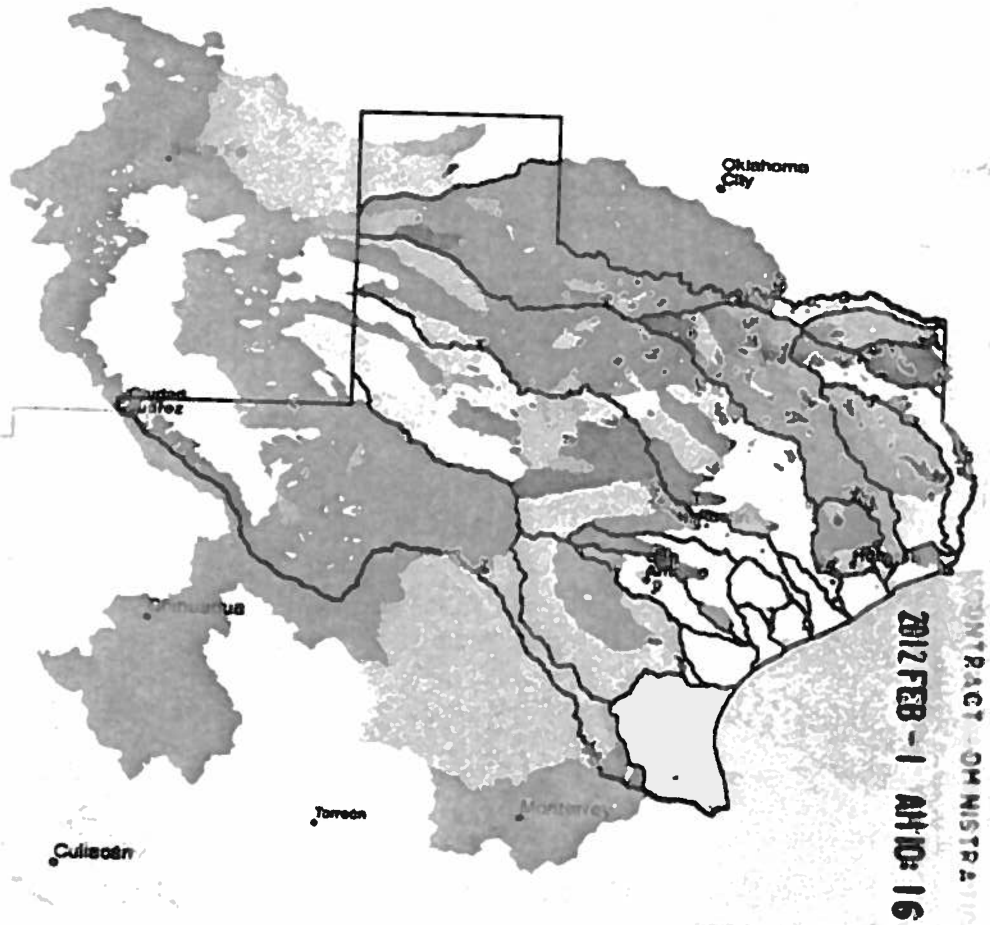
WATERSHED PROTECTION FOR TEXAS RESERVOIRS
Addressing Sedimentation and Water Quality Risks
(TWDB Contract #: 1004831120)



Texas Water Development Board

January 31, 2012

Project No. 10039.00

RPS Espey PARSONS

Crespo Consulting Services, Inc.
Civil & Environmental Engineering

Wetearth
Water Resources • Green Infrastructure

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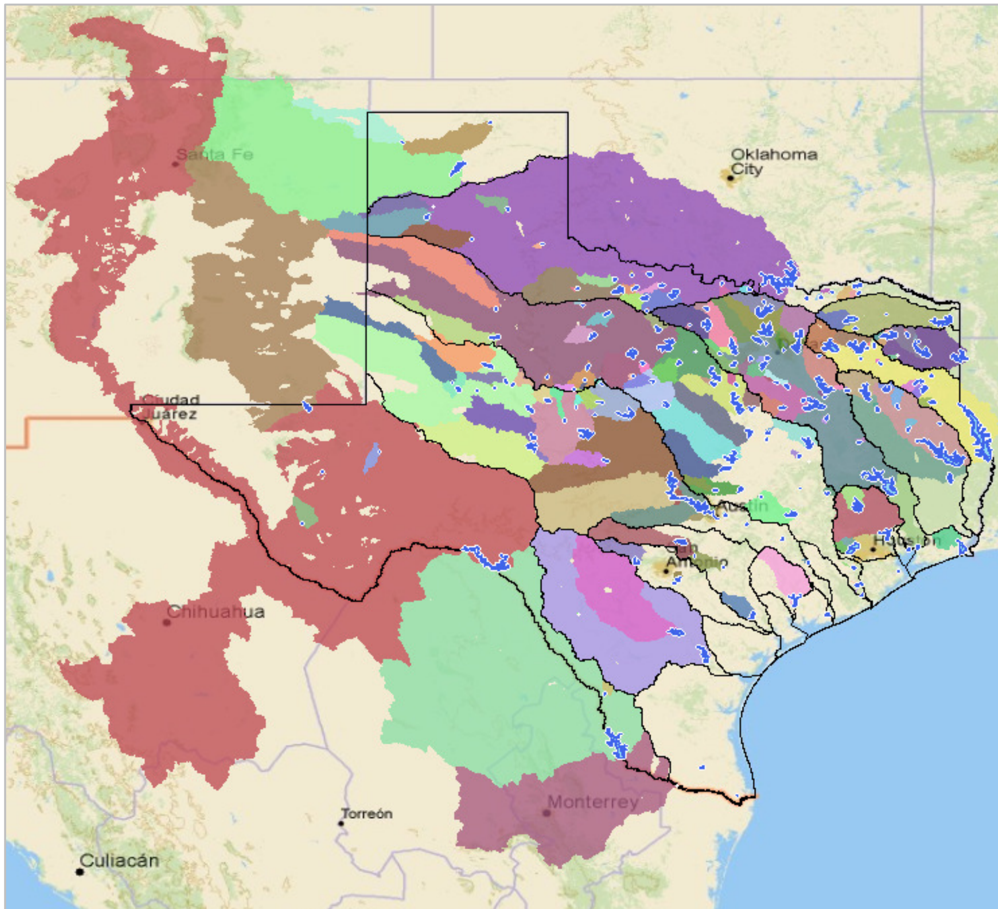

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 EXECUTIVE SUMMARY

Sedimentation in Texas reservoirs is a significant problem that affects both water availability and quality in Texas. The Texas Water Development Board estimates that Texas' major reservoirs are losing 90,000 acre-feet per year due to sedimentation (Water for Texas, 2007). This is equivalent to a loss of 4.5 million acre-feet by 2060 and exceeds the projected increase in storage of 3.4 million acre-feet with the addition of new reservoirs (14 major and 2 minor). The reduction in storage volume from sedimentation has direct impacts on water supply and secondary impact on supply infrastructure and water quality that necessitate modification or relocation of water supply intakes; additional water treatment to address taste, odor, and related issues; more stringent discharge limits and increased wastewater treatment costs; and the release of pollutants to the water column from constituents that persist in sediments for extended periods. Uncertainty regarding total supply and distribution of rainfall due to the anticipated effects of climate change placing further burden on already stressed reservoirs.

The goal of this research is to assist the TWDB in addressing reservoir sedimentation by addressing the following key questions:

1. Which reservoirs need immediate attention to protect storage volume and water quality?
2. What regional influences and reservoir specific characteristics (e.g. soils, rainfall patterns, land use, land management practices) have the most influence on sedimentation and water quality impacts in reservoirs?
3. What portions of "at risk" reservoir watersheds have the highest contribution to nonpoint source load?

This research addresses these questions by identifying factors that are related to sedimentation, compiling sedimentation-related data, creating tools for analyzing the data, and, finally, providing methodologies for ranking the reservoirs by sedimentation-risk. This research also provides a partial list of watershed management strategies that can mitigate sediment loading to receiving waters.

The key contribution of this study is the development of four knowledge bases to support subsequent research. They are listed as follows:

1. a database of analogues that describe a host of factors related to reservoir sedimentation, (e.g. land use and land cover, watershed slope, soil erodibility, and residence time);
2. a substantive compilation of available empirical sedimentation rates from a multiple sources and methodologies;
3. a versatile decision support system tool for stakeholders to weigh the importance of analog measures and to rank reservoirs for sedimentation risk; and,
4. a Best Management Practices matrix that lists commonly-used landscape-based structural BMPs that meet current and anticipated permit requirements along with efficiency, costs and applicability in different environments.

This study proposed methods for integrating the four knowledge bases to identify reservoirs most at-risk for sedimentation. The 20 most at-risk reservoirs identified by this study were suggested for future pilot projects where sophisticated sediment models and watershed management plans may be implemented.

2.0 INTRODUCTION

Nonpoint Source (NPS) loads that include sediment and associated pollutants impact Texas reservoirs by depleting storage and degrading water quality. Therefore understanding and mitigating the potential for sediment loading to these reservoirs is vital to successful stewardship and financial management of the State's existing water resources.

The Texas Water Development Board (TWDB) estimates that Texas' major reservoirs are losing 90,000 acre-feet per year due to sedimentation (Water for Texas, 2007). This is equivalent to a loss of 4.5 million acre-feet by 2060, and represents a greater volume than the increase in storage of 3.4 million acre-feet projected with the addition of new reservoirs (14 major and 2 minor). The reduction in storage volume from sedimentation has direct impacts on water supply and secondary impact on supply infrastructure and water quality that include the need to modify water supply intakes; the need for additional water treatment to address taste, odor, and related issues; the need for more stringent discharge limits and increased wastewater treatment costs; and the release of pollutants to the water column from constituents that persist in sediments for extended periods.

A prior study (TWDB Contract #2004-483-534) compared the cost of dredging versus building new reservoirs and found that the cost of dredging is at least twice the cost of securing storage in new reservoirs. Thus it is economically more viable to protect existing reservoir storage and to reduce the need for constructing new reservoirs.

This study builds on the previous work and supports TWDB's continuing effort of protecting existing reservoir storage and reducing the need for constructing new reservoirs; improving water quality, and reducing water supply and treatment costs caused by sedimentation. Results from this study can be used to identify Texas reservoirs that are most at risk to help direct future investigation and protection efforts. Furthermore, this study provides a general overview of best management practices (BMPs) for controlling sedimentation.

This study was prepared by the project team of Espey Consultants, Inc. (EC), Crespo Consulting Services, Inc. (Crespo), Parsons Water & Infrastructure, Inc. (Parsons), and Watearth, Inc.

3.0 APPROACH

3.1 SCOPE OF INVESTIGATION

This study focuses on the major Texas reservoirs; which, according to the TWDB (TWDB, 2007), refer to reservoirs that have conservation storage capacities that are greater than 5,000 acre-ft. The project team obtained the official list of these reservoirs from the 2007 State Water Plan. The list is shown in Appendix C and contains 196 reservoirs.

3.2 POINTS OF CONSIDERATION

While it is intuitive to assume that sedimentation risk is correlated to the sedimentation rate, and as such reservoirs with higher empirical sedimentation rates would be more at risk, it is not possible to directly apply this assumption to this study because of the following reasons:

1. Empirical sedimentation rates can be expressed using a variety of metrics (e.g. bulk sedimentation rate [ac-ft/yr], %loss in reservoir volume [%change in vol/yr], effective soil erosion rate [ac-ft/sq-mi/yr]). Each metric is useful for describing a different aspect of sedimentation risk and none is superior to another.

   For instance, if the concern is the loss in reservoir yield, then the bulk sedimentation rate (in units of volume/time) can help by quantifying how fast storage volume is decreasing.

   However, if the concern is reservoir water quality, bulk sedimentation rates may not be as useful because a large reservoir can buffer changes in volume better than a small reservoir; and thus, experience less impact to its water quality. For water quality issues, the rate of percentage loss in reservoir volume (in units of percent /time) can be used.

   Finally, if the concern is erosion in a reservoir watershed, then an effective erosion rate would be more useful than either bulk sedimentation or percent volume loss rates. Such an erosion rate can be calculated by dividing the bulk sedimentation rate by the watershed area. This rate or metric can be useful in understanding the impact of watershed properties such as landuse/landcover and channel erosion characteristics and provide insight onto the effectiveness of BMP implementation.

2. In Texas, sedimentation data are not available for all the major reservoirs. Some reservoirs have neither soil erosion studies nor volumetric hydrographic surveys that can be used to quantify sedimentation rates.

3. Even when rates are available, they are not estimated consistently. The two main sources of sedimentation rates in Texas are: Texas Commission on Environmental Quality's (TCEQ) Water Availability Models (WAMs) and TWDB's hydrographic surveys estimate rates based on different types of data. WAM sedimentation rates are estimated primarily on soil erosion studies with some additional volumetric surveys information. Sedimentation rates from TWDB hydrographic surveys are derived by calculating volumetric changes between successive surveys in the same reservoirs. In our study, we have identified many instances where TWDB and WAM sedimentation rates do not agree, thus highlighting the uncertainty of the estimated rates.

4. Even within the same data source, the differences in methodologies for estimating the sedimentation rates result in significant variability within the data set. Uncertainty arising from the spatial resolution of the raw data and the modeling/interpolation method can create large

ranges in the resulting sedimentation rates. The TWDB is in the midst of standardizing its methodologies for estimating sedimentation rates from its hydrographic surveys; but, this effort is not complete at the time of the writing of this report. The WAM sedimentation rates were developed from a variety of reports that used different methods, including results of some hydrographic surveys.

For the reasons stated above, solely relying on sedimentation rate estimates alone is insufficient to rank the reservoirs. In addition to sediment rates, there exists an array of watershed and reservoir specific characteristics that can provide valuable analogues which influence reservoir sedimentation rates. A level of professional judgment based on these other sediment-related data sources is needed to better inform the process.

In the following section, a summary of the study approach is provided to describe how both available sedimentation data and professional judgment are used to identify at-risk reservoirs and to create the research products of this study.

3.3 PROCESS FLOWCHART

Figure 3.1 contains a flow chart that illustrates the approach undertaken by the project team in this study.

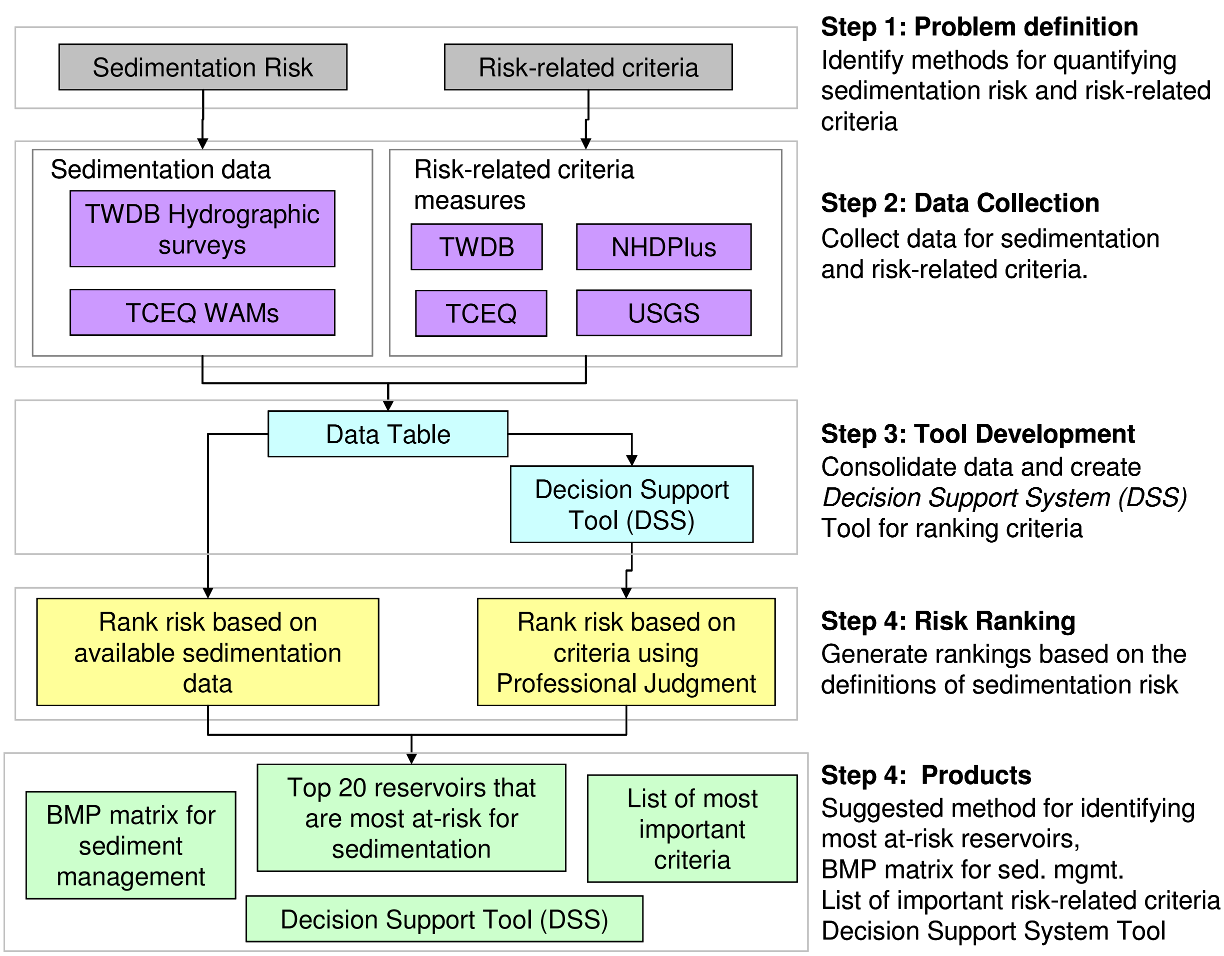


Figure 3.1 Flowchart of Study Approach

Under Step 1, the project team identified methods for quantifying sedimentation rates and what they each represent (e.g. bulk sedimentation rate of volume/yr to represent loss in sediment volume, etc.). Any sedimentation data collected later would be converted into each of these rates (please see Section 5.1.1 for more details). The project team also identified types of ancillary information that are useful in characterizing sedimentation risk. These data were used later in Step 3 to inform the professional judgment process. Examples of risk-related criteria include reservoir characteristics such as residence time, reservoir age, shoreline development index, etc; and watershed characteristics such as landuse, soil erodibility, watershed slope, etc. Methods of quantifying the risk-related criteria (criteria measures) were also identified.

In Step 2, the team collected sedimentation data from TCEQ WAMs and TWDB hydrographic surveys. The team also collected data to quantify the risk-related criteria from multiple sources such as NHDPlus, TWDB, TCEQ and USGS.

In Step 3, the team consolidated the collected empirical sedimentation rates and criteria measure data into a table (DSS database). At the same time, a Decision Support System (DSS) Tool was created to support the professional judgment using the risk-related criteria measures. The tool provides the following functions:

1. converts criteria measures into a common utility measure for scoring and ranking the reservoirs using user-defined utility conversion formulae;
2. multiplies the utility for each criteria with user-defined weights. The DSS tool allows users to specify criteria weights based on their judgment of the relative impacts of criteria on sedimentation risk; and,
3. calculates the final scores for the reservoirs and create a ranked list of reservoirs based on the professional judgment.

In Step 4, the sedimentation DSS tool was used by the project team to rank the reservoirs. The weights and utility functions behind the DSS tool were assigned via professional judgment by the research group. At the same time the sedimentation rates were converted to each of the quantification methods identified in Phase I. The rankings produced from the sedimentation data and the application of best professional judgment was consolidated into one table. To facilitate comparison, rankings were normalized by the number of quantifiable reservoirs and converted to percentile values.

