3,175
Luling	NA	311	400	485	587	695
Municipal Shortage	NA	**1,295**	**1,919**	**2,555**	**3,202**	**3,870**
Supply from LGWSP	NA	**4,000**	**4,000**	**4,000**	**4,000**	**4,000**
Comal County						
New Braunfels	NA	**1,462**	**4,599**	**7,706**	**10,916**	**14,475**
Municipal Shortage	NA	**1,462**	**4,599**	**7,706**	**10,916**	**14,475**
Supply from LGWSP	NA	**14,000**	**14,000**	**14,000**	**14,000**	**14,000**
Hays County (IH-35 Corridor)						
City pf Kyle	NA	2,588	2,865	3,025	3,522	3,851
City of Buda	NA	1,120	1,120	1,120	1,120	1,120
Goforth WSC	NA	532	969	1,415	1,963	2,408
Other	NA	2,500	3,000	3,500	4,500	5,000
Municipal Shortage	NA	**6,740**	**7,954**	**9,060**	**11,105**	**12,379**
Supply from LGWSP	NA	**13,000**	**13,000**	**13,000**	**13,000**	**13,000**
Western Canyon WSP						
Kendall Co. -- Rural	NA	865	1,500	1,500	1,500	1,500
Kendall Co Subtotal	NA	865	1,523	2,049	2,592	3,042
Comal Co. -- City of Bulverde	NA	396	396	396	396	396
Comal Co. -- Rural	NA	1,492	1,211	1,405	1,770	2,071
Comal Co. Subtotal	NA	1,888	1,607	1,801	2,166	2,467
Municipal Shortage	NA	**2,753**	**3,107**	**3,301**	**3,666**	**3,967**
Supply from LGWSP	NA	**7,000**	**7,000**	**7,000**	**7,000**	**7,000**
Total Municipal Shortage	NA	**12,250**	**17,579**	**22,622**	**28,889**	**34,691**
Total Supply from LGWSP	NA	**38,000**	**38,000**	**38,000**	**38,000**	**38,000**

* Needs as presented in 2006 South Central Texas Regional Water Plan, Table 4A-1.

** NA means not applicable, since LGWSP not operational until 2020.

economic impacts of municipal water use are the values of products and/or potential services produced by commercial establishments of the economy (i.e., if the projected needs are not met, these are the direct economic values that can be expected to be foregone by the commercial

establishments that need the water). The economy-wide indirect economic values are the values of business that will be lost by those terminus area businesses that supply services, materials, and other inputs to the commercial establishments who need the water in the first place (i.e.; the businesses that do business with the commercial establishments of the terminus area). For this analysis, the economic value of water for household water use is set at water utility revenue rates (i.e.; value is the water utility revenue that would not be realized if the water is not available).

The projected municipal water needs of the terminus area of the LGWSP for GBRA Needs, as presented in Section 6.1, Table 6-1, above have been divided into commercial and household groups and are summarized for each county of the terminus area, with counties of the terminus area listed alphabetically in Table 6-2. The LGWSP for GBRA Needs is planned to meet only a part of needs of the counties listed. Estimates of direct and indirect economic impacts of not meeting these projected needs are computed based upon the unit values, in dollars per acre foot of unmet need, as computed from the 2006 South Central Texas Regional Water Plan, Appendix E (Table 6-2).

Estimates for those parts of each of the counties of the terminus area can be viewed in Table 6-2, and will not be stated in the text. Instead, the totals, as presented in the Terminus Area Total section of Table 6-2 will be stated, and are as follows: the total direct economic impacts for the terminus area of the LGWSP for GBRA Needs are estimated at $7.1 million per year in 2020, $13.3 million per year in 2040, and $27.8 million per year in 2060 (Table 6-2, with estimates rounded to nearest tenth of million dollars). The estimated total indirect economic impacts for the terminus area in 2020 are $3.6 million per year, in 2040 are $6.6 million per year, and in 2060 are $13.8 million per year (Table 6-2, with estimates rounded to nearest tenth of million dollars). The estimated total (direct plus indirect) economic impacts for the terminus area in 2020 are $10.7 million per year, in 2040 are $19.9 million per year, and in 2060 are $41.2 million per year (Table 6-2, with estimates rounded to nearest tenth of million dollars).

