Chapter 10

Water Management Strategies

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The planning groups recommended more than 4,500 individual water management strategies to meet water supply needs resulting in a projected total of 9.0 million acre-feet per year of new supplies by 2060. Some of the recommended water management strategies are associated with supplies that are available but not physically connected or legally available.

Surface water management strategies, excluding major reservoirs, are projected to result in 3.3 million acre-feet per year.

Municipal water conservation strategies are projected to result in about 617,000 acre-feet per year by 2060.

Irrigation conservation strategies are projected to result in about 1.4 million acre-feet per year by 2060.

The planning groups recommended 14 new major reservoirs that are projected to generate approximately 1.1 million acre-feet per year by 2060.

Recommended water management strategies relying on groundwater are projected to result in about 800,000 acre-feet per year by 2060.

Recommended water reuse water management strategies are projected to result in about 1.3 million acre-feet per year by 2060.

Desalination projects recommended as water management strategies are projected to result in about 313,000 acre-feet per year by 2060.

The previous chapter demonstrates the need for additional water supplies in Texas. A key goal of regional water planning is to assess and recommend water management strategies to meet those needs. A recommended water management strategy is a specific plan to increase water supply or maximize existing supply to meet a specific need. Water management strategies include

- implementing water conservation and drought management;
- developing new groundwater and surface water supplies;
- expanding and improving management of existing water supplies, such as improving reservoir operations, reallocating reservoir storage space, using groundwater and surface water conjunctively, and conveying water from one area to another;
- water reuse; and
- implementing other, less traditional, approaches such as desalinating seawater and brackish water, controlling vegetation that consumes large volumes of water, practicing land stewardship, and weather modification.

Each of the 16 planning groups identified potentially feasible water management strategies for detailed analyses. As a result of their analyses, planning groups recommended a portfolio of water management strategies tailored to meet each region's water supply needs. Some strategies were carried forward from the prior planning cycle and reassessed due to changing conditions or new information. Other water management strategies considered by planning groups introduced new approaches to meeting water supply needs. In total, the planning groups recommended more than 4,500 individual water management strategies resulting in a total of 9.0 million acre-feet per year of new supplies by 2060.

This chapter provides information about the analyses of potentially feasible water management strategies and the resulting recommended water management strategies in the 2006 Regional

Water Plans and this state water plan. For presentation at the state level, recommended water management strategies in this chapter are categorized as water conservation, new or existing surface water supplies, new or existing groundwater supplies, conjunctive use of groundwater and surface water, water reuse, and desalination. In some cases, subcategories are presented for comparison within a major group.

10.1 Identification and Evaluation of Potential Water Management Strategies

Planning groups systematically evaluated each potentially feasible water management strategy before recommending specific water management strategies to meet water supply needs (Figure 10.1). These potentially feasible water management strategies were then assessed based on a variety of factors, including (1) how much water a strategy could produce and at what costs; (2) how the strategy could impact water quality and the state's water, agricultural, and natural resources; and (3) how reliable the strategy would be in providing water during drought conditions. Other factors considered by some planning groups included regulatory requirements, political and local issues, time requirements to implement a strategy, recreational impacts, and other socioeconomic benefits or impacts. The planning groups also identified how their plans would be consistent with the state's long-term goal of protecting Texas' water, agricultural, and natural resources. After a lengthy evaluation process, each planning group ultimately recommended specific water management strategies to meet identified water supply needs in their planning areas.

10.1.1 Quantity, Reliability, and Costs

Water quantity and reliability were among the key criteria used to assess strategies. Quantity refers to the amount of water that a given strategy would provide to water user groups during drought of record conditions. Reliability is an assessment of the availability of specified water quantities to users over time. If the quantity of water is available to the user all the time, then the strategy

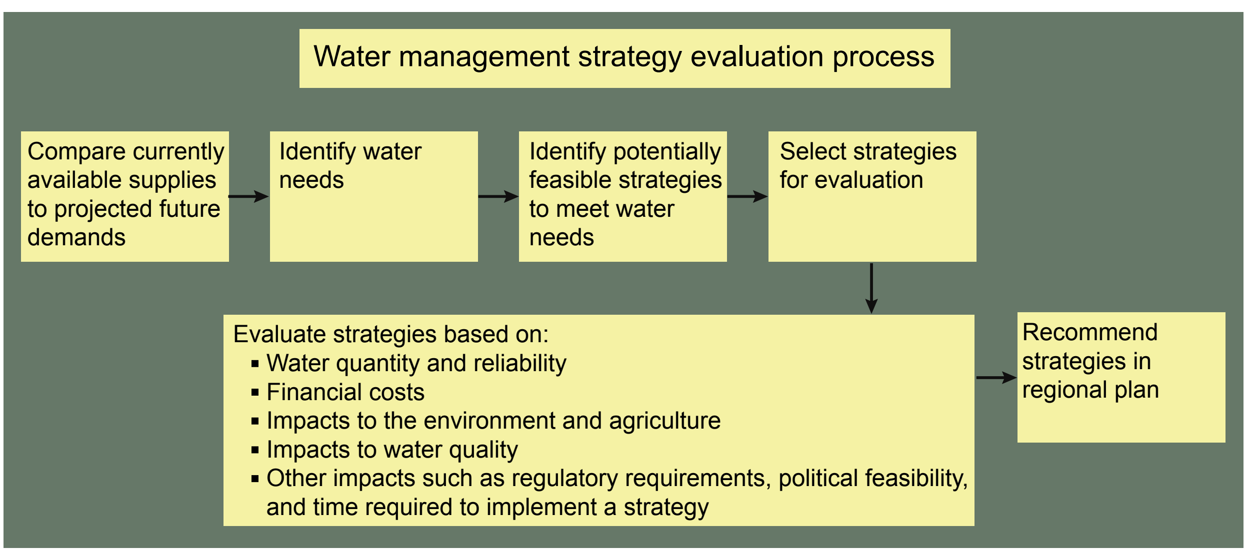


Figure 10.1.Water management strategy evaluation process.

has a high reliability. In contrast, if the quantity of water is contingent on other factors, reliability may be lower.

Financial costs were also an important factor considered when evaluating water management strategies. Planning groups estimated up-front capital requirements and annual costs. Capital costs included both the direct costs of constructing facilities, such as materials, labor, and equipment, and the indirect expenses associated with construction activities, such as costs for engineering studies, legal counsel, land acquisition, contingencies, environmental mitigation, interest during construction, and permitting fees. However, not all strategies have capital costs. For example, water conservation or water transfers using existing infrastructure often do not require up-front capital expenditures.

Annual costs were determined by including both the repayment of borrowed capital funds (debt service), the purchase of power and water, and the operating and maintenance expenses of facilities and water management programs. Debt service is the estimated annual costs of borrowed funds based on total capital costs and a prescribed finance rate and finance period based on the type of water management strategies being evaluated. Operating costs generally consist of labor and materials required to maintain a project in a given year and regular repair and/or replacement of depreciated equipment. Capital, operating, and maintenance costs were reported in year 2002 dollars. Planning groups were also required to consider project costs in terms of discounted present value when evaluating and comparing different strategies. The planning groups reported annual costs, and, thus, the unit cost per acre-foot for each decade for each water management strategy considered. These costs vary according to the type of project and many other factors, including whether or not a given strategy requires capital expenditures and debt service payments.

