Appendix 5B-A

Technical Memorandums of Water Management Strategy Analysis

The 2021 Plan includes a total of 64 recommended water management strategies (WMS) sponsored by entities located within the East Texas Regional Water Planning Area (ETRWPA) as summarized in Tables 5B.1 and 5B.2 in Chapter 5B. Of these strategies, 50 include a capital cost that was broken down further into 61 separate Water Management Strategy Projects (WMSP). All strategies were developed to ensure the ETRWPA will continue to meet the water demands for the area's communities and industries. This Appendix 5B-A provides the required evaluation of each strategy, contained in 64 separate technical memorandums.

As required, each technical memorandum addresses the following elements:

- Project Description
- Supply Development
- Environmental Considerations
- Permitting and Development
- Planning-Level Opinion of Cost
- Project Evaluation

The planning-level opinion of cost (PLOC) is a critical element of the regional water planning process. The PLOC is important to project prioritization, which is one of a number of considerations in the TWDB's funding evaluation. For the 2021 Plan, PLOCs have been analyzed using the TWDB's costing tool, except where more detailed costs analysis has been provided by the WUG or WWP. In accordance with TWDB Guidance (Exhibit C, Second Amended General Guidelines for Fifth Cycle of Regional Water Plan Development – April 2018), the analysis of costs for recommended and alternative WMSs includes capital costs, debt service, and annual operating and maintenance expenses over the planning horizon.

Costs include expenses associated with infrastructure needed to convey water from sources and treat water for end user requirements. Capital costs consist of construction, engineering, contingencies, financial, legal, administration, environmental, permitting and mitigation, land acquisition and easements, and interest on loans. Water transmission lines were assumed to take the shortest route, following existing highways or roads where possible. Profiles were developed using GIS mapping software and USGS topographic maps. Pipes were sized to deliver peak-day flows within reasonable pressure and velocity ranges. Water losses associated with transmission were assumed to be negligible for regional planning purposes.

The annual costs for operation and maintenance infrastructure are generally based on percentages of estimated construction cost of the infrastructure. In addition, purchased water costs, power costs are included.

TECHNICAL MEMORANDUM TABLE OF CONTENTS BY ENTITY

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 1. ANGELINA MANUFACTURING

Water User Group Name:	**Angelina - Manufacturing**
Strategy Name:	**Purchase from Lufkin (Sam Rayburn)**
Strategy ID:	**ANGL-MFG**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**1,625 ac-ft/yr (1.5 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020**
Capital Cost:	**$0**
Project Annual Cost:	**$530,000 (Sam Rayburn to Kurth) (September 2018)**
Unit Water Cost (Rounded):	**$326 per ac-ft ($1.00 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Manufacturing in Angelina County and involves a contract between individual manufacturers and the City of Lufkin for raw water from Lake Kurth. Beginning in 2030, the City of Lufkin will begin transferring water from Sam Rayburn Lake to Lake Kurth, making more water available to meet manufacturing demands near Lake Kurth. Since 2011, The City of Lufkin installed a transmission system from Lake Kurth to multiple manufacturing water users. Therefore, the only cost for additional supply from the City of Lufkin is the cost of raw water. Ultimately, this cost will need to be negotiated with the City of Lufkin and will reflect the City's wholesale water rates at that time. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The City of Lufkin currently supplies approximately 3,000 ac-ft/yr to meet manufacturing demands in Angelina County. The quantity of supply from this strategy represents a contract increase of 1,449 ac-ft/yr, beginning in 2020, and increases to 1,625 ac-ft/yr, beginning in 2030. The supply available in 2020 is limited by the available supply of Lake Kurth to the City of Lufkin. In 2030 through 2070, the supply is limited to the manufacturing need projected by the East Texas Regional Water Planning Group. These supplies are considered highly reliable.

ENVIRONMENTAL CONSIDERATIONS

There are not any significant environmental considerations associated with this strategy. A contract between manufacturers and the City of Lufkin should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries in close proximity to Lake Kurth.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. No capital costs were assumed, but an annual cost was estimated using the East Texas Regional Water Planning Area

regional rate for raw surface water. Overall, this strategy has a low cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG NAME:	**Angelina Manufacturing**				
STRATEGY:	**Purchase from Lufkin**				
Raw Water Quantity:	**1,625**	AF/Y		2.17 MGD	
Treated Water Quantity:	**0**	AF/Y		0.00 MGD	
ANNUAL CONTRACT COSTS		**Size**	**Quantity**	**Unit**	**Cost**
Operational Costs*			530,000	1000 gal	$530,000
ANNUAL COSTS					
TOTAL ANNUAL COST					**$530,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of water					$326
Per 1,000 Gallons					$1.00
UNIT COSTS (After Amortization)					
Per Acre-Foot				NA	
Per 1,000 Gallons				NA	

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits manufacturers in Angelina County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from Lake Kurth will reduce demands on other water supplies in Angelina County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Angelina Manufacturing recommended strategy to purchase water from the City of Lufkin was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 1,625 ac-ft/yr
Reliability	5	High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 2. ANGELINA MINING

Water User Group Name:	**Angelina - Mining**
Strategy Name:	**Purchase from Angelina Neches River Authority (Neches Run of River, Mud Creek)**
Strategy ID:	**ANGL-MIN**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**167 - 572 ac-ft/yr (varies) (0.15 - 0.5 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$7,927,000 (September 2018)**
Annual Cost:	**$1,245,000**
Unit Water Cost (Rounded):	**$2,177 per ac-ft ($6.68 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Mining in Angelina County and involves a contract between individual mining water users and the Angelina Neches River Authority for raw water from Mud Creek as their permit allows. The cost for supply from the Neches River includes the cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the Angelina Neches River Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the mining need projected in Angelina County by the East Texas Regional Water Planning Group. The reliability of this water supply is considered medium due to the availability of water projected in the Neches River using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models. However, this strategy is dependent on sales with the Angelina Neches River Authority and their application for 10,000 ac-ft/yr from the Neches River (Strategy ID: ANRA-ROR). The quantity of supply from this strategy represents a contract of 473 ac-ft/yr, beginning in 2020, and increase to 572 ac-ft/yr in 2030, and decreases to 167 ac-ft/yr, beginning in 2070. In 2030 through 2070, the supply is limited to the mining need projected by the East Texas Regional Water Planning Group.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between mining water users in Angelina County and the Angelina Neches River Authority should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries in close proximity Angelina County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 6 miles of pipeline (the approximate distance from the Neches River to the center of Angelina County), a pump station with an intake, a booster pump station, and one terminal storage tank with one day of storage. The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the length of pipeline required.

WUG NAME:	**Angelina Mining**				
STRATEGY:	**Purchase from ANRA**				
Quantity:	**572** AF/Y		0.77	MGD	
CAPITAL COSTS					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	8 in.	31,680	LF	$40	$1,257,787
Right of Way Easements Rural (ROW)		31,680	LF	$18	$578,970
Land and Surveying (10%)					$58,000
Engineering and Contingencies (30%)					$377,000
Subtotal of Pipeline	**6**	**miles**			**$2,271,757**
Pump Station(s)					
Pump with intake	53 HP	1	LS	$3,547,000	$3,547,000
Booster Pump Station		0	LS		
Engineering and Contingencies (35%)					$1,241,000
Subtotal of Pump Station(s)					**$4,788,000**
Storage Tank(s)					
Storage Tank	0.10 MG	1	LS	$430,669	$430,669
Engineering and Contingencies (35%)					$151,000
Subtotal of Storage Tank(s)					**$581,669**
Permitting and Mitigation					$178,000
Interest During Construction			6	Months	$100,000
TOTAL COST					**$7,927,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$558,000
Operational Costs*					$687,000
TOTAL ANNUAL COST					**$1,245,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$2,177
Per 1,000 Gallons					$6.68
UNIT COSTS (After Amortization)					
Per Acre-Foot					$1,201
Per 1,000 Gallons					$3.69

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits mining users in Angelina County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Neches River will reduce demands on other water supplies in Angelina County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Angelina Mining recommended strategy to purchase water from the Angelina Neches River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 572 ac-ft/yr
Reliability	3	Medium
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 3. CHEROKEE ALTO RURAL WSC

Water User Group Name:	**Cherokee County - Alto Rural WSC**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**CHER-ALT**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**191 ac-ft/yr (0.2 MGD)**
Implementation Decade:	**2050**
Development Timeline:	**2050**
Project Capital Cost:	**$2,426,000 (September 2018)**
Annual Cost:	**$202,000**
Unit Water Cost (Rounded):	**$1,058 per ac-ft ($3.25 per 1,000 gallons)**

PROJECT DESCRIPTION

Alto Rural WSC is a municipal water user in Cherokee County. This water user currently relies on groundwater in the Carrizo Wilcox aquifer in Cherokee County. Alto Rural WSC has a small need starting in 2050 and the maximum need is approximately 215 ac-ft/yr. To meet this need, it is recommended that Alto Rural WSC continue to use supplies from Carrizo Wilcox by drilling additional wells. This strategy is a recommended strategy for Alto Rural WSC in Cherokee County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Cherokee County. The wells will provide approximately 191 ac-ft/yr and are assumed to have a depth of 800 feet. A peaking factor of two was assumed for the well, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

The supply is required only in the later part of the planning cycle, for decades 2050 to 2070. Currently, all of the existing needs are being met by supplies from the Carrizo Wilcox aquifer. There are sufficient supplies available in the Cherokee County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that the wells will provide sufficient ac-ft/yr to meet Alto Rural WSC's needs in Cherokee County providing a total yield required for the strategy. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Cherokee County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 1.2 miles of pipeline, two wells, a peaking factor of two, and a maximum well yield of 250 gpm for each well. This equates to $1,058 per acre-foot ($3.25 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $162 per acre-foot ($0.50 per 1,000 gallons). Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Cherokee County Alto Rural WSC
STRATEGY: Cherokee County - GW Wells

Supply	191	Ac-ft/yr	118	gpm
Well Depth	800	ft		
Wells Needed	2			

CAPITAL COSTS	
Transmission Pipeline (6 in dia., 1.2 miles)	$161,000
Primary Pump Stations (0.2 MGD)	$417,000
Well Fields (Wells, Pumps, and Piping)	$1,113,000
TOTAL COST OF FACILITIES	**$1,691,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$583,000
Environmental & Archaeology Studies and Mitigation	$59,000
Land Acquisition and Surveying (6 acres)	$28,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$65,000
TOTAL COST OF PROJECT	**$2,426,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$171,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$13,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$10,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (95483 kW-hr @ 0.08 $/kW-hr)	$8,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$202,000**
Available Project Yield (ac-ft/yr)	191
Annual Cost of Water ($ per ac-ft), based on PF=1.2	$1,058
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1.2	$162
Annual Cost of Water ($ per 1,000 gallons), based on PF=1.2	$3.25
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1.2	$0.50

PROJECT EVALUATION

This strategy benefits municipal user Alto Rural WSC in Cherokee County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. New wells in the county will reduce demands on other water supplies in Cherokee County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the recommended strategy to drill new wells in Cherokee County for Alto Rural WSC's use was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 191 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local sponsorship by Alto Rural WSC
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 4. CHEROKEE RUSK

Water User Group Name:	**Cherokee - Rusk**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**CHER-RUS**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**122 ac-ft/yr (0.11 MGD)**
Implementation Decade:	**2070**
Development Timeline:	**2070**
Project Capital Cost:	**$2,361,000 (September 2018)**
Annual Cost:	**$192,000**
Unit Water Cost (Rounded):	**$1,574 per ac-ft ($4.83 per 1,000 gallons)**

PROJECT DESCRIPTION

Rusk is a municipal water user in Cherokee County. This water user currently relies on groundwater in the Carrizo Wilcox aquifer in Cherokee County. Rusk has a small need starting in 2070 of approximately 122 ac-ft/yr. To meet this need, it is recommended that Rusk continue to use supplies from Carrizo Wilcox by drilling additional wells. This strategy is a recommended strategy for Rusk in Cherokee County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Cherokee County. The wells will provide approximately 122 ac-ft/yr and are assumed to have a depth of 800 feet. A peaking factor of two was assumed for the well, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

The supply is required only in the later part of the planning cycle, for the decade of 2070. Currently, all of the existing needs are being met by supplies from the Carrizo Wilcox aquifer. There are sufficient supplies available in the Cherokee County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that the wells will provide sufficient ac-ft/yr to meet Rusk's needs in Cherokee County providing a total yield required for the strategy. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Cherokee County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs

assumed 1 mile of pipeline, two wells, a peaking factor of two, and a maximum well yield of 250 gpm for each well. This equates to $1,574 per acre-foot ($4.83 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $213 per acre-foot ($0.65 per 1,000 gallons). Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Cherokee County – Rusk
STRATEGY: New wells - Carrizo Aquifer Wells

Supply	122	Ac-ft/yr	62	gpm
Well Depth	800	ft		
Wells Needed	2			

CAPITAL COSTS	
Transmission Pipeline (6 in dia., 1 miles)	$134,000
Primary Pump Stations (0.2 MGD)	$399,000
Well Fields (Wells, Pumps, and Piping)	$1,113,000
TOTAL COST OF FACILITIES	**$1,646,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$569,000
Environmental & Archaeology Studies and Mitigation	$54,000
Land Acquisition and Surveying (6 acres)	$28,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$64,000
TOTAL COST OF PROJECT	**$2,361,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$166,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$12,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$10,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (55507 kW-hr @ 0.08 $/kW-hr)	$4,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$192,000**
Available Project Yield (ac-ft/yr)	122
Annual Cost of Water ($ per ac-ft), based on PF=1.2	$1,574
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1.2	$213
Annual Cost of Water ($ per 1,000 gallons), based on PF=1.2	$4.83
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1.2	$0.65

PROJECT EVALUATION

This strategy benefits municipal users in Cherokee County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Developing groundwater supplies in Cherokee County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Cherokee County Rusk WUG recommended strategy to develop

new wells in Carrizo Wilcox was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 122 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local sponsorship by the City of Rusk
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 5. CHEROKEE WRIGHT CITY WSC

Water User Group Name:	**Cherokee - Wright City WSC**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**CHER-WCW**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**25 - 121 ac-ft/yr (varies) (0.02 - 0.11 MGD)**
Implementation Decade:	**2050**
Development Timeline:	**2050**
Project Capital Cost:	**$2,361,000 (September 2018)**
Annual Cost:	**$192,000**
Unit Water Cost (Rounded):	**$1,574 per ac-ft ($4.83 per 1,000 gallons)**

PROJECT DESCRIPTION

Wright City WSC is a municipal water user in Cherokee and Rusk Counties. This water user currently relies on groundwater in the Carrizo Wilcox aquifer in Cherokee County. Wright City has a small need starting in 2050 of approximately 25 ac-ft/yr, and increases to 121 ac-ft/yr in 2070. To meet this need, it is recommended that Wright City WSC continue to use supplies from Carrizo Wilcox by drilling additional wells. This strategy is a recommended strategy for Rusk in Cherokee County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Cherokee County. The wells will provide approximately 122 ac-ft/yr and are assumed to have a depth of 800 feet. A peaking factor of two was assumed for the well, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

The supply is required only in the later part of the planning cycle, for the decades 2050 through 2070. Currently, all of the existing needs are being met by supplies from the Carrizo Wilcox aquifer. There are sufficient supplies available in the Cherokee County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that the wells will provide sufficient ac-ft/yr to meet Rusk's needs in Cherokee County providing a total yield required for the strategy. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Cherokee County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 1 mile of pipeline, two wells, a peaking factor of two, and a maximum well yield of 250 gpm for each well. This equates to $1,574 per acre-foot ($4.83 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $213 per acre-foot ($0.65 per 1,000 gallons). Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Cherokee County – Wright City WSC
STRATEGY: New wells - Carrizo Aquifer Wells

Supply	122	Ac-ft/yr	62	gpm
Well Depth	800	ft		
Wells Needed	2			

CAPITAL COSTS	
Transmission Pipeline (6 in dia., 1 miles)	$134,000
Primary Pump Stations (0.2 MGD)	$399,000
Well Fields (Wells, Pumps, and Piping)	$1,113,000
TOTAL COST OF FACILITIES	**$1,646,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$569,000
Environmental & Archaeology Studies and Mitigation	$54,000
Land Acquisition and Surveying (6 acres)	$28,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$64,000
TOTAL COST OF PROJECT	**$2,361,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$166,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$12,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$10,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (55507 kW-hr @ 0.08 $/kW-hr)	$4,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$192,000**
Available Project Yield (ac-ft/yr)	122
Annual Cost of Water ($ per ac-ft), based on PF=1.2	$1,574
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1.2	$213
Annual Cost of Water ($ per 1,000 gallons), based on PF=1.2	$4.83
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1.2	$0.65

PROJECT EVALUATION

This strategy benefits mining users in Cherokee County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Developing new wells in Carrizo Wilcox in Cherokee County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Cherokee County Wright City WSC WUG recommended strategy to develop new wells in Carrizo Wilcox was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 121 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local sponsorship by Wright City WSC
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 6. CHEROKEE MINING

Water User Group Name:	**Cherokee - Mining**
Strategy Name:	**Purchase from Angelina Neches River Authority (Neches Run of River, Mud Creek)**
Strategy ID:	**CHER-MIN**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**40 - 247 ac-ft/yr (varies) (0.03 - 0.22 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$7,013,000 (September 2018)**
Annual Cost:	**$853,000**
Unit Water Cost (Rounded):	**$3,453 per ac-ft ($10.60 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Mining in Cherokee County and involves a contract between individual mining water users and the Angelina Neches River Authority for raw water from Mud Creek as their permit allows. The cost for supply from the Neches River includes the cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the Angelina Neches River Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the mining need projected in Angelina County by the East Texas Regional Water Planning Group. The reliability of this water supply is considered medium due to the availability of water projected in the Neches River using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models. However, this strategy is dependent on sales with the Angelina Neches River Authority and their application for 30,000 ac-ft/yr from the Neches River (Strategy ID: ANGL-ROR). The quantity of supply from this strategy represents a contract of 247 ac-ft/yr, beginning in 2030, and decreases to 40 ac-ft/yr, beginning in 2070. In 2030 through 2070, the supply is limited to the mining need projected by the East Texas Regional Water Planning Group.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between mining water users in Cherokee County and the Angelina Neches River Authority should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries in close proximity Cherokee County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 7 miles of pipeline (the approximate distance from the Neches River to the center of Cherokee County), a pump station with an intake, and one terminal storage tank with 0.2 MG of storage. The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the length of pipeline required.

WUG	Cherokee Mining		
STRATEGY:	Purchase from ANRA		
Quantity:	247	AF/Y	0.33 MGD

CAPITAL COSTS

Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	6 in.	36,960	LF	$25	$939,000
Right of Way Easements Rural (ROW)		36,960	LF	$18	$675,000
Land and Surveying (10%)					$68,000
Engineering and Contingencies (30%)					$282,000
Subtotal of Pipeline	**7**	**miles**			**$1,964,000**
Pump Station(s)					
Pump with intake	23 HP	1	LS	$3,048,869	$3,049,000
Engineering and Contingencies (35%)					$1,067,000
Subtotal of Pump Station(s)					**$4,116,000**
Storage Tank(s)					
Storage Tank	0.20 MG	1	LS	$470,060	$470,000
Engineering and Contingencies (35%)					$164,500
Subtotal of Storage Tank(s)					**$634,500**
Permitting and Mitigation					$203,000
Construction Total					**$6,918,000**
Interest During Construction			6	Months	$95,000
TOTAL COST					**$7,013,000**

ANNUAL COSTS

Debt Service (3.5% for 20 years)	$493,000
Operational Costs*	$360,000
TOTAL ANNUAL COST	**$853,000**

UNIT COSTS (Until Amortized)

Per Acre-Foot of treated water	$3,453
Per 1,000 Gallons	$10.60

UNIT COSTS (After Amortization)

Per Acre-Foot	$1,457
Per 1,000 Gallons	$4.47

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits mining users in Cherokee County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Neches River will reduce demands on other water supplies in Cherokee County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Cherokee Mining recommended strategy to purchase water from the Angelina Neches River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 247 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor(s) identified; commitment level uncertain
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Angelina Neches River Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 7. HENDERSON EDOM WSC

Water User Group Name:	**Henderson County – EDOM WSC**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**HDSN- EDOM**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**2 - 9 ac-ft/yr (varies) (0.002 - 0.01 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020**
Project Capital Cost:	**$1,088,000 (September 2018)**
Annual Cost:	**$136,000**
Unit Water Cost (Rounded):	**$2,125 per ac-ft ($6.52 per 1,000 gallons)**

PROJECT DESCRIPTION

Edom WSC provides water service in Van Zandt and Henderson Counties. The WUG population is projected to be 1,395 by 2020 and increases to 2,025 by 2070. Edom WSC supplies its customers with groundwater from the Carrizo-Wilcox aquifer with water wells in Van Zandt County. Edom WSC is projected to have a total deficit of 13 ac-ft/yr in 2020 and increasing to a deficit of 64 ac-ft/yr by 2070; the shortage projected to occur in Van Zandt County is 11 ac-ft/yr in 2020 increasing to 55 ac-ft/yr by 2070. The shortage in Henderson County is 2 ac-ft/yr in 2020, increasing to 9 ac-ft/yr in 2070.

SUPPLY DEVELOPMENT

There are sufficient supplies available in the Henderson County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that the wells will provide sufficient ac-ft/yr to meet Edom WSC's needs in Henderson County providing a total yield required for the strategy. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Henderson County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital cost includes wells, pumps, and piping. This equates to $2,125 per acre-foot ($6.52 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $922 per acre-foot ($2.83 per 1,000 gallons). Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional

Water Plan.

WUG: Henderson County – EDOM WSC
WMS: New wells in Carrizo-Wilcox Aquifer

	Supply	64	Ac-ft/yr
	Well Depth	560	

CAPITOL COSTS	
Well Fields (Wells, Pumps, and Piping)	$715,000
Water Treatment Plant (0.2 MGD)	$28,000
TOTAL COST OF FACILITIES	**$743,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$260,000
Environmental & Archaeology Studies and Mitigation	$36,000
Land Acquisition and Surveying (3 acres)	$19,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$30,000
TOTAL COST OF PROJECT	**$1,088,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$77,000
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$7,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$17,000
Advanced Water Treatment Facility	$0
Pumping Energy Costs (41446 kW-hr @ 0.08 $/kW-hr)	$3,000
Purchase of Water (64 ac-ft/yr @ 500 $/ac-ft)	$32,000
TOTAL ANNUAL COST	**$136,000**
Available Project Yield (ac-ft/yr)	64
Annual Cost of Water ($ per ac-ft), based on PF=1	$2,125
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1	$922
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$6.52
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$2.83

PROJECT EVALUATION

This strategy benefits municipal water users in Henderson County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Edom WSC recommended strategy to develop new Groundwater wells was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 9 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local sponsorship by Edom WSC
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Region D.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 8. HENDERSON CHANDLER

Water User Group Name:	**Henderson County – City of Chandler**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**HDSN-CHN**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**101 ac-ft/yr (0.1 MGD)**
Implementation Decade:	**2070**
Development Timeline:	**2070**
Project Capital Cost:	**$1,397,000 (September 2018)**
Annual Cost:	**$113,000**
Unit Water Cost (Rounded):	**$1,119 per ac-ft ($3.43 per 1,000 gallons)**

PROJECT DESCRIPTION

The City of Chandler is a municipal water user in Henderson County. The City currently relies on groundwater in the Carrizo Wilcox aquifer in Henderson County. The City has a small need starting in 2070 of approximately 118 ac-ft/yr. To meet this need, it is recommended that the City of Chandler continue to use supplies from Carrizo Wilcox by drilling additional wells. This strategy is a recommended strategy for the City of Chandler in Henderson County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Henderson County. The wells will provide approximately 101 ac-ft/yr and are assumed to have a depth of 700 feet. A peaking factor of two was assumed for the well, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

The supply is required only in the later part of the planning cycle, for the decade of 2070. Currently, all of the existing needs are being met by supplies from the Carrizo Wilcox aquifer. There are sufficient supplies available in the Henderson County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that the wells along with municipal conservation will provide sufficient ac-ft/yr to meet the City's needs in Henderson County. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Henderson County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 1 mile of pipeline, two wells, a peaking factor of two, and a maximum well yield of 100 gpm for each well. This equates to $1,119 per acre-foot ($3.43 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $149 per acre-foot ($0.46 per 1,000 gallons). Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Henderson County – City of Chandler
WMS: New wells in Carrizo-Wilcox Aquifer

Supply	101	Ac-ft/yr	63	gpm
Well Depth	700			
Wells Needed	2			

CAPITAL COSTS	
Transmission Pipeline (6 in dia., 1 miles)	$134,000
Primary Pump Stations (0.1 MGD)	$180,000
Well Fields (Wells, Pumps, and Piping)	$637,000
TOTAL COST OF FACILITIES	**$951,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$326,000
Environmental & Archaeology Studies and Mitigation	$54,000
Land Acquisition and Surveying (6 acres)	$28,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$38,000
TOTAL COST OF PROJECT	**$1,397,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$98,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$8,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$4,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (32509 kW-hr @ 0.08 $/kW-hr)	$3,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$113,000**
Available Project Yield (ac-ft/yr)	101
Annual Cost of Water ($ per ac-ft), based on PF=1	$1,119
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1	$149
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$3.43
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$0.46

PROJECT EVALUATION

This strategy benefits municipal water users in Henderson County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the City of Chandler recommended strategy to develop new wells

in Carrizo Wilcox was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 101 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local sponsorship by City of Chandler
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 9. HENDERSON MOORE STATION WSC

Water User Group Name:	**Henderson County – Moore Station WSC**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**HDSN-MSW**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**38 - 111 ac-ft/yr (varies) (0.03 - 0.1 MGD)**
Implementation Decade:	**2060**
Development Timeline:	**2060**
Project Capital Cost:	**$1,417,000 (September 2018)**
Annual Cost:	**$116,000**
Unit Water Cost (Rounded):	**$1,045 per ac-ft ($3.21 per 1,000 gallons)**

PROJECT DESCRIPTION

Moore Station WSC is a municipal water user in Henderson County. Moore Station WSC currently relies on groundwater in the Carrizo Wilcox aquifer in Henderson County. This water user has a small need starting in 2060 of approximately 38 ac-ft/yr, and increases to 111 ac-ft/yr beginning in 2070. To meet this need, it is recommended that Moore Station WSC continue to use supplies from Carrizo Wilcox by drilling additional wells. This strategy is a recommended strategy for Moore Station WSC in Henderson County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Henderson County. The wells will provide approximately 111 ac-ft/yr and are assumed to have a depth of 700 feet. A peaking factor of two was assumed for the well, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

The supply is required only in the later part of the planning cycle, for decades 2060 through 2070. Currently, all of the existing needs are being met by supplies from the Carrizo Wilcox aquifer. There are sufficient supplies available in the Henderson County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that the wells will provide sufficient ac-ft/yr to meet the City's needs in Henderson County. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Henderson County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 1 mile of pipeline, two wells, a peaking factor of two, and a maximum well yield of 100 gpm for each well. This equates to $1,045 per acre-foot ($3.21 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $144 per acre-foot ($0.44 per 1,000 gallons). Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Henderson County – Moore Station WSC
WMS: New wells in Carrizo-Wilcox Aquifer

Supply	111	Ac-ft/yr	69	gpm
Well Depth	700			
Wells Needed	2			

CAPITAL COSTS	
Transmission Pipeline (6 in dia., 1 miles)	$134,000
Primary Pump Stations (0.1 MGD)	$195,000
Well Fields (Wells, Pumps, and Piping)	$637,000
TOTAL COST OF FACILITIES	**$966,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$331,000
Environmental & Archaeology Studies and Mitigation	$54,000
Land Acquisition and Surveying (6 acres)	$28,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$38,000
TOTAL COST OF PROJECT	**$1,417,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$100,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$8,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$5,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (35811 kW-hr @ 0.08 $/kW-hr)	$3,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$116,000**
Available Project Yield (ac-ft/yr)	111
Annual Cost of Water ($ per ac-ft), based on PF=1	$1,045
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1	$144
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$3.21
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$0.44

PROJECT EVALUATION

This strategy benefits municipal water users in Henderson County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Moore Station WSC recommended strategy to develop new

groundwater wells was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 111 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local sponsorship by Moore Station WSC
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 10. HENDERSON MINING

Water User Group Name:	**Henderson County – Mining**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**HDSN-MIN**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**10 - 19 ac-ft/yr (varies) (0.01 - 0.02 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$201,000 (September 2018)**
Annual Cost:	**$15,000**
Unit Water Cost (Rounded):	**$789 per ac-ft ($2.42 per 1,000 gallons)**

PROJECT DESCRIPTION

Mining users in Henderson County show a projected need in the early decades of the planning cycle. To meet this need, it is recommended that mining users utilize additional supplies from Carrizo Wilcox by drilling additional wells. This strategy is a recommended strategy for mining users in Henderson County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Henderson County. The wells will provide approximately 19 ac-ft/yr and are assumed to have a depth of 200 feet. A peaking factor of two was assumed for the wells.

