5C Evaluation of Major Water Management Strategies

The total water needs for Region C increase to almost 1.3 million acre-feet by 2070. To meet these large needs, the region has identified a diverse list of potential water management strategies.

Each of these strategies is described in detail and evaluated further in Appendix G with detailed costs included in Appendix H.

This chapter of the report summarizes the major potentially feasible water management strategies. Major strategies are those that would supply a substantial amount of water, typically around 30,000 acre-feet per year or more. These major water management strategies are generally sponsored by the Region C major and regional wholesale water providers and account for most of the new water supplies. Region C has identified seven new major reservoirs of which six are designated as unique reservoir sites or are recommended for designation.

Chapter Outline

Section 5C.1 – New Surface Water
Section 5C.2 – Connection of Existing Supplies
Section 5C.3 – New Groundwater
Section 5C.4 – Reuse Strategies
Section 5C.5 – Desalination
Section 5C.6 – Aquifer Storage and Recovery
Section 5C.7 – Summary of Recommended Major Water Management Strategies

Related Appendices

Appendix F – Potentially Feasible Water Management Strategies
Appendix G – Water Management Strategy Evaluations
Appendix H – Cost Estimates
Appendix J - Updated Quantitative Marvin Nichols Analysis
5C.1 New Surface Water

Region C has identified multiple new surface water strategies for potential future supplies, including seven new major reservoirs, two river diversions with off-channel storage, and reallocation of flood storage in Wright Patman Reservoir. The new reservoirs include Bois d’Arc Lake in the Red River Basin, four potential reservoir sites in the Sulphur River Basin, Lake Tehuacana in the Trinity River Basin, and Lake Columbia in the Neches River Basin. Each of these sites have been previously studied by Region C and six are designated as unique reservoir sites or are recommended for designation.

5C.1.1 Bois d’Arc Lake

Bois d’Arc Lake, formerly known as Lower Bois d’Arc Creek Reservoir, was a recommended strategy for the North Texas Municipal Water District (NTMWD) in the past four Region C Water Plans.

The project is located in Region C on Bois d’Arc Creek in Fannin County, northeast of the City of Bonham. At the conservation pool elevation of 534 feet MSL, the lake will have a surface area of 16,641 acres and a storage capacity of 367,609 acre-feet.

This project is currently under construction and includes the dam and lake, raw water intake, a 35-mile transmission pipeline to the Leonard Water Plant (also currently under construction), and approximately 19,000 acres of mitigation. Mitigation construction has also begun. Impoundment of water is expected to begin in 2021 with initial operation beginning in 2022.

Bois d’Arc Lake will provide NTMWD with 120,200 acre-feet per year of firm supply. It also provides a new fresh water source that NTMWD intends to use to blend with its existing Lake Texoma supplies.

The Bois d’Arc Lake project is a recommended strategy for NTMWD and has an associated capital cost of over $939 million. Water from Bois d’Arc Lake will be used as part of NTMWD’s system and will meet the needs of NTMWD customers.

Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.
5C.1.2 Dredging or Reallocation

While increasing the capacities of existing lakes does not qualify as a major strategy (> 30,000 acre-feet per year of supply), this concept has been raised by the public as an alternative to new reservoir development. Region C evaluated the potential for increased water supply and associated costs to increase the storage capacities at 4 lakes in the greater Metroplex area through dredging or reallocation of flood storage for water supply. The quantity of reliable supply gained through dredging to the permitted conservation storage ranged from 1,700 to 3,360 acre-feet per year for the lakes evaluated. Consideration of reallocation provided new supplies of only 7,200 acre-feet per year due to the lack of unappropriated water in the Trinity River Basin. The costs for these strategies averaged $143.64 per 1,000 gallons of supply for dredging, and no costs were developed for the reallocation. Reallocation was considered not potentially feasible due to the permitting obstacles and uncertainty of impacts on flooding.

Dredging a large major reservoir is a massive technical and financial undertaking with only small gains in water supply. While reallocating water to water supply at area lakes does not provide reliable water of the quantity needed for the Metroplex, it also potentially places an increasingly urban area at risk for flooding. Dredging and reallocation are not recommended or alternative strategies for Region C. Additional details for these strategies can be found in the corresponding technical memorandum in Appendix G.
5C.1.3 George Parkhouse Reservoir (North)

George Parkhouse Reservoir (North), also known as Parkhouse II, is a potential reservoir located on the North Sulphur River in Lamar and Delta Counties, about 15 miles southeast of the City of Paris. This reservoir site was originally proposed as the second phase of the larger George Parkhouse Reservoir, also known as Sulphur Bluff Reservoir. At a proposed conservation elevation of 410.0 feet MSL, the reservoir would store approximately 331,000 acre-feet of water and inundate 14,400 acres. It is assumed that the project will either be pursued solely by NTMWD or as a joint strategy with UTRWD.

The firm yield of George Parkhouse (North) with Consensus Criteria Environmental Flow Needs instream releases is estimated to be 106,500 acre-feet per year. As adopted for Marvin Nichols, it is assumed that the total amount of supply assumed available to Region C users is approximately 80 percent of the project yield and 20 percent would remain within Region D for local use; however, the amount to remain for local use would likely be determined at the time of development. This yield considers new drought of record conditions in the Sulphur River Basin and assumes senior priority over other potential future Sulphur Basin projects (excluding Lake Ralph Hall). If other proposed projects in the Sulphur River Basin are permitted as senior to George Parkhouse (North), this could have a significant impact to the quantity of available supply. Previous studies have shown that the reduction in yield could be more than 70 percent (1).

Facilities included in this strategy include both the proposed reservoir and the infrastructure needed to transport raw water to the Leonard Water Treatment Plant in Fannin County for NTMWD. For UTRWD, the transmission system delivers water to the Tom Harpool Water Treatment Plant and Lake Lewisville. Of the approximate 15,000 acres of impacted land at the reservoir site, there are less than 1,250 acres of wetlands and 2,000 acres of bottomland hardwoods.

This project has the potential to produce a reliable supply for Region C only if other potential reservoirs are not permitted senior to George Parkhouse (North). It is located near Lake Jim Chapman and Lake Ralph Hall, so it could be operated as a system with those sources. As a stand-alone strategy for NTMWD, there is an associated capital cost of $905.6 million. As a joint strategy between NTMWD and UTRWD, this is an associated capital cost of $613.6 million for NTMWD and $457 million for UTRWD. This is an alternative strategy for NTMWD and UTRWD. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.
5C.1.4 George Parkhouse Lake (South)

George Parkhouse Lake (South) is a potential reservoir located in Region D on the South Sulphur River in Hopkins and Delta Counties. This reservoir site was originally proposed as the first phase of the larger George Parkhouse Reservoir, also known as Sulphur Bluff Reservoir. It is located downstream from Jim Chapman Lake and would yield 116,000 acre-feet per year (with 80 percent available for Region C). At conservation elevation 401 feet MSL, George Parkhouse Lake (South) would inundate approximately 29,000 acres and store 652,000 acre-feet. The yield of George Parkhouse (South) is contingent upon other water development in the Sulphur River Basin. If other downstream projects are permitted with a senior priority to George Parkhouse (South), then the yield would decrease. Previous studies have indicated the reduction in yield could be up to 60 percent of the stand-alone firm yield\(^2\). This would likely make this project not economically viable for Region C providers. This project could be developed in conjunction with George Parkhouse (North). The yield of the combined projects has not been assessed.

