5. Impacts of Recommended Water Management Strategies

The previous section presented a set of recommended water management strategies for Region C wholesale water providers and water user groups. This section discusses the impacts of the recommended water management strategies on key parameters of water quality, the impacts of moving water from rural and agricultural areas, and impacts to third parties.

5.1 Impacts of Recommended Water Management Strategies on Key Water Quality Parameters

For a given water resource, the impact of water management strategies on key water quality parameters is evaluated by comparing current water quality conditions with anticipated water quality conditions when water management strategies are in place. Many of the recommended water management strategies involve diverting water from one water body and discharging this water to another water body. For these strategies, the difference in the quality of the two waters, the quantity of water discharged, and the effectiveness of any mitigation is used to project the impact on the receiving water. Selection of the key water quality parameters used for this comparison is based on the importance of these parameters to the use of the water resource.

The recommended water management strategies can be grouped into the following strategy types:

- Existing surface water sources
- New surface water sources
- Existing groundwater sources
- New groundwater sources
- Direct reuse
- Indirect reuse
- Conservation
- Other

In general, each strategy within a strategy type is anticipated to have a similar qualitative impact on key water quality parameters in the receiving water. Exceptions to

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this generalization are addressed where appropriate. The strategy type defined as "other" includes strategies that do not involve discharge of one source to another and, therefore, have no impact on water quality in the receiving water. Examples of strategies in this category include increased pipeline capacity to a particular water user group or connection of a water user group to a wholesale provider.

The following sections define the parameters selected as key water quality parameters and present the evaluation of impacts of recommended water management strategies on these key parameters.

Selection of Key Water Quality Parameters

Selection of key water quality parameters involved a two-stage approach. First, a list of candidate water quality parameters was compiled from several sources. Then, key water quality parameters were selected from the list of potential parameters based on the general guidelines described below.

Candidate water quality parameters were identified using the following sources:

- Parameters regulated by the Texas Commission on Environmental Quality (TCEQ) in the Texas Surface Water Quality Standards (TSWQS) [(1)]
- Parameters considered for the TCEQ Water Quality Inventory in evaluation of whether water body uses are supported, not supported, or have water quality concerns. The designated water body uses included in the Water Quality Inventory are:
  - Aquatic life use
  - Contact recreation use
  - General use
  - Fish consumption use
  - Public water supply use
- Parameters that may impact suitability of water for irrigation
- Parameters that may impact treatability of water for municipal or industrial supply.

The first two categories above represent environmental water quality parameters, and the last two categories represent water quality as related to water uses.

To develop a manageable and meaningful list of key water quality parameters, the following general guidelines were established for parameter selection:

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- Selected parameters should be representative of water quality conditions that may be impacted on a regional scale and that are likely to be impacted by multiple water management strategies within the region. Water quality issues associated with localized conditions (such as elevated levels of a toxic material within one water body) will be addressed as necessary within the environmental impact evaluations of the individual water management strategies for each water user group.
- Sufficient data must be available for a parameter in order to include it as a key water quality parameter. If meaningful statistical summaries cannot be carried out on the parameter, it should not be designated as a key water quality parameter.

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For the *2011 Region C Water Plan*, the Region C RWPG has selected the same key water quality parameters for consideration as were used in the 2006 Plan. Since the *2006 Region C Water Plan* [2] was developed, the TSWQS have not been modified and parameters that may impact the treatability or suitability of water for agricultural, municipal or industrial supply have not changed. Due to unchanged guidance, the first stage of the process that lists candidate parameters for the *2011 Region C Water Plan* yielded the same results as the *2006 Region C Water Plan* [2]. In addition, baseline water quality conditions have not changed substantially since the last round of planning and key water quality parameters were retained.

Revisions to the TSWQS [1] are expected to be implemented after the *2011 Region C Water Plan* has been adopted. New guidance and rules will be considered in the next round of planning when selecting key water quality parameters. A detailed discussion of the selection of key water quality parameters and definition of baseline conditions for these parameters are included in Appendix M. Table 5.1 summarizes the key water quality parameters selected by the Region C Water Planning Group.