Table 6-2.
Projected Needs (Shortages) and Projected Economic Impacts
in Terminus Areas to be Supplied by LGWSP for GBRA Needs Beginning in 2020*

Terminus Locations	*Units*	*2010 NA***	*2020*	*2030*	*2040*	*2050*	*2060*
			(LGWSP Operational in 2020)				
Caldwell County							
Municipal Total	acft		1,295	1,919	2,555	3,202	3,870
Commercial 15 percent ***	acft		194	288	383	480	581
Household 85 percent ***	acft		1,101	1,631	2,172	2,722	3,290
Projected Economic Impacts							
Commercial Water Use							
Direct Economic Impact [1]	$/acft		460	366	344	481	599
Indirect Economic Impact [1]	$/acft		250	200	188	262	324
Direct Economic Impact	dollars		89,371	105,282	131,967	231,199	347,493
Indirect Economic Impact	dollars		48,628	57,426	71,982	125,829	188,020
Total Economic Impact	dollars		137,999	162,708	203,949	357,028	535,513
Household Water Use							
Water Utility Revenue Losses [1]	$/acft		1,164	1,205	1,241	1,248	1,251
Water Utility Revenue Losses	dollars		1,280,981	1,966,058	2,694,602	3,397,053	4,116,756
Total Economic Impacts			1,418,980	2,128,766	2,898,551	3,754,081	4,652,269
Comal County							
Projected Needs (Shortages)							
Municipal Total	acft		3,350	6,206	9,507	13,082	16,942
Commercial 15 percent ***	acft		503	931	1,426	1,962	2,541
Household 85 percent ***	acft		2,848	5,275	8,081	11,120	14,401
Projected Economic Impacts							
Commercial Water Use							
Direct Economic Impact [1]	$/acft		4,648	3,337	4,698	5,269	6,224
Indirect Economic Impact [1]	$/acft		2,283	1,639	2,307	2,587	3,057
Direct Economic Impact	dollars		2,335,783	3,106,825	6,699,374	10,339,477	15,817,080
Indirect Economic Impact	dollars		1,147,290	1,525,541	3,289,518	5,077,443	7,767,589
Total Economic Impact	dollars		3,483,072	4,632,367	9,988,892	15,416,920	23,584,669
Household Water Use							
Water Utility Revenue Losses [1]	$/acft		1,296	1,253	1,232	1,222	1,216
Water Utility Revenue Losses	dollars		3,689,090	6,610,133	9,954,163	13,584,451	17,507,950
Total Economic Impacts	dollars		7,172,162	11,242,500	19,943,055	29,001,371	41,092,619

Table 6-2 (Continued)

