Region L
South Central Texas Regional Water Planning Group

c/o San Antonio River Authority
P.O. Box 839980
San Antonio, Texas 78283-9980

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www.RegionLTexas.org

November 24, 2014

David Meesey
Texas Water Development Board
1700 North Congress Avenue
P.O. Box 13231
Austin, TX 78711-3231

RE: Region L 2012 State Water Plan Amendment Request (GBRA Integrated Water-Power Project Minor Amendment)

Dear Mr. Meesey:

Over the past several months, the South Central Texas Regional Water Planning Group (Region L) considered changes to its 2011 Regional Water Plan.

In a letter dated April 30, 2014, the Guadalupe-Blanco River Authority (GBRA), a Wholesale Water Provider and Region L member, requested the support of the Planning Group of its proposal to add the Integrated Water-Power Project, formerly known as the GBRA Seawater Desalination Project, as a recommended water management strategy in the 2011 Regional Water Plan by way of minor amendment (enclosed).

At its August 7, 2014, meeting, the Planning Group authorized the San Antonio River Authority (SARA), as Administrator for Region L, to submit a request to the Executive Administrator of the Texas Water Development Board (TWDB) for pre-adoption review to determine whether the proposed amendment constitutes a minor amendment. In a letter dated August 20, 2014, I requested the pre-determination approval (enclosed). After reviewing the project package, the Executive Administrator confirmed in writing that adding GBRA's Integrated Water-Power Project as a recommended water management strategy to the 2011 Region L Regional Water Plan would constitute a minor amendment (enclosed).

Accordingly, on November 6, 2014, the Region L Planning Group held a public meeting. The meeting consisted of 1) a presentation by the technical consultants on the GBRA Integrated Water-Power Project as a minor amendment to the 2011 Region L Regional Water Plan, 2) a brief discussion among planning group members, and 3) an opportunity for public comment. During the public meeting, the planning group noted that the period for public comment would remain open until at least fourteen days after the public meeting, and to contact Cole Ruiz, San Antonio River Authority, for submittal of public comments. Mr. Ruiz's contact information was provided at the meeting and posted in accordance with 31 Tex. Admin. Code Section 357.21 two weeks prior to holding the public meeting. No public comments were submitted.

On November 6, 2014, the Region L Planning Group also held its regularly scheduled meeting, where the planning group approved amending the 2011 Region L Regional

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Water Plan to include GBRA's Integrated Water-Power Project as a recommended water management strategy. Additionally, the Regional L Planning Group authorized SARA, as the Administrator, to request TWDB to amend the 2012 State Water Plan by including GBRA's Integrated Water-Power Project as a recommended water management strategy.

Enclosed is the complete minor amendment package. This is Region L's request that GBRA's Integrated Water-Power Project be included as a recommended water management strategy in the 2012 State Water Plan.

Sincerely,

Con Mims
Chair, Region L

Enclosures: **Volume I** – Tracked or highlighted changes to the Executive Summary; Sections 4.B.1, 4.B.3, and 7; and Appendix D Tables 1, 2, and 3.
Volume II – New Section 4.C.37 (technical evaluation) and tracked changes to the Table of Contents.
Database – Additions to DB12.
Correspondence - GBRA Minor Amendment Request 4-30-2014; GBRA Seawater Desalination Response 5-13-2014; Amendment Request EA Determination (GBRA Integrated Water Power Project Proposed Minor Amendment); and TWDB Letter re Reg L request for minor amendment 10-21-14.

cc: Temple McKinnon, Regional Water Planning (TWDB)
Steve Raabe, PE, Director, Technical Services (SARA)
Brian Perkins, PE, Water Resources Engineer, HDR Engineering, Inc.

April 30, 2014

Mr. Con Mims, Chair
South Central Texas Regional Water Planning Group
c/o San Antonio River Authority
P.O. Box 839980
San Antonio, Texas 78283-9980

RE: Agenda Item for Next Region L Meeting – GBRA Seawater Desalination

Dear Chair Mims:

The Guadalupe-Blanco River Authority (GBRA), as a Wholesale Water Provider, continues to evaluate seawater desalination program options, and in partnership with the General Land Office and the University of Texas at San Antonio has engaged a team of consultants to identify the best facility location, most efficient water treatment and conveyance systems, potential fuel sources, safe brine disposal and other issues, including environmental, economic, and construction timelines. The results of these ongoing studies will be considered during development of the 2016 Region L Plan. GBRA is appreciative that its seawater desalination project (i.e., Integrated Water-Power Project) is scheduled for technical evaluation as part of 2016 Region L Plan development and further requests that this seawater desalination project be a recommended water management strategy in the 2016 Region L Plan and the 2017 State Water Plan.

GBRA is currently pursuing financing options and requests inclusion of its seawater desalination project as a recommended strategy in the 2011 Region L Plan and the 2012 State Water Plan for financing eligibility. Pursuant to Texas Administrative Code, Title 31, Part 10, Chapter 357, Sub-chapter E, Rule §357.51(c), GBRA respectfully requests the support of the Regional Water Planning Group in accomplishing this minor amendment. GBRA will provide a copy of the proposed amendment to you in the near future for submittal to the Executive Administrator of the Texas Water Development Board for determination that the proposed amendment is minor. Furthermore, we respectfully request that you schedule the required public meeting regarding the proposed amendment to be held during the first regularly scheduled quarterly meeting of the RWPG after receipt of the Executive Administrator's determination.

Sincerely,

W. E. West, Jr.
General Manager

Main Office: 933 East Court Street ~ Seguin, Texas 78155
830-379-5822 ~ 800-413-4130 ~ 830-379-9718 fax ~ www.gbra.org

GBRA Guadalupe-Blanco River Authority
flowing solutions

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May 13, 2014

Mr. Bill West, General Manager
Guadalupe-Blanco River Authority
933 East Court Street
Seguin, Texas 78155

RE: Agenda Item for August 2014 Region L Meeting – GBRA Seawater Desalination

Dear Mr. West,

In accordance with Texas Administrative Code §357.51(a), the Region L Planning Group will place the Guadalupe-Blanco River Authority's Seawater Desalination amendment request on the agenda for the next scheduled meeting on August 7, 2014. The Regional Water Planning Group (RWPG) will formally consider appropriate action on submitting the proposed amendment to the Executive Administrator (EA) of the Texas Water Development Board for determination on the amendment as *minor* pursuant to the criteria set forth by the "EA Pre-Adoption Review" [Texas Administrative Code §357.51(c)(2)]. Please submit the proposed amendment referenced in your letter by July 18th, 2014 so it can be included in the agenda packet for the August 7, 2014 RWPG meeting. Upon receipt of the written notification from the EA and receipt of the required technical evaluation, the RWPG will schedule the required public meeting to take appropriate action on adopting the proposed amendment. The meeting to consider the adoption of the proposed amendment will be held during the first regularly scheduled quarterly RWPG meeting after receiving written notice from the EA and receipt of the required technical evaluation.

The technical evaluation requirement for recommended water management strategies to be included in both the Region L Plan and the State Water Plan has not yet been met for this proposed amendment. GBRA's Seawater Desalination project was not included in the 2011 plan either as a recommended or alternative strategy. A technical evaluation for the GBRA Seawater Desalination Project is scheduled to be completed within the timeframe of the development of the 2016 Region L Plan. Should GBRA need or request that the technical evaluation be completed sooner than currently scheduled for the 2016 Region L Plan, GBRA will be responsible for the costs of the expedited evaluation.

I respectfully ask GBRA keep the RWPG informed about the progress of the project in order to efficiently coordinate our respective efforts throughout this process.

Sincerely,

Con Mims,
Chair, Region L

cc: David Meesey, Manager, Regional Water Planning (TWDB)
Steve Raabe, PE, Director, Technical Services (SARA)
Brian Perkins, PE, Water Resources Engineer, HDR Engineering, Inc.

Texas Water Development Board
P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

October 21, 2014

Mr. Con Mims
Region L Chair
Nueces River Authority
200 E. Nopal, Suite 206
Uvalde, Texas 78802

Re: Region L's written request, received August 20, 2014, for approval of a minor amendment to the 2011 Region L Regional Water Plan for the Guadalupe-Blanco River Authority (GBRA) Integrated Water Power Project (IWPP) as a new recommended water management strategy under 31 TAC §357.51(c).

Dear Chairman Mims:

The Texas Water Development Board (TWDB) has reviewed Region L's request for a minor amendment determination for the GBRA's Integrated Water-Power Project. According to the information submitted to TWDB, staff understands that the proposed amendment to the 2011 Region L Regional Water Plan:

- would assume delivery of 50,000 acre-feet/year of the total 100,000 acre-feet/year supply to Gonzales County;
- does not include in the $2,290 per acre-foot unit cost the additional costs of infrastructure that would be required to deliver the Gonzales County supply volume to water user groups; and,
- would not involve assignment of any portion of the additional Gonzalez County or Calhoun County water supply volumes to specific municipal or other water user groups in the regional plan (or, accordingly, the state water planning database (DB12)).

Based on Region L's request and supporting materials, TWDB has determined that adding GBRA's Integrated Water-Power Project as a recommended water management strategy constitutes a minor amendment under 31 TAC §357.51(c). If Region L adopts the proposed minor amendment, Region L will need to:

1. Provide the (TWDB) with documentation of the planning group action adopting this water management strategy as a minor amendment;
2. Issue and distribute an addendum to the 2011 Region L Regional Water Plan updating the plan accordingly;
3. Provide TWDB with corrected DB12 data to reflect all the associated changes to the 2011 Region L Regional Water Plan and the 2012 State Water Plan; and,

4. Request that the Guadalupe-Blanco River Authority obtain a web link from TWDB staff in order to fill out an associated online Infrastructure Financing Survey regarding how the entity plans to finance the projects associated with the amendment.

If Region L makes any substantive changes to the project components or configuration during the minor amendment process, TWDB will need to review the modified proposed amendment to ensure that the modified project still meets all of the criteria under 31 TAC §357.51(c).

If you have any questions concerning this approval or its associated requirements, please contact David Meesey, the Board's designated regional water planning project manager for this region.

Sincerely,

Kevin Patteson
Executive Administrator

cc: Ms. Suzanne Scott, General Manager, San Antonio River Authority
David Meesey, TWDB

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August 20, 2014

Kevin Patteson
Executive Administrator
Texas Water Development Board
1700 North Congress Avenue
P.O. Box 13231
Austin, TX 78711-3231

RE: Local Water Planning Amendment Request (GBRA Integrated Water-Power Project Proposed Minor Amendment)

Dear Mr. Patteson:

At its August 7, 2014 South Central Texas Regional Water Planning Group (Region L) meeting, the Planning Group considered specific changes to its 2011 Regional Water Plan.

Pursuant to Texas Administrative Code, Title 31, Part 10, Chapter 357, Sub-chapter C, Rule §357.51(c) the Guadalupe-Blanco River Authority (GBRA) requested the support of the Region L Planning Group for its proposal to add the Integrated Water-Power Project to the 2011 Regional Water Plan by way of "Minor Amendment."

At its August 7, 2014 meeting, the Planning Group authorized the San Antonio River Authority (SARA), as Administrator for Region L, to submit this request to you for pre-adoption review to determine if the proposed amendment is "minor" as defined by "Texas Administrative Code, Title 31, Part 10, Chapter 357, Sub-chapter C, Rule §357.51(c).

Subject to your determination, GBRA is expected to ask Region L to submit the amendment to the Texas Water Development Board (TWDB) at Region L's November 6, 2014 meeting.

On behalf of the Region L Planning Group, I hereby request your determination as to whether the proposed amendment is "minor," as defined by Texas Administrative Code.

In addition, confirmation should be obtained from the TWDB that, once you determine the type of amendment, the planning group can formally and finally adopt the amendment to the 2011 Regional Water Plan at the November 6, 2014 planning group meeting.

If you disagree with our assessment that this is a minor amendment, please let me know what type of amendment this should be.

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Should you have any questions, please contact Cole Ruiz at (210) 302-3293 or Brian Perkins at (512) 912-5173.

Sincerely,

Con Mims
Chair, Region L

Enclosure (1)

cc: David Meesey, Manager, Regional Water Planning (TWDB)
Steve Raabe, PE, Director, Technical Services (SARA)
Brian Perkins, PE, Water Resources Engineer, HDR Engineering, Inc.

GBRA Integrated Water Power Project (IWPP) Requested Amendment of the 2011 Region L Water Plan

- **Requested Amendment:**
  - Addition of a seawater desalination Water Management Strategy co-located with a power generation facility in Calhoun County, capable of delivering up to 100,000 acft/yr of treated water
  - GBRA seeks a minor amendment to the 2011 SCTRWP

DRAFT (8-7-14) 1

GBRA IWPP – Minor Amendment Determination

Per TWDB rules for regional water planning, an amendment is minor if it meets the following criteria:

A. **"Does not result in over-allocation of an existing or planned source of water"**
   - GBRA intends to divert seawater from the Gulf of Mexico. This source will not be over-allocated.

B. **"Does not relate to a new reservoir"**
   - The project does not include a new reservoir.

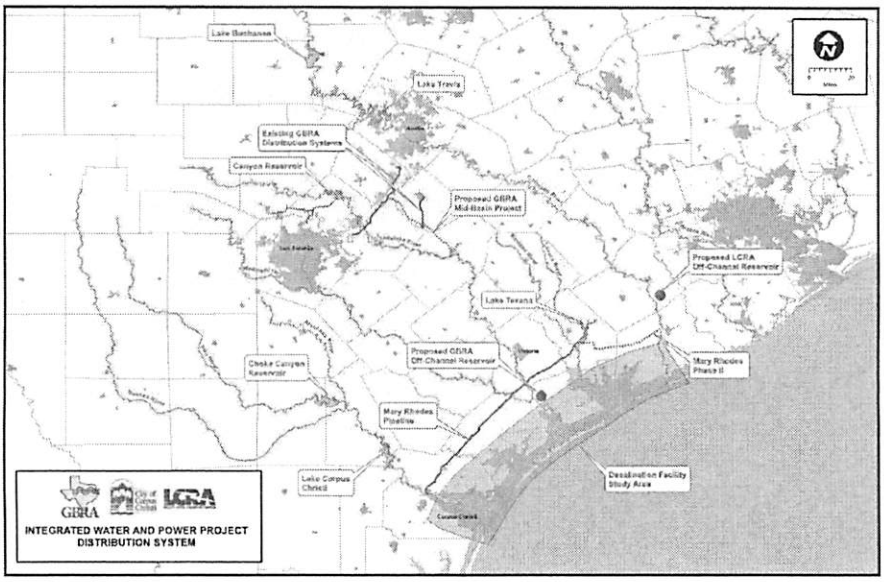
C. **"Does not have a significant effect on instream flows, environmental flows, or freshwater inflows to bays and estuaries"**
   - Given that the source water is Gulf of Mexico seawater, the project will not have an effect on instream flows, environmental flows or freshwater inflows.

D. **"Does not have a significant substantive impact on water planning or previously adopted management strategies"**
   - Addition of this WMS does not impact water planning or previously adopted WMSs.

E. **"Does not delete or change any legal requirements of the plan"**
   - Inclusion of this WMS will not delete or change any legal requirement of the plan.

DRAFT (8-7-14) 2

GBRA IWPP – Minor Amendment to 2011 SCTRWP



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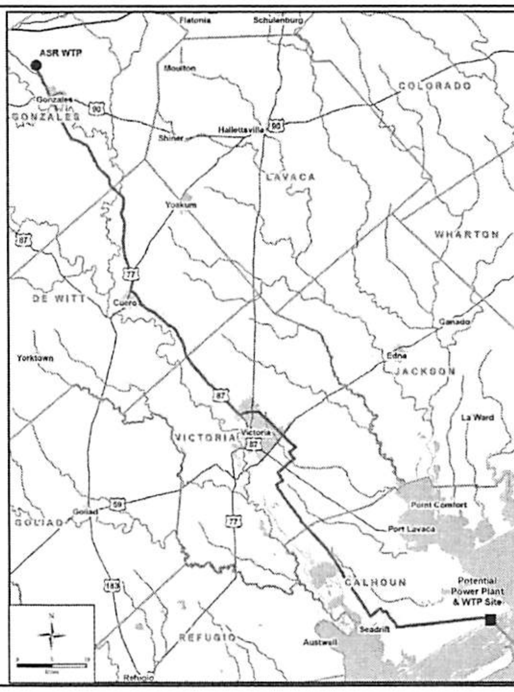
3

GBRA IWPP – Minor Amendment to the 2011 SCTRWP



DRAFT (8-7-14)

4

GBRA IWPP – Minor Amendment to 2011 SCTRWP

- GBRA has an on-going study with MWH
- Source and Supply:
  - Seawater from the Gulf of Mexico
  - Total Envisioned Project Size = 100,000 acft/yr
    - 50,000 acft/yr available in Calhoun County
    - 50,000 acft/yr delivered to Gonzales County
  - Delivery point: Mid-Basin WSP ASR WTP
- Facilities:
  - Peaking Factor = 1.0
  - Off-Shore Intake and 78-inch, 10-mile Pipeline to WTP near Port O'Connor
  - 98.2 MGD Reverse Osmosis WTP
  - 54-inch, 141-mile Transmission Pipeline
  - Pump Station/Booster Stations
  - 24-inch, 10 mile Concentrate Pipeline with Multiport Diffuser Off-Shore

DRAFT (8-7-14)

5

GBRA IWPP – Minor Amendment to 2011 SCTRWP

	GBRA IWPP
Capital Costs	$795,863,000
Project Costs	$1,181,020,000
Annual Costs	$185,208,000
Project Yield (acft/yr)	100,000 (50,000 in Calhoun; 50,000 delivered to Gonzales)
Unit Costs* ($/acft/yr)	$1,852

**Note: Costs in September 2008 dollars, per the 2011 SCTRWP*

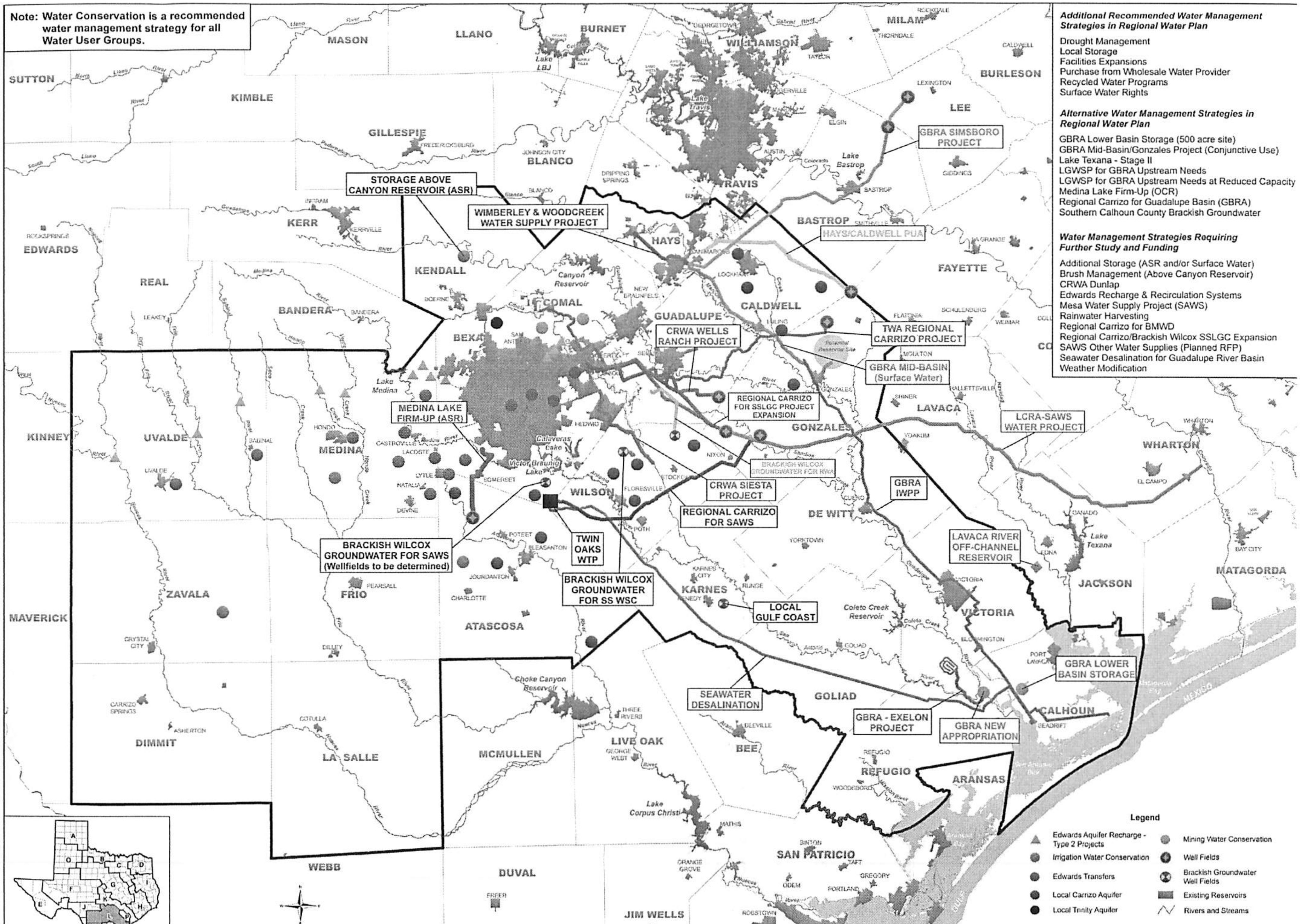
DRAFT (8-7-14)

6

GBRA IWPP
Requested Amendment of the 2011 Region L Water Plan

- **August 7, 2014 GBRA Request of the SCTRWPG:**
  - Discussion and appropriate action regarding solicitation of determination of amendment status by the TWDB Executive Administrator
- **November 6, 2014 GBRA Request of the SCTRWPG:**
  - Discussion and appropriate action regarding amendment of the 2011 Region L Water Plan to include the GBRA IWPP WMS during a noticed public meeting (assuming TWDB written approval of the requested amendment is timely received)

DRAFT (8-7-14) 7



2011 South Central Texas Regional Water Plan
Recommended Water Management Strategies

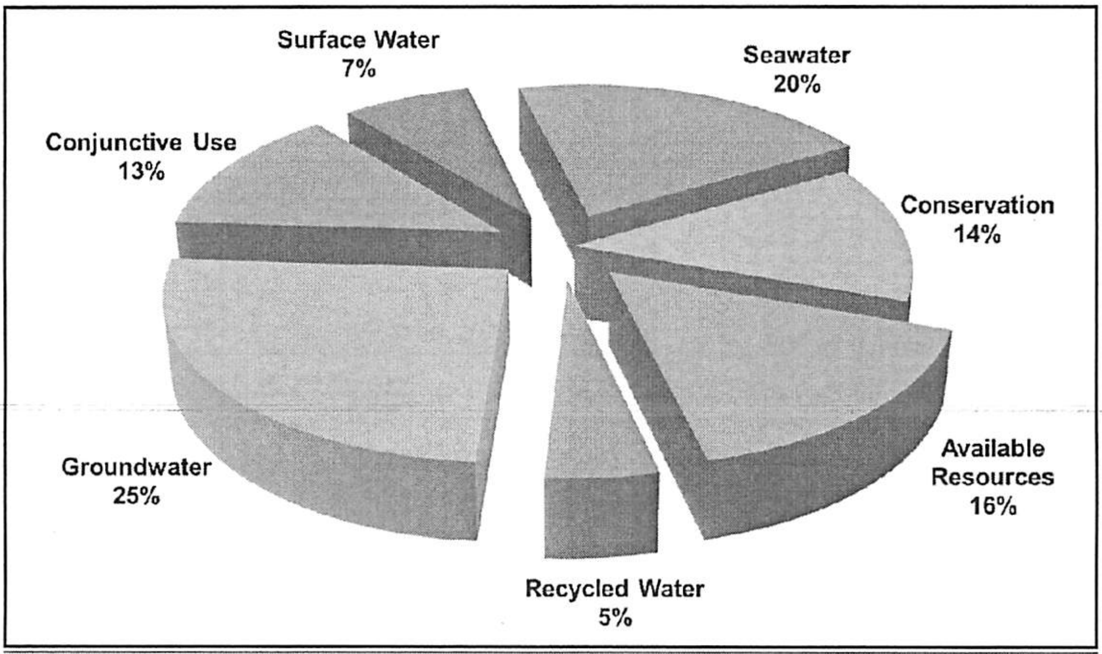


Figure 4B.1-2. Sources of New Supply in 2060

Specific recommended water management strategies in the Plan are summarized by approximate timing of potential implementation in Figure 4B.1-3 and Appendix D, and by geographic location in Figure 4B.1-4. Water management strategies emphasizing conservation comprise about ~~15.5~~13.7 percent of recommended new supplies and include:

- Municipal Water Conservation (72,666 acft/yr @ $648/acft/yr[2]);
- Irrigation Water Conservation (7,238 acft/yr @ $143/acft/yr);
- Drought Management (41,240 acft/yr); and
- Mining Water Conservation (2,493 acft/yr).