10.1.2 Impacts to the State's Water, Agricultural, and Natural Resources

Planning groups evaluated the potential impacts of each water management strategy on the state's water, agricultural, and natural resources.

In analyzing the impact of water management strategies on the state's water resources, the planning groups honored all existing water rights and contracts and considered conservation strategies for all water user groups with a water supply need. They also based their analyses of environmental flow needs on the environmental Consensus Planning Criteria or site-specific studies. In addition, planning groups were required to consider water management strategies to meet the water supply needs of irrigated agriculture and livestock production.

Planning groups also determined mitigation costs and quantified impacts for all water management strategies considered. They used a variety of approaches and assessment factors to quantify impacts of water management strategies on water, agricultural, and natural resources. Some used categorical assessments describing impacts as "high," "moderate," and "low." These ratings were based on existing data and the potential to avoid or mitigate impacts to agricultural and natural resources. For example, a "low" rating implied that impacts could be avoided or mitigated relatively

easily. In contrast, a “high” rating implied that impacts would be significant and mitigation requirements would be substantial. Other planning groups used a numerical rating that indicated the level of impact. Many planning groups based their ratings on factors such as the volume of discharges a strategy would produce or the number of irrigated acres lost. Another approach relied on identifying the number of endangered or threatened species listed in a county with a proposed water source. In general, most planning groups relied on existing information for evaluating the impacts of water management strategies on agricultural and natural resources.

10.1.3 Impacts on Water Quality

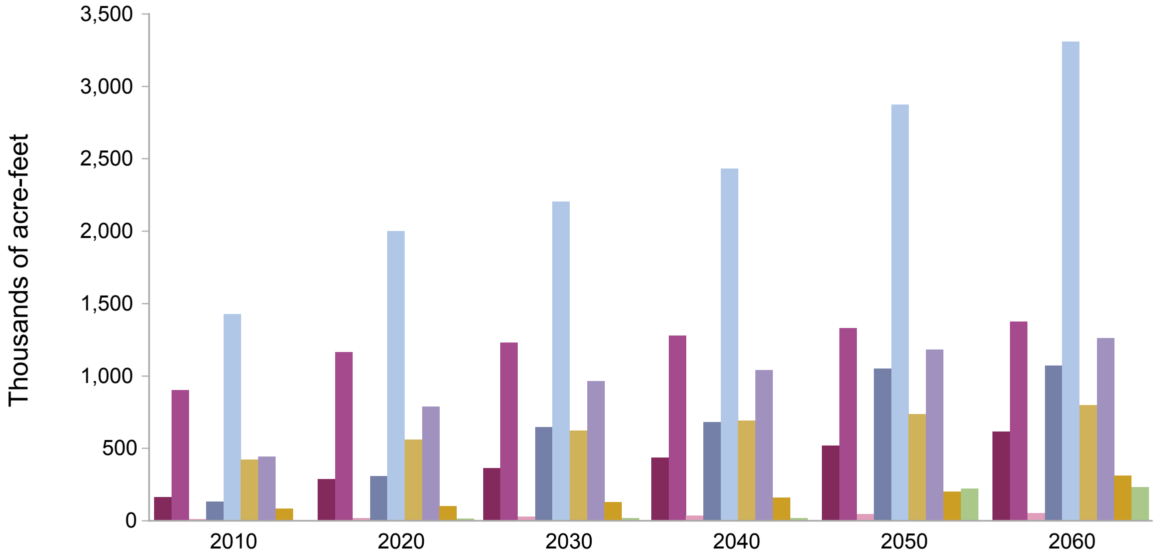
The planning groups also assessed how implementing water management strategies would affect water quality. All the planning groups identified key water quality parameters important for the use of water within their regions. These parameters were generally based on surface and groundwater quality standards and the list of impaired waters maintained and published by the Texas Commission on Environmental Quality. Other sources included water quality parameters and concerns identified by local and regional water management entities and concerns expressed by the public during the planning process. Key water quality parameters considered included bacteria, pH, dissolved oxygen, total suspended solids, temperature, nutrients, total dissolved solids, chlorides, nitrates, mercury, radionuclides, arsenic, salinity, and sediment.

10.2 Overview of Recommended Strategies

Planning groups recommended a variety of water management strategies to help meet needs in the future, including strategies that use water conservation, new or existing surface water supplies, new or existing groundwater supplies, conjunctive use of groundwater and surface water, water reuse, desalination, and land stewardship to provide additional water supplies. These strategies are projected to total 9.0 million acre-feet per year of new supplies by 2060 (Figure 10.2). Many strategies involve water conveyances from the source of water being recommended to meet a water supply need to the place of need (see section 10.2.8).

10.2.1 Water Conservation

Traditionally, water management strategies have focused on bringing water “into the pipe” through dams, reservoirs, and wells. In recent years, however, many communities have begun to focus on “end of the pipe” solutions through a common approach known as water conservation. At a fundamental level, water conservation involves managing existing water supplies to reduce demand and increase effciency of use. In other words, water managers and citizens collectively join forces to use less water in their homes and businesses and on their farms rather than building new projects to supply more of an already scarce resource. For water utilities and their customers, conservation programs are often more economical because they can postpone or eliminate the need for new infrastructure such as dams, wells, pipelines, and water treatment plants.



	2010	2020	2030	2040	2050	2060
Municipal conservation	164,672	286,226	364,924	437,714	519,441	616,679
Irrigation conservation	903,769	1,166,909	1,231,948	1,280,593	1,331,243	1,376,080
Other conservation[a]	10,636	20,276	30,130	37,115	45,128	54,092
New major reservoirs	132,863	306,663	646,993	681,498	1,051,128	1,072,128
Other surface water	1,426,449	2,002,895	2,204,909	2,432,839	2,873,271	3,309,990
Groundwater	424,429	563,081	622,381	691,671	736,609	799,209
Reuse	443,030	788,223	965,593	1,041,433	1,182,441	1,261,579
Desalination	84,295	101,522	130,164	159,922	200,866	312,887
Conjunctive use	1,131	15,244	18,700	18,701	223,090	231,567
Total	3,591,274	5,251,039	6,215,742	6,781,486	8,163,217	9,034,211

[a]Other conservation is associated with manufacturing, mining, and power industries.

Figure 10.2. Total new supply volumes generated by all recommended water management strategies over the planning period.

In recent years, the awareness and understanding of water conservation and water use efficiency has grown significantly in Texas. During the development of the 2006 Regional Water Plans, conservation has become increasingly important as a means to meet water supply needs.

A comparison of the 2007 State Water Plan to the 2002 State Water Plan shows the growing importance of water conservation in Texas. For example, recommended water management strategies for conservation in the 2002 State Water Plan generated 14 percent of the water needed to meet the state's needs in 2050—a total of about 990,000 acre-feet per year. In the 2007 State Water Plan, conservation accounts for nearly 23 percent of required water in 2060—a total of about 2 million acre-feet. These figures represent "active conservation," measures usually initiated by water utilities, individual businesses, residential water consumers, and agricultural producers to reduce water consumption. In addition, Texas will also save large amounts of water through as "passive water conservation." Passive water conservation involves water savings that result from state and federal legislation requiring plumbing manufacturers to sell more water-efficient plumbing fixtures, such as showerheads, faucets, and toilets. Active water conservation is above and beyond passive water conservation. TWDB estimates that passive conservation will reduce municipal water demand by 6.6 percent by 2060, which equals about 587,000 acre-feet, and statewide gallons per capita per day by 11.5 gallons.

