TEXAS WATER DEVELOPMENT BOARD

TO: Regional Water Planning Group Chairs

THROUGH: Carolyn L. Brittin, Deputy Executive Administrator, Water Resources Planning and Information

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FROM: Stuart D. Norvell, Manager, Water Planning Research and Analysis

DATE: August 31, 2009

SUBJECT: Methodology for Socioeconomic Impact Analyses (2011 Regional Water Plans)

As discussed in our conference call held on April 13, 2009, Texas Water Development Board (TWDB) staff agreed to prepare a memorandum summarizing our approach to evaluating the socioeconomic impacts of not meeting water needs. The following document provides an overview of this methodology, and discusses general timeframes and related administrative processes.

Administrative rules require that planning groups evaluate the impacts of not meeting water needs as part of the regional water planning process, and rules direct TWDB staff to provide technical assistance: "*The executive administrator shall provide available technical assistance to the regional water planning groups, upon request, on water supply and demand analysis, including methods to evaluate the social and economic impacts of not meeting needs*" Texas Administrative Code, Title 31, Chapter 357.7, Section (4)(A). Staff of the TWDB's Water Resources Planning Division design and conduct analyses to evaluate these impacts to satisfy the requirements of Chapter 357.7, Section (4)(A); however, planning groups are not required to use our results, and are free to conduct different or additional analyses as they see fit.

Since our administrative rules specify that planning analyses be evaluated under conditions comparable to a drought of record (a static and random event), estimated socioeconomic impacts are point estimates for years in which water needs are reported (2010, 2020, 2030, 2040, 2050 and 2060).

They are independent and distinct "what if" scenarios for each particular year and water shortages are assumed to be temporary events resulting from drought of record conditions. These analyses attempt to measure the socioeconomic impacts in the event that water user groups do not meet their identified water needs associated with a drought of record for a duration of one year. Attachment A provides a more detailed summary of our methodology and key assumptions.

We recognize that other approaches may be better suited for some water user groups and regions dependent upon regional climate, hydrology and other conditions. However, combining different approaches on a statewide basis is problematic for several reasons. For one, it would require a complex array of analyses and models with different and perhaps contradictory assumptions. Equally important is the notion that combining different approaches would generate inconsistent outcomes across regions resulting in a so-called "apples to oranges" comparison among different planning regions.

The socioeconomic models will be developed by late August of 2009, at which point we can begin to conduct the analyses for each region. If you would like us to assist your region in carrying out this analysis, please respond by submitting a written request after entering your estimated water needs for each water user group in the *2012 Regional Water Planning Data Web Interface* at: http://www.twdb.state.tx.us/apps/db12/default.asp). Written requests should be submitted to your TWDB Project Manager. Upon receiving your request, we expect that we can return socioeconomic analysis results within approximately four weeks in the form of a technical memorandum that may be incorporated into your regional water plan.

If you have any questions or comments, please feel free to contact myself at 512.463.7928 or stuart.norvell@twdb.state.tx, or Dan Hardin at 512.936.0880 or dan.hardin@twdb.state.tx.us.

c: Political Subdivisions
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Attachment A

Overview of TWDB Methodology for Estimating the Socioeconomic Impacts of not Meeting Water Needs

Conceptual Approach

When analyzing the economic impacts of not meeting water needs (shortage), three potential scenarios are possible depending upon the characteristics specific to a particular water user group.

- *Scenario* 1 involves situations where there are physical shortages of raw surface or groundwater due to drought of record conditions. For example, City A relies on a reservoir with average conservation storage of 500 acre-feet per year and a firm yield of 100 acre feet. In 2010, the city uses about 50 acre-feet per year, but by 2030 their demands are expected to increase to 200 acre-feet. Thus, in 2030 the reservoir would not have enough water to meet the city's demands, and people would experience a shortage of 100 acre-feet assuming drought of record conditions. Under normal or average climatic conditions, the reservoir would likely be able to provide reliable water supplies well beyond 2030.

- *Scenario* 2 is a situation where despite drought of record conditions, water supply sources can meet existing use requirements; however, limitations in water infrastructure would preclude future water user groups from accessing these water supplies. For example, City B relies on a river that can provide 500 acre-feet per year during drought of record conditions and other constraints as dictated by planning assumptions. In 2010, the city is expected to use an estimated 100 acre-feet per year and by 2060 it would require no more than 400 acre-feet. But the intake and pipeline that currently transfers water from the river to the city's treatment plant has a capacity of only 200 acre-feet of water per year. Thus, the city's water supplies are adequate even under the most restrictive planning assumptions, but their conveyance system is too small. This implies that at some point – perhaps around 2030 - infrastructure limitations would constrain future population growth and any associated economic activity or impacts.

