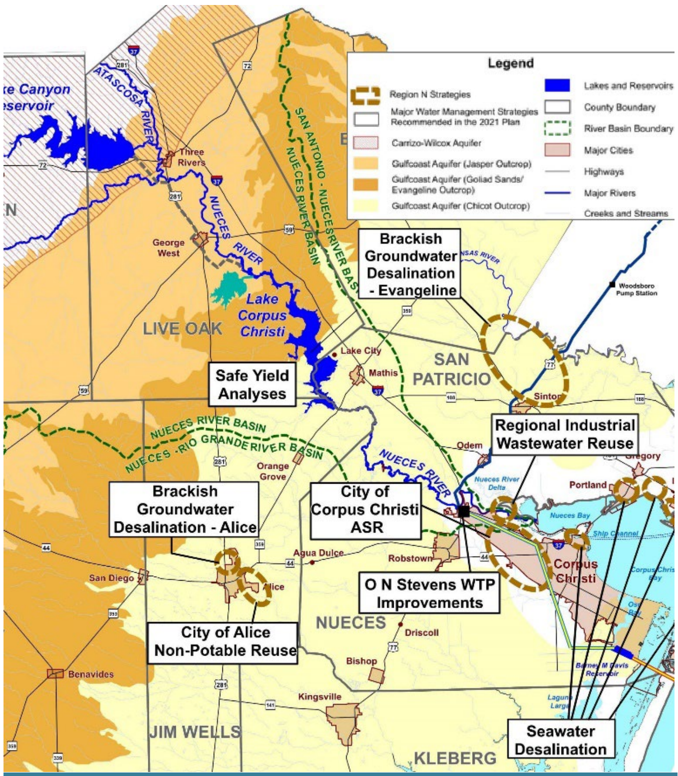

9

Implementation and Comparison to Previous Regional Water Plans

[31 TAC §357.45]

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Chapter 9 Implementation and Comparison to Previous Regional Water Plans

9.1 Implementation of Previous Regional Water Plan

In response to Senate Bill 660 (82nd Legislative Session), the Texas Water Development Board (TWDB) issued guidance for each region to report the level of implementation of previously recommended water management strategies and associated impediments to constructing water projects to meet future water needs in accordance with 31 Texas Administrative Code (TAC) §357.45(a).

The *2021 Coastal Bend Regional Water Plan* included 77 recommended water management strategies, of which 41 (or 52 percent of the total strategies) were related to voluntary water conservation. Emails and follow-up phone calls were placed to water user groups (WUGs) and wholesale water providers (WWPs) to gather information on the implementation status of recommended water management strategies presented in the 2021 regional water plan and preliminary results were discussed at the Coastal Bend Regional Water Planning Group (CBRWPG) meeting on January 30, 2025. Information requested was based on the TWDB survey spreadsheet needs, including the project description, infrastructure type, actions towards supply development, impediments affecting implementation, project phasing, and impacts (if any) on flood control. The WUGs and WWPs were asked to provide updates on the level of implementation currently achieved, the initial volume of water provided, funds expended to date, project cost, funding source and year the project went online. If the project was a phased project, the WUGs were asked about the ultimate volume, project cost, and year that the project will reach maximum capacity. If the project was not implemented, the WUGs were asked to comment on why that was the case. The survey also had a spreadsheet input field regarding inclusion in the 2026 plan for both phased and non-implemented projects.

Comments were received from 19 WUG/WWPs representatives by August 8, 2024, representing 36 of the 77 water management strategies that were recommended in the 2021 regional water plan. Water conservation plans were reviewed to provide updates for an additional 23 municipal water conservation strategies, thus totaling a status update for 59 of the 77 recommended strategies. Results of the survey are summarized in Table 9.1. There is one recommended water management strategies, other than water conservation, from the *2021 Coastal Bend Regional Water Plan* that has been implemented: City of Alice Brackish Groundwater Desalination. The following water management strategies have not been implemented due to changed conditions: Nonpotable Reuse for the City of Alice and the Poseidon Regional Seawater Desalination Project at Ingleside. Others are in various stages of project advancement ranging from the sponsor has taken official action to initiate the project to an ongoing feasibility study to projects being under construction.

The CBRWPG completed the TWDB-provided survey spreadsheet to gather and record this information, along with other project-related details, and the information gathered as of August 8, 2024, which is included in Appendix F.

Table 9.1.
Summary of Project Implementation from 2021 Plan

Responding Entity	WUG/WWP	Projects Implemented	Projects Under Construction	Projects in Design Phase	Feasibility Study Ongoing
Alice	City of Alice	1	0	0	0

9.2 Comparison to Previous Regional Water Plan

The TWDB guidance and TAC Chapter 357.45(b) require that the *2026 Coastal Bend Regional Water Plan* briefly summarizes differences from the previously adopted 2021 regional water plan.

9.2.1 Water Demand Projections

The total water demand projected in 2030 for the region in the 2026 regional water plan is 16,268 acre-feet (ac-ft) less (a reduction of 6 percent) than in the 2021 regional water plan. In subsequent decades, the 2026 regional water plan continues to show lower water demands, with 2070 water demands being 21,415 ac-ft less (a reduction of 8 percent) as compared to the 2021 regional water plan. Much of this is attributed to a change in the TWDB methodology for projecting non-municipal water demands for the 2026 regional water plan by keeping industrial water demands constant after 2030. **The projected water demand reduction from the 2021 regional water plan projections is not consistent with local water supply plans that indicate industrial growth. For this reason, additional water management strategies are recommended for a total amount that exceeds needs calculated based on TWDB projections.** Figure 9-1 compares water demand projections from the 2026 regional water plan to previous 2021 regional water plan/*2022 State Water Plan* projections. For the 2026 regional water plan, municipal projections generally decreased 1 to 2 percent for each decade from 2030 through 2080. Irrigation projections remain constant for the 2026 regional water plan but are 54 percent lower as compared to the 2021 regional water plan estimates. Manufacturing and steam-electric projections for the 2026 regional water plan are all lower than those from the 2021 regional water plan/*2022 State Water Plan*, while livestock projections for the 2026 regional water plan are all higher than those from the 2021 regional water plan/*2022 State Water Plan*. The largest reduction is in the irrigation projections which is 16,345 acre-feet per year (ac-ft/yr) lower for the 2026 regional water plan, as compared to the previous planning cycle.

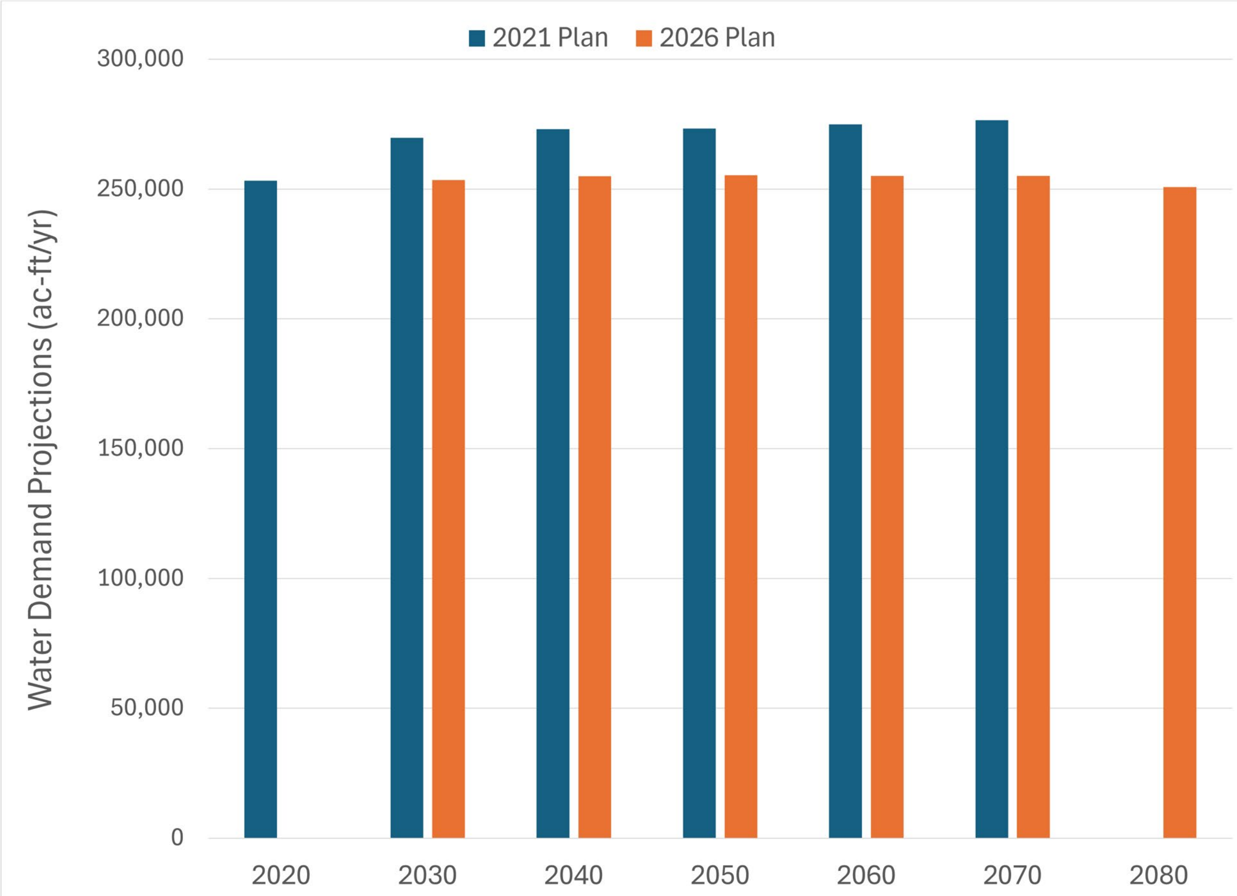

Figure 9-1.
Comparison of Region N Water Demand Projections from 2026 Plan and Previous 2021 Plan, Combined Demands for all Use Types

In the 2021 regional water plan, the total water demands for all entities in the region were projected to increase from 269,766 ac-ft/yr in 2030 to 276,492 ac-ft/yr in 2070. The total water demand projections for the 2026 regional water plan increase from 253,498 ac-ft/yr in 2030 to 255,077 ac-ft/yr in 2070. For the 2026 regional water plan, municipal water demands represent between 42 to 43 percent of the overall water demand in the region through 2080 as compared to 45 to 48 percent of the overall water demand in the 2021 regional water plan. Of the remaining projected water demand which is attributed to non-municipal users (manufacturing, steam-electric, irrigation, mining, livestock), 79 percent is projected to occur within the manufacturing sector in 2030 increasing to 83 percent by 2080. Most of this is attributable to manufacturing in Nueces and San Patricio counties.

Manufacturing demands account for 47 percent of total water demands in 2080. Most of these demands, 96 percent, are in Nueces and San Patricio counties. Jim Wells, Kleberg, Live Oak, and McMullen counties make up the remaining 4 percent. The regional mining demand, 1,026 ac-ft, accounts for only 0.4 percent of total demand in 2080. Irrigation demand remains constant at 13,861 ac-ft over the 50-year planning period and in 2080 represents 5.5 percent of total demand.

9.2.2 Drought of Record and Hydrologic and Modeling Assumptions

Prior to the 2021 regional water plan, the 1992-2002 drought was used to define water availability. With the Corpus Christi Water Supply Model (CCWSM) updated during development of the 2021 regional water plan to include hydrology through 2015, a new drought of record was identified. In terms of severity and duration, the drought from 2007-2013 is considered to be the drought of record (DOR) for the Coastal Bend Region planning area.

For the 2021 regional water plan, the CCWSM was updated to include recent hydrology for the Nueces Basin through 2015 for a total model period of 82 years (1934 to 2015). Additional model updates included extending recent hydrology for Lake Texana and the Colorado River (for Mary Rhodes Pipeline [MRP]Phase II supplies) through 2015 and incorporating new TWDB volumetric survey data for Lake Corpus Christi (2016), Choke Canyon Reservoir (2012), and Lake Texana (2010) and associated updated sedimentation rates.

The updated CCWSM included an 82-year hydrology period through 2015, inclusion of recent MRP Phase II supply, updates for the City of Corpus Christi's reservoir system operations, and Lavaca-Navidad River Authority call-back exercised for a portion of Lake Texana contracted supplies. The model was used to evaluate recent drought conditions to identify a new historic drought of record within the planning area. Average annual inflows to Choke Canyon Reservoir/Lake Corpus Christi and System (CCR/LCC System) continues to trend lower with each successive drought, with the most recent hydrology update[1] for the CCWSM (through 2015) showing a new drought of record for the Corpus Christi Regional Water Supply System (CCR/LCC/Texana/MRP Phase II System) from 2007 to 2013. The critical month of the drought of record, the basis of the Corpus Christi Regional Water System current system yield, occurred in September 2013.

No additional CCWSM updates were incorporated for the 2026 regional water plan.

At the May 18, 2023, CBRWPG meeting, the planning group considered guidance from the TWDB to consider firm yield when determining surface water availability as well the Coastal Bend Region approach that had been taken in previous planning cycles to determine availability based on safe yield. The CCWSM was used to estimate firm yield of the system for 2030 and 2080 sediment conditions, which is the maximum amount of water volume that can be provided under a repeat of DOR conditions assuming that all senior water rights will be totally used and all permit conditions met. In this case, this is the yield that would be available such that reservoir active storage would be equal to zero during the worst month of the DOR. The critical month of the DOR based on the CCWSM extent of hydrology from 1934-2015 is September 2013.

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[1] Corpus Christi Water Supply Yield Results from Hydrology Update, June 1, 2017.

On May 18, 2023, the CBRWPG approved submittal of a hydrologic variance request to use safe yield with 75,000 ac-ft reserve in the CCR/LCC System for determining surface water supplies available from the City of Corpus Christi's Regional Water Supply System, which was subsequently granted by the TWDB on January 8, 2024. This safe yield supply from the City of Corpus Christi's Regional Water Supply System is the basis of the needs analysis of this plan for entities relying on surface water supplies from the City of Corpus Christi, SPMWD, and STWA.

A comparison of water modeling assumptions for the 2026 regional water plan to previous plans is included in Table 9.2.

Table 9.2.
Comparison of Water Modeling Assumptions Used to Develop the 2026 Plan and Previous Coastal Bend Regional Water Plans

2026 Plan	2021 Plan	2016 Plan
Groundwater Availability based on **Modeled Available Groundwater**	Groundwater Availability based on **Modeled Available Groundwater**	Groundwater Availability based on **Modeled Available Groundwater**
Corpus Christi Water Supply Model updated to include hydrology from 1934-2015. Current Supply from CCR/LCC/Lake Texana/**MRP Phase II** System based on Corpus Christi Water Supply Model safe yield analysis (**75,000 ac-ft storage reserve**) for the City of Corpus Christi and its customers only	Corpus Christi Water Supply Model updated to include hydrology from 1934-2015. Current Supply from CCR/LCC/Lake Texana/**MRP Phase II** System based on Corpus Christi Water Supply Model safe yield analysis (**75,000 ac-ft storage reserve**) for the City of Corpus Christi and its customers only	MRP Phase II added. Existing Supply from CCR/LCC/Lake Texana/**MRP Phase II** System based on Corpus Christi Water Supply Model safe yield analysis (**12 month storage reserve**) for the City of Corpus Christi and its customers only
Run of the river water rights in the Nueces Basin, firm yield supplies based on minimum annual supply that could be diverted **limited by minimum month conditions**. No return flows from Region L.	Run of the river water rights in the Nueces Basin, firm yield supplies based on minimum annual supply that could be diverted **limited by minimum month conditions**. No return flows from Region L.	Run of the river water rights in the Nueces Basin, firm yield supplies based on minimum annual supply that could be diverted **limited by minimum month conditions**. Return flows from Region L.
New Surface water management strategies conform to TCEQ Environmental Flow Standards	New Surface water management strategies conform to TCEQ Environmental Flow Standards	New Surface water management strategies conform to TCEQ Environmental Flow Standards

9.2.3 Water Availability, Existing Supplies, and Identified Water Needs

Nearly 75 percent of the water used in the region comes from surface water supplies originating from the CCR/LCC/Texana/MRP Phase II system. In the 2016 regional water plan, the Corpus Christi Regional Water Supply System showed an annual safe yield of 219,000 ac-ft in 2020 declining to 214,000 ac-ft in 2070. For the 2021 regional water plan, the Corpus Christi Regional Water Supply System showed an annual safe yield of 178,000 ac-ft in 2020 declining to 167,000 ac-ft in 2070 due to sedimentation. For the 2026 regional water plan, the Corpus Christi Regional Water Supply System has an annual safe yield of 170,000 ac-ft in 2030 declining to 157,000 ac-ft in 2080 due to sedimentation.