Finally in Step 5 the consolidated rankings were reviewed and a draft list of the top 20 reservoirs that were most at risk for sedimentation was established. This draft list of at risk reservoirs is suggested as the basis for targeting future watershed management planning and implementation efforts to mitigate sediment loading. The most important risk-related criteria were also identified. Finally, a matrix of BMPs for sediment management was created as a basis of consideration for potential future efforts in watershed protection of Texas reservoirs.

4.0 DEFINING SEDIMENTATION RISK

4.1 PURPOSE

In this chapter, the methods for quantifying sedimentation risk and risk-related criteria are defined. These definitions form the basis for data collection and reservoir ranking and analysis described in the ensuing chapters of this report.

The following research questions were posed for this study:

1. Which reservoirs need immediate attention to protect storage volume and water quality?
2. What regional influences (soils, rainfall patterns, land use, land management practices) have the most influence on sedimentation and water quality impacts in reservoirs?
3. What portions of "at risk" reservoir watersheds have the highest contribution to nonpoint source load?

To answer the above questions, it is first necessary to define the following metrics:

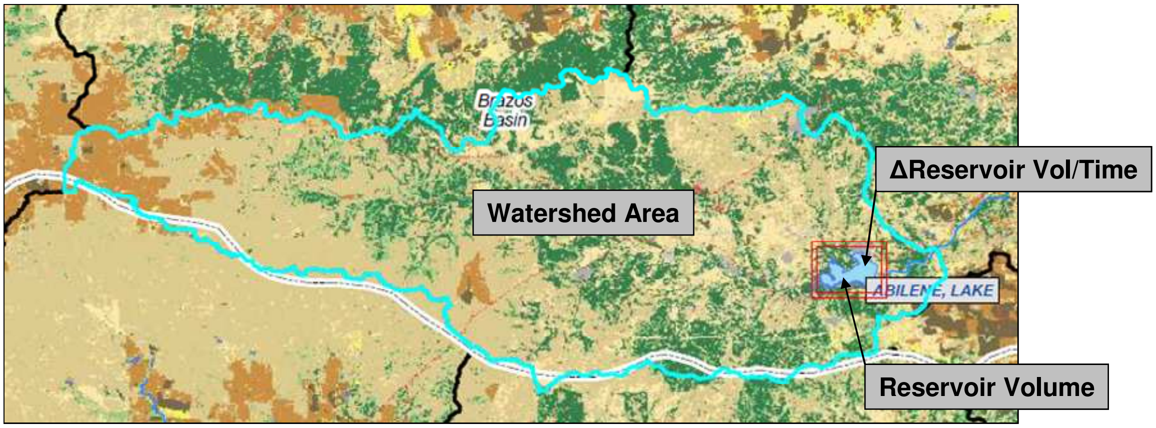
1. a metric to quantify the sedimentation risk to storage volume;
2. a metric to quantify the sedimentation risk to water quality;
3. a metric to quantify sediment contribution of watershed (on a per unit area basis); and,
4. a list of criteria (i.e. "regional influences") that are related to sedimentation and methods for quantifying them.

This chapter provides detailed discussions for each of the above definitions.

4.2 QUANTIFICATION OF SEDIMENTATION RATES

As mentioned in the previous section, sedimentation data are available from the TCEQ WAMs and TWDB hydrographic surveys for a subset of major TX reservoirs. In order to use them appropriately to address the different aspects of sedimentation risk (i.e. storage volume, water quality and watershed erosion), it is necessary to convert them to the correct metric. These metrics are bulk sedimentation rate (ac-ft/yr), percent loss in reservoir volume per year (%/yr), and effective soil erosion rate (ac-ft/sq-mi/yr).

The rationale for choosing these metrics, which are characterized in Figure 4.1, is explained in the following subsections.



Bulk sedimentation rate = Change in Reservoir Volume/time (acre-ft/yr)
Percent loss in volume = Change in Reservoir Volume/Reservoir Conservation Capacity/time (% vol/yr)
Effective erosion rate = Change in Reservoir Volume/Reservoir Watershed Area/time (acre-ft/yr/sq-mi)

Figure 4.1 Illustration of methods for quantifying sedimentation rates.

4.2.1 Bulk sedimentation rate (ac-ft/yr)

From an engineering point of view, loss of volume leads to loss of firm yield. The bulk sedimentation rate (measured in units of volume/time) can be used to quantify how fast storage is decreasing in a given reservoir.

4.2.2 Percent loss in volume (%/year)

From a water quality point of view, a large bulk sediment rate may not always cause a significant impact to water quality. The risk to reservoir water quality is more related to the proportional loss in volume because it directly impacts intrinsic properties, such as residence time, nutrient concentration, TSS, etc. Therefore calculating the percent loss in volume (%/year) by dividing the bulk sedimentation rate by the reservoir conservation capacity can produce a useful metric for the degradation of water quality.

4.2.3 Effective erosion rate (ac-ft/sq-mi/yr)

From a watershed management point of view, understanding how much sediment load that a unit area of watershed produces is important. The effective erosion rate – calculated by dividing the bulk sedimentation rate by the reservoir watershed area – can help guide the implementation of BMPs for sediment control.

4.3 DESCRIPTION OF CRITERIA RELATED TO SEDIMENTATION RISK

4.3.1 Concepts

To address the second research question, "*What regional influences (soils, rainfall patterns, land use, land management practices) dominate sedimentation and water quality impacts in reservoir"*, the project team identified a set of criteria related to sedimentation risk in reservoirs. This set of criteria consists of a wide array of natural and anthropogenic factors that could be quantitatively or qualitatively measured. The criteria are grouped into five subcategories (listed below) which provide a useful hierarchical organization scheme.

1. Watershed Erosion Characteristics
2. Landuse/Land Cover
3. Channel Erosion
4. Reservoir Capacity & State
5. Cultural & Economics

The first four of the five subcategories can be derived by considering the sediment dynamics of a reservoir. The amount of sediment that accumulates in a reservoir depends on 1) how much sediment originates from a reservoir's contributing watershed and channels; and 2) conditions in the reservoir that are favorable towards accumulation of sediment. The fifth subcategory includes criteria that are not directly related to sedimentation dynamics but may modify risk from sedimentation.

Watershed erosion characteristics such as soil erodibility, watershed slope and **land use/land cover** are important factors that influence contributions of sediment loading to a reservoir. Apart from watershed erosion, sediment can also be contributed by **channel erosion**, which is associated with the erodibility of the channels and the amount of channel bank available for erosion.

Factors related to the **reservoir capacity and state** such as residence time and the availability of deposition zones influence whether sediments settle in the reservoir or are carried by the flow over the dam.

Finally, the sedimentation risk can also be influenced by factors that are not directly related to sedimentation dynamics. These criteria are grouped under the "**Culture and Economics**" subcategory. Some major Texas reservoirs, for example, do not have any water supply function (such as the South Texas Project Reservoirs). As such their sedimentation issues may be less important than those that have firm yields. Sedimentation can impose additional environmental risk to reservoirs apart from reduction in volume. For instance pollutants can be attached to particulate matter and transported. For this reason, data on water quality constituents such as TSS in reservoirs may provide insight to environmental risk by sedimentation.

A diagram of the 5 subcategories and the criteria associated with them is illustrated in Figure 4.2.

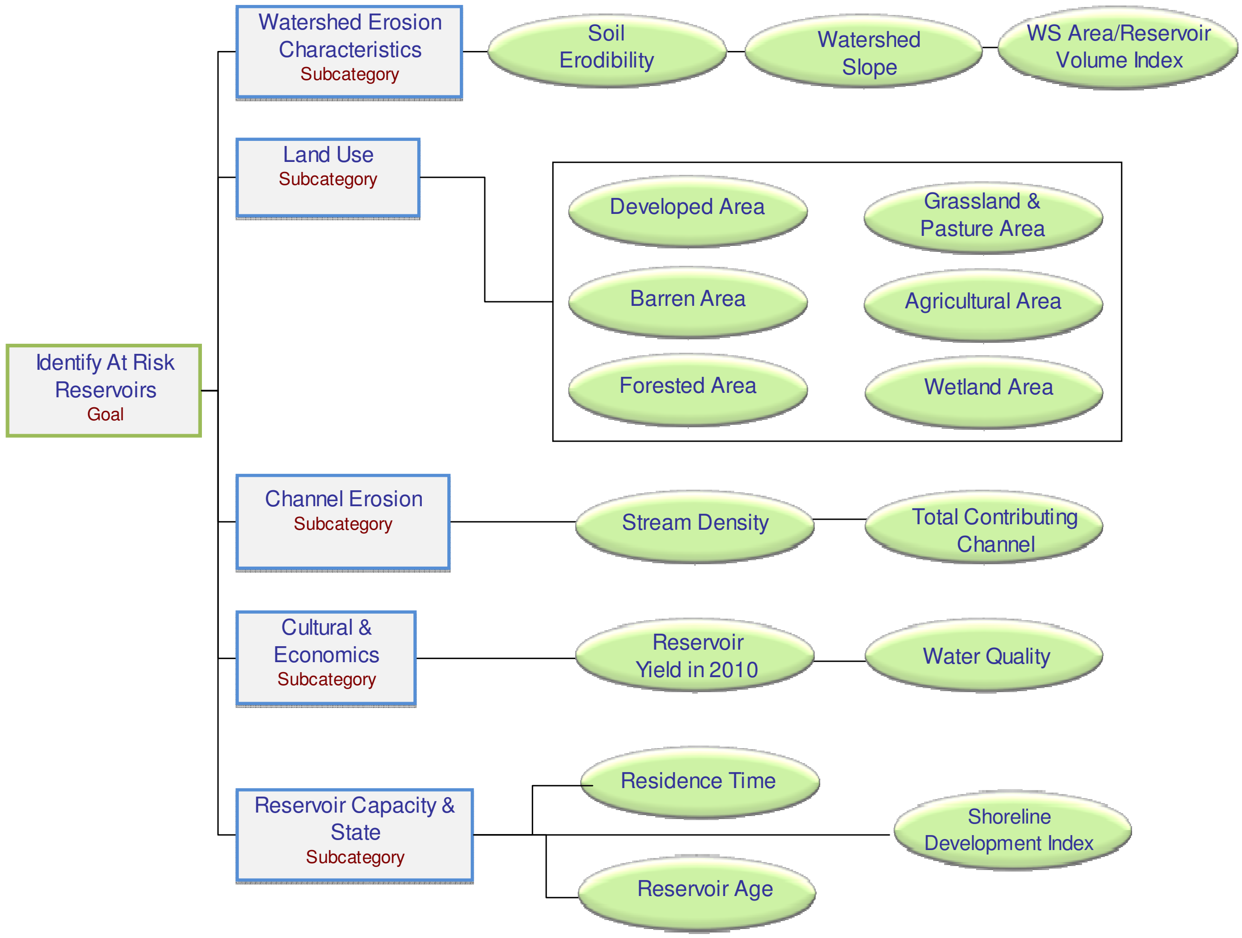


Figure 4.2 Risk-related criteria for determining sedimentation risk for major TX reservoirs

Detailed explanations of each of the criteria are provided in the following paragraphs. Information on sources of data and methodologies for quantifying them are also described.

4.3.2 Watershed Erosion Characteristics

Watershed erosion characteristics refer to general geographic factors such as size of watershed, slope and erodibility of the soils.

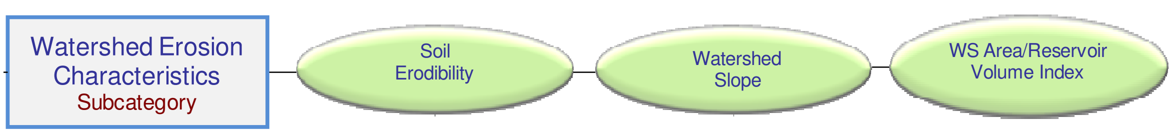


Figure 4.3 Risk-related criteria under Watershed Erosion Characteristics subcategory

4.3.2.1 Watershed Area to Reservoir Volume Index (1/m)

One important factor in determining watershed vulnerability to sedimentation is the ratio of the watershed drainage area to the reservoir's normal capacity ratio (Jones, et al., 1998). The watershed drainage area (referring to the incremental watershed between a given reservoir and its next upstream reservoir(s) in this study) provides the size of the area where runoff contributes directly to sedimentation in the reservoir. On the other hand, the volume of a reservoir helps quantify the ability of a reservoir to buffer the effects of sediments in runoff. To calculate this ratio, watersheds of 194 major TX reservoirs were delineated from EPA's NHDPlus data to obtain their areas. The delineation approach will be described in further detail in Chapter 6. Reservoir volumes were obtained from the TWDB's WIID (Water Information Integration and Dissemination) system database (http://wiid.twdb.state.tx.us/).

4.3.2.2 Soil Erodibility (K-factor)

K factor is soil erodibility factor which represents both susceptibility of soil to erosion and the rate of runoff, as measured under the standard unit plot condition. The standard unit plot is an erosion plot 72.6 ft (22.1 meters) long on a 9 percent slope, maintained in continuous fallow, tilled up and down hill periodically to control weeds and break crusts that form on the surface of the soil. The plots are plowed, disked and cultivated the same for a row crop of corn or soybeans except that no crop is grown on the plot.

Soils high in clay have low K values, about 0.05 to 0.15, because they are resistant to detachment. Coarse textured soils, such as sandy soils, have low K values, about 0.05 to 0.2. This is because even though these soils are easily detached, they have low runoff due to good drainage. Medium textured soils, such as the silt loam soils, have a moderate K values, about 0.25 to 0.4, because they are moderately susceptible to detachment and they produce moderate runoff. Soils that have high silt content are most erodible of all soils. They are easily detached; tend to crust and produce high rates of runoff. Values of K for these soils tend to be greater than 0.4

K-factor values are available on a 1-km by 1-km spatial resolution for the conterminous United States from the USGS STATSGO database at: http://water.usgs.gov/GIS/dsdl/muid.e00.gz. The metadata for the database can be found at: http://water.usgs.gov/GIS/metadata/usgswrd/XML/muid.xml).

4.3.2.3 Watershed Slope (%)

The watershed slope influences soil stability and runoff velocity which leads to great surface erosion. The watershed slopes for each reservoir watershed can be computed from the NHDPlus dataset which contains catchment slopes derived from USGS 100K DEMs (Digital Elevation Models).

4.3.3 Land Use/Land Cover

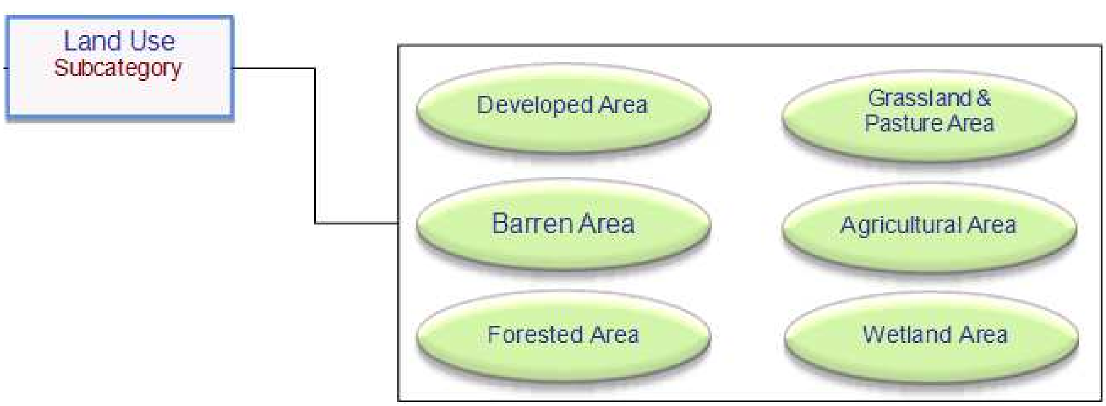


Figure 4.4 Risk-related criteria under Land Use subcategory.

The types of land use and land cover in a given watershed can significantly influence soil erosion. To ease comparison, the NLCD (National Land Cover Database) codes for land use/land cover were reclassified into six types, i.e., Developed, Barren, Forested, Grassland & Pasture, Agriculture, and Wetlands. The percentage of the watershed area of a given reservoir under each NLCD code was calculated from the NHDPlus dataset. For detailed information about the calculation approach, please refer to Chapter 6.

4.3.3.1 Developed Area (%)

The developed area (%) is calculated by summing the percentages of Low (NLCD 21) and High Intensity Residential (NLCD 22), Commercial/Industrial/Transportation (NLCD 23), and Urban/Recreational Grasses (NLCD 85).

4.3.3.2 Barren Area (%)

The barren area (%) is calculated by summing the percentages of Bare Rock/Sand/Clay (NLCD 31), Quarries/Strip Mines/Gravel Pits (NLCD 32), and Transitional (NLCD 33).

4.3.3.3 Forested Area (%)

The forested area (%) is calculated by summing the percentages of Deciduous Forest (NLCD 41), Evergreen Forest (NLCD 42), and Mixed Forest (NLCD 43).

4.3.3.4 Grassland & Pasture Area (%)

The grassland & pasture area (%) is calculated by summing the percentages of Shrubland (NLCD 51), Grasslands/Herbaceous (NLCD 52), and Pasture/Hay (NLCD 43).

4.3.3.5 Agricultural Area (%)

The agricultural area (%) is calculated by summing the percentages of Orchards/Vineyards/Other (NLCD_61), Row Crops (NLCD 82), Small Grains (NLCD 83), and Fallow (NLCD 84).

4.3.3.6 Wetlands Area (%)

The wetlands area (%) is calculated by summing the percentages of Woody Wetlands (NLCD 91) and Emergent Herbaceous Wetlands (NLCD 92).

4.3.4 Channel Erosion

Figure 4.5 Risk-related criteria under Channel Erosion subcategory.

Sediment loads from bank erosion in some cases can occur in addition to watershed (sheet) erosion and therefore it is necessary to quantify bank erosion as well. The two most common bank erodability/stability indices are Rapid Geomorphic Assessment (RGA) and the Bank Erosion Hazard Index (BEHI). Both however are small scale assessment indices that require geomorphic data pertinent to the bank and are not applicable at a large watershed scale. At the watershed scale, we applied two metrics that are relatively easy to calculate: total stream miles and stream density.

4.3.4.1 Total Contributing Channel (miles)

The miles of contributing channel is a direct measurement of the amount of channel bank available for erosion. Upstream segments tend to carry less flow than downstream segments, and as such tend to experience less bank erosion. In this study we only accounted for streams that are 3rd order or above according to their Strahler stream order. Data on stream length and Strahler stream order are available from the NHDPlus data set.

4.3.4.2 Stream Density (mi/mi^2)

In addition to the availability of bank for erosion, the amount of energy carried by the flow is also important. If the kinetic energy of the flow, which is related to channel slope, produces an erosive force higher than the substrate can withstand, the channel first incises, exceeds bank stability, and finally develops sinuous curves and bends (which increase channel length and lower the effective channel slope) that continuously slough to form a meander belt or river valley. This situation produces two significant characteristics, more river channel length per watershed area and many places where the river velocity axis is tangential to the bank. Both of these are characteristic of areas of high bank erosion. So a watershed where the mean sinuousity index is high and/or where the river mile to watershed area ratio is high would indicate a watershed that produces more bank erosion loading.

Of the two metrics (stream density and sinuosity), stream density is easier to quantify and was selected to be the analog of average channel erodability. Only streams with order greater than 3 were used. Data on stream length and stream order were obtained from the NHDPlus data set.

4.3.5 Cultural & Economics

Figure 4.6 Risk-related criteria under Cultural & Economics subcategory.

This subcategory includes criteria that are not directly related to sedimentation dynamics but may modify the risk from sedimentation.

4.3.5.1 Reservoir Yield in 2010 (ac-ft/yr)

Reservoir yields can be used to indicate importance of a reservoir in terms of water supply. Some major Texas reservoirs, for example, do not have any water supply function (such as the South Texas Project Reservoirs). As such their sedimentation issues may be less significant than those that have firm yields. Data for reservoir yield in 2010 are available from the TWDB's State Water Plan (2007).

