

EXECUTIVE SUMMARY

REGION C WATER PLAN

January 2001

Executive Summary

This report presents the Senate Bill One regional water plan developed in the year 2000 for Region C. Region C covers all or part of 16 counties in North Central Texas, as shown in Figure ES-1.

The Region C water plan was developed under the direction of the 19-member Region C Water Planning Group. The planning process included the following steps, which are presented in this executive summary and described in greater detail in the main report and the appendices:

- Description of Region C
- Population and Water Demand Projections
- Analysis of Water Supply Currently Available to Region C
- Comparison of Water Supply and Projected Water Demand
- Evaluation and Selection of Water Management Strategies
- Regulatory, Administrative, Legislative, and Other Recommendations
- Plan Approval Process and Public Participation

ES-1 Description of Region C

As of 1998, the estimated population of Region C was 4,779,210 - 24.4 percent of Texas' total population. The two most populous counties in Region C, Dallas and Tarrant, have 70.6 percent of the region's population. There are 38 cities in Region C with an estimated 1998 population of more than 20,000. These cities include 80.5 percent of the 1998 population of the region.

Economic Activity in Region C

Region C includes most of the Dallas and Fort Worth-Arlington metropolitan statistical areas, which have experienced strong economic growth in the 1990s. Payroll and employment in

Region C are concentrated in the central urban counties of Dallas and Tarrant. The largest business sectors in Region C in terms of payroll are services and manufacturing.

Water-Related Physical Features in Region C

Most of Region C is in the upper portion of the Trinity Basin, with smaller parts in the Red, Brazos, Sulphur, and Sabine Basins. Figure ES-1 shows the major streams in Region C. Precipitation increases west to east in Region C from slightly more than 30 inches per year in western Jack County to more than 44 inches per year in the northeast corner of Fannin County. The average annual runoff in the region also increases from the west to the east. Evaporation is higher in the western part of Region C. The patterns of rainfall, runoff, and evaporation result in more abundant water supplies in the eastern part of Region C than in the west.

There are 34 reservoirs in Region C with conservation storage over 5,000 acre-feet, all of which are shown in Figure ES-1. These reservoirs and others outside of Region C provide most of the region's water supply. Reservoirs are necessary to provide a reliable surface water supply in this part of the state because of the wide variations in natural streamflow. Reservoir storage serves to capture high flows when they are available and save them for use during times of normal or low flow.

The Trinity aquifer supplies most of the groundwater used in Region C. Other aquifers in the region include the Carrizo-Wilcox, the Woodbine, the Nacatoch, and the Queen City.

Current Water Uses and Demand Centers in Region C

Water use in Region C has increased significantly since 1980, primarily in response to increasing population and municipal demand. The historical record shows years of high use, including 1988, 1996, and 1998. High use years are associated with dry weather, which causes higher municipal demands due to increased outdoor water use. It is interesting to note that Region C, with 24.4 percent of Texas' population, had only 7.2 percent of the state's water use in 1997. This is primarily because Region C has very limited water use for irrigation. About 85 percent of the current water use in Region C is for municipal supply, followed by manufacturing use as the second largest category, then by steam electric power generation. Irrigation, mining, and livestock are relatively minor uses of water in Region C.

Current Sources of Water Supply

Total water use in Region C has increased significantly since 1980, but groundwater use has actually decreased in that period. Since 1990, over 90 percent of the water use in Region C has been supplied by surface water, but groundwater is still an important source of supply, especially in some rural areas. Most of the surface water supply in Region C comes from major reservoirs. Another significant water source for Region C is surface water imported from other regions. The Trinity aquifer is by far the largest source of groundwater in Region C, with the Woodbine, Carrizo-Wilcox and other minor aquifers also used. Current use of groundwater exceeds the reliable long-term supply available in many parts of Region C.

Over half of the water used for municipal supply in Region C is discharged as treated effluent from wastewater treatment plants, making wastewater reclamation and reuse a potentially significant source of additional water supply for the region. At present, only a fraction of the region's treated wastewater is actually reclaimed and reused in the region. Many of the region's water suppliers are considering reuse projects, and it is clear that reuse of treated wastewater will be a significant part of future water planning for Region C.

Water Providers in Region C

Water providers in Region C include regional wholesale suppliers (river authorities and water districts) and retail suppliers (cities and towns, water supply corporations, special utility districts, and private water companies). Cities and towns provide most of the retail water service in Region C. Table ES-1 shows some basic data on sales to others by the five major water providers in Region C, which are the only water suppliers in the region with over 20,000 acre-feet per year in wholesale sales.

Agricultural and Natural Resources in Region C

Agricultural and natural resources in Region C are dependent on the region's water resources. Wetlands often rely on water from streams and reservoirs. Wetlands provide food and habitat for fish and wildlife, water quality improvement, flood protection, shoreline erosion control, and groundwater exchange, in addition to opportunities for human recreation, education, and research. Threatened or endangered species can depend on habitat associated with rivers and streams. The Texas Parks and Wildlife Department has identified several Region C stream segments as having significant natural resources based on their high water quality, exceptional

**Table ES-1
Major Water Providers in Region C**

Major Water Provider	1997 Wholesale Sales (Acre-Feet)			Number of Wholesale Customers		
	Raw	Treated	Total	Cities	Water Suppliers	Others
Tarrant Regional WD	258,448	0	258,448	12	11	16
North Texas MWD	0	168,247	168,247	23	14	1
Dallas	13,324	148,281	161,605	17	4	2
Fort Worth	427	39,521	39,948	28	2	4
Trinity River Authority	15,220	22,217	37,437	8	2	1

aquatic life, high aesthetic value, fisheries, spawning areas, unique state holdings, endangered or threatened species, priority bottomland hardwood habitat, wetlands, springs, and pristine areas.

Region C includes almost 6,000,000 acres in farms and over 2,500,000 acres of cropland. Less than 1 percent of the cropland in Region C is irrigated, but there are localized areas of irrigation. The market value of agriculture products is significant in all Region C counties, with a total value for 1997 of almost \$500,000,000. For the region as a whole, the market value of livestock is almost twice that of crops. There are large areas classified as prime farmland by the Natural Resources Conservation Service in Cooke, Denton, Collin, Tarrant, Dallas, and Ellis Counties.

Oil and natural gas fields are significant natural resources in portions of Region C. There is a high density of oil wells in Jack, Wise, Cooke, and Grayson Counties, with a lesser density in Denton, Parker, Navarro, Henderson, and Kaufman Counties. There is a high density of producing natural gas wells in Freestone, Parker, Jack, and Wise Counties, with a lesser density in Navarro, Henderson, Denton, Cooke, and Grayson Counties.

There are some lignite coal resources in Region C. The most significant current lignite production in Region C is in Freestone County to supply TXU Electric's Big Brown Steam Electric Station on Lake Fairfield.

Summary of Threats and Constraints to Water Supply in Region C

The most significant potential threats to existing water supplies in Region C are surface water quality concerns, groundwater drawdown, and groundwater quality. Constraints on the development of new supplies include the availability of sites and unappropriated water for new water supply reservoirs and the challenges imposed by environmental concerns and permitting.

Most of the water suppliers in Region C will have to develop additional supplies before 2050. The major water suppliers have supplies well in excess of current needs, but they will require additional water to meet projected growth. Some smaller water suppliers face a more urgent need for water.

Surface water quality concerns that might affect Region C water supplies include the following:

- Detection of atrazine at low levels in some water supply reservoirs
- Nutrient levels in water supply reservoirs
- Total organic carbon (TOC) levels in source waters
- Elevated levels of dissolved solids in some reservoirs and stream reaches
- Trace levels of arsenic in some waters.

In general, these concerns can be addressed by standard water treatment methods and do not pose a significant threat to water supplies in the region.

Drawdown of aquifers poses a threat to small water suppliers and to household water use in rural areas. As water levels decline, the cost of pumping water grows and water quality generally suffers. Water level declines have been reported in localized areas in each of the aquifers in Region C. In particular, the region-wide pumping from the Trinity and Nacatoch aquifers is estimated to be greater than the recharge. Concern about groundwater drawdown is likely to prevent any substantial increase in groundwater use in Region C and may require conversion to surface water in some areas.

Groundwater quality in Region C aquifers is generally acceptable for most municipal and industrial purposes. However, natural concentrations of arsenic, fluoride, nitrate, chloride, iron, manganese, sulfate, and total dissolved solids in excess of either primary or secondary drinking water standards occur in some areas.

Water-Related Threats to Agricultural and Natural Resources in Region C

Water-related threats to agricultural and natural resources in Region C include changes to natural flow conditions, water quality concerns, and inundation of land due to reservoir development. In general, there are few significant water-related threats to agricultural resources in Region C due to the limited use of water for agricultural purposes. Water-related threats to natural resources are more significant.

ES-2 Population and Water Demand Projections

Methodology for Projections of Population and Water Demand

The Texas Water Development Board's Senate Bill One planning guidelines require the use of TWDB's population and water demand projections from the 1997 *Texas Water Plan* unless revisions are approved by TWDB based on changed conditions or new information. The TWDB projects water demand separately for municipal, manufacturing, steam electric power generation, mining, irrigation, and livestock uses. Municipal demand is developed for each community with a population of over 500 and includes commercial, institutional, and residential water uses but does not include manufacturing use. A "county other" group for each county covers municipal use in rural areas and communities with less than 500 people. All demand categories except municipal are developed on a countywide basis.