The surface water availability decreased in the 2026 regional water plan as compared to 2021 regional water plan attributed primarily to sedimentation rates for Choke Canyon Reservoir and Lake Corpus Christi, and Lavaca-Navidad River Authority call-backs for a portion of Lake

Texana supplies for Jackson County uses per contract. With the updated model in the 2021 regional water plan to extend through 2015, safe yield reserve was changed from 125,000 ac-ft reserve (roughly equal to 1 year supply) in the 2016 regional water plan to a 75,000 ac-ft reserve for the 2021 regional water plan. The 2026 regional water plan uses a 75,000 ac-ft reserve consistent with the previous 2021 regional water plan.

Surface water availability for all other surface water rights, including run of the river rights, is based on Water Availability Mode (WAM) Run 3. Pursuant to TWDB guidance "Run of river availability, or firm diversion, evaluated for a municipal sole-source water use, is defined as the minimum monthly diversion amount that is available 100% of the time during a repeat of the drought of record (i.e., this minimum volume must be available each and every month)." For surface water withdrawals that do not require permits, such as for livestock purposes, Coastal Bend Region estimated local annual water availability volumes under drought of record conditions based on current water use data provided by the TWDB. For Nueces County Water Control and Improvement District #3 (WCID 3), who has a senior run-of-the-river water right on the Nueces River downstream of Lake Corpus Christi, a firm yield of 1,955 ac-ft/yr was shown in the 2016 regional water plan. For the 2026 regional water plan, the Nueces County WCID 3 firm yield is 384 ac-ft/yr from 2030 to 2080 consistent with the 2021 regional water plan.

The modeling assumptions used to develop groundwater availability for the 2026 regional water plan are the same as those used for the 2021 regional water plan. Groundwater availability was limited to Modeled Available Groundwater estimates (MAGs) developed based on desired future conditions (DFCs) provided by GMA/groundwater control districts (GCDs) within the Coastal Bend Region, but the 2021 regional water plan MAGs have been updated with new information since development of the 2016 regional water plan. The 2016 regional water plan groundwater availability based on MAGs is approximately 227,000 ac-ft and was constant from 2020 to 2070. The 2021 regional water plan groundwater availability based on MAGs increases from 145,269 ac-ft in 2020 to 187,096 ac-ft in 2070. The 2026 regional water plan groundwater availability based on MAGs increases from 148,731 ac-ft in 2030 to 168,261 ac-ft in 2080. Overall, most counties showed similar MAGs as compared to the 2026 regional water plan, with Kleberg and Kenedy counties showing over 5,000 ac-ft and over 10,000 ac-ft, respectively, more than in the previous 2021 regional water plan.

Surface water supplies were determined for most surface water users based on safe yield of the Corpus Christi Regional Water Supply System using an updated model that includes a recent, new drought of record. For Nueces County WCID 3 and River Acres Water Supply Corporation (WSC), the firm yield of run-of-the-river rights was used for current supply. There are no known infrastructure constraints that would preclude these supplies from being delivered at the safe or firm yield capacity, respectively. Groundwater supplies in the 2026 regional water plan are based on MAG projections provided by the TWDB, constrained by well capacity as reported in the Texas Commission on Environmental Quality (TCEQ) Public Water System (PWS) database. For non-municipal groundwater users with groundwater capacities that are not readily obtained from publicly available sources, the groundwater supply was calculated based on TWDB historical water use records.

Municipal supplies have decreased on average by 11,000 ac-ft/yr for the entire 50-year period from 2030 through 2080. Non-Municipal WUG supplies including irrigation and livestock have decreased on an average of 16,000 ac-ft/yr over the same 50-year planning period while manufacturing, steam-electric, and mining supplies are projected to increase by an average of 6,000 ac-ft/yr for the entire 50-year period. Some of this is due to groundwater supplies being limited to average day well capacity according to MAGs, but most is attributable to revised surface water availability and supplies based on new drought of record conditions and changes in volumetric surveys for LCC and CCR. Since most of the expected industrial growth occurs in San Patricio and Nueces counties, the regional CCR/LCC/Texana/MRP Phase II System can accommodate flexibility in delivery of these supplies subject to physical delivery constraints and contract provisions. Overall, the total difference in existing supplies between planning cycles range from a reduction of 17,201 ac-ft in 2030 to a reduction of 1,809 ac-ft in 2070.

Municipal and non-municipal need projections are similar and trending lower in the 2026 regional water plan due to supply constraints discussed previously. When comparing total available supplies to total demands for the 2026 regional water plan, the region shows a water supply need throughout the 50-year planning cycle. Beginning in 2030 a shortage of 38,900 ac-ft exists within the Coastal Bend Region and increases to 47,320 ac-ft by 2070. The previous 2021 regional water plan showed regional needs amounting to 66,926 ac-ft in 2070.

On a regional basis, municipal and industrial entities (manufacturing, steam-electric, and mining) show increasing needs from 38,900 ac-ft in 2030 to 50,742 ac-ft in 2080, due primarily to decreasing manufacturing surface water availability accompanied by increasing manufacturing demand. Shortages based on current supplies provided by the CCR/LCC/Texana/MRP Phase II System were placed on industrial (mining and/or manufacturing) demands in San Patricio and Nueces counties. Surface water supplies provide 89 percent of total manufacturing supplies in 2080 with groundwater and reuse comprising the remaining 9 and 2 percent, respectively. Region-wide, there is a manufacturing supply deficit of 33,680 ac-ft in 2030 increasing to 45,756 ac-ft by 2080.

9.2.4 Recommended and Alternative Water Management Strategies and Projects

The CBRWPG has studied numerous water management strategies as part of previous regional water planning efforts as summarized in Table 9.3. Many of these strategies are no longer actively being considered by local sponsors and, therefore, were not evaluated as part of the 2026 regional water plan. For comparison, the strategies recommend in the 2021 regional water plan are identified in Figure 9-2.

The 2026 regional water plan reflects water management strategies identified through conversations with wholesale water providers, water user groups, and potential new providers to address anticipated industrial growth in the Coastal Bend Region. During the development of this plan, cooperation has been encouraged between WWPs and WUGs for the purpose of achieving economies of scale and pursuing strategies that benefit the entire region.

9.2.5 Regional Water Management Strategies and Projects

The 2026 regional water plan considers water management strategies that are intended to serve more than one WUG. Many of these strategies are sponsored by the major WWPs in the region. The strategies considered in the 2021 regional water plan were classified as conservation, reuse, aquifer storage and recovery (ASR), seawater desalination, brackish groundwater desalination, local balancing storage, groundwater supplies, or regional water supply management and treatment facilities. The 2026 regional water plan considered the same categories of strategies in addition to Nueces River Diversion to Choke Canyon Reservoir and Lake Corpus Christi Sediment Removal. The 2021 regional water plan considered 5 water management strategies that serve more than one WUG, not including municipal, irrigation, or manufacturing conservation. The 2026 regional water plan identifies 10 strategies, not including municipal or manufacturing conservation, that serve more than one WUG. Most notably – there are three new reuse strategies and four new regional water supply management and treatment facilities strategies for the 2026 regional water plan compared to the 2021 regional water plan.

The City of Alice's Brackish Groundwater Desalination project is the only recommended water management strategy from the 2021 plan that has been implemented. None of the WMS that benefit more than one WUG in the 2021 plan have been implemented.

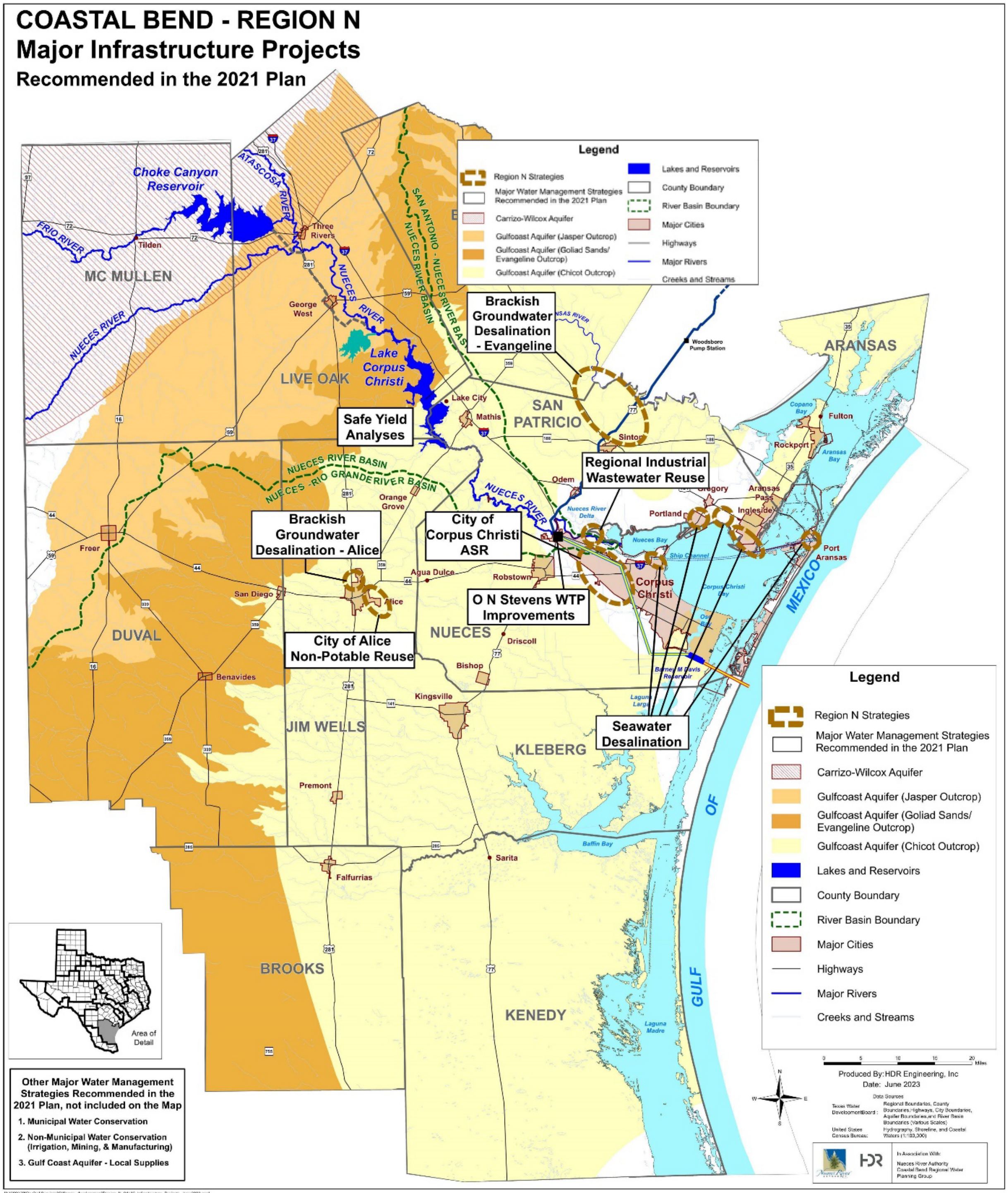


Figure 9-2.
Major Infrastructure Projects Recommended in the 2021 Plan

Table 9.3.
Summary of Water Management Strategies from Previous Coastal Bend Regional Water Plans

Water Management Strategies	2001 Plan	2006 Plan	2011 Plan[A]	2016 Plan	2021 Plan	2026 Plan
Recommended Strategies						
Municipal Water Conservation	√	√	√	√	√	√
Irrigation Water Conservation	√	√	√	√	√	√
Manufacturing Water Conservation and Nueces River Water Quality Issues	√	√	√	√	√	√
Mining Water Conservation	-	√	√	√	√	√
ON Stevens WTP Improvements	-	-	√	√	√	√
SPMWD Industrial WTP Improvements	-	-	-	√	-	-
Reclaimed Wastewater Supplies and Reuse[B]		√	√	√	√	√
Gulf Coast Aquifer Supplies	√ [C]	√	√	√	√	√
Modify Existing Reservoir Operating Policy[B]	-	√ [D]	√ [D]	√	-	-
CCR and LCC Pipeline[B]	-	√ [E]	√ [G]	-	-	-
Voluntary Redistribution of Available Supplies	√	√ [F]	√ [F]	√ [H]	-	-
Nueces Off-Channel Reservoir near Lake Corpus Christi	-	√	√	-	-	-
Stage II of Lake Texana[B]	-	√	√ [G]	-	-	-
Lavaca River Diversion and Off-Channel Reservoir	-	-	√	√	-	-
Garwood Pipeline (and other interbasin transfers)	√	√	√	-	-	-
Seawater Desalination	√	√	√ [G]	√	√	√
Brackish Groundwater Desalination	-	-	√ [G]	√	√	√
Potential Water System Interconnections	√	-	-	√	-	-
Interruptible Lake Texana Supplies (2001 Plan)	√	-	-	-	-	-
Recycle and Reuse of Groundwater or Use of Non-Potable Supplies	√	-	-	-	-	-
Aquifer Storage and Recovery (ASR)	√	√	-	-	√	√
Local Balancing Storage Reservoir (Nueces County WCID #3)	-	-	-	√	√	√
Guadalupe-Blanco River Authority Lower Basin Storage Project	-	-	-	√	-	-
Studied and Considered						
Carrizo-Wilcox Aquifer Supplies	√	√	√	-	-	-
Sediment Removal in Lake Corpus Christi	√	-	-	-	-	-
Brush Management	√	√	√	-	-	
Weather Modification	√	√	√	-	-	
Water Quality (TDS Study) - Lake Corpus Christi, Lake Texana, and Calallen Pool	-	-	√	-	-	-
Nueces River Diversion to Choke Canyon Reservoir	-	-	-	-	-	√
Lake Corpus Christi Sediment Removal	-	-	-	-	-	√

[A] The 2011 Plan also included five special studies related to water supply development.
[B] Studied and considered in the 2001 regional water plan but not recommended.
[C] Included short-term overdrafting in the 2001 Plan for generally small groundwater needs.
[D] Safe yield analysis was recommended strategy in 2006 and 2011 regional water plans.
[E] CCR/LCC Pipeline was revised from 2-way pipeline (in 2001 regional water plan) to 1-way pipeline from CCR to LCC.
[F] Includes USCOE Nueces Feasibility Study project opportunities.
[G] Considered an alternative water management strategy in the 2011 regional water plan.
[H] Voluntary Redistribution of Available Supplies included in Gulf Coast Aquifer Supplies (5D.7) for the 2016 regional water plan. Federal or state Opportunities to Participate in Regional Projects was not included in the 2016 regional water plan.

9.3 Summary of Water Management Strategies from the 2021 Regional Water Plan No Longer Relevant or Actively Evaluated in the 2026 Regional Water Plan

At the request of the CBRWPG, this chapter summarizes strategies previously evaluated in the 2021 regional water plan to retain this knowledge and for efficiency should these strategies become applicable during future planning cycles. Section 9.4summarizes strategies evaluated in plans prior to the 2021 regional water plan. Since these strategies are no longer being considered, costs were not updated to current 2026 regional water plan indices.

9.3.1 Reclaimed Wastewater Supplies and Reuse (N-5) (previous 5D.5, Recommended Water Management Strategy)

9.3.1.1 Wastewater Reuse Considerations for Municipal and Industrial Purposes (previous 5D.5.2, Recommend Water Management Strategy)

In general, primary industrial customers use similar facility processes that are mainly responsible for water consumption, such as cooling towers and boilers. However, the primary differences in water usage are product related. Process and product differences affect water quantity and quality needs. For most chemical and refining plants, cooling accounts for 60 to 75 percent of the water use, boiler water use accounts for 20 to 30 percent, process water accounts for 5 to 9 percent, and potable or sanitary use accounts for 1 percent.