4.3.5.2 Water Quality (mg/L TSS)

Sediment often transports organic matter, nutrients, chemical and waste along with it. Water quality issues such as high phosphorus, nitrates, chlorophyll and total suspended solids concentrations may indicate high levels of sediment in the reservoir. For this study, the metric chosen for water quality is the median TSS concentration which is available from the TCEQ for a subset of the 190+ reservoirs.

4.3.6 Reservoir Capacity & State

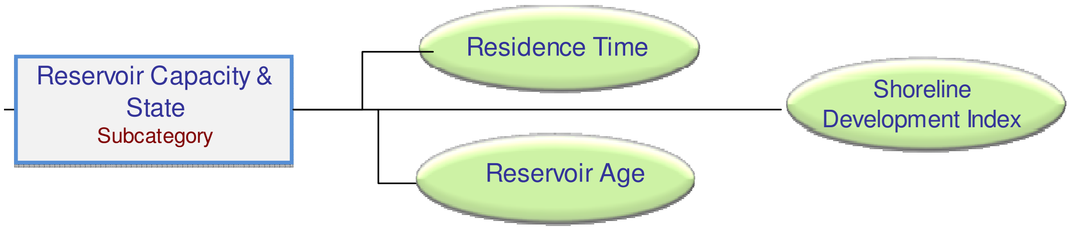


Figure 4.7 Risk-related criteria under Reservoir Capacity & State subcategory.

The reservoir capacity and state influence the accumulation of sediment in the reservoir. Relevant factors are the residence time, reservoir age and the shape of the reservoir which hints on the availability of deposition zones.

4.3.6.1 Residence Time (days)

The residence time in this study refers to the hydraulic residence time which is defined as the reservoir volume divided by the average flow rate. A reservoir with a high flushing rate or short residence time is less likely to accumulate sediment due to limited time for settling. To calculate the hydraulic residence time, reservoir volumes can be obtained from the TWDB WIID database. Long term average inflow can be obtained from average flow rates from NHDPlus. Residence time is calculated using the formula below:

$$\text{Residence Time} = \frac{\text{Reservoir Volume @ Conservation Capacity}}{\text{Average Flow Rate from NHDPlus}}$$

4.3.6.2 Reservoir Age (yr)

Some reservoirs are designed to accommodate a certain volume of sediment (in addition to water volume) over the design life of the dam. Reservoirs that have been in existence longer will tend to approach the point where additional sedimentation will cause a reduction in effective water storage volume. TWDB provides some impoundment dates for the Texas reservoirs; however the list is not complete.

4.3.6.3 Shoreline Development Index

The shoreline development index relates the amount of shoreline to the surface area or volume of the reservoir. A large amount of shoreline relative to the size of the lake increases the potential for sediment import. The TWDB maintains a shapefile of all the major reservoirs in Texas. Perimeters and surface areas can be obtained by performing a map calculation in GIS.

The formula for Shoreline Development Index (SLD) is given as follows:

$SLD = S/[2(A\pi)^{0.5}]$

Where S = length of shoreline (m), A = area of lake (sq m).

4.3.7 Other Criteria Considered

In addition to the above criteria, the project team also considered others risk-related factors. However, because of the difficulty of acquiring data or quantification, they were not included. Below are some examples of other risk-related factors that may warrant more evaluation in future watershed management studies targeted at reservoirs.

4.3.7.1 SCS Structures

The location and functionality of SCS structures can be evaluated to determine if existing sediment controls are potentially controlling the volumes of sediment reaching the reservoirs. The number of SCS structures in each reservoir watershed along with the drainage area and normal storage for each structure could be assessed. Reservoir watersheds having little or no effective structures would pose a greater risk to reservoir sedimentation than those with effective SCS structures.

The difficulty in using this criteria arises from the considerable number SCS structures in Texas and the need to delineate their catchments. This requires processing large amounts of data that are at a higher spatial resolution than that needed for delineating the watersheds for reservoirs. Furthermore, data on the effectiveness of the structures are at best spotty. This is a significant data gap because SCS structures that are not maintained properly may increase instead of prevent sediment input to reservoirs.

4.3.7.2 Reservoir appropriation

Most reservoirs in Texas are assigned one or more of the following beneficial use categories: domestic/municipal, industrial, irrigation, mining, hydroelectric power, navigation and recreation. The different uses can be assigned different values based on the socio-economic value of the beneficial uses assigned. For example, reservoirs appropriated for municipal and domestic water supply would be assigned a greater value than those appropriated for industrial or mining purposes. However, compiling TCEQ water right data by reservoir is a time consuming task which was not feasible for the project time frame.

4.3.7.3 Realized demand

The importance of a reservoir may be better described by the realized water demand for the reservoir instead of the firm yield. However acquiring this data requires substantial effort in compiling TCEQ's Water Rights (Uses) Master List.

5.0 SEDIMENTATION DATA

5.1 COMPILATION OF SEDIMENTATION DATA

Sedimentation rates can be used to determine the accumulation of sediment for each reservoir over a given period of time. These rates provide estimates of the amount of sediment reaching the reservoirs on an annual basis, usually represented as acre-feet per square mile per year or acre-feet per year. For this study, sedimentation rates were compiled from two sources: 1) TCEQ Water Availability Modeling (WAM) Reports; and 2) hydrographic surveys completed by TWDB. Rates were taken from TCEQ WAM reports first, and then compared to rates calculated from the hydrographic surveys (if the surveys were not already used in the WAM studies). Sedimentation rates within the WAM reports were produced from a number of sources as discussed in section 5.1.1. These WAM rates and the TWDB hydrographic surveys provided multiple sets of raw sedimentation rate data for the study, three of which were evaluated further and included in this report. In addition to the results, descriptions of sources, assumptions and qualifiers have been prepared and described below.

5.1.1 WAM Dataset

Empirical sedimentation rate data was collected from TCEQ WAM Reports for most major Texas reservoirs. TCEQ WAM Reports were completed for every major river basin in Texas between 1999 and 2000. Within these reports, sedimentation rates for each major reservoir were developed from a variety of existing sources. The sources for these data are summarized as follows:

- Report 268, Texas Department of Water Resources (TDWR), February 1982 (34 reservoirs; 17%)
- TWDB Hydrographic surveys (58 reservoirs; 30%)
- Other: specialized or reservoir specific studies and estimated rates (42 reservoirs; 21%)
- Sources not reported (32 reservoirs; 16%)
- Not estimated/no data (30 reservoirs; 15%)

Most of the sources came from hydrographic surveys and Report 268. The specialized and reservoir specific studies were performed by entities such as USACE, TWDB, IBWC, Conservation Districts and/or engineering firms. The resulting sedimentation rates developed within the studies were used in the WAM reports to estimate the year 2000 reservoir volumes. In some cases, reservoirs with no existing rates were estimated by using rates from nearby reservoirs.

Fifteen percent of the major reservoirs were not estimated for sedimentation volume and/or not included in the WAM Reports. These reservoirs include those with: no water supply function; off-channel locations with minimal non-contributing drainage areas; no available data, negative hydrographic survey rates; and, primary functions that do not provide reservoir yields. See Table 5.1 for list of these reservoirs.

Table 5.1 Major reservoirs not estimated for sedimentation rate in WAM reports

Name of Reservoir	River Basin	Reason for No Sedimentation Estimate
Addicks Reservoir	San Jacinto	No water supply function; used for flood control
Anzalduas Channel Dam	Rio Grande	No water supply function
Austin , Lake	Colorado	Used as part of system operations; no individual yield total available; has constant water surface elevation; Increase in capacity for TWDB Surveys (i.e. n/a was used instead of a negative sedimentation rate).

Name of Reservoir	**River Basin**	**Reason for No Sedimentation Estimate**
Barker Reservoir	San Jacinto	No water supply function; used for flood control
Brazoria Reservoir	Brazos	Off-channel reservoir; used for industrial water supply
Cedar Bayou Generating Pond (Dutton Lake)	Trinity-San Jacinto	Used as a cooling pond for power plant; no significant drainage area
Delta Lake	Nueces-Rio Grande	No water supply function except for pumped storage; no significant drainage area
Diversion, Lake	Red	Used as part of system operation with other reservoirs; no individual yield total available
Dunlap, Lake	Guadalupe	Used for hydroelectric power purposes
E.V. Spence Reservoir	Colorado	Increase in capacity for TWDB Surveys (i.e. n/a was used instead of a negative sedimentation rate).
Electra, Lake	Red	No data available
Gonzales (H-4) Lake	Guadalupe	Used for hydroelectric power purposes
Gulf Coast Water Authority Lake	San Jacinto	Off-channel reservoir; No significant drainage area
Hubert H. Moss Lake	Red	Increase in capacity for TWDB Surveys (i.e. n/a was used instead of a negative sedimentation rate).
Imperial Reservoir	Rio Grande	Off-channel reservoir
JD Murphee Wildlife Impoundment	Neches-Trinity	No water supply function
Lady Bird Lake	Colorado	Used as part of system operations; no individual yield total available; has constant water surface elevation
Lewis Creek Reservoir	San Jacinto	Industrial cooling water reservoir; no firm yield
Loma Alta Lake	Nueces-Rio Grande	Used as a water storage facility only; no significant drainage area
Lower Running Water Draw WS SCS Site 2 Dam	Brazos	No water supply function
Lower Running Water Draw WS SCS Site 3 Dam	Brazos	No water supply function
Mitchell County Reservoir	Colorado	Off-channel reservoir
Natural Dam Lake	Colorado	Located in non-contributing area of the Colorado Basin
Olney/Lake Cooper	Red	Used for recreation purposes; normal storage volume is under 5,000 ac-ft
Peacock Site 1A Tailings Reservoir	Cypress	Used as part of system operations; no individual yield total available; No significant drainage area
Red Draw Reservoir	Colorado	Off-channel reservoir
River Crest Lake	Sulphur	Off-channel reservoir; used for stream turbine, condenser-cooling purposes by Texas Power and Light Company; No significant drainage area
South Texas Project	Colorado	Off-channel reservoir

Name of Reservoir	River Basin	Reason for No Sedimentation Estimate
Reservoir		
Sulphur Springs Draw Storage Reservoir	Colorado	Has zero yield; Located in non-contributing area of the Colorado Basin
Upper Nueces Lake	Nueces	Used for irrigation purposes; no inactive pool information available; No significant drainage area

In total, the WAM Reports provide a sedimentation rate for 166 of the 196 major reservoirs. These sedimentation rates have been summarized in an Excel spreadsheet and provided in Appendix B.

WAM sedimentation rates were compiled and quantified in two ways as part of this study:

1. Total Load (Bulk Sedimentation) = volumetric (ac-ft/yr)
2. Unit Load (Effective Sediment Loss) = watershed area (ac-ft/sq-mi/yr)

The data gathered from the WAM reports were given in acre-feet per year (ac-ft/yr), acre-feet per square mile per year (ac-ft/sq-mi/yr) or both. Rates were then calculated using the reservoirs' incremental drainage areas in square miles so that each reservoir had a sedimentation rate in both units. Having data in both unit formats allows for overall comparisons from watershed to watershed (unit load) and to provide potential impact to a specific reservoir (total load).

For reservoirs with no WAM data, the average sedimentation rates of their river basin were applied (with the exception of those reservoirs with little to no significant drainage areas). Those reservoirs without a significant drainage area (watershed area under 2.0 square miles) were assigned a sedimentation rate of 0.00 ac-ft/sq-mi/yr. Reservoirs with no data include those with no water supply function, off-channel reservoirs, and reservoirs with primary functions other than water supply along with reservoirs with minimal non-contributing drainage area reservoirs. The adjusted sedimentation rates are listed in Appendix B and were utilized for the DSS model.

5.1.2 Hydrographic Survey Datasets

Hydrographic survey sedimentation rates ('hydrosurvey sedimentation rates') were received from TWDB based on calculations performed by TWDB staff. The hydrosurvey sedimentation rates were compiled and evaluated to compare to existing sedimentation rates and for use in the DSS tool.

In total, 184 hydrographic surveys have been collected by TWDB for 109 major reservoirs. Many of the reservoirs have had multiple surveys conducted. Fifty of the reservoirs have had two surveys completed, 19 have had three surveys; and, six of the reservoirs have had four surveys completed. It should be noted that significant variability exists from one sedimentation rate to the next for some of those reservoirs that have multiple surveys.

In consultation with TWDB, methods of calculating rates were reviewed along with consideration of how to use them in conjunction with the WAM rates. During this meeting, it was determined that the hydrosurvey sedimentation rates should be used in addition to the WAM sedimentation rates and should be calculated using the same units. Based on discussions and further review of the data, two hydrosurvey sedimentation rates were selected to include in the DSS tool: 1) the maximum hydrosurvey sedimentation rate; and 2) the overall hydrosurvey sedimentation rate. The two list of hydrosurvey sedimentation rates were kept separate and not combined.

5.1.2.1 Maximum Hydrosurvey Sedimentation Rate

The maximum hydrosurvey sedimentation rate is the highest sedimentation rate in cases where multiple surveys were conducted. If a reservoir had multiple hydrographic surveys completed, then the highest calculated sedimentation rate from one consecutive survey to the next was selected for this set of data. In cases with only one hydrographic survey, the original survey volumes were used for calculating the rate. This set of maximum rates was selected to represent the most conservative set of rates. This set provided hydrosurvey sedimentation rates for 109 reservoirs.

5.1.2.2 Overall Hydrosurvey Sedimentation Rate

The overall hydrosurvey sedimentation rate is based on the most recently completed hydrographic survey and the original survey. The overall rates represent the sedimentation volume that has accumulated over a longer period, sometimes the lifetime of the reservoir. This set provided hydrosurvey sedimentation rates for the same 109 reservoirs.

5.2 EVALUATION OF THE DATA

The data was evaluated by performing a statistical analysis for each set of rates, including variability and ranges of data by basin and for individual reservoirs. In addition, ArcMap GIS was used to compare sedimentation rates from one reservoir to nearby reservoirs and to identify outliers in the data by basin and by region.

During evaluation of the data, the collected sedimentation rates were assessed in the following ways:

1) WAM report rates were compared to hydrosurvey sedimentation rates provided by TWDB, both the overall hydrosurvey sedimentation rate and the maximum hydrosurvey sedimentation rate
2) WAM rates for each reservoir were compared to other WAM rates for reservoirs within the same major river basin and within the same geographical region
3) Data statistics were calculated for each river basin (minimum, maximum, and mean)
4) Data statistics and percentile ranges were collected for each type of dataset (WAM rates, overall hydrosurvey sedimentation rates and maximum hydrosurvey sedimentation rates)

5.2.1.1 Evaluation of range within the data

A number of apparent outliers existed within the data collected and statistical analysis was completed to determine which outliers to omit. Three sedimentation rates from the WAM reports were determined to be out of range. Table 5.2 shows the top ten (i.e. top 5th percentile) WAM sedimentation rates in ascending order from left to right. It illustrates that there is a gradual increase in the sedimentation rates from 2.07 until 3.7 ac-ft/sq-mi/yr where the rates begin to approximately double with each consecutive value. The last three rates (in bold below) were deemed as outliers and replaced with those numbers as described below in section 5.2.

Table 5.2 Top 5 percentile data numbers (sed. rates in ac-ft/sq-mi/yr)

2.07	2.07	2.23	2.36	2.97	3.3	3.7	**6.31**	**10.57**	**22.97**

The hydrographic survey data presented a greater set of outliers to evaluate. The hydrographic surveys were conducted from 1936 to 2009 using a variety of techniques with most of the surveys completed since 1991. Since the equipment and analysis techniques have been modified and improved over time, variation in the data is expected. This variation in methods explains why some negative sedimentation rates were calculated from one survey to the next. Also, comparisons to original surveys, many of which are over 50 years old, can vary greatly due to major variations in methods.

Statistical analysis for each set of rates included minimum, maximum, mean, median and percentile ranges with the following results as shown in Table 5.3:

Table 5.3 Raw sedimentation rates data statistics

	WAM Rates (ac-ft/sq-mi/yr	Overall Hydrosurvey sedimentation rate (ac-ft/sq-mi/yr	Maximum Hydrosurvey sedimentation rate (ac-ft/sq-mi/yr)
Minimum	0.00	-0.74	-0.81
Maximum	22.97	19.34	19.34
Mean	0.76	1.26	1.57
Median	0.26	0.43	0.66
Standard Deviation	2.05	2.79	3.12
Percentile 2.5	0.00	-0.52	-0.43
5	0.02	-0.21	-0.19
10	0.05	-0.03	-0.02
25	0.13	0.14	0.19
75	0.75	1.15	1.56
90	1.46	3.02	3.91
95	2.07	5.51	5.96
97.5	3.26	7.33	11.19

5.2.1.2 Qualifiers: Establishing the Final Numbers

For the WAM data, the middle 95% (between the 2.5 and 97.5 percentiles) of the data fell between sedimentation rates of 0.00 and 3.26 ac-ft/sq-mi/yr. By using only the data below the 97.5 percentile range, all the large outliers were omitted from the dataset. Basically, the three highest rates were omitted because they were exceptionally high and fell out of the normal pattern of the rest of the data. These outliers were replaced with 3.70 (highest WAM rate remaining in adjusted dataset) for Fairfield Lake and Lake Kurth and 0.72 (recalculated rate using drainage area of 40 sq. mile based on WAM Report Table 1-2 of Brazos Basin Naturalized Flow Report, October 2001) for Camp Creek Lake.

For the hydrographic survey data, the numbers were more variable; thus, a normal range was found in a smaller percentile of the dataset. Negative sedimentation rates were found in the bottom 10 percentile of the data and high range sedimentation rates were found in the top 5 percentile range for both the overall hydrosurvey and maximum hydrosurvey sedimentation rate datasets. All the negative raw data values (bottom 10 percentile) were replaced with 0.00 ac-ft/sq-mi/yr. sedimentation rates. All the high numbers (top 5 percentile) were replaced with the 95 percentile sedimentation rate, 5.96 for maximum hydrosurvey sedimentation rates and 5.51 for overall hydrosurvey sedimentation rates. Data statistics for the qualifiers (adjusted) rates are shown in Table 5.4 below.

Table 5.4 Adjusted sedimentation rates data statistics

	WAM Rates (ac-ft/sq-mi/yr	Overall Hydrosurvey sedimentation rates (ac-ft/sq-mi/yr	Maximum Hydrosurvey sedimentation rates (ac-ft/sq-mi/yr
Minimum	0.00	0.00	0.00
Maximum	3.70	5.51	5.96
Mean	0.54	0.99	1.26
Median	0.25	0.43	0.65
Standard Deviation	0.68	1.41	1.65
Percentile 2.5	0.00	0.00	0.00
5	0.00	0.00	0.00
10	0.04	0.00	0.00
25	0.13	0.14	0.19
75	0.73	1.19	1.53
90	1.38	2.66	3.90
95	1.73	5.16	5.91
97.5	2.47	5.51	5.96

The original raw data and adjusted sedimentation rates along with sources information for all three datasets are in Appendix B.

5.2.1.3 Limitations and Confidence in the Data

Based on the comprehensive data collection performed for this study, the rates collected are the best sedimentation rates available; however, the limitations and variations in methodologies prohibit verification of the rates. The primary limitations in the data are listed below:

- sediment rates may not be representative if changes in land use have occurred in the watershed since the sedimentation rates were calculated;
- sediment rates have been calculated based on a number of different methods (especially the WAM rates) and come from a variety of sources resulting in a high degree of variability and lack of consistency;
- some WAM methods may not include sediment from streambank or shoreline erosion; and,
- confidence in hydrosurvey sedimentation rates is limited by variability in methods, improvements over time in analysis technology and survey equipement, the range of data (including negative values), and limited accuracy of the original surveys.