To develop the population and water demand projections for Region C, the Region C water planning group went through the following steps:

- Assembled historical data and previous TWDB projections and developed tables and figures that could be reviewed by counties, cities, water suppliers, industries, and other interested entities.
- Sent the TWDB data and a questionnaire to all Region C counties, cities with a population over 1,000, regional water suppliers, retail water suppliers (supplying over 0.2 mgd), and large industries.
- Gathered population data from the State Data Center and the North Central Texas Council of Governments.
- Reviewed the previous TWDB population projections for each county and recommended changes to projections where current populations deviate significantly from the previous projections.
- Adjusted city population projections based on historical trends and knowledge of expected future development using the county population projections as controls.

- Compared TWDB's projections of per capita municipal water demand from the 1997 Texas Water Plan with actual per capita water demand in the 1990s from TWDB data.
- Developed data on 1998 per capita water use for Region C water providers.
- Adjusted previous TWDB projections in per capita water demand to reflect actual use in the 1990s, trends in water use, water conservation, reasonable minimum demands for water, knowledge of future development that might affect per capita needs, and other factors.
- Developed tables and graphs for each city in the region to assist in the review of the recommended projections.
- Revised projections of water demand for steam electric power generation based on input from TXU Electric.
- Checked previous TWDB projections for manufacturing, mining, irrigation, and livestock use and left them unchanged after comparison with recent historical data.
- Formed a Technical Review Committee consisting of experienced water resource planners to review the recommendations of the consultants on population and water use and report to the planning group.
- Held a public meeting to receive input on the water demand projections.
- Made a number of additional changes as a result of TWDB review and input.
- Submitted the revised projections to the TWDB board, which approved the revised projections in December of 1999.

Population Projections

Table ES-2 presents the adopted population projections by county for Region C. Figure ES-2 shows the historical and projected population for the region. All counties are projected to increase in population between now and 2050, and the projected 2050 population for Region C is 9,481,157. Once the county population projections were completed, city population projections were adjusted based on historical trends and knowledge of expected future development. The county populations served as controls in this process, and all population not assigned to a particular city was included as county other.

Water Demand Projections

Table ES-3 shows the adopted water demand projections for Region C by county. Table ES-4 and Figure ES-3 show the projected water demand for the region by type of use. The projected 2050 water demand for Region C is 2,536,902 acre-feet per year, which is more than double the 1996 use in the region. Most of the change from previous TWDB projections is in municipal

**Table ES-2
Adopted County Population Projections for Region C**

County	Historical 1996	2000	2010	2020	2030	2040	2050
Collin	373,095	443,000	635,455	923,309	1,150,001	1,351,000	1,501,395
Cooke	33,196	34,209	36,967	38,816	40,000	41,250	42,500
Dallas	1,999,926	2,104,858	2,326,828	2,556,793	2,784,704	3,045,931	3,259,995
Denton	349,566	423,327	591,350	802,461	1,033,731	1,200,000	1,349,999
Ellis	94,097	103,070	123,854	144,054	162,273	175,403	185,364
Fannin	27,435	30,000	33,601	37,000	39,501	40,499	41,001
Freestone	17,757	18,167	18,800	19,300	19,600	20,000	20,300
Grayson	100,611	106,119	110,226	114,702	117,865	120,981	122,000
Henderson (Partial)	45,761	46,562	51,261	55,515	57,704	58,690	60,476
Jack	7,435	7,819	8,139	8,591	8,934	9,175	9,353
Kaufman	61,646	68,368	87,106	108,291	129,359	147,108	162,417
Navarro	42,875	45,191	49,207	53,031	57,015	59,200	61,000
Parker	73,897	80,436	99,095	118,287	139,094	156,023	171,216
Rockwall	34,287	41,175	61,392	88,136	122,000	160,588	203,529
Tarrant	1,306,457	1,415,759	1,594,218	1,798,894	1,915,375	2,111,193	2,205,610
Wise	41,019	44,800	54,674	64,363	73,641	81,000	85,002
Region C Total	4,609,060	5,012,860	5,882,173	6,931,543	7,850,797	8,778,041	9,481,157

demands, with a smaller change in steam electric power demands. No changes were made to TWDB's previous projections for manufacturing, mining, irrigation, or livestock demands.

One of the most important reasons for the increase in projected per capita demand for Region C is the high water use recorded for many Region C water suppliers in 1996 and 1998. This high water use occurred despite significant water conservation efforts in the region and despite the impact of low flow plumbing fixtures. There are several factors that tend to increase per capita municipal water use in the region:

- In many communities, new development is large houses with large lots, sprinkler systems, swimming pools, and other water-using amenities.
- The number of people per household is decreasing in most of Region C. This tends to cause an increase in per capita use because household uses are spread over fewer people.
- Many Region C communities are experiencing rapid commercial development, which increases per capita water use.