The following factors influence and control current water use, the potential for industrial water conservation, and the potential for area industries to use alternative sources of water, including treated municipal wastewater, brackish groundwater, and seawater. The list of important factors includes:

- The location of each water-using industrial plant in relation to a source or sources of water;
- The location of each water-using industrial plant in relation to streams or other features into which wastewater can be discharged;
- The type of industry, which determines the type of water use (i.e., refineries which use varying and/or different grades of crude petroleum, refineries which are producing reformulated gas, chemical plants which produce a range of chemicals and pharmaceuticals, and plants which extract compounds from ores to produce metals and other products); and
- The metallurgy of equipment in the cooling system that would come in contact with the cooling water.

The water quality requirements of industry in the area are determined by the water quality constraints for cooling tower make-up, boiler make-up, process water, and potable water. Because cooling tower make-up can utilize water of poorer quality as compared to the high-quality water required in a boiler, the reuse of wastewater effluent in cooling towers provides the best opportunity for this alternative water supply.

Corpus Christi area industries implemented water conservation and water reuse measures that have significantly reduced quantities of water needed per unit of production.

Major industrial users in the Nueces and San Patricio counties have also implemented various water conservation measures in response to drought and are currently supplementing a portion of their water demands with direct recycled reuse. Following are lists of water conservation measures, which have been implemented by industry as well as future water conservation strategies, including wastewater reuse.

Current Measures

- Recycling Cooling Tower and Boiler Blowdown
- Improved Control Systems
- Dry Cooling, Air Cooled Heat Exchangers
- More Efficient Drift Eliminators
- Changed Washdown Procedures
- Automatic Cooling Tower Blowdown
- Leak Detection/Repair
- Steam Condensate Recovery
- Reuse Wastewater Treatment Effluent for Firewater, Cooling Tower Make-up
- Cycling-Up Cooling Towers
- Stormwater Reuse
- Salt Water for Area Washdown
- Salt Water Lubrication of Circulating Water Feed Pumps
- Reverse Osmosis with Demineralization
- Voluntary Water Conservation Planning
- Regulatory Requirement to Consider Reuse
- Saltwater for Cooling
- Uniform blending of Lake Texana/Nueces River waters to provide consistently better water quality with less variation in dissolved minerals.

Future Measures

- Increased Evaluation of Alternative Water Sources to Replace Treated City Water
- Additional Application of Reverse Osmosis Treatment
- Increased Wastewater Treatment Plant Effluent Reuse
- Possible Side-Stream Softening
- New Process Changes
- Additional Steam Leak Repair
- New Chemical Treatment Technology
- Increased Water Audit by Industry
- Possible Water Conservation Incentives
- Possible Regulatory or Local Government Water Conservation Planning Goals
- Increasing Water Conservation Research and Education
- Additional Industry Pursuing Water Conservation Measures

9.3.1.2 Regional Industrial Wastewater Reuse Plan for Aransas Pass, Gregory, Portland, Ingleside, and Ingleside-by-the-Bay (previous 5D.5.3, Recommended Water Management Strategy)

This strategy investigated the feasibility of a regional wastewater system that could provide a supply of recycled water to industrial users. A proposed San Patricio Regional Wastewater System (SPRWS) would divert wastewater from five customer cities, Aransas Pass, Gregory, Portland, Ingleside, and Ingleside-by-the-Bay, to a new wastewater treatment plant (WWTP). Treated effluent could then be routed to an existing WTP, blended with that plant's effluent, and distributed for industrial reuse. The recycled water project decreases demand on existing freshwater supplies and helps meet water conservation plan requirements for area industries.

The strategy included wastewater transfer pipelines, new or refurbished transfer lift stations, a WWTP, and facilities to treat and deliver recycled water to industrial users, as shown in Figure 9-3. The strategy proposed two WWTP capacity options, 6.47 mgd (7,250 ac-ft/yr) or 4.47 mgd (5,010 ac-ft/yr). The larger capacity reflected the combined projected wastewater flow from all customer cities, while the smaller capacity alternative represented the required regional plant capacity if one of the three larger cities does not participate (Portland, Ingleside, or Aransas Pass). Three potential SPRWS pipeline, or influent flow transfer, scenarios were considered. The recommended flow transfer system included an independent flow transfer from Portland and Gregory and a combined system for Aransas Pass, Ingleside, and Ingleside-on-the-Bay.

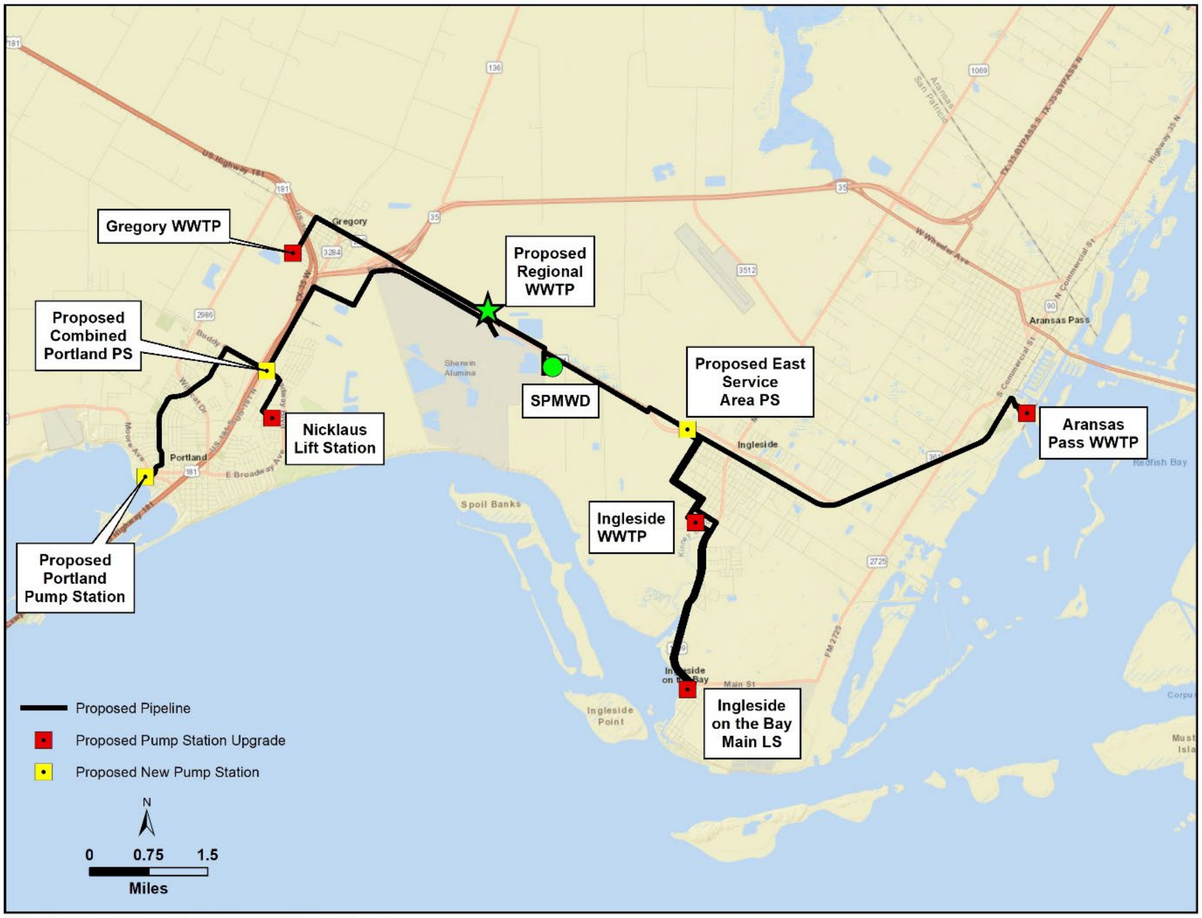


Figure 9-3.
Project Map for Regional Industrial Wastewater Reuse Plan for Aransas Pass, Gregory, Portland, Ingleside, and Ingleside-by-the-Bay

Overall, the project cost is $137,834,000 for the 6.47 mgd plant capacity with an annual cost of $10,046,000, and a unit cost of $1,386 per ac-ft or $4.25 per 1,000 gallons. The project cost for the 4.47 mgd plant capacity is $115,502,000 with an annual cost of $8,475,000 and unit cost of $1,692 per ac-ft or $5.19 per 1,000 gallons. Costs for customer cities, Aransas Pass, Gregory, Portland, Ingleside, and Ingleside-by-the-Bay, vary based on the percentage of capacity reserved for each city.

Studies published between October 2016 and August 2019 identified no major implementation issues.

Table 9.4.
Evaluation Summary for Regional Industrial Wastewater Reuse Plan for Aransas Pass, Gregory, Portland, Ingleside, and Ingleside-by-the-Bay

Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. Firm Yield: 5,010 to 7,250 ac-ft/yr
2. Reliability	2. Good.
3. Cost of treated water	3. $1,386 to $1,692 per ac-ft
b. Environmental factors:	
1. Instream flows	1. Potential for environmental impacts to streams currently receiving wastewater effluent.
2. Bay and estuary inflows and arms of the Gulf of Mexico	2. Environmental impact to estuary in potential reduction of freshwater inflows.
3. Wildlife habitat	3. None or low impact.
4. Wetlands	4. None or low impact.
5. Threatened & endangered species	5. None or low impact.
6. Cultural resources	6. Cultural resources investigations will be required for all pipeline routes.
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. The City of Corpus Christi Integrated Plan provides ongoing studies of water quality issues of the Nueces Delta and Bay. a. Dissolved solids are a concern to be addressed with further studies. b. Salinity is a concern to be addressed with further studies. c. Bacteria is a concern to be addressed with further studies. d. Chlorides are a concern to be addressed. e-h. None or low impact. i. Alkalinity may be a concern. Zinc in wastewater discharges into Nueces Bay is a concern to be addressed with further studies.
c. Impacts to Ag and State resources	• No negative impacts on other water resources
d. Threats to agriculture and natural resources in region	• Temporary damage due to construction of pipeline(s)
e. Recreational impacts	• None
f. Equitable comparison of strategies	• Standard analyses and methods used for portions
g. Interbasin transfers	• None
h. Third party social/ economic impacts from voluntary redistribution of water	• Not applicable
i. Efficient use of existing water supplies and regional opportunities	• Provides reuse opportunities of water supplies
j. Effect on navigation	• None
k. Impacts on water pipelines and other facilities used for water conveyance	• Additional care should be exercised in construction of pipeline in dense industrial area.

9.3.1.3 City of Alice Non-Potable Projects (previous 5D.5.4, Recommended Water Management Strategy)

This strategy considered potential and beneficial uses for non-potable wastewater effluent from the City of Alice's South WWTP. The City of Alice operates two WWTPs. One is centrally located in the northeast side of town, and the other is located south of the city. On average, the northeast plant treats approximately 0.7 mgd and the south plant treats 1.1 mgd.

Due to the South WWTP's proximity to the airport and commercial/industrial development, the reuse of high quality non-potable water could be a viable alternative to the use of drinking water and provide a source for economic development in that area. The anticipated yield of this strategy is 0.8 mgd (897 ac-ft/yr). Figure 9-4 shows the proximity of the South WWTP to industrial end user and a potential south plant pipeline route.

This strategy proposed a new 1.1-million gallons per day (mgd) WTP, a new pump station and storage tank at the South WWTP, and 13 miles of 12-inch diameter pipeline to deliver the non-potable wastewater effluent to an industrial end user. The total project cost is $10,222,000 with an annual cost of $1,300,000 and unit cost of $1,449 per ac-ft or $1.99 per 1,000 gallons.

The South WWTP currently discharges 100 percent of its 1.1-mgd effluent into the San Fernando Creek. The reuse project would use the treated effluent that would otherwise discharge to San Fernando Creek. Additional studies to evaluate local environmental impacts would need to be undertaken prior to project implementation, as the reduced discharge could impact farming and ranching activities. No major implementation issues were identified for the project considered.

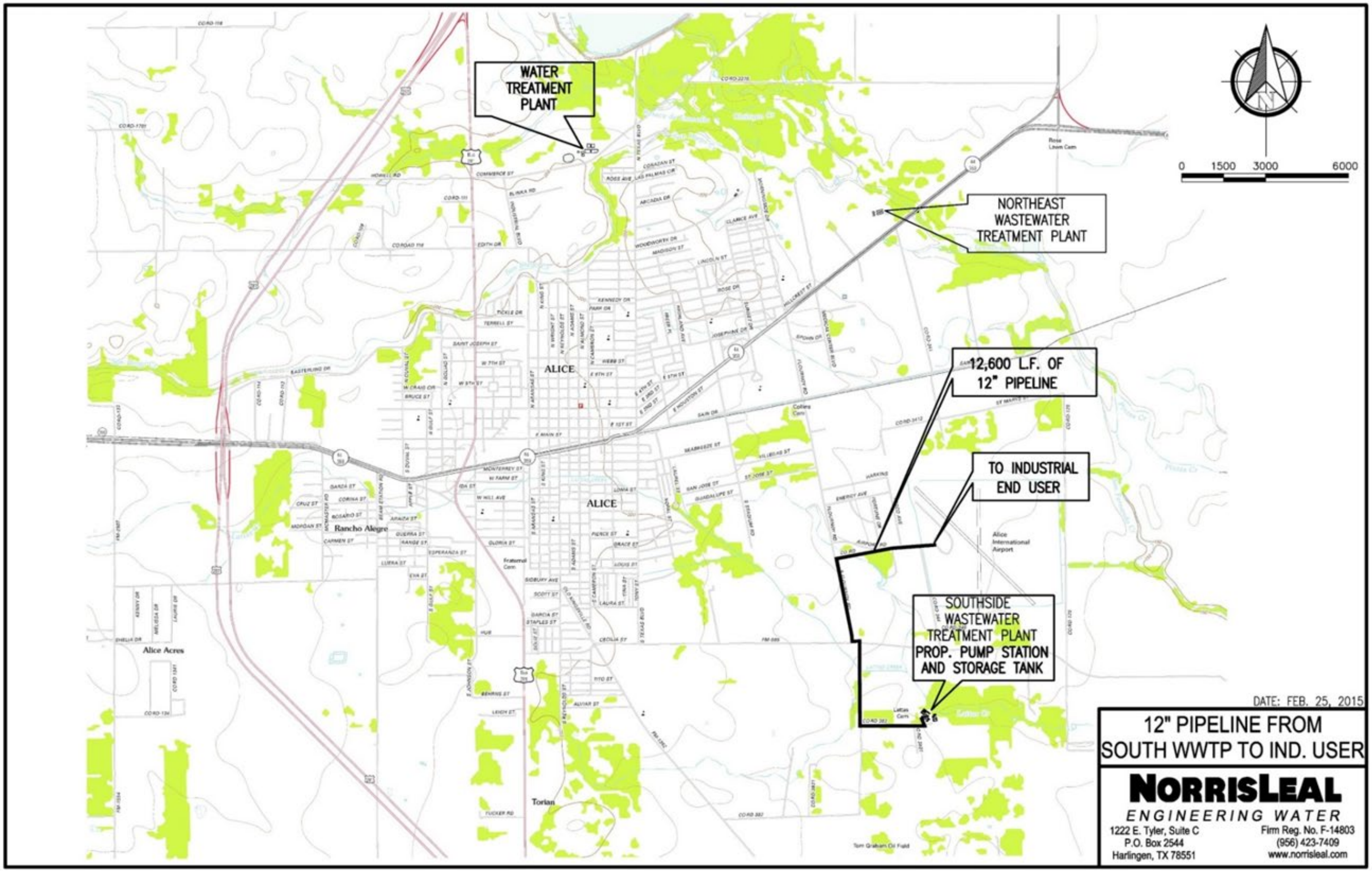


Figure 9-4.
Non-Potable Reuse for Alice

Table 9.5.
Evaluation Summary for City of Alice Non-Potable Reuse

Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. Firm Yield: 897 ac-ft/yr
2. Reliability	2. Good.
3. Cost of treated water	3. $1,449 per ac-ft
b. Environmental factors:	
1. Instream flows	1. Potential for environmental impacts to streams currently receiving wastewater effluent.
2. Bay and estuary inflows and arms of the Gulf of Mexico	2. None or low impact. It is not anticipated that current return flows reach Cayo del Grullo.
3. Wildlife habitat	3. None or low impact.
4. Wetlands	4. None or low impact.
5. Threatened & endangered species	5. None or low impact.
6. Cultural resources	6. Cultural resources investigations will be required for all pipeline routes.
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. a. Dissolved solids are a concern to be addressed with further studies. b. Salinity is a concern to be addressed with further studies. c. Bacteria is a concern to be addressed with further studies. d. Chlorides are a concern to be addressed. e-h. None or low impact. i. Alkalinity may be a concern.
c. Impacts to Ag and State resources	• No negative impacts on other water resources
d. Threats to agriculture and natural resources in region	• Temporary damage due to construction of pipeline(s)
e. Recreational impacts	• None
f. Equitable comparison of strategies	• Standard analyses and methods used for portions
g. Interbasin transfers	• None
h. Third party social/ economic impacts from voluntary redistribution of water	• Not applicable
i. Efficient use of existing water supplies and regional opportunities	• Provides reuse opportunities of water supplies
j. Effect on navigation	• None
k. Impacts on water pipelines and other facilities used for water conveyance	• Additional care should be exercised in construction of pipeline in dense industrial area.