Terminus Locations	*Units*	*2010 NA***	*2020*	*2030*	*2040*	*2050*	*2060*
			(LGWSP Operational in 2020)				
Hays County IH-35 Corridor							
Municipal Total	acft		6,740	7,954	9,060	11,105	12,379
Commercial 15 percent ***	acft		1,011	1,193	1,359	1,666	1,857
Household 85 percent ***	acft		5,729	6,761	7,701	9,439	10,522
Projected Economic Impacts							
Commercial Water Use	(No estimates available for Hays County; values for Comal County were used)						
Direct Economic Impact [1]	$/acft		4,648	3,337	4,698	5,269	6,224
Indirect Economic Impact [1]	$/acft		2,283	1,639	2,307	2,587	3,057
Direct Economic Impact	dollars		4,699,455	3,981,903	6,384,383	8,776,937	11,557,055
Indirect Economic Impact	dollars		2,308,278	1,955,230	3,134,851	4,310,121	5,675,539
Total Economic Impact	dollars		7,007,733	5,937,133	9,519,234	13,087,058	17,232,594
Household Water Use	(No estimates available for Hays County; values for Comal County were used)						
Water Utility Revenue Losses [1]	$/acft		1,296	1,253	1,232	1,222	1,216
Water Utility Revenue Losses	dollars		7,422,228	8,471,963	9,486,139	11,531,519	12,792,523
Total Economic Impacts	dollars		14,429,962	14,409,095	19,005,373	24,618,577	30,025,117
Kendall County							
Projected Needs (Shortages)							
Municipal Total	acft		865	1,500	1,500	1,500	1,500
Commercial 10 percent ***	acft		87	150	150	150	150
Household 90 percent ***	acft		779	1,350	1,350	1,350	1,350
Projected Economic Impacts							
Commercial Water Use	(No estimates available for Kendall county; values for Medina County were used)						
Direct Economic Impact [1]	$/acft		272	306	333	356	389
Indirect Economic Impact [1]	$/acft		752	846	925	986	1,082
Direct Economic Impact	dollars		23,528	45,938	50,022	53,363	58,407
Indirect Economic Impact	dollars		65,064	126,914	138,696	147,860	162,268
Total Economic Impact	dollars		88,591	172,852	188,718	201,223	220,674
Household Water Use	(No estimates available for Kendall county; values for Medina County were used)						
Water Utility Revenue Losses [1]	$/acft		1,158	1,155	1,169	1,182	1,191
Water Utility Revenue Losses	dollars		901,889	1,559,175	1,578,605	1,595,887	1,607,771
Total Economic Impacts	dollars		990,480	1,732,027	1,767,324	1,797,110	1,828,446

Table 6-2 (Concluded)

Terminus Locations	*Units*	*2010 NA***	*2020*	*2030*	*2040*	*2050*	*2060*
			(LGWSP Operational in 2020)				
Terminus Area Total							
Municipal Total	acft		12,250	17,579	22,622	28,889	34,691
Commercial 15 percent ***	acft		1,794	2,562	3,318	4,258	5,129
Household 85 percent ***	acft		10,456	15,017	19,304	24,631	29,562
Projected Economic Impacts							
Commercial Water Use							
Direct Economic Impact	dollars		7,148,136	7,239,948	13,265,746	19,400,975	27,780,034
Indirect Economic Impact	dollars		3,569,260	3,665,112	6,635,048	9,661,254	13,793,416
Total Economic Impact	dollars		10,717,396	10,905,060	19,900,793	29,062,229	41,573,450
Household Water Use							
Water Utility Revenue Losses	dollars		13,294,188	18,607,328	23,713,509	30,108,909	36,025,000
Total Economic Impacts	dollars		24,011,584	29,512,389	43,614,303	59,171,138	77,598,451

* Needs as presented in 2006 South Central Texas Regional Water Plan, Table 4A-1.

** NA means not applicable, since LGWSP not operational until 2020.

*** TWDB estimated proportion of municipal water used for commercial purposes ranges from 5 to 35 percent of total municipal water use at the county level, with less populated counties at the lower end of the range, and larger metropolitan counties at the high end. Estimates used in this analysis are selected near the low end of the range, since much of the area to be supplied is in the county other or unincorporated areas of the counties.

[1] Economic impacts are from the 2006 South Central Texas Regional Water Plan, Appendix E, January 2006.

The estimated water utility revenues that would be foregone if household water needs of the terminus area are not met are $13.3 million per year in 2020, $23.7 million per year in 2040, and $36.0 million per year in 2060 (Table 6-2, with estimates rounded to nearest tenth of million dollars).

The estimated total of the direct economic impact, indirect economic impact and water utility revenues that would be foregone if household water needs of the terminus area are not met are $24.0 million per year in 2020, $43.6 million per year in 2040, and $77.6 million per year in 2060 (Table 6-2, with estimates rounded to nearest tenth of million dollars).