Water management strategies maximizing use of available resources, water rights, and reservoirs comprise about ~~18.0~~16.1 percent of recommended new supplies and include:

- Edwards Transfers (51,875 acft/yr @ $454/acft/yr);
- GBRA-Exelon Project (49,126 acft/yr @ $641/acft/yr);
- GBRA Lower Basin Storage (100 acre site) (28,369 acft/yr @ $104/acft/yr);
- Medina Lake Firm-Up (ASR) (9,933 acft/yr @ $1,696/acft/yr);

[2] $648/acft/yr is an average cost of municipal water conservation. Actual unit costs vary from WUG to WUG and from decade to decade.

- Wimberley & Woodcreek Water Supply Project (4,480 acft/yr @ $2,453/acft/yr);
- Surface Water Rights[3]; and
- Facilities Expansions.

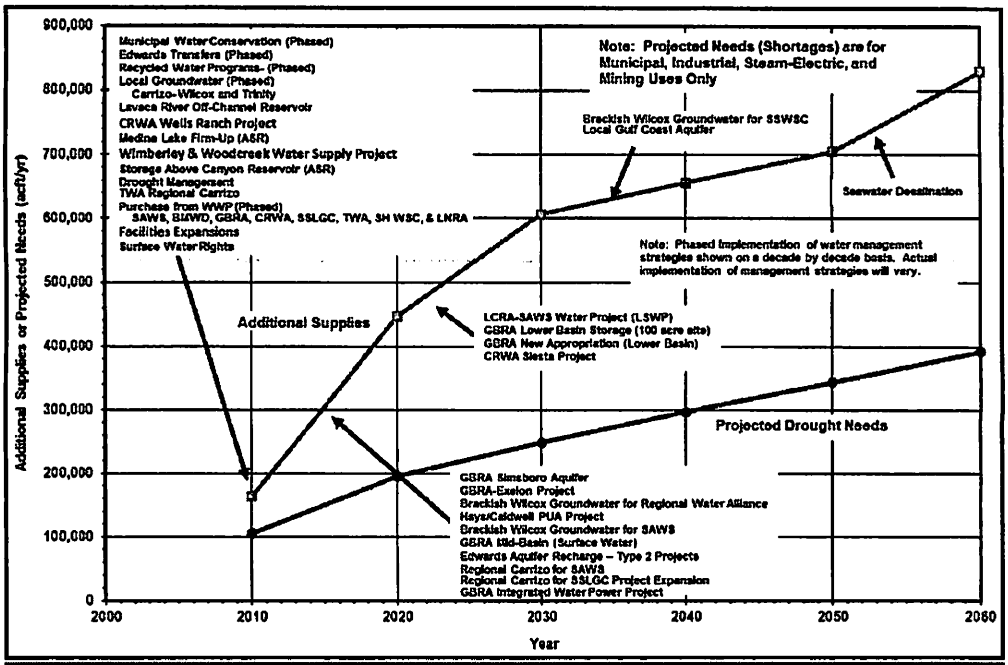


Figure 4B.1-3. Phased Implementation of Water Management Strategies

The Regional Water Plan includes the Recycled Water Programs water management strategy at 41,737 acft/yr which could represent approximately ~~5.2~~4.6 percent of the recommended new supplies.

Water management strategies that simultaneously develop groundwater supplies and limit depletion of storage in regional aquifers comprise about ~~27.9~~25.0 percent of recommended new supplies and include:

- GBRA Simsboro Project (49,777 acft/yr @ $982/acft/yr)[4];
- Local Groundwater Supplies (Carrizo, Gulf Coast, and Trinity) (38,471 acft/yr @ $687/acft/yr - $1,823/acft/yr);

[3] As new supplies and associated costs have not been quantified, this strategy is more explicitly identified as an activity consistent with the 2011 Regional Water Plan.

[4] The new firm supply associated with this strategy was reduced from 50,000 acft/yr to 49,777 acft/yr to resolve a potential inter-regional conflict with Region G. This small change did not warrant revision of Section 4C.21. A portion of the new firm supply for this strategy to be obtained from the Carrizo-Wilcox Aquifer in Bastrop County is identified as an "overdraft" to resolve a potential inter-regional conflict with Region K. See the response to TWDB Level I Comment No. 52 in Section 10 for additional information.

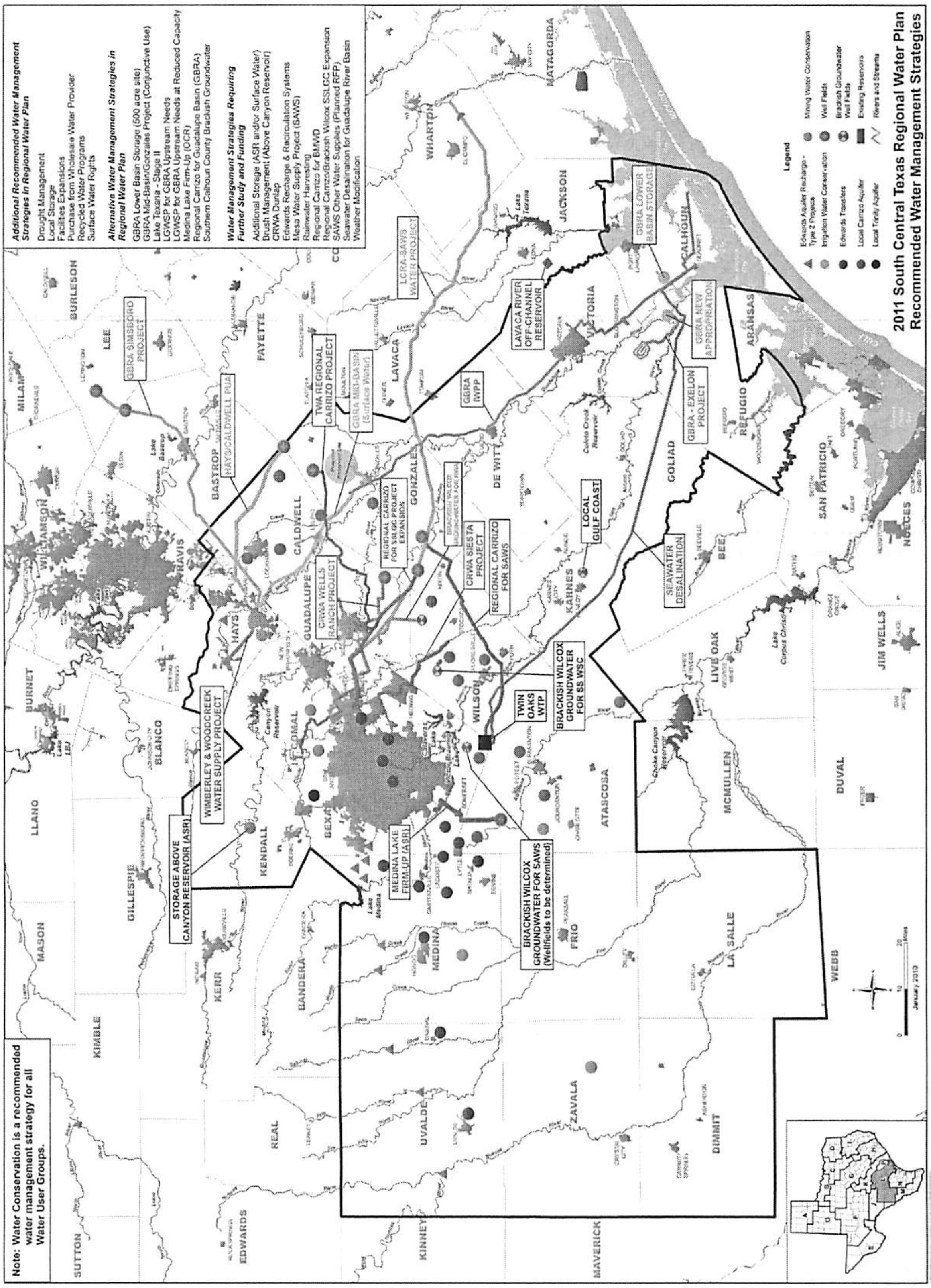


Figure 4B.1-4. Recommended Water Management Strategies

- Hays/Caldwell PUA Project (35,000 acft/yr @ $1,245/acft/yr);
- TWA Regional Carrizo (27,000 acft/yr @ $1,523/acft/yr);
- Brackish Wilcox Groundwater for SAWS (26,400 acft/yr @ $1,245/acft/yr);
- Regional Carrizo for SAWS (11,687 acft/yr @ $1,343/acft/yr);
- Brackish Wilcox Groundwater for Regional Water Alliance (14,700 acft/yr @ $1,293/acft/yr);
- CRWA Wells Ranch Project (11,000 acft/yr @ $725/acft/yr);
- Regional Carrizo for SSLGC Project Expansion (10,364 acft/yr @ $608/acft/yr); and
- Brackish Wilcox Groundwater for SSWSC (1,120 acft/yr @ $1,883/acft/yr).

Water management strategies that engage the efficiency of conjunctive use of surface and groundwater as well as maximize the use of available resources and water rights comprise approximately ~~14.6~~12.9 percent of recommended new supplies and include:

- LCRA-SAWS Water Project (90,000 acft/yr @ $2,394/acft/yr);
- Edwards Aquifer Recharge – Type 2 Projects (21,577 acft/yr @ $1,728/acft/yr); and
- CRWA Siesta Project (5,042 acft/yr @ $1,421/acft/yr).

Water management strategies that involve new surface water appropriations while avoiding development of large mainstem reservoirs comprise approximately ~~8.2~~7.3 percent of recommended new supplies and include:

- Lavaca River Off-Channel Reservoir (26,242 acft/yr @ $701/acft);
- GBRA Mid-Basin Project (Surface Water) (25,000 acft/yr @ $2,204/acft/yr);
- GBRA New Appropriation (Lower Basin) (11,300 acft/yr @ $1,953/acft/yr); and
- Storage Above Canyon Reservoir (ASR) (3,140 acft/yr @ $1,772/acft/yr).

Finally, the Regional Water Plan includes the development of two Seawater Desalination water management strategies: an 84,012 acft/yr (75 mgd) ($2,284/acft/yr) water management strategy and the GBRA Integrated Water Power Project at 100,000 acft/yr ($2,290/acft/yr) which could represent approximately 20.4 percent of the recommended new supplies.

~~Finally, the Regional Water Plan includes the development of a Seawater Desalination water management strategy at 84,012 acft/yr (75 mgd) ($2,284/acft/yr) which could represent approximately 10.5 percent of the recommended new supplies.~~

The South Central Texas Regional Water Planning Group identifies the following as alternative water management strategies that have been technically evaluated in accordance with TWDB rules and may, subject to an appropriate amendment process defined by TWDB rules, replace a recommended water management strategy in the 2011 Regional Water Plan:

- Lower Guadalupe Water Supply Project for Upstream GBRA Needs (60,000 acft/yr @ $1,921/acft/yr);
- GBRA Lower Basin Storage (500 acre site) (59,569 acft/yr @ $109/acft/yr);
- Lower Guadalupe Water Supply Project for Upstream GBRA Needs at Reduced Capacity (35,000 acft/yr @ $2,565/acft/yr);
- GBRA Mid-Basin Project (Conjunctive Use) (25,000 acft/yr @ $1,779/acft/yr);
- Regional Carrizo for Guadalupe Basin (GBRA) (25,000 acft/yr @ $1,280/acft/yr);
- Medina Lake Firm-Up (OCR) (9,078 acft/yr @ $1,197/acft/yr);
- Local Groundwater Supplies (Barton Springs Edwards) (1,358 acft/yr @ $203/acft/yr);
- Calhoun County Brackish Groundwater Project (1,344 acft/yr @ $2,679/acft/yr); and
- Local Groundwater Supplies (Carrizo) (Yancey WSC) (1,210 acft/yr @ $517/acft/yr).

The Regional Water Plan includes several water management strategies that require further study and funding prior to implementation. Several of these strategies rely upon technologies that have been used previously, but further research is necessary to determine the cost of implementation, optimal scale and location, and quantity of dependable water supply that would be available in severe drought. These strategies are:

- Brush Management;
- Weather Modification;
- Rainwater Harvesting;
- Storage Above Canyon Reservoir (Off-Channel);
- Edwards Aquifer Recharge & Recirculation Systems;
- Palmetto Bend – Stage II (LNRA);
- Seawater Desalination for Guadalupe River Basin;
- Mesa Water Supply Project (SAWS);
- SAWS Other Water Supplies (Planned RFP);
- Regional Carrizo for BMWD;
- Regional Carrizo for SSLGC Project Expansion – Wilson County Option;
- CRWA Dunlap Project; and

- Balancing Storage (ASR and/or Surface)[5].

Although specific quantities of new, dependable supply during drought have not been determined for these strategies, it is understood that their implementation will contribute positively to storage and system management of many diverse strategies in the Regional Water Plan. The SCTRWPG recommends that State funding be made available to cooperatively support the refinement and implementation of these strategies.

The 2011 South Central Texas Regional Water Plan also recognizes Edwards Aquifer Recharge and Recirculation Systems (R&R) as a water management strategy requiring further evaluation. As it did in the 2006 Regional Water Plan, the SCTRWPG recommends State and local funding for research at a level that ensures due consideration of this strategy.

There are significant quantities of projected water supply needs or shortages in the region for municipal, industrial, steam-electric, and mining uses. As indicated in Figure 4B.1-3, implementation of a number of water management strategies on an expedited basis will be necessary to avoid significant hardship, water rationing, and/or cessation of discharge from Comal Springs in the event of severe drought during the next decade. Substantial water supply needs or shortages are also projected for irrigation use in the South Central Texas Region. The Irrigation water Conservation Water Management Strategy is projected to meet approximately 42 percent of projected irrigation needs (shortages) in 2010, and 65 percent in 2060. However, based upon present economic conditions for agriculture and the fact that there are no really low-cost water supplies to be developed, the SCTRWPG has determined that it is not economically feasible to meet all projected irrigation needs in Zavala County at this time, since the net farm income to pay for water is less than the costs of water at the potential sources, to say nothing of the cost delivered to farms where water is needed.

Implementation of the 2011 South Central Texas Regional Water Plan will result in the development of new water supplies that will be reliable in the event of a repeat of the most severe drought on record. However, it is evident in Figure 4B.1-3 that implementation of all recommended water management strategies is not likely to be necessary in order to meet projected needs within the planning period. The SCTRWPG explicitly recognizes the difference between additional supplies and projected needs as System Management Supplies and has

[5] As new supplies and associated costs have not been quantified, this strategy is more explicitly identified as an activity consistent with the 2011 Regional Water Plan.

recommended the associated water management strategies in the Regional Water Plan for the following reasons:

- To recognize both the long lead times and the uncertainty associated with risk factors that may prevent implementation of water management strategies and necessitate replacement strategies;
- To preserve flexibility for water user groups or wholesale water suppliers to select the most feasible projects among several consistent with the Regional Plan and therefore ensure that such projects are potentially eligible for permitting and funding;
- To serve as additional supplies in the event that rules, regulations, or other restrictions limit use of any planned strategies; and/or
- To ensure adequate supplies in the event of a drought more severe than that which occurred historically.

Costs associated with the implementation and long-term operations and maintenance of water management strategies have been estimated in accordance with TWDB rules and general guidelines and reflect regional water treatment capacity and balancing storage facilities sufficient to meet peak daily and seasonal water demands in the larger urban areas. Total estimated project cost (in 2008 dollars) for the recommended water management strategies for municipal supply that will likely require long-term financing for implementation is about $7.6 billion. Annual unit costs for recommended water management strategies for municipal supply in the 2011 South Central Texas Regional Water Plan (in 2008 dollars) are estimated to range from a low of about $104/acft/yr ($0.32 per 1,000 gallons) for GBRA Lower Basin Storage to a high of about $2,429/acft/yr ($7.45 per 1,000 gallons) for the Wimberley/Woodcreek Water Supply Project and average about $1,209/acft/yr ($3.71 per 1,000 gallons). No costs have been included for facilities expansions and potentially feasible water management strategies requiring further study.

4B.1.2 Water Management Strategy Descriptions

A brief description of each of the water management strategies included in the 2011 South Central Texas Regional Water Plan is included in the following text. Descriptions include the dependable (firm) water supply during drought and an estimated annual unit cost (in September 2008 dollars) for water at full operating capacity during the debt service period (if applicable).

4B.1.2.1 Municipal Water Conservation

The Municipal Water Conservation water management strategy includes conservation practices and programs to reduce per capita water use in cities by amounts in addition to reductions already incorporated into the TWDB water demand projections. The SCTRWPG established municipal water conservation goals as follows:

- For municipal WUGs with water use of 140 gpcd and greater, the goal is to reduce per capita water use by one percent per year until the level of 140 gpcd is reached, after which, the goal is to reduce per capita water use by one-fourth percent per year for the remainder of the planning period; and
- For municipal WUGs having year 2000 water use of less than 140 gpcd, the goal is to reduce per capita water use by one-fourth percent per year (0.25% per year).

Best Management Practices (BMPs) for water conservation, as identified by the Water Conservation Implementation Task Force[6], are recommended as means of achieving these municipal water conservation goals. The objective of municipal water conservation programs is to reduce the per capita water use parameter without adversely affecting the quality of life of the people involved. Planned municipal water conservation focuses on the following specific BMPs:

- Use of low flow plumbing fixtures (e.g., toilets, shower heads, and faucets that are designed for low quantities of flow per unit of use);
- The selection and use of more efficient water-using appliances (e.g., clothes washers and dishwashers);
- Modifying and/or installing lawn and landscaping systems to use grass and plants that require less water;
- Repair of plumbing and water-using appliances to reduce leaks; and
- Modification of personal behavior that controls the use of plumbing fixtures, appliances, and lawn watering methods.

The SCTRWPG recognizes that meeting the water conservation goals through implementation of these, or other, BMPs represents the highest practicable level of water conservation pursuant to 31 TAC 357.7(a)(7)(A)(iii). Planned additional municipal water conservation focused on these BMPs could effectively increase supply through demand reduction in the South Central Texas Region by about 72,570 acft/yr in the year 2060 at unit

[6]Water Conservation Implementation Task Force, Report to the 79th Legislature, Texas Water Development Board, Special Report, Austin, Texas, November 2004.

costs ranging from $525 per acft/yr to $770 per acft/yr. Volume II, Section 4C.1 includes a detailed discussion of this water management strategy.

4B.1.2.2 Irrigation Water Conservation

The Irrigation Water Conservation strategy achieves water conservation through the installation of Low Energy Precision Application (LEPA) irrigation systems and furrow dikes. Recommended implementation of these conservation measures in Atascosa, Bexar, Medina, and Zavala Counties could effectively increase supply for irrigation through demand reduction by up to 20,709 acft/yr at a unit cost of $143 per acft/yr. Volume II, Section 4C.1 includes a detailed discussion of this water management strategy.

4B.1.2.3 Industrial Water Conservation

The Industrial Water Conservation strategy can achieve water conservation through the use of BMPs such as water audits, waste reduction submetering, cooling towers, reuse of process water, landscape water conservation, and specific water conservation plans designed for individual manufacturing plants (See Section 4C.1). The SCTRWPG recommends that water conservation be considered by individual industries, as a means to meet a part of the projected water needs.

4B.1.2.4 Steam-Electric Water Conservation

The Steam-Electric Water Conservation strategy achieves water conservation through the use of BMPs such as air-cooling or other cooling systems that can significantly reduce existing and projected water demands for steam-electric power generation. Volume II, Section 4C.1 includes a listing of other potential BMPs. The SCTRWPG recommends that water conservation be considered by individual steam-electric generators, as a means to meet a part of the projected water needs.

4B.1.2.5 Mining Water Conservation

The Mining Water Conservation strategy achieves water conservation through the use of recommended BMPs such as onsite collection and use of precipitation runoff and onsite reuse of process water. Volume II, Section 4C.1 includes a listing of other potential BMPs. The SCTRWPG recommends that water conservation be considered by individual mining operations, as a means to meet a part of the projected water needs.

4B.1.2.6 Drought Management

The SCTRWPG has developed a general methodology for estimating the economic impacts associated with implementation of drought management as a water management strategy.[7] Application of this methodology for regional water planning purposes has facilitated comparison of drought management to other potentially feasible water management strategies on a unit cost basis (Section 4C.2). The SCTRWPG has found, and the San Antonio Water System (SAWS) has demonstrated, that water user groups having sufficient flexibility to focus on discretionary outdoor water use first and avoid water use reductions in the commercial and manufacturing use sectors may find some degrees of drought management to be economically viable and cost-competitive with other water management strategies. Recognizing that implementation of appropriate water management strategies is a matter of local choice, the SCTRWPG recommends due consideration of economically viable drought management as an interim strategy to meet near-term needs through demand reduction until such time as economically viable long-term water supplies can be developed. Hence, new demand reductions associated with the 5 percent drought management scenario are shown at year 2010 for each municipal water user group with projected needs for additional water supply at year 2010[8]. Volume II, Section 4C.2 includes a detailed discussion of this recommended management strategy.

4B.1.2.7 Edwards Transfers

The Edwards Transfers water management strategy is based upon the provisions of Senate Bill 1477, as amended, which provides for the creation of the Edwards Aquifer Authority, establishes a withdrawal permit system, and potentially allows a permit holder to sell or lease up to 50 percent of his irrigation rights. In the 2011 Regional Water Plan, irrigation transfers are included to meet projected needs of 17 municipal water user groups with transfers of 45,645 acft/yr in 2010 increasing to 51,875 acft/yr in 2060 (quantities are part of the 320,000 acft/yr of firm yield used in the development of the 2011 plan). Initial Regular Permit (IRP) value of permits needed to obtain these quantities of firm yield increase from 81,590 acft/yr in 2010 to

[7] SCTRWPG, "2011 Regional Water Plan, Study 3, Enhanced Water Conservation, Drought Management, and Land Stewardship," Texas Water Development Board, San Antonio River Authority, HDR Engineering, Inc., April 2009.

92,285 acft/yr in 2060. Based on available data for transactions to date, typical unit costs are $454 per acft/yr for lease of withdrawal rights and $1,072 per acft/yr for permanent acquisition. Volume II, Section 4C.3 includes a detailed discussion of this recommended management strategy.