SUPPLY DEVELOPMENT

The supply is required only in the early part of the planning cycle, for decades 2020 through 2040. Currently, all of the existing needs are being met by supplies from the Carrizo Wilcox aquifer. However, because this project will likely not be online before January 2023, it must be given an online decade of 2030. There are sufficient supplies available in the Henderson County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that the wells will provide sufficient ac-ft/yr to meet the City's needs in Henderson County. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Henderson County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs

assumed two wells, a peaking factor of two, and a maximum well yield of 50 gpm for each well. This equates to $789 per acre-foot ($2.42 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $53 per acre-foot ($0.16 per 1,000 gallons). Overall, this strategy has a low cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Henderson County – Mining
WMS: New wells in Carrizo-Wilcox Aquifer

Supply	19	Ac-ft/yr	12	gpm
Well Depth	200			
Wells Needed	2			

CAPITAL COSTS	
Well Fields (Wells, Pumps, and Piping)	$135,000
TOTAL COST OF FACILITIES	**$135,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$47,000
Environmental & Archaeology Studies and Mitigation	$8,000
Land Acquisition and Surveying (1 acres)	$5,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$6,000
TOTAL COST OF PROJECT	**$201,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$14,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$1,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (5038 kW-hr @ 0.08 $/kW-hr)	$0
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$15,000**
Available Project Yield (ac-ft/yr)	19
Annual Cost of Water ($ per ac-ft), based on PF=1	$789
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1	$53
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$2.42
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$0.16

PROJECT EVALUATION

This strategy benefits municipal water users in Henderson County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Henderson County Mining recommended strategy to develop new groundwater wells was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 19 ac-ft/yr
Reliability	4	Medium to High
Cost	3	Medium Cost
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 11. HOUSTON LIVESTOCK

Water User Group Name:	**Houston - Livestock**
Strategy Name:	**New wells in Yegua-Jackson**
Strategy ID:	**HOUS-LTK**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**201 ac-ft/yr (0.2 MGD)**
Implementation Decade:	**2070**
Development Timeline:	**2070**
Project Capital Cost:	**$399,000 (September 2018)**
Annual Cost:	**$39,000**
Unit Water Cost (Rounded):	**$194 per ac-ft ($0.60 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Livestock in Houston County and involves the development of four wells located within the Yegua-Jackson Aquifer as this aquifer has been identified as a potential source of water in Houston County. These wells will provide approximately 201 ac-ft/yr and are assumed to have a depth of 200 feet. A peaking factor of two was assumed for the wells, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

It is assumed that each well will provide 50 ac-ft/yr to meet livestock demands in Houston County providing a total strategy yield of 201 ac-ft/yr beginning in 2070. A target yield for this strategy was set to the highest need projected by the East Texas Regional Water Planning Group; the highest need occurs in 2070. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Houston County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed four wells, a peaking factor of two, and a maximum well yield of 50 gpm for each well. This equates to $194 per acre-foot ($0.60 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $55 per acre-foot ($0.17 per 1,000 gallons). Overall, this strategy has a low cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Houston County - Livestock
Strategy: New wells - Yegua-Jackson

Supply	201	Ac-ft/yr	125	gpm
Well Depth	200			
Wells Needed	4			

CAPITAL COSTS	
Well Fields (Wells, Pumps, and Piping)	$270,000
TOTAL COST OF FACILITIES	**$270,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$94,000
Environmental & Archaeology Studies and Mitigation	$15,000
Land Acquisition and Surveying (2 acres)	$9,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$11,000
TOTAL COST OF PROJECT	**$399,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$28,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$3,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (100751 kW-hr @ 0.08 $/kW-hr)	$8,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$39,000**
Available Project Yield (ac-ft/yr)	201
Annual Cost of Water ($ per ac-ft), based on PF=1	$194
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1	$55
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$0.60
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$0.17

PROJECT EVALUATION

This strategy benefits livestock users in Houston County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. New wells in the county will reduce demands on other water supplies in Houston County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the recommended strategy to drill new wells in Houston County for livestock use was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 201 ac-ft/yr
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	5	High Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 12. JASPER LIVESTOCK

Water User Group Name:	**Jasper - Livestock**
Strategy Name:	**Purchase from Lower Neches Valley Authority (Sam Rayburn)**
Strategy ID:	**JASP-LTK**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**8,932 ac-ft/yr (8 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020**
Project Capital Cost:	**$0 (September 2018)**
Annual Cost:	**$2,911,000**
Unit Water Cost (Rounded):	**$326 per ac-ft ($1.00 per 1,000 gallons)**

PROJECT DESCRIPTION

Livestock water demands are projected to be 10,000 ac-ft/yr from 2020 to 2070. Current supplies for Livestock in Jasper County include groundwater from the Gulf Coast aquifer and local surface water supplies; however, these supplies are not sufficient to meet this relatively large demand and needs are shown to be nearly 9,000 ac-ft/yr throughout the planning horizon (2020 to 2070). It is recommended that any large-scale livestock user should obtain surface water from the Sam Rayburn Reservoir through a contract with Lower Neches Valley Authority. This strategy is a recommended strategy for livestock users in Jasper County and involves a contract between livestock water users and the Lower Neches Valley Authority for raw water from the Sam Rayburn Reservoir, as their permit allows. The only cost for supply from the Sam Rayburn Reservoir includes the contractual cost of raw water. Ultimately, the cost for raw water will need to be negotiated with the Lower Neches Valley Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water need projected for Livestock in Jasper County by the East Texas Regional Planning Group during the planning period (2020-2070). The quantity of supply from this strategy represents a contract of 8,932 ac-ft/yr, beginning in 2020, and continuing at this volume through 2070. The reliability of this water supply is considered high due to the availability of water projected in the Sam Rayburn Reservoir using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models. However, this strategy is dependent on coordination with the Lower Neches Valley Authority. This strategy is not dependent on any other water management strategies in the 2021 East Texas Regional Water Plan.

ENVIRONMENTAL CONSIDERATIONS

There are not any significant environmental considerations associated with this strategy. A contract between livestock users and the Lower Neches Valley Authority should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries in close proximity to the Sam Rayburn Reservoir.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. No capital costs were assumed, but an annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a low cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG	**Jasper County - Livestock**				
STRATEGY:	**Purchase from LNVA (Sam Rayburn)**				
Raw Water Quantity:	**8,932**	AF/Y		12.0 MGD	
ANNUAL CONTRACT COSTS		**Size**	**Quantity**	**Unit**	**Cost**
Operational Costs*			2,911,000	1000 gal	$2,911,000
ANNUAL COSTS					
TOTAL ANNUAL COST					**$2,911,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of water					$326
Per 1,000 Gallons					$1.00
UNIT COSTS (After Amortization)					
Per Acre-Foot					NA
Per 1,000 Gallons					NA

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits livestock users in Jasper County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from Sam Rayburn will reduce demands on other water supplies in Jasper County and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the Jasper County Livestock recommended strategy to purchase water from the Lower Neches Valley Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 8,932 ac-ft/yr
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	5	High Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 13. JEFFERSON COUNTY-OTHER

Water User Group Name:	**Jefferson County-Other**
Strategy Name:	**Purchase from Lower Neches Valley Authority (Sam Rayburn)**
Strategy ID:	**JEFF-CTR**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**855 - 1,950 ac-ft/yr (0.8 - 1.7 MGD)**
Implementation Decade:	**2060**
Development Timeline:	**2060**
Project Capital Cost:	**$21,665,000 (September 2018)**
Annual Cost:	**$2,402,000**
Unit Water Cost (Rounded):	**$1,232 per ac-ft ($3.78 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for County-Other in Jefferson County and involves a contract between individual municipal water users and the Lower Neches Valley Authority for raw water from Sam Rayburn, as their permit allows. The cost for supply from Sam Rayburn includes the contractual cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the Lower Neches Valley Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water need projected for County-Other in Jefferson County by the East Texas Regional Planning Group during the planning period (2020-2070). The quantity of supply from this strategy represents a contract of 855 ac-ft/yr, beginning in 2060, and increases over time to 1,950 ac-ft/yr, beginning in 2070. The reliability of this water supply is considered high due to the availability of water projected in Sam Rayburn using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models. However, this strategy is dependent on coordination with the Lower Neches Valley Authority. This strategy is not dependent on any other water management strategies in the 2021 East Texas Regional Water Plan.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between municipal water users in Jefferson County, categorized by the Texas Water Development Board as County-Other, and the Lower Neches Valley Authority should have a minimal impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. This analysis was performed assuming that a project site would be chosen that had minimal impact to bays or estuaries in Jefferson County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 12 miles of pipeline (25% of the approximate distance across Jefferson County), a pump station with an intake, a booster pump station, and one terminal storage tank with one day of storage. The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the length of pipeline required.

WUG **Jefferson County-Other**
STRATEGY: **Purchase from Lower Neches Valley Authority (Sam Rayburn)**
Raw Water Quantity: **1,950** AF/Y 2.6 MGD

CAPITAL COSTS					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	18 in.	63,360	LF	$135	$8,562,000
Right of Way Easements Rural (ROW)		63,360	LF	$30	$2,092,530
Engineering and Contingencies (30%)					$2,569,000
Pump Station(s)					
Pump with intake	57 HP	1	LS	$3,614,000	$3,614,000
Booster Pump Station	57 HP	1	LS	$930,000	$930,000
Engineering and Contingencies (35%)					$1,590,400
Subtotal of Pump Station(s)					**$6,134,400**
Storage Tank(s)					
Storage Tank	1.7 MG	1	LS	$1,036,300	$1,036,300
Engineering and Contingencies (35%)					$362,705
Subtotal of Storage Tank(s)					**$1,399,005**
Permitting and Mitigation					$328,000
Construction Total					**$21,084,935**
Interest During Construction			12	Months	$580,000
TOTAL CAPITAL COST					**$21,665,000**

ANNUAL COSTS	
Debt Service (3.5% for 20 years)	$1,524,000
Operational Costs*	$878,000
TOTAL ANNUAL COST	**$2,402,000**

UNIT COSTS (Until Amortized)	
Per Acre-Foot of treated water	$1,232
Per 1,000 Gallons	$3.78

UNIT COSTS (After Amortization)	
Per Acre-Foot	$450
Per 1,000 Gallons	$1.38

WUG **Jefferson County-Other**

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits municipal users in Jefferson County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from Sam Rayburn will reduce demands on other water supplies in Jefferson County and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the Jefferson County-Other recommended strategy to purchase water from the Lower Neches Valley Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 1,950 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 14. JEFFERSON MANUFACTURING

Water User Group Name:	**Jefferson Manufacturing**
Strategy Name:	**Purchase from Lower Neches Valley Authority (Sam Rayburn)**
Strategy ID:	**JEFF-MFG**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**143,446 - 143,513 ac-ft/yr (varies) (126.08 - 128.14 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$279,210,000 (September 2018)**
Annual Cost:	**$69,673,000**
Unit Water Cost (Rounded):	**$485 per ac-ft ($1.49 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Manufacturing in Jefferson County and involves a contract between individual manufacturers and the Lower Neches Valley Authority for raw water from their Sam Rayburn system, as their permit allows. The Lower Neches Valley Authority currently supplies water to manufacturing water users in Jefferson County. Therefore, the only cost for additional supply is from the contractual cost of raw water. Ultimately, this cost will need to be negotiated with the Lower Neches Valley Authority and will reflect their wholesale water rates at that time. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The Lower Neches Valley Authority is projected to supply Jefferson Manufacturing with over 230,000 ac-ft/yr beginning in 2020; this supply increases through 2070. The strategy recommended for Jefferson Manufacturing is equal to the need projected for this entity during the planning period (2030-2070). The contract required for this strategy increases their supply by 143,513 ac-ft/yr beginning in 2030 continuing until 2070. Of this total supply, it is estimated that Manufacturing entities have the current infrastructure in place to accept 93,513 ac-ft/yr of additional water without constructing additional infrastructure. However, it is estimated that the manufacturing entities in Jefferson County will need to construct additional treatment and distribution infrastructure to access the other 50,000 ac-ft/yr to be supplied by LNVA. The cost estimate provided for this strategy represents the total cost of individual projects required by manufacturing entities throughout Jefferson County to access the additional 50,000 ac-ft/yr, though it is shown below as a single project. These supplies are considered highly reliable; however, the supply is dependent on coordination with the Lower Neches Valley Authority.

ENVIRONMENTAL CONSIDERATIONS

There are not any significant environmental considerations associated with this strategy. A contract between manufacturers in Jefferson County and the Lower Neches Valley Authority should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. Since this strategy does not include any new construction, there is no impact expected to bays or estuaries located in Jefferson County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. A regional rate for raw surface water was used for the purchase costs. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG	**Jefferson County - Manufacturing**		
STRATEGY:	**Purchase from Lower Neches Valley Authority (Sam Rayburn)**		
Infrastructure Quantity:	**50,000** AF/Y	67 MGD	
Purchased Water Quantity:	**93,513** AF/Y		

CAPITAL COSTS

Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	84 in.	89,760	2	$867	$155,604,000
Right of Way Easements Rural (ROW)		89,760	LF	$30	$2,695,000
Land and Surveying (10%)					$270,000
Engineering and Contingencies (30%)					$46,681,000
Subtotal of Pipeline	**17**	**miles**			**$205,250,000**
Pump Station(s)					
Pump with intake	1585 HP	1	LS	$28,726,000	$28,726,000
Booster Pump Station	1858 HP	1	LS	$9,403,000	$9,403,000
Engineering and Contingencies (35%)					$13,345,000
Subtotal of Pump Station(s)					**$51,474,000**
Storage Tank(s)					
Storage Tank	1.4 MG	6	LS	$920,702	$5,524,000
Engineering and Contingencies (35%)					$1,933,000
Subtotal of Storage Tank(s)					**$7,457,000**
Permitting and Mitigation					$473,000
Construction Total					**$264,654,000**
Interest During Construction			24	Months	$14,556,000
TOTAL CAPITAL COST					**$279,210,000**

ANNUAL COSTS

Debt Service (3.5% for 20 years)	$19,646,000
Operational Costs*	$50,027,000
TOTAL ANNUAL COST	**$69,673,000**

UNIT COSTS (Until Amortized)

Per Acre-Foot of treated water	$485
Per 1,000 Gallons	$1.49

UNIT COSTS (After Amortization)

Per Acre-Foot	$349
Per 1,000 Gallons	$1.07

WUG **Jefferson County - Manufacturing**

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits manufacturers in Jefferson County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Lower Neches Valley Authority's Sam Rayburn system will reduce demands on other water supplies in Angelina County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Jefferson Manufacturing recommended strategy to purchase water from the Lower Neches Valley Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 143,513 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 15. JEFFERSON STEAM ELECTRIC POWER

Water User Group Name:	**Jefferson Steam Electric Power**
Strategy Name:	**Purchase from Lower Neches Valley Authority (Sam Rayburn)**
Strategy ID:	**JEFF-SEP**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**2,391 ac-ft/yr (2.13 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$32,302,000 (September 2018)**
Annual Cost:	**$3,464,000**
Unit Water Cost (Rounded):	**$1,449 per ac-ft ($4.45 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Steam Electric Power in Jefferson County and involves a contract between individual steam electric power water users and the Lower Neches Valley Authority for raw water from their Sam Rayburn system, as their permit allows. The cost for supply from Sam Rayburn includes the contractual cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the Lower Neches Valley Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water need projected for Steam Electric Power in Jefferson County by the East Texas Regional Planning Group during the planning period (2030-2070). The quantity of supply from this strategy represents a contract of 2,391 ac-ft/yr, beginning in 2030, and remains constant over time to 2070. The reliability of this water supply is considered high due to the availability of water projected in Sam Rayburn using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models. However, this strategy is dependent on coordination with the Lower Neches Valley Authority. This strategy is not dependent on any other water management strategies in the 2021 East Texas Regional Water Plan.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between steam electric power water users in Jefferson County and the Lower Neches Valley Authority should have a minimal impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. This analysis was performed assuming that a project site would be chosen that had minimal impact to bays or estuaries in Jefferson County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 17 miles of pipeline (25% of the approximate distance across Jefferson County), a pump station with an intake, and a booster pump station. The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the length of pipeline required.

WUG:	**Jefferson County - Steam Electric Power**				
STRATEGY:	**Purchase from Lower Neches Valley Authority**				
Raw Water Quantity:	**2,391** AF/Y			3.20 MGD	
CAPITAL COSTS					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	16 in.	89,760	LF	$118	$10,562,000
Right of Way Easements Rural (ROW)		89,760	LF	$30	$2,695,000
Land and Surveying (10%)					$269,500
Engineering and Contingencies (30%)					$3,169,000
Subtotal of Pipeline	**17**	**miles**			**$16,695,500**
Pump Station(s)					
Pump with intake	296 HP	1	LS	$7,542,000	$7,542,000
Booster Pump Station	296 HP	1	LS	$1,875,000	$1,875,000
Engineering and Contingencies (35%)					$3,295,950
Subtotal of Pump Station(s)					**$12,712,950**
Storage Tank(s)					
Storage Tank	0.4 MG	1	LS	$545,540	$545,540
Engineering and Contingencies (35%)					$190,939
Subtotal of Storage Tank(s)					**$736,479**
Permitting and Mitigation					$473,000
Construction Total					**$30,618,000**
Interest During Construction			24	Months	$1,684,000
TOTAL CAPITAL COST					**$32,302,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$2,273,000
Operational Costs*					$1,191,000
TOTAL ANNUAL COST					**$3,464,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$1,449
Per 1,000 Gallons					$4.45
UNIT COSTS (After Amortization)					
Per Acre-Foot					$526
Per 1,000 Gallons					$1.61

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits steam electric power users in Jefferson County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from Sam Rayburn will reduce demands on other water supplies in Jefferson County and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the Jefferson Steam Electric Power recommended strategy to purchase water from the Lower Neches Valley Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 2,391 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 16. NACOGDOCHES COUNTY-OTHER

Water User Group Name:	**Nacogdoches County Multiple Water Users**
Strategy Name:	**Lake Naconiche Regional Water System**
Strategy ID:	**NACN-LK**
Strategy Type:	**New Surface Water Source**
Potential Supply Quantity:	**1,700 ac-ft/yr (1.5 mgd)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$42,117,000 (September 2018)**
Annual Cost:	**$5,363,000**
Unit Water Cost (Rounded):	**$3,155 per ac-ft ($9.68 per 1,000 gallons)**

PROJECT DESCRIPTION

Lake Naconiche has recently been completed. This lake was built by NRCS for flood storage and recreation, but there are plans to develop water supply from the lake for rural communities. A study was completed in 1992 that evaluated a potential regional water system using water from Lake Naconiche. To provide water to Nacogdoches County-Other users and several rural WSCs, it is recommended to develop this source for water supply. A brief description of the proposed strategy is presented below.

SUPPLY DEVELOPMENT

Lake Naconiche is located in northeast Nacogdoches County on Naconiche Creek. It is permitted to store 9,072 acre-feet of water. To use water from Lake Naconiche for water supply, the County must seek a permit amendment for diversions for municipal use. According to the Neches WAM, the firm yield of the lake would be approximately 3,239 ac-ft/yr. It is assumed that the regional water system would serve County-Other entities in Nacogdoches County (including Caro WSC, Lilbert-Looneyville, Libby and others), Appleby WSC, Lily Grove WSC and Swift WSC. At this time, the primary sponsor of the system has not been confirmed. It could possibly be one of the entities served or a new water provider dedicated to the operation of this system.

The project is initially sized for 3 MGD peak capacity. This includes a lake intake, new water treatment plant located near Lake Naconiche, pump station and a distribution system of pipelines in the northeast part of the county. Overall unit costs are estimated at $9.68 per 1,000 gallons during amortization. After amortization, costs will decrease to $4.41 per 1,000 gallons. The costs for each participant are based on the unit cost of water for the strategy and capital costs are proportioned by strategy amounts. Actual costs would be negotiated by each user.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. The project should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries in Nacogdoches County.

PERMITTING AND DEVELOPMENT

The water right permit for Lake Naconiche has to be changed from recreational use to multi-purpose use.

COST ANALYSIS

Detailed cost estimates for this strategy are included in the table below. The capital costs assumed 28 miles of pipeline (serving all the potential customers for this source of supply), a pump station with an intake, a booster pump station, a 3 MGD treatment plant, and one terminal storage tank with 0.38 MG of storage. The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has moderate to high cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG:	**Nacogdoches County-Other**		
WMS:	**Lake Naconiche Regional Water System - Phase 1**		
AMOUNT (ac-ft/yr):	**1,700**	1.5 MGD	3.0 MGD

CAPITAL COSTS

Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline		147,840		Varies	$9,153,000
Right of Way Easements Rural (ROW)		147,840	LF	$30	$4,883,000
Engineering and Contingencies (30%)					$2,746,000
Subtotal of Pipeline					**$16,782,000**
Pump Station(s)					
Pump Station	200 HP	1	LS	$1,281,000	$1,281,000
Lake Intake	200 HP	1	LS		$500,000
Engineering and Contingencies (35%)					$623,000
Subtotal of Pump Station(s)					**$2,404,000**
Storage Tank(s)					
Storage Tank	0.38 MG	1	LS	$538,000	$538,000
Engineering and Contingencies (35%)					$188,000
Subtotal of Storage Tank(s)					**$726,000**
Water Treatment Plant					
Water Treatment Plant	3.0 MGD	1	LS	$13,912,000	$13,912,000
Engineering and Contingencies (35%)					$4,869,000
Subtotal of Pump Station(s)					**$18,781,000**
Permitting and Mitigation - infrastructure					$754,000
Construction Total					**$39,447,000**
Water rights Permitting					$500,000
Interest During Construction			24	Months	$2,170,000
TOTAL COST					**$42,117,000**

ANNUAL COSTS	
Debt Service (3.5% for 20 years)	$2,963,000
Operational Costs*	$2,400,000
TOTAL ANNUAL COST	**$5,363,000**

UNIT COSTS (Until Amortized)	
Per Acre-Foot of treated water	$3,155
Per 1,000 Gallons	$9.68

UNIT COSTS (After Amortization)	
Per Acre-Foot	$1,436
Per 1,000 Gallons	$4.41

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits multiple municipal users in Nacogdoches County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Using supplies from this source will reduce the demands on other water supplies in Nacogdoches County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Lake Naconiche Regional System is identified as a recommended strategy for Nacogdoches County and it was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 1,700 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 17. NACOGDOCHES D & M WSC

Water User Group Name:	**Nacogdoches County - D & M WSC**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**NACW-DMW**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**32 - 374 ac-ft/yr (varies) (0.03 - 0.33 MGD)**
Implementation Decade:	**2040**
Development Timeline:	**2040**
Project Capital Cost:	**$4,567,000 (September 2018)**
Annual Cost:	**$373,000**
Unit Water Cost (Rounded):	**$997 per ac-ft ($3.06 per 1,000 gallons)**

PROJECT DESCRIPTION

D & M WSC is a municipal water user in Nacogdoches County. This water user currently relies on groundwater in the Carrizo Wilcox aquifer in Nacogdoches County. D & M WSC has a small need starting in 2040 and the maximum need is approximately 374 ac-ft/yr. To meet this need, it is recommended that D & M WSC continue to use supplies from Carrizo Wilcox by drilling additional wells. This strategy is a recommended strategy for D & M WSC in Nacogdoches County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Nacogdoches County. These wells will provide approximately 400 ac-ft/yr and are assumed to have a depth of 600 feet. A peaking factor of two was assumed for the wells, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

The supply is required only in the later part of the planning cycle, for decades 2040 and 2070. Currently, all of the existing needs are being met by supplies from the Carrizo Wilcox aquifer. There are sufficient supplies available in the Nacogdoches County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that each well provide 200 ac-ft/yr to meet D & M WSC's needs in Nacogdoches County providing a total yield required for the strategy. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Nacogdoches County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed ten miles of pipeline, two wells, a peaking factor of two, and a maximum well yield of 250 gpm for each well. This equates to $997 per acre-foot ($3.06 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $139 per acre-foot ($0.43 per 1,000 gallons). Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Nacogdoches County - D & M WSC
WMS: New wells in Carrizo-Wilcox Aquifer

Supply	374	Ac-ft/yr	232	gpm
Well Depth	600			
Wells Needed	2			

CAPITAL COSTS	
Transmission Pipeline (6 in dia., 10 miles)	$1,339,000
Primary Pump Stations (0.2 MGD)	$819,000
Well Fields (Wells, Pumps, and Piping)	$956,000
TOTAL COST OF FACILITIES	**$3,114,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$1,023,000
Environmental & Archaeology Studies and Mitigation	$279,000
Land Acquisition and Surveying (6 acres)	$28,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$123,000
TOTAL COST OF PROJECT	**$4,567,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$321,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$23,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$20,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (115018 kW-hr @ 0.08 $/kW-hr)	$9,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$373,000**
Available Project Yield (ac-ft/yr)	374
Annual Cost of Water ($ per ac-ft), based on PF=1.2	$997
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1.2	$139
Annual Cost of Water ($ per 1,000 gallons), based on PF=1.2	$3.06
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1.2	$0.43

PROJECT EVALUATION

This strategy benefits municipal user D & M WSC in Nacogdoches County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. New wells in the county will reduce demands on other water supplies in Nacogdoches County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the recommended strategy to drill new wells in Nacogdoches County for D & M WSC's use was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 374 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	2	Sponsor identifiable, but uncommitted
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 18. NACOGDOCHES LIVESTOCK

Water User Group Name:	**Nacogdoches County - Livestock**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**NACW-LTK**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**6,399 - 9,113 ac-ft/yr (varies) (5.71 - 8.1 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$26,677,000 (September 2018)**
Annual Cost:	**$2,695,000**
Unit Water Cost (Rounded):	**$296 per ac-ft ($0.91 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for livestock users in Nacogdoches County and involves the development of 27 wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Nacogdoches County. These wells will provide approximately 9,100 ac-ft/yr and are assumed to have a depth of 500 feet. A peaking factor of two was assumed for the wells, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

The supply is required for all decades of the planning cycle to help meet the needs. Currently, local supply provides half of the supply for the livestock needs and the remainder is taken from the Carrizo Wilcox aquifer. There are sufficient supplies available in the Nacogdoches County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that each well will provide 340 ac-ft/yr to meet livestock demands in Nacogdoches County providing a total yield required for the strategy. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Nacogdoches County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 10 miles of pipeline, 27 wells, a peaking factor of two, and a maximum well yield of 250 gpm for each well. This equates to $296 per acre-foot ($0.91 per 1,000 gallons); after the infrastructure is fully

paid (30 years), the cost drops to $90 per acre-foot ($0.28 per 1,000 gallons). Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Nacogdoches County – Livestock
WMS: New wells in Carrizo-Wilcox Aquifer

Supply	9,113	Ac-ft/yr	5,650	Gpm
Well Depth	500			
Wells Needed	27			

CAPITAL COSTS	
Transmission Pipeline (24 in dia., 10 miles)	$8,112,000
Primary Pump Stations (9.8 MGD)	$3,406,000
Well Fields (Wells, Pumps, and Piping)	$7,670,000
TOTAL COST OF FACILITIES	**$19,188,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$6,311,000
Environmental & Archaeology Studies and Mitigation	$376,000
Land Acquisition and Surveying (19 acres)	$88,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$714,000
TOTAL COST OF PROJECT	**$26,677,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$1,877,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$158,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$85,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (7182267 kW-hr @ 0.08 $/kW-hr)	$575,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$2,695,000**
Available Project Yield (ac-ft/yr)	9,113
Annual Cost of Water ($ per ac-ft), based on PF=1.2	$296
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1.2	$90
Annual Cost of Water ($ per 1,000 gallons), based on PF=1.2	$0.91
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1.2	$0.28

PROJECT EVALUATION

This strategy benefits livestock users in Nacogdoches County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. New wells in the county will reduce demands on other water supplies in Nacogdoches County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the recommended strategy to drill new wells in Nacogdoches County for livestock use was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 9,113 ac-ft/yr
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	5	High Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 19. NACOGDOCHES MINING

Water User Group Name:	**Nacogdoches County - Mining**
Strategy Name:	**Purchase from Angelina Neches River Authority (Neches Run of River, Mud Creek)**
Strategy ID:	**NACW-MIN**
Strategy Type:	**New Surface Water Source**
Potential Supply Quantity:	**118 - 2,975 ac-ft/yr (varies) (0.15 - 2.66 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$14,557,000 (September 2018)**
Annual Cost:	**$4,159,000**
Unit Water Cost (Rounded):	**$1,398 per ac-ft ($4.29 per 1,000 gallons)**

PROJECT DESCRIPTION

Mining users in Nacogdoches County show a projected need in the early decades of the planning cycle. This strategy is a recommended strategy for Mining in Nacogdoches County and involves a contract between individual mining water users and the Angelina Neches River Authority for raw water from Mud Creek as their permit allows. Potential mining customers in Nacogdoches County have reached out to Angelina Neches River Authority for a contract to sell water. It is assumed that the individual mining customers will develop the infrastructure required to access supplies from Neches River to the project location. The cost for supply from the Neches River includes the cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the Angelina Neches River Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the mining need projected in Nacogdoches County by the East Texas Regional Water Planning Group. Currently mining needs are met by local supplies in Nacogdoches County and groundwater supplies from other aquifers in the County. The recommended source of supply for the future mining needs will be the run-of-river supplies from Neches River that Angelina Neches River Authority is applying for. The reliability of this water supply is considered medium due to the availability of water projected in the Neches River using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models. However, this strategy is dependent on sales with the Angelina Neches River Authority and their application for 30,000 ac-ft/yr from the Neches River (Strategy ID: ANRA-ROR). The quantity of supply from this strategy represents a contract of 2,975 ac-ft/yr, beginning in 2030 and decreases to 118 ac-ft/yr by 2040.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between mining water users in Nacogdoches County and the Angelina Neches River Authority should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries in Nacogdoches County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 6 miles of pipeline (approximate distance from the potential location for run-of-river diversions on Neches River to the center of Nacogdoches County), a pump station with an intake and one terminal storage tank with 1.2 MG of storage. The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the length of pipeline required.

WUG:	**Nacogdoches County Mining**				
STRATEGY:	**Purchase from ANRA**				
Raw Water Quantity:	**2,975** AF/Y			5.31 MGD	
CAPITAL COSTS					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	24 in.	31,680	LF	$154	$4,879,000
Right of Way Easements Rural (ROW)		31,680	LF	$18	$579,000
Land and Surveying (10%)					$58,000
Engineering and Contingencies (30%)					$1,464,000
Subtotal of Pipeline	**6**	**miles**			**$6,980,000**
Pump Station(s)					
Pump with intake	114 HP	1	LS	$4,547,000	$4,547,000
Engineering and Contingencies (35%)					$1,591,000
Subtotal of Pump Station(s)					**$6,138,000**
Storage Tank(s)					
Storage Tank	0.7 MG	1	LS	$645,025	$645,000
Engineering and Contingencies (35%)					$226,000
Subtotal of Storage Tank(s)					**$871,000**
Permitting and Mitigation					$178,000
Construction Total					**$14,167,000**
Interest During Construction			12	Months	$390,000
TOTAL CAPITAL COST					**$14,557,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$1,024,000
Operational Costs*					$3,135,000
TOTAL ANNUAL COST					**$4,159,000**

UNIT COSTS (Until Amortized)

Per Acre-Foot of treated water	$1,398
Per 1,000 Gallons	$4.29

UNIT COSTS (After Amortization)

Per Acre-Foot	$1,054
Per 1,000 Gallons	$3.23

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits mining users in Nacogdoches County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Neches River will reduce demands on other water supplies in Nacogdoches County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Nacogdoches Mining recommended strategy to purchase water from the Angelina Neches River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 2,975 ac-ft/yr
Reliability	3	Medium
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor(s) are identified and committed to the strategy
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 20. NEWTON MINING

Water User Group Name:	**Newton Mining**
Strategy Name:	**Purchase from Sabine River Authority (Toledo Bend)**
Strategy ID:	**NEWT-MIN**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**115 - 59 ac-ft/yr (0.1 - 0.05 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020**
Project Capital Cost:	**$0 (September 2018)**
Annual Cost:	**$111,000**
Unit Water Cost (Rounded):	**$965 per ac-ft ($2.96 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Mining in Newton County and involves a contract between individual mining water users and the Sabine River Authority from their Toledo Bend system, as their permit allows. The Sabine River Authority currently supplies water to mining water users in Newton County. Therefore, the only cost for additional supply from is the contractual cost of raw water. Ultimately, this cost will need to be negotiated with the Sabine River Authority and will reflect their wholesale water rates at that time. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

Currently, the Sabine River Authority is the only provider of water to mining users in Newton County. Therefore, this recommended strategy calls for a contract amendment equal to the projected need of Newton Mining during the planning period. The contract required for this strategy increases their supply by 115 ac-ft/yr beginning in 2020 and decreases to 59 ac-ft/yr beginning in 2030. Newton mining is not projected to have a need from 2040 through 2070. These supplies are considered highly reliable because the supply is available in Toledo Bend and the infrastructure is already in place; however, the supply is dependent on coordination with the Sabine River Authority.