Figure ES-2
Historical and Projected Population for Region C

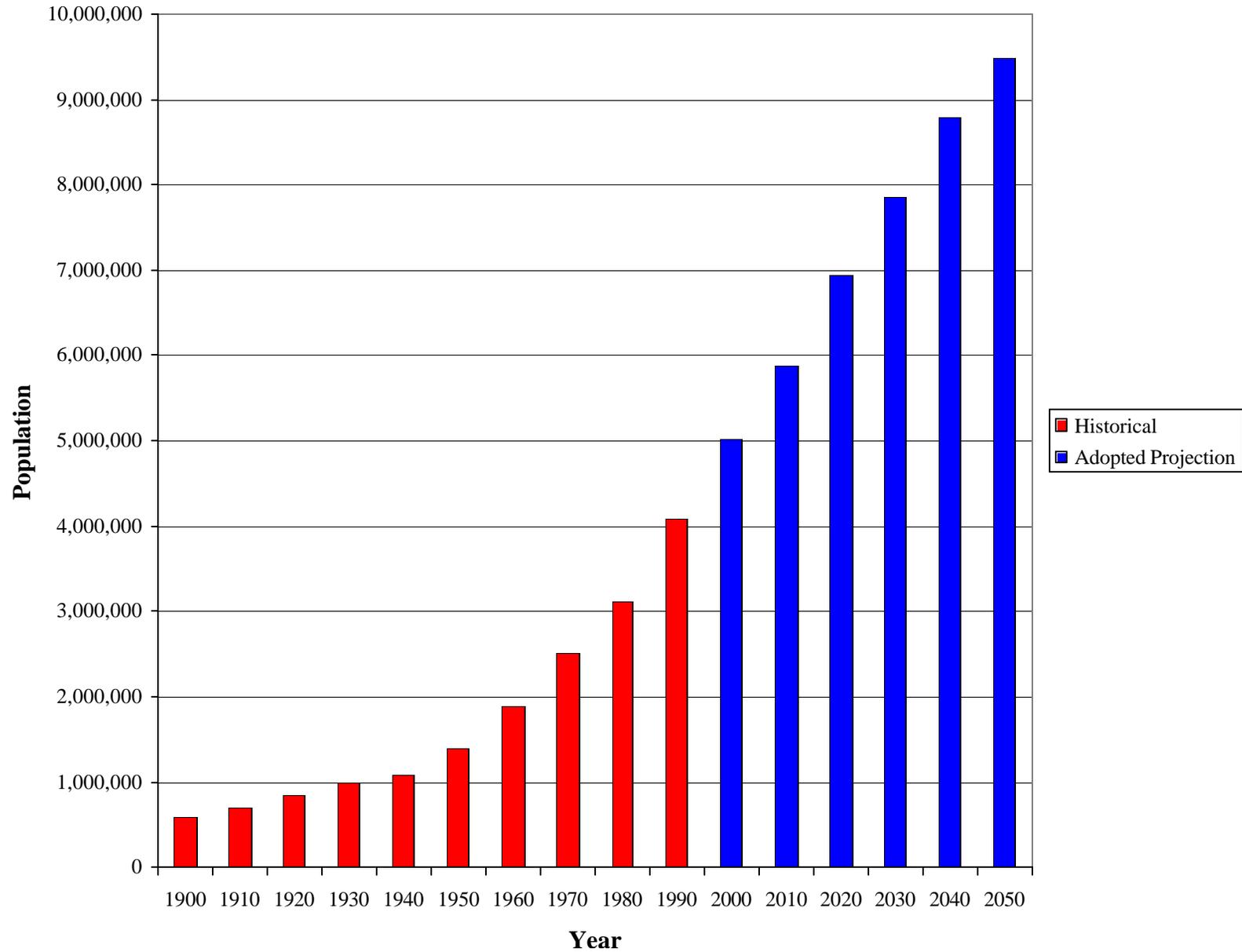


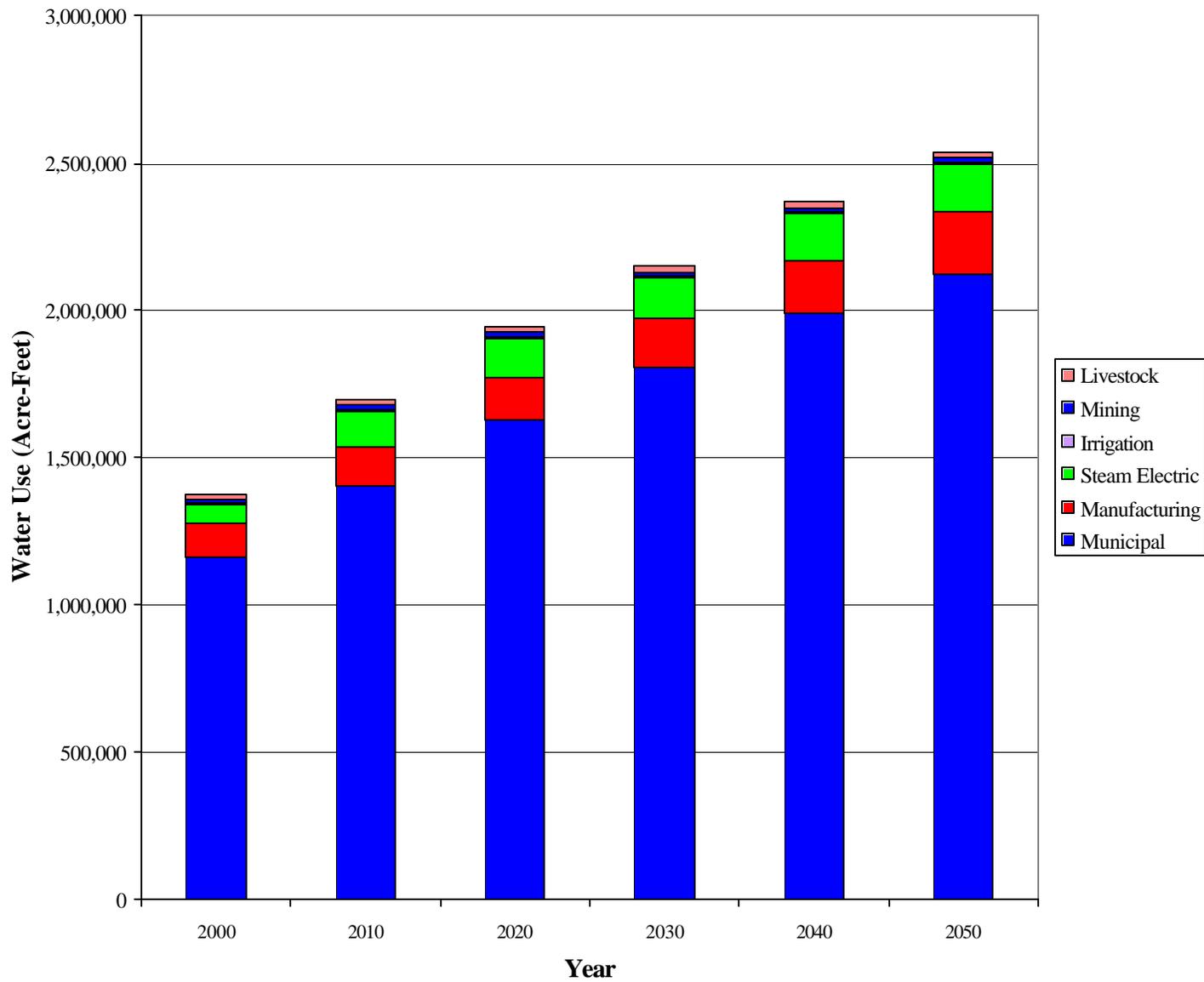
Table ES-3
Adopted County Water Demand Projections for Region C
 - Values in Acre-Feet per Year -

County	Historical 1996	Projected Water Demand					
		2000	2010	2020	2030	2040	2050
Collin	89,230	129,015	199,964	262,520	312,307	363,821	401,007
Cooke	8,429	9,054	9,133	9,238	9,304	9,581	9,879
Dallas	505,423	594,937	683,097	751,767	810,356	883,850	940,289
Denton	65,075	90,209	135,740	185,725	230,286	257,410	281,989
Ellis	19,721	24,372	43,204	46,030	49,309	53,991	55,575
Fannin	17,515	12,100	13,330	14,500	15,597	16,572	17,515
Freestone	20,608	20,074	31,058	33,000	33,036	37,260	37,290
Grayson	29,152	29,060	29,760	30,242	31,347	32,508	33,688
Henderson (Partial)	10,785	12,697	13,169	13,478	13,697	13,737	13,908
Jack	3,337	2,644	2,589	2,574	2,591	2,615	2,652
Kaufman	10,653	21,219	24,401	27,392	32,361	34,832	42,017
Navarro	10,558	10,301	10,845	11,210	11,850	12,303	12,735
Parker	12,372	14,120	24,528	28,455	37,697	42,853	45,725
Rockwall	6,566	9,160	19,805	26,027	33,061	41,320	50,249
Tarrant	291,406	379,205	423,578	468,728	490,960	527,716	553,302
Wise	25,688	18,206	31,460	34,007	36,067	37,819	39,082
Region C Total	1,126,518	1,376,373	1,695,661	1,944,893	2,149,826	2,368,188	2,536,902

Table ES-4
Adopted Water Demand Projections for Region C by Type of Use
 - Values in Acre-Feet per Year -

Use	Historical 1996	Projected Water Demand					
		2000	2010	2020	2030	2040	2050
Municipal	946,454	1,162,093	1,401,197	1,625,412	1,808,337	1,988,513	2,125,330
Manufacturing	71,366	117,577	135,114	148,798	162,714	183,188	207,637
Steam Electric Power	52,103	59,800	122,300	132,700	139,700	156,192	162,192
Mining	22,576	13,046	13,231	14,190	15,294	16,515	17,950
Irrigation	9,689	5,382	5,344	5,318	5,306	5,305	5,318
Livestock	24,330	18,475	18,475	18,475	18,475	18,475	18,475
Total	1,126,518	1,376,373	1,695,661	1,944,893	2,149,826	2,368,188	2,536,902

Figure ES-3
Adopted Projections
for Water Use by Category in Region C



ES-3 Analysis of Water Supply Currently Available to Region C

Total water use in Region C in 1996 was over 1,100,000 acre-feet. About 74 percent of the region's 1996 water use came from in-region reservoirs. The projected total reliable water supply available to Region C in 2050 from current sources will be about 2,023,000 acre-feet per year. (This figure does not consider supply limitations due to the capacities of current raw water transmission facilities and wells.) Figure ES-4 shows the projected total water availability for Region C. The sources of supply for Region C in 2050 include:

- 1,138,000 acre-feet per year (56%) from in-region reservoirs
- 181,000 acre-feet per year (9%) from groundwater
- 70,000 acre-feet per year (3%) from local supplies
- 82,000 acre-feet per year (4%) from reuse
- 552,000 acre-feet per year (28%) from imports from other regions

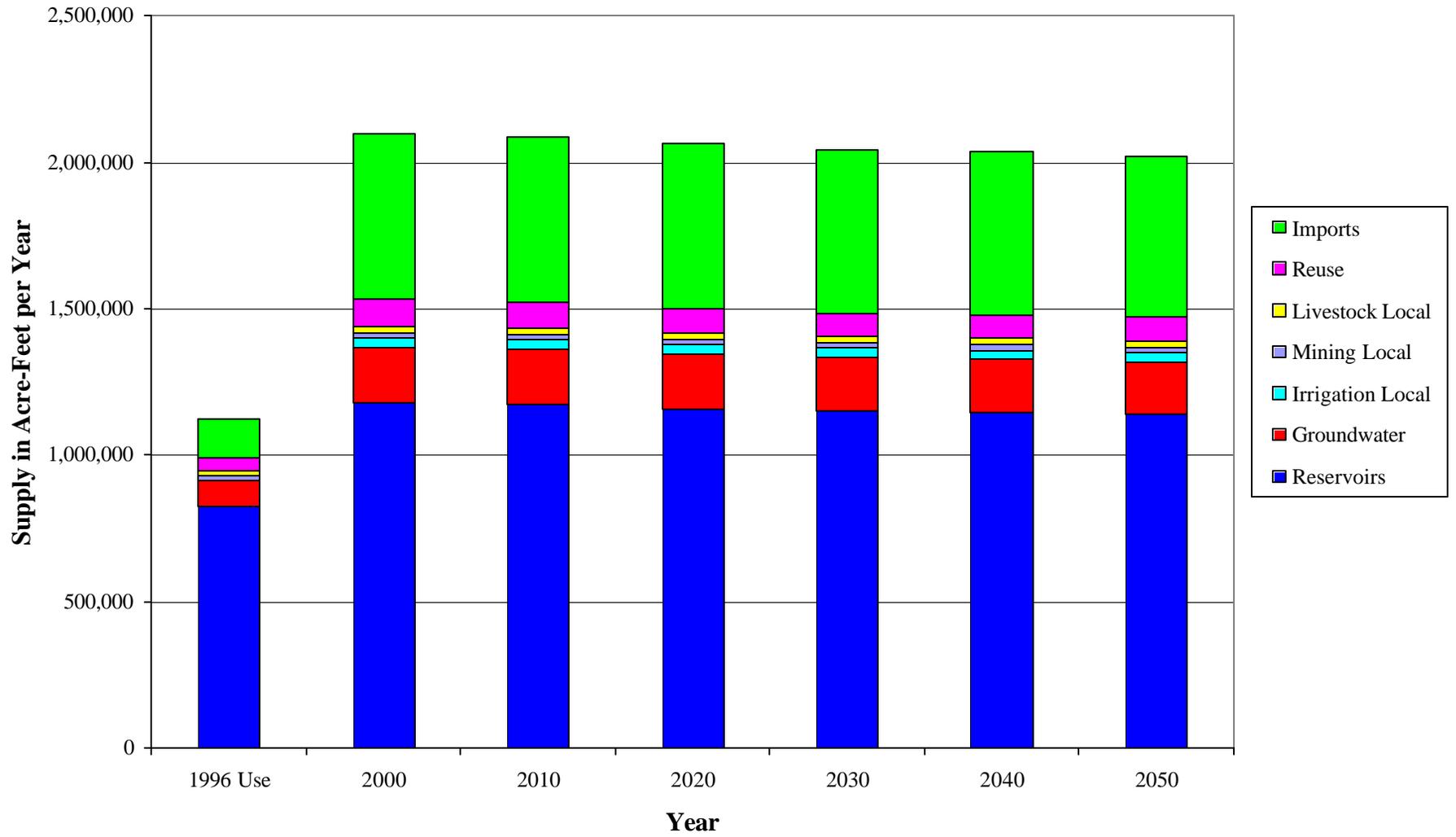
The projected supply available to Region C from existing sources in 2050 is significantly less than the projected 2050 water use.