4B.1.2.8 Edwards Recharge – Type 2 Projects

The Edwards Recharge – Type 2 Projects involves the construction of recharge enhancement structures located atop the Edwards Aquifer recharge zone (Type 2 Projects) on streams that are often dry. These structures impound water only for a few days or weeks following storm events and recharge water very quickly to the aquifer, typically draining at a rate of 2 to 3 feet per day. Planned projects include Indian Creek, Lower Frio, Lower Sabinal, Lower Hondo, Lower Verde, San Geronimo, Northern Bexar / Medina County Projects (Limekiln, Culebra, Government Canyon, Deep Creek, Salado Dam No. 3), Salado Creek FRS, Cibolo Dam No. 1, Dry Comal, and Lower Blanco. Consensus Criteria for Environmental Flow Needs were applied in the technical evaluations of projects comprising this management strategy located on streams which typically flow. Implementation of these projects could enhance spring discharge and increase dependable municipal water supply for Bexar County by about 21,600 acft/yr. It is specifically recognized by the SCTRWPG that alternative projects at these locations that may be larger in size and storage capacity are consistent with the 2011 Regional Water Plan. Volume II, Section 4C.4 includes a detailed discussion of this recommended water management strategy.

4B.1.2.9 Recycled Water Programs

The Recycled Water Programs water management strategy involves direct reuse of reclaimed municipal wastewater for non-potable uses such as irrigation of golf courses, parks, and open spaces of cities, landscape watering of large office and business complexes, cooling of large office and business complexes, steam-electric power plant cooling, process or wash water for mining operations, irrigation of farms that produce livestock feed and forage, irrigation of farms that produce sod, ornamentals, and landscape plants, and for instream uses such as riverwalks and waterways. This strategy is being used within the region by entities including

[8] In accordance with the SAWS 2009 Water Management Plan Update, 37,622 acft/yr is the drought management supply (demand reduction) shown for SAWS in year 2010. This quantity is between the 15 and 20 percent drought management scenarios presented in Section 4C.2.

SAWS, SARA, New Braunfels Utilities, the City of Seguin and the City of San Marcos and can be expanded as the quantities of municipal wastewater increase with population growth. An advantage of this strategy is that the water has already been developed and brought to the locations of many of the uses listed above. In regional planning, this strategy is used to meet some of the needs for Bexar County Industrial and Comal County Industrial.

The SCTRWPG recognizes that water suppliers throughout the region, including SAWS, City of Marion, City of San Marcos, City of Floresville, SS WSC, and County Line WSC, may choose to reuse or reclaim the increased treated wastewater volumes associated with increased municipal water use, especially such wastewater volumes that are derived from privately owned groundwater and interbasin transfer of surface water. The SCTRWPG further recognizes that this reuse may be accomplished directly ("flange-to-flange") or indirectly through bed and banks delivery to downstream diversion and/or storage sites subject to applicable law. Such lawful reuse of treated wastewater is consistent with the 2011 South Central Texas Regional Water Plan. Volume II, Section 4C.5 includes a detailed discussion of this recommended water management strategy.

4B.1.2.10 Facilities Expansions

Several Water User Groups (WUGs) are interested in projects to expand major components of their existing infrastructure (facilities) so they can continue to provide a safe and reliable water supply to their customers during the planning period. These facilities expansions are considered to be independent of any potential water management strategies to acquire a new water supply, and instead are intended to address expected future improvements to the water system, such as the installation of new water transmission facilities or additional water treatment Volume II, Section 4C.6 summarizes the expansions associated with this recommended water management strategy.

4B.1.2.11 Brush Management

The Brush Management water management strategy focuses on the selective removal of brush from rangeland in the watershed upstream of Canyon Reservoir, located in the Edwards Plateau Vegetational Area. Brush Management could enhance the firm yield of Canyon Reservoir between 5,590 acft/yr and 12,180 acft/yr with land owner participation rates of 25 percent and 50 percent, respectively, of the suitable lands as identified by Texas A&M

University. Associated unit costs for the 25 percent and 50 percent participation when financed for 20 years at 6 percent (including contingencies, treatment, and integration) are $897/acft/yr and $799/acft/yr, respectively. Analyses of this water management strategy requiring further study were performed with the assistance of Texas A&M University and are presented in Volume II, Section 4C.7.

4B.1.2.12 Wimberley & Woodcreek Water Supply Project

The Wimberley & Woodcreek Water Supply Project water management strategy involves short-term water supply from Canyon Reservoir and/or San Marcos and long-term supply from the GBRA Mid-Basin Project or the Hays/Caldwell PUA Project. Short-term supplies may be made available through leasing of committed supplies from Canyon Reservoir that are not currently being taken. Once Canyon contract holders grow into their purchased water supplies, Wimberley and Woodcreek will rely on long-term water supplies of 4,480 acft/yr expected to be obtained from one of the projects identified above, each of which includes delivery to the San Marcos Water Treatment Plant (WTP) area located 18 miles from Wimberley. Volume II, Section 4C.8 includes a detailed discussion of this recommended water management strategy.

4B.1.2.13 Storage above Canyon Reservoir

The Storage above Canyon Reservoir water management strategy, which involves diverting streamflows from the Guadalupe River above Canyon Reservoir during wet periods and storing them either in an off-channel reservoir (OCR) or a large-scale Aquifer Storage and Recovery (ASR) system, is a strategy to potentially meet needs for Water User Groups (WUGs) in Kendall and Comal Counties. In the Storage above Canyon Reservoir water management strategy, surface water storage sites and ASR well fields in the watershed upstream of Canyon Reservoir are assessed, and the firm supply is determined using the storage to firm up run-of-river water available under a new appropriation. Only the formulation of this water management strategy relying on ASR is recommended to meet projected needs for additional water supply at this time. Volume II, Section 4C.9 includes a detailed discussion of this strategy.

4B.1.2.14 GBRA-Exelon Project

The GBRA-Exelon Project involves the development of a reliable supply of 49,126 acft/yr of cooling water to the Exelon Generation Company, LLC (Exelon) for the development of nuclear power plant in Victoria County south of Victoria, Texas. Two concepts for supplying raw water to the plant are being considered: the river diversion option, which involves diversion from the Guadalupe River at the GBRA Saltwater Barrier, and the canal diversion option, which involves diversion from the GBRA Calhoun Canal system. Either option could supply up to 75,000 acft/yr from existing GBRA/Dow Lower Basin Water Rights to Exelon's Victoria County Site. Volume II, Section 4C.10 includes a detailed discussion of this recommended water management strategy.

4B.1.2.15 Lower Guadalupe Water Supply Project (LGWSP) for Upstream GBRA Needs at Reduced Capacity

The Lower Guadalupe Water Supply Project (LGWSP) for Upstream GBRA Needs at Reduced Capacity water management strategy involves the diversion of up to 60,000 acft/yr of presently underutilized surface water rights from the Guadalupe-Blanco River Authority (GBRA) Calhoun Canal System, transmission to an approximately 16,500 acft off-channel reservoir, transmission of 35,000 acft/yr of firm supply to water treatment plants near Luling, San Marcos, New Braunfels, and Canyon Reservoir, and integration into municipal water supply systems. This water management strategy serves to ensure that long-term, reliable, and renewable surface water supplies will be available throughout the GBRA statutory district including Calhoun, Refugio, and Victoria Counties. Volume II, Section 4C.11 includes a detailed discussion of this alternative water management strategy.[9]

4B.1.2.16 Lower Guadalupe Water Supply Project (LGWSP) for Upstream GBRA Needs

The Lower Guadalupe Water Supply Project (LGWSP) for Upstream GBRA Needs at Reduced Capacity water management strategy involves the diversion of up to 75,000 acft/yr of presently underutilized surface water rights from the Guadalupe-Blanco River Authority (GBRA) Calhoun Canal System, transmission to an approximately 19,000 acft off-channel reservoir, transmission of 60,000 acft/yr of firm supply to water treatment plants near Luling, San Marcos, New Braunfels, and Canyon Reservoir, and integration into municipal water supply systems. This water management strategy serves to ensure that long-term, reliable, and renewable surface water supplies will be available throughout the GBRA statutory district

[9] If fresh groundwater from the lower Guadalupe Basin is added to this strategy, then the plan must be amended in order for the modified strategy to be recommended for implementation.

including Calhoun, Refugio, and Victoria Counties. Volume II, Section 4C.12 includes a detailed discussion of this alternative water management strategy.[10]

4B.1.2.17 GBRA Lower Basin Storage

The Guadalupe-Blanco River Authority (GBRA) and Dow Chemical Company (Dow), individually and collectively, own surface water rights in the lower Guadalupe – San Antonio River Basin (the GBRA Lower Basin Water Rights) authorizing diversions totaling 175,501 acre-feet per year (acft/yr). Water available for diversion under these rights is governed by the complex interactions of natural, anthropogenic, and legal factors including rainfall, runoff, springflow, evaporation, aquifer recharge, diversions by other water right owners, reservoir operations, off-channel storage, treated effluent from municipal and industrial water users, terms and conditions of the water rights, and the prior appropriation doctrine as enforced by the South Texas Watermaster of the Texas Commission on Environmental Quality (TCEQ). Given that the GBRA Lower Basin Water Rights point of diversion near Tivoli is below the San Antonio River confluence and that they are senior in priority to most upstream water rights, it is recognized that they are quite reliable but not firm. In order to firm up the existing interruptible GBRA/Dow lower basin water rights, a 100 acre or 500 acre off-channel reservoir is considered for implementation. The two proposed OCR sites would be located approximately 3 miles east of Green Lake near the Dow Chemical Company. The off-channel reservoirs would have a maximum water depth of 25-ft and be capable of impounding 2,500 acft and 12,500 acft of water at the 100 acre and 500 acre OCR sites respectively. The recommended 100-acre site could firm-up an additional 28,369 acft/yr, while the alternative 500-acre site could firm-up an additional 59,569 acft/yr. Volume II, Section 4C.13 includes a detailed discussion of this water management strategy.

4B.1.2.18 GBRA New Appropriation (Lower Basin)

The GBRA New Appropriation (Lower Basin) water management strategy involves diversion of up to 189,484 acft/yr under a new appropriation from the Guadalupe River in Calhoun County using existing gravity-flow diversion facilities located immediately upstream of GBRA's Saltwater Barrier and Diversion Dam at a rate of diversion not to exceed 500 cfs

[10] If fresh groundwater from the lower Guadalupe Basin is added to this strategy, then the plan must be amended in order for the modified strategy to be recommended for implementation.

(within the existing 622 cfs maximum authorized diversion rate) and authorization to impound up to 200,000 acft in Calhoun County. The diversions and storage will serve municipal and industrial water users in GBRA's ten-county statutory district and are the subject of Application No. 12482 for surface water rights pending before the Texas Commission on Environmental Quality (TCEQ). The firm supply from this strategy, with a 100,000 acft off-channel reservoir, is 11,300 acft/yr. Implementation of this water management strategy will help to meet projected demands for current and future GBRA customers through the next 50 years and beyond. Volume II, Section 4C.14 includes a detailed discussion of this recommended water management strategy.[11]

4B.1.2.19 GBRA Mid-Basin (Surface Water)

The Guadalupe-Blanco River Authority (GBRA) is in the planning and permitting stages of a phased Mid-Basin Project to provide supplemental water supplies directly to customers in Hays and Caldwell Counties in the near-term and indirectly to customers in Comal, Guadalupe, and Kendall Counties by replacement or reduction of Canyon Reservoir supplies currently delivered to the San Marcos WTP in the long-term. GBRA is currently considering at least three formulations of the Mid-Basin Project using available surface water and/or groundwater supply sources to ensure unrestricted delivery of a firm yield of approximately 25,000 acft/yr. In all three formulations, 4,000 acft/yr will be delivered to the Luling Water Treatment Plant (WTP) and the remaining balance of approximately 21,000 acft/yr will be delivered to the San Marcos WTP. This water management strategy focuses on the surface water only formulation which would divert run-of-river water from the Guadalupe River below Gonzales backed-up with stored water from an off-channel reservoir in Gonzales County. GBRA has submitted Application No. 12378 for the surface water rights associated with this water management strategy and this application has been declared administratively complete by the TCEQ. Volume II, Section 4C.15 includes a detailed discussion of this recommended water management strategy.[12]

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[11] Project subject to senior water rights, full application of environmental flow standards adopted pursuant to Section 11.1471 of the Texas Water Code, and the TCEQ permitting process. If fresh groundwater from the lower Guadalupe Basin is added to this strategy, then the plan must be amended in order for the modified strategy to be recommended for implementation.

[12] Project subject to senior water rights, full application of environmental flow standards adopted pursuant to Section 11.1471 of the Texas Water Code, and the TCEQ permitting process.

from wells completed in this aquifer, and thereby extend the capabilities of this aquifer to support the demands that are projected to be placed upon it.

4B.1.2.45 Recharge and Recirculation Studies

The Recharge and Recirculation water management strategy involves artificial recharge of the Edwards Aquifer, capture of the resulting increased springflows, and returning these quantities of water to further recharge the aquifer. Artificial recharge could be done using runoff from the Edwards Plateau, water imported from other watersheds, the subsequent increment of springflow resulting from artificial recharge, and/or a combination of these sources. The purpose of this strategy is to maintain springflows at satisfactory levels to protect the habitats of endangered species that exist in the springs and specified reaches of spring fed streams, while at the same time increasing the quantity of water that can be withdrawn from the aquifer to meet the needs of water user groups. The quantities of water that could be withdrawn from the aquifer depend upon the quantities of recharge, the location(s) at which the recharge is made to the aquifer, levels of the aquifer at the time of recharge, residence time of recharged water in the aquifer, and perhaps other factors that are not known or well understood. The major reason for the Recharge and Recirculation strategy is to use the aquifer to store and distribute water to water user groups that have already established themselves in proximity to the aquifer.

4B.1.2.46 Mesa Water Supply Project (SAWS)

This strategy involves the production of groundwater from the Ogallala and Simsboro Aquifers and surface water from the Brazos River and transmission of same via pipelines and the bed and banks of the Brazos River to San Antonio. The SCTRWPG recognizes this as a potential water management strategy requiring further evaluation and study prior to implementation.

4B.1.2.47 Seawater Desalination

The GBRA Integrated Water Power Project water management strategy involves the long-term development of intake and treatment facilities of seawater from the Gulf of Mexico and transmission of treated water to Calhoun, Victoria, DeWitt, and Gonzales Counties. This water management strategy utilizes a source of water that is essentially unlimited; however, costs of treatment and location for brine discharge (as may affect marine habitat and species) remain concerns. Planned implementation of this strategy will provide a dependable annual supply of approximately 100,000 acft by 2020 at an estimated unit cost of $2,290/acft/yr. Volume II, Section 4C.37 includes a detailed discussion of this recommended water management strategy.

4B.1.3 Summary of Key Information

Pursuant to 31 TAC§357.7(a)(7), regional water plan development shall include evaluations of water management strategies providing certain key information pursuant to TWDB criteria. Key information regarding the 2011 South Central Texas Regional Water Plan is summarized by subject area below.

4B.1.3.1 Quantity, Reliability, and Cost

- Plan reflects substantial commitment to Water Conservation throughout the South Central Texas Region, thereby encouraging efficient utilization of existing water supplies and reducing quantities of new supply needed.
- Plan includes reliable new water supplies sufficient to meet projected drought needs for municipal, industrial, steam-electric power, and mining uses through the year 2060.
- Plan recognizes that water management strategies such as brush management, weather modification, rainwater harvesting, and small recharge dams contribute positively to storage and system management of diverse sources of supply.
- Unit costs associated with new supplies delivered to each water user group range from $104/acft/yr to $2,429/acft/yr and average about $~~1,209~~1,314/acft/yr or $~~3.71~~4.03 per 1,000 gallons based on September 2008 dollars.

4B.1.3.2 Environmental Factors

- See Section 7.3 for summary of environmental benefits and concerns.

4B.1.3.3 Impact on Water Resources

- Plan implementation results in no unmitigated reductions in water available to existing rights.
- Long-term reductions in water levels in the Carrizo-Wilcox Aquifer.

4B.1.3.4 Impacts on Agricultural and Natural Resources

- Inclusion of water management strategies to meet projected irrigation needs (shortages) in full is estimated to be economically infeasible at this time. Irrigation Water Conservation through the installation of Low Energy Precision Application

(LEPA) systems is recommended to offset a portion of projected irrigation needs (shortages) in four counties.

- Plan includes Brush Management and Weather Modification which are expected to contribute positively to storage and system management of diverse water management strategies. Weather Modification assists irrigation and dry-land agriculture (crops and ranching), increases water supply for wildlife habitat, and increases Edwards Aquifer recharge.
- Plan includes about 99 percent of potential maximum of unrestricted voluntary transfer of Edwards Aquifer irrigation permits to municipal use through lease or purchase.

4B.1.3.5 Other Relevant Factors per SCTRWPG

- Potential effects of Plan implementation on Edwards Aquifer springflows has been identified as a relevant factor by the SCTRWPG. As shown in Section 7.1, implementation of Plan is expected to increase long-term average discharges from both Comal Springs and San Marcos Springs.
- Flexibility in the phasing and order of implementation of management strategies comprising the Plan has been identified as a relevant factor or concern by the SCTRWPG. Wholesale Water Provides and water user groups need the ability to expedite or reschedule implementation of any specific management strategy as necessary and appropriate.

4B.1.3.6 Comparison of Strategies to Meet Needs

- Selection of water management strategies comprising the 2011 Regional Water Plan is based upon guiding principles and assumptions approved by the SCTRWPG.

4B.1.3.7 Interbasin Transfer Issues

- Plan includes two potential surface water interbasin transfers from the Lower Colorado River near Bay City to Bexar County and from the Lavaca-Navidad River Basin to the Colorado-Lavaca Coastal Basin (Point Comfort).
- Projected needs (shortages) in basins of origin are met throughout the planning period.

4B.1.3.8 Third-Party Impacts of Voluntary Transfers

- Positive effects for municipal water user groups associated with Edwards Transfers.
- Payment to farmers for voluntary irrigation water transfer provides capital for farmers to install higher efficiency irrigation systems. In many cases, this allows irrigation to

continue at present levels so that the transfer does not adversely affect the regional economy.

- Lower water levels in some portions of the Carrizo Aquifer.

4B.1.3.9 Regional Efficiency

- Edwards Transfers require no new facilities. Transferred water would likely be available at or very near locations having projected municipal and industrial water needs in Uvalde, Medina, Atascosa, and Bexar Counties.
- Regional water treatment and balancing storage facilities increase efficiency, improve reliability, and reduce unit cost.

4B.1.3.9 Water Quality Considerations

- Assuming that wastewater treatment standards and plant performance continue to improve over time, no significant impacts on water quality are expected to result from implementation of the 2011 South Central Texas Regional Water Plan.

4B.1.3.10 Impacts on Navigation

- None of the recommended water management strategies of the plan have any identifiable effect on navigation.

impacts. Implementation of economically appropriate drought management strategies, as determined at the water user group level, may provide similar benefits while projects delivering reliable water supplies to meet projected needs are permitted and constructed.

- Development of new water supply sources for Bexar, Comal, and Hays Counties reduces reliance on the Edwards Aquifer during drought thereby contributing to maintenance of springflow and protection of endangered species. The Regional Water Plan recognizes the on-going efforts of the participants in the Edwards Aquifer Recovery Implementation Program (EARIP) to develop a Habitat Conservation Plan which will help to define the requirements for maintenance of springflow and protection of endangered species and meet with approval from the U.S. Fish & Wildlife Service.
- Implementation of the 2011 Regional Water Plan is likely to result in increased instream flows in the San Antonio River. These increases in flow are attributable to increases in treated effluent from all wastewater discharges (most notably associated with projected growth in Bexar County) and increases in springflow (associated with Edwards Aquifer Recharge Type 2 Projects).
- Edwards Aquifer Recharge Enhancement through the construction of Type 2 recharge dams contributes not only to municipal water supply, but also to maintenance of springflow, protection of endangered species in and below the springs, increased instream flows, and increased freshwater inflows to the Guadalupe Estuary.
- The 2011 Regional Water Plan emphasizes beneficial use of existing surface water rights thereby minimizing the development of new water supply sources and associated environmental impacts. Examples include reliance on presently under-utilized water rights held by the Guadalupe-Blanco River Authority (GBRA) and Dow Chemical Company (Dow) below the confluence of the Guadalupe and San Antonio Rivers and by the Lower Colorado River Authority (LCRA) on the Lower Colorado River. Enhanced use of existing surface water rights accounts for approximately one-quarter of the total new water supplies for municipal, industrial, steam-electric, and mining uses by 2060.
- The Regional Water Plan avoids large-scale development of new mainstem reservoirs having associated terrestrial and aquatic habitat and cultural resources impacts and focuses on smaller, off-channel reservoirs.
- Inclusion of Edwards Aquifer transfers from irrigation use to municipal use through lease/purchase of pumpage rights and development of conserved water through installation of LEPA irrigation systems results in substantial increases in municipal water supply without construction of additional transmission and storage facilities having associated environmental effects.
- Inclusion of groundwater development has limited associated environmental effects as compared to those typically associated with development of new surface water supply reservoirs.
- Inclusion of Seawater Desalination and the GBRA Integrated Water Power Project is perceived to have fewer associated environmental effects, as compared

to those typically associated with development of new (fresh) surface water supplies.

7.3.2 Environmental Concerns

- Potential reductions in freshwater inflows to bays and estuaries, including associated effects on wetland and marsh habitats and marine species, are identified as matters of concern. Primary concerns focus upon the potential effects of the LCRA-SAWS Water Project on freshwater inflows to Matagorda Bay and the GBRA New Appropriation (Lower Basin) on freshwater inflows to the Guadalupe Estuary. It is important to note, however, that as part of the studies directed through the LCRA-SAWS Definitive Agreement, the Matagorda Bay inflow criteria and the Aquatic Habitat Instream Flow studies were studied thoroughly and shown to meet the legislative directives of protecting Bay Health and the Lower Colorado River aquatic systems. Concerns have also been expressed that increased uses of existing water rights may reduce freshwater inflows to bays and estuaries.
- Concentration of Edwards Aquifer pumpage closer to Comal Springs as a result of implementation of Edwards Transfers tends to reduce discharge from Comal Springs.
- Potential conflicts with stream segments identified by TPWD as ecologically significant are associated with the LCRA-SAWS Water Project, Edwards Recharge – Type 2 Projects, GBRA New Appropriation (Lower Basin), Lavaca River Off-Channel Reservoir, and Storage Above Canyon (ASR).
- Potential effects on small springs and instream flows below these springs may be associated with the development of groundwater supplies.
- Intake siting, brine discharge location(s), and potential effects on marine habitat and species, as well as large demands for electrical power, are environmental concerns associated with Seawater Desalination and the GBRA Integrated Water Power Project.