ENVIRONMENTAL CONSIDERATIONS

There are not any significant environmental considerations associated with this strategy. A contract between mining water users in Newton County and the Sabine River Authority should have a minimal impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries located in Newton County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. No capital costs were assumed, but an annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water equal to $3.00 per 1,000 gallons. Overall, this strategy has a low cost

compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG NAME:	**Newton Mining**		
STRATEGY:	**Purchase from Sabine River Authority (Toledo Bend)**		
Raw Water Quantity:	**115** AF/Y	0.15 MGD	
CONSTRUCTION COSTS			
ANNUAL CONTRACT COSTS			
ANNUAL COSTS			
Operational Costs*			**$111,000**
UNIT COSTS (Until Amortized)			
Per Acre-Foot of treated water			$965
Per 1,000 Gallons			$2.96
UNIT COSTS (After Amortization)			
Per Acre-Foot		NA	
Per 1,000 Gallons		NA	

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits mining water users in Newton County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Sabine River Authority's Toledo Bend system will reduce demands on other water supplies in Newton County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Newton Mining recommended strategy to purchase water from the Sabine River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 115 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 21. ORANGE IRRIGATION

Water User Group Name:	**Orange Irrigation**
Strategy Name:	**Purchase from Sabine River Authority (Sabine River)**
Strategy ID:	**ORAN-IRR**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**526 ac-ft/yr (0.47 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$14,624,000 (September 2018)**
Annual Cost:	**$1,355,000**
Unit Water Cost (Rounded):	**$2,576 per ac-ft ($7.91 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for irrigation water users in Orange County and involves a contract between individual irrigators and the Sabine River Authority for raw water from the Sabine River, as their permit allows. The cost for supply from the Sabine River includes the contractual cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the Sabine River Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water need projected for irrigation users in Orange County projected by the East Texas Regional Planning Group during the planning period (2030-2070). The quantity of supply from this strategy represents a contract of 526 ac-ft/yr, beginning in 2030 and continuing to 2070. The reliability of this water supply is considered high due to the availability of water projected in the Sabine River using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models. However, this strategy is dependent on coordination with the Sabine River Authority. This strategy is not dependent on any other water management strategies in the 2021 East Texas Regional Water Plan.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between irrigators in Orange County and the Sabine River Authority should have a minimal impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. Sabine River Authority already supplies to some irrigation users in Orange County. The strategy is highly reliable since some of the transmission connections may be already in place.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 13 miles of pipeline (the approximate distance from the Sabine River to the center of Orange

County), a pump station with an intake, a booster pump station, and a terminal storage tank (0.1 million gallon). The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the length of pipeline required and the large supply volume.

WUG:	**Orange County – Irrigation**				
STRATEGY:	**Purchase from Sabine River Authority (Sabine River)**				
Raw Water Quantity:	**526** AF/Y			0.9 MGD	
CAPITAL COSTS					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	10 in.	68,640	LF	$65	$4,481,000
Right of Way Easements Rural (ROW)		68,640	LF	$30	$2,060,900
Land and Surveying (10%)					$206,090
Engineering and Contingencies (30%)					$1,344,000
Subtotal of Pipeline	**13**	**miles**			**$8,091,990**
Pump Station(s)					
Pump with intake	20 HP	1	LS	$2,997,000	$2,997,000
Booster Pump Station	20 HP	1	LS	$837,000	$837,000
Engineering and Contingencies (35%)					$1,341,900
Subtotal of Pump Station(s)					**$5,175,900**
Storage Tank(s)					
Storage Tank	0.1 MG	1	LS	$438,839	$438,839
Engineering and Contingencies (35%)					$153,594
Subtotal of Storage Tank(s)					**$592,433**
Permitting and Mitigation					$373,000
Construction Total					**$14,233,000**
Interest During Construction			12	Months	$391,000
TOTAL CAPITAL COST					**$14,624,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$1,029,000
Operational Costs*					$326,000
TOTAL ANNUAL COST					**$1,355,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$2,576
Per 1,000 Gallons					$7.91
UNIT COSTS (After Amortization)					
Per Acre-Foot					$639
Per 1,000 Gallons					$1.96

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits irrigation water users in Orange County and is expected to have a positive impact on their water supply security. Sabine River Authority currently supplies water to some irrigators in Orange County. Therefore, this strategy is highly reliable as some of the connections may already be in place and the strategy may be just an extension of current contracts. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Sabine River will reduce demands on other water supplies in Orange County and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the Orange Irrigation recommended strategy to purchase water from the Sabine River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 526 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	5	High Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 22. PANOLA LIVESTOCK

Water User Group Name:	**Panola County – Livestock**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**PANL-LTK**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**982 ac-ft/yr (0.88 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$1,172,000 (September 2018)**
Annual Cost:	**$122,000**
Unit Water Cost (Rounded):	**$124 per ac-ft ($0.38 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for livestock users in Panola County and involves the development of four wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Panola County. These wells will provide approximately 982 ac-ft/yr and are assumed to have a depth of 200 feet. A peaking factor of two was assumed for the wells, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

It is assumed that each well will provide 245 ac-ft/yr to meet livestock demands in Panola County providing a total strategy yield of 982 ac-ft/yr beginning in 2030. A target yield for this strategy was set to the highest need projected by the East Texas Regional Water Planning Group; the highest need occurs in 2020 and continues throughout the planning period. However, this project will not be online before January 2023, so the online decade will be 2030. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Panola County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed four wells, a peaking factor of two, and a maximum well yield of 275 gpm for each well. This equates to $124 per acre-foot ($0.38 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $40 per acre-foot ($0.12 per 1,000 gallons). Overall, this strategy has a low cost

compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Panola County – Livestock
WMS: New wells in Carrizo-Wilcox Aquifer

Supply	982	Ac-ft/yr	609	gpm
Well Depth	200			
Wells Needed	4			

CAPITAL COSTS	
Well Fields (Wells, Pumps, and Piping)	$827,000
TOTAL COST OF FACILITIES	**$827,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$289,000
Environmental & Archaeology Studies and Mitigation	$15,000
Land Acquisition and Surveying (2 acres)	$9,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$32,000
TOTAL COST OF PROJECT	**$1,172,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$83,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$8,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (391758 kW-hr @ 0.08 $/kW-hr)	$31,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$122,000**
Available Project Yield (ac-ft/yr)	982
Annual Cost of Water ($ per ac-ft), based on PF=1	$124
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1	$40
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$0.38
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$0.12

PROJECT EVALUATION

This strategy benefits livestock water users in Panola County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Developing new groundwater wells in Panola County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Panola County livestock recommended strategy to develop groundwater wells was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage, 982 ac-ft/yr
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	5	High Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Regional Water Planning Group and Groundwater Management Areas.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 23. RUSK JACOBS WSC

Water User Group Name:	**Rusk – Jacobs WSC**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**RUSK-JAW**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**22 ac-ft/yr (0.02 MGD)**
Implementation Decade:	**2070**
Development Timeline:	**2070**
Project Capital Cost:	**$1,795,000 (September 2018)**
Annual Cost:	**$140,000**
Unit Water Cost (Rounded):	**$6,364 per ac-ft ($19.53 per 1,000 gallons)**

PROJECT DESCRIPTION

Jacobs WSC has a small need starting in 2070 of approximately 22 ac-ft/yr. This strategy is a recommended strategy for Jacobs WSC in Rusk County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Rusk County. The wells will provide approximately 22 ac-ft/yr and are assumed to have a depth of 400 feet. A peaking factor of two was assumed for the well, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

The supply is required only in the later part of the planning cycle beginning in 2070. Currently, all of the existing needs are being met by supplies from the Carrizo Wilcox aquifer. There are sufficient supplies available in the Rusk County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that the wells will provide sufficient ac-ft/yr to meet Jacobs WSC's needs in Rusk County providing a total yield required for the strategy. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Rusk County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 1 mile of pipeline, two wells, a peaking factor of two, and a maximum well yield of 350 gpm for each well. This equates to $6,364 per acre-foot ($19.53 per 1,000 gallons); after the infrastructure is fully

paid (30 years), the cost drops to $636 per acre-foot ($1.95 per 1,000 gallons). Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Rusk – Jacobs WSC
WMS: New wells in Carrizo-Wilcox Aquifer

Supply	22	Ac-ft/yr	14	gpm
Well Depth	400			
Wells Needed	2			

CAPITAL COSTS	
Transmission Pipeline (6 in dia., 1 miles)	$134,000
Primary Pump Stations (0 MGD)	$76,000
Well Fields (Wells, Pumps, and Piping)	$1,028,000
TOTAL COST OF FACILITIES	**$1,238,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$426,000
Environmental & Archaeology Studies and Mitigation	$54,000
Land Acquisition and Surveying (6 acres)	$28,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$49,000
TOTAL COST OF PROJECT	**$1,795,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$126,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$12,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$2,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (6151 kW-hr @ 0.08 $/kW-hr)	$0
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$140,000**
Available Project Yield (ac-ft/yr)	22
Annual Cost of Water ($ per ac-ft), based on PF=1	$6,364
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1	$636
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$19.53
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$1.95

PROJECT EVALUATION

This strategy benefits Jacobs WSC municipal users in Rusk County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Developing new groundwater supplies Rusk County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this new supply will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Rusk Jacobs WSC recommended strategy to develop new groundwater wells was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 22 ac-ft/yr
Reliability	3	Medium
Cost	1	>$5,000/ac-ft (High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by Jacobs WSC
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 24. RUSK LIVESTOCK

Water User Group Name:	**Rusk County - Livestock**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**RUSK-LTK**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**20 - 83 ac-ft/yr (varies) (0.02 - 0.07 MGD)**
Implementation Decade:	**2040**
Development Timeline:	**2040**
Project Capital Cost:	**$283,000 (September 2018)**
Annual Cost:	**$24,000**
Unit Water Cost (Rounded):	**$289 per ac-ft ($0.89 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for livestock users in Rusk County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Rusk County. These wells will provide approximately 83 ac-ft/yr and are assumed to have a depth of 190 feet. A peaking factor of two was assumed for the wells, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

It is assumed that each well will provide approximately 42 ac-ft/yr to meet irrigation demands in Rusk County providing a total strategy yield of 83 ac-ft/yr beginning in 2040. A target yield for this strategy was set to the highest need projected by the East Texas Regional Water Planning Group; the highest needs occurs beginning in 2060. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Rusk County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed two wells, a peaking factor of two, and a maximum well yield of 200 gpm for each well. This equates to $289 per acre-foot ($0.89 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $48 per acre-foot ($0.15 per 1,000 gallons). Overall, this strategy has a low cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Rusk County - Livestock
WMS: New wells in Carrizo-Wilcox Aquifer

Supply	83	Ac-ft/yr	51	gpm
Well Depth	190			
Wells Needed	2			

CAPITAL COSTS	
Well Fields (Wells, Pumps, and Piping)	$194,000
TOTAL COST OF FACILITIES	**$194,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$68,000
Environmental & Archaeology Studies and Mitigation	$8,000
Land Acquisition and Surveying (1 acres)	$5,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$8,000
TOTAL COST OF PROJECT	**$283,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$20,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$2,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (19000 kW-hr @ 0.08 $/kW-hr)	$2,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$24,000**
Available Project Yield (ac-ft/yr)	83
Annual Cost of Water ($ per ac-ft), based on PF=1	$289
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1	$48
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$0.89
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$0.15

PROJECT EVALUATION

This strategy benefits livestock users in Rusk County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Developing new groundwater wells in Rusk County will have no other apparent impact on other State water resources. From a third party social and economic perspective, this new supply will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Rusk Livestock recommended strategy to purchase water from the Angelina Neches River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 83 ac-ft/yr
Reliability	3	Medium
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	5	High Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 25. RUSK MINING

Water User Group Name:	**Rusk Mining**
Strategy Name:	**Purchase from Angelina Neches River Authority (Neches Run of River, Mud Creek)**
Strategy ID:	**RUSK-MIN**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**22 - 305 ac-ft/yr (varies) (0.02 - 0.27 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$14,808,000 (September 2018)**
Annual Cost:	**$1,291,000**
Unit Water Cost (Rounded):	**$4,233 per ac-ft ($12.99 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Mining in Ruck County and involves a contract between individual mining water users and the Angelina Neches River Authority for raw water from Mud Creek as their permit allows. The cost for supply from the Neches River includes the cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the Angelina Neches River Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the mining need projected in Rusk County by the East Texas Regional Water Planning Group. The reliability of this water supply is considered medium due to the availability of water projected in the Neches River using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models. However, this strategy is dependent on sales with the Angelina Neches River Authority and their application for 10,000 ac-ft/yr from the Neches River (Strategy ID: ANRA-ROR). The quantity of supply from this strategy represents a contract of 305 ac-ft/yr, beginning in 2030, and decreases to 22 ac-ft/yr in 2050.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between mining water users in Rusk County and the Angelina Neches River Authority should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries in Rusk County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs

assumed 16 miles of pipeline (50% of the approximate distance across Rusk County), a pump station with an intake, a booster pump station, and one terminal storage tank with one day of storage. The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the length of pipeline required.

WUG:	**Rusk County - Mining**				
STRATEGY:	**Purchase from Angelina Neches River Authority**				
Raw Water Quantity:	**305** AF/Y		0.5 MGD		
CAPITAL COSTS					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	8 in.	84,480	LF	$48	$4,040,000
Right of Way Easements Rural (ROW)		84,480	LF	$30	$2,536,000
Land and Surveying (10%)					$253,600
Engineering and Contingencies (30%)					$1,212,000
Subtotal of Pipeline	**16**	**miles**			**$8,041,600**
Pump Station(s)					
Pump with intake	25 HP	1	LS	$3,087,000	$3,087,000
Booster Pump Station	25 HP	1	LS	$880,000	$880,000
Engineering and Contingencies (35%)					$1,388,450
Subtotal of Pump Station(s)					**$5,355,450**
Storage Tank(s)					
Storage Tank	0.1 MG	1	LS	$420,238	$420,000
Engineering and Contingencies (35%)					$147,000
Subtotal of Storage Tank(s)					**$567,000**
Permitting and Mitigation					$448,000
Construction Total					**$14,412,050**
Interest During Construction			12	Months	$396,000
TOTAL CAPITAL COST					**$14,808,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$1,042,000
Operational Costs*					$249,000
TOTAL ANNUAL COST					**$1,291,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$4,233
Per 1,000 Gallons					$12.99
UNIT COSTS (After Amortization)					
Per Acre-Foot					$839
Per 1,000 Gallons					$2.58

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits mining users in Rusk County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Neches River will reduce demands on other water supplies in Rusk County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Rusk Mining recommended strategy to purchase water from the Angelina Neches River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 305 ac-ft/yr
Reliability	3	Medium
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor(s) are identified and committed to strategy
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Angelina Neches River Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 26. RUSK STEAM ELECTRIC POWER

Water User Group Name:	**Rusk Steam Electric Power**
Strategy Name:	**Purchase from Sabine River Authority (Toledo Bend)**
Strategy ID:	**RUSK-SEP**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**1,103 ac-ft/yr (0.98 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$30,008,000 (September 2018)**
Annual Cost:	**$2,795,000**
Unit Water Cost (Rounded):	**$2,534 per ac-ft ($7.78 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Steam Electric Power in Rusk County and involves a contract between individual steam electric power water users and the Sabine River Authority for raw water from the Sabine River, as their permit allows. The cost for supply from the Sabine River includes the contractual cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the Sabine River Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water need projected for Steam Electric Power in Rusk County projected by the East Texas Regional Planning Group during the planning period (2020-2070). The quantity of supply from this strategy represents a contract of 1,103 ac-ft/yr, beginning in 2030, and continuing throughout the planning period to 2070. This project will not be completed prior to January 2023, therefore the TWDB requires the project to come online in the 2030 decade. The reliability of this water supply is considered high due to the availability of water projected in the Sabine River using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models. However, this strategy is dependent on coordination with the Sabine River Authority. This strategy is not dependent on any other water management strategies in the 2021 East Texas Regional Water Plan.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between steam electric power water users in Rusk County and the Sabine River Authority should have a minimal impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries within Rusk County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 25 miles of pipeline (the approximate distance from the Sabine River to the center of Rusk County), a pump station with an intake, a booster pump station, and a storage tank (0.2 million gallon). The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the length of pipeline required.

WUG:	**Rusk County - Steam Electric Power**				
STRATEGY:	**Purchase from Sabine River Authority (Sabine River)**				
Raw Water Quantity:	**1,103** AF/Y		2.0 MGD		
CAPITAL COSTS					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	12 in.	132,000	LF	$83	$10,922,000
Right of Way Easements Rural (ROW)		132,000	LF	$30	$3,963,200
Land and Surveying (10%)					$396,320
Engineering and Contingencies (30%)					$3,277,000
Subtotal of Pipeline	**25**	**miles**			**$18,558,520**
Pump Station(s)					
Pump Station with intake	183 HP	1	LS	$5,673,000	$5,673,000
Booster Pump Station	183 HP	1	LS	$1,227,000	$1,227,000
Engineering and Contingencies (35%)					$2,415,000
Subtotal of Pump Station(s)					**$9,315,000**
Storage Tank(s)					
Storage Tank	0.2 MG	1	LS	$487,422	$487,422
Engineering and Contingencies (35%)					$170,598
Subtotal of Storage Tank(s)					**$658,020**
Permitting and Mitigation					$673,000
Construction Total					**$29,204,540**
Interest During Construction			12	Months	$803,000
TOTAL CAPITAL COST					**$30,008,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$2,111,000
Operational Costs*					$684,000
TOTAL ANNUAL COST					**$2,795,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$2,534
Per 1,000 Gallons					$7.78
UNIT COSTS (After Amortization)					
Per Acre-Foot					$655
Per 1,000 Gallons					$2.01

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits steam electric power water users in Rusk County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Sabine River will reduce demands on other water supplies in Rusk County and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the Rusk Steam Electric Power recommended strategy to purchase water from the Sabine River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 1,103 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Sabine River Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 27. SAN AUGUSTINE SAN AUGUSTINE

Water User Group Name:	**San Augustine County - San Augustine**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**SAUG-SAG**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**89 - 105 ac-ft/yr (varies) (0.08 - 0.09 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$1,045,000 (September 2018)**
Annual Cost:	**$88,000**
Unit Water Cost (Rounded):	**$838 per ac-ft ($2.57 per 1,000 gallons)**

PROJECT DESCRIPTION

San Augustine has needs throughout the planning period, with the maximum need of approximately 120 ac-ft/yr occurring in 2020. To meet this need, it is recommended that San Augustine continue to use supplies from Carrizo Wilcox by drilling additional wells. This strategy is a recommended strategy for San Augustine in San Augustine County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Cherokee County. The wells will provide approximately 60 ac-ft/yr and are assumed to have a depth of 250 feet. A peaking factor of two was assumed for the well, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply. Though the maximum need occurs in the 2020 decade, this project will not be completed prior to January 2023, so it must be shifted to have an online decade of 2030, according to TWDB planning requirements.

SUPPLY DEVELOPMENT

The supply is required throughout the planning cycle, for decades 2030 and 2070. Currently, all of the existing needs are being met by supplies from the Carrizo Wilcox aquifer. There are sufficient supplies available in the San Augustine County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that each well provide 60 ac-ft/yr to meet San Augustine's needs in San Augustine County providing a total yield required for the strategy. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of San Augustine County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 1 mile of pipeline, two wells, a peaking factor of two, and a maximum well yield of 100 gpm for each well. This equates to $807 per acre-foot ($2.48 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $128 per acre-foot ($0.39 per 1,000 gallons). Overall, this strategy has a low cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: San Augustine County - San Augustine
WMS: New wells in Carrizo-Wilcox Aquifer

Supply	105	Ac-ft/yr	65 gpm
Well Depth	250		
Wells Needed	2		

CAPITAL COSTS	
Transmission Pipeline (6 in dia., 1 miles)	$134,000
Primary Pump Stations (0.1 MGD)	$186,000
Well Fields (Wells, Pumps, and Piping)	$378,000
TOTAL COST OF FACILITIES	**$698,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$237,000
Environmental & Archaeology Studies and Mitigation	$54,000
Land Acquisition and Surveying (6 acres)	$28,000
Interest During Construction (3% for 1 years with a 0.5% ROI)	$28,000
TOTAL COST OF PROJECT	**$1,045,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$74,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$5,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$5,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (54366 kW-hr @ 0.08 $/kW-hr)	$4,000
Purchase of Water (ac-ft/yr @ $/ac-ft)	$0
TOTAL ANNUAL COST	**$88,000**
Available Project Yield (ac-ft/yr)	105
Annual Cost of Water ($ per ac-ft), based on PF=1	$838
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1	$133
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$2.57
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$0.41

PROJECT EVALUATION

This strategy benefits municipal users in San Augustine County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Developing new groundwater wells in San Augustine County will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for municipal users in San Augustine County to purchase water from the Angelina Neches River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 105 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor(s) are identified and committed to strategy
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 28. SAN AUGUSTINE LIVESTOCK

Water User Group Name:	**San Augustine County - Livestock**
Strategy Name:	**Purchase from SRA (Toledo Bend)**
Strategy ID:	**SAUG-LTK**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**1,539 - 2,349 ac-ft/yr (varies) (1.37 - 2.1 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$41,302,000 (September 2018)**
Annual Cost:	**$4,121,000**
Unit Water Cost (Rounded):	**$1,754 per ac-ft ($5.38 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for livestock users in San Augustine County and involves the purchase of supplies from Sabine River Authority's Toledo Bend Reservoir. The cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

A target yield for this strategy was set to the highest need projected by the East Texas Regional Water Planning Group; the highest need occurs in 2060. Overall, the reliability of this supply is considered high, based on the supply availability from Toledo Bend. Though there is a need in 2020, this project will not be completed prior to January 2023 due to time constraints, so the online decade for this project will be 2030 because of TWDB planning requirements.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. The impact to the environment due to pipeline construction is expected to be temporary and minimal. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of San Augustine County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. This equates to $1,754 per acre-foot ($5.38 per 1,000 gallons); after the infrastructure is fully paid (30 years), the cost drops to $542 per acre-foot ($1.66 per 1,000 gallons). Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG:	**San Augustine County - Livestock**				
STRATEGY:	**Purchase from Sabine River Authority (Sabine River)**				
Raw Water Quantity:	**2,349** AF/Y			4.2 MGD	
CAPITAL COSTS					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	18 in.	132,000	LF	$135	$17,837,000
Right of Way Easements Rural (ROW)		132,000	LF	$30	$4,359,520
Engineering and Contingencies (30%)					$5,351,000
Subtotal of Pipeline	**25**	**miles**			**$27,547,520**
Pump Station(s)					
Pump Station with intake	246 HP	1	LS	$6,714,000	$6,714,000
Booster Pump Station	246 HP	1	LS	$1,565,000	$1,565,000
Engineering and Contingencies (35%)					$2,897,650
Subtotal of Pump Station(s)					**$11,176,650**
Storage Tank(s)					
Storage Tank	0.5 MG	1	LS	$592,331	$592,331
Engineering and Contingencies (35%)					$207,316
Subtotal of Storage Tank(s)					**$799,647**
Permitting and Mitigation					$673,000
Construction Total					**$40,196,817**
Interest During Construction			12	Months	$1,105,000
TOTAL CAPITAL COST					**$41,302,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$2,906,000
Operational Costs*					$1,215,000
TOTAL ANNUAL COSTS					**$4,121,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$1,754
Per 1,000 Gallons					$5.38
UNIT COSTS (After Amortization)					
Per Acre-Foot					$542

PROJECT EVALUATION

This strategy benefits livestock water users in San Augustine County and is expected to have a positive

impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Toledo Bend will reduce demands on other water supplies in San Augustine County and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for livestock users in San Augustine County to purchase water from the Sabine River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 2,349 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	5	High Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 29. SAN AUGUSTINE MINING

Water User Group Name:	**San Augustine County - Mining**
Strategy Name:	**Purchase from Angelina Neches River Authority (Neches Run of River, Mud Creek)**
Strategy ID:	**SAUG-MIN**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**1,102 ac-ft/yr (0.98 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$36,269,000 (September 2018)**
Annual Cost:	**$3,911,000**
Unit Water Cost (Rounded):	**$3,549 per ac-ft ($10.89 per 1,000 gallons)**

PROJECT DESCRIPTION

San Augustine County shows shortages for mining users for the decades 2020 and 2030. The mining water users have a contract with Angelina Neches River Authority to use Angelina Neches River Authority's supplies to meet the water needs. Current supply is from other aquifers and San Augustine City Lake. This strategy is a recommended strategy for mining users in San Augustine County and involves a contract between mining water users and the Angelina Neches River Authority for raw water from Mud Creek. The cost for supply from the Neches River includes the contractual cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the Angelina Neches River Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water. Though there is a need in 2020, this project will not be completed prior to January 2023 due to time constraints, so the online decade for this project will be 2030 because of TWDB planning requirements.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water need projected for mining in San Augustine County projected by the East Texas Regional Planning Group during the planning period (2020-2070). The shortage manifests for decades 2020 and 2030. The quantity of supply from this strategy represents a contract of 1,102 ac-ft/yr in 2030. Angelina Neches River Authority put in an application for 10,000 ac-ft/yr of run-of-river supplies and the application is administratively complete. Angelina Neches River Authority has a water management strategy in the 2021 Plan to apply for additional run-of-river supplies to address the mining demands in the region. Because of the nature of the application and the process involved in securing the water rights, this supply is not considered very reliable at this time. Therefore, this strategy is dependent on successful execution of Angelina Neches River Authority's water management strategies in the 2021 East Texas Regional Water Plan to secure additional run-of-river supplies.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between mining water users in San Augustine County and the Angelina Neches River Authority should have a minimal impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area.

PERMITTING AND DEVELOPMENT

There are permitting and supply development issues associated with this strategy. Angelina Neches River Authority has to work with Texas Commission on Environmental Quality to furnish all the required documentation required for the successful procurement of the new and currently pending run-of-river water right applications. Also, the availability of this supply is potentially limited to the environmental flow requirements and supply availability in the Neches River in that region.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 30 miles of pipeline (the approximate distance from Neches River to the center of San Augustine County), a pump station with an intake, and a terminal storage tank (0.4 million gallon). The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water equal to $3.00 per 1,000 gallons. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the length of pipeline required and the quantity of supply delivered for the infrastructure.

WUG: **San Augustine County - Mining**
STRATEGY: **Purchase from Angelina Neches River Authority**
Quantity: **1,102** AF/Y 1.48 MGD

CAPITAL COSTS

Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	16 in.	158,400	LF	$118	$18,638,000
Right of Way Easements Rural (ROW)		158,400	LF	$18	$3,184,000
Engineering and Contingencies (30%)					$5,591,000
Subtotal of Pipeline					**$27,413,000**
Pump Station(s)					
Pump Station with intake	79 HP	1	LS	$3,965,000	$3,965,000
Engineering and Contingencies (35%)					$1,888,000
Subtotal of Pump Station(s)					**$5,853,000**
Storage Tank(s)					
Storage Tank	0.2 MG	1	LS	$939,000	$939,000
Engineering and Contingencies (35%)					$329,000
Subtotal of Storage Tank(s)					**$1,268,000**
Permitting and Mitigation					$778,000
Construction Total					**$35,312,000**
Interest During Construction			12	Months	$957,000
TOTAL COST					**$36,269,000**

ANNUAL COSTS

Debt Service (3.5% for 20 years)	$2,517,000
Operational Costs*	$1,394,000
TOTAL ANNUAL COST	**$3,911,000**

UNIT COSTS (Until Amortized)

Per Acre-Foot of treated water	$3,549
Per 1,000 Gallons	$10.89

UNIT COSTS (After Amortization)

Per Acre-Foot	$1,286
Per 1,000 Gallons	$3.95

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits mining water users in San Augustine County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Neches River will reduce demands on other water supplies in San Augustine County and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for mining users in San Augustine County to purchase water from the Angelina Neches River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	**4**	**Meets 75-100% of Shortage. 1,102 ac-ft/yr**
Reliability	**4**	**Medium to High**
Cost	**2**	**$1,000 to $5,000/ac-ft (Medium-High)**
Environmental Factors	**4**	**Low Negative Impacts / Some Positive Impacts**
Impact on Other State Water Resources	**4**	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	**4**	**Low Negative Impacts / Some Positive Impacts**
Interbasin Transfers		**No**
Other Natural Resources	**4**	**Low Negative Impacts / Some Positive Impacts**
Major Impacts on Key Water Quality Parameters	**4**	**Low Negative Impacts / Some Positive Impacts**
Political Feasibility	**4**	**Sponsor(s) identified and committed to strategy**
Implementation Issues	**4**	**Low Implementation Issues**

REFERENCES

Discussions with Angelina Neches River Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 30. SHELBY SAND HILLS WSC

Water User Group Name:	**Shelby County - Sand Hills WSC**
Strategy Name:	**Purchase from Center**
Strategy ID:	**SHEL-SHW**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**61 - 105 ac-ft/yr (varies) (0.05 - 0.09 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020 - 2070**
Project Capital Cost:	**$0 (September 2018)**
Annual Cost:	**$102,000**
Unit Water Cost (Rounded):	**$971 per ac-ft ($2.98 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for the Sand Hills WSC in Shelby County and involves a contract between Sand Hills WSC and the City of Center for raw water. As the Sand Hills WSC already purchases water from the City of Center, the only cost for additional supply from the City of Center is the cost of raw water. Ultimately, this cost will need to be negotiated with the City of Center and will reflect the City's wholesale water rates at that time. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The City of Center currently supplies approximately 3,000 ac-ft/yr to meet the municipal demands of the Sand Hills WSC in Shelby County. The quantity of supply from this strategy represents a contract increase of 61 ac-ft/yr, beginning in 2020, and increases to 105 ac-ft/yr, beginning in 2070. From 2020 through 2070, the supply is limited to the Sand Hills WSC's need projected by the East Texas Regional Water Planning Group. These supplies are considered highly reliable.