If the supply limitations due to the capacities of current raw water transmission facilities and wells are considered, the available supply for Region C is reduced significantly. Most water user groups will have to make improvements to water transmission facilities or wells to provide for their projected needs. Several major Region C water supplies will require additional raw water transmission facilities before they can be utilized fully.

Current groundwater use in parts of Region C exceeds the projected long-term water supply availability. Supplies from other sources will be needed in these areas so that groundwater use can be reduced. Counties and aquifers where current use exceeds long-term supplies include the following:

- Trinity aquifer in Cooke County
- Trinity and Woodbine aquifers in Denton County
- Woodbine aquifer in Ellis County
- Trinity and Woodbine aquifers in Grayson County
- Nacatoch aquifer in Kaufman County
- Trinity aquifer in Parker County
- Trinity aquifer in Tarrant County.

Figure ES-4
Overall Water Supply Availability in Region C by Source



Some of the total supply shown as available to Region C will probably not be utilized fully during the period covered by this plan. This includes over 90,000 acre-feet per year of groundwater shown to be available in the Carrizo-Wilcox aquifer in Freestone County.

The five major water providers in Region C (City of Dallas, Tarrant Regional Water District, North Texas Municipal Water District, City of Fort Worth, and Trinity River Authority) provided over 903,000 acre-feet of water in 1996 (80% of the total provided in the region). They have 74% of the 2050 water supply currently available to the region.

The recent dry summers of 1996, 1998, 1999, and 2000 have caused very high water use for many Region C water suppliers. These droughts have put stress on some of the region's major reservoirs, which are designed for a 5 to 7 year drought like that of the 1950's. The high demands also exposed supply limitations for many smaller suppliers (especially those dependent on groundwater) and exposed treatment and distribution limitations for other suppliers.

ES-4 Comparison of Current Water Supply and Projected Water Demand

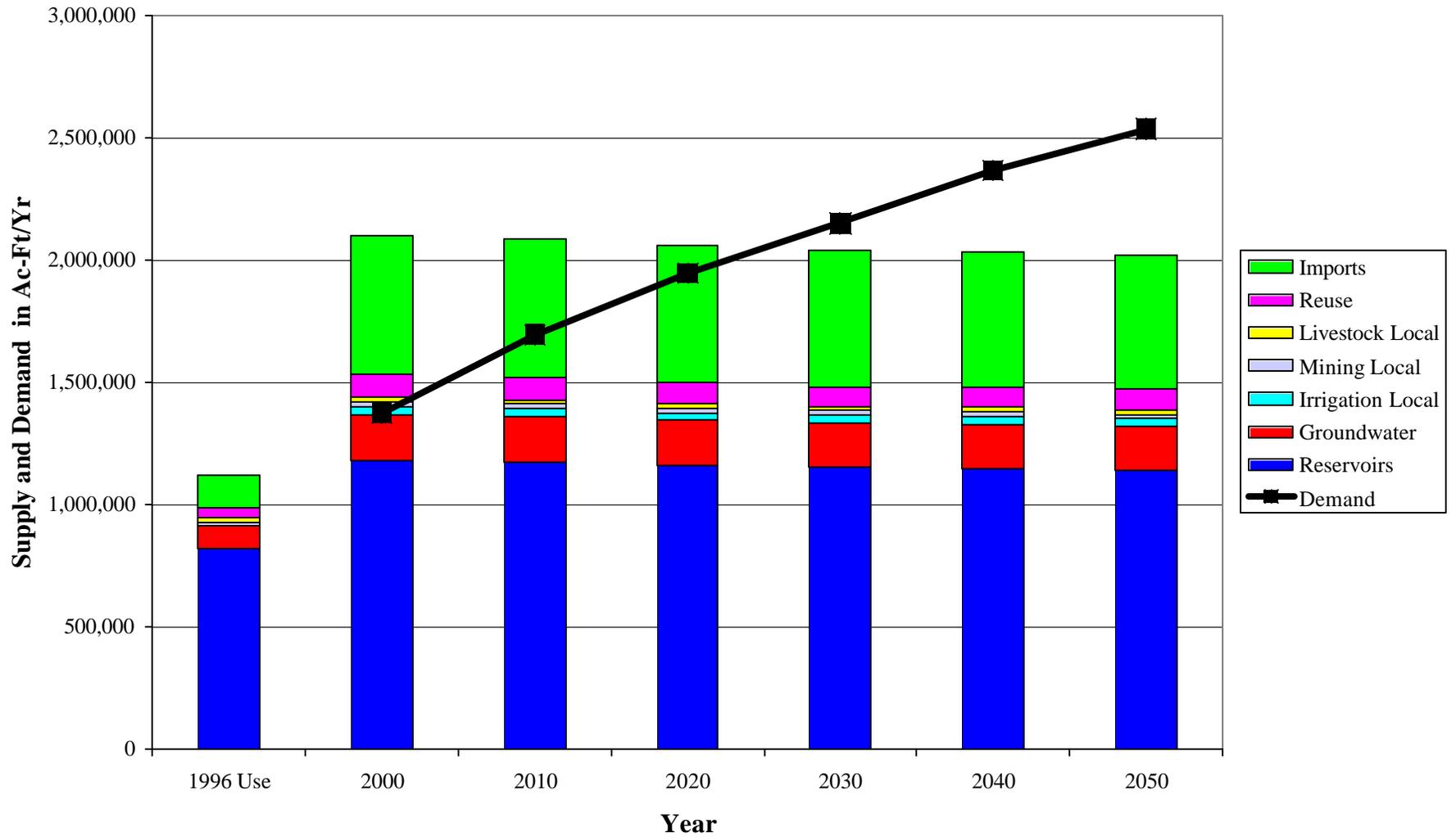
Comparison of Supply and Demand

Figure ES-5 shows the comparison of total supply with demand for Region C, including supplies that require additional water transmission facilities before they are available to the region. By 2030, the projected demand for Region C exceeds the total supply, even if all of the supplies available to the region are used in full.

Considering only currently connected supplies (those with transmission systems already in place), the following facts emerge for Region C:

- In 2000, three Region C counties (Cooke, Dallas, and Parker) show a net need for immediate additional supplies when all demands and all connected supplies are totaled.
- Significant additional supplies need to be connected before 2010 in Region C. (Several major projects to connect existing supplies are already underway.)
- By 2050, 11 out of the 16 Region C counties show a need for the connection or development of additional supplies to meet projected demands.
- By 2050, 193 out of 281 Region C water user groups show a need for the connection or development of additional supplies to meet projected demands.
- Current plans call for the connection of significant additional supplies for Region C over the next few years, including the following:
 - Irving and Upper Trinity Regional Water District's Lake Chapman pipeline is scheduled for completion by 2003 and will connect 65,700 acre-feet per year.

Figure ES-5
Comparison of Total Connected and Unconnected Supply with Demand for Region C



- Dallas Water Utilities Lake Fork pipeline is scheduled for completion by 2004 and will connect 120,000 acre-feet per year.
- Tarrant Regional Water District is planning additional capacity for its pipeline to Richland-Chambers Lake that will connect an additional 110,000 acre-feet per year by 2005.
- Many Region C water suppliers depend on the region's major water providers (Dallas Water Utilities, Tarrant Regional Water District, North Texas Municipal Water District, Fort Worth, and Trinity River Authority) for all or part of their supplies. Each of those major water providers will need additional supplies by 2050.