Appendix D, Table 2
2011 South Central Texas Regional Water Plan
Recommended Water Management Strategies (RevA)

Region	Section	Description	Total Capital Costs	First Decade Estimated Annual Average Unit Cost ($/acft/yr)	Water Supply Volume (acre-feet per year) 2010	2020	2030	2040	2050	2060	Year 2060 Estimated Annual Average Unit Cost ($/acft/yr)
L	4C.1	Municipal Water Conservation	-	$ 648	13,231	22,742	31,616	40,528	53,925	72,570	-
L	4C.1	Irrigation Water Conservation	$1,035,034	$ 143	20,087	17,561	14,429	11,421	8,543	7,238	-
L	4C.1	Mining Water Conservation	-	Varies	521	726	1,771	1,991	2,292	2,492	Varies
L	4C.2	Drought Management	-	Varies	41,240	0	0	0	0	0	Varies
L	4C.3	Edwards Transfers	$23,551,250	$ 454	45,896	47,479	48,931	49,870	50,855	51,875	-
L	4C.4	Edwards Aquifer Recharge – Type 2 Projects	$527,643,000	$ 2,005	0	13,451	13,451	13,451	13,451	21,577	$ 340
L	4C.5	Recycled Water Programs	$465,339,000	Varies	21,666	26,046	30,151	34,178	37,706	41,737	Varies
L	4C.6	Facilities Expansions	$144,560,579	-	0	0	0	0	0	0	-
L	4C.8	Wimberley and Woodcreek Water Supply Project	$33,771,000	$ 2,429	1,120	4,480	4,480	4,480	4,480	4,480	$ 1,772
L	4C.9	Storage Above Canyon Reservoir (ASR)	$37,326,000	$ 1,772	0	3,140	3,140	3,140	3,140	3,140	$ 587
L	4C.10	GBRA-Exelon Project	$280,598,000	$ 646	0	49,126	49,126	49,126	49,126	49,126	$ 224
L	4C.13	GBRA Lower Basin Storage (100 acre site)	$33,800,000	$ 104	0	0	28,369	28,369	28,369	28,369	$ 60
L	4C.14	GBRA New Appropriation (Lower Basin)	$246,849,000	$ 1,910	0	0	11,300	11,300	11,300	11,300	$ 223
L	4C.15	GBRA Mid-Basin (Surface Water)	$546,941,000	$ 1,879	0	25,000	25,000	25,000	25,000	25,000	$ 370
L	4C.18	Regional Carrizo for SAWS	$136,550,000	$ 1,343	0	11,687	11,687	11,687	11,687	11,687	$ 324
L	4C.19	Regional Carrizo for SSLGC Project Expansion	$28,189,000	$ 568	0	10,364	10,364	10,364	10,364	10,364	$ 331
L	4C.20	Hays/Caldwell PUA Project	$323,296,000	$ 1,245	0	12,000	12,000	35,000	35,000	35,000	$ 439
L	4C.21	GBRA Simsboro Project	$330,782,000	$ 982	0	30,000	30,000	30,000	49,777	49,777	$ 386
L	4C.22	Local Groundwater Supplies (Carrizo)	$166,718,000	$ 687	6,773	11,610	15,440	17,255	23,947	33,874	$ 258
L	4C.22	Local Groundwater Supplies (Gulf Coast)	$2,194,000	$ 1,823	0	0	0	161	161	161	$ 637
L	4C.22	Local Groundwater Supplies (Trinity)	$30,224,000	$ 710	2,016	3,146	3,468	3,630	3,952	4,436	$ 116
L	4C.23	Brackish Wilcox Groundwater for SAWS	$236,220,000	$ 1,245	0	12,000	21,000	26,400	26,400	26,400	$ 465
L	4C.24	Brackish Wilcox Groundwater for RWA	$127,753,000	$ 1,293	0	0	7,600	7,600	13,200	14,700	$ 536
L	4C.25	Brackish Wilcox Groundwater for SSWSC	$14,357,000	$ 1,883	0	0	0	1,120	1,120	1,120	$ 766
L	4C.27	CRWA Wells Ranch Project	$34,910,000	$ 725	11,000	11,000	11,000	11,000	11,000	11,000	$ 672
L	4C.28	CRWA Siesta Project	$53,481,000	$ 1,421	0	0	1,000	5,042	5,042	5,042	$ 497
L	4C.29	LCRA-SAWS Water Project	$1,986,684,000	$ 2,394	0	0	90,000	90,000	90,000	90,000	$ 829
L	4C.30	Medina Lake Firm-Up (ASR)	$146,237,000	$ 1,696	9,933	9,933	9,933	9,933	9,933	9,933	$ 450
L	4C.31	Seawater Desalination	$1,293,827,000	$ 2,284	0	0	0	0	0	84,012	$ 941
L	4C.34	Lavaca River Off-Channel Reservoir	$224,183,000	$ 701	26,242	26,242	26,242	26,242	26,242	26,242	$ 100
L	4C.36	TWA Regional Carrizo	$313,060,000	$ 1,523	0	27,000	27,000	27,000	27,000	27,000	$ 512
L	4C.37	GBRA Integrated Water Power Project	$1,282,426,000	$ 2,290	0	100,000	100,000	100,000	100,000	100,000	$ 1,172

natural resources, consistency comparisons among strategies, recreational effects, third party social and economic impacts of voluntary transfers, efficient use of existing supplies, and water quality considerations. The planning process for the South Central Texas Region is summarized in Figure ES-6.

ES.8 South Central Texas Regional Water Plan

The South Central Texas Regional Water Plan includes recommended water management strategies that emphasize water conservation; maximize utilization of available resources, water rights, and reservoirs; engage the efficiency of conjunctive use of surface and groundwater; include new surface water appropriations while avoiding development of large mainstem reservoirs; and limit depletion of storage in aquifers. There are additional strategies that have significant support within the region, yet require further study regarding quantity of dependable water supply made available during severe drought, feasibility, and/or cost of implementation, that are also included in the Plan. **Water management strategies recommended to meet projected needs in the South Central Texas Region could produce new supplies in excess of ~~755~~855,000 acft/yr in 2060 and may be categorized by source as shown in Figure ES-7.**

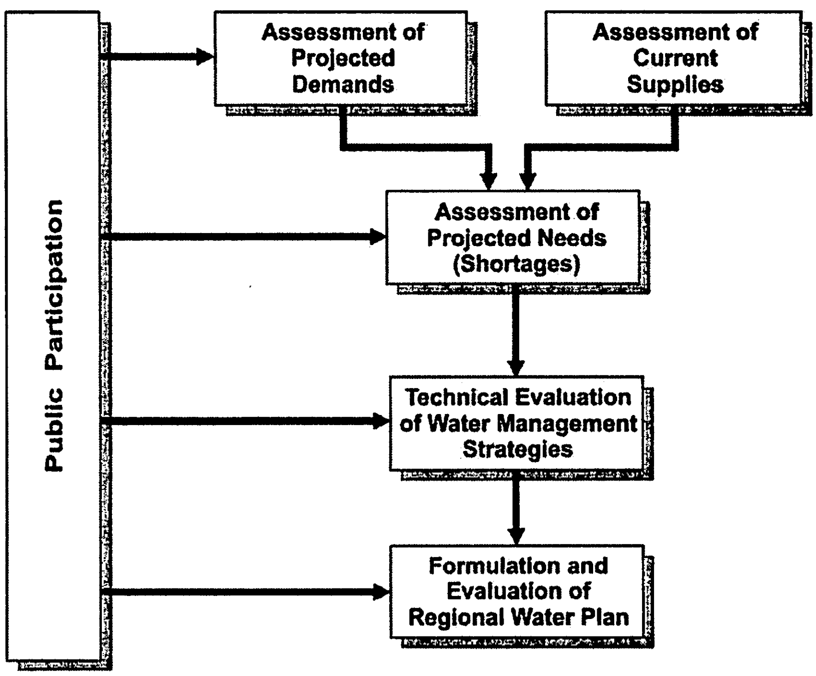

Figure ES-6. Regional Planning Process

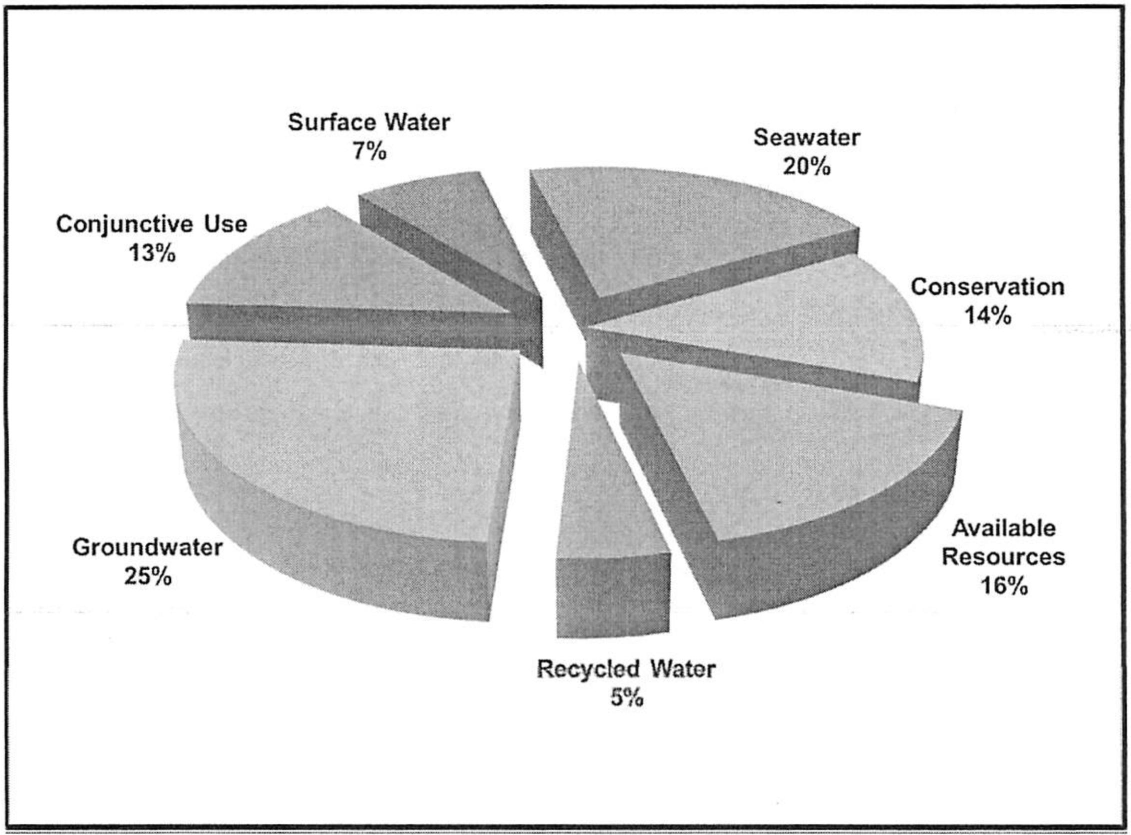

Figure ES-7. Sources of New Supply

Specific recommended water management strategies in the Plan are summarized by approximate timing of potential implementation in Figure ES-8. Water management strategies emphasizing conservation comprise about ~~15.5~~13.7 percent of recommended new supplies and include:

- Municipal Water Conservation (72,666 acft/yr @ $648/acft/yr[3]);
- Irrigation Water Conservation (7,238 acft/yr @ $143/acft/yr);
- Drought Management (41,240 acft/yr); and
- Mining Water Conservation (2,493 acft/yr).

[3] $648/acft/yr is an average cost of municipal water conservation. Actual unit costs vary from WUG to WUG and from decade to decade.

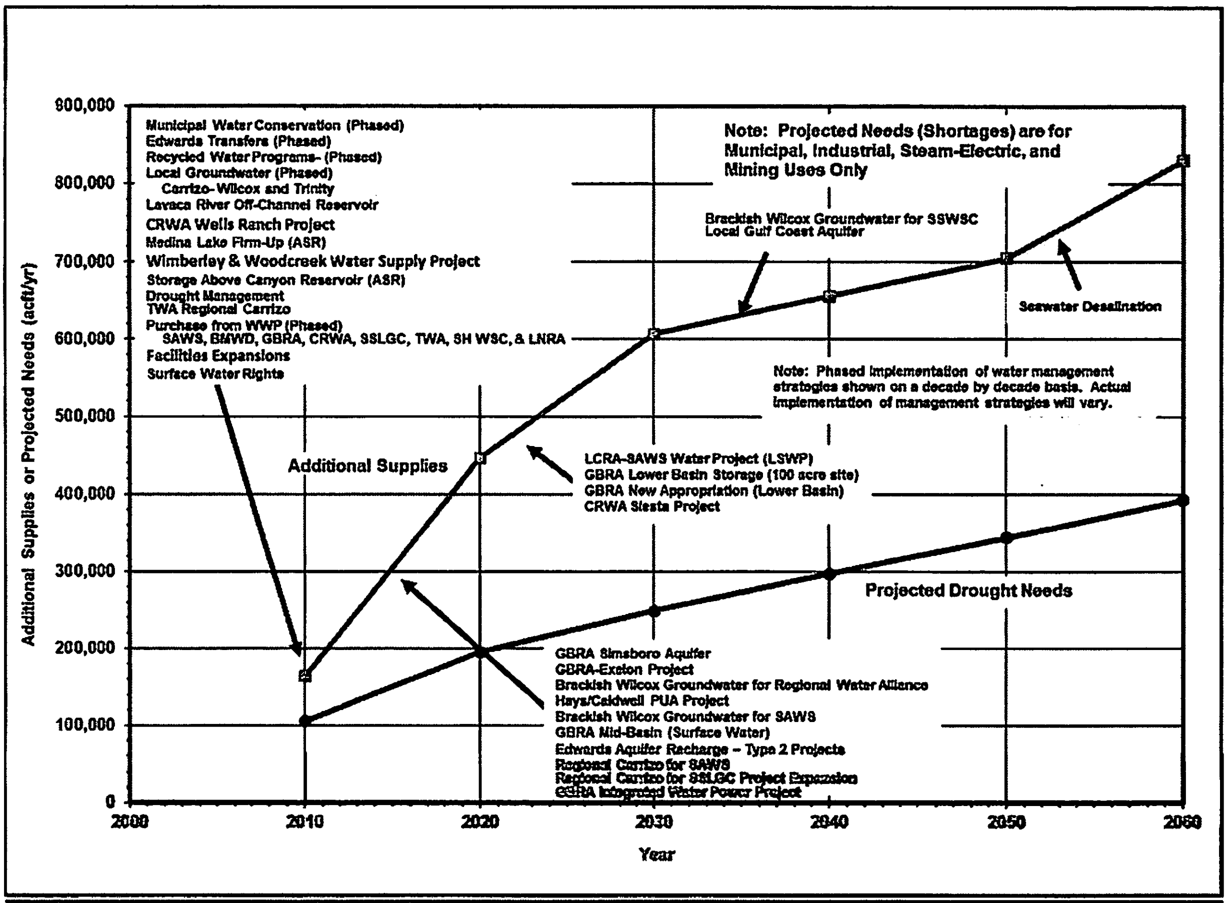

Figure ES-8. Phased Implementation of Water Management Strategies

Water management strategies maximizing use of available resources, water rights, and reservoirs comprise about ~~18.0~~16.1 percent of recommended new supplies and include:

- Edwards Transfers (51,875 acft/yr @ $454/acft/yr);
- GBRA-Exelon Project (49,126 acft/yr @ $641/acft/yr);
- GBRA Lower Basin Storage (100 acre site) (28,369 acft/yr @ $104/acft/yr);
- Medina Lake Firm-Up (ASR) (9,933 acft/yr @ $1,696/acft/yr);
- Wimberley & Woodcreek Water Supply Project (4,480 acft/yr @ $2,453/acft/yr);
- Surface Water Rights[4]; and
- Facilities Expansions.

The Regional Water Plan includes the Recycled Water Programs water management strategy at 41,737 acft/yr which could represent approximately ~~5.2~~4.6 percent of the recommended new supplies.

[4] As new supplies and associated costs have not been quantified, this strategy is more explicitly identified as an activity consistent with the 2011 Regional Water Plan.

Water management strategies that simultaneously develop groundwater supplies and limit depletion of storage in regional aquifers comprise about ~~27.9~~25.0 percent of recommended new supplies and include:

- GBRA Simsboro Project (49,777 acft/yr @ $982/acft/yr)[5];
- Local Groundwater Supplies (Carrizo[6], Gulf Coast, and Trinity) (38,471 acft/yr @ $687/acft/yr - $1,823/acft/yr);
- Hays/Caldwell PUA Project (35,000 acft/yr @ $1,245/acft/yr);
- TWA Regional Carrizo (27,000 acft/yr @ $1,523/acft/yr);
- Brackish Wilcox Groundwater for SAWS (26,400 acft/yr @ $1,245/acft/yr);
- Regional Carrizo for SAWS (11,687 acft/yr @ $1,343/acft/yr);
- Brackish Wilcox Groundwater for Regional Water Alliance (14,700 acft/yr @ $1,293/acft/yr);
- CRWA Wells Ranch Project (11,000 acft/yr @ $725/acft/yr);
- Regional Carrizo for SSLGC Project Expansion (10,364 acft/yr @ $608/acft/yr); and
- Brackish Wilcox Groundwater for SSWSC (1,120 acft/yr @ $1,883/acft/yr).

Water management strategies that engage the efficiency of conjunctive use of surface and groundwater as well as maximize the use of available resources and water rights comprise approximately ~~14.6~~12.9 percent of recommended new supplies and include:

- LCRA-SAWS Water Project (90,000 acft/yr @ $2,394/acft/yr);
- Edwards Aquifer Recharge – Type 2 Projects (21,577 acft/yr @ $1,728/acft/yr); and
- CRWA Siesta Project (5,042 acft/yr @ $1,421/acft/yr).

Water management strategies that involve new surface water appropriations while avoiding development of large mainstem reservoirs comprise approximately ~~8.2~~7.3 percent of recommended new supplies and include:

- Lavaca River Off-Channel Reservoir (26,242 acft/yr @ $701/acft);
- GBRA Mid-Basin Project (Surface Water) (25,000 acft/yr @ $2,204/acft/yr);
- GBRA New Appropriation (Lower Basin) (11,300 acft/yr @ $1,953/acft/yr); and
- Storage Above Canyon Reservoir (ASR) (3,140 acft/yr @ $1,772/acft/yr).

[5] The new firm supply associated with this strategy was reduced from 50,000 acft/yr to 49,777 acft/yr to resolve a potential inter-regional conflict with Region G. This small change did not warrant revision of Section 4C.21. A portion of the new firm supply for this strategy to be obtained from the Carrizo-Wilcox Aquifer in Bastrop County is identified as an "overdraft" to resolve a potential inter-regional conflict with Region K. See the response to TWDB Level I Comment No. 52 in Section 10 for additional information.

[6] The portion of the new firm supply for this strategy to be obtained by Bexar Metropolitan Water District from the Carrizo-Wilcox Aquifer in Bexar County is identified as a "temportary overdraft." See the response to TWDB Level I Comment No. 52 in Section 10 for additional information.

Finally, the Regional Water Plan includes the development of ~~a~~ two Seawater Desalination water management strateg~~y~~ies: ~~at~~ a 84,012 acft/yr (75 mgd) ($2,284/acft/yr) water management strategy and the GBRA Integrated Water Power Project at 100,000 acft/yr ($2,290/acft/yr) which could represent approximately ~~10.5~~20.4 percent of the recommended new supplies.

The South Central Texas Regional Water Planning Group identifies the following as alternative water management strategies that have been technically evaluated in accordance with TWDB rules and may, subject to an appropriate amendment process defined by TWDB rules, replace a recommended water management strategy in the 2011 Regional Water Plan:

- Lower Guadalupe Water Supply Project for Upstream GBRA Needs (60,000 acft/yr @ $1,921/acft/yr);
- GBRA Lower Basin Storage (500 acre site) (59,569 acft/yr @ $109/acft/yr);
- Lower Guadalupe Water Supply Project for Upstream GBRA Needs at Reduced Capacity (35,000 acft/yr @ $2,565/acft/yr);
- GBRA Mid-Basin Project (Conjunctive Use) (25,000 acft/yr @ $1,779/acft/yr);
- Regional Carrizo for Guadalupe Basin (GBRA) (25,000 acft/yr @ $1,280/acft/yr);
- Medina Lake Firm-Up (OCR) (9,078 acft/yr @ $1,197/acft/yr);
- Local Groundwater Supplies (Barton Springs Edwards) (1,358 acft/yr @ $203/acft/yr);
- Calhoun County Brackish Groundwater Project (1,344 acft/yr @ $2,679/acft/yr); and
- Local Groundwater Supplies (Carrizo) (Yancey WSC) (1,210 acft/yr @ $517/acft/yr).

The Regional Water Plan includes several water management strategies that require further study and funding prior to recommendation for implementation. Several of these strategies employ technologies that have been used previously, but further research is necessary to determine the cost of implementation, optimal scale and location, and quantity of dependable water supply that would be available in severe drought. These strategies are:

- Brush Management;
- Weather Modification;
- Rainwater Harvesting;
- Storage Above Canyon Reservoir (Off-Channel);
- Edwards Aquifer Recharge & Recirculation Systems;
- Palmetto Bend – Stage II (LNRA);
- Seawater Desalination for Guadalupe River Basin;
- Mesa Water Supply Project (SAWS);

- SAWS Other Water Supplies (Planned RFP);
- Regional Carrizo for BMWD;
- Regional Carrizo for SSLGC Project Expansion – Wilson County Option;
- CRWA Dunlap Project; and
- Balancing Storage (ASR and/or Surface)[7].

Although specific quantities of new supply dependable in drought have not been determined for these strategies, it is understood that their implementation will contribute positively to storage and system management of many diverse strategies in the Regional Water Plan. The SCTRWPG recommends that State funding be made available to cooperatively support the refinement and implementation of these strategies.

There are significant quantities of projected water supply needs or shortages in the region for municipal, industrial, steam-electric, and mining uses. As indicated in Figure ES-8, implementation of a number of water management strategies on an expedited basis will be necessary to avoid significant hardship, water rationing, and/or cessation of discharge from Comal Springs in the event of severe drought during the next decade. Substantial water supply needs or shortages are also projected for irrigation use in the South Central Texas Region. However, based upon present economic conditions for agriculture and the fact that there are no really low-cost water supplies to be developed, the SCTRWPG has determined that it is not economically feasible to meet projected irrigation needs at this time, since the net farm income to pay for water is less than the costs of water at the potential sources.

Implementation of the 2011 South Central Texas Regional Water Plan will result in the development of new water supplies that will be reliable in the event of a repeat of the most severe drought on record. It is evident in Figure ES-8 that implementation of all recommended water management strategies is not likely to be necessary in order to meet projected needs within the planning period. The SCTRWPG explicitly recognizes the difference between additional supplies and projected needs as System Management Supplies and has recommended water management strategies over and above those apparently needed to meet projected demands in the Regional Water Plan for the following reasons:

- To recognize both the long lead times and the uncertainty associated with risk factors that may prevent implementation of water management strategies and necessitate replacement strategies;

[7] As new supplies and associated costs have not been quantified, this strategy is more explicitly identified as an activity consistent with the 2011 Regional Water Plan.

- To preserve flexibility for water user groups or wholesale water suppliers to select the most feasible projects among several consistent with the Regional Plan and, therefore, ensure that such projects are potentially eligible for permitting and funding;
- To serve as additional supplies in the event that rules, regulations, or other restrictions limit use of any planned strategies; and/or
- To ensure adequate supplies in the event of a drought more severe than that which occurred historically.

Costs associated with the implementation and long-term operations and maintenance of water management strategies have been estimated in accordance with TWDB rules and general guidelines and reflect regional water treatment capacity and balancing storage facilities sufficient to meet peak daily and seasonal water demands in the larger urban areas. **Total estimated project cost (in 2008 dollars) for the recommended water management strategies for municipal supply that will likely require long-term financing for implementation is about $~~7.6~~8.9 billion. Annual unit costs for recommended water management strategies for municipal supply in the 2011 South Central Texas Regional Water Plan (in 2008 dollars) are estimated to range from a low of about $104/acft/yr ($0.32 per 1,000 gallons) for GBRA Lower Basin Storage to a high of about $2,429/acft/yr ($7.45 per 1,000 gallons) for the Wimberley/Woodcreek Water Supply Project and average about $~~1,209~~1,314/acft/yr ($~~3.71~~4.03 per 1,000 gallons).** No costs have been included for projects that are presently under construction, alternative water management strategies, and potentially feasible water management strategies requiring further study.

The South Central Texas Regional Water Planning Group has identified the following environmental benefits and concerns associated with the implementation of the Regional Water Plan.