6.3 Estimates of Direct, Indirect and Induced Economic Impacts of LGWSP for GBRA Needs Construction in the Source Area

The LGWSP for GBRA Needs is proposed to be constructed in Calhoun County, with the main pipeline extending through Victoria, DeWitt, Gonzales, and Guadalupe Counties, spur extensions of pipelines from the main line to Luling, San Marcos, New Braunfels, and points in Comal County to serve customers of the Western Canyon Project, water treatment plant expansions at Luling, San Marcos, New Braunfels, and the Western Canyon Project in Comal

County, a new water treatment plant at Lake Dunlap, and integration into each respective receiving system (Figure 1-1). The capital cost of the LGWSP for GBRA Needs, including construction of the diversion, off-channel storage reservoir, pump stations, transmission lines, water treatment plant expansions, a new water treatment plant, integration, engineering, legal, environmental and archeological studies and mitigation, land acquisition and surveying, and interest during construction is estimated at $804,679,000 (Table 4-1). A part of the project construction cost will be spent within the area where construction is to occur, however, a large part of the cost will be paid to suppliers of materials and services that are located outside the construction area(s). Only that part of project construction cost that is paid to local area suppliers is the basis for local or source area economic impacts. The project construction expenditures will be made during the 3-year estimated construction period, and are a one time economic impact.

For purposes of this analysis, the capital costs of the LGWSP for GBRA Needs are expressed in terms of major types of expenditures, with estimates of percent of each that would be paid to local suppliers (Table 6-3). In the case of diversion works and pipelines, it is estimated that 18 percent of total expenditures would be made to local suppliers, including labor hired locally, for water treatment plant construction, it is estimated that 12 percent of the total would be paid to local suppliers, including labor hired locally, and for integration into local water distribution systems, it is estimated that 56 percent of the total cost would be paid to local suppliers, including locally hired labor (Table 6-3).

Table 6-3.
LGWSP for GBRA Needs Cost Allocation to Local Suppliers of Source Area

Major Types of Project Construction Costs	*Percent of Total Cost **	*Percent to Local Suppliers ***		
		Diversion Works & Pipelines	*Water Treatment Plants*	*Integration to Local Systems*
Labor	19	4	3	14
Materials - concrete, rebar, pipe, pumps, motors,	40	3	2	10
Construction equipment and operation	8	1	1	6
Fuel	5	3	3	4
Subcontractors - electrical, plumbing, carpenters, masonry	20	6	2.5	16
Management, supervision, administration	8	1	0.5	6
Total	100	18	12	56
Source: HDR Design-Build, Inc.				

Operation and maintenance costs are annual costs which begin upon completion of the LGWSP for GBRA Needs, with estimates of payments to local suppliers and employees of 70 percent of total operation and maintenance.

The percentages shown in Table 6-3, along with the 70 percent for operation and maintenance will be used to compute estimates of the economic impact of the LGWSP construction and operation upon the source area economy.

The LGWSP for GBRA Needs, Scenerio 1 cost estimate of Table 4-1 has been expressed below in Table 6-4 in terms of county of location of each major element, the percent of total cost paid or spent locally, has been calculated, and to each local expenditure, economic impact multipliers shown in the box below have been applied to calculate the direct and indirect and the direct, indirect and induced economic impacts of the local expenditures.

Sector	***Multipliers***	
	Type I	***Type II***
Water, Sewer, and Pipeline Construction	1.21	1.49
Water, Sewage, and Other Systems	1.14	1.49
Other State and Local Government Enterprises	1.40	1.63
Multipliers are from TWDB economic model of the counties where the LGWSP is to be located.		

Type I multipliers give the total business impact per dollar of direct expenditure for construction expenditure, while the Type II multipliers give the total business impact plus the business that is induced by personal income expenditures from the additional wages and salaries paid to employees of the area by the LGWSP for GBRA Needs construction activity. Estimates of economic impacts are presented in Table 6-4.