Socio-Economic Impacts of Not Meeting Projected Water Needs

If no additional water supplies are developed, Region C will face substantial shortages in water supply over the next 50 years. The Texas Water Development Board provided technical assistance to regional water planning groups in the development of information on the socio-economic impacts of failing to meet projected water needs. TWDB's findings for Region C can be summarized as follows:

- The currently connected supplies in Region C would meet only 52.5 percent of the projected 2050 demand.
- Without any additional supplies, the region's projected 2050 population would be limited to 6,078,289, instead of 9,481,157, a reduction of 35.9 percent.
- Without any additional supplies, the region's projected 2050 employment would be limited to 2,605,111, instead of 4,425,184, a reduction of 41.1 percent.
- Without any additional supplies, the region's projected 2050 income would be limited to \$109,505,000,000, instead of \$171,199,000,000, a reduction of 36.3 percent.

ES-5 Evaluation and Selection of Water Management Strategies

The regional water planning group went through several steps in the evaluation and selection of water management strategies for Region C:

- Review of previous plans for water supply in Region C, including locally developed plans and the most recent state water plan
- Development of goals, issues, and concerns for the planning process
- General consideration of the types of water management strategies required by Senate Bill One regional planning guidelines
- Development of evaluation criteria for management strategies
- Evaluation of individual strategies

- Development of cost information for individual strategies
- Selection of strategies.

The development of a water plan covering fifty years for a region as large and populous as Region C is full of uncertainties. The implementation of the resulting plan must be flexible to allow for slower or faster than expected growth, unexpected obstacles in development of water management strategies, and unexpected opportunities. Specific points to remember include the following:

- The order in which steps are taken and the exact amount of supply available from each source are subject to variation.
- Water suppliers may need to turn to other alternatives if the recommended alternatives prove to be impractical.
- Changes in one element of the plan can affect other elements.
- Given the uncertainty in developing future supplies, flexibility in plan implementation is essential to success.
- The details of the plan will probably change as implementation proceeds.

Goals of the Planning Process

The goals for the Region C water planning effort are as follows:

- Provide sufficient water to meet realistic estimates of demand in a timely manner.
- Develop an effective continuing planning process to maintain reliable estimates of supply, maintain realistic estimates of demand, and identify appropriate programs and facilities to meet the water supply needs of Region C.
- Provide for the water supply needs of Region C in a manner that supports the continued economic strength of both Region C and the state as a whole.
- Develop a water supply plan that recognizes the economic, environmental, and cultural importance of natural resources and provides for the maintenance of those resources.
- Address the water supply needs of small cities and rural areas as well as large metropolitan areas.
- Provide for sustainable groundwater use in areas where groundwater is an essential component of the water supply plan.

Types of Water Management Strategies Considered

As required by Senate Bill One guidelines, the Region C Water Planning Group considered specific types of water management strategies as means of developing additional water supplies:

- Water conservation and drought response planning
- Reuse of wastewater
- Expanded use or acquisition of existing supplies
- Reallocation of reservoir storage to new uses
- Voluntary redistribution of water resources
- Voluntary subordination of water rights
- Enhancement of yields of existing sources
- Control of naturally occurring chlorides
- Interbasin transfers
- New supply development
- Water management strategies in the current state water plan
- Brush control, precipitation enhancement, and desalination
- Water right cancellation
- Aquifer storage and recovery
- Other measures.

Methodology for Evaluating Water Management Strategies

The Region C Water Planning Group considered the following factors in the evaluation of potential water management strategies:

- Quantity of water made available
- Reliability of supply
- Unit cost of delivered and treated water
- Difficulty of addressing environmental issues
 - Instream flows
 - Bay and estuary flows
 - Wildlife habitat
 - Cultural resources
 - Wetlands
 - Water quality
 - Other
- Impacts on water resources and other management strategies

- Impacts on agricultural and natural resources
- Consistency with plans of Region C water suppliers
- Consistency with other regions.

Development of cost estimates for water management strategies followed guidelines provided by the Texas Water Development Board. The costs include a 30 percent allowance for engineering and contingencies for pipelines and a 35 percent engineering and contingency allowance for other projects. Costs are for development of new supplies and do not include costs for:

- Facilities already in place
- Replacement or upgrading of aging facilities
- Improvements to meet changing regulatory requirements
- Improvements for water distribution to retail customers.

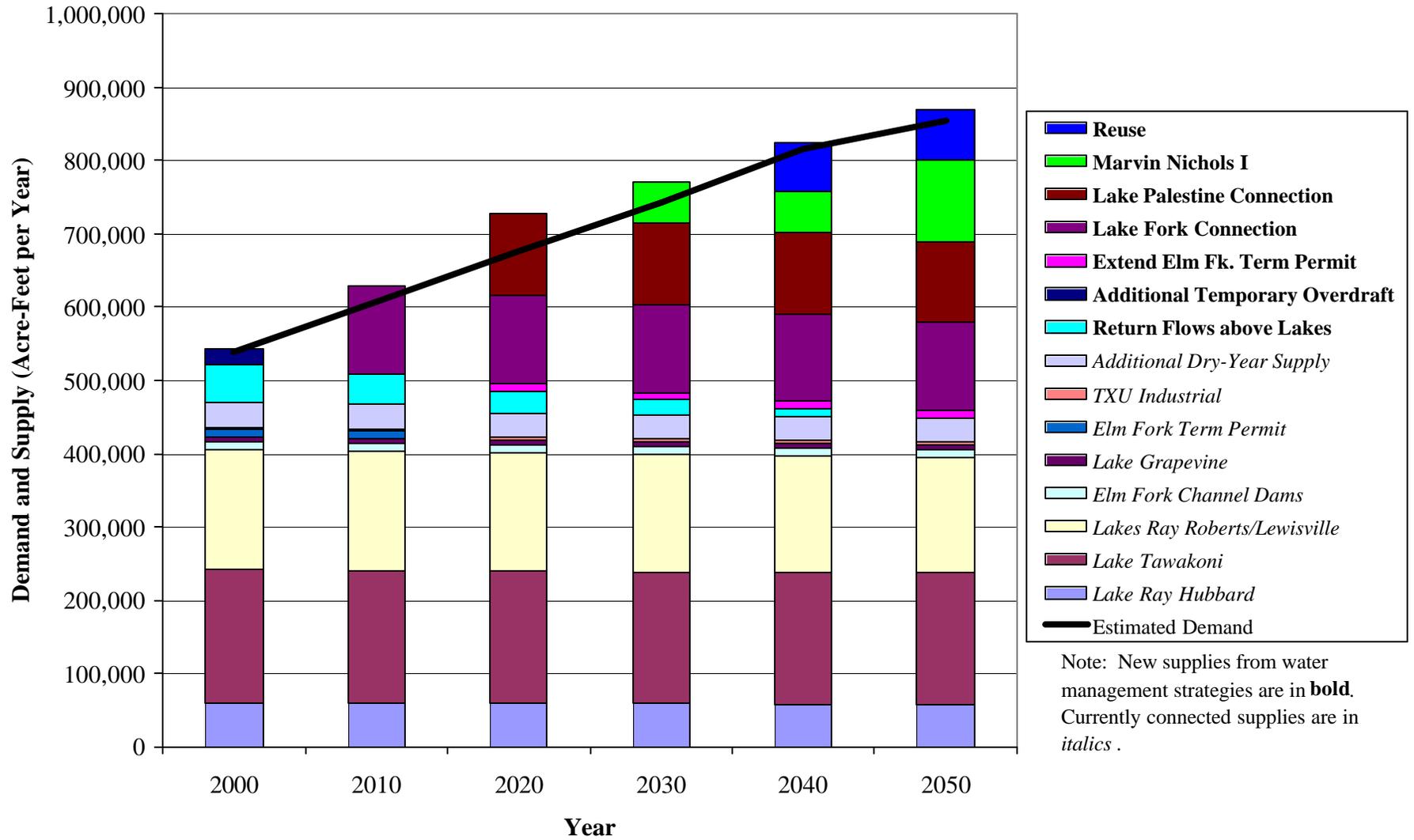
Recommended Water Management Strategies for Major Water Providers

A large part of the water supplied in Region C is provided by the five major water providers in the region: Dallas Water Utilities, Tarrant Regional Water District, North Texas Municipal Water District, Fort Worth, and Trinity River Authority. These five entities will continue to provide the majority of the water supply for Region C through 2050, and they will also develop most of the new supply developed in that time period. Recommended water management strategies to meet the needs of these major water providers include the following:

- **Marvin Nichols I Lake**
 - Major new reservoir in the Sulphur River Basin in the North East Texas Region (Region D)
 - Cooperative effort of Region C and Region D water suppliers
 - Total yield of 619,100 acre-feet per year
 - 123,800 acre-feet per year to Region D
 - 112,000 acre-feet per year to Dallas Water Utilities
 - 156,000 acre-feet per year to Tarrant Regional Water District
 - 163,300 acre-feet per year to North Texas Municipal Water District
 - 25,000 acre-feet per year to Irving
 - 39,000 acre-feet per year to meet other Region C needs.