ENVIRONMENTAL CONSIDERATIONS

There are not any significant environmental considerations associated with this strategy. A contract between the Sand Hills WSC and the City of Center should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries within Shelby County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. No capital costs were assumed, but an annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a low cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG:	**Shelby County - Sand Hills WSC**				
STRATEGY:	**Purchase from Center**				
Raw Water Quantity:	**105** AF/Y			0.14 MGD	
CONSTRUCTION COSTS					
ANNUAL CONTRACT COSTS					
ANNUAL COSTS					
O&M and Other Costs*	34,000	34,000	1000 gal	$3.00	$102,000
Treatment		0	1000 gal	$3.00	$0
Operational Costs*					**$102,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$971
Per 1,000 Gallons					$2.98
UNIT COSTS (After Amortization)					
Per Acre-Foot				NA	
Per 1,000 Gallons				NA	

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits municipal users in Sand Hills WSC in Shelby County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the City of Center reservoirs will reduce demands on other water supplies in Shelby County and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for Sand Hills WSC in Shelby County to purchase water from the City of Center was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 105 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by Sand Hills WSC
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 31. SHELBY LIVESTOCK

Water User Group Name:	**Shelby County - Livestock**
Strategy Name:	**Purchase from Sabine River Authority (Toledo Bend)**
Strategy ID:	**SHEL-LTK**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**6,491 - 19,006 ac-ft/yr (varies) (5.8 - 17.0 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020 - 2070**
Project Capital Cost:	**$0 (September 2018)**
Annual Cost:	**$18,582,000**
Unit Water Cost (Rounded):	**$978 per ac-ft ($3.00 per 1,000 gallons)**

PROJECT DESCRIPTION

Livestock water demands are projected to increase significantly in Shelby County, partially due to the growing poultry industry. Current supply is from Carrizo-Wilcox aquifer and local surface water supplies. It is recommended that any large-scale user should obtain surface water from Toledo Bend Reservoir through a contract with Sabine River Authority. This strategy is a recommended strategy for livestock users in Shelby County and involves a contract between livestock water users and the Sabine River Authority for raw water from the Sabine River, as their permit allows. The cost for supply from the Sabine River includes the contractual cost of raw water. Ultimately, the cost for raw water will need to be negotiated with the Sabine River Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water need projected for Livestock in Shelby County projected by the East Texas Regional Planning Group during the planning period (2020-2070). The quantity of supply from this strategy represents a contract of 6,491 ac-ft/yr, beginning in 2020, and increases over time to 19,006 ac-ft/yr, beginning in 2070. The reliability of this water supply is considered high due to the availability of water projected in the Sabine River using the Texas Commission on Environmental Quality (TCEQ) Water Availability Models. However, this strategy is dependent on coordination with the Sabine River Authority. This strategy is not dependent on any other water management strategies in the 2021 East Texas Regional Water Plan.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between livestock water users in Shelby County and the Sabine River Authority should have a minimal impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries within Shelby County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the length of pipeline required and the large quantity of supply.

WUG:	**Shelby County - Livestock**				
STRATEGY:	**Purchase from Sabine River Authority (Toledo Bend)**				
Raw Water Quantity:	**19,006** AF/Y		25.43 MGD		
CONSTRUCTION COSTS					
ANNUAL CONTRACT COSTS					
ANNUAL COSTS					
O&M and Other Costs*	6,194,000	6,194,000	1000 gal	$3.00	$18,582,000
Treatment		0	1000 gal	$3.00	$0
Operational Costs*					**$18,582,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$978
Per 1,000 Gallons					$3.00
UNIT COSTS (After Amortization)					
Per Acre-Foot					NA
Per 1,000 Gallons					NA

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits livestock water users in Shelby County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Sabine River will reduce demands on other water supplies in Shelby County and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for livestock users in Shelby County to purchase water from the Sabine River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 19,006 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	5	High Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Sabine River Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 32. SMITH BULLARD

Water User Group Name:	**Smith County - Bullard**
Strategy Name:	**Purchase from City of Tyler**
Strategy ID:	**SMTH-BLD**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**322 - 1,145 ac-ft/yr (varies) (0.29 - 1.00 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030 - 2070**
Project Capital Cost:	**$14,264,000 (September 2018)**
Annual Cost:	**$1,615,000**
Unit Water Cost (Rounded):	**$1,410 per ac-ft ($4.33 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for municipal water user Bullard in Smith County and involves a contract between individual Bullard and the City of Tyler for raw water. Bullard is located in ETRWPA region of Smith County. Bullard currently obtains most of its supply from Carrizo Wilcox and sales from North Cherokee WSC. A feasible strategy would be to continue using groundwater from Carrizo Wilcox. However, this cannot be recommended because of the MAG limitations in Smith County. Therefore, a contract to use City of Tyler's supplies is the recommended strategy for Bullard. In addition to this, municipal conservation is another recommended strategy. Discussion on Conservation strategies is included in a separate technical memorandum. The cost for supply from the City of Tyler includes the contractual cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the City of Tyler and will reflect the wholesale water rates of this entity at the time a contract is made. City of Tyler may have existing infrastructure near the service area for this water user and that can be used to deliver supplies to Bullard's customers. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water. Though there is a need in 2020, this project will not be completed prior to January 2023 due to time constraints, so the online decade for this project will be 2030 because of TWDB planning requirements.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water need projected for Bullard in Smith County projected by the East Texas Regional Planning Group during the planning period (2020-2070). The quantity of supply from this strategy represents a contract of 322 ac-ft/yr in 2030, increasing to 1,182 ac-ft/yr in 2070. The reliability of this water supply is considered high due to the availability of water in City of Tyler's sources of supply. City of Tyler owns Lake Tyler and has a contract for water from Lake Palestine. In addition to this, the City also has groundwater supplies in the Smith County Carrizo Wilcox. City of Tyler will decide the appropriate source of supply that is in close proximity to the water user location. However, this strategy is dependent on coordination with the City of Tyler. Depending on the source of supply City of Tyler choses for this water user, this strategy may be dependent on the completion of Tyler's construction of transmission system to access the full amount of Lake Palestine supplies. This is a recommended water management strategy for City of Tyler in 2021 Regional Water Plan.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In

addition, a contract between Bullard and the City of Tyler should have a minimal impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries within Smith County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed ten miles of pipeline (the approximate distance from the City of Tyler supplies to Bullard's service area in Smith County), a pump station with an intake, and a terminal storage tank (0.2 million gallon). The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the yield generated by the infrastructure required.

WUG: **Smith County - Bullard**
STRATEGY: **Purchase from City of Tyler**
Quantity: **1,145** AF/Y 1.53 MGD

CAPITAL COSTS

Pipeline	**Size**	**Qty**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	10 in.	52,800	LF	$54	$2,851,000
Right of Way Easements Rural (ROW)		52,800	LF	$18	$964,900
Land and Surveying (10%)					$96,000
Engineering and Contingencies (30%)					$855,000
Subtotal of Pipeline					**$4,766,900**
Pump Station(s)					
Pump with intake	178 HP	1	LS	$5,604,000	$5,604,000
Booster Pump Station	0 HP	1	LS	$0	$0
Engineering and Contingencies (35%)					$1,961,400
Subtotal of Pump Station(s)					**$7,565,400**
Storage Tank(s)					
Storage Tank	0.2 MG	1	LS	$942,000	$942,000
Engineering and Contingencies (35%)					$330,000
Subtotal of Storage Tank(s)					**$1,272,000**
Permitting and Mitigation					$278,000
Construction Total					**$13,882,300**
Interest During Construction			12	Months	$382,000
TOTAL COST					**$14,264,000**

ANNUAL COSTS

Debt Service (3.5% for 20 years)	$1,004,000
Operational Costs*	$611,000
TOTAL ANNUAL COST	**$1,615,000**

UNIT COSTS (Until Amortized)

Per Acre-Foot of treated water	$1,410
Per 1,000 Gallons	$4.33

UNIT COSTS (After Amortization)

Per Acre-Foot	$573
Per 1,000 Gallons	$1.76

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits municipal water users in Smith County and is expected to have a positive impact on their water supply security. City of Tyler's supplies provide relief to the Carrizo Wilcox aquifer as more entities switch from groundwater to purchase water from City of Tyler. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the City of Tyler's supplies will reduce demands on other water supplies in Smith and Anderson Counties and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for Bullard to purchase water from the City of Tyler was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 1,145 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local sponsorship by the City of Tyler
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with City of Tyler.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 33. SMITH CRYSTAL SYSTEMS TEXAS

Water User Group Name:	**Smith County - Crystal Systems Texas**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**SMTH-CYS**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**78 - 538 ac-ft/yr (varies) (0.07 - 0.48 MGD)**
Implementation Decade:	**2040**
Development Timeline:	**2040**
Project Capital Cost:	**$2,531,000 (September 2018)**
Annual Cost:	**$231,000**
Unit Water Cost (Rounded):	**$429 per ac-ft ($1.32 per 1,000 gallons)**

PROJECT DESCRIPTION

The Crystal Systems Texas system is located in northwestern Smith County and serves the un-incorporated area surrounding Hideaway Lake. In 2018, the system had 2050 residential connections. The population is projected to increase from 4,343 persons in 2020 to 8,881 persons in 2070. The System is included as a WUG. in Smith County. The system's current water supply consists of five water wells from the Carrizo-Wilcox Aquifer. The total rated capacity of these wells is 3,560 GPM, or 1,914 ac-ft/yr. The system is bounded on the north and southeast by the Lindale Rural WSC and on the east by the City of Lindale. The System does have a water conservation plan. The System is projected to have a water supply surplus of 558 ac-ft/yr in 2020 decreasing to a deficit of 816 ac-ft/yr in 2070.

SUPPLY DEVELOPMENT

Below tables show the detail of water supply and demand analysis:

	2020	2030	2040	2050	2060	2070
Population	3026	3384	3812	4324	4950	5715
Projected Water Demand	945	1045	1175	1331	1522	1757
Current Water Supply	1376	1376	1376	1376	1376	1376
Projected Supply Surplus (+)/Deficit (-)	431	331	201	45	-146	-381

Neches River Basin:

	2020	2030	2040	2050	2060	2070
Population	1317	1657	2000	2372	2758	3166
Projected Water Demand	411	512	616	730	848	973
Current Water Supply	538	538	538	538	538	538
Projected Supply Surplus (+)/Deficit(-)	127	26	-78	-192	-310	-435

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could

reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Smith County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning Four alternative strategies were considered to meet the Crystal System's water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 140 gpcd threshold set by the planning group. Water reuse was not considered because the system does not have a sewer collection system. Surface water alternatives were omitted since there is not a supply source within close proximity to the system and surface water treatment is not economically feasible for a system of this size. Wells in the Carrizo-Wilcox Aquifer (Sabine and Neches River Basins) were identified as a potentially feasible strategy for the WUG.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Envr.* Impact
Advanced Water Conservation					
Water Reuse					
Groundwater (Sabine)	538	$ 2,531,000	$ 231,000	$ 429	1
Groundwater (Neches)	538	$ 2,531,000	$ 231,000	$ 429	1
Surface Water					

*Environmental Impact

Recommendations:

	2020	2030	2040	2050	2060	2070
Drill New Wells (Carrizo-Wilcox Aquifer, Sabine; ac-ft/yr)	0	0	135	135	269	538
Drill New Wells (Carrizo-Wilcox Aquifer, Neches; ac-ft/yr)	0	0	135	135	269	538

The recommended strategy for Crystal Systems to meet their projected deficit of 78 ac-ft/yr in 2040 and 816 ac-ft/yr in 2070 would be to construct four additional water wells similar to their existing wells just prior to each decade as the deficits occur. The recommended supply source will be the Carrizo Wilcox Aquifer in Smith County. Four wells with rated capacity of 500 gpm each would provide approximately 269 acre-feet each. The Carrizo Wilcox Aquifer in Smith County is projected to have a more than ample supply availability to meet the needs of Crystal Systems for the planning period. During the planning period two wells will be drilled in the Carrizo Wilcox formation of the Sabine River Basin while two wells will be drilled into the Carrizo Wilcox formation of the Neches River Basin.

Given the increasing costs to comply with more stringent regulations and the decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

PROJECT EVALUATION

This strategy benefits municipal water users in Smith County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Developing groundwater wells in Region D portion of Smith County will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for Crystal Systems to develop new groundwater wells was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 538 ac-ft/yr
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local sponsorship by Crystal Systems
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Region D.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 34. SMITH LINDATE

Water User Group Name:	**Smith County - Lindale**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**SMTH-LIN**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**25 - 696 ac-ft/yr (varies) (0.02 - 0.62 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020**
Project Capital Cost:	**$7,592,000 (September 2018)**
Annual Cost:	**$714,000**
Unit Water Cost (Rounded):	**$370 per ac-ft ($1.13 per 1,000 gallons)**

PROJECT DESCRIPTION

The City of Lindale is located in northern Smith County and serves the incorporated city limits and an area immediately northwest of the City of Lindale. The population is projected to increase from 5,806 persons in 2020 to 13,985 persons in 2070. The City is included as a WUG. in Smith County. The system's current water supply consists of four water wells from the Carrizo-Wilcox Aquifer. The total rated capacity of these wells is 2,320 GPM, or 1,247 ac-ft/yr. The system is bounded on the west, north, and east by the Lindale Rural WSC and on the south by the City of Tyler. The City does have a water conservation plan. The City of Lindale is projected to have a water supply deficit of 70 ac-ft/yr in 2020 increasing to a deficit of 1,833 ac-ft/yr in 2070. The Sabine River Basin is included in Region D and the Neches River Basin is included in Region I.

SUPPLY DEVELOPMENT

Below tables show the detail of water supply and demand analysis:

Sabine River Basin (Region D)	2020	2030	2040	2050	2060	2070
Population	3707	4499	5396	6107	7280	8674
Projected Water Demand	841	1005	1195	1347	1607	1910
Current Water Supply	796	779	773	756	762	773
Projected Supply Surplus (+)/Deficit(-)	-45	-226	-422	-591	-842	-1137

Neches River Basin (Region I)	2020	2030	2040	2050	2060	2070
Population	2099	2704	3311	3964	4629	5311
Projected Water Demand	476	604	733	875	1020	1170
Current Water Supply	451	468	474	491	485	474
Projected Supply Surplus (+)/Deficit(-)	-25	-136	-259	-384	-535	-696

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary

and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Smith County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

Four alternative strategies were considered to meet the City of Lindale's water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 140 gpcd threshold set by the planning group. Water reuse was not considered because the City does not have a demand for non-potable water. Surface water alternatives were omitted since there is not a supply source within close proximity to the City and surface water treatment is not economically feasible for a system of this size. Groundwater wells in the Carrizo-Wilcox Aquifer in the Neches Basin were identified as a potentially feasible strategy for the City.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Envr.* Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	1,932	$ 7,592,000	$ 714,000	$ 370	1
Surface Water					

***Environmental Impact**

Recommendations:

	2020	2030	2040	2050	2060	2070
Drill New Wells (Carrizo-Wilcox Aquifer, Neches; ac-ft/yr)	**322**	**644**	**966**	**1288**	**1610**	**1932**

The recommended strategy for the City of Lindale to meet their projected deficit of 70 ac-ft/yr in 2020 and 1,833 ac-ft/yr in 2070 would be to construct six additional water wells similar to their existing wells just prior to each decade as the deficits occur. The recommended supply source will be the Carrizo Wilcox Aquifer in Smith County. Six wells with rated capacity of 600 gpm each would provide approximately 322 acre-feet each. The Carrizo Wilcox Aquifer in Smith County (Neches River Basin) is projected to have a more than ample supply availability to meet the needs of the City of Lindale for the planning period.

Given the increasing costs to comply with more stringent regulations and the decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

PROJECT EVALUATION

This strategy benefits municipal water users in Smith County and is expected to have a positive impact on

their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Developing new groundwater wells in Smith County will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for Lindale to develop new groundwater wells was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 696 ac-ft/yr (Region I portion of Shortage)
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local Sponsorship by the City of Lindale
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Region D.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 35. SMITH OVERTON

Water User Group Name:	**Smith - Overton**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**SMTH-OVN**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**129 - 416 ac-ft/yr (varies) (0.11 - 0.37 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030 - 2070**
Project Capital Cost:	**$8,914,000 (September 2018)**
Annual Cost:	**$846,000**
Unit Water Cost (Rounded):	**$2,034 per ac-ft ($6.24 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for the City of Overton located in both Rusk and Smith Counties with Smith County being the primary county of the City. The strategy involves the development of new wells in the Carrizo Wilcox aquifer. Overton currently obtains most of its supply from Carrizo Wilcox. In addition to new wells, municipal conservation is another recommended strategy. Discussion on Conservation strategies is included in a separate technical memorandum. Overton has a small need starting in 2020 of approximately 70 ac-ft/yr, and this need increases to 416 ac-ft/yr by 2070. To meet this need, it is recommended that Overton continue to use supplies from Carrizo Wilcox by drilling additional wells. This strategy is a recommended strategy for Overton in Smith County and involves the development of two wells located within the Carrizo-Wilcox Aquifer as this aquifer has been identified as a potential source of water in Smith County. The wells will provide approximately 407 ac-ft/yr and are assumed to have a depth of 600 feet. A peaking factor of two was assumed for the well, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply.

SUPPLY DEVELOPMENT

The supply would be required for the entirety of the planning cycle. Currently, all of the existing needs are being met by supplies from the Carrizo Wilcox aquifer. There are sufficient supplies available in the Smith County Carrizo Wilcox to develop the supply needed for this water management strategy. It is assumed that the wells along with municipal conservation will provide sufficient ac-ft/yr to meet Overton's needs in Smith County providing a total yield required for the strategy. Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Smith County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 4 miles of pipeline, a pump station, and a terminal storage tank (0.09 million gallon). The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the yield generated by the infrastructure required.

WUG: Smith/Rusk County - Overton

WMS: Nacogdoches County - Carrizo Aquifer Wells

Supply	416	Ac-ft/yr	258	gpm
Depth to Water	300			
Well Depth	600			
Well Size	12	in		
Wells Needed	2			

Construction Costs	Number	Unit Cost	Total Cost
Water Wells	2	$461,866	$923,732
Connection to Transmission System	2	$50,000	$100,000
Engineering and Contingencies (30% for pipelines, 35% for other items)			$353,000
Subtotal of Well(s)			**$1,376,732**

Transmission System	Size	Quantity	Unit	Unit Cost	Total Cost
Pipeline - Rural	8 in.	21,120	LF	$40	$839,000
Pump Station	71 HP	1	EA	$3,844,000	$3,844,000
Ground Storage Tank	0.09 MG	1	EA	$429,605	$429,605
Easement - Rural		21,120	LF	$18	$424,600
Engineering and Contingencies (30% for pipelines, 35% for other items)					$1,747,000
Subtotal for Transmission		**4**	**miles**		**7,284,205**

Permitting and Mitigation			$132,000
Construction Total			**$8,793,000**
Interest During Construction	6	Months	$121,000
TOTAL CAPITAL COST			**$8,914,000**

ANNUAL COSTS	
Debt Service (3.5% for 20 years)	$627,000
Operational Costs*	$218,700
TOTAL ANNUAL COST	**$846,000**

UNIT COSTS (Until Amortized)	
Cost per ac-ft	$2,034
Cost per 1000 gallons	$6.24

UNIT COSTS (After Amortization)	
Cost per ac-ft	$526
Cost per 1000 gallons	$1.61

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits Overton in Smith County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Developing groundwater wells in Overton will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for Overton to develop new groundwater wells was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 416 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the East Texas Regional Water Planning Group (Region I).

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 36. SMITH R P M WSC

Water User Group Name:	**Smith County - R P M WSC**
Strategy Name:	**New wells in Carrizo-Wilcox Aquifer**
Strategy ID:	**PRM_WSC**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**2 - 17 ac-ft/yr (varies) (0.01 - 0.02 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$3,469,000 (September 2018)**
Annual Cost:	**$428,000**
Unit Water Cost (Rounded):	**$1,972 per ac-ft ($6.05 per 1,000 gallons)**

PROJECT DESCRIPTION

R P M WSC provides water service in Van Zandt, Henderson, and Smith Counties. The WUG population is projected to be 2,957 by 2020 and increases to 5,530 by 2070. R P M WSC supplies its customers with groundwater from the Carrizo-Wilcox and Queen City aquifers with five water wells in Van Zandt County. R P M WSC is projected to have a total deficit of 34 ac-ft/yr in 2030 increasing to a deficit of 217 ac-ft/yr by 2070; the shortage projected to occur in Van Zandt County is 25 ac-ft/yr in 2030 increasing to 152 ac-ft/yr by 2070. The shortage in Henderson County is 7 ac-ft/yr in 2030, increasing to 48 ac-ft/yr in 2070. Shortages in Smith County range from 2 ac-ft/yr in 2030 up to 17 ac-ft/yr in 2070.

SUPPLY DEVELOPMENT

Below tables show the detail of water supply and demand analysis:

RPM WSC	2020	2030	2040	2050	2060	2070
Population	2,957	3,602	4,112	4,653	5,116	5,530
Projected Water Demand	323	378	423	475	519	561
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	344	344	344	344	344	344
Projected Supply Surplus (+) / Deficit (-)	21	-34	-79	-131	-175	-217

Neches River Basin

Projected Supply Surplus (+) / Deficit (-) by County	2020	2030	2040	2050	2060	2070
Van Zandt	14	-25	-58	-93	-124	-152
Henderson	5	-7	-16	-27	-38	-48
Smith	2	-2	-5	-11	-13	-17
Total	21	-34	-79	-131	-175	-217

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water

in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. There are no bays or estuaries in close proximity of Smith County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

Four alternative strategies were considered to meet the WSC's water supply shortages as summarized in the following table. Advanced conservation was not selected because the per capita use per day was less than the 140 gpcd threshold set by the water planning group. Water reuse was not considered because the WSC does not have a demand for non-potable water. Surface water was not considered because the WSC does not currently have surface water treatment. Groundwater has been identified as a potential strategy for R P M WSC.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Envr.* Impact
Demand Reduction					
Water Reuse					
Drill New Wells (Carrizo-Wilcox Aquifer, Neches Basin)	217	$3,469,000	$428,000	$1,972	1
Drill New Wells (Queen City Aquifer, Neches Basin)					

***Environmental Impact**

Recommendations:

	2020	2030	2040	2050	2060	2070
Drill New Wells (Carrizo-Wilcox, Neches Basin; ac-ft/yr)	0	34	79	131	175	217

The recommended strategy for R P M WSC to meet their projected deficit of 34 ac-ft/yr in 2030 and 217 ac-ft/yr in 2070 would be to construct nine additional water wells similar to their existing wells just prior to each decade as the deficits occur. The recommended supply source will be the Carrizo-Wilcox Aquifer in the Neches Basin in Van Zandt County. Nine wells with rated capacity of 50 gpm each, pumping at an approximately depth of 560 ft., would provide approximately 27 acre-feet each.

PROJECT EVALUATION

This strategy benefits municipal water users in Smith County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. Developing supplies in Smith County will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for R P M WSC to develop new groundwater wells was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 217 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local sponsorship by R P M WSC
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Region D

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 37. SMITH WHITEHOUSE

Water User Group Name:	**Smith County - Whitehouse**
Strategy Name:	**Purchase from City of Tyler (Lake Palestine/Lake Tyler/Carrizo-Wilcox)**
Strategy ID:	**SMTH-WTH**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**39 - 257 ac-ft/yr (varies) (0.03 - 0.23 MGD)**
Implementation Decade:	**2060**
Development Timeline:	**2060 - 2070**
Project Capital Cost:	**$7,666,000 (September 2018)**
Annual Cost:	**$737,000**
Unit Water Cost (Rounded):	**$2,868 per ac-ft ($8.80 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Whitehouse in Smith County and involves a contract between Whitehouse and the City of Tyler for raw water. The cost for supply from the City of Tyler includes the cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the City of Tyler and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water need projected for Whitehouse in Smith County projected by the East Texas Regional Planning Group during the planning period (2020-2070). The quantity of supply from this strategy represents a contract of 39 ac-ft/yr in 2060, increasing to 257 ac-ft/yr in 2070. The reliability of this water supply is considered high due to the availability of water in City of Tyler's sources of supply. City of Tyler owns Lake Tyler and has a contract for water from Lake Palestine. In addition to this, the City also has groundwater supplies in the Smith County Carrizo Wilcox. City of Tyler will decide the appropriate source of supply that is in close proximity to the water user location. However, this strategy is dependent on coordination with the City of Tyler.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between Whitehouse and the City of Tyler should have a minimal impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries within Smith County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed seven miles of pipeline (the approximate distance from the City of Tyler supplies to Whitehouse's

service area in Smith County), a pump station with an intake, and a terminal storage tank (0.05 million gallon). The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the yield generated by the infrastructure required.

WUG:	**Smith County - Whitehouse**				
STRATEGY:	**Purchase from City of Tyler**				
Quantity:	**257** AF/Y		0.34	MGD	
CAPITAL COSTS					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	6 in.	36,960	LF	$25	$939,000
Right of Way Easements Rural (ROW)		36,960	LF	$18	$675,500
Land and Surveying (10%)					$68,000
Engineering and Contingencies (30%)					$282,000
Subtotal of Pipeline					**$1,964,500**
Pump Station(s)					
Pump with intake	25 HP	1	LS	$3,087,000	$3,087,000
Booster Pump Station	0 HP	1	LS	$0	$0
Engineering and Contingencies (35%)					$1,080,000
Subtotal of Pump Station(s)					**$4,167,000**
Storage Tank(s)					
Storage Tank	0.05 MG	1	LS	$834,000	$834,000
Engineering and Contingencies (35%)					$292,000
Subtotal of Storage Tank(s)					**$1,126,000**
Permitting and Mitigation					$203,000
Construction Total					**$7,460,500**
Interest During Construction			12	Months	$205,000
TOTAL COST					**$7,666,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$539,000
Operational Costs*					$198,000
TOTAL ANNUAL COST					**$737,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$2,868
Per 1,000 Gallons					$8.80
UNIT COSTS (After Amortization)					
Per Acre-Foot					$798
Per 1,000 Gallons					$2.45

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits Whitehouse in Smith County and is expected to have a positive impact on their water supply security. City of Tyler's supplies provide relief to the Carrizo Wilcox aquifer as more entities switch from groundwater to purchase water from City of Tyler. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the City of Tyler's supplies will reduce demands on other water supplies in Smith and Anderson Counties and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the recommended strategy for Whitehouse to purchase water from the City of Tyler was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 257 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by the City of Whitehouse
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with City of Tyler.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 38. SMITH MANUFACTURING

Water User Group Name:	**Smith Manufacturing**
Strategy Name:	**Purchase from City of Tyler (Lake Palestine/Lake Tyler/Carrizo-Wilcox)**
Strategy ID:	**SMTH-MFG**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**84 ac-ft/yr (0.08 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030**
Project Capital Cost:	**$6,198,000 (September 2018)**
Annual Cost:	**$545,000**
Unit Water Cost (Rounded):	**$6,488 per ac-ft ($19.91 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Manufacturing in Smith County and involves a contract between individual manufacturing water users and the City of Tyler for raw water. City of Tyler already supplies to most of the manufacturing users in the Smith County so in some cases, it might just be an extension of the contract with current customers. This strategy will serve both the East Texas Region and North East Texas Region (Region D) manufacturing demand in Smith County. The cost for supply from the City of Tyler includes the contractual cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the City of Tyler and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water need projected for manufacturing in Smith County projected by the East Texas Regional Planning Group during the planning period (2020-2070). The quantity of supply from this strategy represents a contract of 84 ac-ft/yr in 2030 continuing throughout the planning cycle to 2070. The reliability of this water supply is considered high due to the availability of water in City of Tyler's sources of supply. City of Tyler owns Lake Tyler and has contract for water from Lake Palestine. In addition to this, the City also has groundwater supplies in the Smith County Carrizo Wilcox. City of Tyler will decide the appropriate source of supply that is in close proximity to the water user location. However, this strategy is dependent on coordination with the City of Tyler. Depending on the source of supply City of Tyler choses for this water user, this strategy may be dependent on the completion of Tyler's construction of transmission system to access the full amount of Lake Palestine supplies. This is a recommended water management strategy for City of Tyler in 2021 Regional Water Plan.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be temporary and minimal. In addition, a contract between manufacturing water users in Smith County and the City of Tyler should have a minimal impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries within Smith County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed seven miles of pipeline (the approximate distance from the City of Tyler supplies to center of Smith County), a pump station with an intake, and a terminal storage tank (0.05 million gallon). The annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the yield generated by the infrastructure required.