Total LGWSP for GBRA Needs construction cost is estimated at $804,679,000, of which $118,741,000 or 15 percent is estimated to be spent in the local area where construction is to occur (Table 6-4). The source area is Calhoun and Victoria Counties, in which total construction cost is estimated at $194,937,000, of which $35,089,000, or 18 percent is estimated to be spent with local suppliers of materials, labor and services (Table 6-4). The direct and indirect economic impact of construction of the LGWSP for GBRA Needs is estimated at $143,156,000, of which $42,457,000 or 30 percent is estimated to be in the Calhoun-Victoria source area (Table 6-4). The total direct, indirect and induced economic impact of construction of the

LGWSP is estimated at $176,701,000, of which $52,282,000 or 30 percent is estimated to be in the Calhoun-Victoria source area (Table 6-4).

The annual operation and maintenance costs (O&M), including cost of water and energy are $90,332,000 if the LGWSP for GBRA Needs is operating at full capacity of 60,000 acft/yr. of which $5,649,000, or 6.2 percent are in the Calhoun-Victoria source area (Table 6-5). The estimated total annual O&M local area expenditures for the LGWSP for GBRA Needs, not including cost of water and energy, are estimated $9,454,000, of which $3,948,000 or 42 percent is estimated to occur in the Calhoun-Victoria source area (Table 6-5). The direct and indirect economic impact of O&M of the LGWSP for GBRA Needs is estimated at $12,826,000, of which $5,536,000, or 43 percent is estimated to be in the Calhoun-Victoria source area, and the total direct, indirect, and induced economic impact of O&M of the LGWSP is estimated at $15,410,000, of which $6,446,000, or 42 percent is estimated to be in the Calhoun-Victoria source area (Table 6-5).

Table 6-4.
Projected Economic Impacts in Source Areas of Lower Guadalupe Water Supply Project for GBRA Needs