Municipal Water Conservation

In state and regional water planning, municipal water conservation strategies focus on reducing residential, commercial, and institutional water use that typically involves water for drinking, cooking, cleaning, sanitation, air conditioning, and outdoor uses, such as landscape irrigation and swimming pools.

Municipal water conservation strategies focus on reducing these types of uses through a variety of social or technological approaches. Social approaches include changing water pricing structures to encourage more efficient water use and creating a greater awareness of the importance of conservation through promotional and educational campaigns. For example, programs such as bill explanation, plant tours, school programs, and educational and outreach activities have proven beneficial. Technological approaches include installing more efficient plumbing fixtures in homes and businesses.

In general, many communities throughout the state have taken great strides in developing municipal water conservation programs. Each city uses water conservation for different reasons. For example, the city of Austin wants to lower demand to meet a growing customer base; Corpus Christi hopes to postpone need for additional supply; El Paso has a limited long-term supply; and San Antonio has a limited existing water supply during drought conditions. However, water conservation is not limited to large cities. Many small- and medium-sized systems are also committed to increasing water use efficiency. To provide a unified conservation message, many smaller systems have partnered with

Table 10.1. Summary of recommended municipal water conservation management strategies in 2060

Region	New supplies from all recommended strategies (acre-feet per year)	New supplies from municipal conservation (acre-feet per year)	Percentage of all new supplies from municipal conservation	Estimated capital costs (millions of dollars)	Average annual unit costs per acre-foot of water [a] (dollars)
A	412,146	4,255	1	0.00	489
B	81,021	1,855	2	0.00	131
C	2,653,248	291,909	11	1.10	421
D	108,742	—	—	—	—
E	137,737	23,437	17	0.00	153
F	239,250	9,727	4	0.00	238
G	736,032	21,406	3	0.00	380
H	1,300,639	100,987	8	0.00	214
I	324,756	1,916	1	0.00	111
J	14,869	55	<1	0.00	419
K	861,930	51,315	6	0.00	209
L	732,779	72,566	10	0.00	442
M	807,587	24,412	3	8.77	141
N	149,496	2,415	2	0.00	333
O	441,511	10,424	2	0.00	863
P	32,468	—	—	—	—
Texas	9,034,211	616,679	7	9.87	234

Note: A dash indicates a value of zero.
[a]Reported figures are an average of unit costs in the first decade of strategy implementation and unit costs in 2060 weighted by the amount of water produced by a given strategy.

neighboring water systems in public-awareness campaigns to increase exposure, limit confusion, and reduce costs.

Municipal water conservation strategies identified by planning groups in their 2006 Regional Water Plans relied heavily on the Water Conservation Implementation Task Force's Best Management Practices Guide and include aggressive plumbing fixture replacement programs, water-efficient landscaping codes, water loss and leak detection programs, education and public awareness programs, rainwater harvesting, and changes in water rate structures. Fifteen of the 16 planning groups recommended municipal water conservation. Fourteen planning groups recommended it as a potential way to meet future municipal water needs (Table 10.1). In total, municipal water conservation strategies make up nearly 617,000 acre-feet (7 percent) of water generated by all recommend strategies by 2060.

When compared to the total volume of water generated by all recommended water management strategies, municipal water conservation strategies are an important source of water in many of the regions with large metropolitan areas, including Region E (17 percent), Region C (11 percent), Region H (8 percent), and Region L (10 percent). As noted previously, capital costs needed for implementing municipal water conservation programs are relatively small, amounting to about $9.9 million. Average operating costs per acre-feet of water generated from municipal water conservation strategies range from $111 per acre-foot in Region I to $863 in Region 0. The statewide average is $234 per acre-foot.

Agricultural Water Conservation

Irrigated agriculture has long been one of Texas' greatest water consumers. For example, irrigation currently accounts for about 60 percent of all water demand in the state, much of which consists of groundwater. By 2060, irrigation water demand is projected to decline to about 40 percent of total water demand in the state. Agricultural irrigation conservation programs have been widely promoted in areas of the state with large concentrations of irrigated crop production, such as the High Plains and Lower Rio Grande Valley.

Twelve of the 16 planning groups recommended agricultural water conservation as water management strategies to meet water needs including

- irrigation water use management, such as irrigation scheduling, volumetric measurement of water use, crop residue management, conservation tillage, and on-farm irrigation audits;
- land management systems, including furrow dikes, land leveling, conversion from irrigated to dry land farming, and brush control/management;
- on-farm delivery systems, such as lining of farm ditches, low pressure center pivot sprinkler systems, drip/micro irrigation systems, surge flow irrigation, and linear move sprinkler systems;
- water district delivery systems, including lining of district irrigation canals and replacing irrigation district and lateral canals with pipelines; and
- miscellaneous systems, such as water recovery and reuse.

In total, irrigation conservation strategies would generate nearly 1.4 million acre-feet of water in 2060, which equals about 37 percent of all irrigation water needs (Table 10.2). When compared to the total volume of water generated by all recommended water management strategies, agricultural water conservation is an important source of water where agriculture is a major economic sector. For example, Region A, Region O, and Region M collectively produce about 80 percent of irrigated crops in the state, with an economic value of around $1.5 billion annually. In total, these three planning groups recommended irrigation conservation strategies that would generate approximately 1 million acre-feet of water by 2060 (76 percent of the total water generated by irrigation conservation strategies in the state). Regions K, H, and J, which also produce substantial amounts of irrigated crops, adopted irrigation conservation strategies generating 222,333 acre-feet by 2060. Estimated capital costs for irrigation con-

Table 10.2. Summary of recommended irrigation water conservation management strategies in 2060

Region	New supplies from all recommended strategies (acre-feet per year)	New supplies from irrigation conservation (acre-feet per year)	Percentage of all new supplies from irrigation conservation	Estimated capital costs (millions of dollars)	Average annual unit costs per acre-foot of water[a] (dollars)
A	412,146	282,549	69	144.97	5
B	81,021	14,607	18	58.50	216
C	2,653,248	3,121	<1	0.00	211
D	108,742	–	–	–	–
E	137,737	–	–	–	–
F	239,250	72,247	30	43.15	51
G	736,032	8,027	1	0.00	154
H	1,300,639	77,881	6	0.62	83
I	324,756	–	–	–	–
J	14,869	1,452	10	<0.01	47
K	861,930	143,000	17	2.90	1
L	732,779	7,477	1	0.00	107
M	807,587	438,011	54	325.40	173
N	149,496	342	<1	0.00	171
O	441,511	327,366	74	353.51	65
P	32,468	–	–	–	–
Texas	9,034,211	1,376,080	15	929.06	77

Note: Dashes indicate a value of zero.
[a]Reported figures are an average of unit costs in the first decade of strategy implementation and unit costs in 2060 weighted by the amount of water produced by a given strategy.

servation are $929 million, and average operating costs per acre-feet of water generated range from $1 per acre-feet in Region K to $216 in Region B.