- *Scenario* 3 involves water user groups that rely primarily on aquifers that are being depleted. In this scenario, projected and in some cases existing demands may be unsustainable as groundwater levels decline. Areas that rely on the Ogallala aquifer are a good example. In some communities in the Panhandle region, irrigated agriculture forms a major base of the regional economy. With less irrigation water from the Ogallala, population and economic activity in the region could decline significantly assuming there are no offsetting developments.

Assessing the social and economic effects of each of the above scenarios requires various levels and methods of analysis and would generate substantially different results for a number of reasons; the most important of which has to do with the time frame of each scenario. Scenario 1 falls into the general category of static analysis. This means that models would measure impacts for a small interval of time such as a drought. Scenarios 2 and 3, on the other hand imply a dynamic analysis meaning that models are concerned with changes over a much longer time period.

Since administrative rules specify that planning analyses be evaluated under conditions comparable to a drought of record (a static and random event), socioeconomic impact analysis developed by the TWDB for the state water plan is based on assumptions of Scenario 1. Estimated impacts under scenario 1 are point estimates for years in which needs are reported (2010, 2020, 2030, 2040, 2050 and 2060). They are independent and distinct "what if" scenarios for each particular year and water shortages are assumed to be temporary events resulting from drought of record conditions. Estimated impacts attempt to measure what would happen if water user groups do not meet their identified water needs for a period of one year.

We recognize that dynamic models may be more appropriate for some water user groups; however, combining the three approaches on a statewide basis is problematic for several reasons. For one, it would require a complex array of analyses and models, and might require developing supply and demand forecasts under "normal" climatic conditions as opposed to drought of record conditions. Equally important is the notion that combining the approaches would produce inconsistent results across regions resulting in a so-called "apples to oranges" comparison.

Basic Steps

1) *Generate IO/SAM Models and Develop Economic Baselines*

Water shortages would likely affect the ability of business and industry to operate resulting in lost output, which would adversely affect the state's economy. A variety of tools are available to estimate such impacts, but by far the most widely used are input-output models (IO models) combined with social accounting matrices (SAMs). Referred to as IO/SAM models, these tools form the basis for estimating economic impacts for agriculture (irrigation and livestock water user groups) and industry (manufacturing, mining, steam-electric and commercial business activity for municipal water user groups).

An IO/SAM model is an accounting framework that traces spending and consumption between different economic sectors including businesses, households, government, and outside economies (exports and imports). We estimate our models using IMPLAN (Impact for Planning Analysis) software that contains databases with recent economic data from a variety of sources. Using these data, we create an economic baseline for counties, planning regions and the state that contains the following variables for 528 economic sectors:

- **output** - total production of goods and services measured by gross sales revenues;
- **final sales** – sales to end users in Texas a region and exports out of a region;
- **employment** - number of full and part-time jobs (annual average) required by a given industry including self-employment;
- **regional income** - total payroll costs (wages and salaries plus benefits) paid by industries, corporate income, rental income and interest payments; and
- **business taxes** - sales, excise, fees, licenses, and other taxes paid during normal operation of an industry (does not include income taxes).

Since the planning horizon extends through 2060, economic variables in the baseline are allowed to change in accordance with projected changes in demographic and economic activity. Growth rates for municipal water use sectors (i.e., commercial, residential and institutional) are based on TWDB population forecasts. Future values for manufacturing, agriculture, and mining and steam-electric activity are based on the same underlying economic forecasts used to estimate future water use for each category.

2) *Estimate Direct and Indirect Impacts to Business, Industry and Agriculture*

Using IMPLAN we can estimate both the direct and indirect economic impacts. Direct effects are the immediate reductions in output by sectors experiencing water shortages. For example, without adequate cooling and process water a refinery would have to curtail or cease operation, car washes may close, or farmers may not be able to irrigate their orchards in a given year and would lose a season's worth of sales revenues. Indirect impacts are changes in inter-industry transactions as supplying industries respond to decreased demands for their services, and how seemingly non-related businesses are affected by decreased incomes and spending due to direct impacts. Using the above example, if a farmer ceased operations due to a lack of irrigation water, they would likely reduce expenditures on supplies such as fertilizer, labor and equipment, and businesses that provide these goods would suffer as well.

Direct impacts would likely vary depending upon the severity of a shortage. A small shortage relative to total water use may have a nominal effect, but as shortages became more critical, effects on productive capacity would increase. For instance, farmers facing small shortages might fallow marginally productive acreage to save water for more valuable crops. Livestock producers might employ emergency culling strategies, or they may consider hauling water by truck to fill stock tanks. Note that the efforts described above are not planned programmatic or long-term operational changes. They are emergency measures that individuals might pursue to alleviate what they consider a temporary condition. Thus, they are not characteristic of long-term management strategies designed to ensure more dependable water supplies such as capital investments in conservation technology or development of new water supplies.