ES.9 Environmental Benefits

- Substantial commitment to water conservation through adoption of an aggressive water conservation water management strategy effectively reduces projected water shortages thereby delaying or eliminating the need for implementation of other water management strategies having greater associated environmental impacts. Implementation of economically appropriate drought management strategies, as determined at the water user group level, may provide similar benefits while projects delivering reliable water supplies to meet projected needs are permitted and constructed.
- Development of new water supply sources for Bexar, Comal, and Hays Counties reduces reliance on the Edwards Aquifer during drought thereby contributing to maintenance of springflow and protection of endangered species. The Regional Water

Plan recognizes the on-going efforts of the participants in the Edwards Aquifer Recovery Implementation Program (EARIP) to develop a Habitat Conservation Plan which will help to define the requirements for maintenance of springflow and protection of endangered species and meet with approval from the U.S. Fish & Wildlife Service.

- Implementation of the 2011 Regional Water Plan is likely to result in increased instream flows in the San Antonio River. These increases in flow are attributable to increases in treated effluent from all wastewater discharges (most notably associated with projected growth in Bexar County) and increases in springflow (associated with Edwards Aquifer Recharge Type 2 Projects).
- Edwards Aquifer Recharge Enhancement through the construction of Type 2 recharge dams contributes not only to municipal water supply, but also to maintenance of springflow, protection of endangered species in and below the springs, increased instream flows, and increased freshwater inflows to the Guadalupe Estuary.
- The 2011 Regional Water Plan emphasizes beneficial use of existing surface water rights thereby minimizing the development of new water supply sources and associated environmental impacts. Examples include reliance on presently under-utilized water rights held by the Guadalupe-Blanco River Authority (GBRA) and Dow Chemical Company (Dow) below the confluence of the Guadalupe and San Antonio Rivers and by the Lower Colorado River Authority (LCRA) on the Lower Colorado River. Enhanced use of existing surface water rights accounts for approximately one-quarter of the total new water supplies for municipal, industrial, steam-electric, and mining uses by 2060.
- The Regional Water Plan avoids large-scale development of new mainstem reservoirs having associated terrestrial and aquatic habitat and cultural resources impacts and focuses on smaller, off-channel reservoirs.
- Inclusion of Edwards Aquifer transfers from irrigation use to municipal use through lease/purchase of pumpage rights and development of conserved water through installation of LEPA irrigation systems results in substantial increases in municipal water supply without construction of additional transmission and storage facilities having associated environmental effects.
- Inclusion of groundwater development has limited associated environmental effects as compared to those typically associated with development of new surface water supply reservoirs.
- Inclusion of Seawater Desalination and the GBRA Integrated Water Power Project is perceived to have fewer associated environmental effects, as compared to those typically associated with development of new (fresh) surface water supplies.

ES.10 Environmental Concerns

- Potential reductions in freshwater inflows to bays and estuaries, including associated effects on wetland and marsh habitats and marine species, are identified as matters of concern. Primary concerns focus upon the potential effects of the LCRA-SAWS Water Project on freshwater inflows to Matagorda Bay and the GBRA New Appropriation (Lower Basin) on freshwater inflows to the Guadalupe Estuary. It is important to note, however, that as part of the studies directed through the LCRA-

SAWS Definitive Agreement, the Matagorda Bay inflow criteria and the Aquatic Habitat Instream Flow studies were studied thoroughly and shown to meet the legislative directives of protecting Bay Health and the Lower Colorado River aquatic systems. Concerns have also been expressed that increased uses of existing water rights may reduce freshwater inflows to bays and estuaries.

- Concentration of Edwards Aquifer pumpage closer to Comal Springs as a result of implementation of Edwards Transfers tends to reduce discharge from Comal Springs.
- Potential conflicts with stream segments identified by TPWD as ecologically significant are associated with the LCRA-SAWS Water Project, Edwards Recharge – Type 2 Projects, GBRA New Appropriation (Lower Basin), Lavaca River Off-Channel Reservoir, and Storage Above Canyon (ASR).
- Potential effects on small springs and instream flows below these springs may be associated with the development of groundwater supplies.
- Intake siting, brine discharge location(s), and potential effects on marine habitat and species, as well as large demands for electrical power, are environmental concerns associated with Seawater Desalination and the GBRA Integrated Water Power Project.

ES.11 Regional Water Plan Summary

Recommended water management strategies to meet the projected needs of each city, utility, water user group, and wholesale water provider in the South Central Texas Region are summarized by county in Table ES-4.

ES.12 Summary of the First Biennium Studies

ES.12.1 Study 1 – Lower Guadalupe Water Supply Project for Upstream GBRA Needs

The purpose of Study 1 was 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 provided information of relevance to the SCTRWPG for consideration of a refined LGWSP for Upstream GBRA Needs as a recommended or alternative water management strategy (WMS) in the 2011 SCTRWP. Ultimately, both the LGWSP for Upstream GBRA Needs WMS (Section 4C.12) and the LGWSP for Upstream GBRA Needs at Reduced Capacity WMS (Section 4C.11) are listed as alternative WMS for GBRA in the 2011 Initially Prepared Plan.

Table ES-4 (Concluded)

County/Water User Group	Demand 2010 (acft)	Demand 2060 (acft)	Need (Shortage) 2010 (acft)	Need (Shortage) 2060 (acft)	Recommended Management Strategies to Meet Needs (Shortages)	Amount from WMS 2010 (acft)	Amount from WMS 2060 (acft)
Guadalupe-Blanco River Authority					GBRA Lower Basin Storage		26,452
					GBRA New Appropriation (Lower Basin)		11,500
					Western Canyon WTP Expansion		5,600
					GBRA Integrated Water Power Project		100,000
Bexar Met	43,439	57,954	16,638	35,418	Municipal Water Conservation[2]		
					Edwards Transfers	3,000	3,000
					Local Trinity	2,016	2,016
					Local Carrizo	4,030	16,129
					Medina Lake Firm-Up (ASR – 15 wells)	9,933	9,933
					Purchase from WWP (CRWA)	2,800	8,250
Canyon Regional Water Authority	21,054	53,534	7,920	40,400	Municipal Water Conservation[2]		
					Wells Ranch Project Phase I	5,200	5,200
					Wells Ranch Project Phase II	5,800	5,800
					Purchase from WWP (GBRA)		5,000
					Brackish Wilcox Groundwater for RWA		11,200
					Siesta Project		5,042
					Hays/Caldwell PUA Project		10,260
Lavaca-Navidad River Authority			10,046	10,489	Municipal Water Conservation[2]		
					Lavaca River Off-Channel Reservoir	26,242	26,242
Schertz-Seguin Local Government Corp.	12,704	21,071	0	4,935	Municipal Water Conservation[2]		
					Regional Carrizo for SSLGC Project Expansion		10,364
					Brackish Wilcox Groundwater for RWA		2,000
Springs Hill WSC	3,384	5,365	0	0	Municipal Water Conservation[2]		
					Purchase from WWP (TWA)		3,000
					Brackish Wilcox Groundwater for RWA		1,500
Texas Water Alliance	0	18,480	0	18,480	Municipal Water Conservation[2]		
					TWA Regional Carrizo	27,000	27,000

[1] Historical per capita water use data unavailable or insufficient for calculation of yield.
[2] Municipal Water Conservation

ES.12.2 Study 2 – Brackish Groundwater Supply Evaluation

Study 2 included evaluations of example brackish groundwater projects in: (1) the Gulf Coast Aquifer with projects in southern Calhoun County and Refugio County for the City of Woodsboro and potential developments near Copano Bay; and (2) the Wilcox and Edwards Aquifers in the vicinity of southern Bexar County for municipal supplies in Bexar County. These three aquifers and diverse locations were related, in part, as illustrative examples for evaluation of brackish groundwater as municipal water supply. Evaluations of these water management strategies were intended to demonstrate the range of technical considerations and potential costs associated with development of this water source in Region L.

Based on preliminary information on brackish groundwater and water supply needs in the three areas of interest, the following four strategies were identified for the use of brackish groundwater. They are:

- Gulf Coast Aquifer in southern Calhoun County for potential new development in the vicinity of Seadrift and Port O'Connor;
- Gulf Coast Aquifer in southeastern Refugio County that would replace the conventional groundwater supply for the City of Woodsboro and potential new developments near Copano Bay;

- Wilcox Aquifer in Bexar, Atascosa, and Wilson Counties to provide supplemental water to SAWS (Bexar County); and
- Edwards Aquifer from southern Bexar County to provide supplemental water to SAWS (Bexar County).

In the 2011 Plan, the Wilcox Aquifer in Bexar, Atascosa, and Wilson Counties portion of Study 2 is revised and presented as the Brackish Wilcox Groundwater for SAWS WMS (Section 4C.23). It is a recommended water management strategy for SAWS that will provide up to 26,400 acft/yr of new supply. In addition, a smaller scale version of the Gulf Coast Aquifer in southern Calhoun County portion of Study 2, called Calhoun County Brackish Groundwater Project (Section 4C.26), is listed as an alternative WMS for GBRA to potentially meet needs in portions of Calhoun County should other supplies be unavailable.

ES.12.3 Study 3 – Enhanced Water Conservation, Drought Management, and Land Stewardship

Study 3, Enhanced Water Conservation, Drought Management, and Land Stewardship of the First Biennium of the 2011 South Central Texas Regional Water Plan (SCTRWP) focused on four subject areas of particular interest to the South Central Texas Regional Water Planning Group (SCTRWPG). These four subject areas were fundamental water conservation, as recommended to meet projected needs for additional water supply throughout the South Central Texas Regional Water Planning Area in the 2006 South Central Texas Regional Water Plan, and enhanced water conservation through such means as condensate collection for water supply, drought management, and land stewardship.

Water Conservation (Section 4C.1) continues to be a primary water management strategy in the 2011 Plan. Drought Management (Section 4C.2) is a recommended water management strategy in the 2011 IPP. In addition, Land Stewardship, also identified as Brush Management (Above Canyon Reservoir) (Section 4C.7) has been evaluated in cooperation with Texas A&M University researchers, and is designated as a water management strategy requiring further study and/or funding.

ES.12.4 Study 4 – Environmental Studies

The purpose of Study 4 was to continue environmental studies focused on bays & estuaries, instream flows, bottomland hardwoods, endangered species, and other relevant subjects of interest to the regional water planning group. The results of Study 4 provided information relevant to the potential environmental effects of the regional water plan and aided planning group members in making decisions regarding water management strategies to be recommended for implementation in the 2011 South Central Texas Regional Water Plan (SCTRWP).

Study 4 Part A (Study 4A) focused on three tasks:

1. Research and refine estimates of historical diversions and effluent discharges affecting flows in the lower Guadalupe River and freshwater inflows to the Guadalupe Estuary prior to 1977.
2. Perform ecologically-based streamflow assessments (similar to those for the Guadalupe Estuary in Section 7 of the 2006 Regional Plan) for the Guadalupe River at Victoria and the San Antonio River at Falls City.
3. Develop and deliver presentation materials and GIS-based graphics to support SCTRWPG and education programs focused on regulatory processes, endangered species habitat ranges, and other factors potentially affecting implementation of planned strategies.

Study 4B summarized work performed by Texas A&M University (TAMU) and was presented in a separate report. TAMU developed an ecosystem simulation model that integrated existing project field data with information from the scientific literature to project possible ecosystem responses to variation in freshwater inflows to the Guadalupe Estuary.

The procedures outlined in the ecologically-based streamflow assessment of Study 4A were used to quantify and assess the cumulative effects of the 2011 Plan as summarized in Section 7.

ES.12.5 Study 5 – Environmental Evaluations of Water Management Strategies

The South Central Texas Regional Water Planning Group (SCTRWPG) has prepared two regional water plans[8,9] with unique focus on quantitative reporting of potential effects of plan implementation on surface water flows, groundwater levels, surface water / groundwater interactions, water quality and aquatic habitat, vegetation and terrestrial habitat, endangered and threatened species, and cultural resources. Despite its past efforts, the SCTRWPG has continued

[8] South Central Texas Regional Water Planning Group, "2001 South Central Texas Regional Water Plan," Vols. I, II, & III, Texas Water Development Board, San Antonio River Authority, HDR Engineering, Inc., et al., January 2001.

[9] South Central Texas Regional Water Planning Group, "2006 South Central Texas Regional Water Plan," Vols. I & II, Texas Water Development Board, San Antonio River Authority, HDR Engineering, Inc., et al., January 2006.

to improve its environmental assessments in the 2011 South Central Texas Regional Water Plan (SCTRWP). Seeking the best environmental assessments economically feasible for regional planning purposes as a long-term goal, the South Central Texas Regional Water Planning Group (SCTRWPG) formed an Environmental Assessment Committee in November 2007. The Environmental Assessment Committee made a number of recommendations to the SCTRWPG regarding the environmental evaluations of WMSs. All of these recommendations are reflected in the technical evaluations of WMS (Volume II) and assessments of cumulative effects (Section 7, Volume I) in the 2011 Plan.

- GBRA Integrated Water Power Project to be implemented prior to 2020. This strategy can provide an additional 100,000 acft/yr for 2020 through 2070.

The following are alternative water management strategies: Lower Guadalupe Water Supply Project (LGWSP) for Upstream GBRA Needs, GBRA Lower Basin Storage (500 acre Site), Regional Carrizo for Guadalupe Basin (GBRA), GBRA Mid-Basin (Conjunctive Use), and Calhoun County Brackish Groundwater.

Table 4B.3.4-1. Recommended Water Supply Plan for GBRA

	2010 (acft/yr)	2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)
Projected Need (Shortage)*	0	10,226	23,808	36,564	51,163	67,580
Recommended Plan						
Municipal Water Conservation[1]	—	—	—	—	—	—
Wimberley and Woodcreek Water Supply Project	1,120	4,480	4,480	4,480	4,480	4,480
GBRA Simsboro Aquifer	—	30,000	30,000	30,000	49,777	49,777
GBRA Mid-Basin (Surface Water)	—	25,000	25,000	25,000	25,000	25,000
Storage Above Canyon Reservoir (ASR)	—	3,140	3,140	3,140	3,140	3,140
GBRA-Exelon Project	—	49,126	49,126	49,126	49,126	49,126
GBRA Lower Basin Storage	—	—	28,369	28,369	28,369	28,369
GBRA New Appropriation (Lower Basin)	—	—	11,300	11,300	11,300	11,300
Western Canyon WTP Expansion	—	—	—	—	5,600	5,600
GBRA Integrated Water Power Project (IWPP)		100,000	100,000	100,000	100,000	100,000
Total New Supply	**4,480**	**~~107~~207,266**	**~~146~~246,935**	**~~146~~246,935**	**~~172~~272,312**	**~~172~~272,312**

** Projected needs in upper portion of GBRA district are offset by management supplies in the lower portion of the GBRA district.*
[1] Assigned by Water User Group based on Municipal Conservation water management strategy recommended by SCTRWPG.

Estimated costs of the recommended plan to meet the GBRA projected needs are shown in Table 4B.3.4-2.

Table 4B.3.4-2. Recommended Plan Costs by Decade for GBRA

Plan Element	2010	2020	2030	2040	2050	2060
Municipal Water Conservation[1]						
Annual Cost ($/yr)	—	—	—	—	—	—
Unit Cost ($/acft)	—	—	—	—	—	—
Wimberley and Woodcreek Water Supply Project						
Annual Cost ($/yr)	$2,747,360	$10,989440	$9,253,000	$9,253,000	$9,253,000	$9,253,000
Unit Cost ($/acft)	$2,453	$2,453	$2,065	$2,065	$2,065	$2,065
GBRA Simsboro Aquifer						
Annual Cost ($/yr)	—	$29,460,000	$29,460,000	$11,580,000	$19,300,000	$19,300,000
Unit Cost ($/acft)	—	$982	$982	$386	$386	$386
GBRA Mid-Basin (Surface Water)						
Annual Cost ($/yr)	—	$46,975,000	$46,975,000	$16,200,000	$16,200,000	$9,250,000
Unit Cost ($/acft)	—	$1,879	$1,879	$648	$648	$370
Storage Above Canyon Reservoir (ASR)						
Annual Cost ($/yr)	—	$5,564,080	$5,564,080	$1,843,180	$1,843,180	$1,843,180
Unit Cost ($/acft)	—	$1,772	$1,772	$587	$587	$587
GBRA-Exelon Project						
Annual Cost ($/yr)	—	$31,735,396	$31,735,396	$22,990,968	$22,990,968	$11,004,224
Unit Cost ($/acft)	—	$646	$646	$468	$468	$224
GBRA Lower Basin Storage						
Annual Cost ($/yr)	—	—	$2,751,008	$2,751,008	$1,587,120	$1,587,120
Unit Cost ($/acft)	—	—	$104	$104	$60	$60
GBRA New Appropriation (Lower Basin)						
Annual Cost ($/yr)	—	—	$21,585,000	$21,585,000	$2,521,000	$2,521,000
Unit Cost ($/acft)	—	—	$1,910	$1,910	$223	$223
Western Canyon WTP Expansion						
Annual Cost ($/yr)	—	—	—	—	$1,764,000	$1,764,000
Unit Cost ($/acft)	—	—	—	—	$315	$315
GBRA Integrated Water Power Project						
Annual Cost ($/yr)	—	$228,997,000~~$254,877,000~~	$228,997,000~~$254,877,000~~	$117,189,000~~$118,695,517~~	$117,189,000~~$118,695,517~~	$117,189,000~~$118,695,517~~
Unit Cost ($/acft)	—	$2,~~549~~290	$2,290~~549~~	$1,172~~87~~	$1,172~~87~~	$1,172~~87~~

[1] These costs have been assigned to the individual Water User Groups.

4B.3.5 Lavaca-Navidad River Authority (LNRA)

Lavaca-Navidad River Authority obtains its supply from Lake Texana Stage I and is projected to have shortages throughout the planning period. Working within the planning criteria established by the SCTRWPG and the TWDB, it is recommended that LNRA implement the following water supply plan to meet the projected needs for LNRA (Table 4B.3.5-1).

- Lavaca River Off-Channel Reservoir to be implemented prior to 2010. This strategy can provide an additional 26,242 acft/yr of supply, starting in 2020 and continuing through 2060.
- Facilitate temporary reallocation of presently contracted supplies to meet projected needs of Point Comfort until addition firm supplies are developed.

Table 4B.3.5-1.
Recommended and Alternative Water Supply Plan for LNRA

	2010 (acft/yr)	2020 (acft/yr)	2030 (acft/yr)	2040 (acft/yr)	2050 (acft/yr)	2060 (acft/yr)
Projected Need (Shortage)*	10,046	10,145	10,322	10,499	10,489	10,489
Recommended Plan						
Lavaca River Off-Channel Reservoir	26,242	26,242	26,242	26,242	26,242	26,242
Total New Supply	**26,242**	**26,242**	**26,242**	**26,242**	**26,242**	**26,242**

Projected needs are reported only for the portion of LNRA service area within Calhoun County in Region L. 10,000 acft/yr of the projected need is for Formosa Plastics Corporation based on information provided by LNRA during an inter-regional coordination meeting held on April 8, 2009. The remainder is for Point Comfort.

Estimated costs of the recommended and alternative plan to meet the LNRA projected needs are shown in Table 4B.3.5-2.

Table 4B.3.5-2.
Recommended and Alternative Plan Costs by Decade for LNRA

Recommended Plan Element	2010	2020	2030	2040	2050	2060
Municipal Water Conservation[1]						
Annual Cost ($/yr)	—	—	—	—	—	—
Unit Cost ($/acft)	—	—	—	—	—	—
Lavaca River Off-Channel Reservoir						
Annual Cost ($/yr)	$18,395,642	$18,395,642	$14,774,246	$14,774,246	$2,624,200	$2,624,200
Unit Cost ($/acft)	$701	$701	$563	$563	$100	$100

[1] *These costs have been assigned to the individual Water User Groups.*

4B.3.6 Schertz-Seguin Local Government Corporation (SSLGC)

Current water supply for SSLGC is obtained from the Carrizo Aquifer. SSLGC is projected to need additional water supplies prior to the year 2040. Working within the planning criteria established by the SCTRWPG and the TWDB, it is recommended that SSLGC implement the following water supply plan to meet the projected needs for SSLGC (Table 4B.3.6-1).

- Municipal Water Conservation to be implemented or enhanced in the immediate future. This strategy has been assigned to each individual Water User Group (WUG) based on the Municipal Conservation water management strategy recommended by the SCTRWPG.
- Regional Carrizo for SSLGC Project Expansion[12] to be implemented prior to 2020. This strategy can provide an additional 10,364 acft/yr of supply in the year 2020 through 2060.
- Brackish Wilcox Groundwater for RWA[18] to be implemented prior to 2030. This strategy can provide an additional 2,000 acft/yr of supply in the year 2030 through 2060.

An alternative water management strategy is the Regional Carrizo for SSLGC Project Expansion – Wilson County Option.

[12] Part or all of the water needed by this Water Management Strategy (WMS) is anticipated to be supplied from locations within the jurisdiction of a groundwater conservation district (District) and may exceed the amount of available water identified in the District's approved management plan, or may for other reasons not be permitted by the District. The amount of water needed by this WMS that exceeds the available water in the District's management plan, or for other reasons is not permitted by the District, cannot be implemented as part of this WMS unless and until all necessary permits are received from the District. The amount of water needed by this WMS that exceeds the available water in the District's management plan, or for other reasons is not permitted by the District, introduces an added element of uncertainty to reliance upon this WMS and, therefore, additional management supplies may be needed for this WMS.