9.3.2 Gulf Coast Aquifer Supplies (previous 5D.8, Recommended Water Management Strategy)

9.3.2.1 Evangeline/Laguna LP Raw Groundwater Project (previous 5D.8.2, Recommended Water Management Strategy)

This project included groundwater production of up to 25.4 mgd (28,486 ac-ft/yr) from 23,000+ acres located in San Patricio County for conveyance and delivery to the City of Corpus Christi and/or future industries in San Patricio County. Since publication of the 2016 regional water plan, project developers have moved this project toward implementation by securing permits from the San Patricio County Groundwater Conservation District (SPCGCD), drilling and collecting data from a test well, and performing a corrosion analysis, but no blending analysis has been conducted yet. The strategy presented here is for the raw, groundwater supply with minimal treatment options based on the water quality results provided by Evangeline/Laguna LP that shows water quality results within TCEQ drinking water standards.

The project infrastructure was phased based on MAG limitations, with full well field build-out after 2050. The first phase is a well field with 13 wells (production constrained by MAG), but at full project production, the wellfield consists of 18 wells, including contingency. The wells will be around 1,000 feet deep and have an estimated pumping rate of 1,200 gallons per minute (gpm). The current raw groundwater quality is around 800 milligrams per liter (mg/L) total dissolved solids (TDS), and wells would be screened and operated in such a manner to target groundwater with lower levels of TDS and chlorides. Based on test well data, water quality meets drinking water standards and could be delivered to a customer untreated or with minimal chlorine treatment.

Based on data collected and provided by Evangeline/Laguna LP, three strategy configurations were identified and evaluated for planning and costing purposes for 2021 regional water plan water management strategy and are shown in Figure 9-5.

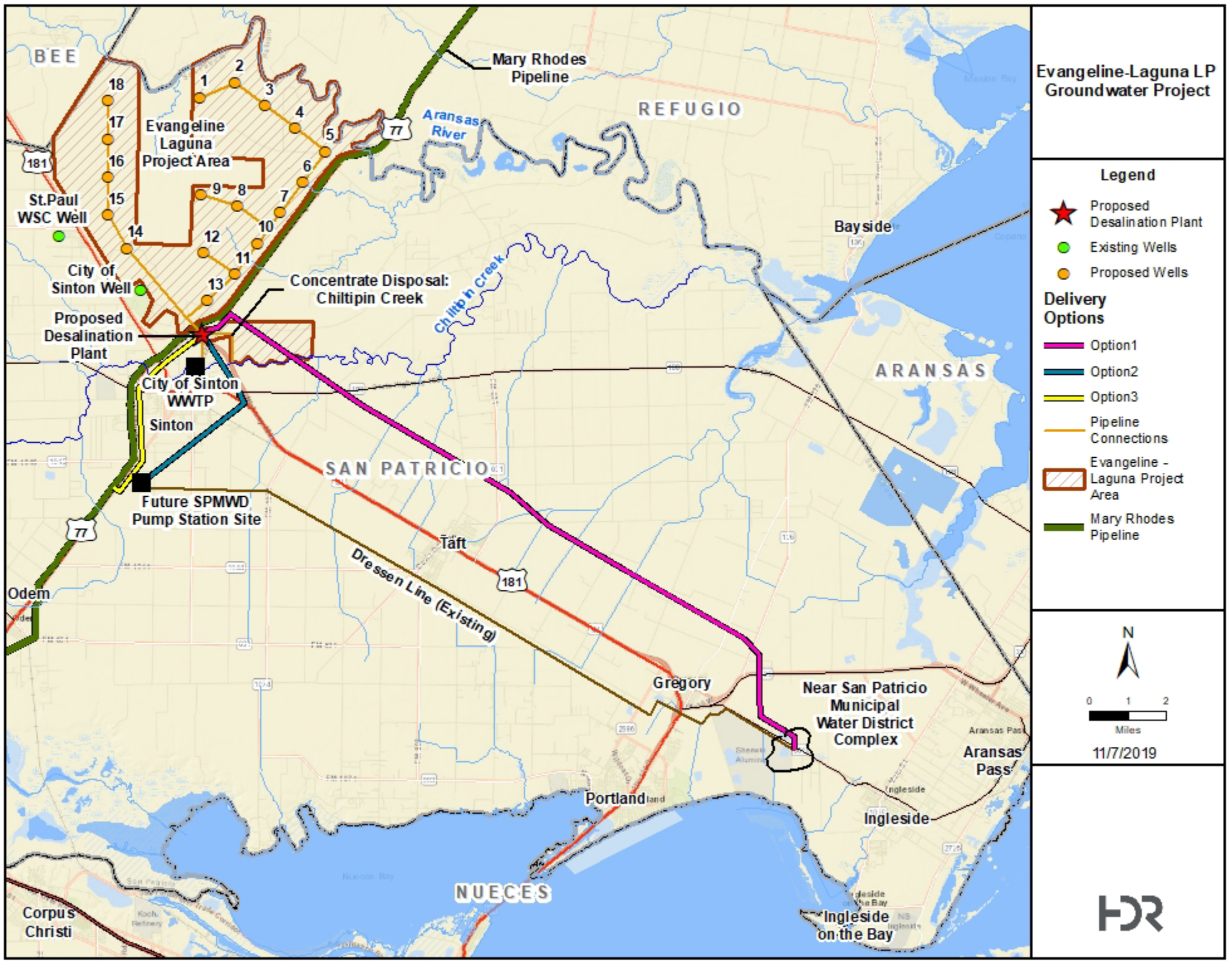


Figure 9-5.
Location of Conceptual Layout of Evangeline/Laguna LP Groundwater Project

Overall, the project cost ranges from $74,596,000 to $115,585,000 depending on delivery option. Annual costs range from $18,492,000 to $22,210,000. At a yield of 24,873 ac-ft/yr, the unit cost of water ranges from $743 to $893 per ac-ft.

Multiple implementation issues were identified for this strategy. Some the issues identified included verification of the Gulf Coast Aquifer water quality, impact of water levels in the aquifer, and USACE Section 10 and 404 dredge and fill permits for pipelines.

Table 9.6.
Evaluation Summary of the Evangeline/Laguna LP Raw Groundwater Project Option

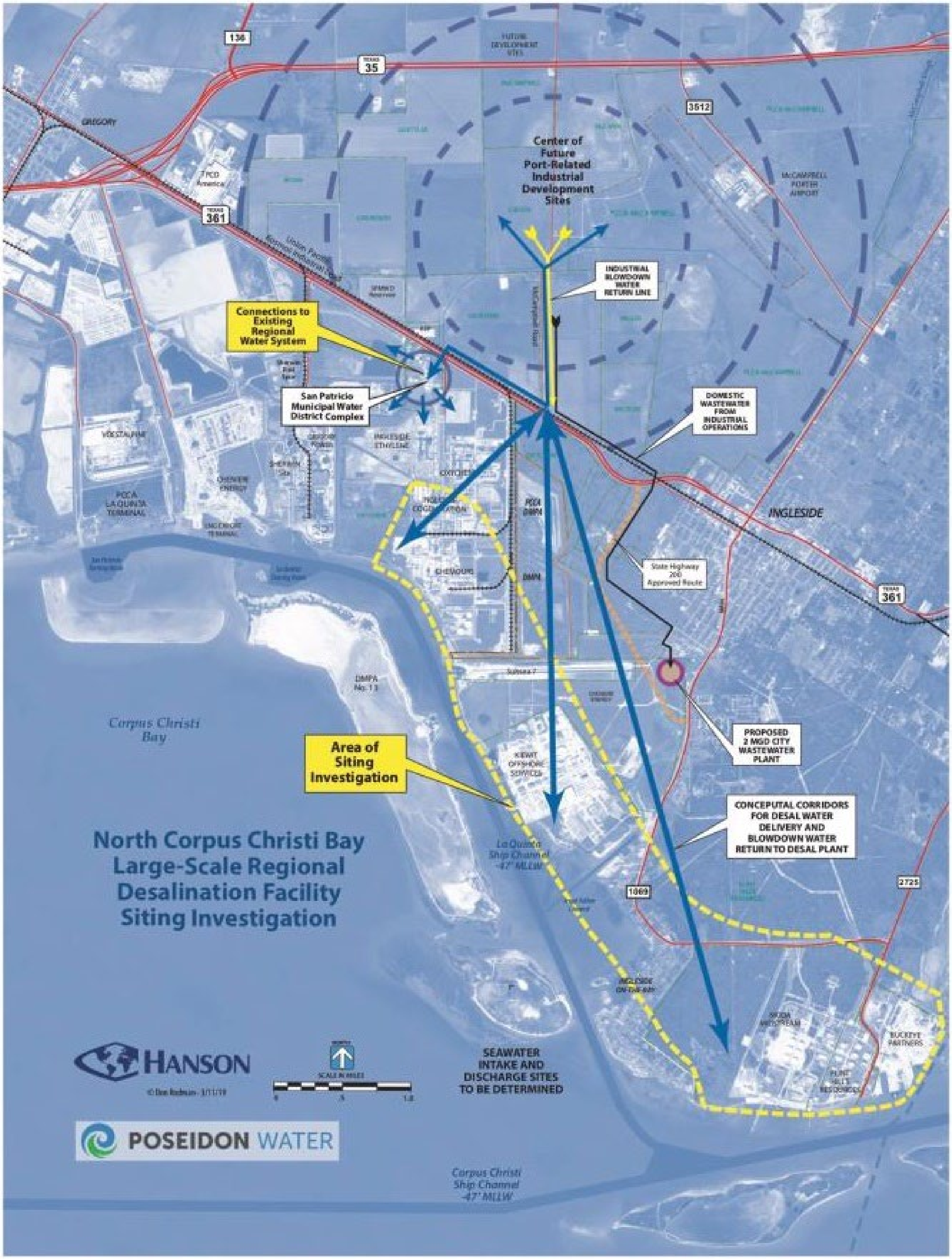
Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. Yield limited to 24,873 ac-ft/yr through 2050 based on MAG.
2. Reliability	2. High reliability.
3. Cost of treated water	3. Generally moderate cost; between $743 to $893 per ac-ft for three different delivery options.
b. Environmental factors:	
1. Instream flows	1. Moderate impact.
2. Bay and estuary inflows and arms of the Gulf of Mexico	2. None or low impact.
3. Wildlife habitat	3. None or low impact
4. Wetlands	4. None or low impact
5. Threatened and endangered species	5. None identified. Project can be adjusted to bypass sensitive areas. Endangered species survey will be needed to identify impacts.
6. Cultural resources	6. Cultural resources survey will be needed to identify any significant sites.
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. a-b,d. Total dissolved solids, chloride, and salinity of water is expected to be within TCEQ drinking water standards. c. None or low impact. e-i. Sulfate, uranium and arsenic concentrations in groundwater will need to be considered prior to implementation of project.
c. Impacts to Agricultural Resources or State water resources	• Negligible impacts to agricultural resources. • None or low negative impacts on surface water resources
d. Threats to agriculture and natural resources in region	• None or low impacts. Temporary damage due to construction of pipeline
e. Recreational impacts	• None
f. Equitable comparison of strategies	• Standard analyses and methods used for portions
g. Interbasin transfers	• Not applicable
h. Third party social and economic impacts from voluntary redistribution of water	• Not applicable
i. Efficient use of existing water supplies and regional opportunities	• Provides regional opportunities for water that would otherwise be unused
j. Effect on navigation	• None
k. Impacts on water pipelines and other facilities used for water conveyance	• Construction and maintenance of transmission pipeline corridor. Possible impact to wildlife habitat along pipeline route and right-of-way.

9.3.3 Seawater Desalination (N-10) (previous 5D.10, Recommended Water Management Strategy)

9.3.3.1 Poseidon Regional Seawater Desalination Project at Ingleside (Previous 5D.10.6, Recommended Water Management Strategy)

The project involved the City of Ingleside, as a project sponsor, who has initiated a process with Poseidon Water to evaluate, design, build, finance, operate and maintain a large-scale seawater desalination plant in San Patricio County. The project contemplates delivery of the facility via a Public-Private-Partnership (P3).

The initial desalination project is for a 50 mgd desalination facility, expandable to up to 100 mgd (112,000 acre-feet-per-year) to meet future industrial demand. The general location for the siting of the plant is within the city limits of Ingleside and potential service area is shown in the map in Figure 9.6. This project evaluation is based on development, production and treatment of seawater via reverse osmosis for new manufacturing (industrial) uses in San Patricio County.



Source: Poseidon *Water* Map, 2019 via email September 2019

Figure 9.6.
Proposed Location for Poseidon Regional Seawater Desalination Project at Ingleside

The plant is expected to have a 45 percent recovery rate, requiring approximately 225 mgd of seawater to produce 100 mgd of treated desalinated water for manufacturing purposes and potentially additional water for brine dilution. The water quality data at La Quinta Channel in Corpus Christi Bay indicates the seawater (source water) salinity ranges from 14,550 mg/L to 40,500 mg/L, with an average salinity of 31,600 mg/L over a 35-year period from 1985 to 2019. Discharge of the reverse osmosis (RO) concentrate will contribute additional salt load to the La Quinta ship channel, and the design of outfall will seek to minimize impact to intake quality. However, there is potential wastewater reuse from industrial return flows as well as municipal wastewater for use in the desalination process and/or brine disposal treatment facilities to be considered and evaluated.

Details regarding intake, desalination process, concentrate disposal outfall, site-specific environmental impacts, and storage needs is unavailable at this time and was not included in the cost estimate. A 3.5-mile (18,480-foot) product water delivery line for delivery to the industrial complex in San Patricio County is included in the cost estimate, based on information provided by Poseidon Water. Energy is the largest operational cost of a desalination facility, and energy use is directly proportional to salinity of the source water. The total project cost for a 50 mgd facility is $724,984,000 and $1,280,848,000 for a 100 mgd facility. The annual cost is expected to range from around $123,638,000 to $218,932,000. This results in a unit cost of water of $1,955 to $2,206 per ac-ft.

Permitting of this facility will require extensive coordination with all applicable regulatory entities. The major project components and issues with implementation will be permitting and construction of pipelines. Also, this strategy contemplates a P3 delivery mechanism calling for risk transference to a private party to Design-Build-Finance-Operate-and-Maintain the project.