During the data evaluation, it was noted that overall the hydrosurvey sedimentation rates were generally two to three times higher than the WAM sedimentation rates. This may be attributable to:

- inaccuracies of the initial surveys developed as part of the dam permitting and design using older methods, such as the common use of USGS topographic maps;
- the advanced and advancing surveying techniques used for the TWDB hydrographic surveys;
- sediment loads from channel and shoreline erosion may not be accounted for in some of the WAM rates, but would be included in the hydrosurvey sedimentation rates; and,

- impacts of extreme flood events that could be measured by the hydrographic surveys that may not be accounted for in the average rates used for the WAM reports.

5.3 SUMMARY OF COLLECTED DATA

The following list is a summary of the sedimentation rates based on the compilation and evaluation of the sedimentation rate data.

- The adjusted WAM rates average 0.54 acre-feet/square mile/year, with a median value of 0.25, with a 10 to 90% data range of 0.04 to 1.38.
- The adjusted TWDB hydrosurvey overall rates average 0.99 acre-feet/square mile/year, with a median value of 0.43, with a 10 to 90% data range of 0.00 to 2.66.
- Evaluation of the data indicated that negative and extreme high values could be reasonably substituted with replacement rates.
- No significant relationship appears to exist between the WAM rates and the hydrosurvey sedimentation rates; however, as a dataset, the hydrosurvey sedimentation rates are significantly higher than the WAM rates.
- Currently, the majority of the major reservoirs lacking sedimentation rate data fall into the no water supply, off-channel, and no significant drainage area categories. Some of these are cooling water reservoirs.
- Even considering the variability of the data, there appears to be enough data to begin assessing and ranking at-risk reservoirs.
- The available data can be used as an input for the DSS tool and for comparative purposes.
- Limitations in the sedimentation rate data suggest that current evaluations of risk should not rely solely on sedimentation rate data.
- Further development of consistent and verifiable sedimentation rates is desirable for long-term water supply purposes.

Although there is significant variability in the data, data review and evaluation provides the most complete compilation of sedimentation rates for Texas reservoirs. This information may be used for reservoir risk evaluations, updating reservoir volumes and yields, long-range water supply planning, guiding further hydrographic surveys and sedimentation studies, and watershed Best Management Practices (BMP) planning.

6.0 RISK-RELATED CRITERIA DATA

This chapter builds upon Chapter 4 and provides a detailed discussion of the methods for deriving and calculating the measures for quantifying risk-related criteria for sedimentation.

6.1 SOURCES OF DATA

Measures for risk-related criteria are quantified from four main sources of data: TWDB, TCEQ, USGS and NHDPlus. Detailed descriptions are provided as follows:

6.1.1 TWDB

The TWDB maintains a GIS shapefile of the major reservoirs in Texas at http://www.twdb.state.tx.us/mapping/gisdata.asp. Within the attribute table of the shapefile are information such as conservation storage information, impoundment year, etc. which provide information for computing criteria related to reservoir capacity and state. In addition, the TWDB's State Water Plan (TWDB, 2007) contains information on reservoir yield, planning region and basin.

6.1.2 TCEQ

The project team acquired a draft list of median TSS values prepared in 2009 for 93 Texas reservoirs around the state. The list was prepared as information for stakeholders during the development of nutrient criteria for reservoirs which lead to proposed water quality standards as part of the TCEQ Triennial Revision process (TCEQ , 2010). These values were used to quantify the water quality criteria under the "Culture and Economics" subcategory.

6.1.3 USGS

The USGS maintains a database of soil erodibility (K-factor) for the conterminous United States at a 1 km x 1 km resolution. It is available at http://water.usgs.gov/GIS/dsdl/muid.e00.gz. (The metadata for the database can be found at: http://water.usgs.gov/GIS/metadata/usgswrd/XML/muid.xml). In order to use it to calculate the average soil erodibility for each reservoir watershed, the watershed area needs to be delineated first from NHDPlus (see below).

6.1.4 NHDPlus

NHDPlus is the most important data set for quantifying the risk-related criteria. NHDPlus is created by the US Environmental Protection Agency with assistance from the US Geological Survey to enhance the EPA WATERS application. It contains an integrated suite of application-ready geospatial data sets that incorporate many of the best features of the National Hydrography Dataset (NHD), the National Elevation Dataset (NED), the National Land Cover Dataset (NLCD), and the Watershed Boundary Dataset (WBD). First released in 2006, the NHDPlus consists of nine components:

1. 1:100K National Hydrography Dataset (NHD) – which provides information on stream lengths;
2. A set of value added attributes to enhance stream network navigation, analysis and display – which provides information on stream connectivity and Strahler stream order;
3. An elevation-based catchment for each flowline in the stream network – which provides information on watershed area;
4. Catchment characteristics – which provides information such as land use and land cover;
5. Headwater node areas;
6. Cumulative drainage area characteristics;

7. Flow direction, flow accumulation and elevation grids;
8. Flowline min/max elevations and slopes – which provide information on watershed slope; and,
9. Flow volume & velocity estimates for each flowline in the stream network – which provides information on average flow rates into reservoirs.

6.2 DELINEATION OF RESERVOIR WATERSHEDS

Gathering data from the TWDB, TCEQ and USGS data sets was relatively straightforward because most of the data were already in the form needed (e.g. reservoir storage volume, TSS values, etc were already calculated in the TWDB and TCEQ data sets). On the other hand, obtaining data from NHDPlus was more involved because it required the delineation of watersheds for the major TX reservoirs. Only after delineation could properties such as watershed area, land use/land cover types, watershed slopes, average flow rate, stream order and stream lengths be extracted from the value-added attribute (VAA) tables of NHDPlus. Additional computation was needed to obtain aggregate statistics for the reservoir watersheds and to calculate measures for the risk-related criteria.

6.2.1 About NHDPlus data

The NHDPlus dataset is available at Horizon Systems website (Horizon Systems Corporation, 2011). The dataset is divided into twenty regions for the conterminous United States. Data for the state of Texas are included in three of the regions: Texas Gulf Basin (12), Rio Grande Basin (13), and the Mississippi Basin (11) (see Figure 6.1). The data for the three regions were downloaded for processing.

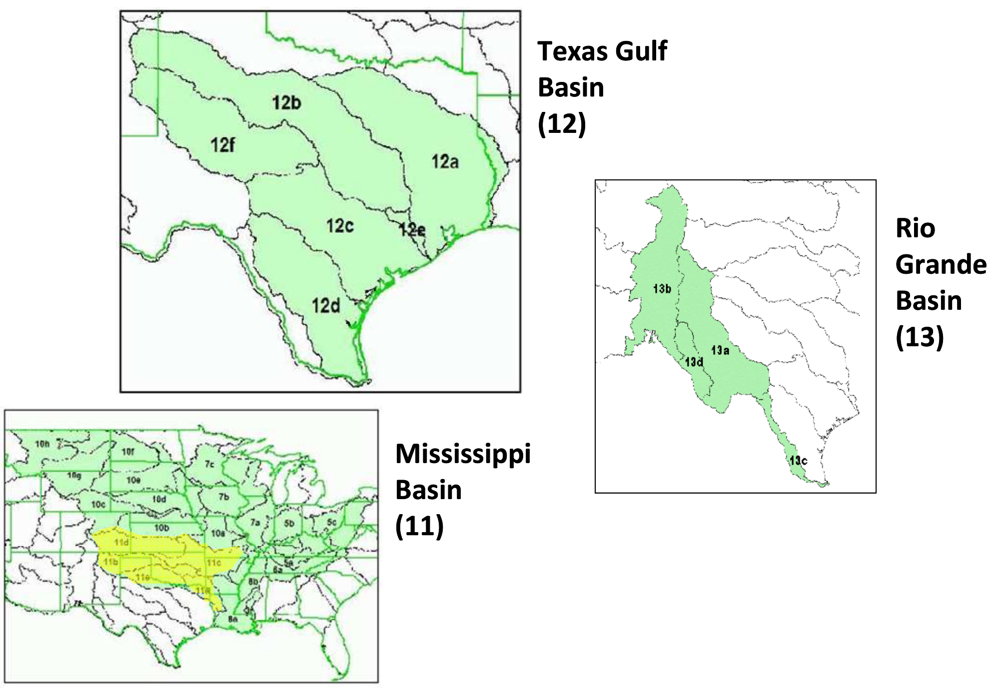


Figure 6.1 NHDPlus data regions that contain data for the state of Texas.

The basic element of NHDPlus is the NHDFlowline reach which is created by breaking down 100K scale NHD flowlines into small reaches that are on average 2-miles in length in Texas. NHDPlus also provides catchment areas for each reach. Thus the dataset comprises of a dense patchwork of flowlines and reaches which the user can filter and select to define the watershed for any given waterbody of interest (see Figure 6.2).

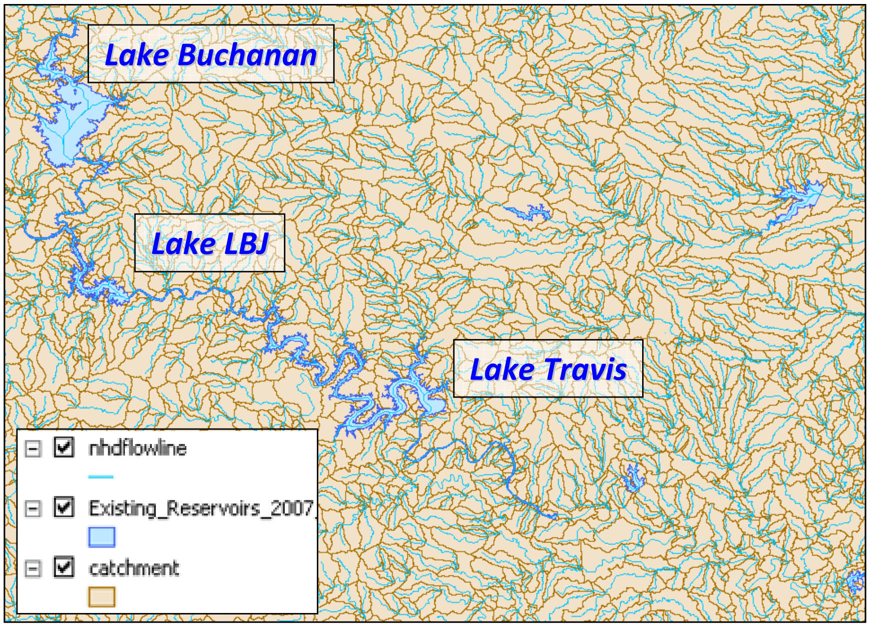


Figure 6.2 NHDFlowline reaches and catchments for a portion of the Lower Colorado River (Region 12).

Key properties of flowlines and catchments, such as hydraulics, landuse, climatology and connectivity are stored in an extra set of tables called Value Added Attribute (VAA) tables. These properties can be linked to each flowline and catchment feature via a common identification field named "COMID" (see Figure 6.3).

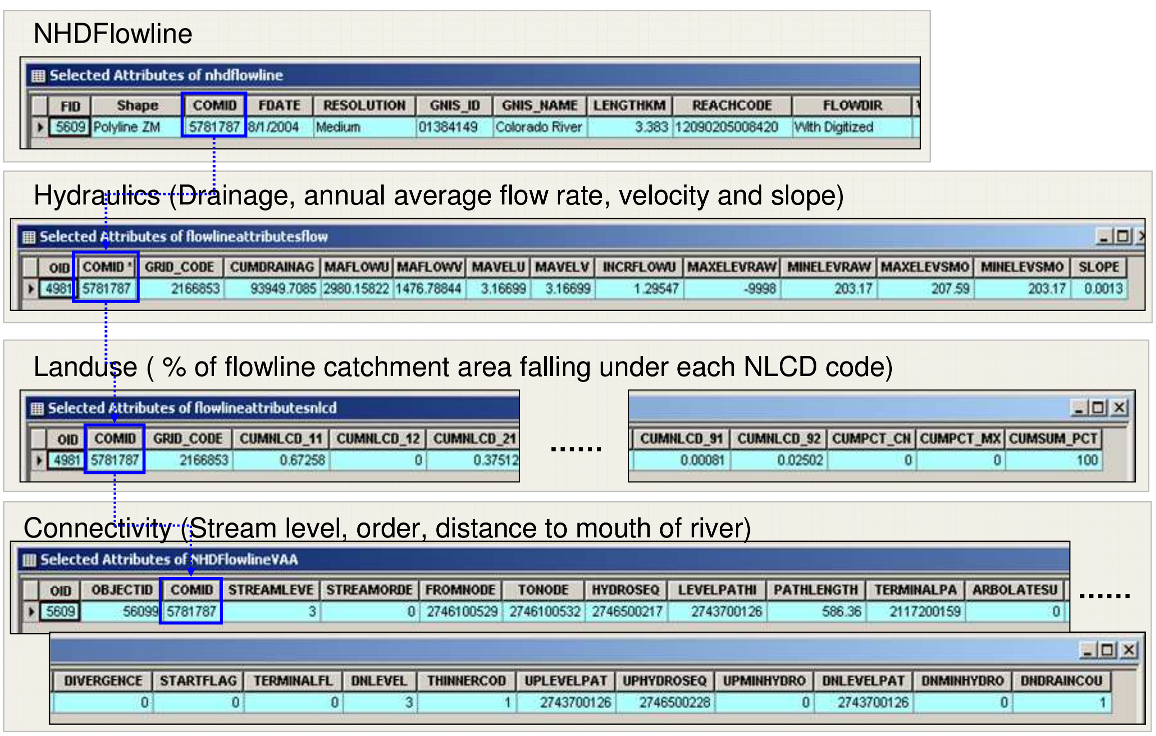


Figure 6.3 Examples of value-added attribute tables in NHDPlus.

6.2.2 Watershed delineation with NHDPlus

Watershed delineation in NHDPlus was achieved by using the connectivity information from the value-added attribute tables. First, the most downstream reach for each of the major TX reservoirs was obtained through a spatial join between the NHDFlowline shapefile and the reservoir shapefile. Next a computer program was created to loop through and process each major TX reservoir in the following manner:

1. Using connectivity information, the program performed upstream tracing of flowlines from the most downstream reach of each reservoir to either 1) the next upstream reservoir or 2) the edge of the basin (if no upstream reservoirs were present). An illustration is provided in Figure 6.4.
2. This tracing produced incremental watersheds for each reservoir where surface runoff travelled directly to the reservoir and without being subjected to influences by any other reservoirs (see Figure 6.5).
3. The COMIDs of flowlines and associate catchments captured via tracing were then tagged with the ID of the reservoir.
4. The COMIDs and their associated reservoirs were compiled into a database. These COMIDs provide linkage to the NHDPlus VAA tables to compute risk-related criteria measures for each reservoir watershed.

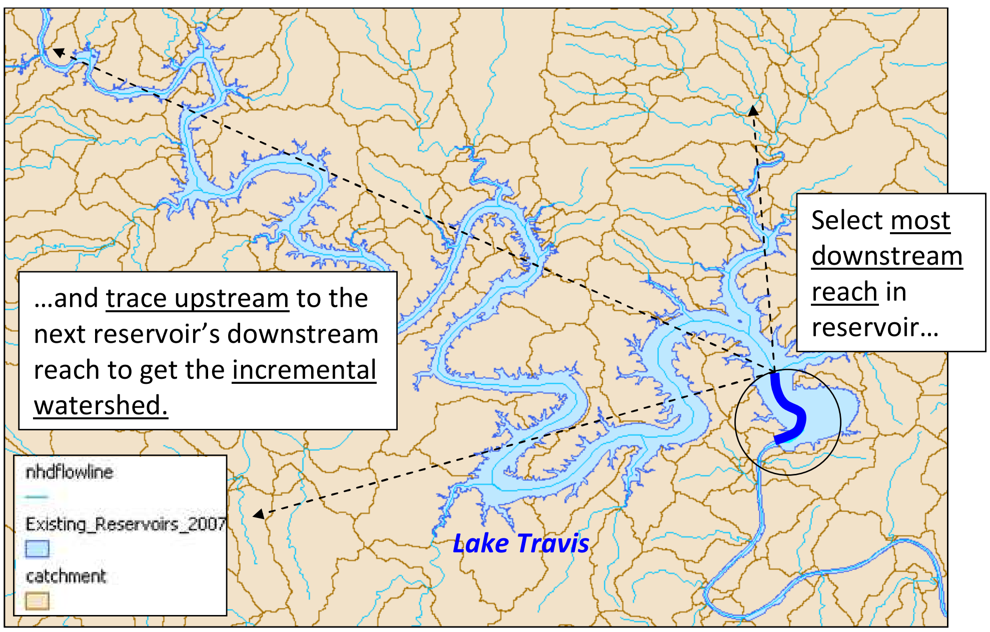


Figure 6.4 Upstream tracing to delineate incremental watershed of a given reservoir (Lake Travis).

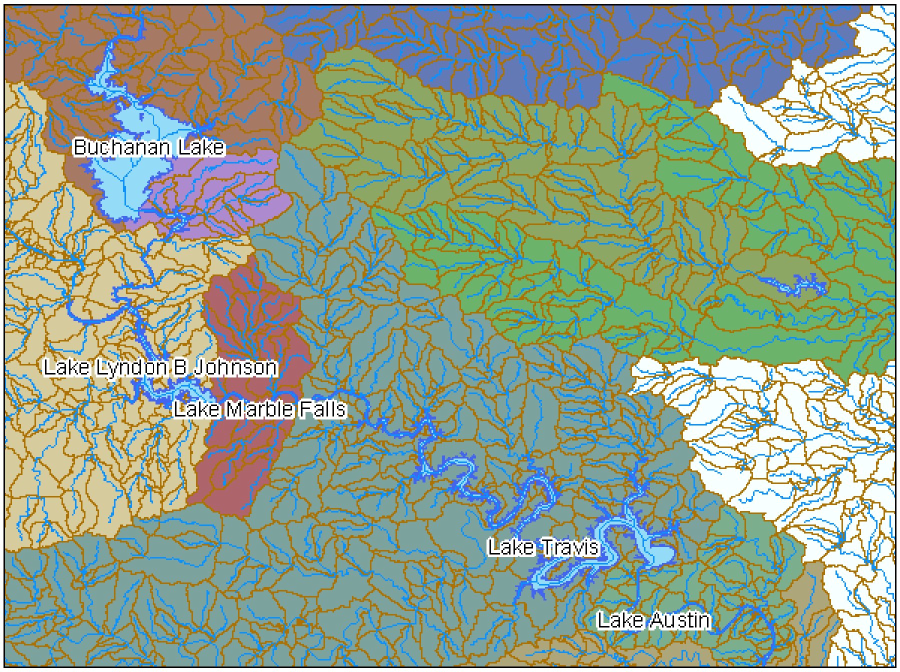


Figure 6.5 Incremental watersheds for a chain of reservoirs in the Lower Colorado River.

By applying the methodology to all the major TX reservoirs, the reservoir watershed map in Figure 6.6 was produced.