Appendix D, Table 3 (Continued)

County/Water User Group	Demand 2010 (acft)	Demand 2060 (acft)	Need (Shortage) 2010 (acft)	Need (Shortage) 2060 (acft)	Recommended Management Strategies to Meet Needs (Shortages)	Amount from WMS 2010 (acft)	Amount from WMS 2060 (acft)
Victoria County	Table 2-12		Table 4A-1		Section 4B.2.19		
Victoria	11,924	14,360	0	0	Municipal Water Conservation	874	2,485
Rural	2,666	3,674	0	310	Municipal Water Conservation		32
					Purchase from WWP (GBRA)		310
Industrial	28,726	43,520	0	14,441	Purchase from WWP (GBRA)		14,441
Steam-Electric	4,052	53,178	1,791	51,076	Purchase from WWP (GBRA - Exelon)		49,126
					Purchase from WWP (GBRA)	1,791	1,950
					Steam Electric Water Conservation	500	500
Mining	3,944	6,041	0	0			
Irrigation	9,936	4,759	0	0			
Livestock	1,085	1,085	0	0			
Wilson County	Table 2-12		Table 4A-1		Section 4B.2.20		
Floresville	1,805	3,000	0	433	Municipal Water Conservation	136	714
					Local Carrizo Aquifer		484
La Vernia	278	764	0	0	Municipal Water Conservation	21	227
					Purchase from WWP (CRWA)	400	400
Oak Hills WSC	693	2,160	0	298	Municipal Water Conservation		136
					Local Carrizo Aquifer		323
Poth	348	585	0	0	Municipal Water Conservation	20	64
SS WSC	1,563	5,030	223	3,690	Municipal Water Conservation		221
					Local Carrizo Aquifer	807	4,033
					Purchase from WWP (CRWA)		690
					Brackish Wilcox Groundwater for SS WSC		1120
					Drought Management	78	
Stockdale	350	558	0	0	Municipal Water Conservation	27	171
Sunko WSC	613	1,326	0	16	Municipal Water Conservation	3	92
					Local Carrizo Aquifer		161
Rural	609	2,006	0	33	Municipal Water Conservation		116
Industrial	1	1	0	0			
Steam-Electric	0	0	0	0			
Mining	242	218	0	0			
Irrigation	11,296	6,330	0	0			
Livestock	1,808	1,808	0	0			
Zavala County	Table 2-12		Table 4A-1		Section 4B.2.21		
Crystal City	2,247	2,370	0	0	Municipal Water Conservation	192	1,002
Rural	864	1,371	0	0	Municipal Water Conservation	42	149
Industrial	1,043	1,315	0	0			
Steam-Electric	0	0	0	0			
Mining	122	130	0	0			
Irrigation	71,800	58,692	54,600	41,492	Irrigation Water Conservation	6,948	6,948
Livestock	756	756	0	0			
Wholesale Water Providers	Tables 2-13 through 2-19		Table 4A-3		Section 4B.3		
San Antonio Water System	217,954	328,442	73,600	193,264	Municipal Water Conservation[2]		
					Drought Management	37,622	0
					Edwards Transfers	35,935	35,935
					ASR Project and Phased Expansion	3,800	16,000
					Recycled Water Program Expansion	15,127	15,127
					Regional Carrizo for Bexar County		11,687
					Edwards Aquifer Recharge – Type 2 Projects		21,577
					Brackish Groundwater Desalination (Wilcox)		26,400
					LCRA/SAWS Water Project		90,000
					Seawater Desalination		84,012
Guadalupe-Blanco River Authority	137,065	279,484	0	67,580	Municipal Water Conservation[2]		
					Wimberley and Woodcreek Water Supply Project	4,480	
					Simsboro Groundwater Project		49,777
					GBRA Mid-Basin/Gonzales Project (Surface Water)		25,000
					Storage Above Canyon Reservoir (ASR)		3,140
					GBRA/Exelon Project		49,126
					GBRA Lower Basin Storage		28,369
					GBRA New Appropriation (Lower Basin)		11,500
					GBRA Integrated Water Power Project		100,000
					Western Canyon WTP Expansion		5,600
Bexar Met	43,439	57,954	16,638	35,418	Municipal Water Conservation[2]		
					Edwards Transfers	3,000	3,000
					Local Trinity	2,016	2,016
					Local Carrizo	4,030	16,129
					Medina Lake Firm-Up (ASR – 15 wells)	9,933	9,933
					Purchase from WWP (CRWA)	2,800	8,250

4C.37 GBRA Integrated Water Power Project (IWPP)

4C.37.1 Description of Water Management Strategy

Desalination of seawater from the Gulf of Mexico along the Texas coast is a potential source of freshwater supplies for municipal and industrial use. The GBRA Integrated Water Power Project (IWPP) water management strategy includes a large-scale seawater desalination water treatment plant with a finished water production capacity of 100,000 acft/yr (89.3 MGD). GBRA is currently conducting a feasibility study, performed by MWH Global (MWH) and funded, in part by the Texas General Land Office (GLO) and the Texas Sustainable Energy Research Institute at the University of Texas at San Antonio (UTSA), to determine the best location, operations, and delivery points for a large-scale desalination water treatment plant co-located with a power plant. This feasibility study is in a relatively early phase of its development and the latest information is summarized in an MWH memorandum attached as Section 4C.37.A.

For regional water planning purposes recognizing that feasibility studies are on-going, GBRA proposes a preliminary water treatment plant location in Calhoun County and transmission facilities to accommodate potential delivery locations in Calhoun, Victoria, DeWitt, and Gonzales Counties as an example of how the project could develop. As the MWH feasibility study continues, refinement of these preliminary assumptions is expected.

The example IWPP technically evaluated herein includes raw water intake and brine disposal in the Gulf of Mexico, a seawater desalination treatment plant located near Port O'Connor, and treated water transmission facilities terminating near Gonzales as shown in Figure 4C.37-1. The seawater desalination process produces a brine concentrate that is conveyed out to the open Gulf of Mexico for diffusion in deep water.

4C.37.1.1 General Desalination Background

Commercially available processes used to desalinate seawater and brackish groundwater for production of potable water include:

- Distillation (thermal) Processes; and
- Membrane (non-thermal) Processes.

The following sub-sections briefly describe each of these processes and discuss selected issues to be considered before selecting a process for desalination of seawater.

4C.37.1.2 Distillation (Thermal) Processes

Distillation processes produce purified water by vaporizing a portion of the saline feedstock to form steam. Since the salts dissolved in the feedstock are nonvolatile, they remain unvaporized and the steam formed is captured as a pure condensate. Distillation processes are normally energy-intensive, expensive, and used for large-scale desalination of seawater. Heat is usually supplied by steam produced by boilers or from a turbine power cycle used for electric power generation. Distillation plants are commonly co-sited with power plants.

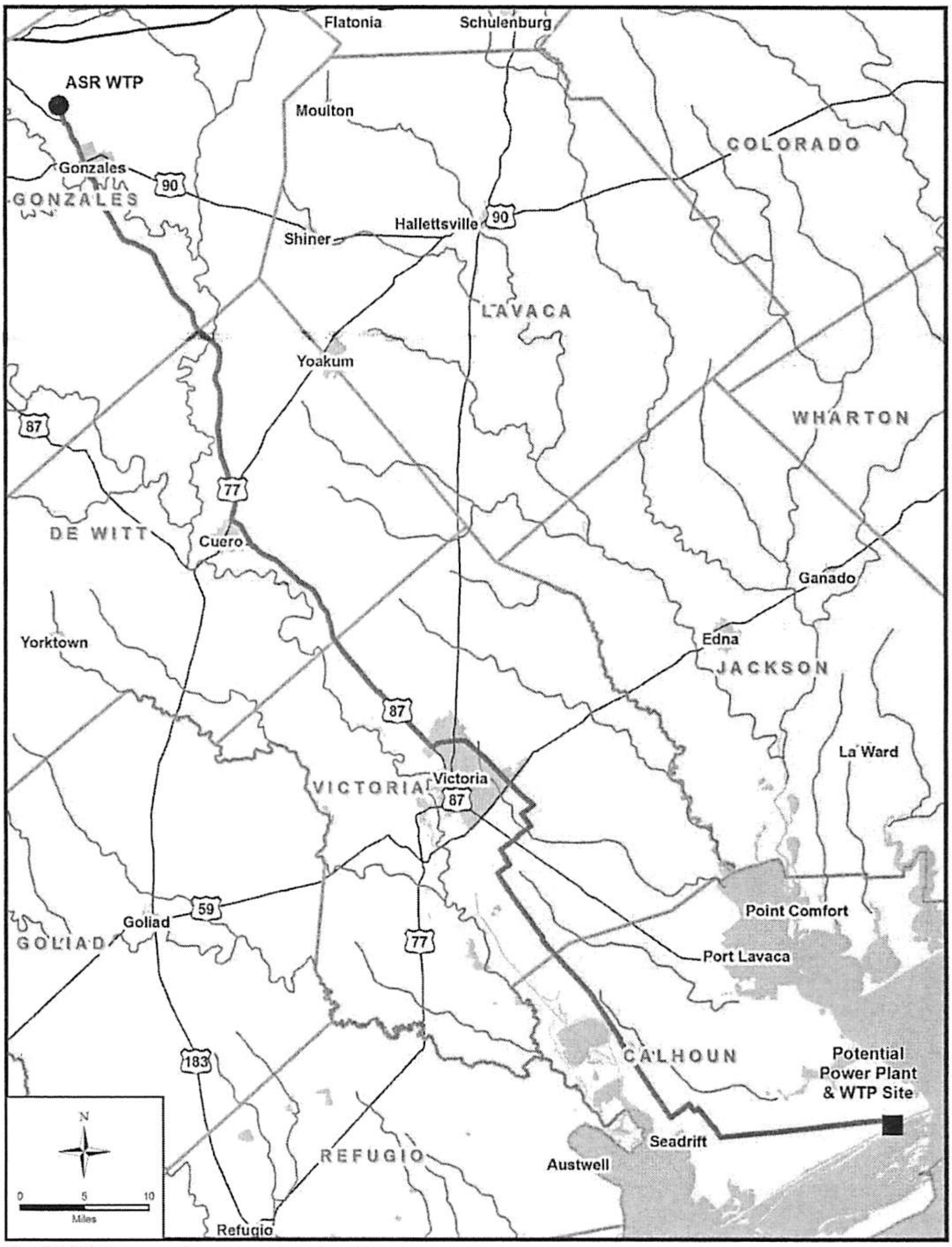

Figure 4C.37-1. GBRA IWPP Location Map

In general, for a specific plant capacity, the equipment in distillation plants tends to be much larger than membrane desalination equipment. However, distillation plants do not have the stringent feedwater quality requirements of membrane plants. Due to the relatively high temperatures required to evaporate water, distillation plants have high-energy requirements, making energy a significant factor in the overall water cost. The high operating temperatures can result in scaling (precipitation of minerals from the feedwater), which reduces the efficiency of the evaporator processes, because, once an evaporator system is constructed, the size of the exchange area and the operating profile are fixed, leaving energy transfer as a function of only the heat transfer coefficient. Therefore, any scale that forms on heat exchanger surfaces reduces heat transfer coefficients. Under normal circumstances, scale can be controlled by chemical inhibitors, which inhibit, but do not eliminate, scale and by operating at temperatures of less than 200°F.

Distillation product water recoveries normally range from 15 to 45 percent, depending on the process. The product water from these processes is nearly mineral free, with very low total dissolved solids (TDS) of less than 25 mg/L. However, this product water is extremely aggressive and is too corrosive to meet the Safe Drinking Water Act (SDWA) corrosivity standards without post-treatment. Product water can be stabilized by chemical treatment or by blending with other potable water.

The three main distillation processes in use today are Multistage Flash Evaporation (MSF), Multiple Effect Distillation (MED), and Vapor Compression (VC). All three of these processes utilize an evaporator vessel that vaporizes and condenses the feedstock. The three processes differ in the design of the heat exchangers in the vessels and in the method of heat introduction into the process. Since there are no active, large-scale distillation processes in Texas that can be shown as comparable installations, distillation is not further considered herein. However, there are membrane desalination operations in Texas, so the following discussion and analyses are based upon information from the use of membrane technology for desalination.

4C.37.1.3 Membrane (Non-thermal) Processes

The two types of membrane processes use either pressure, as in reverse osmosis, or electrical charge, as in electrodialysis reversal, to reduce the mineral content of water. Both processes use semi-permeable membranes that allow selected ions to pass through while other ions are blocked. Electrodialysis reversal (EDR) uses direct electrical current applied across a vessel to attract the dissolved salt ions to their opposite electrical charges. EDR can desalinate brackish water with TDS up to several thousand mg/L, but energy requirements make it economically uncompetitive for seawater, which typically contains approximately 35,000 mg/L

TDS. As a result, only reverse osmosis (RO) is considered for the example seawater desalination project described herein.

RO utilizes a semi-permeable membrane that limits the passage of salts from the saltwater side to the freshwater side of the membrane. Electric motor driven pumps or steam turbines (in dual-purpose installations) provide the 800 to 1,200 psi pressure necessary to overcome the osmotic pressure and drive the saltwater through the membrane, leaving a waste stream of brine/concentrate. The basic components of an RO plant include pre-treatment, high-pressure pumps, membrane assemblies, and post-treatment. Pretreatment is essential because feedwater must pass through very narrow membrane passages during the process and suspended materials, biological growth, and some minerals can foul the membrane. As a result, virtually all suspended solids must be removed and the feedwater must be pre-treated so precipitation of minerals or growth of microorganisms does not occur on the membranes. This is normally accomplished by various levels of filtration and chemical additives and inhibitors. Post-treatment of product water is usually required prior to distribution to reduce its corrosivity and to improve its aesthetic qualities. Specific treatment requirements are dependent on product water composition.

A "single pass/stage" seawater RO plant will produce water with a TDS of 150 to 500 mg/L, most of which is sodium and chloride. The product water will be corrosive, but this may be acceptable, if a source of blending water is available. If not, and if post-treatment is required, care must be exercised to ensure that post-treatment additives do not cause product water to exceed desired TDS levels.

Recovery rates up to 50 percent are common for seawater RO facilities. The recovery rate is dependent on raw water quality and, specifically, the concentrations of dissolved constituents. Higher recovery rates can be obtained for water drawn from a bay or other location that is blended with freshwater resulting in lower TDS. RO plants, which comprise about 59 percent of world-wide desalination capacity, range from a few gallons per day to 130 MGD. The largest seawater RO plant in the United States is the 25-MGD plant in Tampa, Florida. There are several recently completed seawater RO plants, mainly in the Middle East, with capacities around 85 MGD. The current domestic and worldwide trend is for the adoption of RO when a single purpose seawater desalination plant is to be constructed. RO membranes have improved significantly over the past two decades, particularly with respect to efficiency, longer life, and lower prices.

Table 4C.37-1.
Municipal Use Desalination Plants in Texas
(>25,000 gpd and as of 2008)

Location	Source	Total Capacity (MGD)	Desalination Capacity (MGD)	Membrane Type[1]
Abilene, City of	Surface Water	8	8	RO
Bardwell, City of	Groundwater	0.12	0.12	RO
Bayside, City of	Groundwater	0.15	0.15	RO
Brownsville, City of	Groundwater	7.5	7.5	RO
Burleson County MUD 1	Groundwater	0.43	0.43	RO
Country View Estates	Groundwater	0.18	0.18	RO
Dell City, City of	Groundwater	0.11	0.11	EDR
Electra, City of	Groundwater	2.23	2.23	RO
El Paso, City of	Groundwater	27.5	27.5	RO
Ft. Stockton, City of	Groundwater	7.0	6.0	RO
Granbury, City of	Surface Water	0.35	0.35	EDR
Haciendas del Norte (El Paso)	Groundwater	0.23	0.11	RO
Horizon Regional MUD (El Paso)	Groundwater	4	2.2	RO
Kenedy, City of	Groundwater	2.86	0.72	RO
Lake Granbury	Surface Water	10	6	RO
Los Ybanez, City of	Groundwater	0.11	0.11	RO
Oak Trail Shores	Lake Water	1.85	0.79	EDR
Primera, City of	Groundwater	2.5	2	RO
Robinson, City of	Surface Water	2.38	1.8	RO
Seadrift, City of	Groundwater	0.61	0.52	RO
Sherman, City of	Surface Water	10.0	7.5	EDR
Sportsman's World	Surface Water	0.17	0.17	RO
Southmost RWA	Groundwater	7.5	6.75	RO
Windermere Water System	Groundwater	2.88	1	RO

[1] RO = Reverse Osmosis EDR = Electrodialysis Reversal

4C.37.1.4 Examples of Relevant Existing Desalination Projects

Tampa, Florida: Tampa Bay Water has constructed a nominal 25 MGD reverse osmosis (RO) seawater desalination plant. The water treatment plant came online in 2010 at a cost of $158 million, lower than other desalination plants around the world. Some reasons for this might include:

1. Salinity at the Tampa Bay sites ranges from 25,000 to 30,000 mg/L, lower than the more common 35,000 mg/L for seawater. RO cost is sensitive to salinity.
2. The power cost, which is interruptible, is below $0.04 per kilowatt-hour (kWh).
3. Construction cost savings through use of existing power plant canals for intake and concentrate discharge.

4. Economy of scale at 25 MGD.
5. Use of tax-exempt bonds for financing.

The Tampa costs compare with other large-scale desalination projects that have completed construction and become operational in the last several years.

Large-Scale Demonstration Seawater Desalination in Texas: The Texas Water Development Board (TWDB) funded several studies to evaluate the feasibility of large-scale desalination in Texas. As part of this initiative, Corpus Christi, Freeport, and the Lower Rio Grande Valley-Brownsville area were selected as potential locations for large-scale seawater desalination and feasibility studies were conducted for each of these locations. The draft feasibility reports were submitted to TWDB in August 2004 and indicated that the demonstration seawater desalination projects for the three locations are technically feasible. However, all three draft reports indicate that the estimated total costs for capital and O&M of the proposed projects would exceed the cost of alternative sources of drinking water at these locations[1].

Subsequent to the initial study, the Brownsville Public Utilities Board (BPUB) conducted an 18-month reverse osmosis desalination demonstration study at the Brownsville Ship Channel with the final report completed in October 2008[2]. The study evaluated several pretreatment and reverse osmosis desalination alternatives and presented a cost estimate for implementing a 25 MGD seawater desalination project at Brownsville. Table 4C.37-2 shows a summary of the capital cost estimate. At the time of the pilot study report, BPUB decided that full scale project was not recommended for immediate implementation because there would not be adequate regional water demand and the cost of a 25 MGD seawater desalination project was greater than the cost of other water supply strategies. The study recommended that a 2.5-MGD seawater desalination demonstration project be constructed instead with provisions made in the initial design to expand the facility to 25 MGD by 2050.

[1] Texas Water Development Board, "The Future of Desalination in Texas Volume I, Biennial Report on Seawater Desalination," December 2004.
[2] NRS, "Final Pilot Study Repot Texas Seawater Demonstration Project," October 2008.

Table 4C.37-2.
Cost Summary for TWDB Texas Seawater Demonstration Project in Brownsville (Feasibility Estimate from 2004 Compared to Pilot Study Estimate from 2008)[2]

Project Component	Feasibility Estimate (2004)	Pilot Study Estimate (2008)
Capital Costs		
Desalination Plant	$90,167,000	$126,612,000
Concentrate Disposal System	$30,583,000	$21,217,000
Finished Water Transmission System	$9,232,000	$12,180,000
Project Implementation Costs	$21,406,000	$22,400,000
Total Capital Cost	**$151,388,000**	**$182,409,000**

4C.37.2 Available Yield

Seawater is assumed to be a virtually unlimited potential source of supply for the South Central Texas Region given that the Gulf of Mexico is estimated to contain 643 quadrillion gallons of water (1.973 trillion acft)[3]. Hence, for regional water planning purposes, it is assumed the firm water supply or available yield of the GBRA IWPP is limited only by intake, treatment, and transmission system capacity. The example project firm yield evaluated herein is 100,000 acft/yr (89.3 MGD) and this amount is assumed to be available in all decades of the planning period.

4C.37.3 Environmental Issues

One potential location of the seawater desalination water treatment plant is in Calhoun County near Port O'Connor a short distance inland from the Gulf Intracoastal Waterway and Espiritu Santo Bay. Source water for the project will be seawater drawn from the Gulf of Mexico. The brine concentrate resulting from the desalination treatment process will be returned to deep waters of the Gulf of Mexico via pipeline for disposal. Potential treated water delivery locations from Calhoun to Gonzales County may be served by a long water transmission pipeline.

Potential environmental effects associated with construction and operation of a seawater desalination plant in Calhoun County will be sensitive to ultimate plant siting and its associated seawater intake and brine disposal transmission pipelines. Construction of the desalination plant

[3] http://www.epa.gov/gmpo/about/facts.html

will temporarily disrupt habitats in the immediate vicinity. Although the seawater intake is to be located in deep water well offshore, its operations may result in impacts to aquatic organisms. Impingement takes place when organisms are trapped against intake screens by the force of the water passing into the intake structure and entrainment occurs when organisms are drawn through the water intake structure into the pump and transport system. Organisms that become impinged or entrained are normally relatively small organisms, including fish and shellfish in their early life stages. Impingement can result in descaling or other physical damage, and starvation, exhaustion, or asphyxiation when the organism cannot escape the intake structure. Entrained organisms are subject to mechanical, thermal, or toxic stress (e.g., biocides or low dissolved oxygen concentrations) as they pass through the system. In the case of either impingement or entrainment, a substantial proportion of the affected individuals may be killed or subjected to significant harm. Minimization of impingement and entrainment by appropriate site selection and through the use of appropriate screening technology must be considered during the system design as part of the overall effort to avoid or minimize potential impacts to the aquatic environment. In addition, construction of the saltwater intake pipeline may temporarily impact any *Spartina* marshes and seagrass beds that occur within shallower areas of the gulf.

Brine concentrate disposal is expected to occur a substantial distance offshore in deep waters of the open Gulf of Mexico. Potential associated impacts to aquatic species may result from construction of the brine discharge pipeline on bay bottom habitats, and from increases in salinity in areas near the discharge point. Discharge sites are typically selected to avoid areas where organisms tend to concentrate, including rock outcrops and man-made structures. It is expected that the permitting process will include modeling demonstrating that discharge structure design will be adequate to rapidly disperse the concentrate plume to ambient salinities within a relatively small mixing zone in order to minimize impacts to aquatic species.

No changes in instream flows or freshwater inflows are expected from operations of GBRA's IWPP except to the extent that such flows may be increased by the discharge of treated effluent associated with the new water supply. Similarly, no changes in estuarine salinity gradients are expected from operations of the desalination water treatment facilities as seawater diversions and brine discharge are to occur in the Gulf of Mexico well beyond the barrier islands and peninsulas.

Many migratory birds are dependent on the quality of the nearby estuarine environments to support foraging and nesting activities during migration. One of the most well known of the migratory birds is the whooping crane (*Grus Americana)*, which is listed as endangered by both the U.S. Fish and Wildlife Service (USFWS) and the Texas Parks and Wildlife Department (TPWD). A growing population of whooping cranes winter in and near the Aransas National Wildlife Refuge located adjacent to 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 more than 300 birds in 2014. Other migratory birds known to occur in the project area and listed as threatened by TPWD include the bald eagle (*Haliaeetus leucocephalus*), sooty tern (*Sterna fuscata*), reddish egret (*Egretta rufescens*), wood stork (*Mycteria americana*), and the piping plover (*Charadrius melodus*). The piping plover is also listed as threatened by USFWS.

The treated water transmission pipeline corridor in Calhoun, Victoria, DeWitt, and Gonzales Counties would be approximately 118 miles long. Construction of the pipeline would include the clearing and removal of woody vegetation. A 40-foot wide right-of-way corridor, free of woody vegetation and maintained for the life of the project, would total approximately 572 acres. The proposed pipeline route would traverse three of Omernik's[4] ecoregions: the Western Gulf Coastal Plain, the East Central Texas Plains, and the Texas Blackland Prairie. In addition, the lower Guadalupe River, located within the project area, is listed by TPWD as an Ecologically Significant River and Stream Segment. Surveys for protected species should be conducted within the proposed construction corridors where preliminary evidence indicates their existence. Many of these species, such as the Texas tortoise (*Gopherus berlandieri*), the Texas horned lizard (*Phrynosoma cornutum*), and the Texas scarlet snake (*Cemophora coccinea lineri*), are dependent on shrubland or riparian habitat. The timber rattlesnake (*Crotalus horridus*), a state threatened species, may be found in the riparian woody vegetation of the area.

Destruction of potential habitat utilized by terrestrial species can be minimized by selecting a corridor through previously disturbed areas, such as croplands. Selection of pipeline right-of-way alongside existing habitat could also be beneficial to some wildlife by providing edge habitat.

The Texas Natural Diversity Database (TXNDD), produced by TPWD, includes known occurrences of endangered, threatened, or rare species near the potential pipeline right-of-way, desalination plant, storage tanks, and pump stations. Due to the limited amount of area included around the storage tanks and pump stations, no impact to any listed species is anticipated from this portion of the project. The transmission pipeline corridor and desalination plant contain the

[4] Omernik, J.M., "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, 77:118-125, 1987.

most potential to affect aquatic and terrestrial species found within the project area. Careful siting of these components of the project would help minimize impacts to area species.

One endangered species reported by the TXNDD near the transmission pipeline corridor is the Attwater's greater prairie chicken which is found in Victoria County. The Attwater's greater prairie chicken prefers the coastal prairies grassland in areas with 0 to 24 inches vegetation height. In addition, the Cagle's map turtle (*Graptemys caglei*), a state threatened species, has been documented within one mile of the proposed transmission pipeline route. Several state threatened freshwater mussel species also occur within the project counties, including the Texas pimpleback (*Quadrula petrina*), Golden orb (*Quadrula aurea*), and False spike mussel (*Quadrula mitchelli*). These mussel species could potentially be affected by the pipeline crossings of the Guadalupe River and its tributaries found within the project area. Impacts to these species are not anticipated if appropriate Best Management Practices (BMPs) such as directional drilling at river crossings are utilized during pipeline construction.