Table 5.1
Region C Key Water Quality Parameters

Surface Water	Groundwater
Ammonia Nitrogen	Total Dissolved Solids (TDS)
Nitrate Nitrogen	
Total Phosphorus	
Chlorophyll-a	
Total Dissolved Solids (TDS)	

Evaluation of Water Quality Impacts

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Impacts of recommended water management strategies on key water quality parameters were assessed by comparing the water quality of the source water for a given strategy with that of the receiving water. This comparison included an evaluation of historical median concentrations of key parameters, together with consideration of data quality, relative quantities of water, and planned mitigation measures (e.g., treatment, blending, or other operational strategies that serve to mitigate water quality impacts). Each recommended strategy was assigned one of the following five anticipated impact ratings: low, medium low, medium, medium high, and high. No recommended or alternative water management strategy is anticipated to have more than a "medium" impact on key water quality parameters. A "medium" impact is considered to be an impact that results in some changes in water quality, but does not result in impairment of the designated uses of the water body.

The following sections present a discussion of the anticipated water quality impacts for each strategy type. Table 5.2 summarizes the range of anticipated water quality impacts within these strategy types.

Table 5.2
Range of Anticipated Impacts on Key Water Quality Parameters by Strategy Type

Strategy Type	Range of Anticipated Impacts on Key Water Quality Parameters	Comments
Existing Surface Water Sources	Low to Medium	Lake Texoma strategies assumed to include mitigation for TDS.
Existing Groundwater Sources	Low to Medium-Low	
New Surface Water Sources	Low to Medium	Water quality in new sources difficult to predict.
New Groundwater Sources	Medium	
Direct Reuse	Low/Positive	Potential positive impact resulting from reduced nutrient and TDS loadings to surface waters.
Indirect Reuse	Medium	Assumes mitigation to control impacts on nutrients and TDS, if necessary.
Conservation	Low	
Other	Low	Includes strategies not involving blending of 2 water sources (e.g. direct pipeline to a treatment plant).

Existing Surface Water Sources

For strategies utilizing existing surface water sources, impacts on key water quality parameters vary depending on a number of factors, including the location of the source and the intended destination of the water transfer. For strategies that involve pumping existing surface water directly to a water treatment plant, no impact on water quality is anticipated (resulting in a rating of "low"). However, when water is pumped from one source to another, the impacts will depend on the existing water quality of the two sources, as well as the quantities to be transferred and any mitigation that may be applied.

Many of the recommended and alternative strategies call for increased use of water from East Texas reservoirs. In general, reservoirs in East Texas have higher concentrations of nutrients (i.e., nitrogen and phosphorus) than many of the Region C reservoirs. The ultimate impact of importing water with higher nutrient concentrations to Region C reservoirs is difficult to predict due to the complex kinetic relationships between nutrients and chlorophyll-a. Strategies that involve importing water from East Texas reservoirs to Region C reservoirs may result in increases in ammonia, nitrate, total phosphorus, and/or chlorophyll-a, but are not likely to lead to impacts that would impair the designated uses of the Region C water bodies. In general, the total dissolved solids (TDS) concentrations in East Texas reservoirs are lower than in Region C reservoirs. Therefore, in nearly all cases, transfer of East Texas water to Region C reservoirs will have a positive impact on TDS concentrations in the receiving water bodies. All of the recommended water management strategies involving importation of East Texas water to Region C reservoirs are anticipated to have a "low" or "medium-low" impact on key water quality parameters.

In addition to strategies that include transfers from East Texas reservoirs to Region C reservoirs, several recommended and alternative strategies include intermediate transfers between reservoirs outside of Region C. These include transfers from Wright Patman Lake to Lake Fork Reservoir and Chapman Lake and from Toledo Bend Reservoir to Lake Fork Reservoir, Lake Tawakoni, and Chapman Lake. Although there are some minor variations in water quality among these reservoirs, these strategies are all anticipated to have no more than a "medium-low" impact on the key water quality parameters.