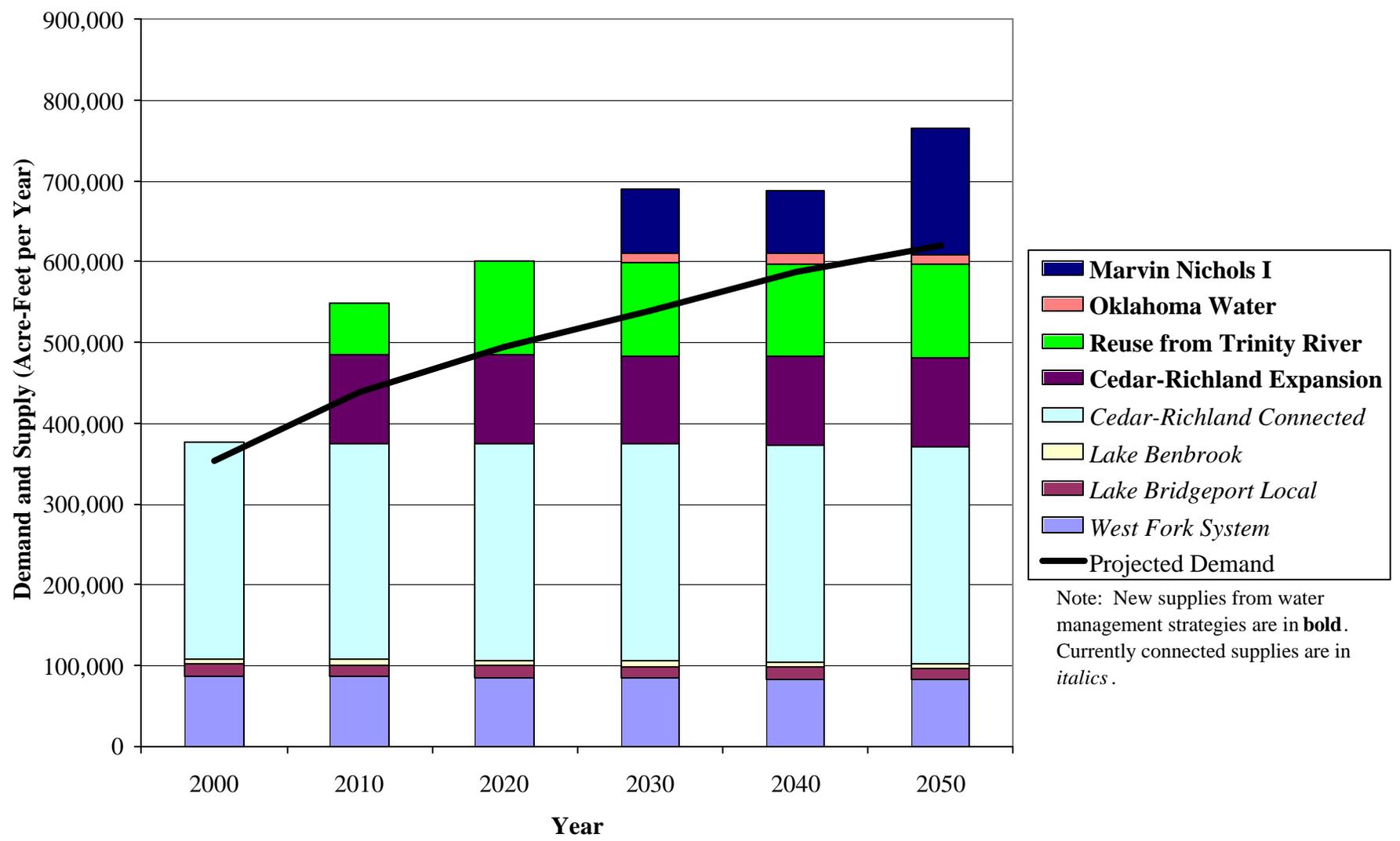
- Estimated capital cost for Region C (including transmission to Region C but not including treatment) of \$1,625,190,000.
- **Dallas Water Utilities**
 - Figure ES-6 shows the overall comparison of supply and demand for Dallas Water Utilities with recommended water management strategies.
 - Continue to use return flows above its lakes (50,000 acre-feet per year in 2000, decreasing to 0 by 2050).
 - Temporarily overdraft its reservoirs in 2000 (22,000 acre-feet per year in 2000).
 - Extend the Elm Fork permit for wet weather diversions (10,000 acre-feet per year).
 - Connect Lake Fork Reservoir to its system (120,000 acre-feet per year).
 - Connect Lake Palestine to its system (109,600 acre-feet per year).
 - Participate in the Marvin Nichols I project (112,000 acre-feet per year).
 - Develop a reuse project (68,300 acre-feet per year).
 - Renew contracts with existing customers as they expire.
 - Develop additional water treatment capacity as needed.
 - Other alternatives for Dallas Water Utilities include additional reuse and development of yield from return flows in the watersheds of water supply reservoirs.
- **Tarrant Regional Water District**
 - Figure ES-7 shows the overall comparison of supply and demand for Tarrant Regional Water District with recommended water management strategies.
 - Add pumps and a booster pump station to develop additional capacity in the pipeline from Richland-Chambers Lake to Tarrant County (110,000 acre-feet per year).
 - Develop the West Fork Connection to allow water to be transferred among the parts of the water supply system.
 - Develop the proposed reuse project to pump water from the Trinity River into Cedar Creek Lake and Richland-Chambers Lake to supplement yields (115,500 acre-feet per year).
 - Develop a water supply from existing water sources in Oklahoma (12,000 acre-feet per year)
 - Develop a third pipeline from Cedar Creek Lake and Richland-Chambers Lake to Tarrant County.
 - Participate in the Marvin Nichols I project (156,000 acre-feet per year).
 - Other alternatives for Tarrant Regional Water District include the development of Lake Tehuacana and obtaining water from Lake Texoma.

Figure ES-6
Dallas Water Utilities Supply and Demand



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**Figure ES-7
Tarrant Regional Water District Supply and Demand**



Note: New supplies from water management strategies are in **bold**.
Currently connected supplies are in *italics*.

- **North Texas Municipal Water District**
 - Figure ES-8 shows the overall comparison of supply and demand for North Texas Municipal Water District with recommended water management strategies.
 - Develop additional water supplies in Lake Lavon from reuse (35,900 acre-feet per year).
 - Develop additional water supplies from Lake Texoma (10,000 acre-feet per year).
 - Develop a water supply from existing water sources in Oklahoma (50,000 acre-feet per year).
 - Develop Lower Bois d'Arc Creek Reservoir on Bois d'Arc Creek (98,000 acre-feet per year).
 - Participate in the Marvin Nichols I project (163,300 acre-feet per year).
 - Develop additional water treatment capacity and treated water transmission system improvements as needed.
 - Other alternatives for North Texas Municipal Water District include obtaining a substantial additional supply from Lake Texoma and extending the existing Lake Texoma pipeline to minimize channel losses.
- **City of Fort Worth**
 - Continue to obtain essentially all of its raw water from Tarrant Regional Water District.
 - Renew contracts with its existing customers as they expire.
 - Develop additional water treatment capacity as needed.
- **Trinity River Authority**
 - Continue to obtain raw water from Tarrant Regional Water District for its Tarrant County water supply project.
 - Expand Tarrant County water supply project raw water transmission, water treatment, and treated water transmission facilities as needed to meet growing demands.
 - Obtain raw water from Tarrant Regional Water District to implement the Ellis County water supply project.
 - Develop raw and treated water transmission lines to implement the Ellis County water supply project.
 - Develop reuse projects:
 - Additional golf course and landscape irrigation in the Las Colinas area.
 - Golf course and landscape irrigation in Denton and Tarrant Counties.
 - Steam electric power supply in Dallas and Ellis Counties
 - Reuse for municipal supply in Dallas County through Joe Pool Lake and Lake Grapevine.