Plant and animal species in the project area listed by the USFWS and TPWD as endangered, threatened, or species of concern are presented in Table 4C.37-3. Species included in this table have habitat requirements or preferences that suggest they could be present within the project area.

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). Based on the review of available GIS datasets from the Texas Historical Commission (THC), there are five National Register Properties, two national Register Districts, twenty eight cemeteries, and seventy three historical markers located within a one-mile buffer of the proposed transmission pipeline route, desalination plant, storage tanks, and pump stations. Additionally, over twenty archeological surveys of both lines and areas have occurred within this one mile buffer.

There is a high probability for undocumented significant cultural resources within the alluvial deposits and terrace formations associated with waterways, specifically the intermittent and perennial aquatic resources. The probability that the transmission pipeline would cross areas which include cultural resources increases near waterways and associated landforms.

A review of archaeological resources in the proposed project area should be conducted during the project planning phase. Taking into consideration that the owner or controller of the project will likely be a political subdivision of the State of Texas (i.e. river authority, municipality, county, etc.), they will be required to coordinate with the Texas Historical Commission regarding impacts to cultural resources. The project sponsor will also be required to coordinate with the U.S. Army Corps of Engineers regarding any impacts to waters of the United States or wetlands.

The water treatment site and transmission pipeline route considered herein do not conflict with the Powderhorn Ranch property acquired recently and intended to be managed by TPWD.

Table 4C.37-3. Endangered, Threatened, and Species of Concern in Calhoun, DeWitt, Gonzales and Victoria Counties

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	*TPWD*[1]	
AMPHIBIANS								
Black-spotted Newt	*Notophthalmus meridionalis*	1	2	2	Ponds and resacas in south Texas		T	Resident
Sheep Frog	*Hypopachus variolosus*	1	2	2	Deep sandy soils of Southeast Texas		T	Resident
BIRDS								
American Peregrine Falcon	*Falco peregrinus anatum*	0	3	0	Open country; cliffs	DL	T	Nesting/ Migrant
Arctic Peregrine Falcon	*Falco peregrinus tundrius*	0	2	0	Open country; cliffs	DL		Nesting/Migrant
Attwater's Greater Prairie-Chicken	*Tympanuchus cupido attwateri*	1	3	3	Coastal Prairies of Gulf Coastal Plain	LE	E	Resident
Bald Eagle	*Haliaeetus leucocephalus*	1	2	2	Large Bodies of water with nearby resting sites	DL	T	Nesting/Migrant
Brown Pelican	*Pelecanus occidentalis*	0	3	0	Coastal inlands for nesting, shallow gulf and bays for foraging	DL		Nesting/Migrant
Eskimo Curlew	*Numenius borealis*	1	3	3	Grasslands, pastures, thought to be extinct.	LE	E	Nonbreeding Resident
Henslow's Sparrow	*Ammodramus henslowii*	1	1	1	Weedy fields, cut over areas; bare ground for running and walking			Nesting/Migrant
Interior Least Tern	*Sterna antillarum athalassos*	1	3	3	Inland river sandbars for nesting and shallow water for foraging	LE	E	Nesting/Migrant
Mountain Plover	*Charadrius montanus*	1	1	1	Non-breeding-shortgrass plains and fields, plowed fields and sandy deserts			Nesting/Migrant
Northern Aplomado Falcon	*Falco femoralis septentrionalis*	0	3	0	Found in open country, especially savanna and open woodland.	LE	E	Resident
Piping Plover	*Charadrius melodus*	1	2	2	Beaches and flats of Coastal Texas	LT	T	Migrant
Reddish Egret	*Egretta rufescens*	1	2	2	Coastal inlands for nesting, coastal marshes for foraging		T	Migrant
Snowy Plover	*Charadrius alexandrinus*	1	1	1	Wintering Migrant on mud flats.			Migrant
Sooty Tern	*Sterna fuscata*	1	2	2	Catches small fish.		T	Resident
Southeastern Snowy Plover	*Charadrius alexandrines tenuirostris*	1	1	1	Wintering migrant along the Texas Gulf Coast.			Migrant
Sprague's Pipit	*Anthus spragueii*	1	1	1	Only in Texas during migration and winter. Strongly tied to native upland prairie.	C		Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
Western Burrowing Owl	*Athene cunicularia hypugaea*	1	1	1	Open grasslands, especially prairie, plains and savanna			Resident
Western Snowy Plover	*Charadrius alexandrines nivosus*	1	1	1	Potential migrant in winter along coast.			Migrant
White-faced Ibis	*Plegadis chihi*	1	2	2	Prefers freshwater marshes.		T	Resident
White-tailed Hawk	*Buteo albicaudatus*	1	2	2	Coastal prairies, savannahs and marshes in Gulf coastal plain		T	Resident
Whooping Crane	*Grus americana*	1	3	3	Potential migrant	LE	E	Migrant
Wood Stork	*Mycteria americana*	1	2	2	Forages in prairie ponds, ditches, and shallow standing water formerly nested in TX		T	Migrant
FISHES								
American Eel	*Anguilla rostrata*	1	1	1	Moist aquatic habitats.			Resident
Blue Sucker	*Cycleptus elongates*	1	2	2	Larger portions of major rivers in Texas.		T	Resident
Guadalupe Bass	*Micropterus teculii*	1	1	1	Endemic to perennial streams of the Edward's Plateau region			Resident
Guadalupe Darter	*Percina sciera apristis*	1	1	1	Guadalupe River basin in raceways of large streams and rivers.			Resident
Opossum Pipefish	*Microphis brachyurus*	1	2	2	Brooding adults found in fresh or low salinity waters.		T	Resident
Smalltooth Sawfish	*Pristis pectinata*	1	3	3	Found in bays, estuaries or river mouths.	LE	E	Resident
INSECTS								
A mayfly	*Tortopus circumfluus*	1	1	1	Mayflies have an aquatic larval stage and adults are generally found in shoreline vegetation.			Resident
Leonora's dancer damselfly	*Argia leonorae*	1	1	1	South central and western Texas in small streams and seepages.			Resident
Texas Asaphomyian Tabanid Fly	*Asaphomyia texanus*	1	1	1	Found near slow-moving water, eggs laid on objects near water; larvae are aquatic, adults prefer shady areas; feed on nectar and pollen			Resident
MAMMALS								
Black Bear	*Usus americanus*	0	2	0	Mountains, broken country, woods, brushlands, forests	T/SA; NL	T	Resident
Cave Myotis Bat	*Myotis velifer*	0	1	0	Roosts colonially in caves.			Resident

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity USFWS[1]	Listing Entity TPWD[1]	Potential Occurrence in County
Jaguarundi	*Herpailurus yaguarondi*	1	3	3	South Texas thick brushlands, favors areas near water	LE	E	Resident
Louisiana Black Bear	*Ursus americanus luteolus*	0	2	0	Within historical range.	LT	T	
Ocelot	*Felis pardalis*	1	3	3	Dense chaparral thickets; mesquite-thorn scrub and live oak mottes	LE	E	Resident
Plains Spotted Skunk	*Spilogale putorius interrupta*	1	1	1	Prefers wooded, brushy areas and tallgrass prairie, fields, prairies, croplands, fence rows, forest edges			Resident
Red Wolf	*Canis rufus*	0	3	0	Extirpated.	LE	E	
West Indian manatee	*Trichechus manatus*	1	3	3	Gulf and bay systems.	LE	E	Resident
White-nosed coati	*Nasua narica*	1	2	2	Found in woodlands, riparian corridors and canyons. Mostly transients from Mexico.		T	Resident
MOLLUSKS								
Creeper (squawfoot)	*Stophitus undulatus*	1	1	1	Small to large streams San Antonio, Neches (historic) and Trinity (historic) River basins.			Resident
False spike mussel	*Quadrula mitchelli*	1	2	2	Possibly extirpated in Texas in medium to large rivers.		T	Possible Resident
Golden orb	*Quadrula aurea*	1	2	2	Found in Guadalupe, San Antonio, Lower San Marcos, and Nueces River Basins.	C	T	Resident
Palmetto pill snail	*Euchemotrema leai cheatumi*	1	1	1	Known from palmetto woodlands of Palmetto State Park.			Resident
Texas fatmucket	*Lampsilis bracteata*	1	2	2	Colorado and Guadalupe river basins.	C	T	Resident
Texas pimpleback	*Quadrula petrina*	1	2	2	Generally in areas with slow flow rates in Colorado and Guadalupe river basins.	C	T	Resident
REPTILES								
Atlantic Hawksbill Sea turtle	*Eretmochelys imbricata*	1	3	3	Gulf and bay system.	LE	E	Migrant
Cagle's map turtle	*Graptemys caglei*	1	2	2	Endemic to Guadalupe River System.		T	Resident
Green Sea Turtle	*Chelonia mydat*	1	2	2	Gulf and bay system.	LT	T	Migrant
Gulf Saltmarsh Snake	*Nerodia clarkii*	1	1	1	Brackish to saline coastal waters			Resident
Kemp's Ridley Sea Turtle	*Lepidochelys kempii*	1	3	3	Gulf and bay system.	LE	E	Migrant
Leatherback Sea Turtle	*Dermochelys coriacea*	1	3	3	Gulf and bay system.	LE	E	Migrant

Common Name	Scientific Name	Impact Value	Multiplier Based on Status	Adjusted Impact	Summary of Habitat Preference	Listing Entity		Potential Occurrence in County
						USFWS[1]	TPWD[1]	
Loggerhead Sea Turtle	*Caretta caretta*	1	2	2	Gulf and bay system.	LT	T	Migrant
Texas Diamondback Terrapin	*Malaclemys terrapin littoralis*	1	1	1	Bays, coastal marshes of the upper two-thirds of Texas Coast			Resident
Texas Horned Lizard	*Phrynosoma cornutum*	1	2	2	Varied, sparsely vegetated uplands, grass, cactus, brush		T	Resident
Texas scarlet snake	*Cemophora coccinea lineri*	1	2	2	Mixed hardwood scrub on sandy soils.		T	Resident
Texas Tortoise	*Gopherus berlandieri*	1	2	2	Open brush w/ grass understory; open grass/bare ground avoided; occupies shallow depressions at base of bush or cactus, underground burrows, under objects; active March through November		T	Resident
Timber Rattlesnake	*Crotalus horridus*	1	2	2	Floodplains, upland pine, deciduous woodlands, riparian zones, abandoned farms, dense ground cover		T	Resident
PLANTS								
Threeflower broomweed	*Thurovia triflora*	1	1	1	Endemic, black clay soils.			Resident
Shinner's sunflower	*Helianthus occidentalis ssp. Plantagineus*	1	1	1	Found on prairies on the Coastal Plain			Resident
Bristle nailwort	*Paronychia setacea*	1	1	1	Endemic to eastern southcentral Texas in sandy soils			Resident
Buckley's spiderwort	*Tradescantia buckleyi*	1	1	1	Occurs on sandy loam or clay soils in grasslands or shrublands.			Resident
Elmendorf's Onion	*Allium elmendorfii*	1	1	1	Endemic; deep sands derived from Queen City and similar Eocene formations			Resident
Green beebalm	*Monarda viridissima*	1	1	1	Endemic perennial herb of the Carrizo Sands.			Resident
Sandhill woolywhite	*Hymenopappus carrizoanus*	1	1	1	Texas endemic found in disturbed or open areas in grasslands and post oak woodlands.			Resident
Welder Machaeranthera	*Psilactis heterocarpa*	1	1	1	Coastal prairie; Shrub-infested grasslands and open mesquite-huisache woodlands			Resident

1 Source: TPWD, Annotated County List of Rare Species, Calhoun Co., 4/28/2014, Dewitt Co 4/28/2014, Gonzales Co., 4/28/2014, Victoria Co., 4/28/2014.

LE/LT=Federally Listed Endangered/Threatened
T/SA=Federally Listed Threatened by Similarity of Appearance
C=Federal Candidate for Listing
DL =Federally Delisted
E, T=State Listed Endangered/Threatened
Blank = Rare, but no regulatory listing status

4C.37.4 Engineering and Costing

This water management strategy provides for a major desalination water treatment plant on the Texas coast and the infrastructure for transferring potable water from the coast to Gonzales County. The entire strategy consists of the offshore intake and brine disposal facilities, water treatment plant, storage tanks, pumping stations, and 138 miles of pipeline (i.e. intake, brine disposal, and treated water transmission). The water treatment plant component includes pretreatment necessary to ensure normal life and efficiency of the reverse osmosis membranes and post-treatment for disinfection and distribution system corrosion scale stability.

Desalination treatment cost estimates are based on recent similar desalination treatment plant construction experience and feasibility studies. This approach takes advantage of the development of membrane technology and the resulting reduction in capital and operating costs in comparison to previously available technology.

The basic assumptions made to determine the size and characteristics of the components of this seawater desalination strategy are listed in Table 4C.37-4. Considering the RO efficiency of a seawater desalination plant (~60 percent), the GBRA IWPP water treatment plant has been sized at 148.8 MGD in order to produce a potable supply of 89.3 MGD (100,000 acft/yr). A 118-mile pipeline route from the desalination plant adjacent to the Gulf of Mexico to Gonzales County was assumed. A 10-mile conveyance line to carry the concentrate offshore is also included in the costs. A concentrate pump station is not included because it is assumed that the residual pressure from the desalination process is utilized to convey the concentrate offshore.

Table 4C.37-4.
Engineering Assumptions for Seawater Desalination

Parameter	Assumption	Description
Raw water TDS	35,000 mg/L	Intake located in the Gulf of Mexico
Finished water chlorides	100 mg/L	
Treatment capacity	148.2 MGD	Assumes 60% RO Efficiency
Finished water capacity	89.3 MGD	100,000 acft/yr
Concentrate Pipeline Length	10 miles total	Diffused in open Gulf
RO Recovery Rate	60 percent	
Power cost	$0.09 per kWh	Assume interruptible power
Pipeline diameter	72" and 54"	Treated water
Booster storage	10 percent of flow	More than 1 hour storage to avoid in-line pumps
Number of booster stations	3	

The estimated annual unit cost for the GBRA IWPP as presented herein is $2,290/acft/yr (Table 4C.37-5). The treatment costs include the water treatment plant (pretreatment, RO desalination, and post-treatment), raw water intake, and offshore concentrate discharge. The pretreatment portion of the plant is essentially a full conventional surface water plant to remove solids from the raw water prior to the RO desalination process. There is some economy of scale in the treatment process with larger processes in the pretreatment and RO desalination components. Also, there are greater economies of scale for components such as the intake and concentrate pump stations and pipelines.

Table 4C.37-5.
Cost Estimate Summary for
GBRA IWPP
(September 2008 Prices)

Item	*Estimated Costs for Facilities*
Seawater Intake & Pump Station (148.8 MGD)	$10,872,000
Intake Pipeline (90 in dia., 10 miles)	$34,153,000
Concentrate Disposal Pipeline and Diffuser (48 in dia., 10 miles)	$12,135,000
Treated Water Transmission Pipeline (72 & 54 in dia., 118 miles)	$234,447,000
Transmission Pump Station(s) & Storage Tank(s)	$29,030,000
Water Treatment (148.8 MGD)	$421,892,000
Integration, Relocations, & Other	$132,700,000
TOTAL COST OF FACILITIES	**$875,229,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$292,294,000
Environmental & Archaeology Studies and Mitigation	$3,920,000
Land Acquisition and Surveying (1726 acres)	$7,799,000
Interest During Construction (4% for 2.5 years with a 1% ROI)	$103,184,000
TOTAL COST OF PROJECT	**$1,282,426,000**
ANNUAL COST	
Debt Service (6 percent, 20 years)	$111,808,000
Operation and Maintenance	
Intake, Pipeline, Pump Station (1% of Cost of Facilities)	$5,132,000
Water Treatment Plant (2.5% of Cost of Facilities)	$102,152,000
Pumping Energy Costs (110056019 kW-hr @ 0.09 $/kW-hr)	$9,905,000
TOTAL ANNUAL COST	**$228,997,000**
Available Project Yield (acft/yr), based on a Peaking Factor of 1	100,000
Annual Cost of Water ($ per acft)	$2,290
Annual Cost of Water ($ per 1,000 gallons)	$7.03

4C.37.5 Implementation Issues

Implementation of this water management strategy requires addressing several financial, environmental, and technological considerations. The cost estimate shows that, while the treatment cost based on recent Tampa experience and other feasibility studies for a planned

25 MGD desalination facility may be competitive, transferring water from the coast inland is a significant overall cost component.

There are several environmental issues that must be considered. One issue with the desalination plant is the disposal of the concentrate created from the treatment process. Disposal would have to occur at a location and in a manner that does not significantly disrupt plant or animal life in in the Gulf. A further complication is the permitting of a 118-mile pipeline across rivers, highways, water bodies, and private rural and urban property.

Technological issues include: (1) confirming that desalination as proposed with membranes is the appropriate technology; (2) confirming that blending desalted seawater with the other water sources in municipal or industrial customer systems can be successfully accomplished; and (3) obtaining an adequate source of electric power to drive the desalination process using membranes.

Substantial verification of technology would need to be accomplished prior to building this project. Blending differing treated waters is critical for the wellbeing of the customers and their distribution or process systems. Considerable investigation would be needed to determine if additional conditioning of the desalinated seawater would be required to make the new water source compatible with existing distribution systems. Conditioning of the desalinated seawater may include addition of alkalinity and hardness to bring the corrosion chemistry closer to existing water sources.

Requirements Specific to Water Rights

1. It will be necessary to obtain the following:
   a. TCEQ Water Right permit.
   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.
2. Permitting, at a minimum, will require these studies:
   a. Assessment of changes in instream flows and freshwater inflows to bays and estuaries, if any.
   b. Habitat mitigation plan.
   c. Environmental studies.
   d. Cultural resources.
3. Other Considerations:

   a. Water compatibility testing, including biological and chemical characteristics will need to be performed.

Requirements Specific to Pipelines

1. Necessary permits:
   a. USACE Sections 10 and 404 dredge and fill permits for stream crossings.
   b. GLO Sand and Gravel Removal permits.
   c. TPWD Sand, Gravel, and Marl permit for river crossings.
2. Right-of-way and easement acquisition.
3. Crossings:
   a. Highways and railroads.
   b. Creeks and rivers.
   c. Other utilities.

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Appendices

GBRA Integrated Water and Power Project (IWPP)

The Guadalupe-Blanco River Authority (GBRA), in partnership with the State of Texas General Land Office (GLO) and the Texas Sustainable Energy Research Institute at the University of Texas at San Antonio (UTSA), is conducting feasibility study for a potential Integrated Water and Power Project (IWPP) that would involve seawater desalination. Funding is also being provided by the US Bureau of Reclamation through a Title XVI Grant. GBRA recently signed a Memorandum of Understanding (MOU) with the Lower Colorado River Authority (LCRA) to jointly address regional water planning, and an MOU with the City of Corpus Christi that addresses regional water planning including seawater desalination.

The IWPP, as envisioned by GBRA and its partners, presents a regional approach for providing water supply and power generation that will help address the needs of the Coastal Bend and South Central region of Texas. As envisioned, the IWPP would include a desalination plant on the Gulf Coast with a co-located power plant. Facilities would be developed in phases as demands grow. The water treatment plant would be initially constructed to serve a demand of 25 to 50 million gallons per day (mgd), and could be expanded to an ultimate capacity of 250 mgd. The power plant would be sized at an initial capacity of 500 megawatts (MW) and potentially be expanded to 3,000 MW. At full capacity the IWPP could supply enough water for over 350,000 homes and electricity for up to 3 million homes.

The study area encompasses a large region of southeast Texas, extending along the Gulf Coast from north of Freeport southwest to Corpus Christi. The study area also extends inland to include the cities of Austin and San Antonio and the rapidly growing region between these cities, the City of Corpus Christi, and numerous small to mid-size cities (Figure 1). In total, the study area encompasses over 29,000 square miles. It includes 31 counties, three major cities (Austin, San Antonio, and Corpus Christi), several small and mid-sized growing communities including the IH-35, SH 130, and IH10 corridors, several ports, numerous industrial water users, and agricultural water users.

The study area includes all or part of twelve river basins that drain to the Gulf Coast, the most significant of which include the Brazos, Colorado, Lavaca, Guadalupe (and San Antonio), and Nueces. Water demands in the study area will increase in response to rapid municipal and industrial growth. Based on estimates prepared for the 2011 State Water Plan, the combined increase in water demand in the study area is 836 thousand acre feet (TAF) per year by the year 2060. This increase will be driven by municipal, manufacturing, and steam electric use, and includes an over 150 TAF/yr reduction in agricultural demand. In addition, portions of the study area affected by the oil and gas exploration boom related to the Eagle Ford Shale discovery. The Eagle Ford Shale formation stretches across 30 Texas counties and 10 of those counties are located in the study area.

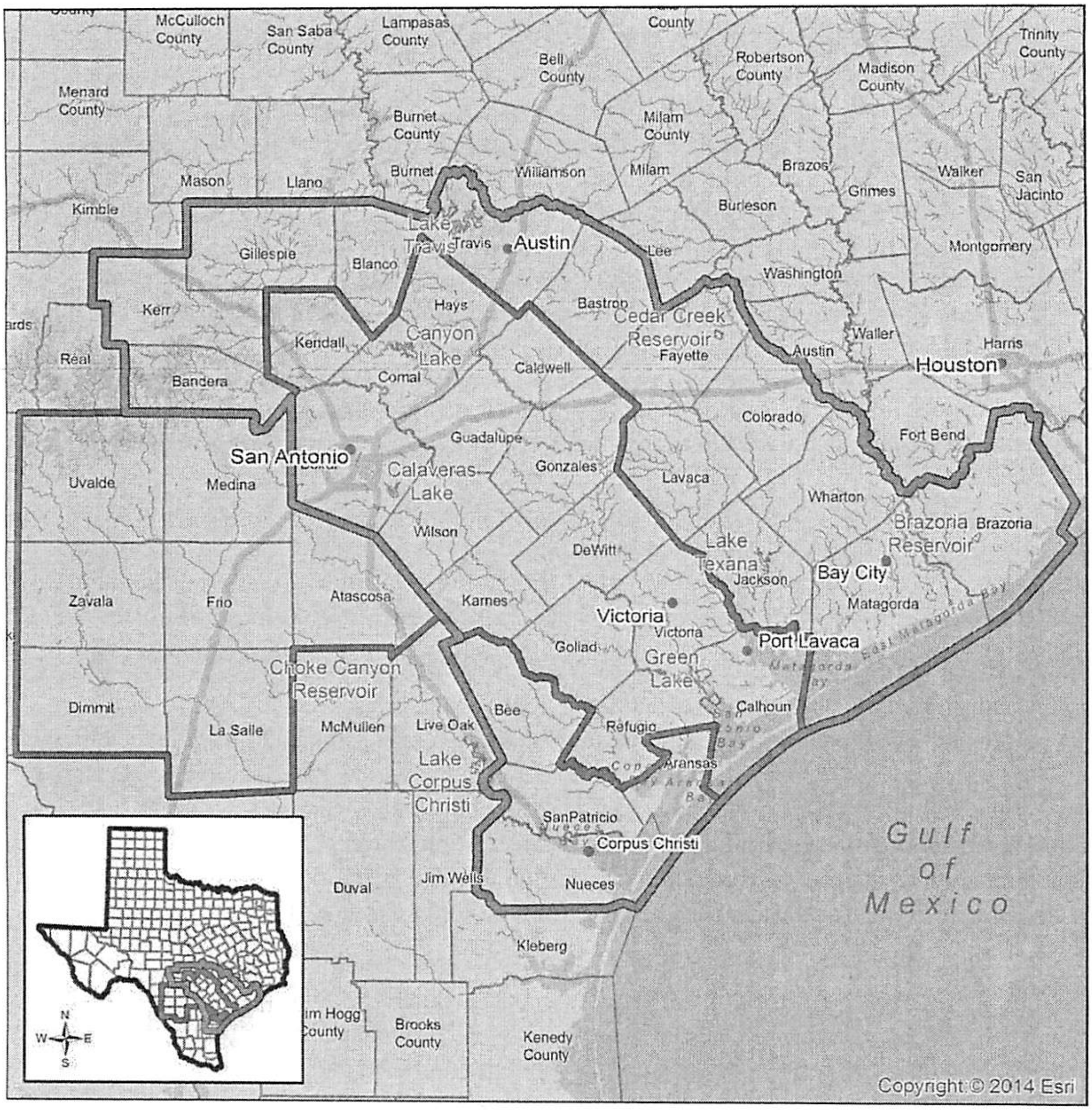


Figure 1 – IWPP Study Area

Seawater Intake and Location

The two primary intake configurations utilized for seawater intakes will be considered; subsurface intakes (beach wells) and open intakes. Subsurface intakes are direct-bury systems that use granular formations as a filter, thereby minimizing aquatic impingement and entrainment. The capacity of subsurface intakes can be limited based on the porosity of the granular material. These facilities also can cause significant environmental impacts during construction.