The lake, as currently configured, would abut the dam for Jim Chapman Lake and over fifty percent of the land impacted would be bottomland hardwood forest or marsh\(^1\). This reservoir site has over 10,000 acres of bottomland hardwood forest and potential wetlands (marsh and seasonally flooded shrubland). The impacts to these resources would require mitigation, which is included in the cost estimate.

This project is considered a potential strategy for NTMWD and UTRWD. It is assumed that the project will either be pursued solely by NTMWD or as a joint strategy with UTRWD. As a stand-alone strategy for NTMWD, there is an associated capital cost of $1.15 billion. As a joint
strategy between NTMWD and UTRWD, this is an associated capital cost of $776 million for NTMWD and $535 million for UTRWD. This is an alternative strategy for NTMWD and UTRWD. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.1.5 Lake Columbia

Lake Columbia is a proposed new reservoir in the Neches River Basin on Mud Creek in Cherokee County in Region I. Angelina and Neches River Authority (ANRA) is the sponsor for the Lake Columbia project. ANRA has been granted a water right permit by the TCEQ to impound 195,500 acre-feet and to divert 85,507 acre-feet per year (76.3 MGD) for municipal and industrial purposes. Based on discussions between ANRA and DWU, Dallas would contract for supplies from ANRA and participate in the development of this project. The projected share of the proposed Lake Columbia project for DWU is 56,000 acre-feet per year. Lake Columbia would be connected to Dallas’ western system via a pipeline from the reservoir to the IPL pump station at Lake Palestine. Supplies would then be transported to the Lake Joe Pool area via a new pipeline parallel to the IPL.

Currently, the Lake Columbia project is subject to completion of the NEPA process and issuance of a 404 permit from the USACE. If Dallas were to participate in the Lake Columbia project, the current water right permit would be amended for an interbasin transfer from the Neches to the Trinity basin.

Lake Columbia would provide a new water source near existing water resources for DWU. This makes it easier to operate and maintain as part of the overall DWU system. Dallas’ share of the
capital cost is estimated at $313 million. This strategy is recommended for DWU for implementation in 2070. This strategy is also recommended for other users located in Region I. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.1.6 Lake Ralph Hall and Reuse

Lake Ralph Hall is a proposed new reservoir on the North Fork of the Sulphur River in Fannin County in Region C. The lake would store 160,235 acre-feet of water and inundate 7,605 acres at the normal pool elevation of 551 feet MSL. This project is sponsored by the Upper Trinity Regional Water District (UTRWD), which has a water right permit to impound Lake Ralph Hall and divert 45,000 acre-feet per year. Of this amount, 39,220 acre-feet per year is firm supply.

UTRWD intends to reuse the water originating from Lake Ralph Hall. The source of reuse water will be various UTRWD WWTPs in the Lewisville Lake Basin, based on the percentage of effluent that originates from Lake Ralph Hall. This reuse will augment UTRWD’s supply in Lewisville Lake at no additional capital cost to UTRWD.

The strategy includes construction of the Lake Ralph Hall, a transmission pipeline from the reservoir to a new balancing reservoir, a lake intake pump station (intake is sized for full permitted amount), and land acquisition of the reservoir site and transmission system easements. The Lake Ralph Hall Dam would be constructed across the valley of the North Fork Sulphur River near the City of Ladonia. The North Fork of the Sulphur River is a highly eroded channel that continues to erode during high flow events. Lake Ralph Hall Dam and Lake would
slow down erosive flows, reduce continued degradation of the downstream channel, and provide storage for water supply.

Environmental considerations were analyzed as part of the Lake Ralph Hall Environmental Impact Statement. There are no wetlands within the reservoir site. Most of the site consists of grasslands, pastures and cropland. A mitigation plan has been developed for this project, and it has been accepted by TCEQ for the water right and is under review by the U.S. Army Corps of Engineers (USACE) for the federal Section 404 permit. The project is expected to be constructed and supplying water by 2030. The development of the reuse supplies from Lake Ralph Hall source water will occur over time beginning as early as 2030. Capital costs to construct this project are estimated at $443 million. This is a recommended project for UTRWD. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.1.7 Marvin Nichols Reservoir

The Marvin Nichols Reservoir has been included in the previous four Region C Water Plans (2001, 2006, 2011, and 2016) and is being retained as a potentially feasible strategy for the 2021 Region C Water Plan. Marvin Nichols Reservoir is a potential reservoir located on the Sulphur River in Titus, Red River, and Franklin Counties, about 45 miles west of Texarkana. The reservoir, if constructed, would be approximately 100 miles from the Metroplex. This strategy has historically been pursued as a joint strategy by several Metroplex water providers.

At a proposed conservation elevation of 328 feet MSL, the reservoir would store 1,532,000 acre-feet of water with a water surface area of 66,103 acres. A smaller version of this project with a
conservation elevation of 313.5 feet MSL was also analyzed (see Technical Memorandum for Marvin Nichols Reservoir, 313.5 feet MSL, in Appendix G).

The firm yield of Marvin Nichols at 328 feet MSL is estimated to be 451,300 acre-feet per year. Of this amount, it is assumed that 361,000 acre-feet per year would be available to water providers in Region C, and the remaining 20 percent of the yield would remain in the Sulphur Basin for local use. This yield considers new drought of record conditions in the Sulphur River Basin and assumes senior priority over other potential future Sulphur Basin projects (excluding Lake Ralph Hall, which is already permitted). If other proposed projects in the Sulphur River Basin are permitted as senior to the Marvin Nichols Reservoir, this could have an impact on available supply.

Feasibility studies have been conducted for the Marvin Nichols Reservoir, but no detailed field studies or permit applications have been submitted. Environmental studies indicate there are approximately 24,000 acres of existing wetlands and 10,000 acres of bottomland hardwood forests within the reservoir footprint. Impacts to these resources and associated streams would be mitigated as part of the strategy implementation and are included in the cost. Capital costs to construct the Marvin Nichols Reservoir and deliver water to the sponsors are estimated at $4.4 billion. This equates to approximately $2.80/1,000 gallons of raw water during debt service and $0.73/1,000 gallons after debt service.