Table 9.7. Evaluation Summary of the Poseidon Regional Seawater Desalination Project at Ingleside Project

Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. Project size: 56,000-112,000 ac-ft/yr;
2. Reliability	2. Highly reliable quantity.
3. Cost of treated water	3. Unit cost between $1,955 - $2,206 ac-ft.
b. Environmental factors:	
1. Instream flows	1. None or low impact.
2. Bay and estuary inflows and arms of the Gulf of Mexico	2. Some environmental impact to estuary.
3. Wildlife habitat	3. Some. Disposal of concentrated brine created from process may impact fish and wildlife habitats or wetlands.
4. Wetlands	4. Some. Disposal of concentrated brine created from process may impact fish and wildlife habitats or wetlands.
5. Threatened and endangered species	5. None identified. Endangered species survey will be needed to identify impacts.
6. Cultural resources	6. Cultural resources survey will be needed to identify any significant sites.
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. 7a-b. Total dissolved solids and salinity of water is removed with reverse osmosis treatment. Brine concentrate disposal issues will need to be evaluated. 7c-i. Bacteria, chlorides, nitrate, alkalinity, ammonia, and copper were all identified as constituents of concern for the Corpus Christi Bay in the TCEQ and NRA Basin Highlights Report. Additional studies regarding impacts on or as a result of project are needed
c. Impacts to Agricultural Resources and State water resources	• None or low impacts on other water resources • Negligible impacts to agricultural resources
d. Threats to agriculture and natural resources in region	• Some. Temporary damage due to construction of pipeline
e. Recreational impacts	• None
f. Equitable comparison of strategies	• Standard analyses and methods used for portions • Seawater desalination cost modeled after bid and manufacturers' budgets, but not constructed, comparable project • Project does not include off-shore brine disposal.
g. Interbasin transfers	• Not applicable
h. Third party social and economic impacts	• Not applicable
i. Efficient use of existing water supplies and regional opportunities	• Provides regional opportunities
j. Effect on navigation	• None
k. Impact of water pipelines and other facilities used for water conveyance	• Construction and maintenance of transmission pipeline corridor (in future). Possible impact to wildlife habitat along pipeline route and right-of-way.

9.4 Summary of Water Management Strategies from the 2016 Regional Water Plans or Prior No Longer Relevant or Actively Evaluated in the 2026 Regional Water Plan

9.4.1 Manufacturing Water Conservation and Nueces River Water Quality Issues (previous 5D.3, Considered Water Management Strategy)

9.4.1.1 Previous Water Quality Analyses

For the 2001 regional water plan, a surface water and groundwater evaluation was conducted for the Nueces River downstream of Lake Corpus Christi. The study showed the most significant concentration increase in chlorides (and dissolved minerals in general) occurs with increasing depth within the channel. Another phase of this evaluation aimed to identify the possible sources of elevated levels of dissolved solids in the Nueces River water. The results of the surface water and groundwater interaction study are included in the 2001 regional water plan.

The Nueces River Partnership developed a watershed protection plan for the Lower Nueces River for the 182.6 square miles contributing to the Nueces between Lake Corpus Christi and the saltwater barrier dam. The Texas Clean Rivers Program developed a watershed management approach to conducting basin wide water quality assessments required by Senate Bill 818. Water quality data from this effort is available for Lake Corpus Christi and the 39 river miles downstream to the saltwater barrier. The Nueces BBASC Study #3, conducted by HDR Engineering, Inc. (HDR), describes nutrient budgets based on quantitative understanding of natural supply of all nutrient forms and anthropogenic changes in these supplies over time for the Nueces Bay watershed and determines annual loads for pre-development and current conditions.

9.4.1.2 Assessment of Water Budget and Salinity in the Lower Nueces River Basin

The major purpose of this assessment included in the 2016 regional water plan is to improve understanding of: 1) surface water/groundwater interactions; and 2) influences on water quality conditions. The areas of interest are Lake Corpus Christi (LCC) and the Nueces River between LCC and Calallen. A map of the study area and stream gaging stations is shown in Figure 9-7. Data used for the study included streamflow, groundwater levels, groundwater quality, stream water quality, precipitation, lake evaporation, LCC stage, volume, and direct lake diversions, and Calallen diversions.

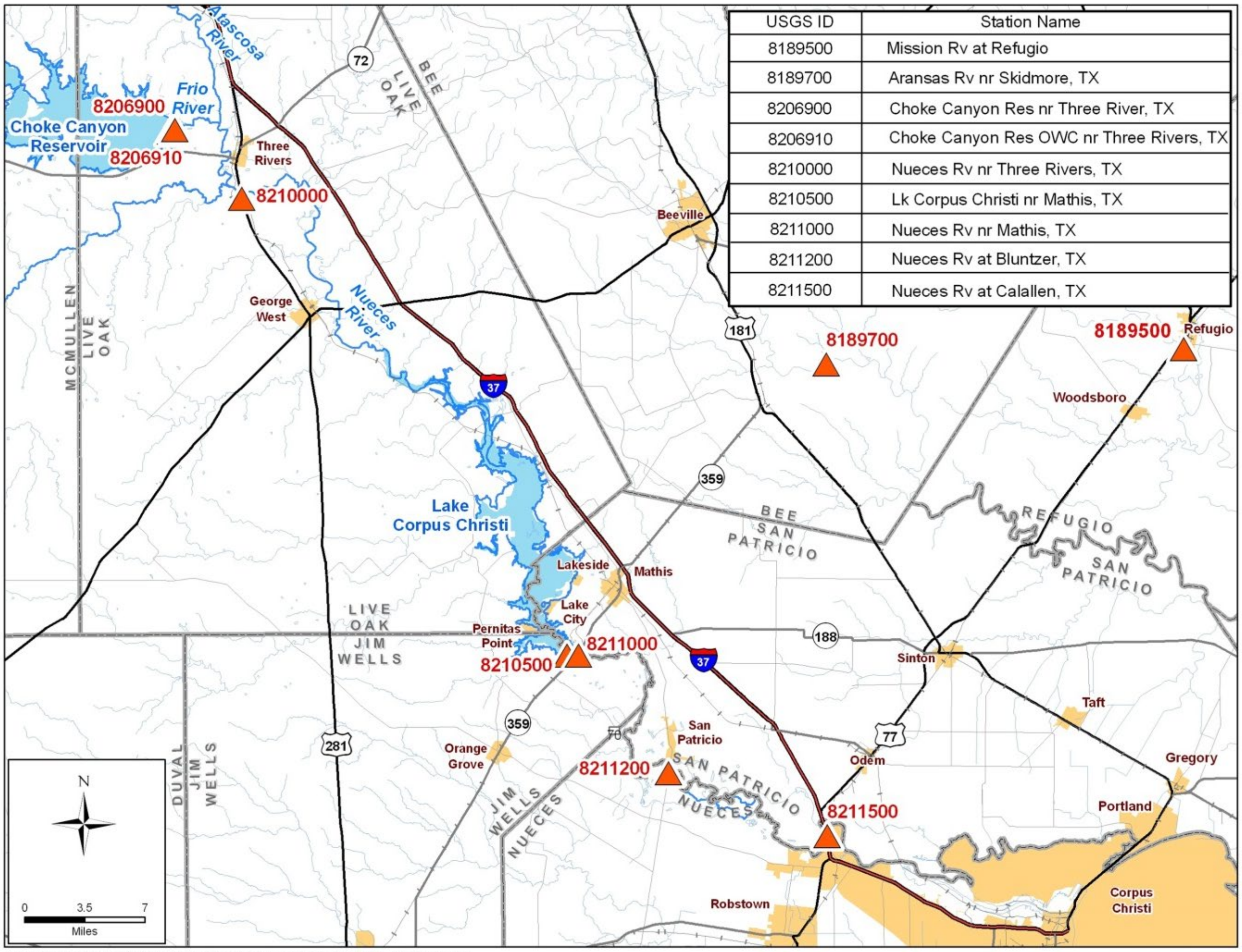


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Figure 9-7.
Location of Study Area and Streamflow Gaging Stations

The interaction or movement of water between the Nueces River, LCC, and major aquifers is studied for the Nueces River reach between Mathis and Calallen (Figure 9-7). For LCC, the interaction is studied by calculating the seepage into and out of the lake from a water budget model. For the Lower Nueces River, the interaction is studied by calculating the streamflow gains and losses between streamflow U.S. Geological Survey (USGS) gaging stations.

A major use of the water from LCC and the Lower Nueces River is for municipal and industrial purposes. As a result, there is a great interest in not only having a sufficient supply during all times but to have water quality meet drinking water standards and be consistent over time. One of the long-term issues with water from the Calallen Pool is variable water quality, especially with regard to salinity (chloride concentrations) during the summer and periods of drought. For LCC, the hydrologic influences on water quality are studied with regard to the inflow from the Nueces River and surface water/groundwater interaction. Other potential significant influences are stratification of the lake, especially in the deep section near the dam, and evaporation. Increasing and decreasing salinity between streamflow gaging stations is studied for the Nueces River downstream of LCC.

9.4.2 Reclaimed Wastewater Supplies and Reuse (previous 5D.5, Recommended Water Management Strategy)

9.4.2.1 Choke Canyon/Lake Corpus Christi Yield Recovery through Diversion of the City of Corpus Christi WWTP Effluent and/or Freshwater River Diversions through the Rincon Pipeline to the Nueces Delta

The TCEQ 1992 Interim Order established operational procedures for the CCR/LCC System that included a monthly schedule of desired inflows to Nueces Bay to be comprised of releases, spills, and return flows. The Interim Order also directed studies such as the feasibility of relocating wastewater discharges to locations where increased biological productivity could justify an inflow credit computed by multiplying the amount of discharge by a number greater than one. Prior to reopening the Rincon Bayou Demonstration Project in 2001, the Nueces River bypassed the Nueces Delta and flowed directly into Nueces Bay except during periods of high flow. Previous studies have shown that diversions of both river water and treated wastewater to the Nueces Delta can be expected to increase primary production by factors of about three to five when compared to allowing these waters to enter Nueces Bay via the Nueces River.

Previous studies indicate that the Nueces Delta and Nueces Bay are critically important as the site of much of the planktonic primary production that drives biological processes throughout the Nueces Estuary. There is evidence that treated wastewater could have as much as a five-fold stimulatory effect on primary productivity if discharged into the Nueces Delta rather than being discharged into the Nueces River. Therefore, it is recommended that wastewater be diverted and discharged into the Nueces Delta to help meet the freshwater inflow requirement, as specified in the 2001 Agreed Order, under which the CCR/LCC System now operates.

This strategy considered in the 2016 regional water plan examines potential yield recovery assuming 2 mgd of wastewater from Allison WWTP and up to 32 mgd of river water from the Calallen Pool through the Rincon Pipeline that could be discharged into the Nueces Estuary. Without biological productivity multipliers, 2 mgd of wastewater would be expected to yield 250 ac-ft/yr. A series of model runs were performed using the updated CCWSM to determine and quantify water supply benefits associated with different quantities of water being delivered to the Nueces Estuary for a range of biological multipliers.

Model simulation results indicate that yield increase ranges from just under 1,000 ac-ft for diverting 2 mgd of treated wastewater to the Nueces Estuary with a multiplier of 2 to over 17,000 ac-ft with a river diversion of 32 mgd and a multiplier of 5. A 2 mgd treated effluent diversion project with a multiplier of 5 is roughly equivalent in terms of increased yield to a combination project of 13 mgd diverted to the Nueces Estuary (11 mgd of river water and 2 mgd of treated effluent) with a multiplier of 2. The 32-mgd scenarios produce the highest yield increases compared to the other scenarios. By changing a biological multiplier of 2 to 5, at least for the volumes evaluated herein, an increase of about 2.4 to 2.5 times in firm yield would be expected.

Much of the infrastructure is already in place for this water management strategy. The Rincon Pipeline was built by the City of Corpus Christi and became operational in November 2007. The

Allison WWTP owned and operated by the City of Corpus Christi also has some infrastructure still in place from the Allison demonstration project. These facilities can deliver about 2 mgd from the plant. The estimated operating costs to deliver 2 mgd from the Allison WWTP are approximately $84,000 per year. This annual costs produces a unit cost ranging from $90.23 per ac-ft for a multiplier of 2 down to $17.25 per ac-ft for a multiplier of 5. The estimated annual operating costs for the Rincon Pipeline are $150,000 for delivering 11 mgd, which results in unit costs ranging from $109.07 per ac-ft for a multiplier of 2 down to $45.08 per ac-ft for a multiplier of 5. If the options were combined with both the 11 mgd of river water and 2 mgd of effluent the annual operating costs are estimated to be $548,000. This annual costs produces a unit cost ranging from $116.35 per ac-ft for a multiplier of 2 down to $45.85 per ac-ft for a multiplier of 5.

9.4.2.2 Wastewater Reuse Considerations for Municipal and Industrial Purposes

In general, primary industrial customers use similar facility processes that are mainly responsible for water consumption, such as cooling towers and boilers. In addition, industry also uses freshwater for drinking water, sanitary use, equipment wash-down, and fire protection. However, the primary differences in water usage are product related. Process requirements influence the size and type of cooling systems and boilers needed for steam production. Process and product differences affect water quantity and quality needs. Depending on the industrial facility's plant size, age, and market conditions, different plants in the same industry category can have different water needs and water use efficiencies.

The following factors influence and control current water use, the potential for industrial water conservation, and the potential for area industries to use alternative sources of water, including treated municipal wastewater, brackish groundwater, and seawater. The list of important factors includes:

- The location of each water-using industrial plant in relation to a source or sources of water;
- The location of each water-using industrial plant in relation to streams or other features into which wastewater can be discharged;
- The type of industry, which determines the type of water use (i.e., refineries which use varying and/or different grades of crude petroleum, refineries which are producing reformulated gas, chemical plants which produce a range of chemicals and pharmaceuticals, and plants which extract compounds from ores to produce metals and other products); and
- The metallurgy of equipment in the cooling system that would come in contact with the cooling water.

9.4.2.3 Analyses and Discussion of Consumptive Wastewater Reuse and Advanced Conservation as Related to Estuaries Inflow Requirements

Without implementation of water conservation measures wastewater discharges are projected to increase at a rate of about 900 ac-ft/yr. If selected accelerated conservation measures are implemented, then wastewater flows could be expected to reduce, depending on the type of conservation measures. Therefore, the benefit of increased water supply associated with advanced conservation must be weighed against the resultant reductions in the steady discharge of treated effluent containing nutrients to primary productivity in the Nueces Estuary.

9.4.3 Modify Existing Reservoir Operating Policy and Safe Yield Analyses (previous 5D.6- Recommended Water Management Strategy)

The City of Corpus Christi operates the Calallen Pool, Lake Corpus Christi, Choke Canyon Reservoir, MRP Phase I (Lake Texana), and MRP Phase II (LCC/CCR/Lake Texana/MRP Phase II System) as a system to supply water for municipal and industrial users of the Coastal Bend Region. Using the CCWSM, this water management strategy examines modifying the current reservoir operating policy from firm yield to safe yield. The maximum yields available under the City of Corpus Christi's current reservoir operating policies and existing schedule governing freshwater pass-throughs to the bay and estuary in 2020 and 2070 are 259,000 and 249,000 ac-ft/yr. With safe yield supplies, the yield of the system is reduced by 40,000 ac-ft/yr in 2020 and 35,000 ac-ft/yr in 2070, based on sedimentation conditions, to 219,000 and 214,000 ac-ft/yr.

The modification of existing reservoir operating policy strategy from firm to safe yield reduces the planned supply (yield) from the LCC/CCR/Lake Texana/MRP Phase II System to account for unprecedented severe drought conditions in the future or underestimation in regional growth. The additional stored water in LCC/CCR under safe yield provisions results in higher system storage levels and therefore more frequent opportunities for larger pass-through events to the Nueces Bay to meet inflow targets of the 2001 TCEQ Agreed Order. With safe yield, the median monthly flow to the Bay is 2,171 acre-feet per month (ac-ft/mo) compared to 1,625 ac-ft/mo under firm yield conditions (increase of 546 ac-ft/mo). A flow frequency showing monthly Bay inflow comparing firm and safe yield is shown in Figure 9-8. An evaluation summary of this regional water management strategy is provided in Table 9.8.