While many planning groups have adopted agricultural water conservation management strategies as a way to meet agricultural needs, implementing these strategies will be challenging for a variety of reasons. One overarching constraint, however, is economics. For on-farm water conservation practices, the cost per acre-foot for implementation, while lower than other water management strategies, is still cost-prohibitive for many individual farmers. In Region M, surface water rights and cost structures of irrigation districts may also provide disincentives for on-farm conservation. On the other hand, recent increases in energy costs are providing new economic incentives to adopt water conservation practices in areas that rely primarily on groundwater, such as Region A and Region O.

However, the immediate effect on farm income from these increases will limit farmers' abilities to invest in conservation practices that require capital expenditures.

To address economic and technical issues for implementing irrigation water conservation strategies, two large-scale, multiyear agricultural water conservation demonstration projects are underway in Region M and Region O to

- expedite the transfer of available water conservation technology to irrigated farms;
- develop comprehensive data using large-scale demonstration sites;
- assess the cost effectiveness of selected technologies; and
- evaluate and determine the impacts of conservation implementation on crop productivity, reduced irrigation water use, and available water supplies.

TWDB has developed partnerships to implement these projects, which will be used to support and enhance future agricultural conservation efforts. The projects represent major collaborative efforts by producers who volunteer their operations and time to the project to demonstrate cost-effective ways of implementing conservation strategies in the state. Several planning groups have also recommended continued and/or increased funding of federal and state financial and technical assistance for agricultural water conservation programs.

10.2.2 Strategies Using New and Existing Surface Water

Surface water management strategies generally consist of (1) building new reservoirs to impound surface waters or (2) managing existing surface waters through various approaches, such as moving water from one area to another through pipelines, purchasing additional water through contracts with major water providers, obtaining additional water rights, reallocating water in existing reservoirs, and changing the operating framework for a system of reservoirs (that is, system optimization).

In total, surface water strategies would produce about 4.4 million acre-feet of water in 2060 (Table 10.3). This represents a decrease from the 2002 State Water Plan of about 418,000 acre-feet. When compared to the total volume of water produced by all recommended strategies in the 2006 Regional Water Plans, surface water accounts for about 49 percent of the new supply for the state compared to nearly 66 percent in the 2002 State Water Plan. However, in some regions, surface water strategies make up the majority of new water, primarily in the eastern half of the state: Region C (61 percent), Region D (93 percent), Region G (70 percent), Region H (64 percent), Region I (92 percent), Region J (52 percent), and Region N (69 percent). Capital costs for surface water strategies total about $18 billion.

Planning groups recommended 14 new major reservoirs that would generate approximately 1.1 million acre-feet per year by 2060 (Table 10.3, Figure 10.3). These reservoirs account for about 12 percent of new water supplies at a capital cost of about $5 billion, which is 16 percent of total capital costs. The planning groups made the following recommendations:

Table 10.3. Summary of recommended surface water management strategies in 2060

Region	New supplies from all recommended strategies (acre-feet per year)	New supplies from surface water (acre-feet per year)		Percentage of all new supplies from surface water		Estimated capital costs (millions of dollars)		Average annual unit costs per acre-foot of water[a] (dollars)	
		New major reservoirs	Other surface water strategies	New major reservoirs	Other surface water strategies	New major reservoirs	Other surface water strategies	New major reservoirs	Other surface water strategies
A	412,146	–	3,750	–	1	–	72.27	–	1,122
B	81,021	–	51,875	–	64	–	89.08	–	198
C	2,653,248	746,540	874,102	28	33	3,338.57	6,461.72	354	331
D	108,742	–	100,636	–	93	–	4.82	–	362
E	137,737	–	20,000	–	15	–	103.49	–	408
F	239,250	–	90,075	–	38	–	30.12	–	36
G	736,032	36,520	477,101	5	65	89.06	493.58	186	208
H	1,300,639	129,520	707,393	10	54	567.79	4,206.81	223	88
I	324,756	75,700	222,875	23	69	387.11	190.36	643	197
J	14,869	–	7,690	–	52	–	6.65	–	124
K	861,930	–	398,215	–	46	–	15.23	–	66
L	732,779	–	98,214	–	13	–	853.37	–	887
M	807,587	20,643	169,460	3	21	66.55	230.62	537	539
N	149,496	42,005	61,615	28	41	304.21	186.55	684	493
O	441,511	21,200	26,500	5	6	150.76	230.58	688	1,186
P	32,468	–	489	–	2	–	–	–	na
Texas	9,034,211	1,072,128	3,309,990	12	37	4,904.05	13,175.25	374	254

Note: Dash indicates a value of zero and "na" indicates that data are not currently available.
[a]Reported figures are an average of unit costs in the first decade of strategy implementation and unit costs in 2060 weighted by the amount of water produced by a given strategy.