This strategy provides a reliable new source of fresh water supplies for Region C water providers at a reasonable cost. It is located near other existing water sources that could potentially be operated as a system. The challenges to this strategy are permitting and the current political opposition. Economic studies conducted as part of the Sulphur River Basin Feasibility Study show that the construction and operation of the reservoir would induce economic benefit to the local communities\(^2\). The construction of the reservoir would provide nearly $1.5 billion economic benefit over the 3-year construction period and $52 million annually during operation\(^2\).

Appendix J of the 2021 Region C Water Plan contains additional information on the quantitative evaluation of this strategy. This strategy is a recommended strategy for NTMWD, TRWD, and UTRWD. It is an alternative strategy for DWU and Irving. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.
5C.1.8  Red River Off-Channel Reservoir

This strategy would develop new water supplies from the Red River, downstream of Lake Texoma. Dallas proposes to permit a portion of Texas’ share of the flow in the Red River for diversion and impoundment in a series of off-channel reservoirs (OCR). The water would then be transported to Lake Ray Roberts for subsequent diversion and use.

This project includes an intake and pump station on the Red River at Arthur City, Texas, immediately downstream of the Highway 271 Bridge. Diversions from the Red River would be pumped approximately 2 miles to three off-channel reservoirs in series. The first OCR would consist of a 2,500-acre-foot basin for initial sediment settling and removal. The next OCR in the series would have a capacity of 5,300 acre-feet and would provide additional sediment removal and water quality improvement. The third and final OCR would consist of a 32,000-acre-foot storage basin to allow for extended pumping when the flow in the Red River is extremely low or water quality is impaired. Water would be diverted from the third OCR by an intake and pump station that would transport supplies via a transmission pipeline to Lake Ray Roberts for subsequent blending and use by Dallas. The total area of the reservoirs is 803 acres with a total capacity of 39,800 acre-feet. The reliable supply from the reservoir would be 114,000 acre-feet per year. Capital costs for this project are $937 million.

The Red River OCR project has the potential to provide DWU with significant new water supplies. Potential issues with this project include bank stability for the intake structure along the Red River, water quality, sediment control and invasive species. Other risks include permitting and potential future upstream diversions and impoundments. A significant portion of the available
flow to the project originates in the Blue and Muddy Boggy River watershed in Oklahoma. If large reservoirs are constructed in these watersheds, the available flow could be reduced.

The Red River OCR project is an alternative strategy for DWU and UTRWD in the Region C Regional Water Plan. There is a possibility that BRA would also participate in the implementation of this strategy. More information on BRA’s potential involvement is detailed in the Region G Regional Water Plan. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.
5C.1.9 Tehuacana Reservoir

Tehuacana Reservoir is a proposed reservoir on Tehuacana Creek within the Trinity River Basin in Freestone County in Region C. Tehuacana Creek is a tributary of the Trinity River and lies immediately south and adjacent to Richland Creek on which the existing Richland-Chambers Reservoir is located. Tehuacana Reservoir would connect to Richland-Chambers Reservoir by a 9,000-foot channel and be operated as an integrated extension of that reservoir. The project would have a firm yield of 25,400 acre-feet per year. The reservoir would store approximately 338,000 acre-feet and inundate approximately 15,000 acres. Supplies derived from Tehuacana would be transported from the expanded reservoir utilizing existing and proposed TRWD transmission facilities.

Most of the reservoir site is classified as upland deciduous forest and grassland. Less than 3 percent is presently classified as marsh or open water. There are about 1,200 acres of bottomland hardwood forest that are concentrated near the dam site. Further, part of the Tehuacana Reservoir site is underlain by lignite.

Lake Tehuacana is a recommended strategy for TRWD and has an associated capital cost of $309 million. The reservoir would provide a new water source near existing water resources for TRWD, which makes it easier to operate and maintain as part of the TRWD East Texas Reservoir System. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.
5C.1.10 Wright Patman Reallocation

This strategy is the reallocation of flood storage in Wright Patman Lake to elevation 235 feet MSL. The USACE selected an increase of Lake Wright Patman water supply pool to an elevation of 235.0 to be the Tentatively Selected Plan (TSP) in February 2019. This reallocation would provide an additional amount of approximately 200,000 acre-feet per year. The USACE-sponsored study evaluated a total of sixty combinations of alternative scales and locations of new surface water development in the Sulphur Basin.

Wright Patman Lake is an existing reservoir on the Sulphur River, about 150 miles from the Metroplex. It is owned and operated by the USACE. The City of Texarkana has contracted with the Corps of Engineers for storage in the lake and holds a Texas water right to use up to 180,000 acre-feet per year from the lake. Presently, the available supply from Wright Patman Lake is limited due to the USACE “Interim Rule” operating curve. The reallocation of flood storage along with changes in operation would result in the full water right of 180,000 acre-feet per year being available to Texarkana and 122,200 acre-feet per year available to Region C.

The higher conservation pool at Wright Patman Lake would inundate an additional 14,372 acres above the permitted conservation pool elevation (ultimate rule curve). This recommendation provides the desired quantity of water for Region C, while minimizing impacts to the White Oak Mitigation Area.

Reallocation at Wright Patman Lake on the scale envisioned in this strategy would require approval of the U.S. Congress. A new State water right and inter-basin transfer approval would be required from TCEQ.

This strategy provides a reliable new source of fresh water supplies for Region C water providers at a reasonable cost. It is located near other existing and proposed water sources that could potentially be operated as a system. The challenges to this strategy are permitting and the current political opposition. This is a recommended strategy for NTMWD, TRWD and UTRWD. It is an alternative strategy for DWU and Irving.

Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.2 Connection of Existing Supplies

There are several existing water sources in Region C and surrounding areas that can potentially provide water supplies to Region C. Some of these sources have been developed by or have existing contracts with Region C providers, and simply need infrastructure to move the water to these providers (such as Lake Palestine). Others require new contracts with the owner of the water source. Connection of existing supplies is an important part of the Region C water supply plan. There are seven major potentially feasible strategies that consider connections to existing supplies. Some of these strategies would be developed by a single water provider, while others would be developed jointly.
5C.2.1 Cypress Basin Supplies (Lake O’ the Pines)

Lake O’ the Pines is an existing Corps of Engineers reservoir, about 120 miles from the Metroplex, with Texas water rights held by the Northeast Texas Municipal Water District (NETMWD). The lake is on Cypress Creek in the Cypress Basin in Senate Bill One water planning Region D, the North East Texas Region. Some Metroplex water suppliers have explored the possibility of purchasing supplies in excess of local needs from the Cypress Basin for use in the Metroplex. However, based on the most recent information available from Region D, there is no available water from the Lake O’ the Pines Reservoir\(^3\). This information on availability is based on contracted amounts rather than projected use. The strategy is therefore maintained as a potentially feasible strategy, as water could potentially be purchased by Region C water providers. For planning purpose, the strategy is evaluated for 50,000 acre-feet per year.