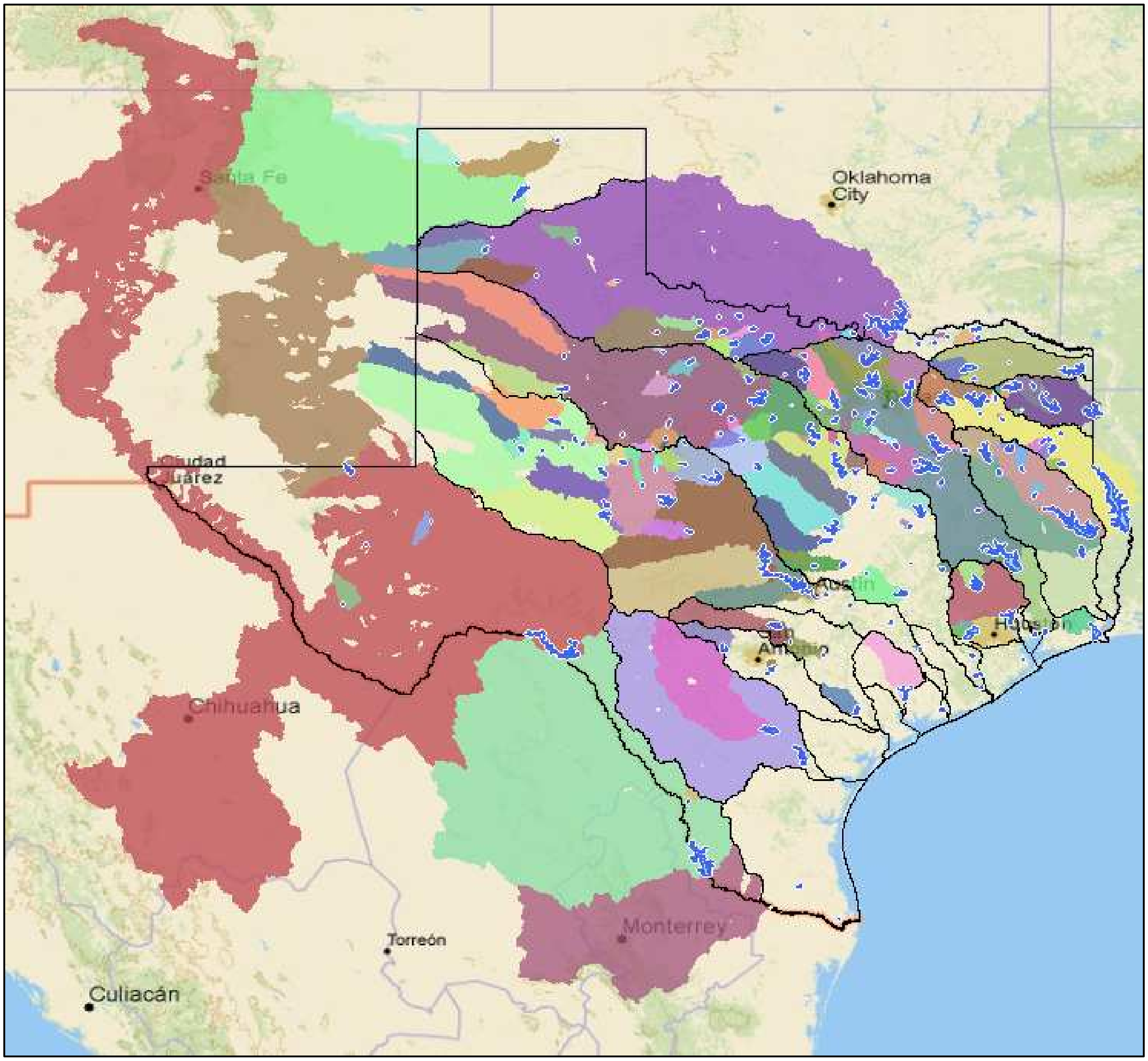


Figure 6.6. Watersheds of 194 major TX reservoirs.

6.2.3 Calculation of reservoir watershed properties

Data in NHDPlus VAAs are provided at the flowline reach/catchment level. Therefore they need to be aggregated to produce representative statistics for each reservoir watershed. In the process of delineating the watershed, the linkages among reservoir watersheds, associated NHDPlus flowlines and catchments, and the NHDPlus VAA tables were defined. Table 6.1 summarizes how this information was used to calculate the associated risk-related criteria measure.

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Table 6.1 Summary of methods for calculating reservoir watershed properties

Property	Units	Method/Formula
Watershed Area	acres	Sum the area of all catchments falling within a reservoir watershed.
Developed Area	%	Calculate area-weighted averages of the following NLCD codes in the catchments. Then sum them up. NLCD_21 +NLCD_22 +NLCD_23+NLCD_85
Barren Area	%	Calculate area-weighted averages of the following NLCD codes in the catchments. Then sum them up. NLCD_31 +NLCD_32 +NLCD_33
Forested Area	%	Calculate area-weighted averages of the following NLCD codes. Then sum them up. NLCD_41 +NLCD_42 +NLCD_43
Grassland & Pasture Area	%	Calculate area-weighted averages of the following NLCD codes in the catchments. Then sum them up. NLCD_51 + NLCD_71 +NLCD_81
Agricultural Area	%	Calculate area-weighted averages of the following NLCD codes in the catchments. Then sum them up. NLCD_61+NLCD_82 +NLCD_83+NLCD_84
Woody Wetlands, Emergent Herbaceous Wetlands	%	Calculate area-weighted averages of the following NLCD codes in the catchments. Then sum them up. NLCD_91 +NLCD_92
% of total watershed area in Mexico	%	Calculate the area-weighted average of % of catchments falling within Mexico. (This property is for QAQC purposes only. NHDPlus does not have any data apart from catchment extents in Mexico. Therefore the higher the %area in Mexico, the less accurate the risk-related criteria measures that were computed for the reservoir)
>3rd Order Stream Length	mi	Sum the lengths of NHDFlowlines that are greater than 3rd order within a given reservoir watershed.
Total Stream Length	mi	Sum the lengths of all NHDFlowlines for a given reservoir watershed.
Stream Density	mi/mi^2	Divide >3rd Order Stream Length by watershed area.
Mean Precipitation	in	Calculate area-weighted annual precipitation in watershed.
Watershed Slope	%	Calculate area-weighted stream slope in watershed.
Mean Temperature	deg C	Calculate area-weighted annual mean temperature in watershed.
Average Flow Rate	cfs	Obtain the average flow of most downstream NHDFlowline reach in the watershed.

6.3 RESERVOIR WATERSHED MAPS

Risk-related measures calculated from TWDB, USGS, TCEQ and NHDPlus were summarized and presented in maps for each reservoir. They are included in Appendix C. Figure 6.7 shows an example (Lake Travis). There are three map panels within this map. The main panel on the left shows the land use and streams of the reservoir watershed. Associated watershed statistics such as watershed area, precipitation, landuse percentages etc. are posted below the map. The top right panel shows the location of the watershed within the river basin (which is the Colorado in this case). Information on impoundment date and the reservoir dam location are posted below this panel. Finally, the bottom right panel shows an aerial photo of the reservoir and its immediate vicinity. Statistics associated with the reservoir, such as yield, conservation capacity and residence time, are posted below the map.

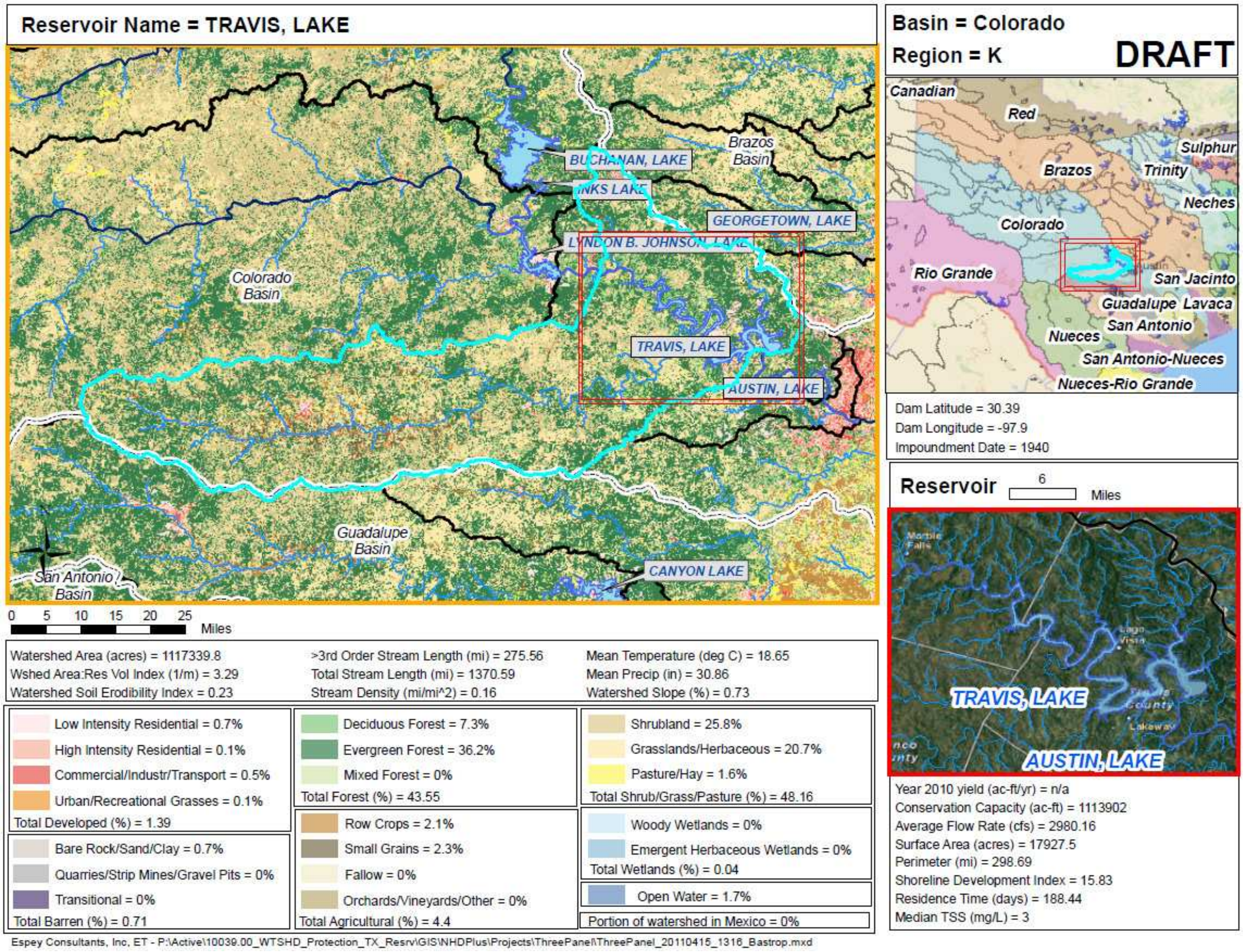


Figure 6.7 Reservoir Watershed Map for Lake Travis, Colorado Basin.

6.4 DATA LIMITATIONS

Several limitations in the available data were encountered when acquiring risk-related criteria data. They are described in the following:

6.4.1 Limitations on GIS information

Two out of the 196 major TX reservoirs did not have any GIS information, making it impossible to delineate their watersheds and to acquire reservoir characteristics like shoreline development index. These two reservoirs are Lower Running Water Draw WS SCS Site 2 dam and Lower Running Water Draw WS SCS Site 3 Dam. Fortunately, these two reservoirs are small (5,429 and 8213 ac-ft respectively) and have no water supply function. Therefore it is highly unlikely they will be ranked high for sedimentation risk and significantly impact on the study results. These two reservoirs have been omitted in the analysis in this report.

6.4.2 Lack of data in Mexico

Three reservoirs in the Rio Grande Basin straddle the US-Mexico international borders. These are International Amistad Reservoir (38% of watershed area in Mexico), International Falcon Reservoir (87% of watershed area in Mexico), and Anzalduas Channel Dam (93% of area in Mexico). Because NHDPlus does not have data in Mexico, computing accurate watershed characteristics for these reservoirs is difficult. The watershed data (e.g. landuse, soil erodibility) compiled for these reservoirs are based solely on information available on the US side.

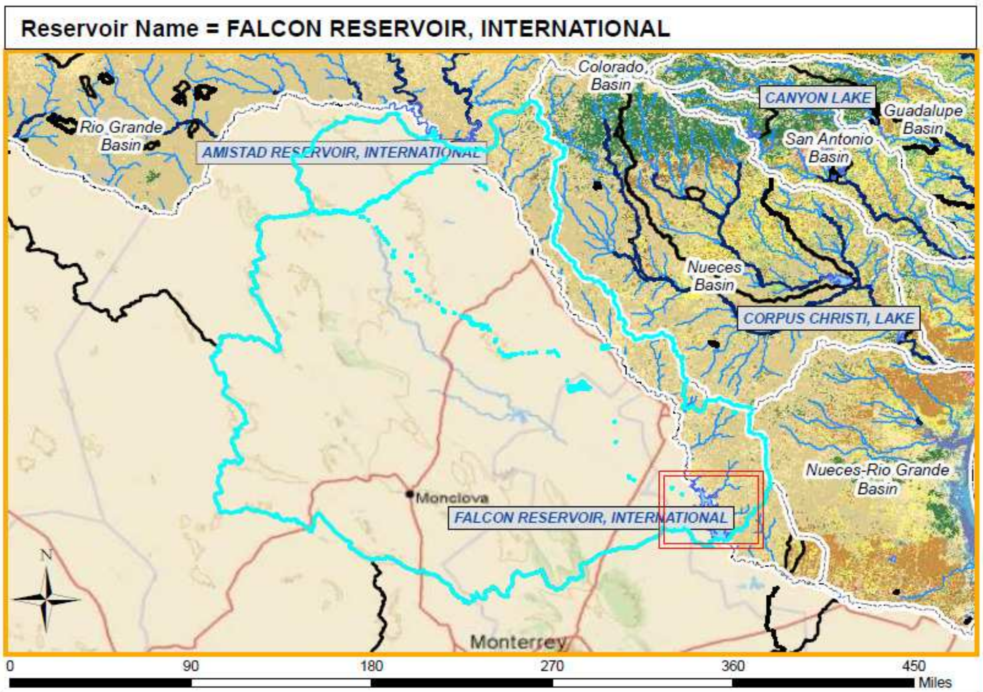


Figure 6.8 An example of a reservoir watershed that straddles the US-Mexican border (Falcon Reservoir, Rio Grande Basin).

6.4.3 Spatial resolution issues in NHDPlus

The average NHDflowline reach in Texas is about 2 miles long. Most reservoir watersheds span at least two or more of such reaches. However, several small off-channel reservoirs comprise of only one reach and their reservoir areas are smaller than their immediate catchment of the reach (see Figure 6.9). Since the delineation procedure does not subdivide catchments, the entire catchment is used to compute watershed characteristics. This can lead to overestimation of watershed area. The list of these reservoirs is provided below:

- Brazoria Reservoir (Brazos Basin)
- Cedar Creek Reservoir (Colorado)
- Gulf Coast Water Authority Reservoir (San Jacinto-Brazos)
- New Terrell City Lake (Trinity)
- North Lake (Trinity)
- Olney/Lake Cooper Lake (Red)

- River Crest Lake (Sulphur)
- Trinidad Lake (Trinity)
- Upper Nueces Lake (Nueces)
- Camp Creek Lake (Brazos)
- William Harris Reservoir (Brazos)

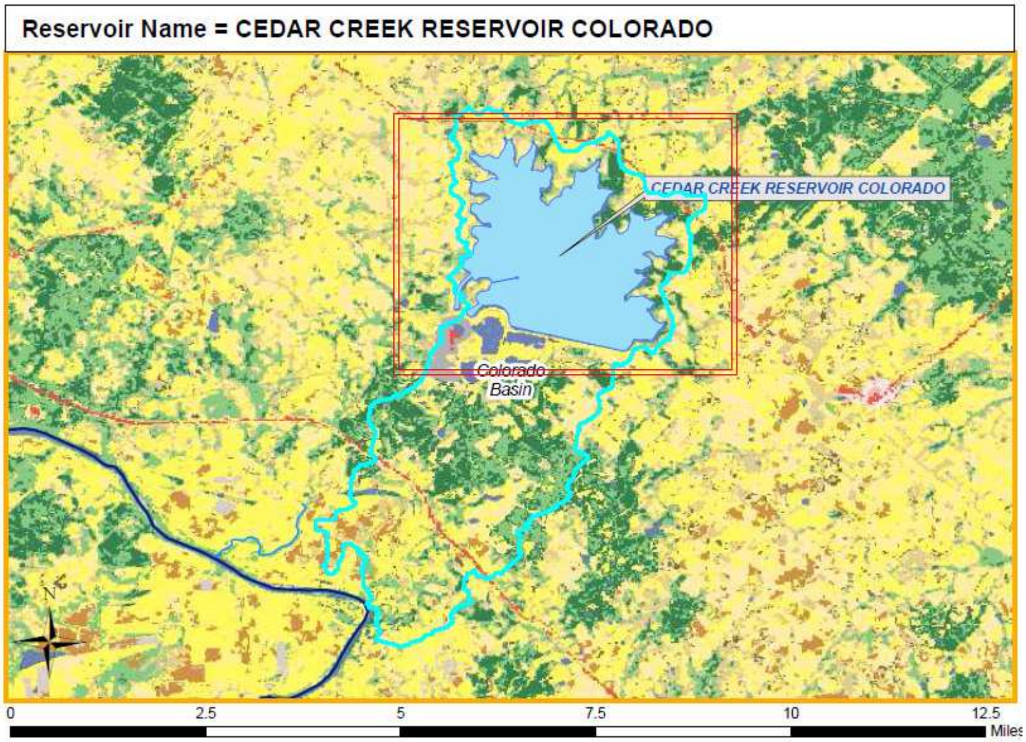


Figure 6.9 An example of a small off-channel reservoir watershed that is smaller than its immediate NHD catchment (Cedar Creek Reservoir, Colorado Basin).

Fortunately, because of the small watershed areas, the sediment contribution from the surrounding surface of these reservoirs are most likely to be small. For this reason it is unlikely that these reservoirs would be rank high for sedimentation risk. The derived values for these reservoirs are still used in the analyses in this report. However a footnote is provided in the data table in Appendix A to indicate the presence of spatial resolution issues in those watersheds.

6.4.4 No flow direction in coastal/marsh areas

Delineation of the watershed for a given reservoir requires a defined flow direction in the NHD flowlines, otherwise it would not be possible to trace upstream from a given reservoir. In the Nueces-Rio Grande basin in South Texas, much of the land is either coastal flatlands or marshy areas. NHDflowlines in these areas are mostly ditches where flows are driven by pumps rather than by gravity which thus have no definite flow direction. Two reservoirs, Loma Alta and Delta Lake, are affected by this problem and the delineation program did not work properly for them. Figure 6.10 shows the program selecting the closest catchment that has flow direction as the watershed for Delta Lake. Unfortunately the catchment is located 20 miles away from the reservoir (see example Figure 6.10). Fortunately for this study, neither of these two reservoirs have any water supply function because they are used for storage of water that is diverted by pumps. As a result the risk posed by sedimentation in these reservoirs to water supply is likely insignificant. The derived values for these reservoirs are still used in the analyses in this report. However a footnote is provided to indicate flow direction issues in the data table.

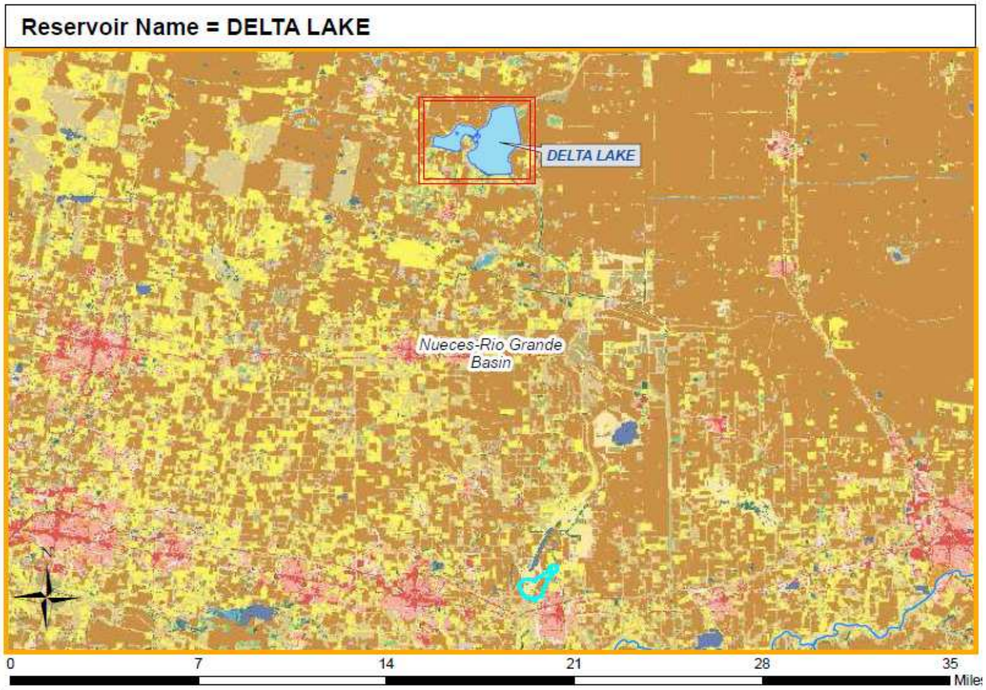


Figure 6.10 An example of a lake in a coastal flatland with no well-defined watershed (Delta Lake, Nueces-Rio Grande Basin).