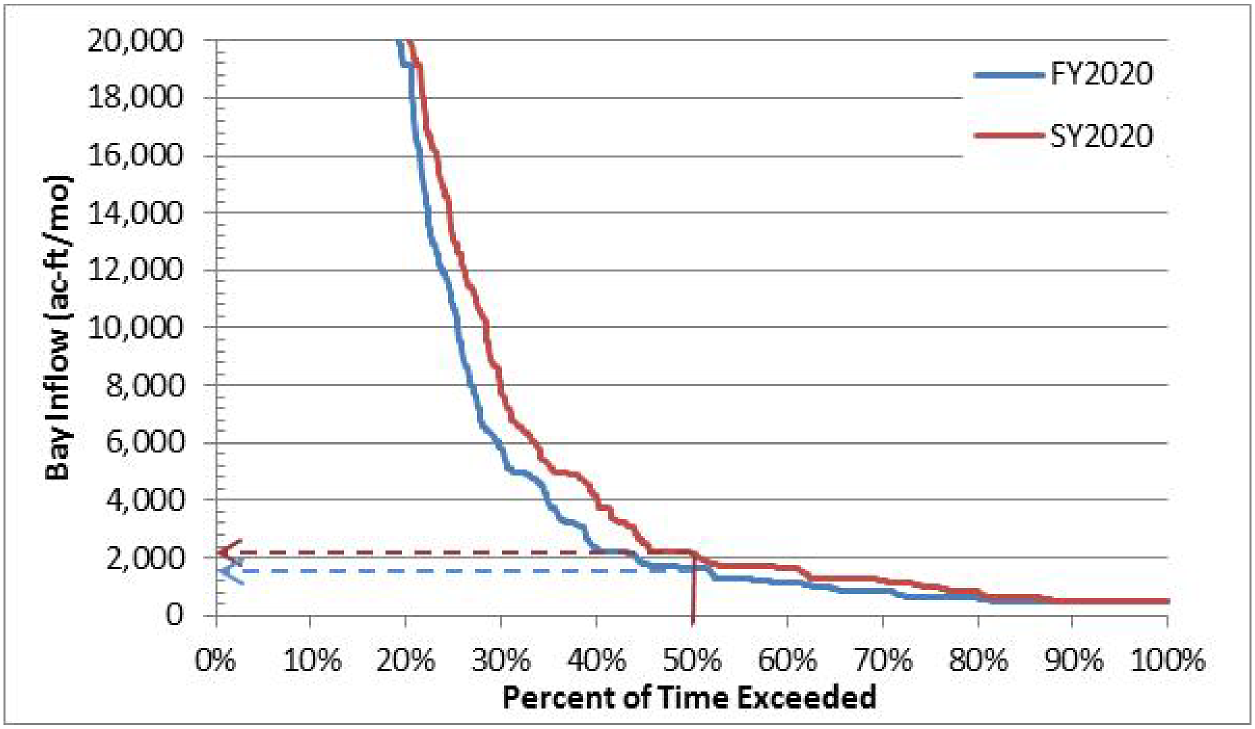

Figure 9-8.
Comparison of Monthly Flow Frequency Distribution for Nueces Bay Inflow for Firm Versus Safe Yield

Table 9.8.
Evaluation Summary for Modifications to Existing Reservoir Operating Policy

Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. No project yield. Safe yield supply is less than firm yield.
2. Reliability	2. Good reliability. Provides storage reserve of 125,000 ac-ft (equal to one year of demand). Drought management measure amid climate uncertainty.
3. Cost of treated water	3. No cost.
b. Environmental factors:	
1. Instream flows	1. None or low impact.
2. Bay and estuary inflows	2. Potential increase to bay and estuary inflows with higher storage levels to maintain safe yield reserve.
3. Wildlife habitat	3. None or low impact.
4. Wetlands	4. None or low impact.
5. Threatened and endangered species	5. None or low impact.
6. Cultural resources	6. None or low impact.
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. None or low impact.
c. State water resources	• No negative impacts on other water resources • Potential benefit to Nueces Estuary from increased fresh water flow.
d. Threats to agriculture and natural resources in region	• None
e. Recreational	• None
f. Equitable comparison of strategies	• Standard analyses and methods used
g. Interbasin transfers	• None
h. Third party social and economic impacts from voluntary redistribution of water	• Not applicable
i. Efficient use of existing water supplies and regional opportunities	• Provides enhanced recreational opportunities for the lakes.
j. Effect on navigation	• None

9.4.4 Blending Groundwater and Treated Surface Water Strategies (portion of Gulf Coast Aquifer Supplies 5D.7- considered Water Management Strategy)

This strategy evaluated the potential for blending brackish groundwater with existing treated surface water supplies at three different well fields located in Aransas, San Patricio, and Nueces counties, as shown in Figure 9-9. The Aransas and San Patricio counties' options would blend brackish groundwater with treated surface water from SPMWD, while the Nueces County option would blend groundwater with treated City of Corpus Christi surface water from the O.N. Stevens WTP. A key consideration for this strategy is the quantity of brackish groundwater that can be blended with existing surface water supplies while maintaining water quality within acceptable limits and avoiding increased corrosion within the system. Water quality goals are established for the evaluated locations based on existing water quality compared to blended water quality and standard corrosion indices calculations.

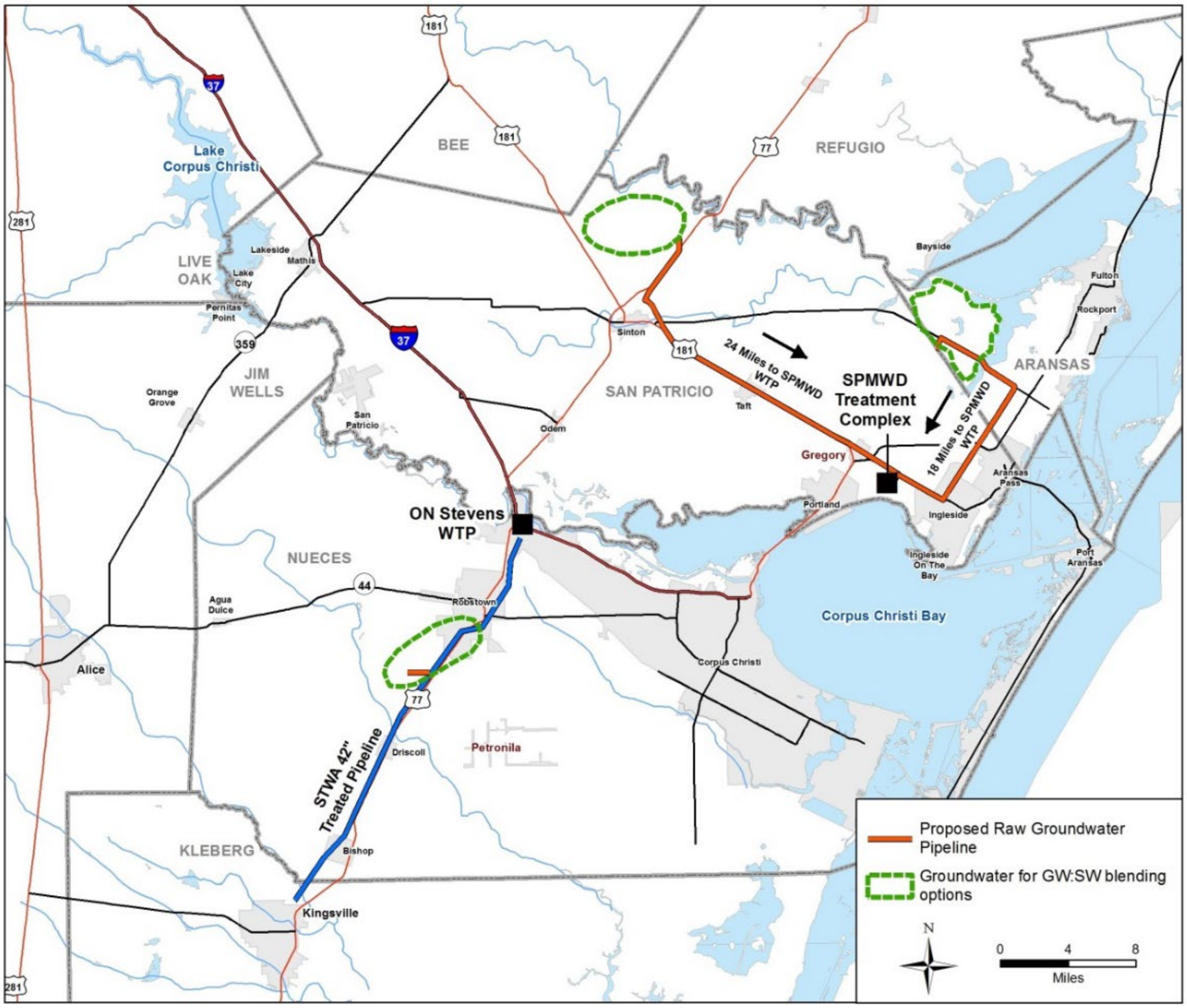

Figure 9-9.
Location of Brackish Groundwater Well Fields

For all three blending options, chloride is the limiting constituent. The target maximum chloride concentration for the Aransas and San Patricio counties' brackish groundwater blended with SPMWD is 210 mg/L based on industrial water quality targets. The Nueces County blend with City of Corpus Christi surface water from O.N. Stevens WTP has a target chloride maximum of 300 mg/L, the regulatory limit. At these target chloride concentrations the maximum percentage of each of groundwater that can be blended with surface is shown in Figure 9-10.

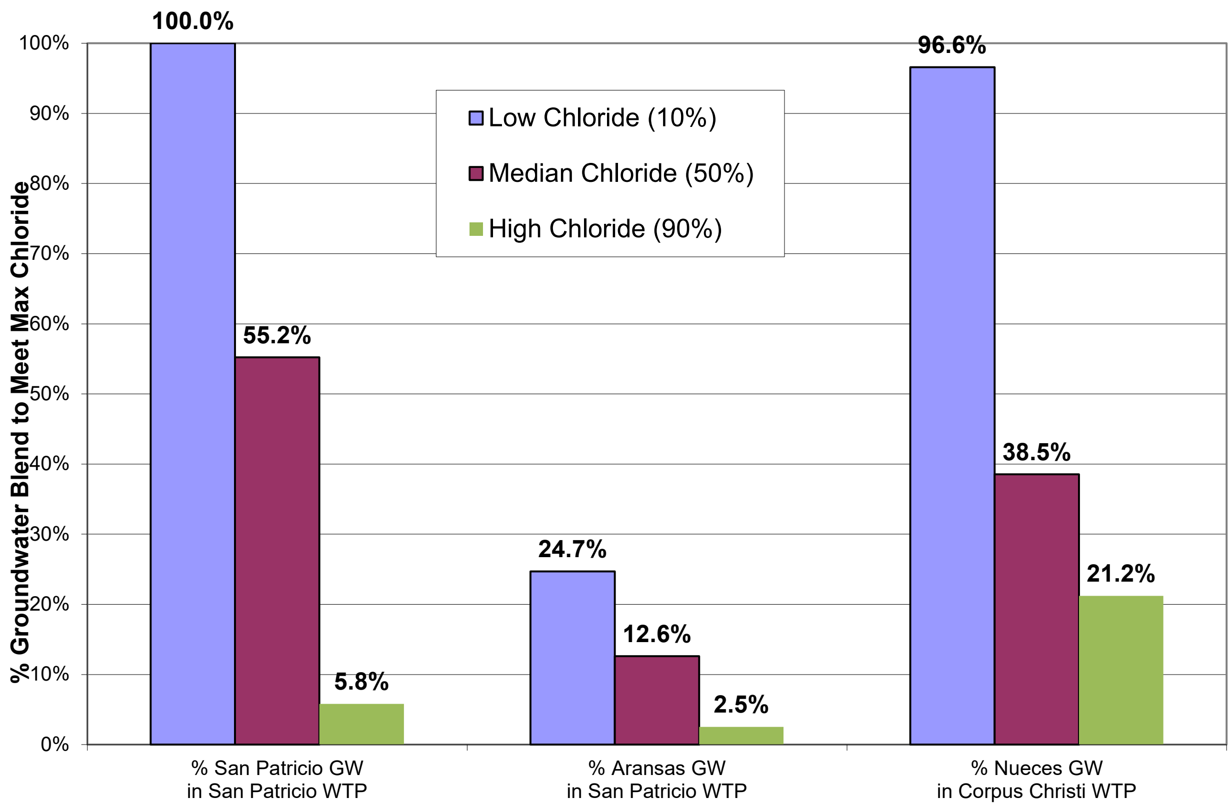

Figure 9-10.
Maximum Brackish Water Blend to Meet Chloride Limits

Cost estimates were performed for each study area considering high (90 percent) chloride concentrations. For the Aransas County well field, 12 wells are suggested with an assumed capacity of 75 gpm at a depth of 400 feet. Eighteen miles of 12-inch diameter transmission line is needed for blending at the SPMWD treatment complex. The total project cost for the Aransas County option is estimated at $13,480,000 with an annual cost of $1,326,000. For an available project yield of 1,174 ac-ft/yr, the treated water will cost $1,129 per ac-ft and have a unit cost of $3.47 per 1,000 gallons. The Nueces County option considers three wells with a capacity of 200 gpm at a depth of 500 feet and 2 miles of 6-inch diameter transmission line. The total project cost is estimated at $4,630,000 with an annual cost of $514,000. The treated water will cost $727 per ac-ft and have a unit cost of $2.23 per 1,000 gallons.

The San Patricio County option considers eight wells with an assumed capacity of 250 gpm at a depth of 600 feet. Twenty-four miles of 14-inch diameter transmission line is needed for blending at the SPMWD treatment complex. The total project cost is estimated at $24,190,000 with an annual cost of $2,667,000. The addition of brackish groundwater to the existing treated water system will cost $902 per ac-ft and have a unit cost of $2.77 per 1,000 gallons. An additional cost estimate for San Patricio County was conducted considering median chloride concentrations and a blend consisting of 55.2 percent brackish groundwater – significantly increasing the project yield from 2,958 to 28,155 ac-ft/yr. This option considers 78 wells with an assumed capacity of 250 gpm at a depth of 600 feet, and 24 miles of 36-inch diameter transmission line. The total project cost is estimated at $110,706,000 with an annual cost of $14,772,000. The treated water will cost $525 per ac-ft and have a unit cost of $1.61 per 1,000 gallons.

Table 9.9 provides a summary of blending groundwater and treated surface water strategies within the Gulf Coast Aquifer.

Table 9.9.
Evaluation Summary for Blending Groundwater and Treated Surface Water

Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. Firm Yield: 707 to 28,155 ac-ft/yr.
2. Reliability	2. Water Quality: Fair.
3. Cost of treated water	3. Cost: $525 to $1,129 per ac-ft.
b. Environmental factors:	
1. Instream flows	1. May slightly decrease instream flow and discharge of freshwater into coastal estuaries due to local pumping and groundwater-surface water interaction.
2. Bay and estuary inflows	2. May slightly decrease instream flow and discharge of freshwater into coastal estuaries due to local groundwater-surface water interaction.
3. Wildlife habitat	3. Negligible impacts.
4. Wetlands	4. Negligible impacts.
5. Threatened and endangered species	5. Negligible impacts.
6. Cultural resources	6. Cultural resources will need to be surveyed and avoided.
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. Negligible impacts. a. Low to moderate impact. b. Low to moderate impact. c. No impact. d. Low to moderate impact. e. Low to moderate impact. f. Low to moderate impact. g-h. Low to moderate impact associated with mining. i. Boron may be a potential water quality concern.
c. Impacts to State water resources	• No negative impacts on water resources other than lowering Gulf Coast Aquifer; Potential benefit to Nueces Estuary from increased freshwater return flows attributed to increased supplies and demands.
d. Threats to agriculture and natural resources in region	• May slightly increase pumping costs for agricultural users in the area due to localized drawdowns
e. Recreational impacts	• None
f. Equitable comparison of strategies	• Standard analyses and methods used
g. Interbasin transfers	• Not applicable to groundwater sources
h. Third party social and economic impacts from voluntary redistribution of water	• May require the purchase of groundwater rights
i. Efficient use of existing water supplies and regional opportunities	• Provides regional opportunities with local resources
j. Effect on navigation	• None

9.4.5 Regional Well-Field Systems (portion of Brackish Groundwater Desalination 5D.8- Alternative Water Management Strategy)

Brackish groundwater supplies have been desalinated to potable standards in areas near Region N and are likely to become more prevalent under the compounding pressures of increasing water demands and climate uncertainty. The Regional Well Field Systems strategy, included in the 2016 regional water plan, provides an evaluation of three independent well fields, as shown in Figure 9-11, for brackish groundwater supplies from the Gulf Coast Aquifer, and includes treatment and delivery to one or more Coastal Bend Region utilities. A key consideration in developing this strategy is groundwater availability. Groundwater Availability Models (GAMs) used to administer permits and manage groundwater resources do not currently delineate between fresh and slightly brackish water. Therefore, brackish water is often included in MAG estimates, which limits groundwater availability for regional water planning purposes. For any of the three independent well fields to be developed, the MAGs and DFCs from the 2016 regional water plan will need to be increased by the withdrawal amount.