The Cypress Basin Supplies (Lake O’ the Pines) strategy was evaluated for NTWMD and customers. This is an alternative strategy for NTMWD. Additional details for this strategy can be found in Appendix G.

5C.2.2 GTUA Regional System with Treatment Expansion at Sherman

A regional water system strategy was developed for communities in northern Collin, Cooke, northern Denton and Grayson counties. Several of the entities in this area hold water rights in Lake Texoma but currently do not have access to this resource. The amount of water available from this strategy is 33,106 acre-feet per year to be developed in two phases. This strategy focuses on treating and connecting these entities to Lake Texoma supplies. The Lake Texoma supplies would be transported to and then treated at the site of the existing Sherman Water Treatment Plant. Due to the higher level of TDS of the supplies from Lake Texoma, advanced treatment is necessary to achieve drinking water level standards.

For siting of physical transmission infrastructure, delivery points are located at existing water system infrastructure where possible and transmission pipelines generally follow existing highways or county roads to minimize right-of-way impacts. This strategy includes expansion at Sherman Desalination Plant, expansion of the existing Lake Texoma Intake Pump Station, a new transmission line providing additional capacity between the intake pump station and the water treatment plant, and other transmission infrastructure such as pipeline and booster pump stations.

Since the reservoir is existing, these strategies provide a reliable source of additional supplies with limited impacts. This strategy would utilize water that is already developed and permitted, and it will enable several of the participating entities to begin using water that has been contracted. However, this strategy would provide water that is more expensive than current supplies. Unit costs of water range from $6.82 during debt service to $3.96 after debt service for Phase I and $5.07 during debt service to $3.73 after debt service for Phase II. The strategy is costly mainly because of the advanced treatment required and the length of transmission pipeline required to connect the treated supplies to the end-users. Due to the transmission distance and relatively small quantities of water for each entity, this strategy would be best developed as a regional concept. To make the regional system effective, it requires commitment from the participants and a sponsor for the operation, maintenance, and administration of the system. For purposes of this study, it is assumed that GTUA will be the...
5C.2.3 Integrated Pipeline (Tarrant Regional Water District and Dallas Water Utilities)

The Tarrant Regional Water District (TRWD) and Dallas Water Utilities (DWU) have partnered to construct and operate the Integrated Pipeline (IPL) Project. The IPL project is an integrated water delivery transmission system that extends from Lake Palestine to Benbrook Lake with connections to Cedar Creek and Richland-Chambers Reservoirs. The pipeline will have an ultimate capacity of approximately 350 MGD (200 MGD for TRWD and 150 MGD for DWU). Dallas’s share of the project will deliver water from Lake Palestine and is discussed in Section 5C.2.4. TRWD’s share will deliver surface water and reuse supplies from Cedar Creek and Richland-Chambers Reservoirs. A portion of the IPL has been constructed and is currently delivering raw water to TRWD customers from the Richland-Chambers Reservoir. However, there is no infrastructure currently in place to transport DWU's supplies from Lake Palestine. Similarly, the Cedar Creek wetlands have not yet been constructed although supplies from the wetlands will eventually be transported via the IPL as well.

The IPL provides the means to use existing water supplies that are currently not available to TRWD or DWU because of infrastructure limitations. The IPL also provides a means to share water resources between TRWD and DWU during emergencies or on an interim basis. The flexibility in operations provided by the IPL increases the resiliency of the water supplies. The
IPL Project is recommended by the Region C Regional Water Planning Group, and the total capital cost is approximately $1 billion. The IPL Project is sponsored by TRWD and DWU and will serve the customers of both. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

### 5C.2.4 Lake Palestine

Lake Palestine is an existing reservoir located in the East Texas Region (Region I) on the Neches River. The lake is owned and operated by the Upper Neches River Municipal Water Authority (UNRMWA). The permitted diversion is 238,110 acre-feet per year. Dallas Water Utilities (DWU) has a contract with UNRMWA for 53.73% of the yield of the reservoir up to a maximum of 114,337 acre-feet per year (102 MGD). The contract includes an interbasin transfer permit allowing the use of water from the lake in the Trinity River Basin.

To date, DWU has not used water from Lake Palestine because there is no infrastructure to transport the water to the Dallas area. DWU is working with TRWD to build the Integrated Pipeline (IPL), which would include a segment to move DWU’s share of Lake Palestine to Dallas County. The infrastructure necessary to move the water from Lake Palestine to a location near the upper end of Joe Pool Lake for this strategy is discussed in Section 5C.2.3. There will be a separate project to move the water from the IPL delivery point to the Bachman Water Treatment Plant. It is assumed that the water from the IPL will be delivered directly to the Bachman WTP by pipeline.
Permits to use the water from Lake Palestine have already been obtained. Any permits associated with the transmission system to Joe Pool Lake are discussed under the IPL Project. Associated permits for the pipeline from the IPL delivery point to the Bachman WTP are discussed in the corresponding technical memorandum in Appendix G. The Lake Palestine strategy is sponsored by DWU and the strategy is recommended for DWU by the Region C Regional Water Planning Group. The total capital cost is approximately $297 million. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.2.5 Lake Texoma

Lake Texoma is an existing Corps of Engineers reservoir on the Red River on the border between Texas and Oklahoma. The reservoir is about 50 miles from the Metroplex. Under the terms of the Red River Compact, the yield of Lake Texoma is divided equally between Texas and Oklahoma. In Texas, the North Texas Municipal Water District (NTMWD), the Greater Texoma Utility Authority (GTUA), the City of Denison, Luminant (previously TXU), and the Red River Authority (RRA) have contracts with the Corps of Engineers and Texas water rights allowing them to use water from Lake Texoma. Dallas (DWU) and Upper Trinity Regional Water District (UTRWD) have expressed interest in developing supplies from Lake Texoma. However, all of the currently authorized storage in the lake is contracted with other users.

Water from Lake Texoma is brackish, which means that the use of Texoma water requires the water to be blended with a freshwater source or desalinated for municipal use. The amount of water available to the entities listed above, by blending, ranges from 25,000 to 120,386 acre-feet per year. For NTMWD, there are four potential sources of water for blending: Bois d’Arc Lake, Toledo Bend, Marvin Nichols Reservoir, and Wright Patman Reallocation. NTWMD already
blends Texoma water with its current supplies (up to 76,614 acre-feet per year by 2070). NTMWD would blend additional Texoma water (120,386 acre-feet per year by 2070) with the three new sources of water listed above. This new blending will bring NTWMD to the limit of their current water right from Texoma, 197,000 acre-feet per year. The blending source for UTRWD is also supplies from Marvin Nichols Reservoir and the Wright Patman Reallocation.