Project Implementation Expenditures (Basis for Source Area Economic Benefits)	Locations where Facilities to be Constructed (Counties Impacted)	Total Costs (1,000 $s)	Percent of Total Spent Locally (percent)	Total Costs Spent Locally (1,000 $s)	Multipliers: Direct & Indirect (Type I)	Multipliers: Direct, Indirect, & Induced (Type II)	Economic Impacts: Direct & Indirect (I) (1,000 $s)	Economic Impacts: Direct, Indirect, & Induced (II) (1,000 $s)
Capital Costs								
Canal Intake and Pump Station	Calhoun and Victoria	8,766	18%	1,578	1.21	1.49	1,909	2,351
Transmission Pipeline to OCS (96 in dia., 3 miles)	Calhoun and Victoria	10,060	18%	1,811	1.21	1.49	2,191	2,698
Off-channel Storage Reservoir (18,500 acft, 925 acres)	Calhoun and Victoria	32,450	18%	5,841	1.21	1.49	7,068	8,703
Intake and Pump Station at OCS (56.3 MGD)	Calhoun and Victoria	15,566	18%	2,802	1.21	1.49	3,390	4,175
Transmission Pipeline to Luling (60 in dia., 112 miles)	239,111 (total)							
A. (60 in dia., 60 miles)	Calhoun and Victoria	128,095	18%	23,057	1.21	1.49	27,899	34,355
Calhoun and Victoria Source Area Subtotal of Economic Impacts		**194,937**		**35,089**			**42,457**	**52,282**
B. (60 in dia., 27 miles)	DeWhitt	57,643	18%	10,376	1.21	1.49	12,555	15,460
C. (60 in dia., 25 miles)	Gonzales	53,373	18%	9,607	1.21	1.49	11,625	14,315
Transmission Pipeline to Lake Dunlap (54 in dia., 27 miles)	Guadalupe	36,221	18%	6,520	1.21	1.49	7,889	9,714
Transmission Pipeline to New Braunfels (33 in dia., 6 miles) ($	5,939 (total)							0
A. (33 in dia., 4 miles)	Guadalupe	3,959	18%	713	1.21	1.49	862	1,062
B. (33 in dia., 2 miles)	Comal	1,980	18%	356	1.21	1.49	431	531
Transmission Pipeline to Western Canyon Project (20 in dia.,15 miles)	Comal	9,645	18%	1,736	1.21	1.49	2,101	2,587
Transmission Lift Stations	35,087 (total)							
A. Near Cuero	DeWitt	11,698	18%	2,106	1.21	1.49	2,548	3,137
B. Near Luling	Guadalupe	18,262	18%	3,287	1.21	1.49	3,977	4,898
C. West of Lake Dunlap	Comal	5,127	18%	923	1.21	1.49	1,117	1,375
Spur Pipeline to Luling WTP (16 in dia., 1 mile)	Guadalupe	393	18%	71	1.21	1.49	86	105
Spur Pipeline to San Marcos WTP (27 in dia., 20 miles)	Guadalupe	9,039	18%	1,627	1.21	1.49	1,969	2,424
Spur Pipeline to New Braunfels WTP (27 in dia., 1 mile)	Comal	555	18%	100	1.21	1.49	121	149
Luling WTP Expansion (4 MGD)	Guadalupe	5,329	12%	639	1.14	1.46	729	934
San Marcos WTP Expansion (11 MGD)	Hays	10,952	12%	1,314	1.14	1.46	1,498	1,919
New Braunfels WTP Expansion (14 MGD)	Comal	14,209	12%	1,705	1.14	1.46	1,944	2,489
Western Canyon WTP Expansion (6 MGD)	Comal	5,772	12%	693	1.14	1.46	790	1,011
New WTP at Lake Dunlap (20 MGD)*	Guadalupe	25,771	12%	3,093	1.14	1.46	3,525	4,515
Integration (35 MGD)	69,263 (total)							
A. Luling System (4 MGD)	Caldwell	7,916	56%	4,433	1.21	1.49	5,364	6,605
B. San Marcos System (11 MGD)	Hays	21,768	56%	12,190	1.21	1.49	14,750	18,164
C. New Braunfels System (14 MGD)	Comal	27,705	56%	15,515	1.21	1.49	18,773	23,117
D. Western Canyon System (6 MGD)	Comal	11,874	56%	6,649	1.21	1.49	8,046	9,907
Total Capital Costs		**534,128**		**118,741**			**14,156**	**176,701**
Engineering, Legal, and Contingency Costs	Outside the Area	171,397	0	0	NA	NA	0	0
Environmental & Archaeology Studies and Mitigation	Outside the Area	6,391	0	0	NA	NA	0	0
Land Acquisition and Surveying Services (1,786 acres)	Outside the Area	9,924	0	0	NA	NA	0	0
Interest During Construction (3 years)	Outside the Area	82,839	0	0	NA	NA	0	0
Total Project Costs		**804,679**		**118,741**			**143,156**	**176,701**

Table 6-5.
Projected Economic Impacts of Operation and Mainentance of Lower Guadalupe Water Supply Project for GBRA Needs