Figure ES-8
North Texas Municipal Water District Supply and Demand

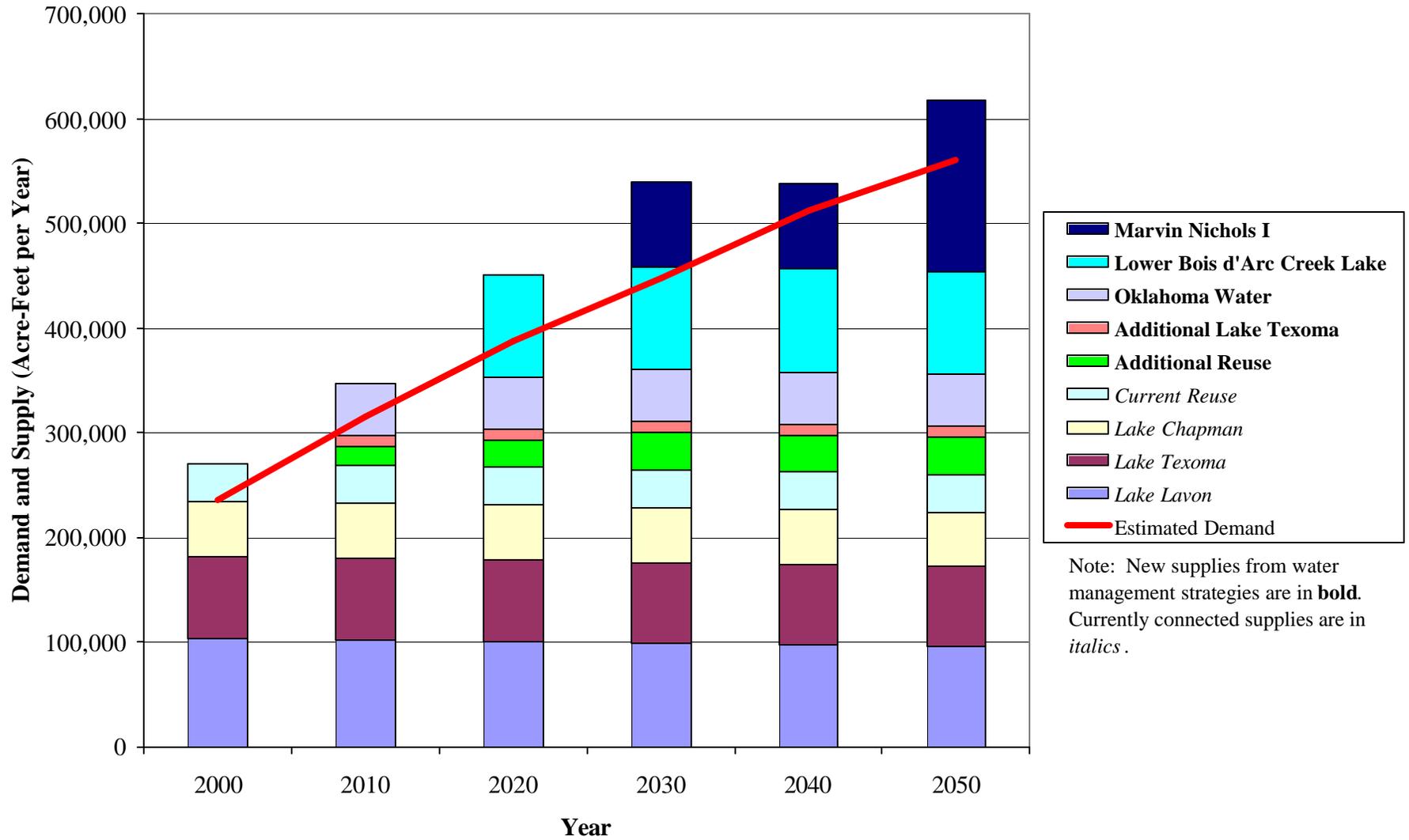


Table ES-5
New Supply from Water Management Strategies and
Estimated Capital Costs for Region C Major Water Providers

Major Water Provider	New Supply, 2000-2050 (Acre-Feet per Year)	Estimated Capital Cost
Dallas Water Utilities	419,900	\$1,492,649,000
Tarrant Regional Water District	393,500	\$1,167,652,000
North Texas Municipal Water District	357,200	\$1,435,447,000
Fort Worth	- ^(a)	\$221,475,000
Trinity River Authority	81,500 ^(a)	\$166,081,000
Total	1,252,100	\$4,483,304,000

Note: (a) New supplies for Fort Worth and Trinity River Authority are included in the Tarrant Regional Water District total.

Table ES-5 shows the total new supply from 2000 through 2050 and the estimated capital cost to develop the supply for the five major water providers in Region C.

Recommended Water Management Strategies by County

The recommended strategies for each county in Region C are summarized below:

- **Collin County**

- Most Collin County water user groups will continue to obtain treated water from North Texas Municipal Water District.
- Blue Ridge will develop new wells and continue to rely on the Woodbine aquifer.
- Celina will obtain treated water from the Upper Trinity Regional Water District.
- Dallas Water Utilities will supply the part of Dallas in Collin County.
- Prosper will purchase treated water from North Texas Municipal Water District and Upper Trinity Regional Water District.
- Water suppliers will temporarily overdraft groundwater while developing surface supplies.
- Water for steam electric power will be provided by a direct reuse project.

- **Cooke County**

- Current groundwater use in Cooke County exceeds TWDB's estimated long-term reliable supply.
- Gainesville is currently developing transmission and treatment facilities to connect to its existing Moss Lake surface water supply.

- Muenster is planning to develop a 500 acre-foot per year supply from the proposed Muenster Lake in the next few years.
- The Cooke County water supply system will be developed using raw water from Gainesville's Moss Lake to provide surface water supplies for water users in the county.
- Water users will temporarily overdraft groundwater while developing surface supplies.
- Water users in Cooke County might consider formation of a groundwater management district.
- The Upper Trinity Regional Water District will supply treated water to Valley View and a portion of Cooke County Other.
- **Dallas County**
 - Most water user groups in Dallas County will continue to obtain treated water from Dallas Water Utilities and North Texas Municipal Water District, renewing contracts as they expire.
 - Irving will complete facilities to bring its water supply from Lake Chapman to Lake Lewisville for treatment by Dallas and use by Irving.
 - Irving will develop a supply from Marvin Nichols I Reservoir.
 - Grapevine will implement its authorized direct reuse project.
 - Dallas County Other demands will be met from Dallas Water Utilities, Trinity River Authority reuse projects, and the proposed Marvin Nichols I project.
 - Water for steam electric power generation and mining will come from Dallas Water Utilities and a Trinity River Authority reuse project.
- **Denton County**
 - Current groundwater use in Denton County exceeds TWDB's estimated long-term reliable supply.
 - Upper Trinity Regional Water District will continue to develop its surface water supply system. Most Denton County water suppliers will purchase raw or treated water from UTRWD.
 - Upper Trinity Regional Water District will deliver raw water from Lake Chapman to Lewisville Lake through lines constructed by Irving.
 - Upper Trinity Regional Water District will develop reuse of the water imported from Lake Chapman.
 - Upper Trinity Regional Water District, Denton, and Lewisville will continue to purchase raw water from Dallas Water Utilities.
 - Lewisville will purchase raw water from Lake Chapman from UTRWD.

- Dallas Water Utilities, North Texas Municipal Water District, and Fort Worth will continue to supply treated water to current customers in Denton County, renewing contracts as they expire.
- Water users will temporarily overdraft groundwater while developing surface supplies.
- Water users in Denton County might consider formation of a groundwater management district.
- Trinity River Authority will develop a reuse project for golf course and landscape irrigation.
- Additional mining supplies will be obtained from other local supplies.
- Water for steam electric power will be provided by a direct reuse project.
- **Ellis County**
 - Current groundwater use in Ellis County exceeds TWDB's estimated long-term reliable supply.
 - The Trinity River Authority and water suppliers in Ellis County will develop the Ellis County water supply system using raw water from Tarrant Regional Water District, treatment capacity from Waxahachie, and transmission facilities developed for the project.
 - Dallas Water Utilities will continue to provide treated water to Ellis County water suppliers, renewing contracts as they expire.
 - Ennis, Mansfield, and Midlothian will obtain raw water from Tarrant Regional Water District.
 - Milford will continue to obtain treated water from Files Valley Water Supply Corporation.
 - Water users will temporarily overdraft groundwater while developing surface supplies.
 - Water for steam electric power will be provided from Trinity River Authority and Ennis reuse projects and TRA's Joe Pool Lake and Lake Bardwell.
- **Fannin County**
 - Fannin County water user groups will develop a regional surface water supply system.
 - Until that system is developed, Fannin County water suppliers will continue to rely on groundwater.
- **Freestone County**
 - Fairfield will develop an additional well in the Carrizo-Wilcox aquifer.
 - Wortham will obtain treated water from Mexia.
 - Water for steam electric power will be provided from TRWD's Richland-Chambers Lake.

- **Grayson County**
 - Current groundwater use in Grayson County exceeds TWDB’s estimated long-term reliable supply.
 - Development of the Grayson County water supply system is proposed to deliver water to users throughout the county. The system includes a raw water pipeline from Lake Texoma, a treatment and desalination plant, and treated water pipelines.
 - Water users will temporarily overdraft groundwater while developing surface supplies.
 - Water users in Grayson County might consider formation of a groundwater management district.
 - Denison will sell treated water to Pottsboro (using raw water rights obtained by Pottsboro).
- **Henderson County**
 - Most Henderson County water user groups have an adequate supply to meet projected water demands through 2050.
 - Malakoff will develop a surface water supply system using raw water from TRWD’s Cedar Creek Lake.
- **Jack County**
 - All Jack County water user groups have an adequate supply to meet projected water demands through 2050.
- **Kaufman County**
 - Current groundwater use in Kaufman County exceeds TWDB’s estimate of long-term reliable supply.
 - North Texas Municipal Water District, Terrell, and Dallas Water Utilities will continue to supply their current customers in Kaufman County.
 - Treated wastewater from Garland will be reused for steam electric power demand.
 - Water users will temporarily overdraft groundwater while developing surface supplies.
 - TRWD will supply surface water for mining.
 - Additional irrigation local supplies will be developed for irrigation demands.
- **Navarro County**
 - Corsicana will continue to provide treated water for most of the water suppliers in Navarro County, and Corsicana has an adequate water supply.
 - A new well will be developed in the Carrizo-Wilcox aquifer for mining use.