7.0 SUMMARY OF DATA COLLECTED

Results from the compilation of sedimentation data and risk-related criteria data were consolidated into a single database (DSS input table) to support the ranking of reservoirs for sedimentation risk. This database is available in Appendix A. A summary of the fields in the database is provided in Table 7.1.

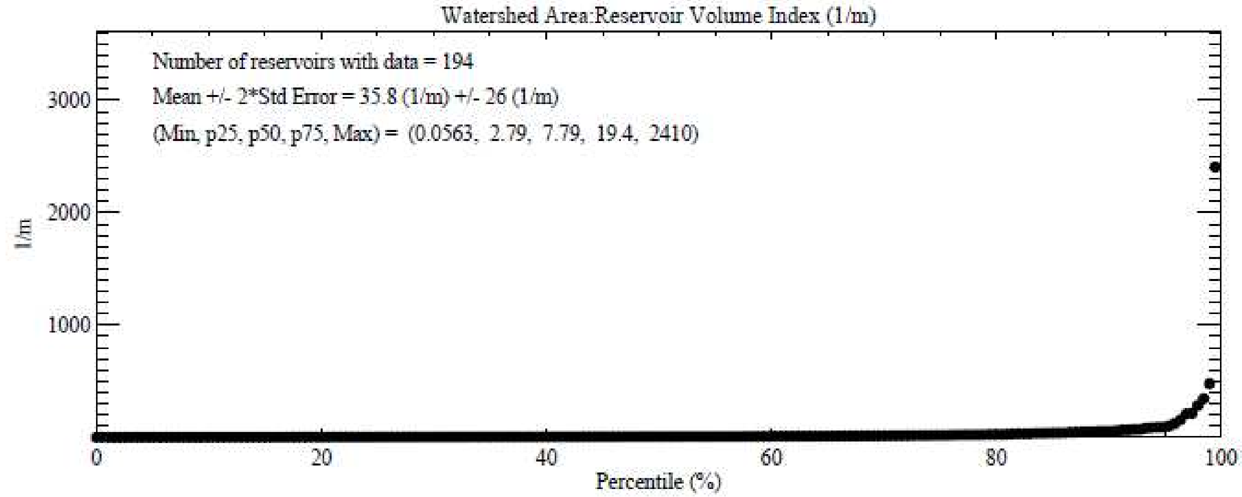
Additional fields are included to provide better description of the reservoirs (e.g. Basin_Name, Region Name). For sedimentation data, only the effective erosion rates (ac-ft/sq-mi/yr) are included in the database as these are how sedimentation rates are presented in the TCEQ WAMs. The bulk sedimentation rate (ac-ft/yr) can be calculated by multiplying the effective erosion rates by the watershed areas present in the database. The percent loss in volume/year can be computed by dividing the bulk sedimentation rate by the reservoir conservation capacity.

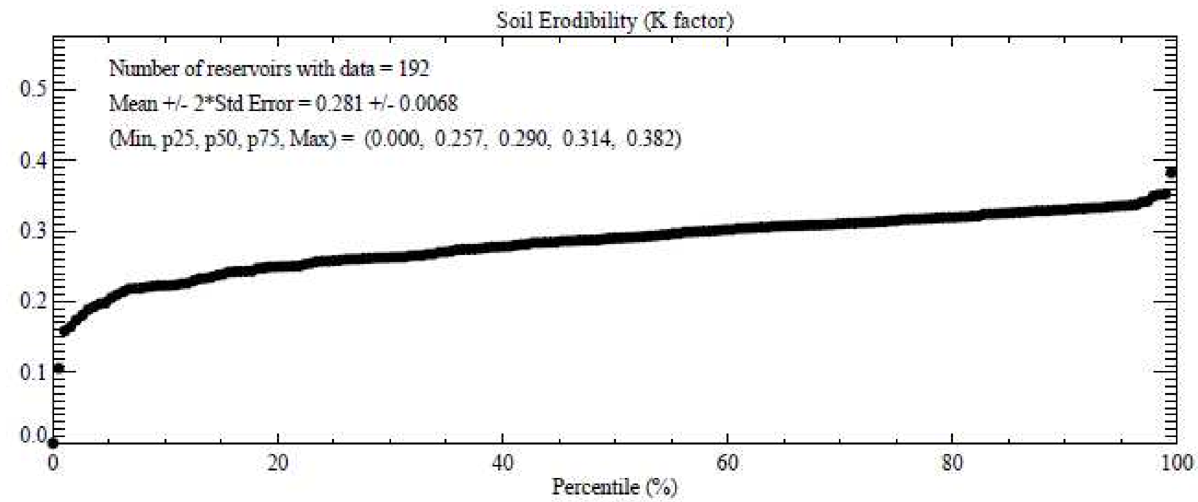
Table 7.1 Summary of fields in DSS input database.

Fieldname	Explanation	Associated criteria subcategory	Units	Source
RES_NAME	Reservoir Name			TWDB
BASIN_NAME	Basin			TWDB
REGION_NAME	Planning Region			TWDB
DAM_IMPOUND_DATE	Impoundment Date			TWDB
DAM_IMPOUND_YEAR	Impoundment Year	Reservoir Capacity/State		TWDB
DAM_LAT	Dam Latitude		dec. deg	TWDB
DAM_LONG	Dam Longitude		dec. deg	TWDB
WSHD_KFACT	Soil Erodibility	Watershed Erosion Characteristics		USGS
WSHD_DEVELOPED_PCT	Developed Area	Land Use/Land Cover	%	NHDPlus
WSHD_BARREN_PCT	Barren Area	Land Use/Land Cover	%	NHDPlus
WSHD_FOREST_PCT	Forested Area	Land Use/Land Cover	%	NHDPlus
WSHD_SHRUBGRASSPASTURE_PCT	Grassland & Pasture Area	Land Use/Land Cover	%	NHDPlus
WSHD_AGRI_PCT	Agricultural Area	Land Use/Land Cover	%	NHDPlus
WSHD_WETLANDS_PCT	Wetland Area	Land Use/Land Cover	%	NHDPlus
PCT_MX	% of watershed area in Mexico		%	NHDPlus
WSHD_3RDSTREAM_MILES	>3rd Order Stream Length		mi	NHDPlus
WSHD_ALLSTREAM_MILES	Total Stream Length		mi	NHDPlus
WSHD_AREA_ACRES	Watershed Area		acres	NHDPlus
WSHD_MSI_INV_MILE	Stream Density	Stream Density	mi/mi^2	NHDPlus
WSHD_PCP_IN	Mean Precip		in	NHDPlus
WSHD_AREA_RES_VOLUME_INDEX	Wshed Area:Res Vol Index	Watershed Erosion Characteristics	1/m	NHDPlus,TWDB
WSHD_SLOPE_PCT	Watershed Slope	Watershed Erosion Characteristics	%	NHDPlus
WSHD_TMP_C	Mean Temperature		deg C	NHDPlus
RES_AREA_ACRES	Surface Area		acres	TWDB
RES_FLOW_CFS	Average Flow Rate		cfs	NHDPlus
RES_PERIM_MILES	Perimeter		mi	TWDB
RES_SLD	Shoreline Development Index	Reservoir Capacity/State		TWDB
RES_YIELD_ACFT_PER_YR	Reservoir Yield in 2010 (Firm yield or safe yield)	Cultural & Economics	ac-ft/yr	TWDB (Appendix 6.1 of Statewater Plan)
RES_STORAGE_ACFT	Conservation Capacity		ac-ft	TWDB
RES_TIME_DAYS	Residence Time	Reservoir Capacity/State	days	TWDB, NHDPlus
RES_TSS_MEDIAN_MGL	Median TSS	Cultural & Economics	mg/L	TCEQ
NHDPLUS_NOTES	Notes in calculating risk-related measures from NHDPlus			
SEDRATE_WAM	Sedimentation rate derived from TCEQ WAM		ac-ft/sq-mi/yr	TCEQ WAMS
WAM_NOTES	WAM compilation notes			

SEDRATE_HYDRO_MAX	Max sed. rate from any two consecutive TWDB hydrographic surveys		ac-ft/sq-mi/yr	TWDB
SEDRATE_HYDRO_OVERALL	Sedimentation rate based on first to last TWDB hydrographic survey		ac-ft/sq-mi/yr	TWDB
NUM_HYDROSURVEYS	Number of hydrographic surveys conducted in reservoir			TWDB

Figures 7.1 to 7.5 contain cumulative frequency plots of criteria measures associated with the four categories mentioned in Chapter 4, i.e. 1) Watershed Erosion Characteristics, 2) Landuse, 3) Channel Erosion and 4) Cultural and Economics. Representative statistics such a number of reservoirs with data, mean, standard error, minimum, maximum, 25th, 50th and 75th percentiles are also presented for each criteria measure.





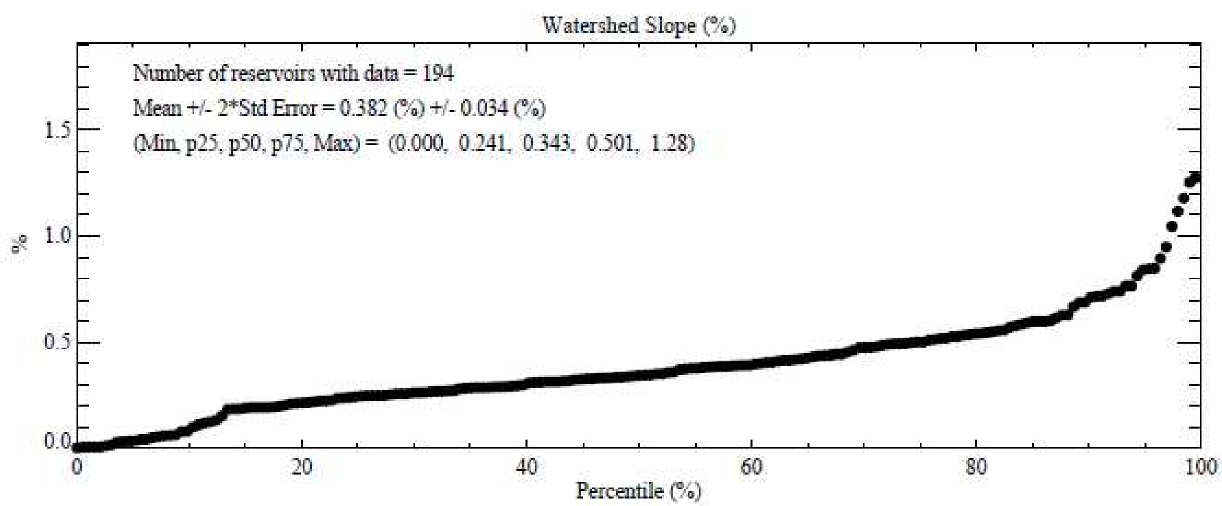


Figure 7.1 Cumulative frequency plots of criteria measures associated with <u>watershed erosion characteristics</u>

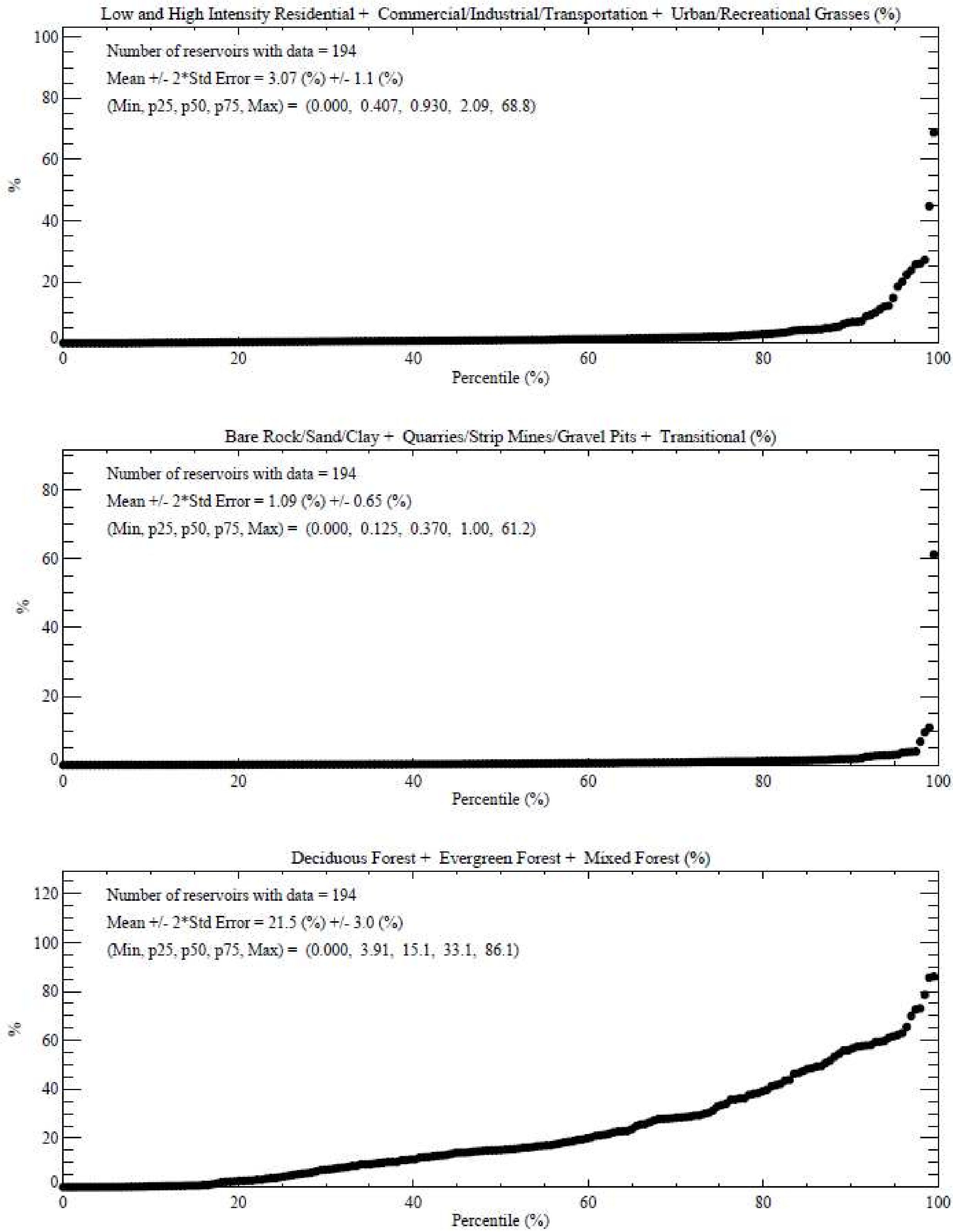


Figure 7.2 Cumulative frequency plots of criteria measures associated with landuse (Developed, Bare, Forest)

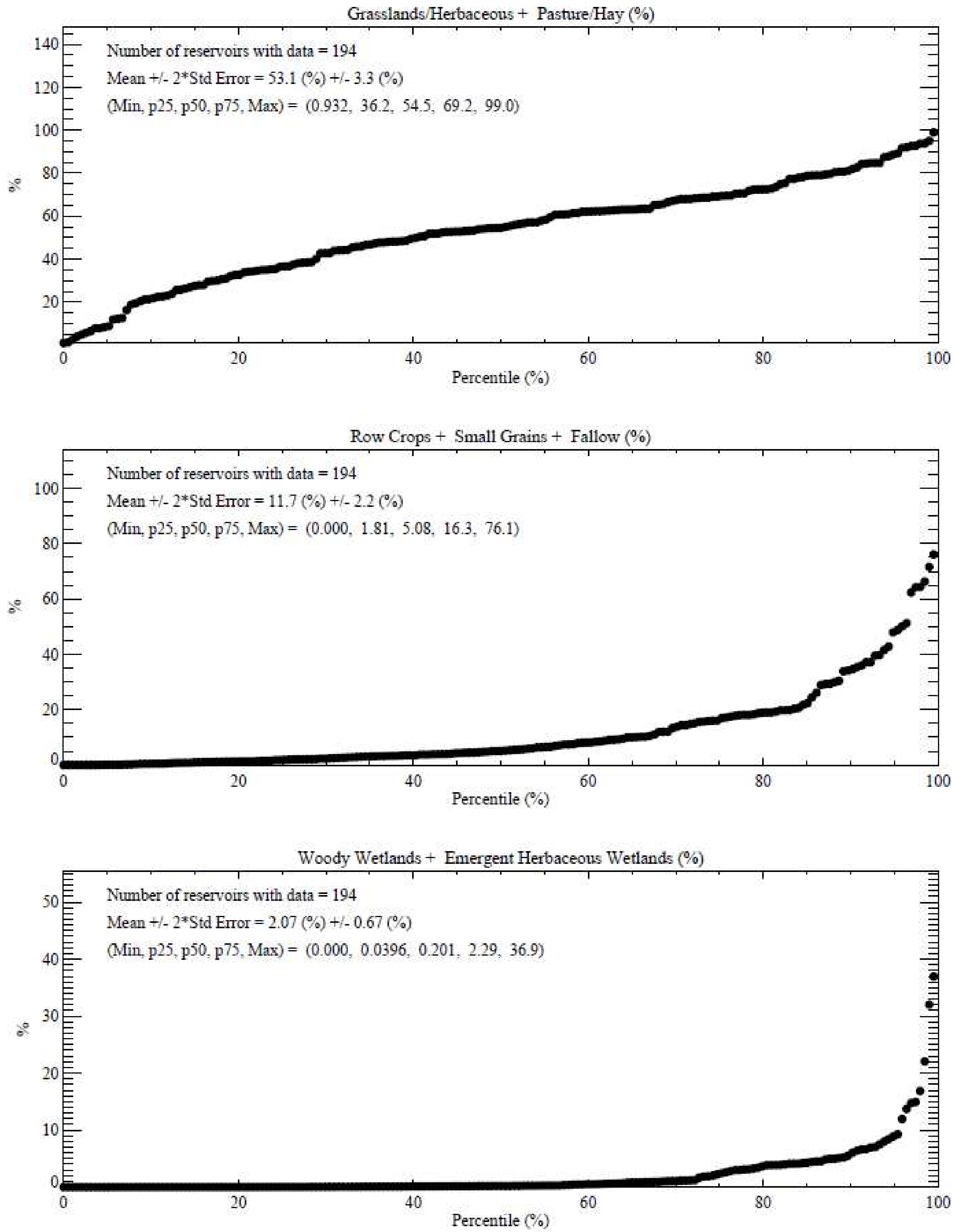
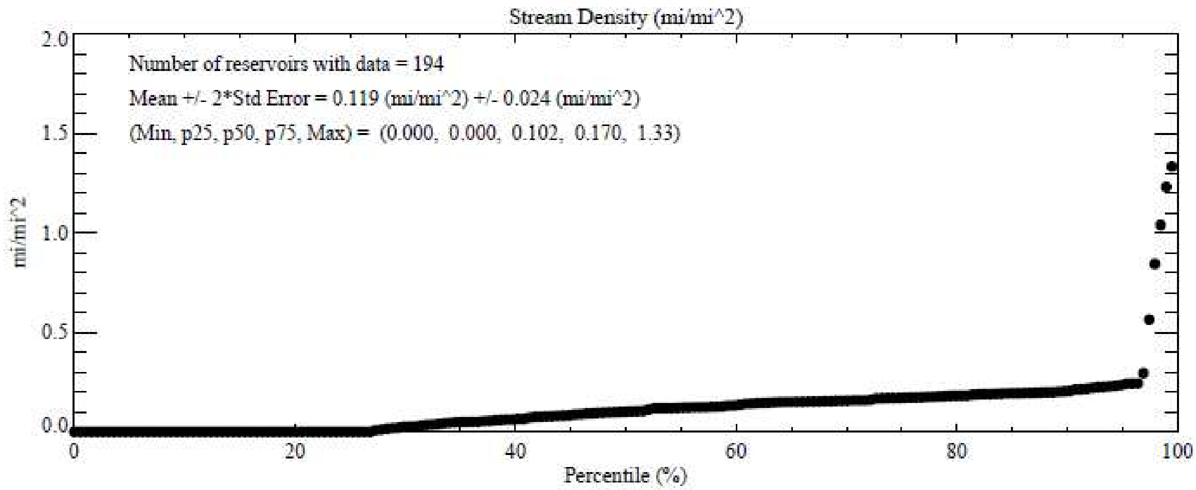