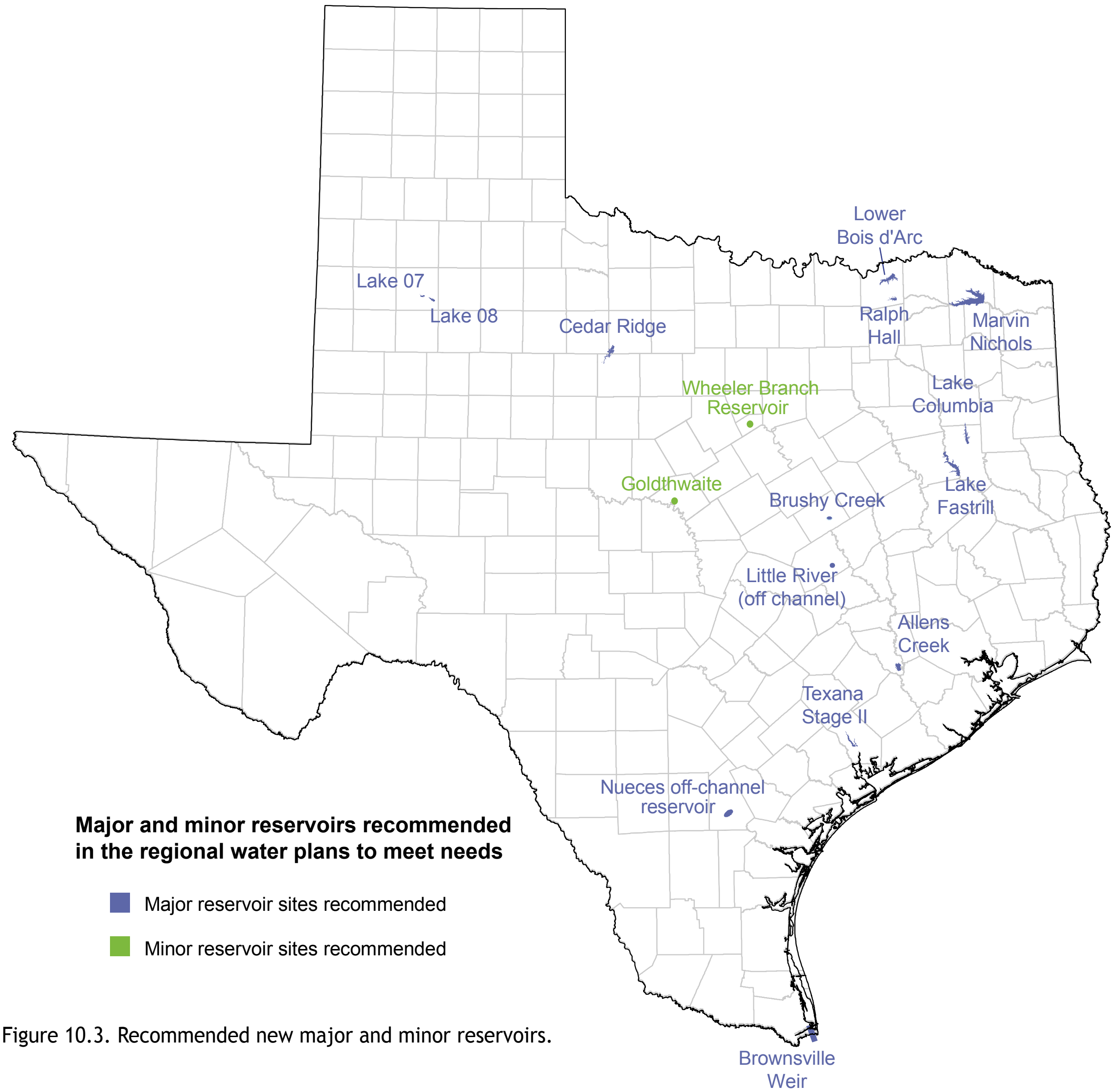


Figure 10.3. Recommended new major and minor reservoirs.

- Region C recommended four major reservoirs providing 28 percent of new supplies for the region in 2060 at a capital cost of about $3.3 billion
- Region G recommended two major reservoirs generating 5 percent of new supplies for the region at a capital cost of about $89 million
- Region H recommended two major reservoirs generating 10 percent of new supplies for the region at a capital cost of about $568 million
- Region I recommended one major reservoir providing 23 percent of new supplies for the region at a capital cost of about $387 million
- Region M recommended one major reservoir generating 3 percent of new supplies for the region at a capital cost of about $67 million
- Region N recommended two major reservoirs producing 28 percent of new supplies for the region at a capital cost of about $304 million
- Region O recommended two major reservoirs generating 5 percent of new supplies for the region at a capital cost of about $151 million

Average unit costs for reservoirs range from $186 per acre-foot in Region G to $688 per acre-foot in Region O. The statewide average unit cost for new major reservoirs is $374 per acre-foot. For other surface water strategies, average unit costs range anywhere from $36 per acre-foot in Region F to $1,186 per acre-foot in Region O, with the lower end reflecting costs of voluntary reallocation and purchases and the higher end representing costs of conveyance infrastructure.

The planning groups had the option of recommending unique reservoir sites and river and stream segments of unique ecological value for designation by the state legislature. A unique reservoir site is a location where a reservoir could be built. A river or stream segment of unique ecological value is a length of stream with distinctive ecological characteristics. Once designated as a unique reservoir site by the legislature, a state agency or political subdivision would not be allowed to purchase land or obtain an easement that would prevent the construction of a reservoir at the site. Similarly, once designated as a unique stream segment by the legislature, a state agency or political subdivision would not be allowed to finance the actual construction of a reservoir on that specific river or stream segment. This 2007 State Water Plan recommends that a total of 19 major and minor reservoir sites be designated by the legislature as unique reservoir sites. The planning groups recommended 11 unique reservoir sites (Figure 10.4), seven of which were recommended water management strategies. The remaining four recommended by planning groups as unique reservoir sites, Ringgold, Tehuacana, Little River, and Bedias, were not recommended as water management strategies to meet water supply needs over this planning horizon. TWDB is recommending eight additional unique reservoirs sites that were recommended by planning groups as water management strategies to meet water supply needs. TWDB's recommended sites include Cedar Ridge, Brushy Creek, Nueces River Off-Channel, Brownsville Weir, Wheeler Branch, and Goldthwaite. Fifteen river and stream segments of unique ecological value were recommended by two planning groups, seven for Region E (Figure 10.5) and eight for Region H (Figure 10.6).

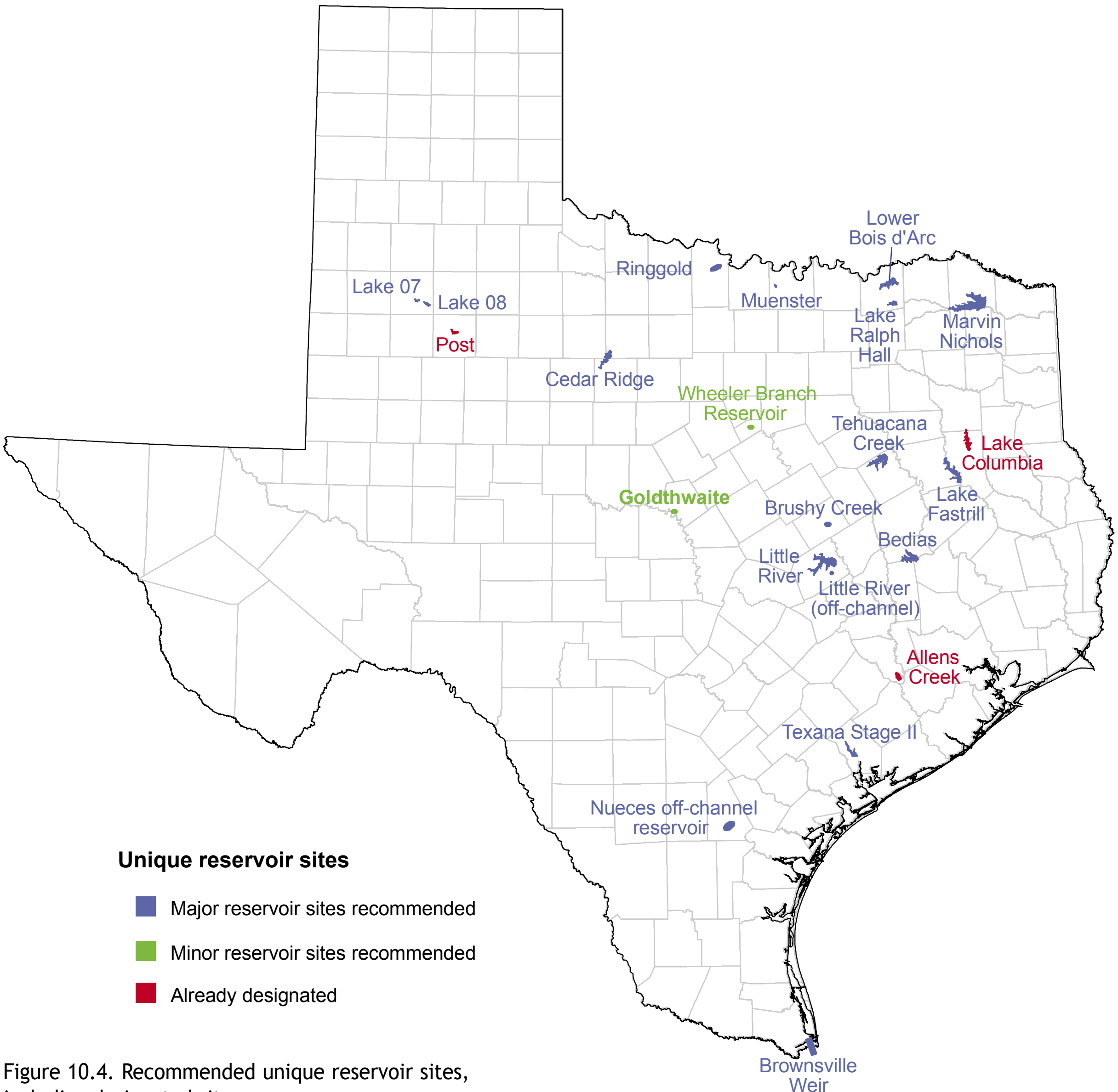


Figure 10.4. Recommended unique reservoir sites, including designated sites.