WUG:	**Smith County – Manufacturing**				
STRATEGY:	**Purchase from City of Tyler**				
Quantity:	**84** AF/Y			0.11	MGD
CAPITAL COSTS					
Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	6 in.	36,960	LF	$25	$939,000
Right of Way Easements Rural (ROW)		36,960	LF	$18	$675,500
Land and Surveying (10%)					$68,000
Engineering and Contingencies (30%)					$282,000
Subtotal of Pipeline					**$1,964,500**
Pump Station(s)					
Pump with intake	5 HP	1	LS	$2,028,000	$2,028,000
Booster Pump Station	0 HP	1	LS	$0	$0
Engineering and Contingencies (35%)					$710,000
Subtotal of Pump Station(s)					**$2,738,000**
Storage Tank(s)					
Storage Tank	0.05 MG	1	LS	$834,000	$834,000
Engineering and Contingencies (35%)					$292,000
Subtotal of Storage Tank(s)					**$1,126,000**
Permitting and Mitigation					$203,000
Construction Total					**$6,031,500**
Interest During Construction			12	Months	$166,000
TOTAL COST					**$6,198,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$436,000
Operational Costs*					$109,000
TOTAL ANNUAL COST					**$545,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$6,488
Per 1,000 Gallons					$19.91

UNIT COSTS (After Amortization)

Per Acre-Foot	$1,310
Per 1,000 Gallons	$4.02

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits manufacturing water users in Smith County and is expected to have a positive impact on their water supply security. Since Tyler is already supplying to Smith County's manufacturing demands, it would be easy to set up contracts with City of Tyler. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the City of Tyler's supplies will reduce demands on other water supplies in Smith and Anderson Counties and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the Smith County Manufacturing recommended strategy to purchase water from the City of Tyler was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 84 ac-ft/yr
Reliability	4	Medium to High
Cost	1	>$5,000/ac-ft (High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	1	No sponsor readily identifiable
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with City of Tyler.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 39. ANRA LAKE COLUMBIA

Project Name:	**Lake Columbia**
Project ID:	**ANRA-COL**
Project Type:	**New Surface Water Source**
Potential Supply Quantity (Rounded):	**75,400 - 75,720 ac-ft/yr (varies) (67.3 - 67.6 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**5-10 years**
Project Capital Cost:	**$402,862,000 (September 2018)**
Annual Cost:	**$23,509,000**
Unit Water Cost (Rounded):	**$311 per ac-ft ($0.95 per 1,000 gallons)**

PROJECT DESCRIPTION

Angelina Neches River Authority is the sponsor for the Lake Columbia project on Mud Creek in Cherokee and Rusk Counties. Lake Columbia is a recommended strategy in this round of planning. Angelina Neches River Authority has been granted a water right permit (Permit No. 4228) by the TCEQ to impound 195,500 ac-ft/yr and to divert 85,507 ac-ft/yr (76.3 MGD) for municipal and industrial purposes. Angelina Neches River Authority currently has contracted with customers for 53 percent of the 85,507 ac-ft/yr permit of the proposed Lake Columbia reservoir. The City of Dallas is also considering Lake Columbia as a recommended strategy. After considering the local needs in the East Texas Region, Dallas' projected share of the proposed Lake Columbia project is 56,000 ac-ft/yr by 2070. This water management strategy for Angelina Neches River Authority was developed to address the total current contracted and potential future customer demand through the construction of Lake Columbia. Angelina Neches River Authority holds the water right for the supply source and will be the project sponsor. It was specified in the 2014 Draft Dallas Long Range Supply Plan that Dallas will be responsible for 70 percent of the dam, reservoir land acquisition, and relocations, and Angelina Neches River Authority will be responsible for the remaining 30 percent of the reservoir construction and land acquisitions costs. This cost split is subject to change during the potential negotiations between Dallas and Angelina Neches River Authority. The Lake Columbia dam site is located two to three miles downstream of Highway 79 on Mud Creek in Cherokee County. The contributing drainage area for the reservoir is approximately 384 square miles. The total conservation pool volume is 195,500 ac-ft/yr and the top of conservation pool is at the elevation of 315 ft MSL. The conservation pool covers an area of approximately 10,133 acres and the flood pool covers an additional area of 1,367 acres.

CURRENT CONTRACTED AND POTENTIAL CUSTOMERS

Angelina Neches River Authority has contracts with several customers in East Texas Regional Planning Area. The water suppliers currently under contract with Angelina Neches River Authority are listed below along with the current participation percentage. Also included below is a table showing the potential future customers for Angelina Neches River Authority and their corresponding demands. The contract amounts are based on the full permitted diversion. The development of infrastructure to deliver the water to the end users is discussed in separate strategies.

Customers for Lake Columbia				
Recipient	**County**	**Basin**	**Percent Participation in Columbia**	**Contract Amount (ac-ft/yr)**
Current Contracted Customers				
Afton Grove WSC, Stryker Lake WSC	Cherokee	Neches	4.5%	3,848
Jacksonville	Cherokee	Neches	5.0%	4,275
New Summerfield	Cherokee	Neches	3.0%	2,565
North Cherokee WSC	Cherokee	Neches	5.0%	4,275
Rusk	Cherokee	Neches	5.0%	4,275
Rusk Rural WSC	Cherokee	Neches	1.0%	855
City of Alto	Cherokee	Neches	0.5%	428
Caro WSC	Nacogdoches	Neches	0.5%	428
Nacogdoches	Nacogdoches	Neches	10.0%	8,551
New London	Rusk	Sabine	1.0%	855
Troup	Smith	Neches	5.0%	4,275
Arp	Smith	Neches	0.5%	428
Blackjack WSC	Smith	Neches	1.0%	855
Jackson WSC	Smith	Neches	1.0%	855
Whitehouse	Smith	Neches	10.0%	8,551
Additional Customers for Lake Columbia				
City of Dallas		Trinity		56,050

Recipient	2020	2030	2040	2050	2060	2070
Holmwood Utility	65	70	70	70	70	70
Steam Electric Demand – Cherokee	8,000	15,000	20,000	20,000	20,000	20,000
Manufacturing – Rusk County Refinery	5,600	5,600	5,600	5,600	5,600	5,600
Mining - Angelina	474	573	398	300	225	168
Mining - Cherokee	238	247	210	147	84	40
Mining - Nacogdoches	5,475	2,975	118	0	0	0
Mining – San Augustine	2,102	1,102	0	0	0	0
Mining – Rusk	1,075	2,092	1,955	1,809	1,686	1,677
Total Future Customer Demand	**23,028**	**27,658**	**28,350**	**27,926**	**27,665**	**27,555**

SUPPLY DEVELOPMENT

Firm yield for Lake Columbia was determined by means of the water availability analysis using the Neches Basin Water Availability Model (WAM). This model was downloaded from TCEQ website in 2009. The firm yield of the Lake was estimated to be 75,720 ac-ft/yr in 2030 and reducing to 75,400 ac-ft/yr in 2070. It should be noted that the water management strategies for the reservoir development and the transmission connections were all based on the firm supplies available from Lake Columbia.

ENVIRONMENTAL CONSIDERATIONS

The summary of environmental considerations was developed based on the known environmental factors that have been discussed in the Draft Environmental Impact Study (DEIS).

Habitat – The footprint of Lake Columbia will impact approximately 5,746.5 acres of waters of the U.S., including 3,689 acres of forested wetlands and the remainder comprised of shrub and emergent wetlands (144 and 1,518 acres, respectively), open water, streams and a hillside bog.

Environmental Flows – The current TCEQ Permit No. 4228 allowing the construction and operation of Lake Columbia does not require any instream flow releases. However, if Dallas wants to move water from Lake Columbia in Neches Basin to Trinity River Basin, an amendment to the Permit is required to allow interbasin transfers. Amendments to the Permit may be subject to recently adopted instream flow standards.

Bays and Estuaries – Lake Columbia project is over 280 river miles upstream from the Neches estuary at Sabine Lake and is therefore expected to have no measurable effect on the freshwater inflows into Sabine Lake and Sabine Lake estuary. Recognizing the diminishing effect of upstream distance on bay and estuary inflows, the Texas Water Code (Section 11.147) requires consideration of such effects only if a proposed project is within 200 river miles of the coast.

Threatened and Endangered Species - The Lake Columbia project area includes six federally listed species, five of which are also listed by the state. The state lists fourteen additional species within Smith and Cherokee Counties where the lake would be developed.

Environmental Factors	Level of Concern
Habitat	High
Environmental Water Needs	Medium Impact
Bay and Estuaries	Low Impact
Threatened and Endangered Species	Low Impact
Wetlands	High (5,351.5 acres of wetlands)

PERMITTING AND DEVELOPMENT

Angelina Neches River Authority has a water right for Lake Columbia and is currently seeking a 404 permit for construction. A draft environmental impact study (DEIS) has been prepared for Lake Columbia by the USACE. The DEIS was published on January 29, 2010 and public and agency comments were provided on March 30, 2010. Currently, the Lake Columbia project is subject to completion of the EIS and issuance of a 404 permit from the United States Army Corps of Engineers (USACE).

Lake Columbia is in the permitting phase, and has contracts with several local participants. According to Angelina Neches River Authority, the participants have the right of first refusal to contract for water in the next phase of the project. The Texas Water Development Board is a 47% participant and has the right of refusal for 35.9 MGD (40,188 ac-ft/yr) of supply. Process for water contracts will be initiated after the issuance of the Section 404 permit from the USACE.

If Dallas were to participate in the Lake Columbia project, the current permit no. 4228 has to be amended for an interbasin transfer from the Neches to the Trinity basin. There is a potential that the authorized diversions from Lake Columbia project may be subject to some reductions due to the environmental flow standards that may be applied during the amendment process.

Permit	Regulatory Entity	Potential Challenges
Water Right Permit Amendment	TCEQ	May require interbasin transfer authorization for Dallas to transfer water from Neches to Trinity basin.
404	USACE	Required to proceed with construction in waters of the US.

PLANNING LEVEL OPINION OF COST

Both Angelina Neches River Authority and participating entities will share in the costs associated with the Lake Columbia water management strategy. Construction costs are divided into three separate categories: reservoir, water treatment plant and transmission system. A planning level opinion of cost (PLOC) for the construction of the reservoir is included below. A planning level opinion of cost (PLOC) for the water treatment plant and distribution system is included in a separate Tech Memo. For reservoir construction, unit costs are based on the WAM Run 3 yield estimate of 75,720 ac-ft/yr. The detailed cost estimate below represents the total cost for the construction of the project. It was noted in the Dallas Long Range Supply Plan that Dallas will bear responsibility for 70 percent of reservoir construction and relocation costs and Angelina Neches River Authority will be responsible for the remaining 30 percent. However, the actual percent distribution of the project cost will be determined based on the future negotiations between Angelina Neches River Authority and other participants. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP NAME: ANRA
STRATEGY: Lake Columbia
AMOUNT (ac-ft/yr): 75,720

Dam	**Cost**
Embankment	$32,037,700
Internal Drainage	$769,107
Slope Protection & Crest Roadway	$5,411,955
Service Spillway	$7,476,287
Outlet Works	$1,532,309
Instrumentation	$812,378
Miscellaneous Items	$6,226,744
Engineering	$8,856,606
Contingencies	$10,853,320
Sub Total for Dam	**$73,976,406**
Transportation Conflicts	
Roads	$3,850,237
Highways	$42,063,937
Railroads	$35,612,042
Erosion Protection	$5,183,911
Engineering	$13,603,352
Contingencies	$17,341,977
Subtotal for Transportation Conflicts	**$117,655,457**
Utility Conflicts	
Communications	$3,158,631
Electric Utilities	$18,945,279
Oil and Gas	$4,735,054
Water Utilities	$199,961
Engineering	$81,117
Contingencies	$5,407,737
Subtotal for Utility Conflicts	**$32,527,778**
Project Site Acquisition	
Property Purchase	$28,698,031
Conservation Easement	$2,079,519

Survey and Appraisal	$1,627,287
Professional Fees	$944,721
Engineering	$1,024,994
Contingencies	$6,669,936
Sub Total for Project Site Acquisition	**$41,044,488**
Mitigation	
Mitigation	$107,357,398
Contingencies	$9,098,150
Sub Total for Mitigation	**$116,455,548**
Cultural Resources	
Archeological/Historical Resources	$17,379,101
Engineering	$347,611
Contingencies	$3,475,868
Sub Total for Cultural Resources	**$21,202,580**
TOTAL CONSTRUCTION COST	**$402,862,000**
ANNUAL COSTS	
Debt Service for Reservoirs (3.5% for 40 years)	$11,832,272
Debt Service for Relocations (3.5% for 20 years)	$10,567,054
Operation & Maintenance	$1,109,600
TOTAL ANNUAL COST	**$23,509,000**
UNIT COSTS (Until Amortized)	
Per Acre-Foot of treated water	$311
Per 1,000 Gallons	$0.95
UNIT COSTS (After Amortization)	
Per Acre-Foot	$14.7
Per 1,000 Gallons	$0.04

PROJECT EVALUATION

Based on the analysis provided above, the Lake Columbia Reservoir Construction project was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 75,720 ac-ft/yr
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	3	Low Negative Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	3	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		Yes, if Dallas uses the Supplies
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by ANRA
Implementation Issues	3	Low Implementation Issues. Contract with City of Dallas

REFERENCES

October 2014 Draft Dallas Long Range Water Supply Plan.

2016 East Texas Regional Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 40. ANRA WATER TREATMENT PLANT

Project Name:	**ANRA Treatment Plant and Distribution System**
Project ID:	**ANRA-WTP**
Project Type:	**Existing Surface Water Source**
Potential Supply Quantity (Rounded):	**0 ac-ft/yr (0 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**5 years**
Project Capital Cost:	**$228,001,000 (September 2018)**
Project Annual Cost:	**$49,839,000**
Unit Water Cost (Rounded):	**$2,242 per ac-ft (during loan period) $6.88 per 1,000 gallons**

PROJECT DESCRIPTION

Angelina Nacogdoches River Authority is the sponsor for the Lake Columbia project on Mud Creek in Cherokee and Rusk Counties. Lake Columbia is a recommended strategy in this round of regional water planning. Angelina Neches River Authority has been granted a water right permit (Permit No. 4228) by the TCEQ to impound 195,500 ac-ft/yr and to divert 85,507 ac-ft/yr (76.3 MGD) for municipal and industrial purposes. Angelina Neches River Authority currently has contracted customers for 53 percent of the 85,507 ac-ft/yr permit of the proposed Lake Columbia reservoir. This water management strategy for Angelina Neches River Authority was developed to address the current contracted demand for the customers receiving treated water from this wholesale provider.

Angelina Neches River Authority has contracts with several customers in East Texas Regional Planning Area. The water suppliers currently under contract with Angelina Neches River Authority are listed in Table below along with the current participation percentage. It is assumed that Afton Grove WSC, Stryker Lake WSC, New Summerfield, and all municipal customers in Smith County will purchase treated water from Angelina Neches River Authority. Therefore, a recommended water management strategy for Angelina Neches River Authority is to construct a Water Treatment Plant and the distribution system to supply treated water to these customers. Transmission system costs are shared among the contracted suppliers that receive treated water.

SUPPLY DEVELOPMENT

The cities of Nacogdoches, Jacksonville, and Rusk are assumed to purchase raw water from Lake Columbia and develop their own raw water transmission and treatment facilities. Most of the municipal water users (and current customers of Angelina Neches River Authority) in Cherokee, Rusk, and Smith Counties will be purchasing treated water from Angelina Neches River Authority. Costs for water treatment and transmission system are shared among currently contracted entities that are assumed to buy treated water from Angelina Neches River Authority. This project will not provide any additional raw water, and therefore, has a supply of 0 ac-ft/yr. Instead, the strategy will provide treatment capacity for 22,232 ac-ft/yr of raw water from Lake Columbia.

STRATEGY DESCRIPTION

The purpose of this water management strategy is to develop a treatment facility to treat the supplies delivered to potential municipal customers purchasing treated water from Angelina Neches River Authority. The municipal customers are Stryker WSC, Afton Grove WSC, Jackson WSC, Blackjack WSC, City of New Summerfield, City of New London, City of Troup, City of Arp, and City of Whitehouse.

ENVIRONMENTAL CONSIDERATIONS

There are no significant environmental considerations associated with the treatment plant construction and the transmission system strategy.

PERMITTING AND DEVELOPMENT

There are no permitting issues associated with the construction of the water treatment facilities and the transmission facilities.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for the water treatment plant and distribution system is included below. Construction costs include the construction of water treatment plant, pipeline segments, pump station and storage tank to deliver the supplies. The annual costs were estimated assuming 3.5% interest rate over a period of 20 years. The planning level opinion of probable construction cost estimates also include cost of purchase of raw water and treated water from Angelina Neches River Authority. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP NAME: **ANRA**
STRATEGY: **Regional Water Treatment Facilities**
Quantity: **22,232 AF/Y** 30 MGD Peak

CONSTRUCTION COSTS

Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Segment A: WTP to Troup	30 in.	57,771	LF	$197	$11,374,000
Segment B: Troup to Arp	12 in.	36,610	LF	$68	$2,500,000
Segment C: Troup to Whitehouse & Jackson WSC	24 in.	40,879	LF	$154	$6,296,000
Segment D: Arp to New London & Blackjack WSC	8 in.	42,398	LF	$40	$1,683,000
Segment E: WTP to New Summerfield	18 in.	1,916	LF	$111	$213,000
Pipeline Segments Subtotal					$22,066,000
Right of Way Easements Rural (ROW)		179,573	LF	$30	$5,391,500
Land and Surveying (10%)					$539,150
Engineering and Contingencies (30%)					$6,620,000
Subtotal of Pipeline					**$34,616,650**
Pump Station(s)					
Pump with intake & building	3157 HP	2	LS	$37,283,000	$74,566,000
Engineering and Contingencies (35%)					$26,098,100
Subtotal of Pump Station(s)					**$100,664,100**
Water Treatment Plant	30 MGD	1	LS	$61,736,000	$61,736,000
Storage Tanks	3.7 MG	1	LS	$1,715,865	$1,716,000
Engineering and Contingencies (35%)					$22,208,200
Subtotal					**$85,660,200**

Permitting and Mitigation			$957,746
Construction Total			**$221,898,696**
Interest During Construction	12 Months		$6,102,000
TOTAL COST			**$228,001,000**

ANNUAL COSTS			
Debt Service (3.5% for 20 years)			$16,042,000
Electricity ($0.08 kWh)			$1,149,000
Operational Costs*			$33,797,300
Raw Water Purchase	1000 gal	$1.00	$7,244,000
Treatment	1000 gal	$3.00	$21,733,000
TOTAL ANNUAL COST			**$49,839,000**

UNIT COSTS (Until Amortized)	
Per Acre-Foot of treated water	$2,242
Per 1,000 Gallons	$6.88

UNIT COSTS (After Amortization)	
Per Acre-Foot	$1,520
Per 1,000 Gallons	$4.67

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

Based on the analysis provided above, the Angelina Neches River Authority Regional Water Treatment Facilities project was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. Enables usage of 22,232 ac-ft/yr of raw water from Lake Columbia
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by ANRA
Implementation Issues	3	Low Implementation Issues. Dependent on Lake Columbia Construction

REFERENCES

2016 East Texas Regional Plan

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 41. ANRA GROUNDWATER WELLS

Project Name:	**ANRA Groundwater Wells**
Project ID:	**ANRA-GW**
Project Type:	**New Groundwater Source**
Potential Supply Quantity (Rounded):	**4,500 - 5,600 ac-ft/yr (4 - 5 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**3 years**
Project Capital Cost:	**$29,775,000 (September 2018)**
Annual Cost:	**$3,185,000**
Unit Water Cost (Rounded):	**$569 per ac-ft ($1.75 per 1,000 gallons)**

PROJECT DESCRIPTION

Angelina Neches River Authority will plan to develop groundwater wells in Cherokee and Rusk counties to supply water to manufacturing demand in Rusk County. Angelina Neches River Authority will develop approximately 5,600 ac-ft/yr. The supply will reduce to 4,500 ac-ft/yr by 2070 due to lack of water availability in the Carrizo-Wilcox Aquifer.

SUPPLY DEVELOPMENT

The supply for this strategy comes from Carrizo Wilcox aquifer in Cherokee and Rusk counties. Based on the supplies reported in the Modeled Available Groundwater (MAG) reports, there are sufficient groundwater supplies available in Cherokee and Rusk counties for this strategy. It was noted that developing this strategy will not result in over allocation of groundwater supplies in those counties.

ENVIRONMENTAL CONSIDERATIONS

There are no significant environmental considerations associated with the treatment plant construction and the transmission system strategy.

PERMITTING AND DEVELOPMENT

There are no permitting issues associated with the construction of the water treatment facilities and the transmission facilities.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for the constructing new wells, transmission system and storage is included below. The annual costs were estimated assuming 3.5% interest rate over a period of 20 years. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP: ANRA - New Ground Water Wells
WMS: New Wells in Cherokee and Rusk Counties

Supply	5,600	Ac-ft/yr	3,472	gpm
Depth to Water	300	ft		
Well Depth	1,000	ft		
Well Yield	200	gpm		
Well Size	12	in		

Construction Costs	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Water Wells	18	EA	$559,437	$10,069,861
Connection to Transmission System	18	EA	$50,000	$900,000
Engineering and Contingencies (30% for pipelines, 35% for other items)				$3,794,000
Subtotal of Well(s)				**$14,763,861**

Transmission System	**Size**	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**
Pipeline - Rural	24 in.	26,400	LF	$154	$4,066,000
Pump Station	890 HP	1	EA	$5,450,000	$5,450,000
Ground Storage Tank	0.63 MG	1	EA	$630,505	$630,505
Easement - Rural		26,400	LF	$18	$482,500
Land and Surveying Rural (10%)					$48,250
Engineering and Contingencies (30% for pipelines, 35% for other items)					$3,348,000
Subtotal for Transmission		**5**	**miles**		**14,025,255**

Permitting and Mitigation				$189,000
Construction Total				**$28,978,116**
Interest During Construction	12	Months		$797,000
TOTAL CAPITAL COST				**$29,775,000**

ANNUAL COSTS	
Debt Service (3.5% for 20 years)	$2,095,000
Operational Costs*	$1,090,490
TOTAL ANNUAL COST	**$3,185,000**

UNIT COSTS (Until Amortized)	
Cost per ac-ft	$569
Cost per 1000 gallons	$1.75

UNIT COSTS (After Amortization)	
Cost per ac-ft	$195
Cost per 1000 gallons	$0.60

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

Based on the analysis provided above, the ANRA Groundwater Wells project was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 5,600 ac-ft/yr
Reliability	3	Medium
Cost	3	
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local Sponsorship by ANRA
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Angelina Neches River Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 42. ANRA RUN-OF-RIVER SUPPLIES

Project Name:	**ANRA Run-of-River Supplies**
Project ID:	**ANRA-ROR**
Project Type:	**New Surface Water Source**
Potential Supply Quantity (Rounded):	**30,000 ac-ft/yr (27 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**5 years**
Project Capital Cost:	**N/A**
Annual Cost:	**N/A**
Unit Water Cost (Rounded):	**N/A**

PROJECT DESCRIPTION

Angelina Neches River Authority has been approached to supply water for mining purposes Angelina, Cherokee, Nacogdoches, Shelby, San Augustine, Rusk, and Sabine counties. The mining demand will be met with run-of-the-river diversions. Additional potential customer are the steam electric power plant owners in Cherokee county. Angelina Neches River Authority has already applied for 10,000 ac-ft/yr of run-of-the-river supplies from Mud Creek in Cherokee County. The application process for this permit is administratively complete. Angelina Neches River Authority is planning to apply for additional 20,000 ac-ft/yr of run-of-the-river supplies in Cherokee County for a total project supply of 30,000 ac-ft/yr for ANRA. With the additional supplies from these two sources, Angelina Neches River Authority can meet the mining and steam electric power customer demand. A table summarizing the potential demands for these customers is provided below.

Recipient	2020	2030	2040	2050	2060	2070
Holmwood Utility	65	70	70	70	70	70
Steam Electric Demand – Cherokee	8,000	15,000	20,000	20,000	20,000	20,000
Manufacturing – Rusk County Refinery	5,600	5,600	5,600	5,600	5,600	5,600
Mining – Angelina	474	573	398	300	225	168
Mining – Cherokee	238	247	210	147	84	40
Mining – Nacogdoches	5,474	2,975	118	0	0	0
Mining – San Augustine	2,102	1,102	0	0	0	0
Mining – Rusk	1,075	2,092	1,955	1,809	1,686	1,677
Total Future Customer Demand	23,028	27,659	28,351	27,926	27,665	27,555

SUPPLY DEVELOPMENT

The supply for this strategy comes from run-of-the-river supplies in Cherokee County. Angelina Neches River Authority will submit a permit application to TCEQ for the new run-of-river supplies of 20,000 ac-ft/yr and will monitor the application status for the current permit for run-of-river supplies of 10,000 ac-ft/yr.

ENVIRONMENTAL CONSIDERATIONS

The environmental flow rules for Neches basin may impact the supply available to Angelina Neches River Authority for the run-of-river water rights. Other than the process required to complete the application

process, there are no significant environmental considerations for this strategy. Environmental flow needs were considered for in calculation of the supply yield through the use of the TCEQ WAM Run 3 scenario, which includes Senate Bill 3 environmental flow criteria.

PERMITTING AND DEVELOPMENT

Angelina Neches River Authority will apply for a water right permit for the new run-of-river supplies in Cherokee County. The permitting process is dependent on the TCEQ guidelines for granting run-of-river application requests

PLANNING LEVEL OPINION OF COST

Other than the planning levels costs and the lawyer fees for tracking the permit applications, there are not additional costs involved with this strategy. It is assumed that the customers contracted for this supply will develop the infrastructure to access the supplies from the run-of-river supply source in Cherokee County.

PROJECT EVALUATION

Based on the analysis provided above, the Angelina Neches River Authority Run-of-River Supplies project was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 30,000 ac-ft/yr (Permit Application for 10,000 ac-ft/yr already administratively complete, 20,000 ac-ft/yr new run-of-river supplies)
Reliability	3	Medium
Cost	5	No Cost (Other than Administrative and Lawyer Fees)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by ANRA
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 43. AN WCID#1 HYDRAULIC DREDGING

Project Name:	**Hydraulic Dredging (Volumetric Survey and Normal Pool Elevation Adjustment)**
Project ID:	**ANCD-VOL**
Project Type:	**Existing Surface Water Source**
Potential Supply Quantity (Rounded):	**5,600 ac-ft/yr (5 MGD)**
Implementation Decade:	**2040**
Development Timeline:	**5 years**
Project Capital Cost:	**$23,716,000**
Unit Water Cost (Rounded):	**$476 per ac-ft $1.46 per 1,000 gal**

PROJECT DESCRIPTION

Internal studies conducted by Angelina Nacogdoches WCID #1 resulted in higher yield estimates for Lake Striker than those obtained from the Water Availability Model. Angelina Nacogdoches WCID #1 believes that the additional yield in Lake Striker is sufficient to meet the shortages manifested for this entity in this planning cycle. To address this inconsistency, Angelina Nacogdoches WCID #1 is considering a recommended strategy to conduct volumetric survey of Lake Striker to determine the Lake yield. Angelina Nacogdoches WCID #1 will coordinate with TWDB to get on a schedule for the lake volumetric survey. Angelina Nacogdoches WCID #1 believes that the volumetric survey will result in an additional yield that will address shortages in the first two decades. To address the shortages in the later decades, a recommended strategy was proposed. The strategy is to work with the Texas Water Development Board on the Normal Pool Elevation Adjustment of Lake Striker. The timing for the volumetric surveys and potential normal pool elevation adjustment is 2040.

SUPPLY DEVELOPMENT

At this time, it is not known how much (if any) additional yield will be realized from the normal pool elevation adjustment but for planning purposes it is assumed to be 5,600 ac-ft/yr.

ENVIRONMENTAL CONSIDERATIONS

No known environmental considerations at this time but these would be studied in further details during the volumetric survey process.

PERMITTING AND DEVELOPMENT

The process for volumetric survey and adjusting of the normal pool elevation may require some significant coordination with the Texas Water Development Board and Texas Council on Environmental Quality on permitting and development issues.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) was not developed for this strategy. TWDB will charge a fixed fee for conducting volumetric surveys. A cost estimate is not included for this strategy, as this cost will be determined by Angelina Nacogdoches WCID #1 during their negotiations with TWDB.

PROJECT EVALUATION

The addition of the additional yield from Lake Striker will help address the shortages in Angelina Nacogdoches WCID #1's customer demands.

The recommended strategy for infrastructure improvements was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	-	NA
Reliability	3	Medium
Cost	5	No Cost
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by AN WCID#1
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Angelina Nacogdoches WCID #1.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 44. ATHENS MWA FISH HATCHERIES

Water User Group Name:	**Athens MWA**
Strategy Name:	**Indirect Reuse of Flows from Fish Hatcheries**
Strategy ID:	**AMWA-FH**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**2,872 ac-ft/yr (2.6 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020**
Project Capital Cost:	**$0 (September 2018)**
Annual Cost:	**$0 per ac-ft**
Unit Water Cost (Rounded):	**$0 per ac-ft ($0 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Athens MWA. The strategy involves an indirect reuse project from the flows returned by the Fish Hatcheries to Lake Athens. Athens MWA has a contract to supply 3,023 ac-ft/yr to the Fish Hatcheries. The Fish Hatcheries have a separate intake on Lake Athens to access the lake supplies. Currently, approximately 95 to 100 percent of the diverted water for the Fish Hatchery is returned to Lake Athens; however, the Fish Hatchery is under no contractual obligations to continue this practice. To assure adequate supplies for the fish hatchery and other uses, Athens MWA should work with the fish hatchery to assure that the hatchery continues to return diverted water to Lake Athens for subsequent reuse. For purposes of this plan, it is assumed that 95 percent of the contracted water will be returned. This equates to 2,872 ac-ft/yr of additional supply. Athens MWA has to apply for a permit amendment on their permit to provide water to fish hatcheries to be able to utilize the flows returned by the fish hatcheries.

SUPPLY DEVELOPMENT

The fish hatcheries return approximately 95 to 100 percent of the water diverted from Lake Athens. Assuming that 95% of the water is returned, approximately 2,872 ac-ft/yr of supplies can be developed from this strategy.

ENVIRONMENTAL CONSIDERATIONS

The yield of this strategy will be dependent upon negotiations with the TCEQ regarding environmental flow requirements. Environmental flow requirements will be set so the new permit has a minimum impact to environmental water needs and the surrounding habitat. No impacts to cultural resources in the area are expected.

PERMITTING AND DEVELOPMENT

Athens MWA has to apply for an amendment to their permit to supply water to the fish hatcheries. This amendment will allow them to utilize the water returned by the fish hatcheries to Lake Athens. Previous attempts of working with TCEQ on the permit amendment have not been successful. Athens MWA is hopeful that the amendment will be approved during the planning period. This permit amendment is dependent upon coordination with the TCEQ.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) was not prepared for this strategy because costs associated with the permit amendment are considered minimal. Any costs incurred by Athens MWA will be related to engineering and lawyer fees.

PROJECT EVALUATION

The recommended strategy for infrastructure improvements was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 2,872 ac-ft/yr
Reliability	4	Medium to High
Cost	5	No Cost (Other than Administrative and Lawyer Fees)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by Athens MWA
Implementation Issues	3	Low Implementation Issues. Requires agreement with Fish Hatcheries

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 45. ATHENS MWA NEW GROUNDWATER WELLS

Water User Group Name:	**Athens MWA - Additional Carrizo-Wilcox Groundwater**
Strategy Name:	**New Wells in Carrizo-Wilcox Aquifer (Region C)**
Strategy ID:	**AMWA-AGW**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**2,000 ac-ft/yr (varies) (1.78 MGD)**
Implementation Decade:	**2060**
Development Timeline:	**2060**
Project Capital Cost:	**$15,151,000 (September 2018)**
Annual Cost:	**$1,885,000 per ac-ft**
Unit Water Cost (Rounded):	**$943 per ac-ft ($ 2.89 per 1,000 gallons)**

PROJECT DESCRIPTION

Athens MWA is currently pursuing developing groundwater from the Carrizo-Wilcox aquifer on property near Lake Athens. It is anticipated that 17 new wells (with a capacity of 250 gallons per minute each) will be drilled to provide around 1.78 MGD of groundwater supply. The water would be transported directly from the well field to the distribution system. It should be noted that although Athens MWA has permits to develop the wells, this strategy cannot be included in the 2021 Regional Plan as a recommended strategy because of the MAG limitations.