Figure 7.3 Cumulative frequency plots of criteria measures associated with <u>landuse (Grassland, Agricultural and Wetlands).</u>



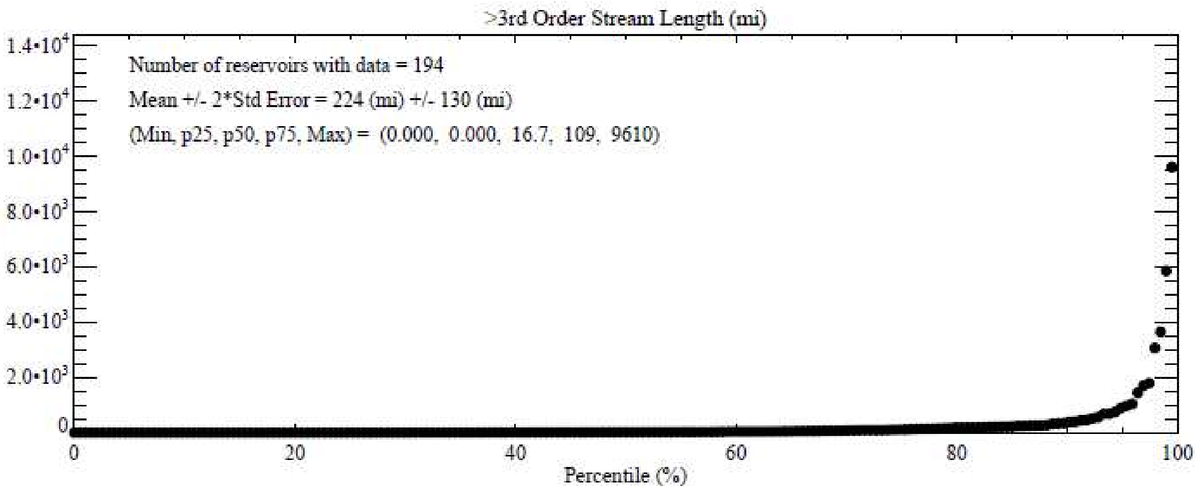
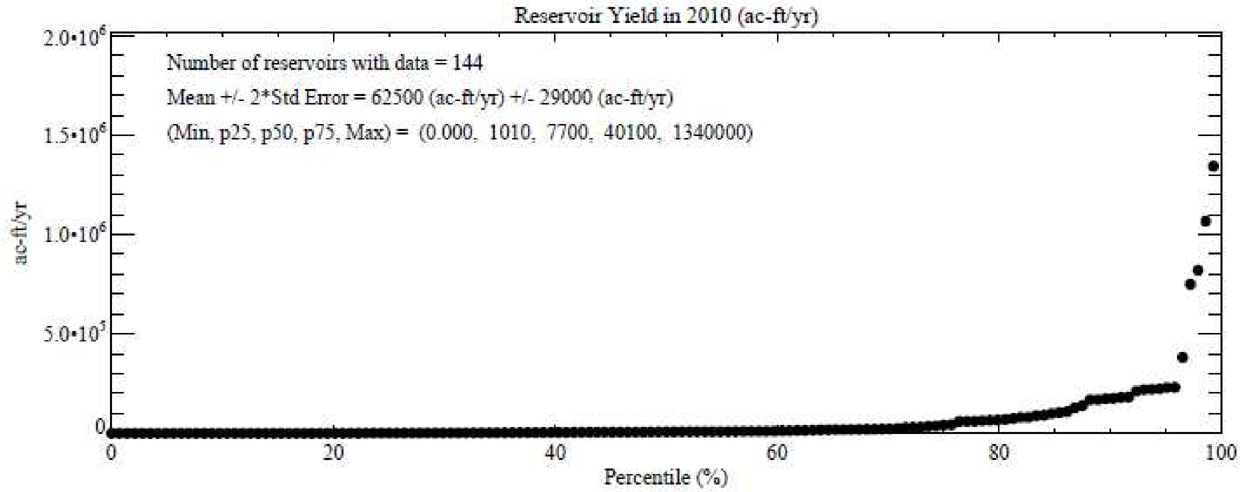


Figure 7.4 Cumulative frequency plots of criteria measures associated with <u>channel erosion</u>



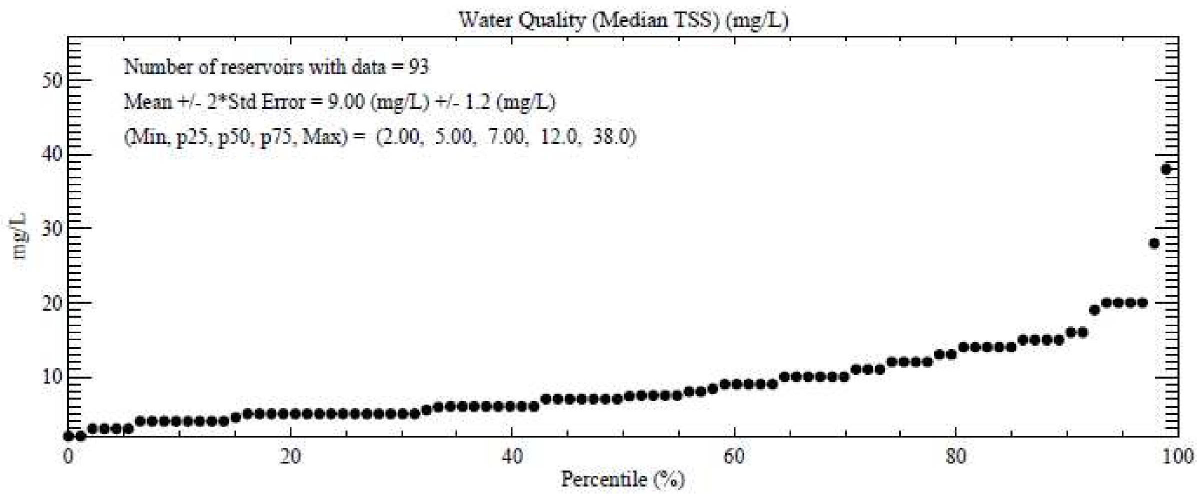


Figure 7.5 Cumulative frequency plots of criteria measures associated with <u>cultural and economics.</u>

(Reservoir yields are from Appendix 6.1 of TWDB State Water Plan and reflect either the firm yield or safe yield in 2010)

8.0 PROFESSIONAL JUDGMENT WITH DECISION SUPPORT SYSTEM TOOL

As illustrated in previous sections, the assessment and prioritization of the threat to Texas reservoirs from sedimentation involves the consideration of many variables and parameters. Additionally, prioritizing the risk requires assessment of the relative importance of these parameters. The field of multi-objective decision analysis (MODA) was developed to formally encompass and develop the theory and approach to evaluate difficult real-life decisions such as the sedimentation threat to Texas reservoirs. MODA was developed in the 1960s and 1970s at Stanford, MIT and other major universities and is generally considered a branch of the engineering discipline of Operations Research, but also has links to economics, mathematics and psychology.

The essence of MODA is to break complicated decisions down into small pieces that can be dealt with individually and subsequently recombined in a logical and consistent fashion. A key goal of decision analysis is to make a clear distinction between the choices that are available (referred to as alternatives), the characteristics of these alternatives (quantified by the measures) and the relative desirability of different sets of characteristics (preferences). These distinctions provide a clear separation between the objective and subjective parts of the decision making process.

To facilitate the communication of both the objective and subjective components of this study, a MODA based decision support (DSS) tool was tailored to the needs of this project. The DSS was originally a part of a larger modeling/decision facilitation/optimization suite developed by Parsons for use in environmental and engineering assessments. The decision support core of the original suite was extracted from the source code and adapted to become a monolithic or "stand-alone" application that could be freely redistributed to interested parties without the restrictions of commercial software licensing limitations. The design of the new DSS allows interested parties to inspect both the objective and subjective components of the analysis resulting from this project and provides the option for any interested party to investigate the effect of varying the subjective assessment components (preferences). The DSS tool is available in Appendix D.

8.1 DSS TOOL MANUAL

The DSS is arranged as a series of tabbed panels that appear in the program window. Figure 8.1 illustrates the default view that is visible after starting the program.

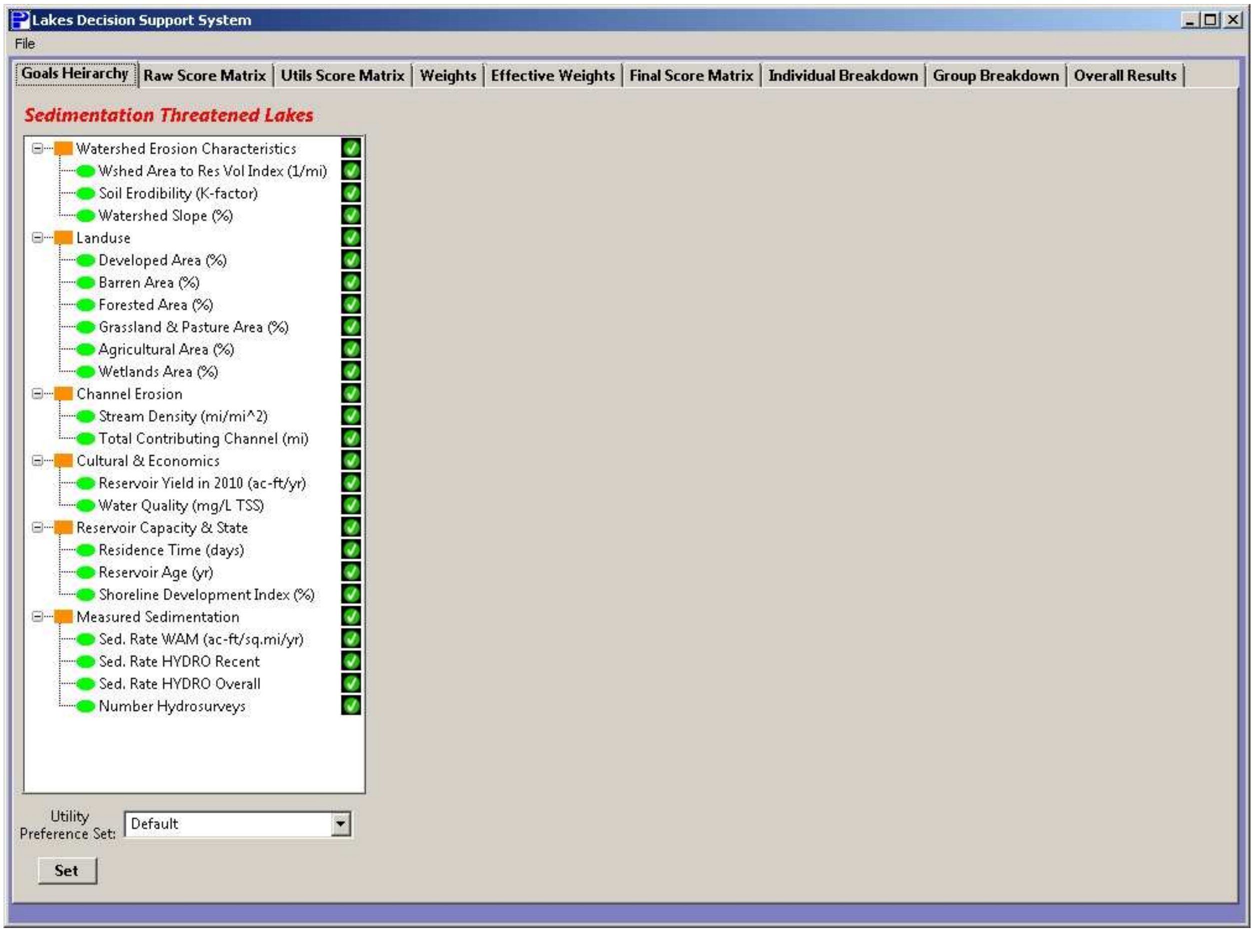


Figure 8.1 DSS Default View

The basic MODA process imbedded in the DSS tool consists of several steps:

- Structuring the problem
- Defining the alternatives
- Developing the Preference Sets that include:
  - Developing the Measures (green ovals in Figure 8.1) and Categories of Measures (orange boxes in Figure 8.1) that characterize the Alternatives
  - Developing Util conversion curves for each Measure
  - Developing Weightings for each Categories of Measures and Measures
- Analyzing the components of the decision
- Calculating the Rankings

This stepwise progression approach to the problem is reflected in the structure of the DSS. Each task is represented by a tab sequenced in order from left to right, where the far left tab is the default initial views and the far right tab contains the final ranking calculations.

For this particular analysis, most of the objective steps have been preloaded in the DSS tool. The DSS tool allows user input and intervention only for the subjective tasks of Util curve development and the determination of Measure and Measure Category Weight determination. For example, on the default or Goals Hierarchy tab both the Measure Categories and the Measures themselves have been predetermined, which sets the structure of the analysis. As previously described, a great deal of effort was invested in determining the appropriate Measures for the analysis. The Measures are arranged into Measure Categories partly to create an easily understandable structure, however research into the psychology of decision making indicates the humans can, on average, only simultaneously consider only about a half dozed or so items or Measures at once. The Measure Categories are then also arranged to contain no more that 6 Measures since these Measures must subsequently be ranked against one another.

After the problem structure is developed by selecting the salient Measures and arranging the Measure Categories, the next step is to determine the Util conversion curves for each Measure. In the DSS this is accomplished by clicking the green check marks adjacent to each Measure. Figure 8.2 shows the Util conversion dialog that is spawned by clicking the green check. In addition a floating window with a graphical representation of the Util conversion curve is also spawned by clicking the green check and is show in Figure 8.2.

The program starts with the Default preference set loaded, as shown in the lower left of the figure. The Default preference set is the one developed by the project team as our best estimate or best professional judgement of the most appropriate Util Conversion Curves. The Default preference set may not be altered, however if an interested party wished to examine the effect of varying the Util Conversion Curves, a new preference set may be created by Typing a news preference set in the drop-down field and clicking the Set button. A new editable preference set will be created from the Default set and the Util Conversion Dialog will contain a yellow "SAVE" button to instigate changes made to any Util Conversion Curve. The preference set with which the ranking calculations are performed may be changed between any stored preference sets (available on the drop-down list).

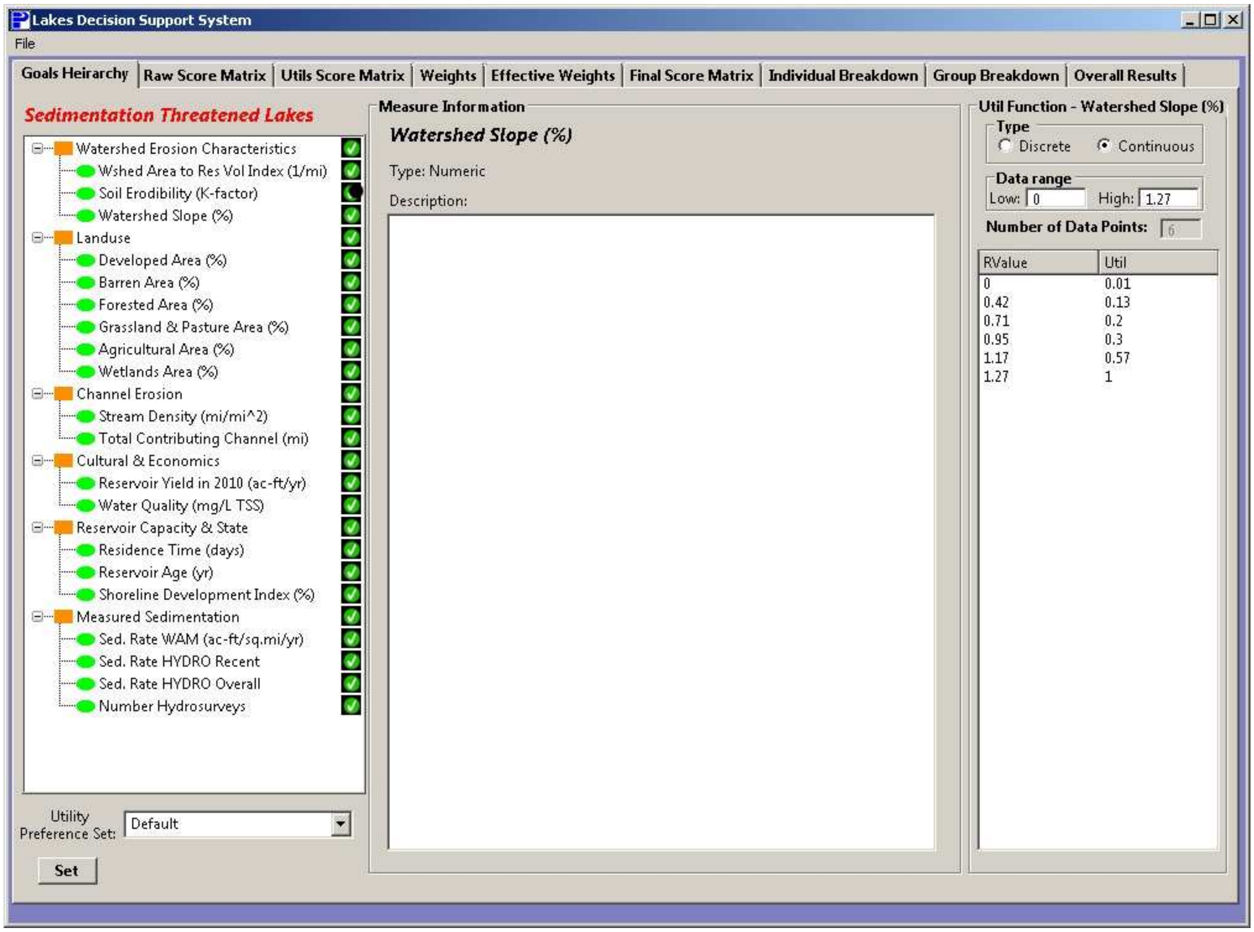
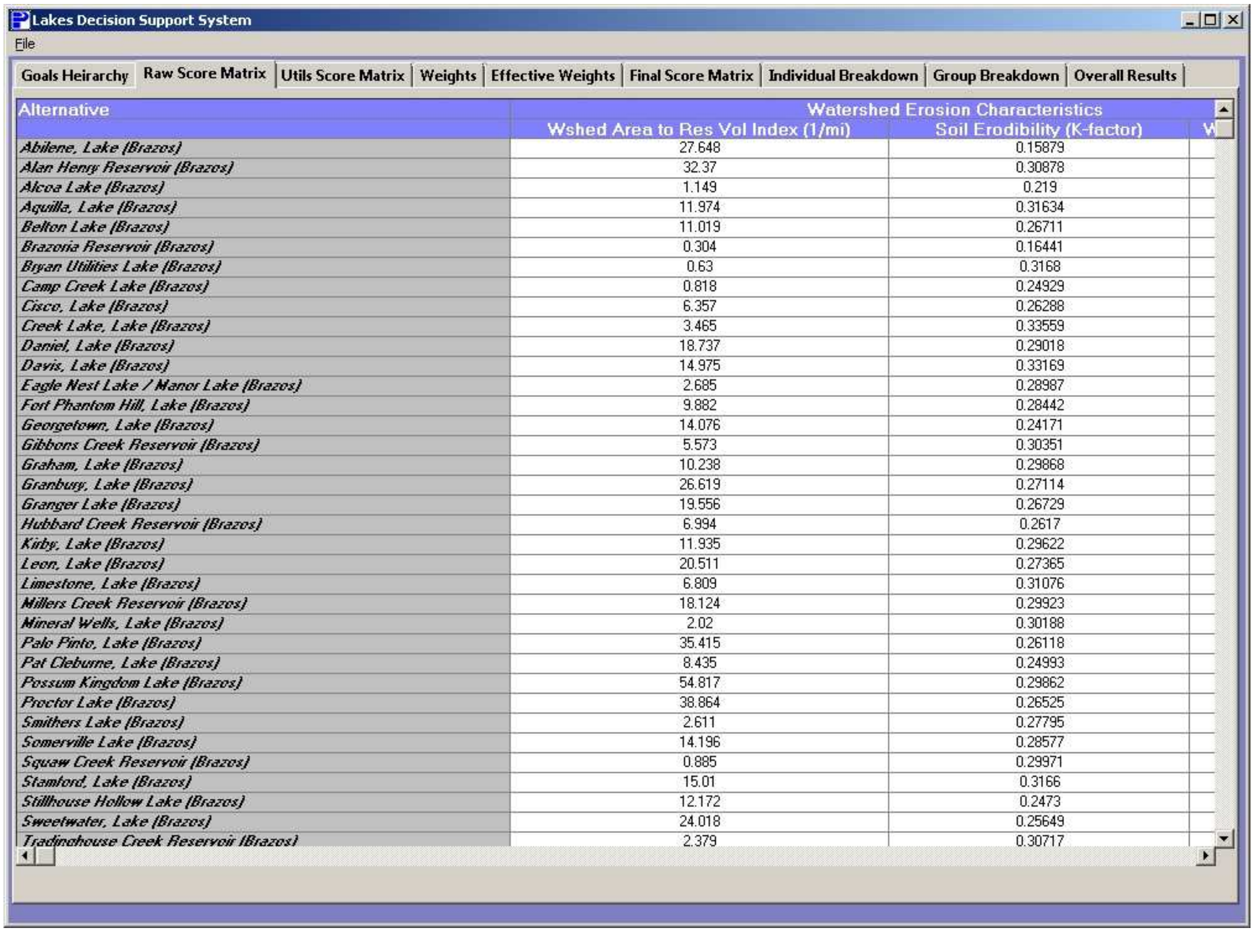