10.2.3 Strategies Using Groundwater

Recommended water management strategies using groundwater involve one or a combination of the following: (1) installing new wells; (2) increasing pumping from existing wells; (3) installing supplemental wells; (4) temporarily overdrafting of aquifers during drought conditions to supplement water supplies; (5) expanding treatment plants to make groundwater supplies meet water quality standards; and (6) reallocating and/

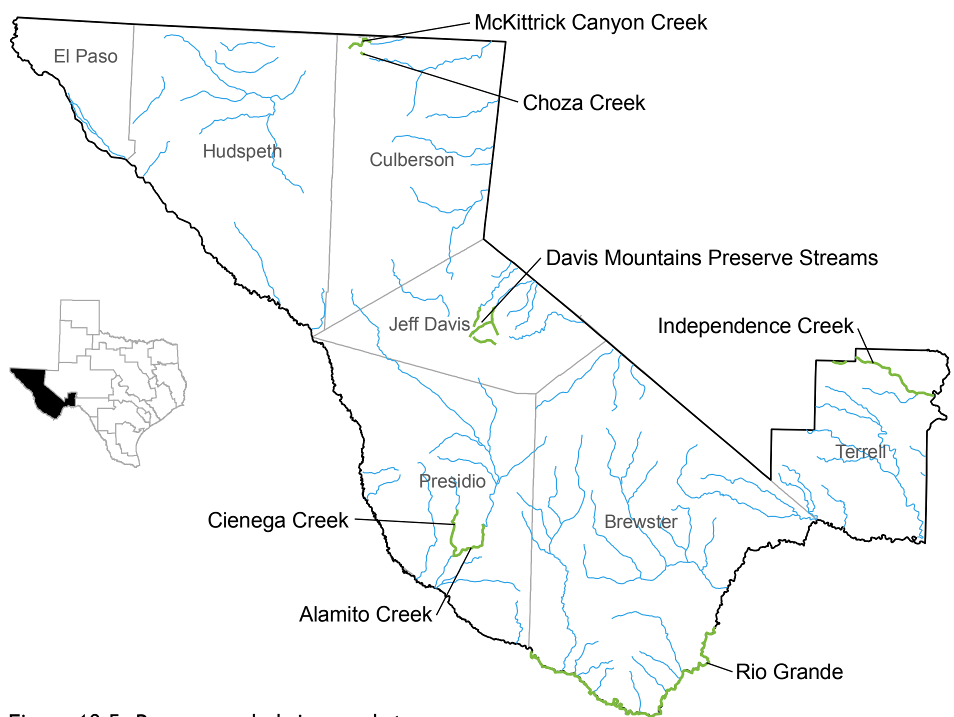


Figure 10.5. Recommended river and stream segments of unique ecological value in Region E.

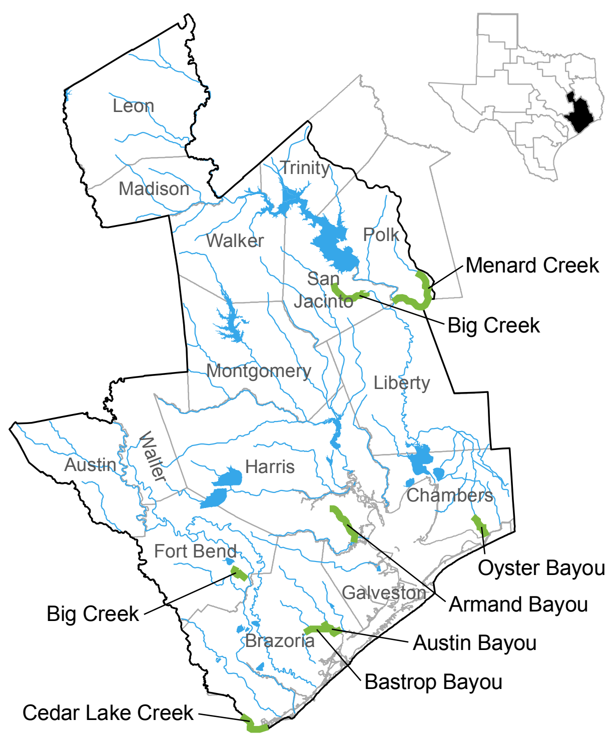


Figure 10.6. Recommended river and stream segments of unique ecological value in Region H.

or transferring groundwater supplies from areas where projections indicate that surplus groundwater will exist to areas with water needs.

Water management strategies relying on groundwater account for about 9 percent of the total projected water volume to be provided by all recommended water management strategies on a statewide basis in 2060, about 0.8 million acre-feet (Table 10.4). This represents an increase of about 20,000 acre-feet in 2050 from the 2002 State Water Plan. In terms of volume, recommended groundwater management strategies are the largest for Region L (206,111 acre-feet per year in 2060) and Region A (117,220 acre-feet per year in 2060). Total capital costs for groundwater strategies amount to about $2.3 billion, and average annual unit costs range from $33 per acre-foot in Region P to $634 per acre-foot in Region D. The statewide average unit cost for groundwater is $260 per acre-foot.

10.2.4 Strategies Using Water Reuse

Water reuse is an increasingly attractive water management strategy to meet water supply needs (see Chapter 8, Water Reuse). On a statewide basis, recommended water reuse strategies will generate about 1.3 million acre-feet in 2060 (Table 10.5), which accounts for about 14 percent of new water supplies to be provided from all recommended water management strategies. This represents a substantial increase when compared to the 2002 State Water Plan in which reuse made up about 6 percent (about 420,000 acre-feet) of new water supplies in 2050.

On a regional basis, Region C recommended reuse strategies that would produce about 720,000 acre-feet by 2060—nearly 27 percent of new water for the region. Reuse in Region H totals about 170,000 acre-feet per year by 2060, and regions K, L, and M collectively recommended over 240,000 acre-feet per year by 2060. Estimated capital costs for reuse strategies amount to about $4.0 billion, and average annual unit costs range from $100 to $1,259 per acre-foot of water generated, with a statewide average of $248 per acre-foot.

10.2.5 Strategies Using Desalination

Simply put, desalination is converting saline water to usable water. Today, desalination technology has been proven both reliable and cost effective in areas where water is scarce. Eight planning groups recommended desalinating brackish groundwater or seawater as a water management strategy. In total, recommended desalination projects would create about 313,000 acre-feet per year of new water supplies by 2060, with 44 percent of this water coming from seawater desalination and 56 percent coming from brackish groundwater desalination (Table 10.6). Desalination accounts for about 3 percent of all new water supplies from recommended water management strategies in 2060. Capital costs to implement recommended desalination water management strategies total about $2.6 billion. Average annual costs per acre-foot range from $768 to $1,390 for seawater desalination and $429 to $953 for brackish groundwater desalination.