Desalination provides treated water but is a more expensive strategy, and there are uncertainties in the long-term costs. There is some uncertainty regarding the ability to desalinate and dispose of the large quantities of reject water. Lake Texoma desalination is discussed in Section 5C.5.2.

Lake Texoma supplies requires an interbasin transfer permit, state water rights, possible Congressional authorization, and a contract with USACE. The State of Oklahoma does retain the right to a significant portion of unpermitted water that is allocated to municipal and industrial use. However, Oklahoma has a moratorium on exporting water. Development of this supply will require agreement between the water rights stakeholders in Texas, the state of Oklahoma and the Corps of Engineers.

Lake Texoma is a recommended source of additional water supply by blending for the NTMWD (blending with Bois d'Arc Lake, Marvin Nichols Reservoir and Wright Patman Reallocation). It is an alternative strategy by blending for UTRWD. The total capital cost ranges from approximately $228 million to $345 million. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

### 5C.2.6 Neches River Run-of-the-River Diversion

The Neches River Run-of-River Diversion Strategy was originally developed as an alternative to the Lake Fastrill project after the development of the reservoir was determined unlikely due to the designation of Neches River National Wildlife Refuge (NRNWR) within the reservoir site. This project would be sponsored by the Upper Neches River Municipal Water Authority (UNRMWA) with water supplies contracted to Dallas Water Utilities (DWU).

The Neches River Run-of-River Diversion Strategy would include a new river intake and pump station on the Neches River near the State Highway 21 crossing. Water would be delivered through a 42-mile pipeline to DWU's pump station at Lake Palestine for delivery to DWU through the Integrated Pipeline (see Section 5C.2.3). The run-of-river diversions would be operated as a system with Lake Palestine to supplement existing water supplies. Dallas’ existing contract with UNRMWA for Lake Palestine water is for an annual quantity of 114,337 acre-feet per year (102 MGD). The IPL will have a capacity of 150 MGD, so there is a remaining infrastructure capacity of approximately 48 MGD available for this strategy. The new run-of-river diversion will be interruptible, so the quantity available with this strategy is the incremental increase in the firm yield of Lake Palestine resulting from system operations of the new diversion and the existing reservoir. If other new water rights are granted in the Neches River Basin before the water right for this project, the yield could be affected.

The Neches Run-of-the-River strategy provides supplemental water for DWU that is located near existing DWU water sources. This strategy assumes that existing and planned (IPL) infrastructure can be used to transport this water to DWU service area, which minimizes transmission costs. Also, the use of a small river diversion structure provides fewer
environmental impacts than a new reservoir, and the operations with Lake Palestine provide the necessary reliability for the river diversion. It is anticipated that this project will be online by 2060 and will provide 42 MGD (47,250 acre-feet per year) of supply.

This is a recommended strategy for DWU and the estimated capital cost is $254 million. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.2.7 Oklahoma Water

Several wholesale water providers in the Metroplex have been pursuing the purchase of water from Oklahoma. At the present time, the Oklahoma Legislature has established a moratorium on the export of water from the state. Previously, the Tarrant Regional Water District (TRWD) pursued a case in Federal Court to determine whether this moratorium could be overturned, and the Supreme Court ruled in favor of Oklahoma. For the long term, Oklahoma remains a potential source of water supply for Region C. Since this strategy would not be implemented for several decades, the source of water is simply defined as Oklahoma water. For planning purpose, the strategy is evaluated for 50,000 acre-feet per year.

The public and political opposition to this strategy limit development opportunities in the near future. Additional information on these challenges can be found in the corresponding technical memorandum in Appendix G. It is expected that this opposition will subside over time. Raw water from Oklahoma would have relatively low environmental impacts because of the use of existing sources. Water from Oklahoma is a recommended strategy for NTMWD (50,000 acre-feet per year). It is identified as an alternative strategy for UTRWD (15,000 acre-feet per year),
and Irving (25,000 acre-feet per year). Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

### 5C.2.8 Toledo Bend Reservoir

Toledo Bend Reservoir is an existing impoundment located in the Sabine River Basin on the border of Texas and Louisiana. It was built in the 1960s by the Sabine River Authority of Texas (SRA) and the Sabine River Authority of Louisiana. The yield of the project is split equally between the two states, and Texas’ share of the yield is slightly over 1,000,000 acre-feet per year\(^{(a)}\). The SRA currently holds a Texas water right to divert 970,067 acre-feet per year from Toledo Bend for municipal, industrial, and irrigation purposes.

Further, several Region C Metroplex water suppliers have been investigating the possibility of developing substantial water supplies from Toledo Bend Reservoir, with up to 650,000 acre-feet per year delivered to Region C. Toledo Bend Reservoir is located in Region I, the East Texas Region. The development of this supply will require an agreement among the SRA and Metroplex suppliers, an interbasin transfer permit from the Sabine River Basin to the Trinity River Basin, and possibly other basins, and development of water transmission facilities. Supply from Toledo Bend is identified as an alternative joint strategy for NTMWD, TRWD, DWU, and UTRWD. The strategy would be constructed in two phases. Phase 1 and 2 would supply the same amounts of water to each entity. However, Phase 2 of this strategy would likely not occur until after the end of this planning cycle and is not included in this strategy evaluation.

Phase 1 would transport 350,000 acre-feet per year. This is a relatively expensive source of supply because Toledo Bend Reservoir is approximately 200 miles from Region C. In addition to costs, the length of the pipelines increases concerns over line breakage or pump failure. However, this strategy does offer substantial water supply and environmental impacts will be limited since it is an existing source. Additional details can be found in Appendix G.
There are limited groundwater resources within Region C. Much of the groundwater has been developed and the amount available for future development is approximately 55,000 acre-feet per year. About a third of this unallocated groundwater (17,800 acre-feet per year) is in Denton County. Some of this supply will be developed by smaller WUGs, but suppliers in this county have begun to move toward surface supplies as population has become denser. Another 22 percent of the unallocated groundwater (11,800 acre-feet per year) is in Cooke County. About 12 percent of the unallocated groundwater (6,700 acre-feet per year) is in Henderson County. The City of Athens plans to over 2,000 acre-feet per year of this supply. The remaining unallocated groundwater supplies (18,700 acre-feet per year) are scattered through the remaining 13 counties of the region. Any major new groundwater development (over 50,000 acre-feet per year) is likely to occur outside Region C.

The Carrizo-Wilcox aquifer is a large aquifer system that spans from the East Texas-Louisiana boarder across northeast and central Texas to the border of Mexico. Three new groundwater development projects were identified in the Carrizo-Wilcox aquifer, two in east Texas and one partially in east Texas and partially in Region C.