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Lake Texoma is included in the recommended and alternative strategies for multiple entities. Currently, typical TDS concentrations in Lake Texoma are in the 800-1,200 milligram per liter (mg/L) range. Most Trinity River basin reservoirs in Region C have TDS standards (from the TSWQS) in the 400-500 mg/L range. Therefore, to import a significant quantity of Lake Texoma water into a Trinity River Basin reservoir, mitigation will likely be needed in the form of desalination or blending with another lower TDS water (such as an East Texas source) to prevent significant increases in TDS concentrations in the receiving body and to prevent violation of the Texas Surface Water Quality Standard for TDS. To project the impact of strategies involving use of Lake Texoma water, it has been assumed that mitigation measures will be used to maintain TDS concentrations in the receiving water body at levels that do not violate the Texas Surface Water Quality Standard for TDS. In addition, for strategies that use desalination treatment as mitigation, disposal of the highly saline reject stream can result in increased TDS concentrations, depending on the method and location of disposal. Based on these issues, each of the recommended strategies involving importation of Lake Texoma water to another reservoir is anticipated to have no more than a "medium" impact on key water quality parameters.

New Surface Water Sources

In general, the impact of the development of new surface water sources on key water quality parameters will be similar to that of existing reservoir sources. All of the proposed reservoir sites identified as potential Region C sources are located in the Red, Trinity, Sulphur, or Neches River Basins. As such, the impacts on key water quality parameters from these reservoirs are likely to be similar to the impacts of importing existing East Texas sources to the Trinity River Basin. (The proposed reservoir in the Red River Basin, Lower Bois d'Arc Creek Reservoir, is on a low-TDS tributary of the Red River.) All strategies involving the importation of water from new reservoirs to Trinity River Basin reservoirs are anticipated to have no more than a "medium" impact on key water quality parameters. Water management strategies calling for the pumping of new surface water sources directly to a water treatment plant are anticipated to have a "low" impact on key water quality parameters.

One new surface water source alternative strategy involves the transfer of water between reservoirs that are both outside of Region C. ~~An~~ That is an alternative strategy for Dallas Water Utilities involving transfer of Lake Columbia water to Lake Palestine. This strategy ~~-~~is anticipated to have no more than a "medium" impact on water quality parameters.

Existing Groundwater Sources

Since all recommended strategies involving existing groundwater sources do not involve blending of groundwater within a supply reservoir, no significant impacts on key surface water quality parameters are expected. For those strategies involving the temporary overdrafting of an aquifer, groundwater TDS concentrations could increase in the presence of underlying brackish waters. However, no strategies call for long-term overdrafting of groundwater supplies and, therefore, this potential impact is anticipated to be temporary. Potential impacts on key water quality parameters resulting from alternative and recommended strategies in this category are anticipated to be "low" or "medium low".

New Groundwater Sources

There are no new major groundwater sources included in the recommended water management strategies for Region C. However, several alternative strategies propose obtaining water from groundwater sources that are new to the region, Roberts County groundwater and Brazos County groundwater. Potential receiving water bodies for groundwater from Roberts County include Ray Roberts Lake (Dallas Water Utilities), Lake Lavon (North Texas Municipal Water District), and Lake Bridgeport (Tarrant Regional Water District). Roberts County groundwater, which is drawn from the Ogallala aquifer, has a median TDS concentration that is only slightly higher than that in the potential receiving water bodies. However, the median nitrate concentration is high in comparison to baseline nitrate concentrations in each of the potential receiving water bodies. As a result of the high nitrate concentration in this groundwater source, this group of strategies is anticipated to have a "medium" impact on key water quality parameters.

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Lake Lavon (North Texas Municipal Water District) is the potential receiving water body for Brazos County groundwater. Brazos County groundwater, drawn from the Carrizo-Wilcox aquifer, has a median TDS concentration that is greater than that in Lake Lavon and greater than the stream standard for Lake Lavon. The TDS concentration in Brazos County groundwater relative to the stream standard may limit the use of this resource in Region C. As a result this strategy is anticipated to have a "medium" impact on key water quality parameters.