The Bee-San Patricio well field option considers two alternatives for delivery of treated water to the O.N. Stevens WTP and to SPMWD's water main near U.S. Highway 77 located about 2 miles south of Sinton. There are two options for disposal of concentrate, deep-well injection and discharge to Copano Bay. The project is designed to yield 21.4 mgd (24,000 ac-ft/yr) and provide a treated water supply with a total dissolved solids concentration of about 400 mg/L. Estimated total annual costs for these options range from $20,470,000 to $22,424,000, or $853 to $934 per ac-ft.

The Nueces Northwest well field project is designed to deliver treated water to the O.N. Stevens WTP. Concentrate would be disposed into deep-injection wells. The project design is to yield 16.1 mgd (18,000 ac-ft/yr) and provide a treated water supply with a TDS of about 400 mg/L. The total annual cost of project is estimated at $18,566,000 or $1,031 per ac-ft.

The Nueces South-Central project is designed with two options. One is to deliver treated water to the City of Corpus Christi's distribution system near the intersection of Texas Highway 286 and Texas Highway 2444 and to dispose the concentrate to Oso Bay through the Barney Davis Power Station. The other option is to deliver treated water to the STWA pipeline near Bishop and dispose of the concentrate to deep-injection wells. This strategy is to make water available for STWA customers and to supplement the supplies at the O.N. Stevens WTP. The projects are designed to yield 10.7 mgd (12,000 ac-ft/yr) at a uniform rate. The project is to provide a treated water supply with TDS of about 400 mg/L. The estimated annual cost to deliver treated water to the City of Corpus Christi and concentrate to Oso Bay is $13,590,000, or $1,133 per ac-ft. The annual cost to deliver treated water to STWA and concentrate to deep-injection wells is $15,028,000 or $1,252 per ac-ft.

A summary of all three well field options is included in Table 9.10.

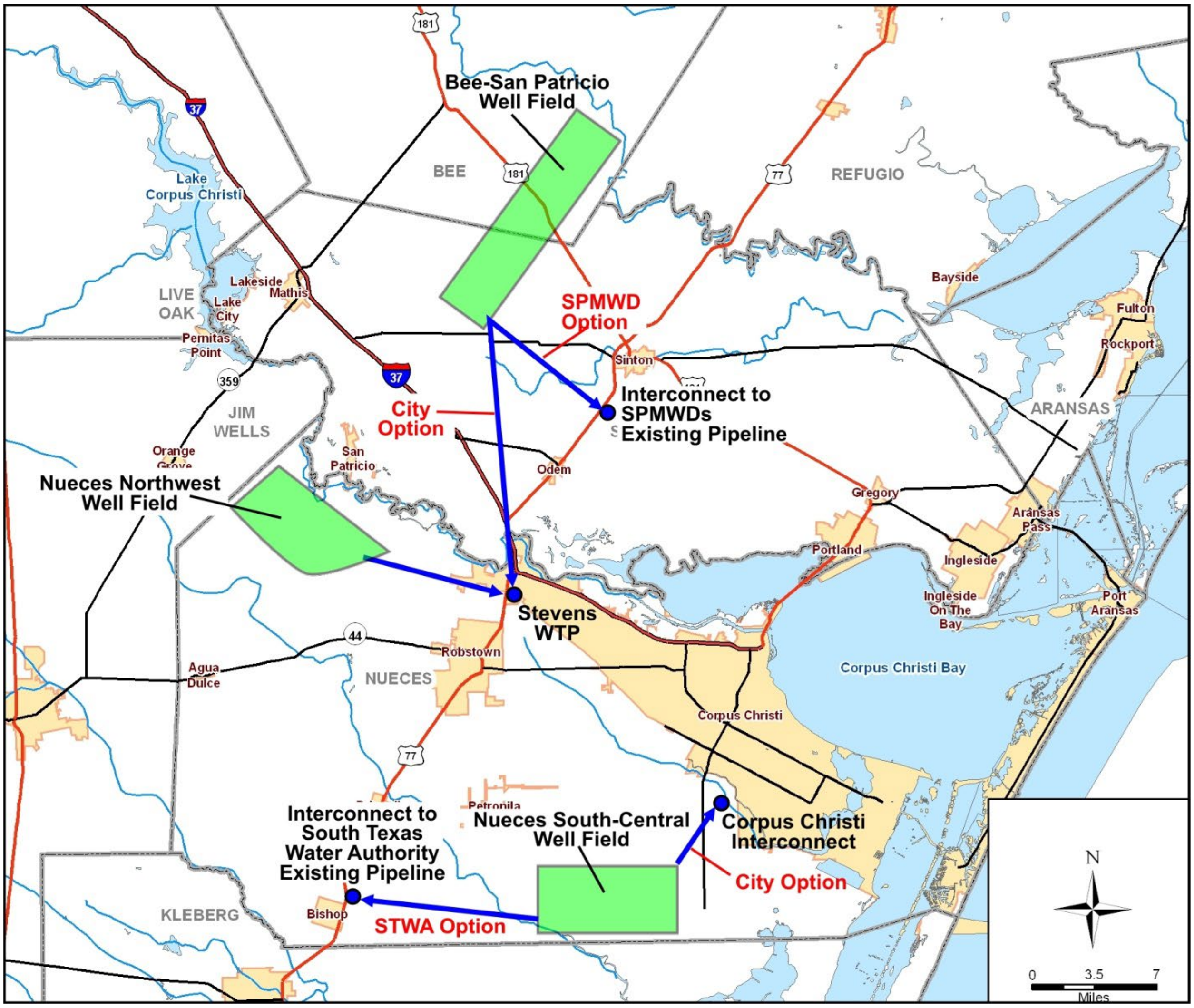

Figure 9-11.
Location of Brackish Groundwater Well Fields

Table 9.10.
Evaluation Summary for the Brackish Groundwater Desalination Option

Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. Variable, well field capacities ranges from up to about 24,000 ac-ft/yr.
2. Reliability	2. High reliability.
3. Cost of treated water	3. Generally moderate to high cost; between $828 to $1,151/ac-ft for projects ranging from 12,000 to 24,000 ac-ft/yr.
b. Environmental factors:	
1. Instream flows	1. Moderate impact.
2. Bay and estuary inflows	2. None to low. However, greatest impact is during low-flow conditions.
3. Wildlife habitat	3. Disposal of concentrated brine with bay option may impact fish and wildlife habitats or wetlands.
4. Wetlands	4. None to low.
5. Threatened and endangered species	5. None identified. Project can be adjusted to bypass sensitive areas. Endangered species survey will be needed to identify impacts.
6. Cultural resources	6. Cultural resources survey will be needed to identify any significant sites.
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. 7a-b. Total dissolved solids and salinity of water is removed with reverse osmosis treatment. Brine concentrated disposal issues will need to be evaluated. 7d-i. Chloride, sulfate, uranium and arsenic concentrations in groundwater will need to be considered prior to implementation of project.
c. Impacts to State water resources	• Little to minor negative impacts on surface water resources
d. Threats to agriculture and natural resources in region	• Temporary damage due to construction of pipeline
e. Recreational impacts	• None
f. Equitable comparison of strategies	• Standard analyses and methods used for portions • Brackish groundwater desalination cost modeled after bid and manufacturers' budgets, but not constructed, comparable project
g. Interbasin transfers	• Not applicable
h. Third party social and economic impacts from voluntary redistribution of water	• Not applicable
i. Efficient use of existing water supplies and regional opportunities	• Provides regional opportunities for water that would otherwise be unused
j. Effect on navigation	• None
k. Consideration of water pipelines and other facilities used for water conveyance	• Construction and maintenance of transmission pipeline corridor. Possible impact to wildlife habitat along pipeline route and right-of-way.

9.4.6 Potential Water System Interconnections (Previous 5D.10-Recommended Water Management Strategy)

In addition to providing backup water supplies for emergencies, water system interconnections were considered in the 2016 regional water plan as another potential source of freshwater supplies for municipal and industrial uses. Within the Nueces Region, there are a number of municipal water systems that rely totally on local groundwater. Many of these groundwater systems operate under challenges inducing insufficient groundwater supply, insufficient well capacity, and unsuitable water quality. Therefore, connecting to the regional surface water system can make for a more reliable water supply. Community water system candidates considered in 2016 are located in Duval, Jim Wells, Brooks, Kleberg, and San Patricio Counties for interconnection within the Coastal Bend Region. Yields were determined by the maximum demands for each entity over the planning period and infrastructure constraints. For San Diego in Duval County, an additional analysis was run based on needs rather than the demand. Costs were calculated using the TWDB Unified Costing Model.

The interconnection strategies for Duval, Jim Wells, and Brooks counties were dependent on Alice's WTP, which had a treated water capacity of 7,560 ac-ft/yr at the time of analysis. The City of Alice used 4,000 ac-ft of water in 2012 meaning that there are approximately 3,560 ac-ft/yr of water available for potential interconnect strategies. If all of the interconnection strategies that rely on Alice's WTP were to be implemented there would need to be an additional capacity of 2,486 ac-ft/yr.

All proposed water system interconnections are summarized in Table 9.11, and the overall strategy is summarized in Table 9.12.

Table 9.11.
Summary of Proposed Water System Interconnections (Sept 2013 prices)

County	Alt.	Pipeline From	Pipeline To	Pipeline Diameter (inches)	Pipeline Length (miles)	Additional Facilities	Yield (ac-ft/yr)	Total Cost of Project	Annual Cost of Water ($ per 1,000 gall)
Duval	1	Alice	San Diego, Benavides, Realitos, Concepcion, and Freer	6,10,18	83	5 Pump Stations	2,708	$34,786,000	$6.43
	2	Alice	San Diego, Benavides, and Freer	6,10,16	52	3 Pump Stations	2,098	$22,515,000	$5.82
	3	Alice	San Diego and Benavides	6,12	28	1 Pump Station	1,344	$10,542,000	$4.92
	4*	Alice	San Diego and Freer	10,14	36	2 Pump Stations	1,826	$18,035,000	$5.57
	5A	Alice	San Diego All Demands	14	11	-	1,072	$5,177,000	$3.99
	5B	Alice	San Diego Needs Only	6	11	-	158	$3,154,000	$8.35
Jim Wells	1	Alice	Orange Grove	8	17	1 Pump Station	494	$6,815,000	$6.86
	2	Alice	Premont	10	24	1 Pump Station	929	$9,398,000	$5.54
Brooks	1	Premont	Falfurrias	14	9	-	2,844	$21,117,000	$4.68
San Patricio	1	SPMWD Transmission Main	Sinton	12	8	-	1,507	$3,042,791	$3.32
	2	SPMWD Transmission Main	Edroy	6	6	-	125	$1,833,000	$6.36
	3	Six New Groundwater Wells	Mathis	6	6	6 Groundwater Wells	700	$5,545,000	$4.58
Kleberg/ Brooks/ Jim Wells	1	Kingsville	Riviera, Falfurrias, and Premont	10, 18	48	1 Pump Station	3,024	$34,899,000	$6.26
Nueces/ Jim Wells	-	STWA Pipeline at Agua Dulce	Alice	12	11.4	Storage Tank and 1 Pump Station	2,800	$5,866,000	$3.55

*September 2008 Prices

Table 9.12.
Evaluation Summary of the Potential Water System Interconnections

Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. Firm yield: Range from 2,800 ac-ft/yr to 125 ac-ft/yr, depending on interconnection project.
2. Reliability	2. Good reliability.
3. Cost of treated water	3. Generally high project cost; between $2,722 to $336 per ac-ft.
b. Environmental factors:	
1. Instream flows	1. Possible low impact.
2. Bay and estuary inflows	2. Possible low impact.
3. Wildlife habitat	3. Construction and maintenance of transmission pipeline corridor(s) may impact wildlife species.
4. Wetlands	4. None or low impact.
5. Threatened and endangered species	5. Endangered species survey will be needed to avoid significant sites.
6. Cultural resources	6. Cultural resource survey will be needed to avoid significant sites.
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. May potentially enhance water quality for rural communities. 7d. May improve water quality issues associated with chlorides for Sinton. 7f. May improve water quality issues associated with high hydrogen sulfide for Edroy.
c. Impacts to State water resources	• No negative impacts on other water resources
d. Threats to agriculture and natural resources in region	• Temporary damage due to construction of pipeline(s)
e. Recreational impacts	• None
f. Equitable comparison of strategies	• Standard analyses and methods used for portions
g. Interbasin transfers	• Not applicable
h. Third party social and economic impacts from voluntary redistribution of water	• Not applicable
i. Efficient use of existing water supplies and regional opportunities	• Provides regional opportunities
j. Effect on navigation	• None

9.4.7 Lavaca Off-Channel Reservoir Project (previous 5D.12-Recommended Water Management Strategy)

The Lavaca-Navidad River Authority has considered multiple scenarios for construction of new reservoir storage, including both on- and off-channel reservoirs. The Lavaca River Water Supply Project Feasibility Study, completed in 2011 by Freese & Nichols, Inc., compared a variety of these configuration options, as shown in Figure 9-12, and recommended the most feasible scenarios for implementation, including either the West Off-Channel Reservoir Project or the East Off-Channel Reservoir Project Alternative B.