### 5C.3.1 Carrizo-Wilcox Aquifer Groundwater in Anderson County

A local water marketer has groundwater holdings in multiple counties in east Texas south of Lake Palestine. A portion of these holdings lie in the eastern part of Anderson County. Additionally, there are groundwater supplies available in Wood, Upshur and Smith counties. This strategy would develop a well field and pump the water to existing infrastructure near Lake
Tawakoni. This strategy is evaluated for the North Texas Municipal Water District. Much of NTMWD’s Sabine Basin supply is transported to Lake Lavon for subsequent diversion and treatment, but an interim contract with SRA for 40,000 acre-feet expires in 2025. The proposed groundwater supplies would provide up to 42,000 acre-feet per year of supply. This could replace the current interim supplies from SRA for NTMWD.

The additional infrastructure for this project includes a new well field, pump station and transmission pipeline from the well field to the Lake Tawakoni water treatment plant, and a new pump station and 60-inch pipeline from the water plant to the existing 84-inch East Fork Wetlands Project pipeline.

This strategy can provide additional supplies, but the reliability is uncertain. Changes in groundwater conservation district (GCD) operating rules and Desired Future Conditions (DFCs), as well as the Modeled Available Groundwater (MAG), for this source of groundwater would likely be needed in order to permit the well field. There is uncertainty whether the quantities as specified in this alternative can actually be permitted. Supply amounts can change based on changes in rules. This can impact the long-term reliability of this source.

There also may be political opposition to a large export of local groundwater. This could delay the project and increase costs. The total capital cost is approximately $496 million. The Carrizo Groundwater Project for NTMWD is recommended to remain as an alternative strategy by the Region C Regional Water Planning Group.

Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.
5C.3.2 Carrizo-Wilcox Aquifer Groundwater in Wood, Upshur, and Smith Counties

The Carrizo-Wilcox and Queen City aquifers cover a large portion of northeast Texas. This strategy evaluates the potential for groundwater development in Smith, Wood, and Upshur Counties in Region D for DWU. Use of these aquifers for other major water providers is discussed separately.

Where appropriate, the wells would be co-screened in both the Carrizo-Wilcox and Queen City aquifers to provide the greatest amount of available supply. A series of wellfields and pump stations would be strategically located to transport the water 58 miles to the Lake Fork intake and pump station. From this location the groundwater would be transported to DWU Eastside water treatment plant via existing infrastructure.

The quantity of water for this strategy is 30,000 acre-feet per year. This is less than half of the potentially available supply from the two aquifers within the target counties. Most of this supply would be from the Queen City aquifer. With no GCDs in the targeted counties, there are no pumping regulations or limitations. The amount of available water is limited to the economically sustainable production from specific well fields. Securing sufficient groundwater rights would help protect the long-term productivity of the well fields, since groundwater is a property right and there could be competing development that may impact supplies. While there are few regulatory requirements with this strategy, there may be public opposition to a large groundwater project that exports the water outside of the county and region. This strategy could take 5 to 10 years to develop, considering acquisition of water rights, pilot tests, and final design and construction.

Groundwater provides a reliable water supply to DWU’s portfolio of water resources. This source is less susceptible to drought-related impacts, such as evaporation. The source of water is relatively near existing infrastructure and other DWU resources and there are few development concerns. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G. The Carrizo-Wilcox/Queen City (Region D) Groundwater strategy was evaluated for DWU. The total capital cost is approximately $180 million. It is recommended to remain an alternative strategy by the Region C Regional Water Planning Group.
5C.3.3 Carrizo-Wilcox Aquifer Groundwater – Tarrant Regional Water District

This strategy proposes to develop groundwater from the Carrizo-Wilcox and Queen City aquifers in Freestone and Anderson Counties. (Wells fields in Navarro and Henderson Counties were initially considered but ruled out in TRWD’s preliminary feasibility studies.) The groundwater would be transported approximately 28 miles to the Integrated Pipeline (IPL) near Cedar Creek Reservoir. The IPL would then be used to move the groundwater to TRWD’s service area. This strategy assumes the groundwater is mixed directly in the IPL with surface water and/or reuse water.

This groundwater supply would supplement TRWD’s existing water sources and provide diversity to its existing portfolio. As a supplemental supply, TRWD may choose to operate the well system on a continual basis or seasonally to provide water during the higher demand periods. This strategy assumes the wells are operated continuously on an average annual basis. The Average Scenario assumes that up to 32,000 acre-feet per year could be developed from the targeted area, with the project operating year-round at a fairly steady level of production. Peak Scenario details can be found in the corresponding Technical Memorandum in Appendix G.

The infrastructure required for this strategy includes 39 wells (most likely distributed over multiple well fields), well field piping, ground storage, pump station, and 28 miles of 36- to 54-inch diameter transmission pipeline. The proposed water management strategy includes costs for sites E1A, E4, and E1B.
Development of a well field would require groundwater permits. The amount of water that could be permitted under the current Modeled Available Groundwater (MAG) value is near the proposed total quantity for this strategy. Additionally, large-scale groundwater export proposals could face public opposition, especially if perceived to affect neighboring wells. Further study is likely to address these potential concerns.

This strategy provides a new water source that provides higher level of resistance to future droughts than current surface water sources. The proposed groundwater well fields are located near TRWD’s existing water sources, and existing infrastructure can be used to transport the water to TRWD’s service area. The quality of the water is generally good and likely would not require extensive treatment. The total capital cost is approximately $191 million. This strategy is recommended for TRWD by the Region C Regional Water Planning Group. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.4 Reuse Strategies

Region C has identified multiple reuse strategies to more efficiently utilize water supplies within the Region. Many entities have permitted their return flows and developed strategies to either temporarily store and/or further treat this water. Including wetlands and off-channel storage reservoirs which can provided fewer environmental concerns in comparison to other strategies. Reuse water is generally a reliable supply.
5C.4.1 Wetland Project – Tarrant Regional Water District

The Tarrant Regional Water District (TRWD) has water rights allowing the diversion of return flows of treated wastewater from the Trinity River. To utilize these flows, TRWD has developed a reuse project at Richland-Chambers Reservoir. Treated wastewater is discharged to the Trinity River and its tributaries, flows downstream, is pumped from the Trinity River into the constructed George W. Shannon Wetlands and then pumped into Richland-Chambers Reservoir. The reuse water is then diverted from Richland-Chambers Reservoir and transported to the TRWD service area. However, this project can only divert and treat a portion of the permitted reuse supplies. To fully utilize the available reuse, TRWD will develop a similar reuse project at Cedar Creek Reservoir. The amount of permitted reuse supply at Cedar Creek Reservoir is 88,059 acre-feet per year.

This strategy addresses the development of a reuse project at Cedar Creek Reservoir, which includes a new diversion structure, created wetlands, and infrastructure necessary to discharge the treated return flows into Cedar Creek Reservoir. The wetlands will be constructed adjacent to the Trinity River, east of the City of Ennis. The reuse supplies would then be diverted from the lake and transported by the Integrated Pipeline (see Integrated Pipeline Technical Memorandum, Appendix G).