Direct Reuse

By definition, direct reuse involves the transfer of treated wastewater effluent directly to a point of use and not into another water body. As such, the impact on key water quality parameters for all direct reuse strategies is anticipated to be "low." In some cases there may be a positive impact. By reducing the quantity of effluent discharged into a stream or reservoir segment, the nutrient and TDS loads to that segment will also be reduced, thereby potentially improving downstream water quality.

Indirect Reuse

Indirect reuse is a recommended strategy for multiple entities within Region C. This strategy involves the discharge of treated wastewater effluent into a body of water used for water supply. Treated wastewater can contain nutrient and TDS concentrations that are high in comparison to the receiving water. However, for most of the recommended strategies that include indirect reuse, some form of mitigation (e.g., advanced wastewater treatment, constructed wetlands, blending, etc.) is planned to address potential water quality impacts associated with nutrients and TDS. For the purposes of this evaluation, it is assumed that some form of mitigation for potential water quality impacts associated with the key parameters will be implemented, if necessary, such that the designated uses of the water body will not be impaired. For this reason, recommended indirect reuse strategies are anticipated to have no more than a "medium" impact on key water quality parameters.

Conservation

Conservation is a recommended strategy for all municipal water user groups in Region C, including those without shortages. Water conservation is the development of water resources and practices to reduce the consumption or loss of water, increase the recycling and reuse of water, and improve the efficiency in the use of water. Water conservation plans are designed to implement practices to conserve water and quantitatively project water savings. The water conservation measures recommended in Region C are not expected to affect water quality adversely. The results should generally be beneficial because the demand on surface and groundwater resources will be decreased. Quantifying such positive impacts could be very difficult. Chapter 6 contains additional discussion of water conservation.

5.2 Impacts of Recommended Water Management Strategies on Moving Water from Rural and Agricultural Areas and Impacts to Third Parties

This section discusses the potential impacts of the *2011 Region C Water Plan* on rural and agricultural activities and possible impacts to third party entities, and specifically focuses on the impacts associated with moving water from rural and agricultural areas. This section also discusses the considerations given during the development of the plan to protect rural and agricultural activities.

The *2011 Region C Water Plan* includes several strategies that move water from rural areas to urban centers. These strategies fall into two general categories:

- New connections to existing water sources: Toledo Bend Reservoir to TRWD and NTMWD, Wright Patman Lake to DWU, Lake Fork Reservoir to DWU, Lake Palestine to DWU, Texoma to NTMWD and GTUA, Oklahoma water to NTMWD, TRWD and UTRWD, etc.
- New reservoirs: Marvin Nichols, Ralph Hall, and Lower Bois d'Arc Creek.

Large groundwater projects also may move large quantities of water from rural to urban areas, but these are not recommended strategies. Both the Roberts County Project and the Carrizo-Wilcox project in Brazos County, located outside of the Region C planning area, are identified as alternate strategies.

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The impacts from the recommended water management strategies will vary depending on the location of the project, current use of the water and the quantity of water that is being transferred. The types of impacts that may occur include:

- Transfer of water rights from agricultural use to other uses.
- Removal of agriculture through inundation from new reservoirs.

- Changes in stream flow immediately downstream of a new reservoir.
- Increased water level fluctuations at existing lakes as more water is used.

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The recommended water plan considered many different factors as strategies were developed and recommended for inclusion. One consideration is the development of a plan that minimizes the potential impacts to rural and agricultural areas through utilization of existing sources with a strong emphasis on conservation and reuse. Over 25 percent of the water available to Region C in 2060 under this plan is from conservation and reuse – over 35 percent of the new supplies to the region. The emphasis on conservation and reuse reduces the number of strategies and amount of water needed from other sources, including transfers of water from rural and agricultural areas.