SUPPLY DEVELOPMENT

Current use in the Carrizo-Wilcox aquifer in Henderson County (both in Region C and I) is near the MAG for the county. The strategy will be changed to a recommended strategy when the MAG volumes are updated in the near future. Currently there is an unmet need of 5,567 ac-ft/yr in 2070 for Athens MWA. Since this is a primary strategy for Athens MWA, the 2021 Regional Plan will show shortages for Athens MWA, which in reality will be addressed by the well field development.

ENVIRONMENTAL CONSIDERATIONS

No environmental issues identified.

PERMITTING AND DEVELOPMENT

Athens MWA already has permits to drill the wells. The yield from the new wells is above the MAG limits for Henderson County in Regions C and I. If and when the MAG numbers are updated, the yield from the wells will be compared with the MAG availability and the project will be converted to a recommended strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) is provided below. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

Cost Estimate Summary
Water Supply Project Option
September 2018 Prices
Athens - New Well(s) in Carrizo-Wilcox Aquifer

Cost based on ENR CCI 11170.28 for September 2018 and a PPI of 201.9 for September 2018

Item	*Estimated Costs for Facilities*
CAPITAL COSTS	
Transmission Pipeline (16 in dia., 5 miles)	$2,551,000
Primary Pump Stations (3.6 MGD)	$50,000
Well Fields (Wells, Pumps, and Piping)	$8,025,000
Disinfection Facilities (3.6 MGD)	$225,000
TOTAL COST OF FACILITIES	**$10,851,000**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$3,670,000
Environmental & Archaeology Studies and Mitigation	$312,000
Land Acquisition and Surveying (36 acres)	$112,000
Interest During Construction (3% for 0.5 years with a 0.5% ROI)	$206,000
TOTAL COST OF PROJECT	**$15,151,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$1,066,000
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$106,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$1,000
Disinfection Facilities	$135,000
Pumping Energy Costs (1097876 kW-hr @ 0.08 $/kW-hr)	$88,000
Purchase of Water (2000 ac-ft/yr @ 244.38825 $/ac-ft)	$489,000
TOTAL ANNUAL COST	**$1,885,000**
Available Project Yield (ac-ft/yr)	2,000
Annual Cost of Water ($ per ac-ft), based on PF=2	$943
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=2	$410
Annual Cost of Water ($ per 1,000 gallons), based on PF=2	$2.89
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=2	$1.26

PROJECT EVALUATION

The recommended strategy for infrastructure improvements was evaluated across eleven different criteria for the purpose of quick comparison against projects incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 2,000 ac-ft/yr
Reliability	2	Low to Medium. Not reliable because of MAG overallocation
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by the City of Athens
Implementation Issues	1	High Implementation Issues. Supply from this strategy reaches or exceeds MAG limits for Henderson County in Regions C and I

REFERENCES

Discussions with Region C.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 46. ATHENS MWA EXPANDED GROUNDWATER SUPPLY

Water User Group Name:	**Athens MWA**
Strategy Name:	**Expanded Groundwater Supply**
Strategy ID:	**AMWA-GWE**
Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**200 ac-ft/yr (0.18 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020**
Project Capital Cost:	**$2,573,000 (September 2018)**
Annual Cost:	**$218,000 per ac-ft**
Unit Water Cost (Rounded):	**$1,090 per ac-ft ($3.35 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Athens MWA. The strategy involves addition of new groundwater wells in the Carrizo Wilcox aquifer in Henderson County. Athens MWA is currently pursuing developing groundwater from Carrizo Wilcox aquifer on the property near Lake Athens. The water would be transported directly from the well field to the distribution system. The Carrizo Wilcox in Henderson County (both in Region C and I) is severely limited by its availability for additional wells.

SUPPLY DEVELOPMENT

The City of Athens and Athens MWA are considering increasing the groundwater supply capacity that pumps directly into their distribution system. This strategy consists of developing infrastructure to increase this groundwater supply, including a new well (with a capacity of 250 gallons per minute), ground storage tank, and booster pump station.

ENVIRONMENTAL CONSIDERATIONS

No environmental issues identified.

PERMITTING AND DEVELOPMENT

Athens MWA already has permits to drill the wells. The yield from the new wells is above the MAG limits for Henderson County in Regions C and I. If and when the MAG numbers are updated, the yield from the wells will be compared with the MAG availability and the project will be converted to a recommended strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) is provided below. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP:	**Athens MWA**				
WMS:	**Groundwater Supply Expansion**				
Supply:	**200**	Ac-ft/yr		250	gpm

Construction Costs	**Size**	**Quantity**	**Unit Cost**	**Total Cost**
New Well	250 gpm	1	$500,000	$500,000
Booster Pump Station, Connection to Distribution System		1	$128,000	$128,000
Ground Storage Tank	0.30 MG	1	$565,000	$565,000
Contingencies (35%)				$418,000
Subtotal of Well, Pump Station, and Storage Tank				**$1,611,000**
Construction Allowance (5%)				$80,550
Mobilization (5%)				$84,578
Overhead and Profit (18%)				$320,000
Construction Total				**$2,096,000**
Professional Services/Engineering, Construction (20%)				$419,000
Interest During Construction		12	Months	$58,000
TOTAL CAPITAL COST				**$2,573,000**
ANNUAL COSTS				
Debt Service (3.5% for 20 years)				$181,000
Operational Costs*				$36,600
Disinfection	65,170	$0.30	per 1000 gal	$19,600
TOTAL ANNUAL COST				**$218,000**
UNIT COSTS (First 30 Years)				
Cost per ac-ft				$1,090
Cost per 1000 gallons				$3.35
UNIT COSTS (After 30 Years)				
Cost per ac-ft				$183
Cost per 1000 gallons				$0.56

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

The recommended strategy for infrastructure improvements was evaluated across eleven different criteria for the purpose of quick comparison against projects incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 200 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by Athens MWA
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Athens Municipal Water Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 47. ATHENS BOOSTER PUMP STATION

Water User Group Name:	**Athens MWA**
Alternative Strategy Name:	**WTP Booster PS Improvement**
Alternative Strategy ID:	**AMWA-BSI**
Alternative Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**450 ac-ft/yr (0.4 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020**
Project Capital Cost:	**$65,000 (September 2018)**
Annual Cost:	**$57,000 per ac-ft**
Unit Water Cost (Rounded):	**$127 per ac-ft ($0.39 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is an alternative strategy for Athens MWA. The strategy involves infrastructure improvements at the water treatment plant owned by Athens MWA. The improvements will be applied to the existing booster pump station located at the water treatment plant.

Existing treatment capacity for City of Athens is 8 MGD, with a 7.5 MGD treated water pipeline to the city of Athens. The total yield from Lake Athens and the groundwater well at the WTP property is approximately 6 MGD. The WTP has sufficient capacity to treat the current supplies. Since the future supply from the groundwater wells will be directly added to the distribution system, there is no need for WTP capacity improvements. However, the Booster pump station at the WTP is limited by its capacity (5 MGD) and age. Athens MWA plans to replace the existing pump station with a new 8 MGD pump station. Therefore, the alternative water management strategy for Athens MWA is to address the booster pump station infrastructure improvements at the WTP.

In this strategy, the existing booster pump station will be replaced by a new booster pump station of 6 MGD average capacity and 9 MGD peak capacity.

SUPPLY DEVELOPMENT

No additional supplies associated with this strategy. This strategy will ensure access to the permitted supply from Lake Athens and the amount that is treated at the water treatment plant.

ENVIRONMENTAL CONSIDERATIONS

No known environmental impacts associated with this strategy.

PERMITTING AND DEVELOPMENT

No permitting issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for the infrastructure improvements is provided below. Overall, this strategy has a low cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP:	**Athens MWA**			
WMS:	**Booster PS Improvements at WTP**			
Amount	450	Ac-ft/yr	0.60	MGD

Construction Costs	**Size**	**Quantity**	**Unit Cost**	**Total Cost**
Pump Replacement at WTP	1600 gpm	1	$30,000	$30,000
Contingencies (35%)				$11,000
Subtotal of Well(s)				**$41,000**
Construction Allowance (5%)				$2,000
Mobilization (5%)				$2,000
Overhead and Profit (18%)				$8,000
Construction Total				**$53,000**
Professional Services/Engineering, Construction (20%)				$11,000
Interest During Construction		12	Months	$1,000
TOTAL CAPITAL COST				**$65,000**
ANNUAL COSTS				
Debt Service (3.5% for 20 years)				$5,000
Operational Costs*				$52,000
TOTAL ANNUAL COST				**$57,000**
UNIT COSTS (First 30 Years)				
Cost per ac-ft				$127
Cost per 1000 gallons				$0.39
UNIT COSTS (After 30 Years)				
Cost per ac-ft				$116
Cost per 1000 gallons				$0.36

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

The recommended strategy for infrastructure improvements was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 450 ac-ft/yr
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	5	Sponsor is identified and strategy is in development. Local sponsorship by Athens MWA
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with Athens Municipal Water Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 48. CITY OF BEAUMONT CONTRACT AMENDMENT

Water User Group Name:	**Jefferson - Beaumont**
Strategy Name:	**Amendment to Supplemental Contract with LNVA**
Strategy ID:	**JEFF-BEA**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**228 - 2,249 ac-ft/yr (varies) (0.05 - 2.01 MGD)**
Implementation Decade:	**2060**
Development Timeline:	**2060**
Project Capital Cost:	**$0 (September 2018)**
Annual Cost:	**$2,199,000**
Unit Water Cost (Rounded):	**$977 per ac-ft ($3.00 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for the City of Beaumont in Jefferson County and involves an amendment to an existing supplement contract between the City and the Lower Neches Valley Authority for additional water supply. Beginning in 2040, the City of Beaumont will have an additional need of 1,248 ac-ft/yr. The City's need increases each decade of the planning cycle, with a maximum need of 9,218 ac-ft/yr in 2070. The City of Beaumont already has in place existing infrastructure and transmission lines for their existing supply from the Lower Neches Valley Authority. Therefore, the only cost for additional supply from the Lower Neches Valley Authority is the cost of raw water. Ultimately, this cost will need to be negotiated with the Lower Neches Valley Authority and will reflect the City's wholesale water rates at that time. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The Lower Neches Valley Authority currently supplies approximately 3,000 ac-ft/yr to meet the City of Beaumont's demands in Jefferson County. The quantity of supply from this strategy represents a contract increase of 1,248 ac-ft/yr, beginning in 2040, and increases to 9,218 ac-ft/yr, beginning in 2070. In 2040 through 2070, the supply is limited to the municipal need projected by the East Texas Regional Water Planning Group. These supplies are considered highly reliable.

ENVIRONMENTAL CONSIDERATIONS

There are not any significant environmental considerations associated with this strategy. A contract between the City of Beaumont and the Lower Neches Valley Authority should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. As there is no new infrastructure required for this strategy, there will be no impacts to bays or estuaries in close proximity to the City of Beaumont.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST.

A planning level opinion of cost (PLOC) for this strategy is included in the table below. No capital costs were assumed, but an annual cost was estimated using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG:	**City of Beaumont**		
STRATEGY:	**Amendment to Supplemental Contract with LNVA**		
Raw Water Quantity:	**2,249** AF/Y	3.01 MGD	

ANNUAL CONTRACT COSTS	
ANNUAL COSTS	
Operational Costs*	**$2,199,000**

UNIT COSTS (Until Amortized)	
Per Acre-Foot of treated water	$978
Per 1,000 Gallons	$3.00

UNIT COSTS (After Amortization)	
Per Acre-Foot	NA
Per 1,000 Gallons	NA

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits municipal users in Jefferson County and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from Sam Rayburn will reduce demands on other water supplies in Jefferson County and will have no other apparent impact on other State water resources.

Based on the analyses provided above, the Jefferson Beaumont recommended strategy to purchase water from the Lower Neches Valley Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 2,249 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by the City of Beaumont
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 49. CITY OF CENTER REUSE PIPELINE

Project Name:	**City of Center Reuse Pipeline from WWTP to Lake Center**
Project ID:	**CENT-REU**
Project Type:	**Existing Surface Water Source**
Potential Supply Quantity (Rounded):	**1,121 ac-ft/yr (1 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**5 years**
Project Capital Cost:	**$2,456,000 (September 2018)**
Project Annual Cost:	**$262,000**
Unit Water Cost (Rounded):	**$234 per ac-ft (during loan period) $0.72 per 1,000 gallons.**

PROJECT DESCRIPTION

City of Center owns water rights for supplies in Lake Center and Pinkston Reservoir. Currently the City has sufficient supplies to meet the demand in decades 2020 to 2060 and a small shortage in 2070. The City is planning water management strategies to proactively prepare for satisfying any additional demand in the decades through 2060 and also to address the shortage in 2070. One of the recommended water management strategies is to add the return flows from City's WWTP to Lake Center. The City is permitted to use the return flows from the East Bank WWTP. The discharge point for the treated effluent from the WWTP is on a tributary to Mill Creek upstream of Lake Center. The City is planning an indirect reuse project by means of a reuse pipeline from East Bank WWTP to Lake Center. The City has already received wastewater discharge permits necessary to allow alternative discharge of current flow for this reuse project. The portion of the project remaining is final design, funding, and construction with no land acquisition anticipated. The total capacity for the indirect reuse project will be approximately 1 MGD (1,121 ac-ft/yr) and the project will be online in 2030.

SUPPLY DEVELOPMENT

Supply is readily available at the East Bank WWTP owned and operated by the City. City has a permit to use the return flows origination from the WWTP.

ENVIRONMENTAL CONSIDERATIONS

Impacts of the return flows on the receiving water body's water quality parameters needs to be analyzed in detail. Additional environmental considerations may apply during the permitting process.

PERMITTING AND DEVELOPMENT

The City needs to apply for a bed and banks permit to put the supplies in Lake Center.

PLANNING LEVEL OPINION OF COST

Included below is a planning level opinion of cost (PLOC) for the Phase I of the pipeline from City of Center's East Bank WWTP to Lake Center. The transmission system cost estimate also includes a 90 HP pump station, expansion of the treatment plant to treat the additional supplies. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP NAME: **City of Center**
STRATEGY: **Pipeline from East Bank WWTP to Lake Center**
Quantity: **1,121** AF/Y 1.50 MGD

CAPITAL COSTS					
Pipeline to Lake Nacogdoches	**Size**	**Qty**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	10 in.	30,188	LF	$31	$945,000
Pipeline Urban	10 in.	500	LF	$44	$22,000
Engineering and Contingencies (30%)					$290,000
Subtotal of Pipeline					**$1,257,000**
Pump Station(s)					
Pump with intake & building	98 HP	1	LS	$827,000	$827,000
Engineering and Contingencies (35%)					$289,450
Subtotal of Pump Station(s)					**$1,116,450**
Construction Total					**$2,373,000**
Interest During Construction			12	Months	$83,000
TOTAL COST					**$2,456,000**

ANNUAL COSTS	
Debt Service (5.5% for 20 years)	$206,000
Electricity ($0.09 kWh)	$25,000
Operational Costs*	$56,000
TOTAL ANNUAL COST	**$262,000**

UNIT COSTS (Until Amortized)	
Per Acre-Foot of treated water	$234
Per 1,000 Gallons	$0.72

UNIT COSTS (After Amortization)	
Per Acre-Foot	$50
Per 1,000 Gallons	$0.15

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

City of Center already has a permit to use the return flows, so this project has the benefit of providing a renewable source of supply that is readily available in the close proximity of Lake Center. The addition of the additional 1,121 ac-ft/yr will help City of Center supply to the increasing manufacturing demand in Shelby County. City of Center believes that the manufacturing demand reflected in the regional plan is not

reflective of the more aggressive growth in the manufacturing use in the region. This strategy will help meet some of the needs in the region.

The recommended strategy for infrastructure improvements was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 1,121 ac-ft/yr
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (low)
Environmental Factors	3	Low Negative Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	3	Low Negative Impacts. Impact of the return flows on the quality of the receiving bodies
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by the City of Center
Implementation Issues	4	Low Implementation Issues

REFERENCES

October 2020 correspondence with the City of Center.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 50. CITY OF CENTER TOLEDO BEND PIPELINE

Project Name:	**Pipeline from Toledo Bend to Lake Center**
Project ID:	**CENT-TOL**
Project Type:	**Existing Surface Water Source**
Potential Supply Quantity (Rounded):	**2,242 ac-ft/yr (5 MGD)**
Implementation Decade:	**2040**
Development Timeline:	**5 years**
Project Capital Cost:	**$27,865,000 (September 2018)**
Project Annual Cost:	**$3,462,000**
Unit Water Cost (Rounded):	**$1,544 per ac-ft (during loan period)** **$4.74 per ac-ft (1,000 gallons of water)**

PROJECT DESCRIPTION

To meet the current demands and higher expected future demands, the City has proposed this water management strategy for the planning period. The City is planning to purchase water from Sabine River Authority to transfer water from Toledo Bend Lake to Lake Center. The City will construct the raw water transmission pipeline from Toledo Bend Reservoir to Lake Center. At this time, it is not clear the total amount of water that will be transferred through this pipeline. The feasibility study for this project is ongoing as construction of this new pipeline is awaiting a demand trigger for design and construction to proceed. For planning purposes, it is assumed that the pipeline will be delivering approximately 2 MGD (2,242 ac-ft/yr).

SUPPLY DEVELOPMENT

Supply is available from the Toledo Bend Reservoir owned and operated by Sabine River Authority. After honoring the current contracted amounts, SRA has sufficient supplies to provide the amount requested by City of Center.

ENVIRONMENTAL CONSIDERATIONS

There may be some minor impacts of adding water from SRA's Toledo Bend Reservoir to Lake Center. There are not additional environmental considerations known at this time.

PERMITTING AND DEVELOPMENT

No additional permitting issues associated with the project. City of Center will need to sign a contract with Sabine River Authority for the purchase of the water.

PLANNING LEVEL OPINION OF COST

Included below is a planning level opinion of cost for the transmission system from Toledo Bend to Lake Center. Planning level opinion of probable construction cost estimates include a 16-inch pipeline from Toledo Bend to Lake Center, an intake and a booster pump station, and storage tanks. The annual costs are calculated assuming 5.5% interest rate and 20 years of return period. The estimate includes the cost for the purchase of raw water from SRA. For purposes of developing costs for purchasing water, costs were estimated at the regional rate chosen for the ETRWPA. Actual costs will be determined during contract negotiations. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP NAME: **City of Center**
STRATEGY: **Pipeline from Toledo Bend to Lake Center**
Quantity: **2,242** AF/Y 3.00 MGD

CAPITAL COSTS

Pipeline	**Size**	**Qty**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	16 in.	100,529	LF	$58	$5,786,000
Right of Way Easements Rural (ROW)		100,529	LF	$26	$2,839,000
Engineering and Contingencies (30%)					$1,736,000
Subtotal of Pipeline	**19**	**Miles**			**$10,361,000**
Pump Station(s)					
Pump with intake & building	130 HP	1	LS	$1,076,000	$1,076,000
Booster Pump Station	130 HP	1	LS	$1,698,000	$1,698,000
Storage Tanks	0.38 MG	1	EA	$127,000	$127,000
Engineering and Contingencies (35%)					$1,105,000
Subtotal of Pump Station(s)					**$4,006,000**
Water Treatment Facility					
Expand Existing Water Treatment Plant	3 MGD	1	LS	$8,260,000	$8,260,000
Engineering and Contingencies (35%)					$2,891,000
Subtotal of WTP					**$11,151,000**
Permitting and Mitigation					$530,000
Construction Total					**$26,048,000**
Interest During Construction			24	Months	$1,817,000
TOTAL COST					**$27,865,000**

ANNUAL COSTS

Debt Service (5.5% for 20 years)	$2,324,000
Operational Costs*	$1,138,000
TOTAL ANNUAL COST	**$3,462,000**

UNIT COSTS (Until Amortized)

Per Acre-Foot of treated water	$1,544
Per 1,000 Gallons	$4.74

UNIT COSTS (After Amortization)

Per Acre-Foot	$508
Per 1,000 Gallons	$1.57

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

The addition of the additional 2,242 ac-ft/yr will help City of Center supply to the increasing manufacturing demand in Shelby County. City of Center believes that the manufacturing demand reflected in the regional plan is not reflective of the more aggressive growth in the manufacturing use in the region. This strategy will help meet some of the needs in the region.

The recommended strategy for infrastructure improvements was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 2,242 ac-ft/yr.
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	3	Low Negative Impacts. Minor impact of the addition of raw water on the quality of the receiving bodies
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by the City of Center
Implementation Issues	4	Low Implementation Issues

REFERENCES

October 2020 correspondence with the City of Center.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 51. CITY OF CENTER VOLUMETRIC SURVEYS

Project Name:	**Volumetric Surveys of Lake Center and Pinkston Reservoir**
Project ID:	**CENT-VOL**
Project Type:	**Existing Surface Water Source**
Potential Supply Quantity (Rounded):	**NA**
Implementation Decade:	**2020**
Development Timeline:	**2 years**
Project Capital Cost:	**NA**
Unit Water Cost (Rounded):	**NA**

PROJECT DESCRIPTION

To meet the current demands and higher expected future demands, the City has proposed a water management strategy. City of Center is considering a recommended strategy to conduct volumetric survey of Lake Center and Pinkston Reservoir to develop an accurate estimate of the lake yields. Based on the volumetric survey report, subsequent dredging may be required to increase the lake yields of the two bodies of water. City of Center will coordinate with TWDB to get on a schedule for the lake volumetric survey. TWDB will charge a fixed fee for conducting volumetric surveys.

SUPPLY DEVELOPMENT

There may be some potential for additional yield at Pinkston Reservoir, but it is not expected to see any additional supplies at Lake Center.

ENVIRONMENTAL CONSIDERATIONS

No known environmental considerations at this time but these would be studied in further details during the volumetric survey process.

PERMITTING AND DEVELOPMENT

Texas Water Development Board conducts the volumetric surveys so City of Center coordinate with the Board on the timing of the volumetric surveys. No additional permitting issues known at this time.

COST ANALYSIS

No cost was developed for this strategy. TWDB charges a nominal fee for conducting the volumetric surveys but it is not clear what that amount would be in early planning stages.

PROJECT EVALUATION

The addition of the additional yield from Lake Center and Pinkston Reservoir will help City of Center supply to the increasing demand in Shelby County. City of Center believes that the manufacturing demand reported in the regional plan is not reflective of the more aggressive growth in the manufacturing use in the region. This strategy will help meet some of the needs in the region.

The recommended strategy for infrastructure improvements was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity		NA
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by the City of Center
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan. October 2020 correspondence with the City of Center.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 52. HOUSTON COUNTY WCID #1 PERMIT AMENDMENT

Water User Group Name:	**Houston County WCID #1**
Strategy Name:	**Permit Amendment for Houston County Lake**
Strategy ID:	**HCWC-PA**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**3,500 ac-ft/yr (3.1 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020**
Project Capital Cost:	**$0**
Annual Cost:	**$0 per ac-ft**
Unit Water Cost (Rounded):	**$0 per ac-ft ($0 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for Houston County WCID #1 located in Houston County. The strategy involves a permit amendment to take 3,500 ac-ft/yr from Houston County Lake in addition to the 3,500 ac-ft/yr included in their existing permit.

SUPPLY DEVELOPMENT

Houston County WCID #1 was originally permitted for 7,000 ac-ft/yr from Houston County Lake; in 1987, this supply was reduced by the Texas Commission on Environmental Quality (TCEQ) to 3,500 ac-ft/yr. Houston County WCID #1 has applied for a permit amendment to return their permitted diversion to the firm yield of the lake, 7,000 ac-ft/yr, and add industrial use to the permit. The reliability of this water supply is considered medium because while the firm yield of the lake allows for this permit amendment, the amendment is dependent upon decisions made by the TCEQ.

ENVIRONMENTAL CONSIDERATIONS

The yield of this strategy will be dependent upon negotiations with the TCEQ regarding environmental flow requirements. Environmental flow requirements will be set so the new permit has a minimum impact to environmental water needs and the surrounding habitat. Environmental flow needs were considered for in calculation of the supply yield through the use of the TCEQ WAM Run 3 scenario, which includes Senate Bill 3 environmental flow criteria. No impacts to cultural resources in the area are expected. There are no bays or estuaries in close proximity Houston County.

PERMITTING AND DEVELOPMENT

This permit amendment is dependent upon coordination with the TCEQ.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) was not developed for this strategy because costs associated with the permit amendment are considered minimal. Any costs incurred by Houston County WCID #1 will be related to engineering and lawyer fees.

PROJECT EVALUATION

This strategy benefits both municipal and non-municipal users in Houston County and would have a positive impact on their water supply security. Since 2007, Houston County WCID #1 has received multiple requests for additional water supplies from entities and business including the City of Crockett, the Crockett Economic & Industrial Development Corporation, The Consolidated WSC, Nacogdoches Power, LLC, and the Houston County Judge, Erin Ford.

This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from Houston County Lake will reduce demands on other water supplies in Houston County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this permit amendment for existing surface water supplies will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Houston County WCID #1 recommended strategy for a permit amendment was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 3,500 ac-ft/yr
Reliability	3	Medium
Cost	5	No Cost (Other than Administrative and Lawyer Fees)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by Houston County WCID #1
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 53. HOUSTON COUNTY WCID #1 GROUNDWATER WELLS

Water User Group Name:	**Houston County WCID #1**
Alternative Strategy Name:	**New Wells in Carrizo-Wilcox Aquifer**
Alternative Strategy ID:	**HCWC-GW**
Alternative Strategy Type:	**New Groundwater Source**
Potential Supply Quantity:	**3,500 ac-ft/yr (3.1 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2020**
Project Capital Cost:	**$22,793,000**
Annual Cost:	**$1,827,000 per ac-ft**
Unit Water Cost (Rounded):	**$522 per ac-ft ($1.60 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is an alternative strategy for Houston County WCID #1 to develop 22 wells in Houston County within the Carrizo-Wilcox Aquifer. This aquifer has been identified as a potential source of water in Houston County. These wells will have a maximum total yield of 4,500 gpm, and a water depth of 300 feet was assumed. A peaking factor of two was assumed for the wells, and the cost estimate includes conveyance infrastructure in order to capture the peak annual supply. This project will only be implemented if Houston County WCID #1 is unable to attain a permit amendment for 3,500 ac-ft/yr from Houston County Lake (Strategy ID: HCWC-PA).

SUPPLY DEVELOPMENT

It is assumed that each well will have a maximum yield of 500 ac-ft/yr to meet both municipal and non-municipal demands in Houston County providing a total strategy yield of 3,500 ac-ft/yr for every decade in the planning period (2020-2070). A target yield for this strategy was set by Houston County WCID #1; this value corresponds to the amount listed in their recommended strategy for a permit amendment (Strategy ID: HCWC-PA). Overall, the reliability of this supply is considered high, based on the proven use of this source and groundwater availability models.

ENVIRONMENTAL CONSIDERATIONS

The environmental impacts from this strategy are expected to be low. However, groundwater development from this source should be evaluated for potential impacts on spring flows and base flows of surface water in close proximity. The impact to the environment due to pipeline construction is expected to be temporary and minimal. New wells have a potential decrease in the groundwater-surface water nexus, which could reduce base flows. Impacts to environmental water needs, habitat, and cultural resources are expected to be low. In addition, there are no bays or estuaries in close proximity of Houston County.

PERMITTING AND DEVELOPMENT

There are no permitting or development issues associated with this strategy.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 3 miles of pipeline, nine wells, a peaking factor of two, and a

maximum well yield of 200 gpm for each well. This equates to $709 per acre-foot ($2.17 per 1,000 gallons); after the infrastructure if fully paid for (30 years), the cost drops to $201 per acre-foot ($0.62 per 1,000 gallons). Overall, this strategy has a low cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WUG: Houston County WCID #1
STRATEGY: Cherokee County - GW Wells

Supply	3,500	Ac-ft/yr	2,170	gpm
Well Depth	820	ft		
Wells Needed	19			

CAPITAL COSTS	
Water Wells (19 wells)	$9,122,807
Connection to Transmission System	$950,000
Transmission Pipeline (20 in., 15,128 LF)	$1,898,000
Pump Station (3.12 MGD)	$3,122,000
Ground Storage Tank (0.78 MG)	$689,481
Easement – Rural (15,840 LF)	$304,150
TOTAL COST OF FACILITIES	**$16,086,438**
Engineering and Feasibility Studies, Legal Assistance, Financing, Bond Counsel, and Contingencies (30% for pipes & 35% for all other facilities)	$5,381,000
Permitting and Mitigation	$137,629
Interest During Construction (3% for 1 years with a 0.5% ROI)	$1,188,000
TOTAL COST OF PROJECT	**$22,793,000**
ANNUAL COSTS	
Debt Service (3.5 percent, 20 years)	$1,604,000
Operation and Maintenance	$223,000
TOTAL ANNUAL COST	**$1,827,000**
Available Project Yield (ac-ft/yr)	3.500
Annual Cost of Water ($ per ac-ft), based on PF=1.2	$522
Annual Cost of Water After Debt Service ($ per ac-ft), based on PF=1.2	$1.60
Annual Cost of Water ($ per 1,000 gallons), based on PF=1.2	$201
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1.2	$0.62

PROJECT EVALUATION

This strategy benefits both municipal and non-municipal users in Houston County and would have a positive impact on their water supply security. Since 2007, Houston County WCID #1 has received multiple requests for additional water supplies from entities and business including the City of Crockett, the Crockett Economic & Industrial Development Corporation, The Consolidated WSC, Nacogdoches Power, LLC, and the Houston County Judge, Erin Ford.

This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. New wells in the county will reduce demands on other water supplies in Houston County and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this strategy will provide water for economic growth.