To reflect the assumption that the relative magnitude of impacts to farm and business operations will increase with the severity of water shortage, the following analysis employs the concept of elasticity. Elasticity measures the relationship between a percentage reduction in water availability and a percentage reduction in output. For example, an elasticity of 1.0 indicates that a 1.0 percent reduction in water availability would result in a 1.0 percent reduction in economic output. An elasticity of 0.50 would indicate that for every 1.0 percent of unavailable water, output is reduced by 0.50 percent and so on. Output elasticities assumed for the purpose of this analysis are: [1]

- if water shortages are 0 to 5 percent of total water demand, no corresponding reduction in output is assumed;

[1] In some cases, elasticities are adjusted depending upon conditions specific to a given water user group.

- if water shortages are 5 to 30 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 0.50 percent reduction in output;
- if water shortages are 30 to 50 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 0.75 percent reduction in output; and
- if water shortages are greater than 50 percent of total water demand, for each additional one percent of water need that is not met, there is a corresponding 1.0 percent (i.e., a proportional reduction).

Once output responses to water shortages were estimated, direct impacts to total sales, employment, regional income and business taxes were derived using regional level economic multipliers estimating using IO/SAM models. The formula for a given IMPLAN sector is:

$$D_{i,t} = Q_{i,t} *, S_{i,t} * E_Q * RFD_i * DM_{i(Q, L, I, T)}$$

where:

$D_{i,t}$ = direct economic impact to sector *i* in period *t*

$Q_{i,t}$ = total sales for sector *i* in period *t* in an affected county

$RFD_{i,}$ = ratio of final demand to total sales for sector *i* for a given region

$S_{i,t}$ = water shortage as percentage of total water use in period *t*

E_Q = elasticity of output and water use

$DM_{i(L, I, T)}$ = direct output multiplier coefficients for labor (L), income (I) and taxes (T) for sector *i*.

Secondary impacts were derived using the same formula used to estimate direct impacts; however, indirect multiplier coefficients are multiplied by final sales as opposed to gross sales.

3) *Impacts Associated with Domestic Water Uses*

IO/SAM models are not ideally suited for measuring impacts of shortages for domestic water uses, which make up the majority of the municipal water use category. To estimate impacts associated with domestic water uses, municipal water demand and thus needs are subdivided into residential and commercial uses. Shortages associated with residential water uses are valued by estimating proxy demand functions for different water user groups allowing us to estimate the marginal value of water, which would vary depending upon the level of water shortages. The more severe the water shortage, the more costly it becomes. For instance, a 2 acre-foot shortage for a group of households that use 10 acre-feet per year would not be as severe as a shortage that amounted to 8 acre-feet. In the case of a 2 acre-foot shortage, households would probably have to eliminate some or all outdoor water use, which could have implicit and explicit economic costs including losses to the horticultural and landscaping industry. In the case of an 8 acre-foot shortage, people would have to forgo all outdoor water use and most indoor water consumption. Economic impacts would be much higher in this case because people could probably not live with such a reduction, and would be forced to find emergency alternatives assuming alternatives were available.

To estimate the value of domestic water uses, TWDB staff developed marginal loss functions based on constant elasticity demand curves. This is a standard and well-established method used by economists to value resources (such as water) that have an explicit monetary cost.

Additional Clarifications and Assumptions

- Identified water needs (shortages) reported by regional planning groups are the starting point for socioeconomic analyses. No adjustments or assumptions regarding the magnitude or distributions of identified water needs among different water use categories within a water user group are incorporated in the analysis.

- Given that resulting socioeconomic impacts are not cumulative in nature, it is inappropriate to sum these impacts over the entire planning horizon. Doing so would imply that the analysis predicts that drought of record conditions will occur every ten years in the future, which is not the case.

- Economic multipliers are based on "fixed-proportion production functions," which basically means that input use - including labor - moves in lockstep fashion with changes in levels of output. In a scenario where output (i.e., sales) declines, losses in the immediate sector or supporting sectors could be much less than predicted by an IO/SAM model for several reasons. For one, businesses will likely expect to continue operating so they might maintain spending on inputs for future use; or they may be under contractual obligations to purchase inputs for an extended period regardless of external conditions. Also, depending on the expected duration of the water shortage, employers may choose not to lay-off workers given that experienced labor is sometimes scarce and skilled personnel may not be readily available when water shortages subside. Lastly, people who lose jobs might find other employment in the region. As a result, direct losses for employment and secondary losses in sales and employment should be considered an upper bound. Similarly, since impacts on projected population are based on reduced employment in the region, they should be considered an upper bound as well.

- Impacts are annual estimates. If one were to assume that conditions persisted for more than one year, estimates could be developed to reflect the extended duration.