10.2.6 Strategies Using Conjunctive Use

Conjunctive use water management strategies involve the combined use of groundwater and surface water in a way that optimizes the beneficial characteristics of each source. An example

Table 10.4. Summary of recommended groundwater management strategies in 2060

Region	New supplies from all recommended strategies (acre-feet per year)	New supplies from groundwater (acre-feet per year)	Percentage of all new supplies from groundwater	Estimated capital costs (millions of dollars)	Average annual unit costs per acre-foot of water[a] (dollars)
A	412,146	117,220	28	343.34	193
B	81,021	1,550	2	5.09	590
C	2,653,248	12,639	<1	449.53	96
D	108,742	7,806	7	27.76	634
E	137,737	26,191	19	36.78	204
F	239,250	38,270	16	251.83	490
G	736,032	41,075	6	86.71	443
H	1,300,639	90,993	7	173.15	122
I	324,756	21,589	7	32.36	183
J	14,869	5,672	38	7.72	120
K	861,930	95,742	11	65.45	93
L	732,779	206,111	28	713.96	399
M	807,587	31,416	4	43.98	359
N	149,496	20,535	14	48.34	537
O	441,511	50,421	11	43.99	136
P	32,468	31,979	98	0.00	33
Texas	9,034,211	799,209	9	2,329.99	260

[a]Reported figures are an average of unit costs in the first decade of strategy implementation and unit costs in 2060 weighted by the amount of water produced by a given strategy.

of conjunctive use is when water providers use surface water as their primary source of water supply and groundwater to meet peak day needs or to supplement supply during times of drought. Region K, Region L, and Region G recommended conjunctive use strategies in their regional water plans. New supplies provided from these recommended water management strategies in Region L would total about 180,000 acre-feet per year by 2060. This includes water provided from the Lower Colorado River Authority and San Antonio Water System Water Project that is projected to generate 150,000 acre-feet of new water supplies by 2060 through conjunctive use of groundwater from the Gulf Coast Aquifer and surface water

Table 10.5. Summary of recommended water reuse management strategies in 2060

Region	New supplies from all recommended strategies (acre-feet per year)	New supplies from water reuse (acre-feet per year)	Percentage of all new supplies from water reuse	Estimated capital costs (millions of dollars)	Average annual unit costs per acre-foot of water[a] (dollars)
A	412,146	2,700	1	1.83	100
B	81,021	11,134	14	49.60	761
C	2,653,248	722,320	27	2,952.01	113
D	108,742	300	<1	0.00	na
E	137,737	18,109	13	45.84	249
F	239,250	12,710	5	100.89	627
G	736,032	81,728	11	103.68	320
H	1,300,639	165,865	13	256.45	561
I	324,756	2,676	1	3.6	214
J	14,869	–	–	–	–
K	861,930	144,090	17	178.06	268
L	732,779	51,676	7	189.31	449
M	807,587	45,781	6	52.39	559
N	149,496	250	<1	1.50	725
O	441,511	2,240	1	29.75	1,259
P	32,468	–	–	–	–
Texas	9,034,211	1,261,579	14	3,964.91	248

Note: Dash indicates a value of zero and "na" indicates that data are not currently available.
[a] Reported figures are an average of unit costs in the first decade of strategy implementation and unit costs in 2060 weighted by the amount of water produced by a given strategy.

supplies from the Colorado River. In Region G, conjunctive use strategies would produce about 54,000 acre-feet per year of new supplies by 2060. Capital costs for both regions are about $2.8 billion, and average annual unit costs are $749 per acre-foot in Region G and $1,244 per acre-foot in Region L.

10.2.7 Strategies Using Land Stewardship

One of the suggested water management strategies emerging in this round of water supply planning is voluntary land stewardship. There is a relationship between the condition of a watershed and the quality and quantity of water that percolates to aquifers or runs off to streams and rivers. In some parts of the state, it is thought that improving the condition of the watershed's vegetative cover can help clean and increase the amount of water for human use and the environment. Land stewardship practices that help control nuisance vegetation, maintain and restore suitable vegetation in riparian areas, reseed with native plants, maintain open space land and wildlife habitat, conserve wetlands, and control erosion through reduction of overgrazing will promote the health and efficiency of the state's watersheds and should be encouraged.

A component of land stewardship that has garnered much attention is brush control, which involves reducing vegetation that consumes large volumes of water that would otherwise recharge aquifers or flow in rivers and streams in many areas of the state. Region G recommended brush control as a water management strategy to meet irrigation needs; however, potential supplies generated by brush control are difficult to quantify and, as a result, are not included in their regional total.

10.2.8 Major Conveyances

To deliver water to areas with needs, several new water conveyance systems are included as a component of many water management strategies. These conveyance systems connect existing waters sources that are not currently physically available to a water user. Although determining precise conveyance routes was beyond the level of detail required for regional water planning, the general location of the recommended conveyance structures illustrates that most of the water supplies will be conveyed to larger urban areas of the state (Table 10.7, Figure 10.7).

Detailed information on planning group recommended water management strategies are included in Chapter 2, Appendix 2.1, and Volume III.

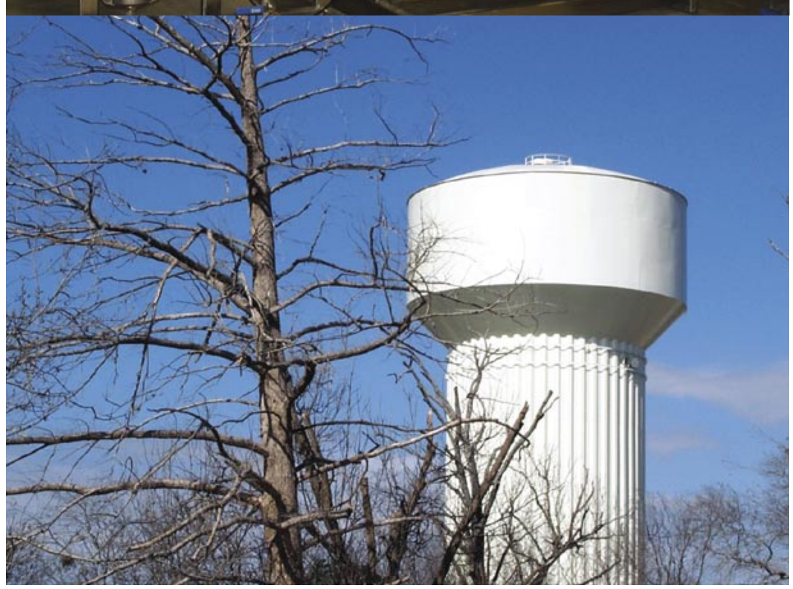


Table 10.6. Summary of recommended desalination water management strategies in 2060

Region	New supplies from all recommended strategies (acre-feet per year)	New supplies from desalination (acre-feet per year)		Percentage of all new supplies from desalination		Estimated capital costs (millions of dollars)		Average annual unit costs per acre-foot of water[a] (dollars)	
		Seawater desalination	Brackish desalination	Seawater desalination	Brackish desalination	Seawater desalination	Brackish desalination	Seawater desalination	Brackish desalination
A	412,146	–	–	–	–	–	–	–	–
B	81,021	–	–	–	–	–	–	–	–
C	2,653,248	–	–	–	–	–	–	–	–
D	108,742	–	–	–	–	–	–	–	–
E	137,737	–	50,000	–	36	–	502.74	–	953
F	239,250	–	16,221	–	7	–	131.45	–	599
G	736,032	–	–	–	–	–	–	–	–
H	1,300,639	28,000	–	2	–	255.70	–	1,300	–
I	324,756	–	–	–	–	–	–	–	–
J	14,869	–	–	–	–	–	–	–	–
K	861,930	–	29,568	–	3	–	96.54	–	429
L	732,779	84,012	5,662	11	1	891.32	93.41	1,390	903
M	807,587	7,902	69,962	1	9	15.94	342.47	768	537
N	149,496	18,200	–	12	–	248.92	–	1,341	–
O	441,511	–	3,360	–	1	–	10.05	–	506
P	32,468	–	–	–	–	–	–	–	–
Texas	9,034,211	138,114	174,773	2	2	1,411.88	1,176.66	1,351	671

Note: Dash indicates a value of zero.