An open intake configuration would likely be tunneled construction and therefore have less environmental impacts during construction activities. The ease of construction for tunneling compared to open water trenching can provide a more cost-effective process, with capital expenditures roughly one-half to one-fourth of those for comparable capacity beach well intakes. The open intake would be at least 425 feet outside of the littoral zone (the coastal zone extending approximately 600 feet from shoreline, which is influenced by high/low tide levels). A minimal water depth of at least 60 feet for is being considered to minimize impacts to aquatic life. Engineering measures such as fine mesh screens and low intake velocities would be applied to minimize ecological disruption.

Water Treatment and Power Plant Site(s)

Candidate site locations were identified throughout the study area to enable evaluation of alternative water supply and power generation integration strategies. Over 20 site locations in the study area were identified from previous studies, study partner input, and a multi-parameter GIS-based review. Site locations were evaluated using a set of criteria that addressed environmental stewardship, social acceptance, intakes and outfalls, proximity to infrastructure, and general site conditions. Sites were rated for each criterion and ranked based on total scores. The results of the evaluation identified a set of Representative Sites that reflect the geographic distribution of the study area, and support a wide range of potential water supply implementation strategies, including delivery directly to industrial water users, delivery to a regional water conveyance network, or delivery directly to municipal water users. Four representative sites were identified in the evaluation process, one in each of four study area sub-regions, as shown on **Figure 2**. All Representative Sites are large enough for full build-out of water treatment power generation facilities.

Each Representative Site will be evaluated further to better refine desirable characteristics for the purpose of siting a seawater desalination plant, potentially co-located with power generation facilities. Preliminary facility layouts; connecting infrastructure to intakes, outfalls, water delivery points, electrical transmission, and fuel sources; cost; and permit requirements will be some of the many factors taken under consideration during representative site refinement.

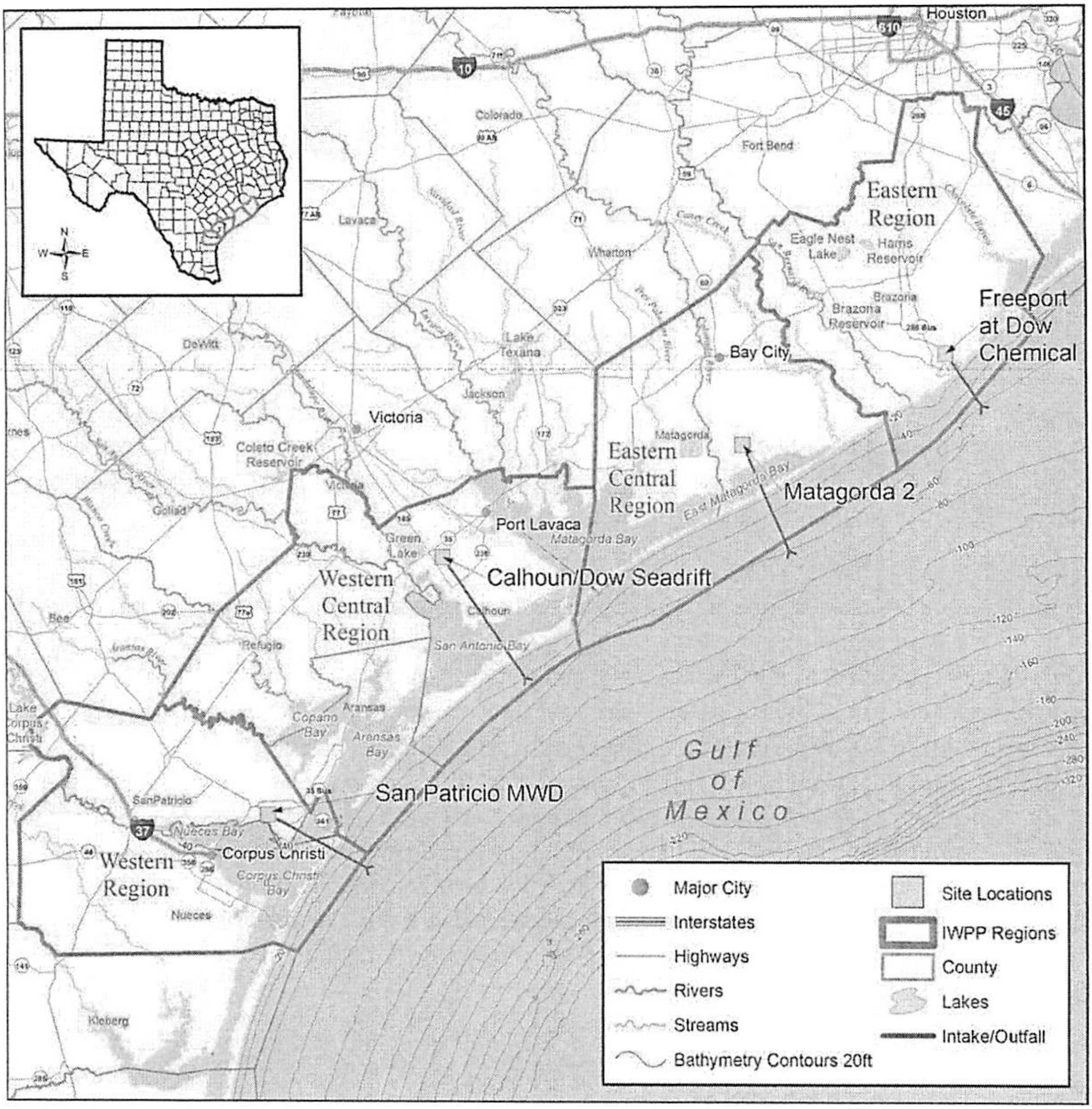


Figure 2 – IWPP Representative Site Regions

Concentrate Handling

Concentrate byproduct is generated during the desalination process. This stream is a derivative of plant recovery, which is typically near fifty percent for the anticipated treatment technology (seawater desalination through high-pressure reverse osmosis). The concentrate stream will have mineral and other constituent ratios roughly 1.5 to 2.5 times greater than that of the source water, and must be safely transported away from areas of consequential environmental impact.

Concentrate handling can be addressed through seawater, deep well injection, or zero-liquid discharge. Seawater return is the most common form of concentrate handling and involves high velocity injection and dispersion back into the ocean. Hydrodynamic mixing characteristics can be modeled to ensure adequate plume dispersion and minimal stratification, thereby reducing or eliminating impacts to surrounding ecosystems. Seawater return also provides an opportunity for combined return of spent cooling water from power generation.

Deep well injection feasibility is dependent on geological conditions in the surrounding area of a final site selection. Injection wells would be constructed in regions of geological confinement to prevent upward migration of concentrate into nearby aquifers. Multiple wells would potentially need to be constructed at various phases of plant expansion to allow for proper pressurization within return lines. Monitoring wells would be constructed adjacent to disposal wells to ensure containment is maintained.

Zero liquid discharge represents a mechanically-induced method of concentrate handling. Here, energy in the form of heat is added to the concentrate stream to crystalize concentrate byproducts. The volume of material remaining after evaporation of residual moisture allows the extraction and potential beneficial use of various minerals such as magnesium compounds, sulphates, and sodium chloride.

At this stage of the study, seawater return is the assumed method for concentrate handling. The majority of the pipeline(s) returning concentrate to the Gulf of Mexico can be constructed and run in parallel with the raw water intake lines. Re-introduction to the ocean and dispersion would occur at a location separate from the intake location to prevent concentrate short-circuiting the dispersion process and returning back to the treatment plant. A distance between intake(s) and outfall(s) of roughly one mile is anticipated at this preliminary planning phase to ensure adequate separation between plant components, with confirmation and adjustment of these distances based on modeling that would be performed in later phases of study.

Treatment Technology

Seawater desalination treatment technology is divided into two major categories: thermal evaporation and membrane separation. Thermal evaporation is an energy intensive method and generally considered economically unfeasible process in the United States due to the power requirements associated with evaporation at such a large scale.

Desalination through reverse osmosis (RO) is a process that utilizes induced pressure to overcome osmotic forces and separate solutions with different concentrations of ions. Initial plant sizing is tentatively scheduled to be 25 mgd (potable water output), expandable to 250 mgd in modular phasing as demand increases. A preliminary flow stream for the desalination of raw seawater is as follows:

- Raw water intake
- Initial screening
- Pretreatment chemical conditioning
- Secondary screening
- RO filtration and subsequent concentrate return
- Finished water chemical conditioning
- Storage and distribution

Planning level details for these items are being developed for layouts at each Representative Site. Various cost-saving measures and Best Engineering Practices (BEPs) will be considered and integrated during detailed planning efforts to maximize the value of construction efforts and minimize the economic impacts on end-customers. The use of energy recovery devices (ERDs) will be considered as a method of capturing and rededicating some of the energy high-pressure feed pumps place on RO feed water. The reuse of pressure will harvest mechanical energy from the membrane concentrate stream that otherwise would be unutilized, and minimize interstage pumping requirements between membrane passes.

The IWPP feasibility study will also consider sizing and phasing of plant components to advance cost-saving measures. Some plant components (such as intake structures, raw water transmission lines, and bulk chemical storage facilities) can be sized for construction beyond what their initial demand would be with no adverse impact to plant performance. The cost savings is realized by simply connecting new equipment as needed during an expansion phase, with no need for disruptive excavations or concrete work. Procedures as simple as obtaining extensive right-of-way for pipeline placement could result in substantial cost and schedule savings.

Plant layout configurations between the seawater desalination facility and the potential power generation facility could be yet another method for cost savings to the overall project. It is assumed that the power generation facility will need substantial amounts of cooling water for their processes. The RO process operates more efficiently at elevated feedwater temperatures, so there is the potential for a symbiotic relationship between the two plants where cooling water is used as RO feedwater to the treatment process. The American Water Works Association (AWWA) has shown that an increase in feedwater temperature from 15oC to 25oC can decrease the feed pressure requirements for the RO process by as much as 100 psi – which provides a substantial cost savings in equipment and power consumption. There is a careful balance that must be maintained during future planning however, as increased water temperatures also hinder the membrane's ability to screen the contaminant boron from the feed water. A wide array of membrane elements, water temperatures, and flux rates will be considered during modeling efforts to find a safe, efficient, combination of feed conditions.

Firm Yield

Seawater desalination provides a rainfall independent source of potable or raw water. The firm yield of any potential water treatment facility is based on facility capacity and operations. The initial phase of the treatment plant is currently anticipated to provide 25 mgd of treated water. Facilities would be developed in phases as demands grow. The water treatment plant would be initially constructed at a capacity of 25 to 50 million gallons per day (mgd), and could be expanded to an ultimate capacity of 250 mgd.

RO treatment of seawater generally has a recovery rate of approximately fifty percent; therefore a firm yield of 25 mgd would require that initial treatment plant intake and process areas upstream of the finished water streams be sized for no less than 50 mgd. Engineering measures such as oversizing of treatment components (intake, chemical storage facilities, etc) may be utilized to cost-effectively manage construction efforts. Adequate power and process redundancies such as diesel-fueled generators and n+1 pump configurations will also ensure reliable plant performance and delivery capabilities.

Amounts and Delivery Points for Use

Specific delivery points and water demand quantities to each of those points have not yet been finalized and evaluations will continue through project feasibility. Integration of desalinated seawater to regional water supplies in the Coastal Bend area could include numerous approaches. The feasibility study will consider a variety of delivery point options to demonstrate the range of opportunity. The following two scenarios would likely demonstrate the widest range of delivery point scenarios for the representative sites.

The first scenario would deliver all of the water produced by the seawater desalination facility to one industrial customer. The plant site would be located at or adjacent to the industrial facility. And the single customer would be the sole delivery point. Because of the close proximity to the delivery point, minimal transmission lines and no booster stations would be required. Water quality produced by the desalination plant would be sufficient to meet industrial process requirements, and may not be potable. This scenario would allow the industrial customer to expand production within their facility and potentially sell or transfer water rights from current sources to other customers, or some combination.

A second scenario would delivery potable water from a seawater desalination plant to a municipal customer a substantial distance inland. Where possible, existing or planned regional infrastructure facilities, such as the Mary Rhodes Pipeline or the Mid-Basin Project, or right of way associated with these projects would be used. New pipelines and pumping facilities would be constructed, which would involve more intensive permitting, greater capital cost, and greater operating costs.

Average Day, Peak Day, or Intermediate Treatment and Transmission Capabilities

Multiple possible plant operation scenarios are possible, depending on the seasonal and daily demand variation, the amount of storage in the conveyance system, and the role of desalinated water in meeting overall water demands. One treatment scenario commonly used in regions where seawater desalination is used to supplement existing water reservoirs is to only run the treatment plant during periods of high demand (meaning summer and early fall seasons). This plan of operation is based on the assumption that the conventional source water is easier, and therefore more cost effective, to transport and treat than utilizing the RO process, which is an energy intensive process compared to other treatment technologies such as deep bed filtration, flocculation/sedimentation, or low pressure RO. The seawater desalination facility is considered an insurance policy during periods of water scarcity, and ready to be brought online with a few days' notice. The plant should be run, at a minimum, a few days each month regardless of need to exercise mechanical plant processes and prevent the RO membranes from drying out and prematurely degrading.

A second treatment scenario would be to run the plant on a constant basis, but only during hours of off-peak energy demand (i.e. evenings and late nights/early mornings) or run cyclically while ramping up/down depending on peak power periods. This option would have the plant running year-round to meet a constant demand of treated water for municipal and/or industrial use. It would also benefit from power consumption during periods where the electrical grid is not experiencing a high demand from daytime customers.

Once final delivery points are determined through additional planning efforts, an operational analysis study can be performed to determine the most cost effective method for plant runtimes between the two options discussed above, or some combination therein.

Power Plant Water Needs

Power plant water needs are dependent on whether or not a power generation facility is co-located (or constructed in the reasonable vicinity of) the seawater desalination plant. If the power generation facility is removed from consideration, there is obviously zero demand for water and all desalination product water is available for transmission to end-user delivery points. If a power generation facility is constructed in conjunction with the seawater treatment facility, the size, phasing, and selected power generation technology all play factors in determining the water demands.

The most water intensive approach would be once-through cooling of the power plant. Alternate technologies, such as wet cooling towers or air-cooled condensers, represent more efficient options in terms of minimizing water demands at the power generation facility. These advanced technologies, however, potentially come with economic or design tradeoffs that should be considered in subsequent planning efforts. A brief summary of water need for various cooling technologies is show in **Table 1.**

Table 1 IWPP - Power Plant Water Demand Estimates

Nominal Combined Cycle Gas Turbine Power Plant Size	Steam Turbine(s) Size	Heat Rejection Technology	Heat Rejection Cooling (Raw) Water Demand (mgd)	Cycle Make-up Demineralized Water Demand (mgd)	Evaporative Cooling Water Makeup (mgd)	Total Raw Water requirements (mgd)
300 MW (1x1 config)	100 MW	Once-through condenser	158.558	0.028	0.025	158.611
		Wet Cooling Tower	4.683	0.028	0.025	4.736
		Air Cooled Condenser	0	0.028	0.025	0.053
650 MW (2x1 config)	220 MW	Once-through condenser	313.877	0.057	0.050	313.984
		Wet Cooling Tower	9.271	0.057	0.050	9.378
		Air Cooled Condenser	0	0.057	0.050	0.107
1000 MW (3x1 config)	340 MW	Once-through condenser	468.847	0.085	0.075	469.007
		Wet Cooling Tower	13.847	0.085	0.075	14.007
		Air Cooled Condenser	0	0.085	0.075	0.160
2000 MW (Two blocks of 3x1 config)	675 MW	Once-through condenser	937.694	0.170	0.150	938.014
		Wet Cooling Tower	27.694	0.170	0.150	28.014
		Air Cooled Condenser	0	0.170	0.150	0.32
3000 MW (Three blocks of 3x1 config)	1000 MW	Once-through condenser	1406.541	0.255	0.225	1407.021
		Wet Cooling Tower	41.541	0.255	0.225	42.021
		Air Cooled Condenser	0	0.255	0.225	0.48

Other Preliminary Specifications

One of the key components in any planning phase of a project is an understanding of project cost. The seawater desalination component of the project presents fine nuances in that there are few ocean water desalination plants currently online in the US from which to compare. The majority of the world's seawater desalination facilities are in the Middle East or Australia – which are scalable comparisons, but not direct correlations due to regional price differences in construction/operation materials, labor, and energy.

The cost projections for the construction of a seawater desalination facility on the Gulf Coast of Texas are dependent on several factors including, but not limited to, the cost to convey raw water from the intake to the treatment plant, the cost to treat the raw water such that it is suitable for industrial and/or municipal use (this number is comprised of factors such as pre-treatment pumping and conditioning activities, the desalination process itself, and post-treatment polishing and pumping activities). Fixed costs would include structures, pipework, and equipment. Variable costs would include operations and maintenance needs and variable electricity rates. A total cost is expected to range from $1,700 per acre foot to $2,550 per acre foot and should be further refined during pre-design activities.

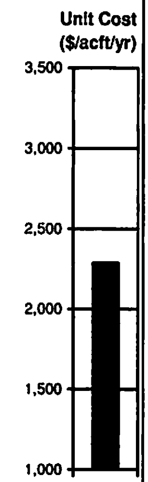
The IWPP project is currently in the feasibility/planning stage. A reasonable schedule on a path forward to potable water delivery is shown in **Figure 3**.

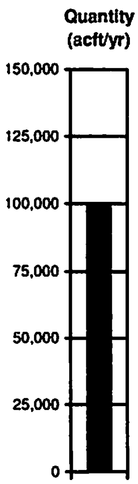
Develop Water and Power Options	• Q3 2014 to Q1 2015
Formulate and Evaluate Alternatives	• Q4 2014 to Q1 2015
Prepare Feasibility Report	• Q4 2014 to Q2 2015
Planning/Predesign	• Q2 2015 to Q1 2016
Environmental Compliance and Permitting	• Q1 2016 to Q1 2018
Design	• Q1 2016 to Q1 2018
Bid and Award	• Q1 2018 to Q4 2018
Construction	• Q1 2018 to Q3 2020
Startup and Commissioning	• Q2 2020 to Q1 2021

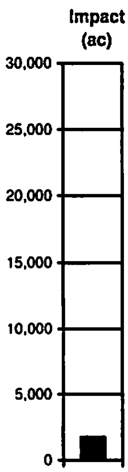
Figure 3 – IWPP Implementation Schedule

The schedule shows that the IWPP could be operational early in the 2020 decade. This schedule is based on estimated durations to accomplish the identified tasks and could be affected by additional time required for decision-making by project partners, securing financing and unforeseen permitting needs. However, it should be possible to accomplish any additional requirements within a timeframe that assures the project could serve water in advance of 2030. For this reason, the decade of need for the project is identified as 2030.

2011 South Central Texas Regional Water Plan
Water Management Strategy Summary Sheet







Name: **GBRA Integrated Water Power Project (IWPP)**

Description: The primary source for the GBRA Integrated Water Power Project will be desalinated seawater from the Gulf of Mexico. Facilities include an off-shore intake, a 148.2 MGD reverse osmosis WTP, 118 miles of 72-inch and 54-inch transmission pipelines, associated pump stations, and a concentrate disposal line to the Gulf of Mexico.

Decade Needed: 2020 - 2030

Cost, Quantity of Water, and Land Impacted

Unit Cost of Water:	**2,290**	**$/acft/yr**	**Treated Water Delivered**
Quantity of Water:	**100,000**	**acft/yr**	**Reliability = Firm**
Land Impacted:	**1,726**	**acres**	

Additional Considerations per Regional Water Planning Guidelines

Environmental Factors:

Conversion of existing habitats and land uses within the pipeline right-of-way.

Impacts on Water Resources:

None anticipated.

Impacts on Agricultural & Natural Resources:

Temporary impacts due to construction of pipeline.

Other Relevant Factors per SCTRWPG:

Confirmation of technology and values used in developing costs prior to implementation. Perceived to have fewer associated environmental effects than typical fresh surface water supplies.

Comparison of Strategies to Meet Needs:

High unit cost, but potential for large drought-proof water supply. Unit cost is approximately 50 percent treatment and 50 percent conveyance. No conflicts with other recommended water management strategies.

Interbasin Transfer Issues:

Not applicable.

Third-Party Impacts of Voluntary Transfers:

Not applicable.

Regional Efficiency:

Provides long-term water supplies throughout the GBRA statutory district. Additional surface water supply without reductions in instream flows or freshwater inflows to the Guadalupe Estuary.

Water Quality Considerations:

Integration of desalinated water with different corrosion chemistry may require conditioning of water to meet distribution system stability requirements.

WMS Project

Sponsor Region:	L
WMS Project ID:	
WMS Project Name:	GBRA Integrated Water Power Project
WMS Description:	Seawater Desalination Plant and Transmission
WMS Type:	N: NEW SURFACE WATER OR GROUNDWATER SOURCE
WMS Infrastructure:	PIPELINE AND WATER TREATMENT PLANT
Additional RWPGs:	None
Include in State Water Plan:	Y

Source(s)

Source Region	Source Name	County Name	Basin Name	Source ID	Source Type
L	GULF OF MEXICO SEA WATER	RESERVOIR	GULF	5124999	SURFACE WATER
Is Source Supply selected for Rollup?			Y		
Is Source Cost selected for Rollup?			Y		

County Name:	RESERVOIR	Water Quality Improvements	DSE: SEAWATER DESALINATION
County ID:	999	Online Data	2020
Basin Name:	GULF	WMS Funding Date	2020
Basin ID:	24		
Include in State Water Plan?			Y
Include WMS Source Total Yield numbers in WMS Project Totla Yield Rollup?			Y
Include WMS Source Cost numbers in WMS Project Cost Rollup?			Y

1.

Sponsor Region:	WWP Name:					
L	Guadalupe-Blanco River Authority					
	2010	2020	2030	2040	2050	2060
Total Strategy Water Supply Volume for this WWP:	0	100,000	100,000	100,000	100,000	100,000

Recommendation Type?	Is Used to Meet Need?		IBT?			
Recommended	N		N			
Include WWP WMS Cost numbers in WMS Source Cost Rollup?		Y				
	2010	2020	2030	2040	2050	2060
WWP WMS Annual Cost:	$0	$228,997,000	$228,997,000	$117,189,000	$117,189,000	$117,189,000
WWP Capital Costs:	$1,282,426,000					
Term of Debt Service:	20					