Based on the analyses provided above, the *alternative* strategy to drill new wells in Houston County for the customers of Houston County WCID #1 was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional

Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 3,500 ac-ft/yr
Reliability	3	Medium
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by Houston County WCID #1
Implementation Issues	4	Low Implementation Issues. Dependent on HC WCID #1 permit amendment application and the TCEQ

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 54. CITY OF JACKSONVILLE SUPPLY FROM LAKE COLUMBIA

Project Name:	**Supply from Lake Columbia**
Project ID:	**JACK-COL**
Project Type:	**Existing Surface Water Source**
Potential Supply Quantity (Rounded):	**1,700 ac-ft/yr (3 MGD)**
Implementation Decade:	**2040**
Development Timeline:	**5 years**
Project Capital Cost:	**$29,390,000 (September 2018)**
Project Annual Cost:	**$3,150,000**
Unit Water Cost (Rounded):	**$1,853 per ac-ft (during loan period)** **$5.69 (per 1,000 gallons)**

PROJECT DESCRIPTION

Lake Columbia is a water management strategy for Angelina Nacogdoches River Authority. Angelina Neches River Authority has contracts with several customers that are participants in the project development. City of Jacksonville is included in the list, participating at five percent contribution. It is assumed that Jacksonville will be purchasing raw water from Angelina Neches River Authority. City of Jacksonville will need a transmission project to transfer supplies from Lake Columbia to the City. The water management strategy associated with the transmission project is discussed in this tech memo. The current contract amount for City of Jacksonville is 4,275 acre-feet. However, City of Jacksonville currently does not have any supply shortages and is also not expecting tremendous growth in the recent future. For these reasons, it is assumed that the transmission strategy will be developed in phases with the first phase for a potential supply of 1,700 ac-ft/yr (3 MGD). The tech memo discussion is associated with the Phase I of the transmission project. Additional phases will be developed at a later stage. The transmission project will include a 5-mile pipeline from Lake Columbia to the City, an intake pump station, and a 3-MGD water treatment plant to treat the supplies before delivery. Figure included at the end of the tech memo show the location map of the project and a preliminary pipeline corridor for the transmission system.

PERMITTING AND DEVELOPMENT

No additional permitting issues associated with the project. The project will commence after the commencement of the Lake Columbia project by Angelina Neches River Authority.

PLANNING LEVEL OPINION OF COST

Included below is a planning level opinion of cost (PLOC) for Phase I of the pipeline from Lake Columbia to City of Jacksonville. Costs are estimated for half-mile of pipeline in urban areas and 4.5 miles of pipeline in rural areas. The transmission system cost estimate also includes the cost of 100 HP intake pump station and a 3 MGD water treatment plant for treating the raw water. The annual costs are calculated assuming 3.5% interest rate and 20 years of return period. The estimate includes the cost for the purchase of raw water from Angelina Neches River Authority. Overall, this strategy has a medium cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP NAME: **Jacksonville**
STRATEGY: **Lake Columbia Pipeline**
Quantity for Phase I **1,700** AF/Y 2.27 MGD

CAPITAL COSTS

Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	12 in.	23,544	LF	$68	$1,608,000
Pipeline Urban	12 in.	3,000	LF	$87	$262,000
Right of Way Easements Rural (ROW)		23,544	LF	$18	$430,000
Right of Way Easements Urban (ROW)		3,000	LF	$108	$325,000
Land and Surveying Rural (10%)					$43,000
Land and Surveying Urban (10%)					$33,000
Engineering and Contingencies (30%)					$561,000
Subtotal of Pipeline					**$3,262,000**
Pump Station(s)					
Pump with intake & building	100 HP	1	LS	$4,315,000	$4,315,000
Storage Tanks	0.28 MG	1	EA	$502,000	$502,000
Engineering and Contingencies (35%)					$1,686,000
Subtotal of Pump Station(s)					**$6,503,000**
Water Treatment Facility					
New Water Treatment Plant	3 MGD	1	LS	$13,837,000	$13,837,000
Engineering and Contingencies (35%)					$4,842,950
Subtotal of WTP					**$18,679,950**
Permitting and Mitigation					$158,231
Construction Total					**$28,603,000**
Interest During Construction			12	Months	$787,000
TOTAL COST					**$29,390,000**

ANNUAL COSTS

Debt Service (3.5% for 20 years)	$2,068,000
Operational Costs*	$1,082,000
TOTAL ANNUAL COST	**$3,150,000**

UNIT COSTS (Until Amortized)

Per Acre-Foot of treated water	$1,853
Per 1,000 Gallons	$5.69

UNIT COSTS (After Amortization)

Per Acre-Foot	$636
Per 1,000 Gallons	$1.95

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

Based on the analysis provided above, the Lake Columbia to Jacksonville Raw Water Transmission System project was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation

can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 1,700 ac-ft/yr
Reliability	4	Medium to High
Cost	2	$1,000 to $5,000/ac-ft (Medium-High)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by the City of Jacksonville
Implementation Issues	3	Low Implementation Issues. Dependent on the completion of Lake Columbia construction

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 55. LNVA PURCHASE FROM SRA

Water User Group Name:	**Lower Neches Valley Authority**
Strategy Name:	**Purchase from Sabine River Authority (Toledo Bend)**
Strategy ID:	**LNVA-SRA**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**200,000 ac-ft/yr (178.4 MGD)**
Implementation Decade:	**2040**
Development Timeline:	**2040**
Project Capital Cost:	**$529,606,000 (September 2018)**
Annual Cost:	**$110,157,000**
Unit Water Cost (Rounded):	**$551 per ac-ft ($1.69 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for the Lower Neches Valley Authority and involves a contract to take raw surface water from the Sabine River Authority's Toledo Bend system as their permit allows. The cost for supply from the Sabine River Authority includes the cost of raw water and infrastructure related to water conveyance. Ultimately, the cost for raw water will need to be negotiated with the Sabine River Authority and will reflect the wholesale water rates of this entity at the time a contract is made. The cost estimate included in this technical memorandum utilizes an assumed rate for the East Texas Regional Water Planning Area regional rate for raw surface water.

SUPPLY DEVELOPMENT

The quantity of supply from this strategy represents the water requested by the Lower Neches Valley Authority as part of their long-term planning. This is equal to 200,000 ac-ft/yr beginning in 2040 and continuing through the end of the planning period, 2070. The reliability of this water supply is considered medium to high due to the availability of water from the Toledo Bend system. However, this project is dependent on coordination with the Sabine River Authority.

ENVIRONMENTAL CONSIDERATIONS

The impact to the environment due to pipeline construction is expected to be moderate. In addition, a contract between the Lower Neches Valley Authority and Sabine River Authority should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries in close proximity to the project area located in Jefferson and Orange Counties. Before this project could be pursued, the Lower Neches Valley Authority would need to perform a site selection study to identify environmental impacts associated with the project.

PERMITTING AND DEVELOPMENT

This strategy is dependent on the Sabine River Authority completing a project to move the location of one of their existing pump stations.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The capital costs assumed 13 miles of pipeline and 17 miles of open canals (distance determined by the Lower Neches Valley Authority), one pump station with an intake, and two booster pump station. The annual cost was estimated assuming a debt service of 3.5% for 20 years and using the East Texas Regional Water Planning Area regional rate for raw surface water. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP: **Lower Neches Valley Authority**
STRATEGY: **Purchase from Sabine River Authority (Toledo Bend)**

Raw Water Quantity:	**200,000**	AF/Y		356.8	MGD
CONSTRUCTION COSTS					
Pipeline	**Size**	**Qty**	**Unit**	**Unit Price**	**Cost**
Pipeline/Canal Rural	144 in.	158,400	LF	$1,806	$286,117,000
Right of Way Easements Rural (ROW)		158,400	LF	$30	$4,755,800
Land and Surveying (10%)					$475,580
Engineering and Contingencies (30%)					$85,835,000
Subtotal of Pipeline/Canal	**30**	**miles**			**$377,183,380**
Pump Station(s)					
Pump with intake	3150 HP	1	LS	$37,274,000	$37,274,000
Booster Pump Station	3150 HP	2	LS	$18,002,000	$36,004,000
Engineering and Contingencies (35%)					$25,647,300
Subtotal of Pump Station(s)					**$98,925,300**
Storage Tank(s)					
Storage Tanks	7.0 MG	3	LS	$3,037,231	$9,111,694
Engineering and Contingencies (35%)					$3,189,093
Subtotal of Storage Tank(s)					**$12,300,787**
Permitting and Mitigation					$834,000
Construction Total					**$489,243,467**
Interest During Construction			36	Months	$40,363,000
TOTAL CAPITAL COST					**$529,606,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$37,264,000
Operational Costs*					$72,893,000
TOTAL ANNUAL COST					**$110,157,000**

UNIT COSTS (Until Amortized)

Per Acre-Foot of treated water	$551
Per 1,000 Gallons	$1.69

UNIT COSTS (After Amortization)

Per Acre-Foot	$364
Per 1,000 Gallons	$1.12

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits customers of the Lower Neches Valley Authority and is expected to have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. A contract to pull water from the Toledo Bend system will reduce demands on Toledo Bend and the Sabine River and will have no other apparent impact on other State water resources. From a third party social and economic perspective, this voluntary redistribution of water will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Lower Neches Valley recommended strategy to purchase water from the Sabine River Authority was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 200,000 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by Lower Neches Valley Authority
Implementation Issues	3	Low Implementation Issues. Contract with SRA

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 56. LNVA BEAUMONT WEST REGIONAL RESERVOIR

Water User Group Name:	**Lower Neches Valley Authority**
Strategy Name:	**Beaumont West Regional Reservoir**
Strategy ID:	**LNVA-WRR**
Strategy Type:	**New Surface Water Source**
Potential Supply Quantity:	**7,700 ac-ft/yr (6.9 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**5 Years**
Project Capital Cost:	**$37,538,000 (September 2018)**
Project Annual Cost:	**$1,970,00**
Unit Water Cost (Rounded):	**$256 per ac-ft ($0.79 per 1,000 gallons)**

PROJECT DESCRIPTION

This recommended strategy involves the construction of an approximate 1,100-acre reservoir on the northwest end of Beaumont. In addition, the location of the reservoir provides a significant advantage to provide water in case of an emergency fire water demand, source pollution in the Neches River or Pine Island Bayou, or losses of either of the Lower Neches Valley Authority pumping stations in severe events, such as what occurred during Hurricane Harvey.

SUPPLY DEVELOPMENT

The reservoir is anticipated to have an approximate capacity of 7,700 acre-feet, which is equivalent to approximately three (3) weeks of water supply to meet municipal and industrial demands downstream. This reservoir is located so that stored water can be sent to all industrial and municipal customers on the LNVA system.

ENVIRONMENTAL CONSIDERATIONS

With the construction of any new reservoir several environmental impacts will be considered. A summary of environmental considerations would be developed based on the known environmental factors such as habitat and aquatic resources for threatened or endangered species within surrounding the reservoir footprint. Environmental flow considerations and how the construction of a reservoir effects the surrounding hydrologic environment is also a consideration. Environmental flow needs were considered for in the calculation of the supply yield through the use of the TCEQ WAM Run 3 scenario, which includes Senate Bill 3 environmental flow criteria.

PERMITTING AND DEVELOPMENT

If this strategy is implemented, the Lower Neches Valley Authority will need a water rights permit as well as a 404 permit before construction can begin.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for the construction of a new reservoir for this strategy includes costs from all aspects of planning to design to construction. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the yield generated by the infrastructure required.

WWP:	**Lower Neches Valley Authority**			
STRATEGY:	**Beaumont West Regional Reservoir**			
Raw Water Quantity	**7,700** acre-feet	2,509	MG	
RESERVOIR STORAGE CAPACITY (1 day of storage = 2,509 MG)				

PROJECT COSTS			**Cost**
Planning			$350,000
Design			$1,700,000
Real Estate			$9,000,000
Environmental			$150,000
Permitting			$150,000
Construction			$13,800,000
Engineering and Contingencies (30%)			$7,545,000
TOTAL COST			**$33,000,000**
Interest During Construction	60	Months	$4,538,000
TOTAL CAPITAL COST			**$37,538,000**

ANNUAL COSTS	
Debt Service (3.5% for 40 years)	$1,758,000
Operational Costs*	$212,000
TOTAL ANNUAL COST	**$1,970,000**

UNIT COSTS (Until Amortized)	
Per Acre-Foot of treated water	$256
Per 1,000 Gallons	$0.79

UNIT COSTS (After Amortization)	
Per Acre-Foot	$28
Per 1,000 Gallons	$0.08

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits both municipal and non-municipal customers of the Lower Neches Valley Authority and would have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. The strategy will have no other apparent impact on other State water resources. From a third party social and economic perspective, this permit amendment for existing surface water supplies will be beneficial because it provides water for economic growth.

Based on the analyses provided above, the Lower Neches Valley Authority recommended strategy for a permit amendment was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 7,700 ac-ft/yr
Reliability	5	High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by Lower Neches Valley Authority
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the Lower Neches Valley Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 57. LNVA NECHES-TRINITY BASIN INTERCONNECT

Water User Group Name:	**Lower Neches Valley Authority**
Strategy Name:	**Neches-Trinity Basin Interconnect**
Strategy ID:	**LNVA-RGH**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**67,000 ac-ft/yr (60 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**5 Years**
Project Capital Cost:	**$102,375,000 (September 2018)**
Project Annual Cost:	**$8,907,000**
Unit Water Cost (Rounded):	**$133 per ac-ft ($0.41 per 1,000 gallons)**

PROJECT DESCRIPTION

The Lower Neches Valley Authority is planning to construct an approximate 13 mile, single 84-inch pipeline that runs in an east-west direction, as well as a 62,000 gpm pump station. The proposed pipeline enables the movement of Neches River water westward toward the upper reaches of the Devers Canal system and potentially back into the Trinity River. The water from this strategy will enable LNVA to provide water for irrigation customers in Region H, as well as to serve new industries as they emerge along the IH-10 corridor.

SUPPLY DEVELOPMENT

The purpose of this water management strategy is to allow the Lower Neches Valley Authority to divert existing supply to areas with greater water need and plan for water needs in areas of future development.

ENVIRONMENTAL CONSIDERATIONS

The pipeline construction is expected to be have a moderate impact to the environment, the route would be chosen as to minimize impacts. In addition, the transport of water towards the Devers Canal system should have a minimum impact to environmental water needs, no impact to the surrounding habitat, and a low impact to cultural resources in the area. There are no bays or estuaries in close proximity to the project area located in Jefferson and Orange Counties. Before this project could be pursued, the Lower Neches Valley Authority may need to perform additional studies to identify environmental impacts associated with the project.

PERMITTING AND DEVELOPMENT

The Lower Neches Valley Authority may need to apply for a bed and banks permit to put supplies in the Devers Canal system and possibly the Trinity River.

PLANNING LEVEL OPINION OF COST

Included below is a planning level opinion of cost (PLOC) for the interconnect pipeline and pump station for the Lower Neches Valley Authority. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan due to the yield generated by the infrastructure required.

WWP:	**Lower Neches Valley Authority**			
STRATEGY:	**Neches-Trinity Basin Interconnect**			
Raw Water Quantity:	**67,000** AF/Y	89.7	MGD	

PROJECT COSTS				**Cost**
Planning				$1,500,000
Design				$6,800,000
Real Estate				$3,500,000
Environmental				$2,000,000
Permitting				$2,000,000
Construction	13-mile 84" pipeline, 62,000 gpm pump station			$53,500,000
Engineering and Contingencies (30%)				$20,790,000
TOTAL COST				**$90,000,000**
Interest During Construction		60	Months	$12,375,000
TOTAL CAPITAL COST				**$102,375,000**

ANNUAL COSTS	
Debt Service (3.5% for 20 years)	$7,203,000
Operational Costs*	$1,704,000
TOTAL ANNUAL COST	**$8,907,000**

UNIT COSTS (Until Amortized)	
Per Acre-Foot of treated water	$133
Per 1,000 Gallons	$0.41

UNIT COSTS (After Amortization)	
Per Acre-Foot	$25
Per 1,000 Gallons	$0.08

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits both municipal and non-municipal customers of the Lower Neches Valley Authority and would have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality.

Based on the analyses provided above, the Lower Neches Valley Authority recommended strategy for an interconnect was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 67,000 ac-ft/yr
Reliability	5	High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	3	Low Negative Impacts
Impact on Other State Water Resources	3	Low Negative Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		Yes
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	3	Low Negative Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by Lower Neches Valley Authority
Implementation Issues	4	Low Implementation Issues

REFERENCES

Discussions with the Lower Neches Valley Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 58. CITY OF LUFKIN CONVEYANCE

Water User Group Name:	**City of Lufkin**
Strategy Name:	**Conveyance from Sam Rayburn to Kurth Lake**
Strategy ID:	**LUFK-RAY**
Strategy Type:	**Existing Surface Water Source**
Potential Supply Quantity:	**11,210 - 28,000 ac-ft/yr (10 - 25 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2030-2050**
Project Capital Cost:	**Phase 1: $78,220,000** **Phase 2: $78,199,000** **Phase 3: $8,834,000 (September 2018)**
Annual Cost:	**Phase 1: $14,413,000** **Phase 2: $27,911,000** **Phase 3: $25,722,000**
Unit Water Cost (Rounded):	**Phase 1: $1,286 per ac-ft ($3.95 per 1,000 gallons)** **Phase 2: $1,255 per ac-ft ($3.85 per 1,000 gallons)** **Phase 3: $919 per ac-ft ($2.82 per 1,000 gallons)**

PROJECT DESCRIPTION

This strategy is a recommended strategy for the City of Lufkin to provide conveyance from Sam Rayburn to Kurth Lake as their permit allows. The cost of the project will occur in three phases and includes the cost of a water treatment plant and infrastructure related to water conveyance. This is a supply that will provide water to both municipal and non-municipal customers in Angelina County; manufacturing in Angelina County is projected to have a need and has a strategy to contract water from this supply. Ultimately, manufacturing water users in Angelina County will make contracts with the City of Lufkin to purchase the water supply created by this project. The cost for raw water will need to be negotiated with the City of Lufkin and will reflect the wholesale water rates of this entity at the time a contract is made.

SUPPLY DEVELOPMENT

As requested by the City of Lufkin, the supply from this strategy represents their water right from Sam Rayburn for 28,000 ac-ft/yr. However, since the strategy will be implemented in phases, the full supply will not be available until 2050, pending the demands of potential future customers. The supply in 2030 will be 11,210 ac-ft/yr (10 MGD), 22,420 ac-ft/yr (20 MGD) in 2040, and 28,000 ac-ft/yr (25 MGD) in 2050. The reliability of this water supply is considered high due to the availability of water from the Sam Rayburn system and because the City of Lufkin already has the water right in place to access this water. In addition, the City of Lufkin would not be dependent on sponsorship from another entity

ENVIRONMENTAL CONSIDERATIONS

A specific location for the new water treatment plant has not been determined. Before this strategy could be pursued, a site selection study would need to be performed, in addition to other studies to identify and quantity potential environmental impacts associated with the projected. For the purposes of this analysis, it is assumed that a site could be selected that would have acceptable impacts. Once the water treatment plant is constructed, expanding the water treatment plant will have minimum environmental impacts.

During the construction of the pipeline, impacts to the environment and other natural resources are expected to be minimal and temporary.

PERMITTING AND DEVELOPMENT

Additional study and mitigation may be required before construction of the transmission pipeline.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below; an estimate was prepared for each phase of this strategy. The total capital cost assumes a pipeline length of 12.4 miles, and the water treatment plant would include a 5-million-gallon storage tank. The annual cost was estimated assuming a debt service of 3.5% for 20 years as well as electrical and operation and maintenance costs. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP NAME:	**Lufkin**				
STRATEGY:	**Develop Water from Sam Rayburn**				
Water Quantity	**28,000** AF/Y			37.5 MGD	
PHASE 1 - 2030 DECADE		**Total Capacity (ac-ft/yr)**			**11,210**
Treated Water Quantity	**11,210** AF/Y		**15** MGD		
Pipeline & Treatment Facility	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline from Sam Rayburn	30 in.	65,500	LF	$197	$12,896,000
Right of Way Easements Rural (ROW)		65,500	LF	$30	$1,967,000
Land and Surveying (10%)					$197,000
Engineering and Contingencies (30%)					$3,869,000
Subtotal of Pipeline	**12.4**	**Miles**			**$18,929,000**
Pump Station(s)					
Lake Intake and Pump Station	900 HP	1	LS	$17,465,000	$17,465,000
Engineering and Contingencies (35%)					$6,113,000
Subtotal of Pump Station(s)					**$23,578,000**
Water Treatment Facility					
Storage	5.00 MG	1	EA	$2,282,000	$2,282,000
Water Treatment Facility	10 MGD	1	LS	$20,886,000	$20,886,000
Engineering and Contingencies (35%)					$8,108,800
Subtotal of WTP					**$31,277,000**

Permitting and Mitigation				$358,133
Construction Total				**$74,142,000**
Interest During Construction		24	Months	$4,078,000
PHASE I TOTAL CAPITAL COST				**$78,220,000**
ANNUAL COSTS				
Debt Service (3.5% for 20 years)				$5,504,000
Debt Service from Previous Phase				$0
Electricity ($0.08 kWh)				$229,000
Operational Costs*				$5,027,000
Raw Water Treatment	3,653,000	1000 gal	$1.00	$3,653,000
TOTAL ANNUAL COST				**$14,413,000**
UNIT COSTS (Until Amortized)				
Per Acre-Foot of treated water				$1,286
Per 1,000 Gallons				$3.95
UNIT COSTS (After Amortization)				
Per Acre-Foot				$795
Per 1,000 Gallons				$2.44

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PHASE 2 - 2040 DECADE		**Total Capacity (ac-ft/yr)**			**22,240**
Treated Water Quantity	**11,210**	AF/Y		**15**	MGD
Expand Treated Water Supply	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline from Sam Rayburn	30 in.	65,500	LF	$197	$12,896,000
Right of Way Easements Rural (ROW)		65,500	LF	$30	$1,967,000
Land and Surveying (10%)					$197,000
Engineering and Contingencies (30%)					$3,869,000
Subtotal of Pipeline	**12.4**	**Miles**			**$0**
Upgrades to Pump Stations					
Lake Intake and Pump Station	900 HP	1	LS	$17,465,000	$17,465,000
Engineering and Contingencies (35%)					$6,112,750
Subtotal of Pump Station(s)					**$23,577,750**
Water Treatment Facility					
Storage	0.00 MG	0	EA	$0	$0
Upgrade Treatment Facility	22 MGD	1	LS	$37,162,000	$37,162,000
Engineering and Contingencies (35%)					$13,006,700
Subtotal of WTP					**$50,168,700**
Permitting and Mitigation					$375,066
Construction Total					**$74,122,000**
Interest During Construction			24	Months	$4,077,000
PHASE 2 TOTAL CAPITAL COST					**$78,199,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$5,502,000
Debt Service from Previous Phase					$5,504,000
Electricity ($0.08 kWh)					$458,000
Operational Costs*					$9,200,000
Raw Water Treatment		7,248,000	1000 gal	$1.00	$7,247,000
TOTAL ANNUAL COST					**$27,911,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$1,255
Per 1,000 Gallons					$3.85
UNIT COSTS (After Amortization)					
Per Acre-Foot					$760
Per 1,000 Gallons					$2.33

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PHASE 3 - 2050 DECADE		**Total Capacity (ac-ft/yr)**			**28,000**
Treated Water Quantity	**5,580**	AF/Y		**7**	MGD
Expand Pump Stations	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline from Sam Rayburn	30 in.	65,500	LF	$197	$12,896,000
Right of Way Easements Rural (ROW)		65,500	LF	$30	$1,967,000
Land and Surveying (10%)					$197,000
Engineering and Contingencies (30%)					$3,869,000
Subtotal of Pipeline	**12.4**	**Miles**			**$0**
Pump Station(s)					
Lake Intake and Pump Station	200 HP	1	LS	$5,958,000	$5,958,000
Engineering and Contingencies (35%)					$2,085,300
Subtotal of Pump Station(s)					**$8,043,300**
Water Treatment Facility					
Storage	0.00 MG	0	EA	$0	$0
Water Treatment Facility	0 MGD	0	LS	$0	$0
Engineering and Contingencies (35%)					$0
Subtotal of WTP					**$0**
Permitting and Mitigation					$330,133
Construction Total					**$8,373,000**
Interest During Construction			24	Months	$461,000
PHASE 3 TOTAL CAPITAL COST					**$8,834,000**
ANNUAL COSTS					
Debt Service (3.5% for 20 years)					$622,000
Debt Service from Previous Phase					$5,502,000
Electricity ($0.08 kWh)					$536,000
Operational Costs*					$9,938,000
Raw Water Treatment		9,125,000	1000 gal	$1.00	$9,124,000
TOTAL ANNUAL COST					**$25,722,000**
UNIT COSTS (Until Amortized)					
Per Acre-Foot of treated water					$919
Per 1,000 Gallons					$2.82

UNIT COSTS (After Amortization)

Per Acre-Foot	$700
Per 1,000 Gallons	$2.15

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

This strategy benefits both municipal and non-municipal customers in Angelina County, specifically manufacturing water users. Angelina Manufacturing has a recommended strategy to purchase water from Lufkin created by this new supply (Strategy ID: ANGL-MFG1). Overall, providing conveyance from Sam Rayburn to Kurth Lake will have a positive impact on their water supply security. This analysis did not identify any impacts to agricultural or natural resources or to key parameters of water quality. This project may reduce demands on other water resources in Angelina County; however, the project is not expected to impact any other State water resources.

Based on the analyses provided above, the City of Lufkin recommended strategy to develop supplies from Sam Rayburn in Angelina County was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the 2021 East Texas Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 28,000 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by the City of Lufkin
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 59. CITY OF NACOGDOCHES RAW WATER TRANSMISSION

Project Name:	**Lake Columbia to Nacogdoches Raw Water Transmission System**
Project ID:	**NACP-COL**
Project Type:	**Existing Surface Water Source**
Potential Supply Quantity (Rounded):	**8,551 ac-ft/yr (7.6 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**2 years**
Project Capital Cost:	**$50,754,000 (September 2018)**
Project Annual Cost:	**$6,739,000**
Unit Water Cost (Rounded):	**$788 per ac-ft (during loan period) $2.42 (per 1,000 gallons)**

PROJECT DESCRIPTION

Lake Columbia is a water management strategy for Angelina Nacogdoches River Authority. Angelina Neches River Authority has contracts with several customers that are participants in the project development. City of Nacogdoches is included in the list, participating at 10 percent contribution, respectively. It is assumed that Nacogdoches will be purchasing raw water from Angelina Neches River Authority. City of Nacogdoches will need a transmission project to transfer supplies from Lake Columbia to the City.

The water management strategy associated with the transmission project is discussed in this technical memorandum. The total current contract amount for City of Nacogdoches is 8,551 ac-ft/yr (7.6 MGD). It is assumed that the transmission strategy will be developed for a potential supply of 8,551 ac-ft/yr. The transmission project will include a 3.5-mile pipeline from Lake Columbia to the City, an intake pump station, and a 12-MGD water treatment plant to treat the supplies before delivery.

PERMITTING AND DEVELOPMENT

No additional permitting issues associated with the project. The project will commence after the commencement of the Lake Columbia project by Angelina Neches River Authority.

PLANNING LEVEL OPINION OF COST

Included below is a planning level opinion of cost (PLOC) for the pipeline from Lake Columbia to City of Nacogdoches. Costs are estimated for 3.5 miles of pipeline in urban areas. The transmission system cost estimate also includes the cost of 324 HP intake pump station and a 12 MGD water treatment plant for treating the raw water. The annual costs are calculated assuming 3.5% interest rate and 20 years of return period. The estimate includes the cost for the purchase of raw water from Angelina Neches River Authority. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP NAME: **Nacogdoches**
STRATEGY: **Lake Columbia Transmission System**
Quantity: **8,551** AF/Y 11.44 MGD

CAPITAL COSTS					
Pipeline to Lake Nacogdoches	**Size**	**Qty**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	30 in.	18,117	LF	$197	$3,567,000
Right of Way Easements Rural (ROW)		18,117	LF	$30	$544,000
Land and Surveying (10%)					$54,000
Engineering and Contingencies (30%)					$1,070,000
Subtotal of Pipeline					**$5,235,000**
Pump Station(s)					
Pump with intake & building	324 HP	1	LS	$7,991,000	$7,991,000
Engineering and Contingencies (35%)					$2,797,000
Subtotal of Pump Station(s)					**$10,788,000**
Water Treatment Facility					
Expand Existing Water Treatment Plant	12 MGD	1	LS	$22,731,000	$22,731,000
Storage Tanks	1.43 MG	1	LS	$934,000	$934,000
Engineering and Contingencies (35%)					$8,283,000
Subtotal of WTP					**$31,948,000**
Permitting and Mitigation					$136,665
Construction Total					**$48,108,000**
Interest During Construction			24	Months	$2,646,000
TOTAL COST					**$50,754,000**

ANNUAL COSTS	
Debt Service (3.5% for 20 years)	$3,571,000
Operational Costs*	$3,168,000
TOTAL ANNUAL COST	**$6,739,000**

UNIT COSTS (Until Amortized)	
Per Acre-Foot of treated water	$788
Per 1,000 Gallons	$2.42

UNIT COSTS (After Amortization)	
Per Acre-Foot	$370
Per 1,000 Gallons	$1.14

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

Based on the analysis provided above, the Lake Columbia to Nacogdoches Raw Water Transmission System

project was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 8,551 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	4	Sponsor is identified and committed to strategy. Local sponsorship by the City of Nacogdoches
Implementation Issues	3	Low Implementation Issues. Dependent on the completion of Lake Columbia project

REFERENCES

2016 East Texas Regional Water Plan

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 60. CITY OF TYLER LAKE PALESTINE EXPANSION

Project Name:	**City of Tyler – Lake Palestine Expansion**
Project ID:	**TYLR-PAL**
Project Type:	**Existing Surface Water Source**
Potential Supply Quantity (Rounded):	**16,815 ac-ft/yr (15 MGD)**
Implementation Decade:	**2030**
Development Timeline:	**1 years**
Project Capital Cost:	**$111,190,000 (September 2018)**
Project Annual Cost:	**$15,385,000**
Unit Water Cost (Rounded):	**$915 per ac-ft (during loan period) $2.81 (per 1,000 gallons)**

PROJECT DESCRIPTION

The current supplies for the City include 34 MGD from Lake Tyler, 30 MGD from Lake Palestine, 0.4 MGD from Bellwood Lake, and 12 groundwater wells in Carrizo Wilcox aquifer producing approximately 8 MGD. The City of Tyler is shown to have sufficient supplies through the planning period using the TWDB approved demand projections.

In addition, there is considerable interest in other users in Smith County contracting with the City of Tyler for water supplies. There are recommended strategies for Tyler to provide additional water to Bullard, Crystal Systems Texas, Lindale, Walnut Grove WSC, Mining, and Manufacturing in Smith County. Until 2060, City of Tyler has sufficient supplies to meet the proposed demands for the potential future customers. City of Tyler has a small shortage in 2070 when current and future customer demands are taken into consideration.