- **Parker County**

- Current groundwater use in Parker County exceeds TWDB's estimated long-term reliable supply.
- Weatherford is constructing a pump station and 36-inch pipeline to bring water from Lake Benbrook to Lake Weatherford. That project is planned for completion in 2002.
- Weatherford will treat raw water made available by Tarrant Regional Water District and sell treated water to Aledo, Annetta, Hudson Oaks, and Willow Park, all of which currently use the Trinity aquifer for their water supply.
- TRWD will provide additional water for Azle, Briar, Reno (through Springtown), and Springtown.
- Additional county other and manufacturing supplies will be developed from TRWD through Weatherford.
- Water for steam electric power will be provided by reuse of treated wastewater from Weatherford and by water from TRWD's Lake Benbrook.
- Water for mining will be provided by increased local water supply diversions.
- Water users will temporarily overdraft groundwater while developing surface supplies.
- Water users in Parker County might consider formation of a groundwater management district.

- **Rockwall County**

- Dallas Water Utilities will continue to supply the part of Dallas in Rockwall County.
- Most water suppliers in Rockwall County will continue to obtain treated water from North Texas Municipal Water District.
- Water for steam electric power will be provided by reuse.

- **Tarrant County**

- Current groundwater use in Tarrant County exceeds TWDB estimate of reliable long-term supply.
- Tarrant Regional Water District will continue to provide raw water for most of the water suppliers in Tarrant County.
- Fort Worth and the Trinity River Authority's Tarrant County water supply project will continue to supply treated water to many Tarrant County water suppliers, renewing contracts as they expire.
- Arlington, Benbrook, Fort Worth, Mansfield and the Trinity River Authority Tarrant County water supply project will expand water treatment plants to keep pace with increasing demands.
- Kennedale and Pantego will obtain treated water from Arlington and Fort Worth.

- Dallas Water Utilities will provide supplies for Grand Prairie and Grapevine, renewing contracts as they expire.
- Grapevine will develop its direct reuse project.
- Water for steam electric power and golf course and landscape irrigation will be provided from reuse.
- Water users will temporarily overdraft groundwater while developing surface supplies.
- **Wise County**
 - Walnut Creek Special Utility District will serve Aurora, Boyd, Newark, and Rhome with treated water, using water purchased from Tarrant Regional Water District.
 - Alvord will add an additional well and continue to use the Trinity aquifer.
 - Briar, Bridgeport, and Decatur will obtain additional supplies from the Tarrant Regional Water District.
 - Upper Trinity Regional Water District will supply a portion of county other needs through Bolivar WSC.
 - Steam electric power needs will be provided by sales from Tarrant Regional Water District.

Table ES-6 summarizes the estimated capital costs of the recommended water management strategies for major water providers and (by county) for others. The estimated capital costs for all recommended water management strategies in the Region C plan total \$6,157,941,000.

Livestock Demands

In 13 of the 16 Region C counties, the estimated county-wide water supply for livestock purposes can meet projected demands for the county as a whole. However, these overall county-wide supply and demand figures do not show areas of shortages that exist within the counties under drought conditions. The Region C Water Planning Group recommends several special measures to address localized livestock water shortages

- Overdrafting of aquifers during droughts
- Local brush control projects
- Maintaining existing stock ponds and adding new stock ponds
- Improving and maintaining existing NRCS dams
- Survey on agricultural water use to gather data for future planning.

Table ES-6
Capital Costs for Region C Recommended Water Management Strategies

Major Water Provider/County	Estimated Capital Cost
Major Water Providers	
Dallas Water Utilities	\$1,492,649,000
Tarrant Regional Water District	\$1,167,652,000
North Texas Municipal Water District	\$1,435,447,000
Fort Worth	\$221,475,000
Trinity River Authority	\$166,081,000
Subtotal for Major Water Providers	\$4,483,304,000
Others (by County)	
Collin County	\$14,371,000
Cooke County	\$42,380,000
Dallas County	\$553,801,000
Denton County	\$581,277,000
Ellis County	\$15,232,000
Fannin County	\$70,658,000
Freestone County	\$14,995,000
Grayson County	\$98,785,000
Henderson County	\$7,809,000
Jack County	\$0
Kaufman County	\$29,912,000
Navarro County	\$5,670,000
Parker County	\$83,017,000
Rockwall County	\$4,795,000
Tarrant County	\$83,452,000
Wise County	\$68,483,000
Subtotal for Others	\$1,674,637,000
TOTAL FOR REGION C	\$6,157,941,000

Consistency with the Regional Water Plan

In evaluating consistency with this regional water plan, TNRCC and TWDB should consider the following factors:

- Willing buyer/willing seller transactions should be allowed.
- Maximum flexibility should be afforded to water suppliers. Changes in timing, order, amount of supply, and details of project development should be allowed.
- Consistency requirements should be waived, if appropriate.
- Small uses that do not affect water supplies should be regarded as consistent with this plan.

- Projects to repair or replace existing facilities should be regarded as consistent with this plan.
- Projects for internal distribution improvements and other projects that do not involve development or connection of a new supply should be regarded as consistent with this plan.
- Projects intended to improve water quality or meet regulatory requirements should be regarded as consistent with this plan.
- Projects that promote regional cooperation should receive state support and be regarded as consistent with this plan.
- TWDB and TNRCC should support fast-track efforts by water suppliers when such efforts are needed.

ES-6 Regulatory, Administrative, Legislative, and Other Recommendations

The Region C Water Planning Group makes the following recommendations for regulatory, administrative, legislative, and other changes:

- Recommendations related to the Senate Bill One planning process
 - Allow alternative strategies for near and long term planning needs.
 - Encourage TWDB to exercise discretion in the consideration and approval of funding for alternatives not presented as part of the regional water plan.
 - Encourage TNRCC to exercise discretion in the consideration and approval of water right permit applications not part of the regional water plan.
 - Allow regional water planning groups to assume that contracts for water supply will be renewed when they expire.
 - Provide clarification of the impact of designating a unique stream segment.
- Recommendations related to TNRCC policy and water rights
 - Make some water rights exempt from cancellation for ten years of non-use.
 - Reduce the regulatory and legislative obstacles to indirect reuse of treated wastewater.
 - Remove barriers to interbasin transfers of water.
- Recommendations for state and federal programs to address water supply issues
 - Increase funding for Texas Water Development Board loans and the state participation program to assist with the development of water supply projects.
 - Accelerate studies of groundwater availability for the Trinity aquifer.
 - Increase state participation in water conservation efforts.

- Provide a program for education of board members of Water Supply Corporations, Special Utility Districts, and Municipal Utility Districts.
- Increase state participation in watershed protection planning.
- Encourage federal funding for development, maintenance, and upgrading of NRCS structures.
- Provide state assistance with maintenance and construction of stock ponds.
- Encourage the Texas Agricultural Statistics Service to include water supply questions on its survey of farmers and ranchers.
- Recommendations for ecologically unique river and stream segments
 - Provide clarification of the impacts of designating a unique stream segment.
- Recommendations for unique sites for reservoir construction
 - Marvin Nichols I
 - Lower Bois d'Arc Creek
 - Muenster
 - Tehuacana

ES-7 Plan Approval Process and Public Participation

The Region C Water Planning Group made special efforts to inform and seek input from the general public, water suppliers, and others with special interest in the planning process.

Regional Water Planning Group

The original legislation for Senate Bill One and the Texas Water Development Board planning guidelines establish regional water planning groups to control the planning process. The Region C Water Planning Group held regular meetings open to the public during development of the plan, including nine meetings in 1998, 11 meetings in 1999, and 15 meetings in 2000.

Outreach to Water Suppliers and Regional Planning Groups

The Region C Water Planning Group made special efforts to contact water suppliers in the region and obtain their input in the planning process.

- The planning group sent out questionnaires early in the Region C planning seeking information on population and water use projections and other water supply issues.
- The planning group appointed a technical review committee composed of experienced water resource planners to review population and water demand projections.

- The planning group instructed its consultants to contact water suppliers as planning progressed.

The Region C and Region D water planning groups formed the Sulphur River Task Group, including members of both water planning groups, to coordinate water supply planning involving the Sulphur River Basin. As a result of cooperative efforts, both planning groups support the development of Marvin Nichols I Reservoir on the Sulphur River in Region D

Outreach to the Public

The Region C Water Planning Group outreach efforts for the public included the following:

- Publication of newsletters to inform the public.
- Public awareness presentations to interested groups throughout the region.
- Media outreach program to involve the news media.
- Publication of the draft of the *Initially Prepared Region C Water Plan* on the Freese and Nichols web page, at <http://www.freese.com/senbill1/regionc/index.htm>.

Public Meetings and Public Hearings

The Region C Water Planning Group has held the following public meetings and hearings to bring the Region C Water Plan to the public:

- Required initial meeting on the planning process.
- Public Hearing on population and water use
- Five public meetings throughout the region on water needs and potential strategies
- Five public meetings and a public hearing on draft initially prepared plan in September of 2000.

Implementation Strategies

Section 7.2 of the report includes a discussion of implementation strategies for complex elements of the water supply plan for Region C:

- Conservation
- Reuse of reclaimed wastewater
- Marvin Nichols I Reservoir
- Water from Oklahoma.