Tarrant Regional Water District has already secured water right permits to develop the wetlands on Cedar Creek. A federal Section 404 permit would be needed to construct the intake pump station, pipelines, and wetlands because of possible impacts to waters of U.S. TRWD acquired the property for the Cedar Creek Wetlands in 2014 and is in the process of acquiring the site and right-of-way for the finished water pipeline and pump station facilities. The total capital cost is approximately $226 million. The Cedar Creek Wetland Reuse Project is sponsored by TRWD and the strategy is recommended for TRWD by the Region C Regional Water Planning Group. The water provided from the Cedar Creek Wetlands Reuse Project will be used by TRWD customers. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.4.2 Indirect Reuse Implementation by DWU and NTMWD

Dallas has rights to the return flow for much of its water supply and plans to utilize those return flows through two projects on the Main Stem of the Trinity River. Those projects are the Main Stem Balancing Reservoir and the Expanded Wetland Reuse. The Expanded Wetland Reuse is a recommended strategy for North Texas Municipal Water District (NTMWD) that allows for a swap of return flows between NTMWD and DWU. More detail is provided on these two specific projects in Section 5C.4.3 and 5C.4.4. The Expanded Wetland Reuse is anticipated to be online in 2030 and provide 69,980 acre-feet per year of supply. The Main Stem Balancing Reservoir is anticipated to be online in 2050 and provide as much as 92,111 acre-feet per year of supply by 2070. Additional details for these strategies can be found in the corresponding technical memoranda in Appendix G.

5C.4.3 Main Stem Balancing Reservoir

The project description for the Main Stem Balancing Reservoir is based on the information provided by the Dallas Long Range Plan\(^6\). Dallas would store return flows from the Central and
Southside wastewater treatment plants in an off-channel reservoir, the Main Stem Balancing Reservoir. The Main Stem Balancing Reservoir would be located in Ellis County southeast of Bristol, Texas, and will receive diversion from the Trinity River. This project has a good amount of flexibility and different potential configurations require additional evaluation. For the configuration selected for Region C, reuse water is delivered from the balancing reservoir to Joe Pool Lake through a 36.5 mile transmission system.

The source of water for the Main Stem Balancing Reservoir is return flows from Dallas’ Central and Southside wastewater treatment plants. However, total return flows available to be stored in the reservoir consider other commitments and an amendment to instream flow requirements. Other commitments are the proposed Elm Fork and Lake Ray Hubbard Swap, an agreement between Dallas Water Utilities (DWU) and the North Texas Municipal Water District (NTMWD). DWU will provide NTMWD with water from the Central and Southside WWTP in equal exchange for NTMWD’s reuse flows into Lake Lewisville (above agreed upon historical amounts) and Lake Ray Hubbard. The return flows available for the Main Stem Balancing Reservoir considering the agreement and amended instream flow requirements total 95,829 acre-feet per year by 2070. More details can be found in the corresponding technical memorandum in Appendix G.

The Main Stem Balancing Reservoir would provide a means to store reuse water and manage water supplies across the DWU system. With the diversion pump station located downstream of the confluence of the Trinity River and East Fork of the Trinity River, water could be released from DWU’s eastern supplies and moved to the western areas of its service area. Reuse water is a reliable supply, and this project does not require additional appropriation of state water. An off-channel reservoir is expected to have fewer environmental concerns than an on-channel reservoir. The Main Stem Balancing Reservoir strategy was evaluated for DWU and its customers. The total capital cost is approximately $733 million. It is a recommended strategy in Dallas’ Long-Range Water Supply Plan. This strategy is recommended for DWU by the Region C Regional Water Planning Group. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.
5C.4.4 Expanded Wetland Reuse (NTMWD)

The proposed Expanded Wetland Reuse project will treat return flows from wastewater treatment plants owned and operated by NTMWD and the City of Dallas. The return flows will be pumped from a pump station on the Trinity River and delivered to a new constructed wetlands facility for nutrient removal before being blended with other raw water sources from the NTMWD system. A new water treatment facility is included as part of the conceptual design of this project. At this time specific locations for the pumping facility, the new wetlands and the water treatment plant have not been identified. Water would be delivered for blending with other sources at a new treatment plant near the existing Tawakoni Water Treatment Plant.

The return flows for this project come from two sources. The first is through growth in return flows from plants owned and operated by NTMWD that discharge into the East Fork of the Trinity River. It is expected that the quantity of return flows available from this source will exceed the treatment capacity of the existing East Fork Wetlands by the year 2030. The second source of water for the project are return flows from Dallas’ (DWU) Central and Southside wastewater treatment plants, provided through a swap agreement between DWU and NTMWD. This agreement provides NTMWD return flow from DWU’s Central and Southside WWTP’s in equal exchange for NTMWD’s return flows into DWU’s reservoirs. The total amount of water expected to be produced by the project is 59,483 acre-feet per year by 2070.

The reliability of the reuse supplies is high. There is the potential for the reuse supplies to develop at a faster or slower rate, depending on the volume of return flows. The water quality is expected to be good, as the wetlands will filter out excess nutrients and pollutants and trap natural sediment and organic matter, providing higher quality water than diverted from the
Trinity River. The proposed project would require an amendment to the existing NTMWD reuse water rights for the additional return flows and the expanded wetlands.

The Expanded Wetland Reuse strategy provides NTMWD with water supply in an ecologically sustainable manner. The unit costs are $5.03 during debt service and $2.30 after debt service. The Expanded Wetland Reuse strategy will provide water to NTMWD customers. This strategy is recommended for NTMWD by the Region C Regional Water Planning Group. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.4.5 Irving Reuse

Irving has contracted with TRA for 25 MGD from the TRA Central Plant discharge effluent. The strategy consists of infrastructure for pre-treatment of the TRA Central discharge (25 MGD) and transmission to the Dallas Bachman Treatment Plant. The total capital cost is approximately $39 million. This reuse project is a recommended strategy for City of Irving by the Region C Regional Water Planning Group.

5C.5 Desalination

Region C has evaluated desalination as a potential strategy for potential future supplies, including the desalinization of sea water and brackish lake water. The desalinization of seawater from the Gulf of Mexico is evaluated in response to public comment during the Region C planning process. The desalinization of brackish water from Lake Texoma is evaluated as an alternative to blending Lake Texoma water with a freshwater source.

5C.5.1 Gulf of Mexico with Desalination

The cost of desalination has been decreasing in recent years, and some municipalities in Florida and California have been developing desalinated seawater as a supply source. The State of Texas has sponsored initial studies of potential seawater desalination projects\(^1\), and this is seen as a potential future supply source for the state. Seawater desalination has been mentioned through public input during the Region C planning process, and it was evaluated in response to that input. However, because of the cost of desalination and the distance to the Gulf of Mexico, seawater desalination is not a particularly promising source of supply for Region C. This strategy assumes seawater would be taken from the Gulf of Mexico near Baytown, Texas, and desalinated near the diversion location. The water would be desalinated by reverse osmosis and the reject stream from the treatment process would be discharged back to the Gulf of Mexico. The treated water would be transported to the Metroplex generally following the I-45 corridor.