[a]Reported figures are an average of unit costs in the first decade of strategy implementation and unit costs in 2060 weighted by the amount of water produced by a given strategy.

Table 10.7. Major water conveyances proposed by planning groups

ID	Conveyance from	To
1	Potter County	Amarillo
2	Roberts County	Amarillo
3	Palo Duro Reservoir	Hansford, Hutchinson, and Moore counties
4	Wichita Falls	Electra
5	Lake Kemp/Diversion System	Archer, Clay, and Wichita counties
6A	Toledo Bend Reservoir	Lake Fork
6B	Lake Fork	Cooper Lake then Lake Lavon
6C	Lake Fork	Lake Tawakoni then Cedar Creek Reservoir
7A	Marvin Nichols Reservoir	Lake Lavon
7B	Lake Lavon	Lewisville Lake
7C	Lewisville Lake	Eagle Mountain Lake
8A	Hugo Lake in southeast Oklahoma	Lavon Lake
8B	Lake Lavon	Lewisville Lake
8C	Lewisville Lake	Eagle Mountain Lake
9	Lake Wright Patman	Dallas Water Utilities
10	Richland-Chambers and Cedar Creek reservoirs	Tarrant Regional Water District
11	Lower Bois d'Arc Reservoir	North Texas Municipal Water District
12	Lake Fork	Dallas Water Utilities
13	Lake Texoma	North Texas Municipal Water District
14	Lake Ralph Hall	Denton and Collin counties
15	Lake Fastrill	Dallas Water Utilities
16	Lake Palestine	Dallas Water Utilities
17	Trinity River near Crandall	Lake Lavon
18	Hudspeth and Culberson counties	Dell City then El Paso
19	Winkler County	Odessa
20	Winkler County	Midland
21	Capitan Reef Aquifer	Odessa
22	Concho and McCulloch counties	San Angelo
23	Brazos River at Johnson County	Johnson County
24	Lake Whitney	Hill County
25	Brazos River at Grimes County	Grimes County
26	Milam County	Lake Granger
27	Lake Travis	Williamson County
28	Lake Fork	Rusk County
29	Kerr County	Kerrville
30	Lower Colorado River	Bexar County
31	Lower Guadalupe River	Hays and Kendall counties
32	Gonzales and Wilson counties	Bexar County
33	Bastrop, Caldwell, and Fayette counties	Hays County
34	Gonzales County/Lake Dunlap	Guadalupe and Bexar counties
35	Desalination plant	Bexar County
36	Wilson County	Bexar County
37	Choke Canyon Reservoir	Lake Corpus Christi
38	Corpus Christi	San Patricio County
39	Lower Colorado River	Lake Texana
40	Lake Alan Henry	Lubbock
41	Lubbock	Constructed wetlands on tributary of White River

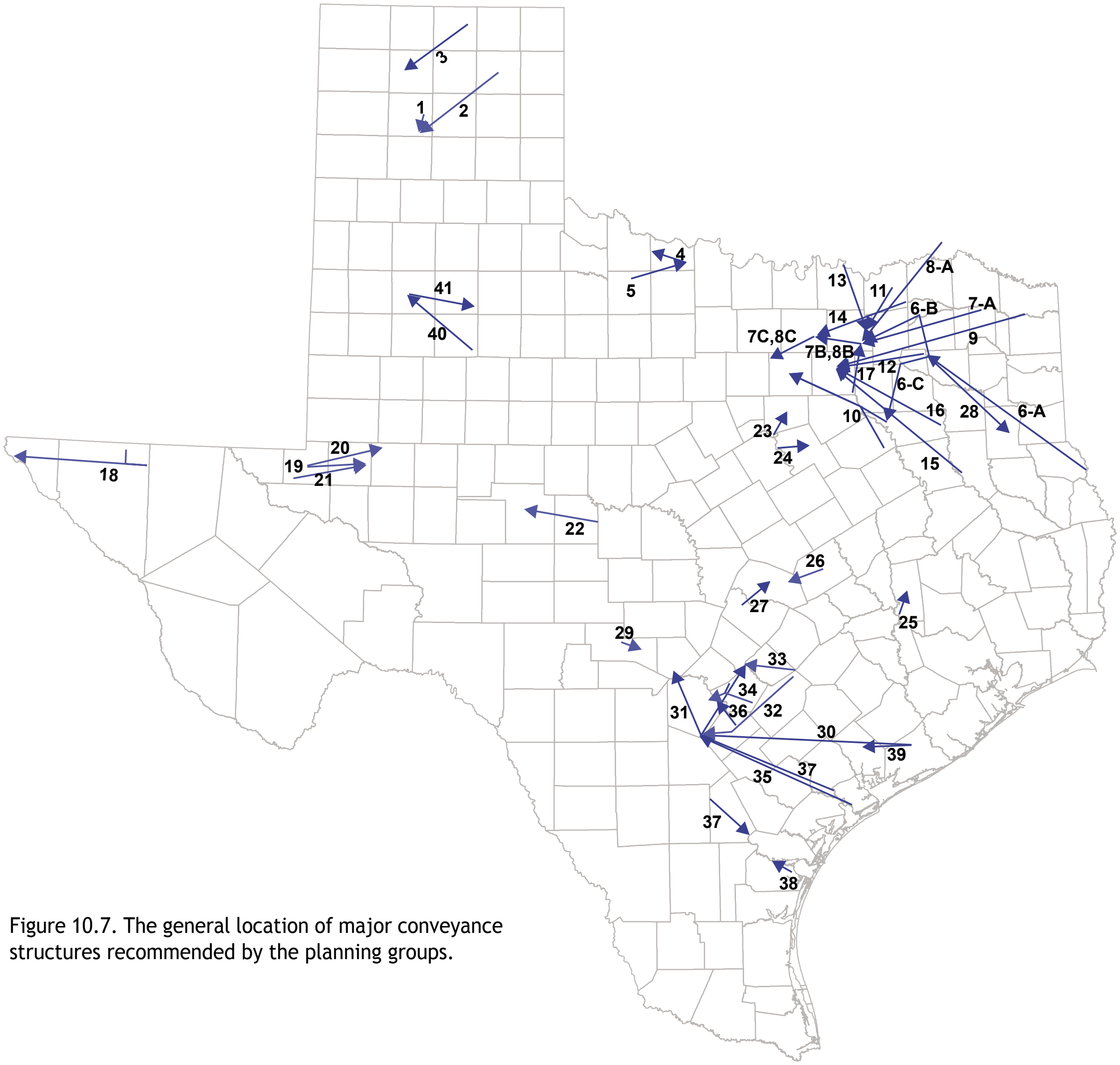


Figure 10.7. The general location of major conveyance structures recommended by the planning groups.