Other protections for agricultural and rural uses were incorporated in the process of evaluating and allocating water supplies. Specifically, these include:

- Existing and proposed surface water supplies were evaluated under the prior appropriation doctrine that governs surface water rights and protects senior water rights. In the final *2011 Region C Water Plan*, there are no transfers of irrigation water rights to urban uses.
- The amount of available supplies from existing sources was limited to firm yield. Existing uses from these sources were protected through the allocation process and only the amount of water that is currently permitted (up to the firm yield) was considered for transfer to Region C. Three existing reservoirs (Texoma, Wright Patman and Toledo Bend) are currently seeking or are recommended to seek additional water rights. This additional water would not impact agricultural or rural activities.
- Supplies from new reservoirs considered instream flow releases in accordance with the planning guidelines set forth by the TWDB. These releases protect recreational and non-consumptive water needs downstream of the proposed reservoir sites.

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In Region C there is little irrigated agriculture, with irrigated cropland making up less than 2 percent of harvested cropland [3]. Most of the irrigation water demand is associated with golf course irrigation in and near urban areas, and much of this water need will be met through reuse. There are no recommended transfers of needed irrigation to other uses and all irrigation and livestock water needs are met through the recommended plan. The potential impacts to agricultural and rural areas are limited to the loss of land from inundation of new reservoirs. The total rural acreage that would be flooded under the *2011 Region C Water Plan* is 116,300 acres. Of this amount, many acres are bottomlands that

are not currently used for agriculture. Impacts from new reservoirs will be mitigated as part of the permitting process. New reservoirs also can stimulate the rural economy through new recreational business and local improvements. The new reservoirs will provide a new water source for rural activities. Each of the proposed reservoir sites includes water set aside for local water supplies.

Possible third party impacts include loss of land and timber, impacts to existing recreational business on existing lakes due to lower lake levels, and impacts to recreational stream activities. Economic studies have been conducted for two of the reservoirs proposed for Region C, and in each case they indicate a significant net economic benefit to the region of origin [4, 5].

The impacts to recreational activities and recreational businesses at existing lakes are expected to be low. While water levels at local and rural lakes may fluctuate more under the recommended plan, these water level changes are within the design constraints of the reservoirs. Four of the major water transmission strategies have water sources that are located in highly prolific rainfall areas. Significant changes in water levels at these sources would be limited to extreme drought.

Impacts to recreational stream activities are mitigated through the permitting process and requirements for instream flow releases. New reservoirs offer new recreational opportunities and recreational business growth that could spur the local economies of rural areas.

5.3 Invasive and Harmful Species

The appearance of several invasive and/or harmful species (including zebra mussels, giant salvinia, and golden algae) poses a potential threat to water supplies throughout the state of Texas. Continued monitoring and management by water suppliers in Region C will be necessary in the coming decades. Invasive species will likely be an ongoing area of interest to Region C, as the appearance of additional invasive species in the future remains a possibility. The issue of invasive and harmful species should be considered as plans for interbasin transfers of water supplies are implemented. A more extensive discussion of these invasive species is found in Section 1.8 of this report.

CHAPTER 5
LIST OF REFERENCES

(1) Texas Administrative Code, Title 30, Chapter 307, [Online], Available URL: http://www.tceq.state.tx.us/assets/public/legal/rules/rules/pdflib/307%60.pdf, January 2010.

(2) Freese and Nichols, Inc., Alan Plummer Associates, Inc., Chiang, Patel and Yerby, Inc., and Cooksey Communications, Inc: 2006 Region C Water Plan, prepared for the Region C Water Planning Group, Fort Worth, January 2006.

(3) U.S. Department of Agriculture: 2007 Census of Agricultural, Volume 1, Chapter 2: Texas County Level Data, Table 1, [Online], Available URL: http://www.agcensus.usda.gov/Publications/2007/Full_Report/index.asp, February 2010.

(4) Weinstein, B. L. and T. L. Clower: *The Economic, Fiscal, and Developmental Impacts of the Proposed Marvin Nichols Reservoir Project*, prepared for the Sulphur River Basin Authority, Denton, March 2003.

(5) Clower, T. L. and B. L. Weinstein: *The Economic, Fiscal, and Developmental Impacts of the Proposed Lower Bois d'Arc Reservoir Project*, prepared for the North Texas Municipal Water District, Denton, September 2004.

TABLES