The supply from seawater desalination is essentially unlimited, but the cost is a great deal higher than the cost of other water management strategies for Region C. For this strategy evaluation, it is assumed that 200,000 acre-feet per year would be delivered to the Metroplex via one 132-inch pipeline (could alternatively use two parallel pipelines). Since this water would require desalination, the amount of source water would need to be 300,000 acre-feet per year and 100,000 acre-feet per year would be discharged as waste. The unit costs associated with this strategy are $13.87 during debt service and $6.43 after debt service.
The major challenges for this strategy are the technical developments for a desalination project of this scale. Maintaining and operating a remote desalination water treatment plant and a 300-mile transmission system is costly and difficult for the water providers. Additionally, there are mixed views on seawater desalination and the project could face public opposition. Developing water from the Gulf of Mexico with desalination is not a recommended or alternative strategy for any water supplier in Region C. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.5.2 Lake Texoma with Desalination

Lake Texoma is an existing Corps of Engineers reservoir on the Red River on the border between Texas and Oklahoma. The reservoir is about 50 miles from the Metroplex. Under the terms of the Red River Compact, the yield of Lake Texoma is divided equally between Texas and Oklahoma. In Texas, the North Texas Municipal Water District (NTMWD), the Greater Texoma Utility Authority (GTUA), the City of Denison, Luminant (previously TXU), and the Red River Authority (RRA) have contracts with the Corps of Engineers and Texas water rights allowing them to use water from Lake Texoma. Dallas (DWU) and Upper Trinity Regional Water District (UTRWD) have expressed interest in developing supplies from Lake Texoma. However, all of the currently authorized storage in the lake is contracted with other users.

Water from Lake Texoma is brackish, which means that the use of Texoma water requires the water to be blended with a freshwater source or desalinated for municipal use. The amount of water available to the entities listed above, by desalination, ranges from 8,500 to 146,000 acre-feet per year. For desalination strategies, a portion of the Texoma source water would be discharged as waste. Loss amounts from the desalination process could range from 15 to 25
percent, depending on the quality of the incoming water. For this analysis, the loss from the treatment process is assumed to be 20 percent.

Desalination provides treated water but is a more expensive strategy, and there are uncertainties in the long-term costs. There is some uncertainty regarding the ability to desalinate and dispose of the large quantities of reject water. Lake Texoma is a recommended source of additional water supply by desalination for the GTUA and Denison. It is an alternative strategy by desalination for NTMWD and DWU. The total capital cost ranges from approximately $1.2 billion to $1.8 billion. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

5C.6 Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) is a water management solution that allows for storing surplus water in local aquifers during periods of high or surplus surface flows and withdrawing the stored water later during periods of drought or peak demands. It also can be used to temporarily store treated brackish groundwater or treated wastewater for use during high demand periods. ASR can provide a cost-effective and reliable alternative to the construction of above-ground storage reservoirs; however, identifying and securing suitable aquifer formations for storage and the geochemical evaluation of the mixed waters can be challenging. ASR in Texas is currently being studied to assess if it is a reliable and cost-effective technology that should be considered as part of a diversified portfolio of water supply options. Large-Scale Aquifer Storage and Recovery (ASR)

In Region C, the most likely application of ASR would be to store surplus surface water when lakes are full and spilling, store reuse water, increase operational flexibility of multiple sources, and serve as a short-term source to meet peak demands. ASR could reduce evaporative losses, store water that would have spilled downstream, maximize use of water rights, and possibly delay infrastructure improvements that would be needed to meet peak demands.

Detailed hydrogeological studies are needed to identify an appropriate receiving formation and size the infrastructure of the recharge system. There have been several recent studies conducted to define the storage and migration potential of the Trinity aquifer, and some regional water providers are currently in the process of confirming the information from the hydrogeological models by means of a pilot study. For these reasons, a generic ASR strategy for 50,000 acre-feet per year was developed for the purpose of this study.

Based on the available literature, this strategy assumes that an appropriate receiving site can be identified in the Trinity aquifer within 50 miles of the major water providers. The depth of this formation is about 2,000 feet below ground surface and the migration potential is minimal to retain the stored water bubble. It is also assumed that there is existing infrastructure capacity to move water to within 50 miles of the ASR site. Additional infrastructure would be needed to move the water to the recharge site. For this strategy, it is assumed that the recharge wells will also serve as recovery wells.

The WMS discussed is a region-wide strategy that benefits multiple major water providers in Region C. It is not a recommended strategy. Specific ASR strategies are considered for
individual water users. The total capital cost associated with this strategy is $2.3 billion. Additional details for this strategy can be found in the corresponding technical memorandum in Appendix G.

### 5C.7 Summary of Recommended Major Water Management Strategies

Table 5C.1 is a summary of the recommended major water management strategies for Region C. These projects represent the majority of the total supply from strategies. Much of the remaining cost of strategies is associated with infrastructure projects to treat and/or deliver these supplies to water user groups.

#### Table 5C.1 Recommended Major Water Management Strategies for Region C

<table>
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<tr>
<th>Strategy</th>
<th>Supplier</th>
<th>Supply (Ac-Ft/Yr)</th>
<th>Supplier Capital Cost</th>
<th>Supplier Unit Cost ($/1000 gallon)</th>
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<td>Indirect Reuse Implementation</td>
<td>DWU</td>
<td>62,559</td>
<td>TBD</td>
<td>TBD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TBD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Stem Balancing Reservoir</td>
<td>DWU</td>
<td>95,829</td>
<td>$772,904,000</td>
<td>$1.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$0.63</td>
<td></td>
<td></td>
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<tr>
<td>Expanded Wetland Reuse</td>
<td>NTMWD</td>
<td>37,510</td>
<td>$625,891,000</td>
<td>$5.03</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>$2.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Region C Total</strong></td>
<td></td>
<td>1,871,845</td>
<td>$30,438,919,000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a The Neches River Run-of-the-River unit costs do not include the cost to transport water from Palestine to DWU through the IPL.

*b Lake Columbia cost reflects transmission to Lake Palestine. Additional infrastructure to move the water to DWU is discussed under DWU infrastructure expansion.

*c This is the total in the whole region for all strategies, not the total of strategies in this table.
5C.8 Chapter 5C List of References


(4) Brown and Root, Inc., Yield Study Toledo Bend Reservoir, prepared for the Sabine River Authority of Texas and the Sabine River Authority of Louisiana, Houston, July 1991.