Project Operation and MaintenanceExpenditures (Basis for Source Area Economic Benefits)	Locations where Operations and Maintance to Occur (Counties Impacted)	Total Costs (1,000 $s)	Percent of Total Spent Locally (percent)	Total Costs Spent Locally (1,000 $s)	Multipliers		Economic Impacts	
					Direct & Indirect (Type I)	Direct, Indirect, & Induced (Type II)	Direct & Indirect (I) (1,000 $s)	Direct, Indirect, & Induced (II) (1,000 $s)
Annual Costs								
Debt Service (6 percent, 30 years)	Outside the Area	54,887	0	0	NA	NA	0	0
Reservoir Debt Service (6 percent, 40 years)	Outside the Area	3,268	0	0	NA	NA	0	0
Operation and Maintenance								
Intake, Pipeline, Pump Station	Calhoun and Victoria	5,162	70%	3,613	1.4	1.63	5,059	5,890
Dam and Reservoir	Calhoun and Victoria	478	70%	341	1.4	1.63	477	556
Calhoun and Victoria Source Area Subtotal of Economic Impacts		**5,649**		**3,954**			**5,536**	**6,446**
Water Treatment Plants	5,604 (total)							0
Luling WTP Expansion (4 MGD)	Guadalupe	641	70%	449	1.4	1.63	628	731
San Marcos WTP Expansion (11 MGD)	Hays	1,761	70%	1,233	1.4	1.63	1,726	2,009
New Braunfels WTP Expansion (14 MGD)	Comal	2,241	70%	1,569	1.4	1.63	2,196	2,557
Western Canyon WTP Expansion (6 MGD)	Comal	961	70%	673	1.4	1.63	942	1,097
New WTP at Lake Dunlap (20 MGD)*	Guadalupe	2,253	70%	1,577	1.14	1.63	1,798	2,571
Purchase of Water (@$75/acft) *	4,815 (total)							
Year 2020 13,455 acft $1,009,125	GBRA Service Area	f/q per year *	NA	NA	NA	NA	NA	NA
Year 2030 17,878 acft $1,340,850	GBRA Service Area	f/q per year	NA	NA	NA	NA	NA	NA
Year 2040 22,078 acft $1,655,850	GBRA Service Area	f/q per year	NA	NA	NA	NA	NA	NA
Year 2050 27,333 acft $2,049,975	GBRA Service Area	f/q per year	NA	NA	NA	NA	NA	NA
Year 2060 32,070 acft $2,405,250	GBRA Service Area	f/q per year	NA	NA	NA	NA	NA	NA
Pumping Energy Costs (@$0.09/kW-hr) ($230.93/acft) *	13,856 (prorated)							
Year 2020 13,455 acft $3,107,329	Outside the Area	f/q per year	NA	NA	NA	NA	NA	NA
Year 2030 17,878 acft $4,128,522	Outside the Area	f/q per year	NA	NA	NA	NA	NA	NA
Year 2040 22,078 acft $5,098,414	Outside the Area	f/q per year	NA	NA	NA	NA	NA	NA
Year 2050 27,333 acft $6,312,098	Outside the Area	f/q per year	NA	NA	NA	NA	NA	NA
Year 2060 32,070 acft $7,405,942	Outside the Area	f/q per year	NA	NA	NA	NA	NA	NA
Total Annual Costs (Beginning in Year 2020 at full Capacity)		**90,332**		**9,454**			**12,826**	**15,410**

*Placeholder for necessary treatment plant when need arises.
f/q (function of quantity each year; see left most colume for quantities and values at decadal points in time.).

Appendix A
Comments from Texas Water Development Board and Responses

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ATTACHMENT 1

TWDB Contract No. 0704830697

Region L, Region-Specific Studies 1-5:

TWDB Comments on Draft Final Region-Specific Study Reports:
1) Lower Guadalupe Water Supply Project for GBRA Needs
2) Brackish Groundwater Supply Evaluation
3) Enhanced Water Conservation, Drought Management and Land Stewardship
4) Environmental Studies
5) Environmental Evaluations of Water Management Strategies

Region-Specific Study 1: Lower Guadalupe Water Supply Project for GBRA Needs

1. Page 21: Please note in the report why median inflow graphs are presented for scenarios 2 and 3 but are not required for scenario 1.

Response – The following sentence will be added to the discussion paragraph: *"Thus graphics showing median inflow and flow frequency are not necessary, as the median values for both Baseline and Lower Guadalupe Water Supply Project for GBRA needs would be equal in all months."*

2. Page 29, bullet number 3: please provide the basis for the assumption that "economic impacts" at the source area are "(benefits)". Please address whether or not there may be potential negative economic impacts and quantify these, if anticipated, in accordance with Task 6 of the Scope of Work.

Response – "Benefits" is equated to "economic impacts" in an illustrative sense in that the value of the goods and services involved are useful to the population. The parenthetic "(benefits)" will be removed. The use of the term has no effect upon the analysis.

3. Page 30: please clarify in section 6.2 that the economic values associated with the terminus impacts are calculated for a drought-of-record year.

Response – The economic values of shortages in the terminus areas are calculated for a drought-of-record year, in that the quantities of shortages (needs) to which the economic values are applied are the difference between projected demands for dry year conditions and projected quantities of water supply available in a repeat of the drought-of-record.

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