City of Tyler proposed the following recommended strategies for the 2021 regional plan. City of Tyler will develop the additional 30 MGD of Lake Palestine water. The City has developed about half of its contracted supply in Lake Palestine and plans to develop the remaining supply by 2030, as part of its long-term water supply plan.

SUPPLY DEVELOPMENT

The supply for this strategy represents City of Tyler's contract with Upper Neches River Municipal Water Authority for 67,200 ac-ft/yr supplies from Lake Palestine. City of Tyler has transmission capacity to access half of the supplies and plans to develop this recommended strategy to access the other half.

ENVIRONMENTAL CONSIDERATIONS

A specific location for the new water treatment plant has been determined. The new water treatment plant will be at the same location as the current plant and the process train will be a mirror image of the current process train. For the purposes of this analysis, it is assumed that the current site would have acceptable impacts. Once the water treatment plant is constructed, expanding the water treatment plant will have minimum environmental impacts. During the construction of the pipeline, impacts to the environment and other natural resources are expected to be minimal and temporary.

PERMITTING AND DEVELOPMENT

Additional study and mitigation may be required before construction of the transmission pipeline.

PLANNING LEVEL OPINION OF COST

A planning level opinion of cost (PLOC) for this strategy is included in the table below. The total capital cost assumes a pipeline length of 5 miles, and 30 MGD water treatment plant would include a 2-million-gallon storage tank. The annual cost was estimated assuming a debt service of 3.5% for 20 years as well as electrical and operation and maintenance costs. Overall, this strategy has a high cost compared to other strategies in the 2021 East Texas Regional Water Plan.

WWP NAME: **City of Tyler**
STRATEGY: **Lake Palestine Expansion**
Quantity: **16,815** AF/Y 30 MGD

CAPITAL COSTS

Pipeline	**Size**	**Quantity**	**Unit**	**Unit Price**	**Cost**
Pipeline Rural	42 in.	23,400	LF	$283	$6,613,000
Pipeline Urban	42 in.	3,000	LF	$370	$1,109,000
Right of Way Easements Rural (ROW)		23,400	LF	$30	$703,000
Right of Way Easements Urban (ROW)		3,000	LF	$180	$540,000
Land and Surveying Rural (10%)					$70,000
Land and Surveying Urban (10%)					$54,000
Engineering and Contingencies (30%)					$2,317,000
Subtotal of Pipeline		**5**	**mile**		**$11,406,000**
Pump Station(s)					
Ground Storage Tanks	2 MG	1	LS	$1,102,000	$1,102,000
Booster Pump Station	1400 HP	1	LS	$8,357,000	$8,357,000
Engineering and Contingencies (35%)					$3,311,000
Subtotal of Pump Station(s)					**$12,770,000**
Water Treatment Facility					
Expand Water Treatment Plant	30 MGD	1	LS	$62,137,000	$62,137,000
Engineering and Contingencies (35%)					$21,748,000
Subtotal of WTP					**$83,885,000**
Permitting and Mitigation					$153,000
Construction Total					**$108,214,000**
Interest During Construction			12	Months	$2,976,000
TOTAL COST					**$111,190,000**

ANNUAL COSTS

Debt Service (3.5% for 20 years)			$7,823,000
Electricity ($0.08 kWh)			$216,000
Operational Costs*			$7,562,000
Raw Water Purchase	1000 gal	$1.00	$5,479,000
TOTAL ANNUAL COST			**$15,385,000**

UNIT COSTS (Until Amortized)

Per Acre-Foot of treated water	$915
Per 1,000 Gallons	$2.81

UNIT COSTS (After Amortization)

Per Acre-Foot	$788
Per 1,000 Gallons	$2.42

* Includes, as appropriate, operation and maintenance, power, water purchase (raw or treated), water treatment chemicals, well pumping (for groundwater), ongoing regulatory support (as needed) and other anticipated annual operating costs.

PROJECT EVALUATION

Based on the analysis provided above, the City of Tyler Lake Palestine Expansion project was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 16,815 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor is identified and committed to strategy. Local sponsorship by the City of Tyler
Implementation Issues	4	Low Implementation Issues

REFERENCES

2016 East Texas Regional Water Plan.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 61. UNRMWA NECHES RUN-OF-RIVER WITH LAKE PALESTINE

WMS Name:	**Run of River, Neches with Lake Palestine**
WMS Project ID:	**UNM-LP**
WMS Type:	**New Surface Water Source**
Potential Supply Quantity (Rounded):	**68,625 ac-ft/yr (61.2 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2-4 years**
Strategy Capital Cost:	**$518,977,000 (September 2018)**
Strategy Annual Cost:	**$47,246,000**
Unit Water Cost (Rounded):	**$688 per ac-ft (during loan period) $2.11 (per 1,000 gallons)**

STRATEGY DESCRIPTION

The Upper Neches River Municipal Water Authority (UNRMWA) owns and operates the Lake Palestine system in the Neches River Basin. Upper Neches River Municipal Water Authority has a water right for 238,110 ac-ft/yr from Lake Palestine and a downstream run-of-river diversion. City of Palestine, City of Tyler, and City of Dallas have contracts for supplies from Lake Palestine for amounts of 28,000 ac-ft/yr, 67,200 ac-ft/yr, and 114,337 ac-ft/yr, respectively. After supplying the contracted amounts to these three contracted customers, Upper Neches River Municipal Water Authority is expected to have 28,573 ac-ft/yr available to supply to other entities in ETRWPA.

Based on current contracts and the available supplies from the Neches Basin WAM, the UNRMWA shows a small shortage during the planning period for Lake Palestine supplies. UNRMWA does not think the shortages to be real as the shortage is primarily associated with the reduced firm yield of Lake Palestine due to projected sediment accumulation in the lake. UNRMWA believes that the storage-area-elevation curves used in the Water Availability Models are severely under-predicting the storage volumes available in various parts of the lake. UNRMWA believes that the sedimentation studies did not perform a thorough evaluation of the storage volumes of the lake and left out major portions of the lake without surveying as there were access issues. Therefore, UNRMWA believes that the lake yield is much larger than what is projected by the Water Availability Models.

To address the shortages for the planning period UNRMWA has evaluated multiple potentially feasible WMSs and have various recommendation for the 2021 ETRWPA Regional Plan. UNRMWA and City of Dallas are considering development of a water supply project from the run-of-river diversions on Upper Neches River and using Lake Palestine, tributary storage, and/or groundwater as system resources. Using the run-of-river diversions operated as a system with Lake Palestine is the recommended strategy. Run-of-river diversions operated as a system with off-channel tributary storage and as conjunctive use along with groundwater are proposed as alternative strategies. All the potentially feasible WMSs for UNRMWA and City of Dallas are discussed in the 2015 Report *Upper Neches River Water Supply Project Feasibility Study*.

STRATEGY DEVELOPMENT

This recommended strategy includes run-of-river diversions near SH 21 on Neches River operated as a system with storage in Lake Palestine. UNRMWA will be the project sponsor for this WMS. The run-of-river diversions will be taken from the river segment between the existing Rocky Point diversion and the Weches Dam site below the SH21 crossing, between the Neches River National Wildlife Refuge and upstream of the Weches Dam site. The run-of-the-river diversions will be authorized under a new appropriation of surface water, subject to senior water rights and environmental flows. New facilities required for this WMS include a small diversion dam on the Neches River, a river intake and pump station,

and a transmission pipeline and booster pump station supporting transmission to Lake Palestine. The run-of-river diversions are an interruptible supply and the firm yield associated with the WMS is the incremental increase in the firm yield of Lake Palestine resulting from the system operation of the new diversions and the transmission facilities with the Lake Palestine.

The feasibility report includes multiple infrastructure alternatives for the recommended strategy, each resulting in a different amount of firm yield at Lake Palestine. Run-of-river diversions with a 108-inch transmission pipeline and a pump station capacity of 317 cfs was selected as the recommended transmission system to yield 68,625 ac-ft/yr of firm yield at Lake Palestine. It should be noted that the project configuration for the recommended WMS for UNRMWA in the 2021 ETRWPA Regional Plan is different from the configuration discussed in Dallas' October 2014 Draft Long Range Water Supply Plan (Draft LRWSP). The project configuration discussed in the City of Dallas Draft LRWSP resulted in a firm yield of 47,250 ac-ft/yr (42 MGD) that is projected to meet Dallas needs starting 2070. A project configuration with a larger firm yield was recommended in ETRWPA Regional Plan so as to meet the projected needs for City of Dallas, shortages for UNRMWA associated with reduced Lake Palestine yield due to sedimentation, and needs for other potential customers in ETRWPA. For regional planning purposes, the WMS is expected to be online in 2020 to address the shortages projected for the current contracted customers for Lake Palestine and potential steam electric power customers in Anderson County. The WMS timing can be changed to a later date if the timing of needs for the current contracted customers and steam-electric power customers changes. City of Dallas is expected to use their share of supplies from this WMS starting in 2060.

SUPPLY DEVELOPMENT

Availability of the Run-of-River supplies was determined using the Neches Basin Water Availability Model and reported in the 2015 Report *Upper Neches River Water Supply Project Feasibility Study.* Environmental flow needs were considered through the use of the TCEQ WAM Run 3 scenario, which includes Senate Bill 3 environmental flow criteria, as the basis for the calculation of yield for the Run-of-River supplies.

PERMITTING AND DEVELOPMENT

The Neches River Run-of-the-River Diversion would require a new water rights permit and an interbasin transfer permit.

COST ANALYSIS

The cost estimates for the Run-of-River strategy were obtained from the 2015 Report *Upper Neches River Water Supply Project Feasibility Study.* Additional details of the cost estimates can be obtained from the report.

PROJECT EVALUATION

Based on the analysis provided above, the Neches River Run-of-the-River Diversion strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 68,625 ac-ft/yr
Reliability	4	Medium to High
Cost	3	$500 to $1,000/ac-ft (Medium)
Environmental Factors	3	Low Negative Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. Local sponsorship by UNRMWA
Implementation Issues	2	Medium High Implementation Issues. Need to secure the run-of-river rights

WATER USER GROUP APPLICATION

The Neches River Run-of-the-River Diversion strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the auditability of the strategy to the WUGs served.

REFERENCES

Discussions with Upper Neches River Municipal Water Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 62. UNRMWA NECHES RUN-OF-RIVER WITH TRIBUTARY STORAGE

WMS Name:	**Run of River, Neches with Tributary Storage**
Alternative WMS Project ID:	**UNM-TS**
Alternative WMS Type:	**New Surface Water Source**
Alternative Potential Supply Quantity (Rounded):	**75,000 ac-ft/yr (67 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2-4 years**
Strategy Capital Cost:	**$404,497,000 (September 2018)**
Strategy Annual Cost:	**$26,598,000**
Unit Water Cost (Rounded):	**$355 per ac-ft (during loan period)** **$1.09 (per 1,000 gallons)**

STRATEGY DESCRIPTION

The Upper Neches River Municipal Water Authority (UNRMWA) owns and operates the Lake Palestine system in the Neches River Basin. Upper Neches River Municipal Water Authority has a water right for 238,110 ac-ft/yr from Lake Palestine and a downstream run-of-river diversion. City of Palestine, City of Tyler, and City of Dallas have contracts for supplies from Lake Palestine for amounts of 28,000 ac-ft/yr, 67,200 ac-ft/yr, and 114,337 ac-ft/yr, respectively. After supplying the contracted amounts to these three contracted customers, Upper Neches River Municipal Water Authority is expected to have 28,573 ac-ft/yr available to supply to other entities in ETRWPA.

Based on current contracts and the available supplies from the Neches Basin WAM, the UNRMWA shows a small shortage during the planning period for Lake Palestine supplies. UNRMWA does not think the shortages to be real as the shortage is primarily associated with the reduced firm yield of Lake Palestine due to projected sediment accumulation in the lake. UNRMWA believes that the storage-area-elevation curves used in the Water Availability Models are severely under-predicting the storage volumes available in various parts of the lake. Therefore, UNRMWA believes that the lake yield is much larger than what is projected by the Water Availability Models.

To address the shortages for the planning period UNRMWA has evaluated multiple potentially feasible WMSs and have various recommendation for the 2021 ETRWPA Regional Plan. UNRMWA and City of Dallas are considering development of a water supply project from the run-of-river diversions on Upper Neches River and using Lake Palestine, tributary storage, and/or groundwater as system resources. Using the run-of-river diversions operated as a system with Lake Palestine is the alternative strategy. Run-of-river diversions operated as a system with off-channel tributary storage and as conjunctive use along with groundwater are proposed as alternative strategies. All the potentially feasible WMSs for UNRMWA and City of Dallas are discussed in the 2015 Report *Upper Neches River Water Supply Project Feasibility Study*.

STRATEGY DEVELOPMENT

The first alternative strategy for UNRMWA includes new run-of-river diversions from the Neches River segment between the existing Rocky Point diversion dam and the Weches dam site with storage in a new tributary or off-channel reservoir. This alternative strategy includes system operations with Lake Palestine. Facilities for implementation of this WMS include a small diversion dam on the Neches River, a high capacity river intake pump station, a transmission pipeline to the reservoir, and a tributary or off-channel reservoir. The interruptible run-of-river diversions will be backed up using stored water in the tributary or off-channel reservoir. Run-of-river diversions and any impoundment of local runoff in a tributary or off-channel reservoir are subject to inflow passage for senior water rights and environmental protection. The alternative infrastructure combinations for this WMS can provide a firm yield of 75,000 ac-ft/yr (67 MGD).

SUPPLY DEVELOPMENT

Availability of the Run-of-River supplies was determined using the Neches Basin Water Availability Model and reported in the 2015 Report *Upper Neches River Water Supply Project Feasibility Study.* Environmental flow needs were considered through the use of the TCEQ WAM Run 3 scenario, which includes Senate Bill 3 environmental flow criteria, as the basis for the calculation of yield for the Run-of-River supplies.

PERMITTING AND DEVELOPMENT

The Neches River Run-of-the-River Diversion would require a new water rights permit and an interbasin transfer permit.

ENVIRONMENTAL CONSIDERATIONS

The cost estimates for the Run-of-River strategy were obtained from the 2015 Report *Upper Neches River Water Supply Project Feasibility Study.* Additional details of the cost estimates can be obtained from the report.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the Neches River Run-of-the-River with Tributary Storage strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 75,000 ac-ft/yr
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	3	Low Negative Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor identified; commitment level uncertain. UNRMWA is the local sponsor for this strategy
Implementation Issues	2	Medium High Implementation Issues. Need to secure the run-of-river rights

WATER USER GROUP APPLICATION

The Neches River Run-of-the-River Tributary Storage strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the strategy as well as other factors that may relate to the auditability of the strategy to the WUGs served.

REFERENCES

Discussions with Upper Neches River Municipal Water Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 63. UNRMWA NECHES RUN-OF-RIVER WITH GROUNDWATER

WMS Name:	**Run of River, Neches with Groundwater**
Alternative WMS Project ID:	**UNM-GW**
Alternative WMS Type:	**New Surface Water Source**
Alternative Potential Supply Quantity (Rounded):	**84,875 ac-ft/yr (76 MGD)**
Implementation Decade:	**2020**
Development Timeline:	**2-4 years**
Strategy Capital Cost:	**$326,646,000 (September 2018)**
Strategy Annual Cost:	**$38,237,000**
Unit Water Cost (Rounded):	**$451 per ac-ft (during loan period)** **$1.38 (per 1,000 gallons)**

STRATEGY DESCRIPTION

The Upper Neches River Municipal Water Authority (UNRMWA) owns and operates the Lake Palestine system in the Neches River Basin. Upper Neches River Municipal Water Authority has a water right for 238,110 ac-ft/yr from Lake Palestine and a downstream run-of-river diversion. City of Palestine, City of Tyler, and City of Dallas have contracts for supplies from Lake Palestine for amounts of 28,000 ac-ft/yr, 67,200 ac-ft/yr, and 114,337 ac-ft/yr, respectively. After supplying the contracted amounts to these three contracted customers, Upper Neches River Municipal Water Authority is expected to have 28,573 ac-ft/yr available to supply to other entities in ETRWPA.

Based on current contracts and the available supplies from the Neches Basin WAM, the UNRMWA shows a small shortage during the planning period for Lake Palestine supplies. UNRMWA does not think the shortages to be real as the shortage is primarily associated with the reduced firm yield of Lake Palestine due to projected sediment accumulation in the lake. UNRMWA believes that the storage-area-elevation curves used in the Water Availability Models are severely under-predicting the storage volumes available in various parts of the lake. Therefore, UNRMWA believes that the lake yield is much larger than what is projected by the Water Availability Models.

To address the shortages for the planning period UNRMWA has evaluated multiple potentially feasible WMSs and have various recommendation for the 2021 ETRWPA Regional Plan. UNRMWA and City of Dallas are considering development of a water supply project from the run-of-river diversions on Upper Neches River and using Lake Palestine, tributary storage, and/or groundwater as system resources. Using the run-of-river diversions operated as a system with Lake Palestine is the recommended strategy. Run-of-river diversions operated as a system with off-channel tributary storage and as conjunctive use along with groundwater are proposed as alternative strategies. All the potentially feasible WMSs for UNRMWA and City of Dallas are discussed in the 2015 Report *Upper Neches River Water Supply Project Feasibility Study*.

STRATEGY DEVELOPMENT

A conjunctive use WMS is the second proposed alternative strategy for UNRMWA. The WMS includes new run-of-river diversions from the Neches River segment between the existing Rocky Point diversion dam and the Weches dam site with groundwater supplies from new wells in Carrizo, Wilcox, and Queen City aquifers in Anderson and Cherokee Counties. This alternative strategy includes system operations with Lake Palestine. New facilities for the implementation of this WMS include a small diversion dam on the Neches River, a river intake and pump station, wells located on properties controlled by Campbell Timberland Management, LLC and Forestar (USA) Real Estate Group, Inc., and a transmission system for the delivery of the supplies to the potential customers. The interruptible run-of-river supplies will be backed up using

groundwater delivered to the run-of-river diversion point using bed and banks of the Neches River and several tributary streams. The run-of-river diversions are subject to inflow passage for senior water rights and environmental protection, but the groundwater supplies are not. The recommended infrastructure combinations for this WMS can provide a firm yield of 84,875 ac-ft/yr (76 MGD).

SUPPLY DEVELOPMENT

Availability of the Run-of-River supplies was determined using the Neches Basin Water Availability Model and reported in the 2015 Report *Upper Neches River Water Supply Project Feasibility Study.* Environmental flow needs were considered through the use of the TCEQ WAM Run 3 scenario, which includes Senate Bill 3 environmental flow criteria, as the basis for the calculation of yield for the Run-of-River supplies.

PERMITTING AND DEVELOPMENT

The Neches River Run-of-the-River Diversion would require a new water rights permit and an interbasin transfer permit.

COST ANALYSIS

The cost estimates for the Run-of-River strategy were obtained from the 2015 Report *Upper Neches River Water Supply Project Feasibility Study.* Additional details of the cost estimates can be obtained from the report.

WATER MANAGEMENT STRATEGY EVALUATION

Based on the analysis provided above, the groundwater supply strategy was evaluated across eleven different criteria for the purpose of quick comparison against alternative strategies that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity	4	Meets 75-100% of Shortage. 84,875 ac-ft/yr
Reliability	4	Medium to High
Cost	4	$0 to $500/ac-ft (Low)
Environmental Factors	3	Low Negative Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	3	Sponsor is identified, commitment level uncertain. UNRMWA is the local sponsor for this strategy
Implementation Issues	2	Medium High Implementation Issues. Need to secure groundwater rights

WATER USER GROUP APPLICATION

The groundwater strategy was evaluated on a basis of several criteria to determine the Water User Groups (WUGs) to which it may be applied. Consideration was given to the proximity of the project to identified needs, the volume of the supply made available, the quality of the water provided, and the unit cost of the

strategy as well as other factors that may relate to the auditability of the strategy to the WUGs served.

REFERENCES

Discussions with Upper Neches River Municipal Water Authority.

WATER MANAGEMENT STRATEGY ANALYSIS TECHNICAL MEMORANDUM FOR 64. MUNICIPAL CONSERVATION

Project Name:	**Municipal Conservation – Multiple Water Users**
Project ID:	**WUG_CONS**
Project Type:	**Conservation**
Potential Supply Quantity (Rounded):	**Varies, Specific to WUG**
Implementation Decade:	**Varies, Specific to WUG**
Development Timeline:	**Varies, Specific to WUG**
Project Capital Cost:	**Varies, Specific to WUG**
Annual Cost:	**Varies, Specific to WUG**
Unit Water Cost (Rounded):	**Varies, Specific to WUG**

STRATEGY DESCRIPTION

Water Conservation best management practices were evaluated for municipal water user groups that have a projected per capita water use greater than 140 gpcd and have either demonstrated needs in the planning period or recommended water management strategies that involve interbasin transfer. Evaluated water conservation practices included enhanced public and school education, water conservation pricing, and an enhanced water loss control program. In ETRWPA, water conservation strategies are identified for the following list of municipal water user groups. In addition to this basic and advanced conservation strategies are proposed for the following wholesale water providers with municipal customers. Discussion of the basic conservation measures, conservation savings, and the corresponding annual costs for these municipal water user groups is discussed in this technical memorandum.

City of Beaumont. The City is projected to have a water shortage beginning in 2040. In 2011, the City had an average per capita consumption of 217 gpcd, well over the statewide goal of 140 gpcd. The City's per capita consumption reduced over the years to 162 gpcd in 2015. After performing a conservation cost estimate, the ETRWPG believes a water conservation strategy for the City is economically achievable. This recommended strategy includes planning level opinion of probable construction cost estimates related to enhanced public and school education, water conservation pricing implementation, and an enhanced water loss control program. The proposed municipal conservation strategy would reduce Beaumont's demand by more than their projected need in 2040 and 2050. However, an additional water management strategy is necessary in 2060 and 2070.

City of Port Arthur. The City provides treated water to municipal users both inside and outside their city limits and industrial users including Cheniere LNG and Motiva Enterprises. Port Arthur is not projected to have a water shortage within the planning period. However, the City had an average per capita consumption of 320 gpcd in 2011. This value is well over the statewide goal of 140 gpcd. In addition, their 2013 Water Loss Report submitted to the TWDB had a total percent loss of over 66%. After performing a conservation analysis, the ETRWPG believes a water conservation strategy for the City is economically achievable. The recommended water management strategy for Port Arthur is water conservation, which includes planning level opinion of probable construction cost estimates related to enhanced public and school education, water conservation pricing implementation, and an enhanced water loss control program.

SUPPLY DEVELOPMENT

The supply for this strategy represents conservation savings due to enhanced public and school education, water conservation pricing implementation, and an enhanced water loss control program. Below is a table showing the conservation savings for the municipal water user groups.

ENVIRONMENTAL CONSIDERATIONS, PERMITTING AND DEVELOPMENT

No environmental considerations associated with this strategy. No additional permitting required for this strategy.

WUG	Conservation Amount (Acre-ft/yr)						Capital Costs	Annual Costs	Unit Cost Before Amortization	
	2020	2030	2040	2050	2060	2070			$/ac-ft	$/1000 gal
ALTO	4	6	7	7	9	10	$0	$3,000	$325.58	$1.00
ALTO RURAL WSC	9	16	18	21	25	28	$0	$8,000	$316.24	$0.97
APPLEBY WSC	9	17	20	23	27	32	$0	$9,000	$335.94	$1.03
ARP	2	0	0	0	0	0	$0	$2,000	$1,000.00	$3.07
ATHENS	7	13	16	20	23	27	$786,000	$25,000	$1,155.70	$3.55
BEAUMONT	2,027	3,425	4,202	5,112	6,171	7,382	$60,175,000	$2,076,000	$370.87	$1.14
BLACKJACK WSC	2	3	4	5	5	6	$0	$2,000	$360.00	$1.10
BROWNSBORO	3	0	0	0	0	0	$0	$2,000	$666.67	$2.05
BULLARD	11	22	28	36	44	54	$0	$14,000	$297.44	$0.91
CARTHAGE	23	39	41	44	47	50	$0	$11,000	$266.39	$0.82
CENTER	26	45	52	57	64	70	$0	$11,000	$187.90	$0.58
CHANDLER	9	17	21	26	32	36	$0	$11,000	$361.70	$1.11
CHESTER WSC	2	5	5	5	6	6	$0	$2,000	$413.79	$1.27
COLMESNEIL	4	6	6	7	7	8	$0	$2,000	$315.79	$0.97
COUNTY-OTHER, HOUSTON	2	3	3	4	4	4	$0	$1,000	$300.00	$0.92
COUNTY-OTHER, JEFFERSON	34	0	0	0	0	0	$0	$20,000	$588.24	$1.80
CROCKETT	19	29	30	32	34	36	$0	$11,000	$366.67	$1.13
CRYSTAL SYSTEMS TEXAS	18	38	52	71	92	118	$954,000	$39,000	$471.16	$1.45
CUSHING	10	19	24	30	37	45	$1,030,000	$42,000	$1,083.14	$3.32
CYPRESS CREEK WSC	2	3	3	3	3	4	$0	$1,000	$333.33	$1.02
DEAN WSC	11	18	0	0	0	0	$0	$7,000	$482.76	$1.48
ELKHART	4	6	6	7	7	8	$0	$2,000	$315.79	$0.97
FRANKSTON	4	6	7	7	7	8	$0	$2,000	$307.69	$0.94
GARRISON	4	6	8	9	10	12	$0	$3,000	$285.71	$0.88
HEMPHILL	4	8	7	7	8	8	$0	$2,000	$285.71	$0.88
HENDERSON	83	148	179	235	283	334	$9,900,000	$370,000	$1,430.53	$4.39
JACKSONVILLE	50	85	110	129	152	178	$0	$42,000	$291.19	$0.89

WUG	Conservation Amount (Acre-ft/yr)						Capital Costs	Annual Costs	Unit Cost Before Amortization	
	2020	2030	2040	2050	2060	2070			$/ac-ft	$/1000 gal
JASPER	75	124	141	158	178	196	$15,444,000	$532,000	$3,007.61	$9.23
KILGORE	10	19	21	25	28	32	$0	$8,000	$288.89	$0.89
KIRBYVILLE	6	9	10	11	11	12	$0	$3,000	$305.08	$0.94
LINDALE	7	14	18	23	29	36	$0	$8,000	$259.84	$0.80
LOVELADY	2	3	3	3	4	4	$0	$1,000	$315.79	$0.97
LUFKIN	151	239	273	0	0	0	$0	$60,000	$271.49	$0.83
MT ENTERPRISE WSC	4	8	0	0	0	0	$0	$3,000	$500.00	$1.53
NACOGDOCHES	247	426	532	656	802	966	$27,720,000	$986,000	$1,349.27	$4.14
NEW LONDON	13	22	26	30	36	40	$0	$6,000	$173.65	$0.53
NEWTON	6	10	10	11	12	12	$0	$4,000	$393.44	$1.21
NORWOOD WSC	2	0	0	0	0	0	$0	$1,000	$500.00	$1.53
OVERTON	8	15	18	21	24	28	$0	$7,000	$289.47	$0.89
PALESTINE	81	129	140	150	161	172	$0	$30,000	$212.48	$0.65
PANOLA-BETHANY WSC	0	0	0	0	1	2	$0	$0	$0.00	$0.00
PLEASANT SPRINGS WSC	2	4	5	5	5	6	$0	$2,000	$407.41	$1.25
PORT ARTHUR	2,708	4,449	5,222	6,029	6,844	7,664	$51,618,000	$1,981,000	$295.29	$0.91
RUSK	15	26	30	34	40	46	$0	$14,000	$361.26	$1.11
SAN AUGUSTINE	10	17	18	20	22	23	$2,297,000	$79,000	$3,660.77	$11.23
SAND HILLS WSC	4	8	8	9	10	12	$0	$3,000	$352.94	$1.08
SOUTHERN UTILITIES	514	866	1,058	1,279	1,527	1,803	$33,264,000	$1,249,000	$807.75	$2.48
TATUM	4	8	9	10	12	14	$0	$4,000	$315.79	$0.97
TDCJ BETO GURNEY & POWLEDGE UNITS	16	27	29	30	32	34	$0	$6,000	$208.33	$0.64
TDCJ COFFIELD MICHAEL	44	75	80	85	91	96	$0	$8,000	$101.91	$0.31
TDCJ EASTHAM UNIT	15	25	27	29	30	32	$0	$4,000	$151.90	$0.47
TENAHA	4	6	6	7	8	8	$0	$2,000	$307.69	$0.94
TROUP	6	11	12	14	17	18	$0	$5,000	$320.51	$0.98
TYLER	657	1,101	1,338	1,613	1,924	2,268	$58,766,000	$2,026,000	$1,123.06	$3.45

WUG	Conservation Amount (Acre-ft/yr)						Capital Costs	Annual Costs	Unit Cost Before Amortization	
	2020	2030	2040	2050	2060	2070			$/ac-ft	$/1000 gal
WELLS	2	0	0	0	0	0	$0	$1,000	$500.00	$1.53
WILDWOOD POA	4	6	7	7	8	8	$0	$2,000	$300.00	$0.92
WOODVILLE	17	28	30	32	34	36	$0	$9,000	$305.08	$0.94

COST ANALYSIS

Capital costs were identified for some of the conservation strategies. Table above includes a summary of capital costs, annual costs, and the unit costs for the water users with conservation strategies.

PROJECT EVALUATION

Based on the analysis provided above, the municipal conservation project was evaluated across eleven different criteria for the purpose of quick comparison against alternative projects that may be incorporated into the Regional Water Plan. The results of this evaluation can be seen in the table below.

Criteria	Rating	Explanation
Quantity		Varies, Specific to Entities
Reliability	4	Medium to High
Cost	3	Varies, Specific to Entities
Environmental Factors	4	Low Negative Impacts / Some Positive Impacts
Impact on Other State Water Resources	4	Low Negative Impacts / Some Positive Impacts
Threat to Agricultural Resources/Rural Areas	4	Low Negative Impacts / Some Positive Impacts
Interbasin Transfers		No
Other Natural Resources	4	Low Negative Impacts / Some Positive Impacts
Major Impacts on Key Water Quality Parameters	4	Low Negative Impacts / Some Positive Impacts
Political Feasibility	2	Varies, Specific to Entities
Implementation Issues	4	Low Implementation Issues, Limited Risk

REFERENCES

2021 East Texas Regional Water Plan.

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