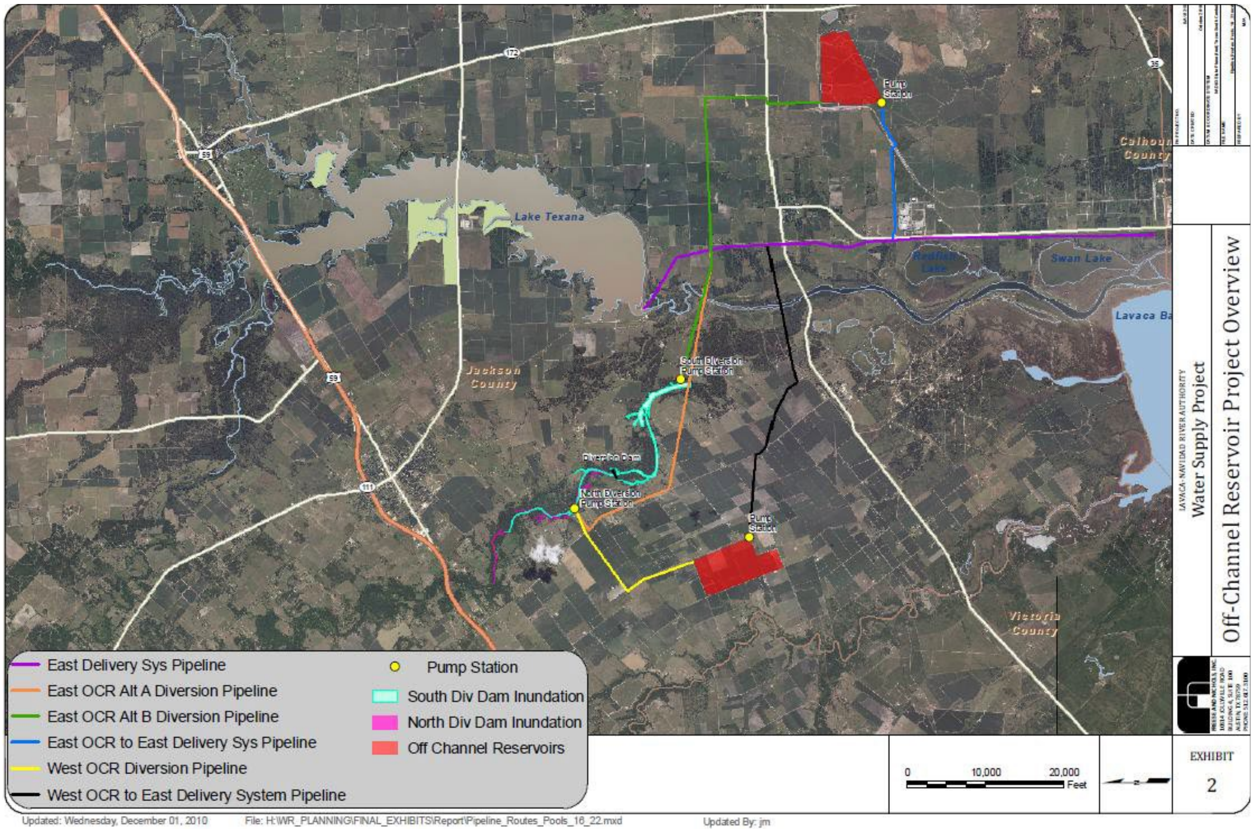

Figure 9-12.
Lavaca Off-Channel Reservoir Project Location

In both cases of the West off-channel and East off-channel B reservoirs, the minimum facility requirements would include the storage reservoir and associated pump stations to deliver water from the river to the reservoir. Diversion points and conceptual level pipeline alignments are different in each scenario and shown in Figure 9-12. Two pump stations are required for both off-channel alternatives, including a Lavaca River diversion pump station to divert flows and an off-channel reservoir pump station to deliver raw water to the existing Lavaca-Navidad River Authority East Delivery System pipeline. A diversion dam to increase the in channel storage and optimize pumping opportunities is also considered in the scenarios in order to increase firm yield. A relatively small amount of in-channel storage could increase the project yield at minimal cost compared to the cost of increasing the size of the off-channel reservoir to store more water.

The total project cost of the Lavaca off-channel reservoir was estimated at $177,485,000 for a yield of 16,963 ac-ft/yr. When considering annual program costs, the unit cost would be approximately $867 per ac-ft for raw water and $1,236 per ac-ft assuming treated water cost of $369 per ac-ft. Costs assumed the more expensive East Off-Channel Alternative B, which is within approximately 10 percent of the cost of the West off-channel scenario. The costs do not include water treatment or raw water purchase. A summary of the Lavaca off-channel reservoir option is described in Table 9.13.

Table 9.13.
Evaluation Summary for Lavaca Off-Channel Reservoir Project

Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. Firm yield: 16,963 ac-ft
2. Reliability	2. Good reliability.
3. Cost of treated water	3. Moderate cost; $1,236 per ac-ft.
b. Environmental factors:	
1. Instream flows	1. Generally decreases instream flow below diversion.
2. Bay and estuary inflows	2. General reduction in bay and estuary inflows.
3. Wildlife habitat	3. Construction and maintenance of off-channel reservoir site and transmission pipeline corridor(s) may impact wildlife species.
4. Wetlands	4. Low impact to wetlands.
5. Threatened and endangered species	5. Likely low impact to endangered species. Endangered species survey will be needed to avoid significant sites.
6. Cultural resources	6. Cultural resources survey will be needed to avoid significant sites.
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. Minimal impact to water quality.
c. Impacts to State water resources	• No negative impacts on other water resources
d. Threats to agriculture and natural resources in region	• None
e. Recreational impacts	• None
f. Equitable comparison of strategies	• Standard analyses and methods used for portions
g. Inter-basin transfers	• May be required for use in Region N.
h. Third party social and economic impacts from voluntary redistribution of water	• Not applicable
i. Efficient use of existing water supplies and regional opportunities	• Maximizes opportunities to capture water from a large drainage area during high/moderate inflow events after environmental instream flow requirements are satisfied. Less evaporative losses expected than traditional reservoir.
j. Effect on navigation	• None

9.4.8 Guadalupe-Blanco River Authority Lower Basin Storage Project (previous 5D.13- Recommended Water Management Strategy)

To firm up the run-of-river supplies of water available under the Guadalupe-Blanco River Authority/Dow Water Rights, an off-channel reservoir near the Guadalupe-Blanco River Authority Main Canal and Dow Seadrift Operations facilities was considered in the 2016 regional water plan. The off-channel reservoir had a proposed water depth of about 25 feet and the capability of impounding approximately 12,500 ac-ft of water. The off-channel reservoir site was located in the lower Guadalupe – San Antonio River basin in Region L in close proximity to Coastal Bend Region infrastructure, presenting an inter-regional opportunity. The City of Corpus

Christi's MRP and Bloomington Pump Station is located 15 miles north of the previously proposed off-channel reservoir and was considered for delivering raw water supplies from the project to O.N. Stevens or SPMWD WTP prior to distribution to water users. Figure 9-13 shows the conceptual project layout.

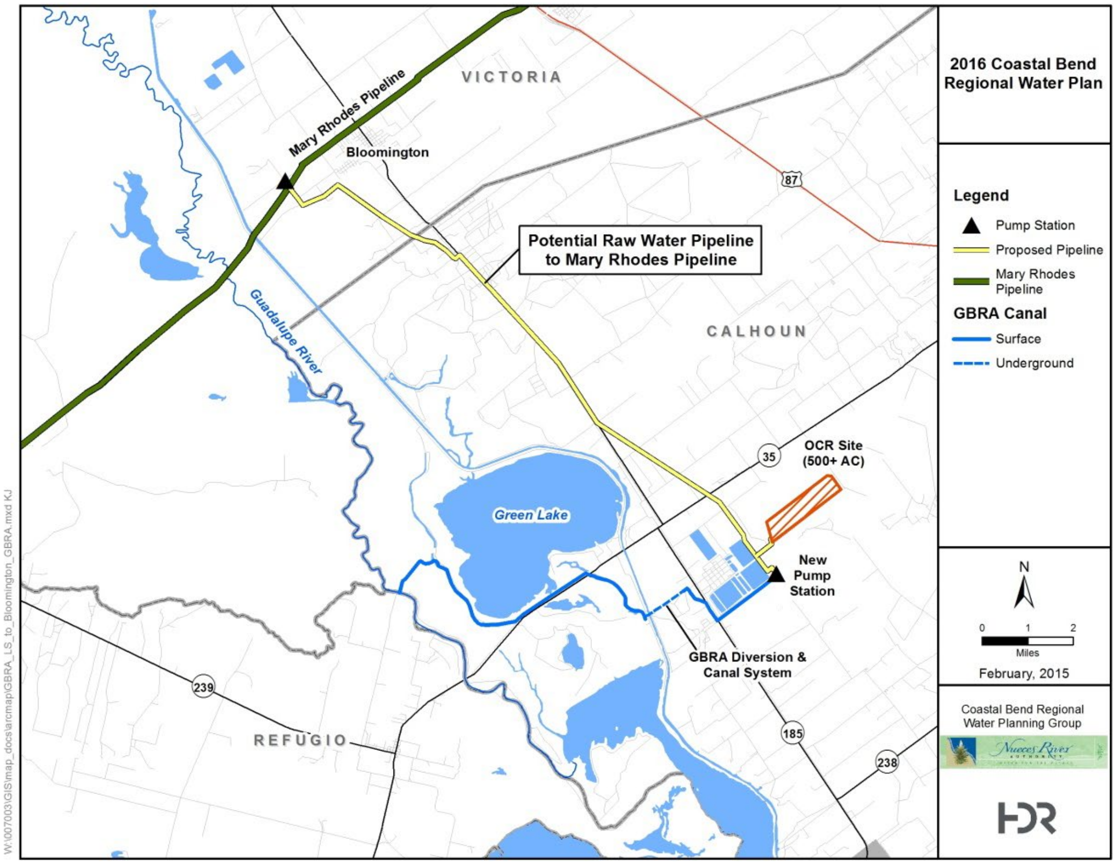

Figure 9-13.
Example Conceptual Route for Delivery of Guadalupe-Blanco River Authority Lower Basin Stored Water to the Mary Rhodes Pipeline at Bloomington Pump Station

The total project and annual costs are $90,543,000 and $7,261,000, respectively, including debt service and operation and maintenance for the 12,500 ac-ft off-channel reservoir and associated facilities, such as the embankment and appurtenant facilities for the off-channel reservoir, a 50 cubic feet per second raw water intake and pump station, a 42-inch transmission pipeline, and a 72-inch outlet pipeline. For a firm yield of 51,800 ac-ft/yr (which assumes 100 percent direct reuse of all treated wastewater in both the Guadalupe and San Antonio river basins), these annual costs translate to an annual unit cost of $140/ac-ft/yr for raw water at the Guadalupe-Blanco River Authority Main Canal during the debt service period.

The Coastal Bend Region's portion of total project and annual costs are $72,546,000 and $8,849,000, respectively, including debt service and operation and maintenance for participation in the 12,500 ac-ft off-channel reservoir and associated facilities on a prorata share basis. For a firm yield of 20,000 ac-ft/yr (38.6 percent of the 51,840 ac-ft project yield), these annual costs translate to an annual unit cost of $442 per ac-ft/yr for raw water at the MRP during the debt service period. This cost assumes that pending upgrades to the MRP to operate at full design capacity are complete at no cost to this water supply strategy. Assuming a treatment cost of $369 per ac-ft comparable to other Coastal Bend Region water management strategies, the annual unit cost of treated water is estimated to be $811 per ac-ft/yr. Table 9.14 provides a summary of the Guadalupe-Blanco River Authority lower basin storage project.

Table 9.14.
Evaluation Summary of Guadalupe-Blanco River Authority Lower Basin Storage Project

Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. Firm Yield (Region N's portion): 20,000 ac-ft/yr. Firm Yield (total project): 51,800 ac-ft/yr.
2. Reliability	2. Highly reliable quantity.
3. Cost of treated water	3. Moderate cost of $811 per ac-ft.
b. Environmental factors:	
1. Instream flows	1. Although source water is available under existing water rights, there may be some impact due to increased diversions from the Lower Guadalupe River. With Region N participation and project integration into the CCR/LCC/Texana/MRP Phase II system, increases in instream flows in the Nueces River may occur due to reduced water supply demands on the CCR/LCC system and consequently higher inflow pass-through targets according to 2001 Agreed Order provisions.
2. Bay and estuary inflows	2. Although source water is available under existing water rights, there may be some impact due to increased diversions from the Lower Guadalupe River, when available, for off-channel reservoir storage needs to firm yield during droughts. With Region N participation and project integration into the CCR/LCC/Texana/MRP Phase II system, increases in instream flows in the Nueces River may occur due to reduced water supply demands on the CCR/LCC system and consequently higher inflow pass-through targets according to 2001 Agreed Order provisions.
3. Wildlife habitat	3. Some impact and wildlife habitat disturbance due to off-channel reservoir, intake, and transmission pipeline construction.
4. Wetlands	4. Low impact.
5. Threatened and endangered species	5. Several threatened and endangered species are listed in Calhoun County. It is not anticipated that this project will have any permanent adverse effect on any federally listed threatened or endangered species, its habitat, or designated habitat nor would it adversely affect any state listed species. Reasonable and prudent measures should be taken to avoid and minimize the potential effects of the proposed project activities on threatened and endangered species as well as bald eagles.
6. Cultural resources	6. No cultural resources affected.

Impact Category	Comment(s)
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. Low impact. a,b,d. May possibly increase dissolved solids, salinity, and chlorides in the Lower Guadalupe River downstream of the Guadalupe-Blanco River Authority Diversion System during periods when permitted run-of-the-river water is diverted to the off-channel reservoir.
c. Impacts to State water resources	• No apparent negative impacts on water resources
d. Threats to agriculture and natural resources in region	• None
e. Recreational impacts	• None
f. Equitable comparison of strategies	• Standard analyses and methods used
g. Interbasin transfers	• New authorization required for use outside of Guadalupe-Blanco River Authority statutory district and within the San Antonio-Nueces Coastal Basin. More requirements must be met to obtain new authorization for uses in the Nueces River Basin or Nueces- Rio Grande Coastal Basin.
h. Third party social and economic impacts from voluntary redistribution of water	• None
i. Efficient use of existing water supplies and regional opportunities	• This project promotes efficient use of existing supplies and presents opportunities for regional supply development
j. Effect on navigation	• None
k. Consideration of water pipelines and other facilities used for water conveyance	• Reasonable and prudent measures should be taken to avoid and minimize the potential effects of the pipeline construction on the environment

9.4.9 San Patricio Municipal Water District – Transmission and Industrial Water Treatment Plant Improvements (previous 5D.14-Recommended Water Management Strategy)

In order to increase SPMWD system capacity to meet projected industrial water supply shortages, this water management strategy considered pump station and industrial water treatment plant improvements. For the purposes of this option, it was assumed that SPMWD and the City of Corpus Christi would develop recommended water management strategies to provide additional raw water supplies as needed.

At the time of analysis, the 36-inch line that ties into the MRP was able to deliver 28.5 mgd of raw water to the SPMWD WTP complex located southeast of Gregory. With pump station improvements, it will be capable of delivering 40.7 mgd. The 36-inch raw water pipeline from the Nueces River Calallen Pool intake was able to deliver 26.1 mgd to the WTP complex at the time of analysis. The 24-inch treated water pipeline from Corpus Christi delivered 5.5 mgd, which would increase to 10 mgd with a pump station. The total cost of facilities for these two pump stations was estimated at $9,400,000. Additionally, SPMWD Industrial WTP improvements are needed to increase average day treatment capacity by 18,529 ac-ft/yr, or 21.4 mgd, to meet industry needs. Estimated costs for WTP facilities are $32,357,000. The total cost of project, excluding land costs as SPMWD already purchased land for pump stations, is an estimated $58,366,000. The total annual cost of system improvements is $14,997,000. Dividing annual cost by the project yield, and projected 2070 shortage of 18,529 ac-ft, equated to an annual cost of $809 per ac-ft or $2.48 per 1,000 gallons, as shown in Table 9.15.

Table 9.15.
Evaluation Summary for SPMWD Transmission and Industrial WTP Improvements

Impact Category	Comment(s)
a. Water supply:	
1. Quantity	1. 18,529 ac-ft/yr.
2. Reliability	2. High reliability.
3. Cost of treated water	3. $809 per ac-ft.
b. Environmental factors:	
1. Instream flows	1. Negligible impact.
2. Bay and estuary inflows	2. Negligible impact. The SPMWD Transmission and Industrial WTP Improvements may have minor increases in return flows to Nueces Bay and Estuary.
3. Wildlife habitat	3. Negligible impact. The SPMWD Transmission and Industrial WTP Improvements will not disturb unaltered and/or new land.
4. Wetlands	4. Negligible impact.
5. Threatened and endangered species	5. Negligible impact. The SPMWD Transmission and Industrial WTP Improvements will not disturb unaltered and/or new land.
6. Cultural resources	6. Negligible impact. All work on SPMWD property or existing right-of-way should be no impact.
7. Water quality a. dissolved solids b. salinity c. bacteria d. chlorides e. bromide f. sulfate g. uranium h. arsenic i. other water quality constituents	7. Low or no impact. The SPMWD Transmission and Industrial WTP Improvements will likely produce water of higher quality than the original source water (including lowered TDS), as the facility would remove solids.
c. Impacts to State water resources	• No apparent negative impacts on water resources
d. Threats to agriculture and natural resources in region	• None
e. Recreational impacts	• None
f. Equitable comparison of strategies	• Standard analyses and methods used
g. Interbasin transfers	• Not applicable
h. Third party social and economic impacts from voluntary redistribution of water	• None
i. Efficient use of existing water supplies and regional opportunities	• Improvement over current conditions
j. Effect on navigation	• None
k. Consideration of water pipelines and other facilities used for water conveyance	• None

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