Figure 8.2 Util conversion curve dialog

Figure 8.3 Util Curve Graph Window

For the decision support analysis, each Measure must be expressed in a "common currency". The convention of using unit less "Utils" avoids any connotation, positive or negative, that may accrue with using a unitized measure such as dollars, for instance. The Util convention is normalized to 1.0 where a value of 0.0 represents the one extreme of the native units for each Measure. For example in the above figure a watershed slope of 0.0 (flat) produces less threat from sedimentation that a steep slope (~1.27) and the line between these extremes determines the Util score for each possible slope value. A similar Util conversion cure must be developed for each Measure used in the analysis.

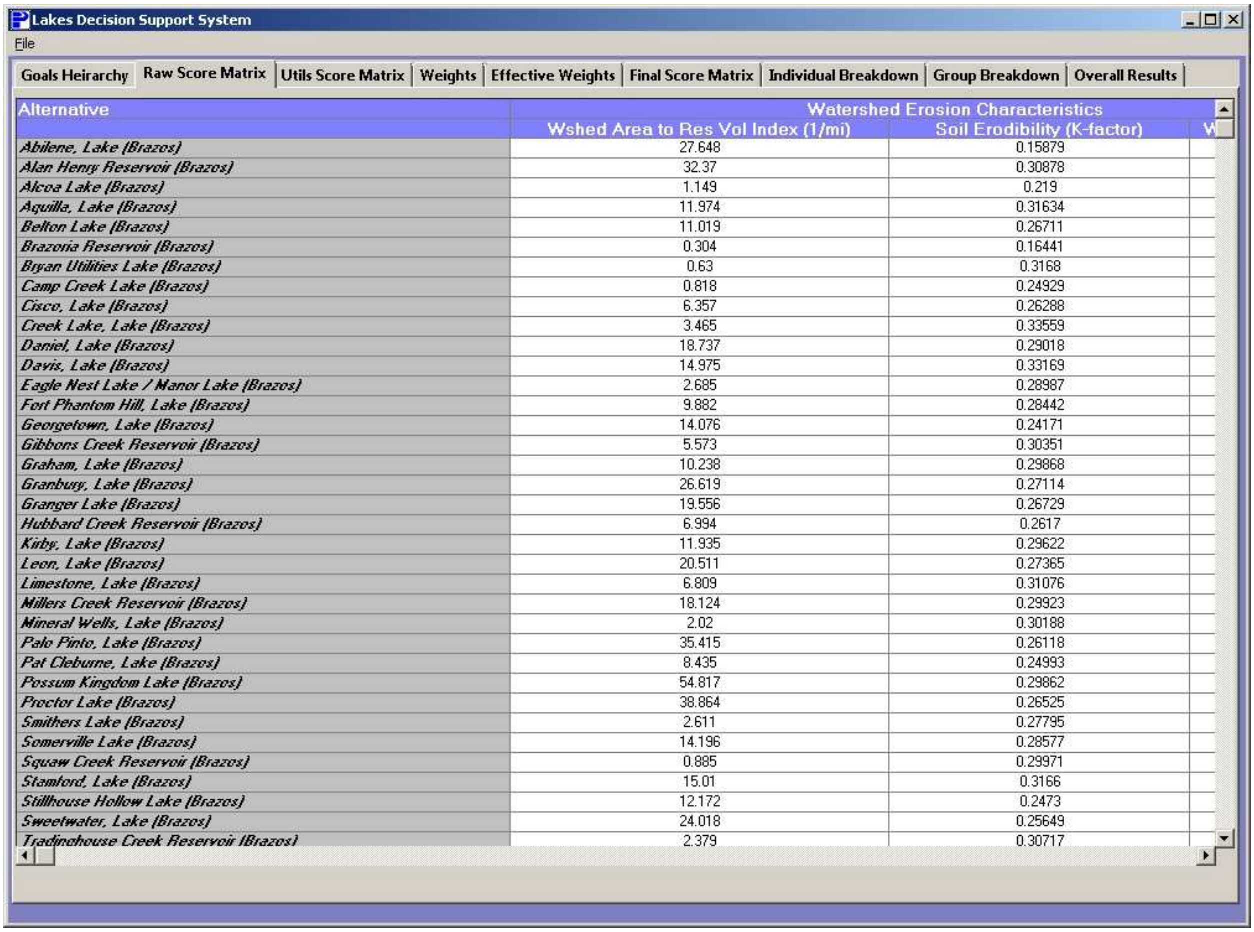
Generally, the next step in the analysis process is to develop the raw scores for each Alternative for each Measure. In this instance of the DSS, these scores were developed previously in the project and pre-loaded into the DSS and are available on the Raw Scores Matrix tab shown in Figure 8.4.



Alternative	Watershed Erosion Characteristics	
	Wshed Area to Res Vol Index (1/mi)	Soil Erodibility (K-factor)
Abilene, Lake (Brazos)	27.648	0.15879
Alan Henry Reservoir (Brazos)	32.37	0.30878
Alcoa Lake (Brazos)	1.149	0.219
Aquilla, Lake (Brazos)	11.974	0.31634
Belton Lake (Brazos)	11.019	0.26711
Brazoria Reservoir (Brazos)	0.304	0.16441
Bryan Utilities Lake (Brazos)	0.63	0.3168
Camp Creek Lake (Brazos)	0.818	0.24929
Cisco, Lake (Brazos)	6.357	0.26288
Creek Lake, Lake (Brazos)	3.465	0.33559
Daniel, Lake (Brazos)	18.737	0.29018
Davis, Lake (Brazos)	14.975	0.33169
Eagle Nest Lake / Manor Lake (Brazos)	2.685	0.28987
Fort Phantom Hill, Lake (Brazos)	9.882	0.28442
Georgetown, Lake (Brazos)	14.076	0.24171
Gibbons Creek Reservoir (Brazos)	5.573	0.30351
Graham, Lake (Brazos)	10.238	0.29868
Granbury, Lake (Brazos)	26.619	0.27114
Granger Lake (Brazos)	19.556	0.26729
Hubbard Creek Reservoir (Brazos)	6.994	0.2617
Kirby, Lake (Brazos)	11.935	0.29622
Leon, Lake (Brazos)	20.511	0.27365
Limestone, Lake (Brazos)	6.809	0.31076
Millers Creek Reservoir (Brazos)	18.124	0.29923
Mineral Wells, Lake (Brazos)	2.02	0.30188
Palo Pinto, Lake (Brazos)	35.415	0.26118
Pat Cleburne, Lake (Brazos)	8.435	0.24993
Possum Kingdom Lake (Brazos)	54.817	0.29862
Proctor Lake (Brazos)	38.864	0.26525
Smithers Lake (Brazos)	2.611	0.27795
Somerville Lake (Brazos)	14.196	0.28577
Squaw Creek Reservoir (Brazos)	0.885	0.29971
Stamford, Lake (Brazos)	15.01	0.3166
Stillhouse Hollow Lake (Brazos)	12.172	0.2473
Sweetwater, Lake (Brazos)	24.018	0.25649
Tradinghouse Creek Reservoir (Brazos)	2.379	0.30717

Figure 8.4 Raw Scores Matrix

After the Util Conversion Curves are completed for each of the Measures, the Util Score Matrix is automatically calculated and is available on the Utils Score Matrix tab. The individual scores in the Util Score Matrix represent the corresponding Raw Score converted with the appropriate Util Conversion Curve. The Util Score Matrix is show in Figure 8.5.



Alternative	Watershed Erosion Characteristics	
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Belton Lake (Brazos)	11.019	0.26711
Brazoria Reservoir (Brazos)	0.304	0.16441
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Hubbard Creek Reservoir (Brazos)	6.994	0.2617
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Stillhouse Hollow Lake (Brazos)	12.172	0.2473
Sweetwater, Lake (Brazos)	24.018	0.25649
Tradinghouse Creek Reservoir (Brazos)	2.379	0.30717

Figure 8.5 Util Scores Matrix

Once the Util scores have been calculated, the next step in the process is to determine the relative weightings of the Measure Categories and Measures. Figure 8.6 shows the Weights Tab for weighting the Measure Categories and individual Measures. The figure illustrates that the initial weighting step is to weight the Measures Categories relative to each other. After the Measure Categories weights are set, clicking on the green checks adjacent to each Measure Category brings up a similar list of the Measures that comprise that Measure Category which must also be weighted relative to each other in a fashion identical to the list of Measure Categories. Any number may be input to the weight column and the program will automatically recalculate the weights to a total of 1.0.

The Weights are factors that, like the Util Conversion Curves, may be altered by an interested party. In a fashion similar to the Util Conversion Curves, the Weights are stored in preference sets as well and a new editable preference set may be created with the Preference Set list box in the lower left of the tab.

Also illustrated in Figure 8.6 is one method of altering the structure of the decision analysis. For this analysis, the measured sedimentation rates contained in the Measured Sedimentation Measure Category are included for comparison and analysis detailed subsequently in this report. Since they are not toe be included in the calculation of the ranking, setting the Measure Category weight to 0.0 effectively removes them from the analysis.

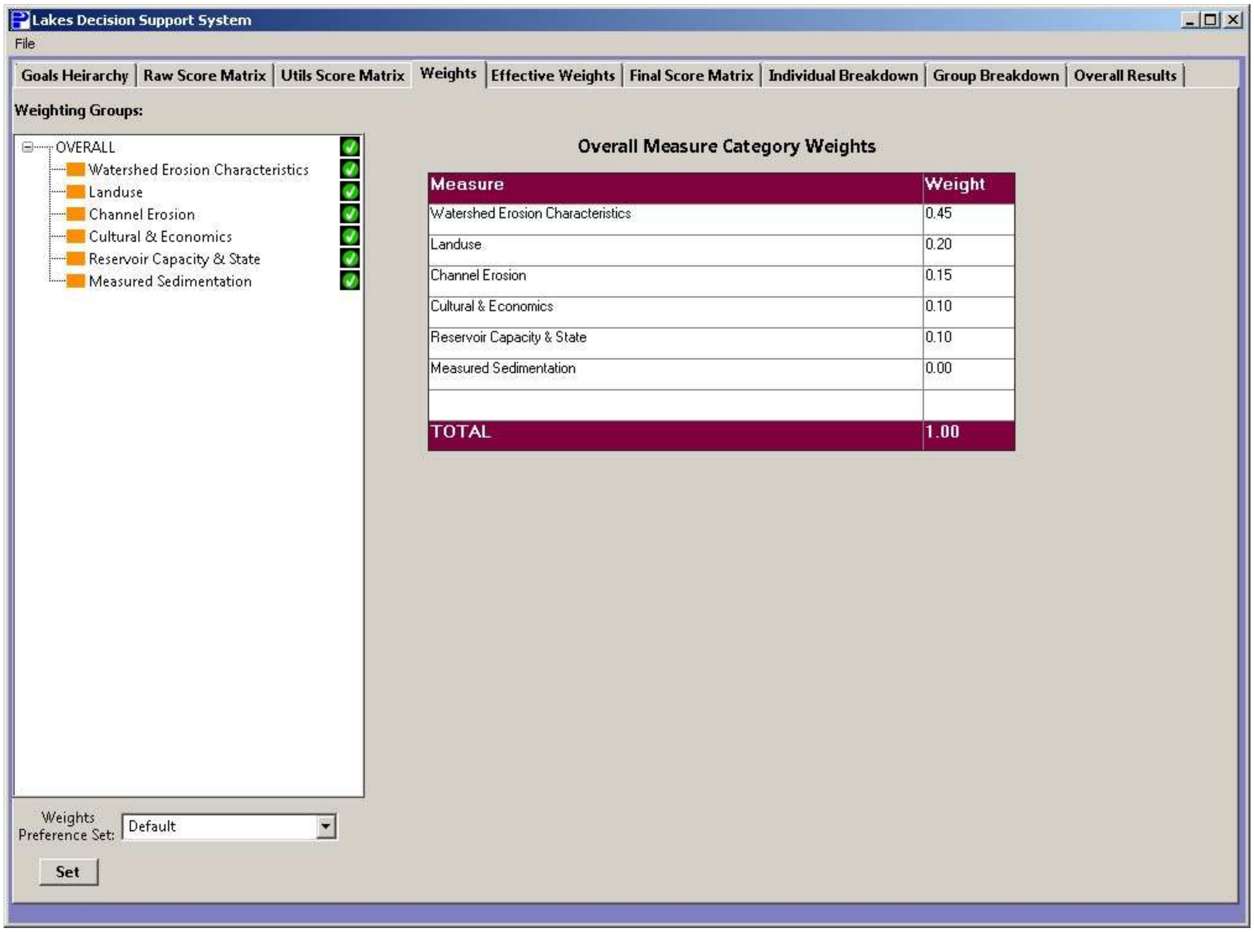


Figure 8.6 Weights Input Tab

Each Measure used in the ranking analysis has an effective weight that is the product of the Measure Category weight for the category to which the Measure belongs and the individual weight of the Measure within the category. The Effective Weights tab graphically and tabularly illustrates the distribution of the effective weights. The Effective Weights tab is show in Figure 8.7. The hierarchical measures list on the left of the tab also allows the structure of the ranking analysis to be temporarily altered by turning off Measures or Measure Categories as shown in Figure 8.8. In addition this hierarchical list allows for the examination of the sensitivity of the analysis to individual measures and groups of measures by including and excluding them from the analysis and examining the effect.

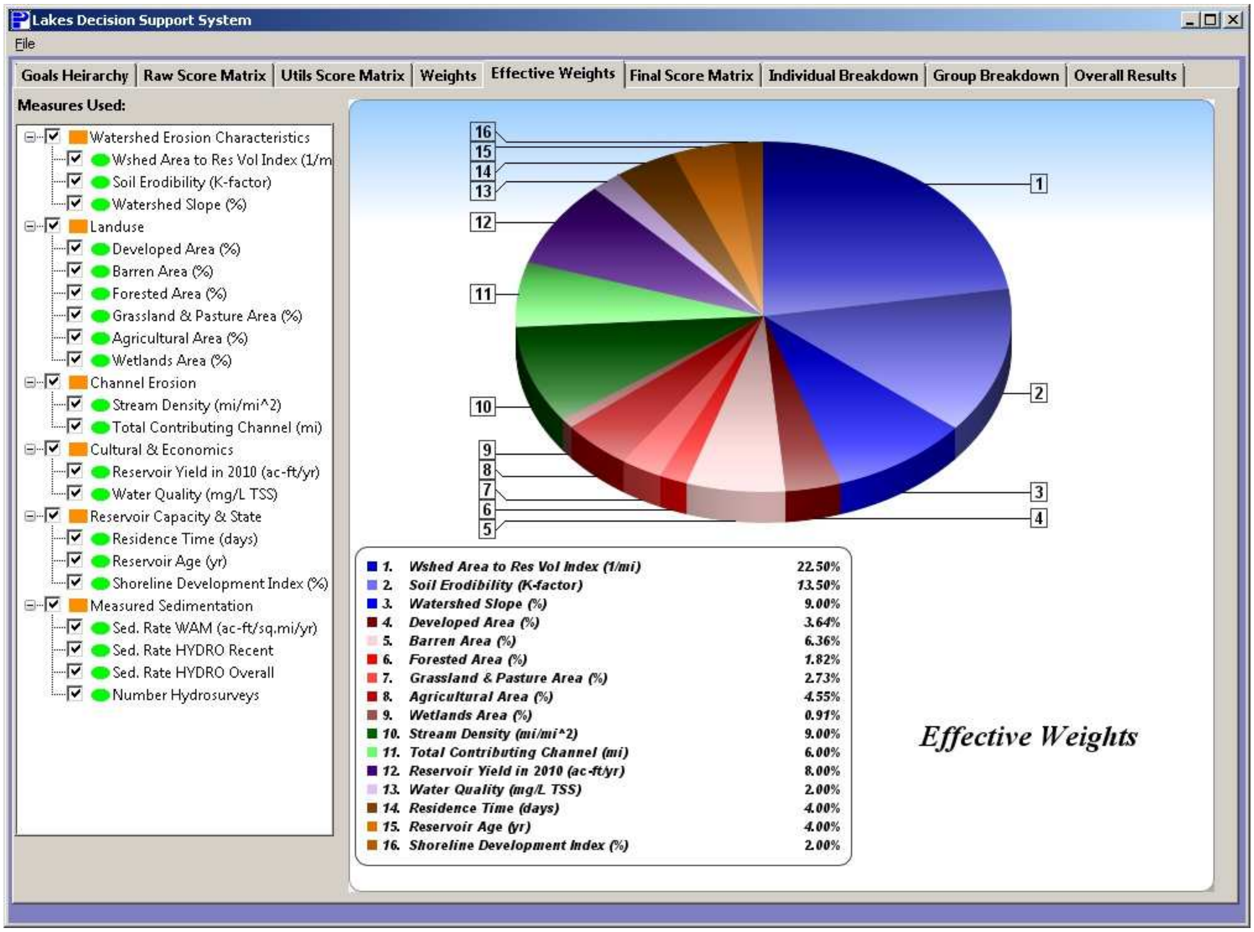


Figure 8.7 Effective Weights Tab

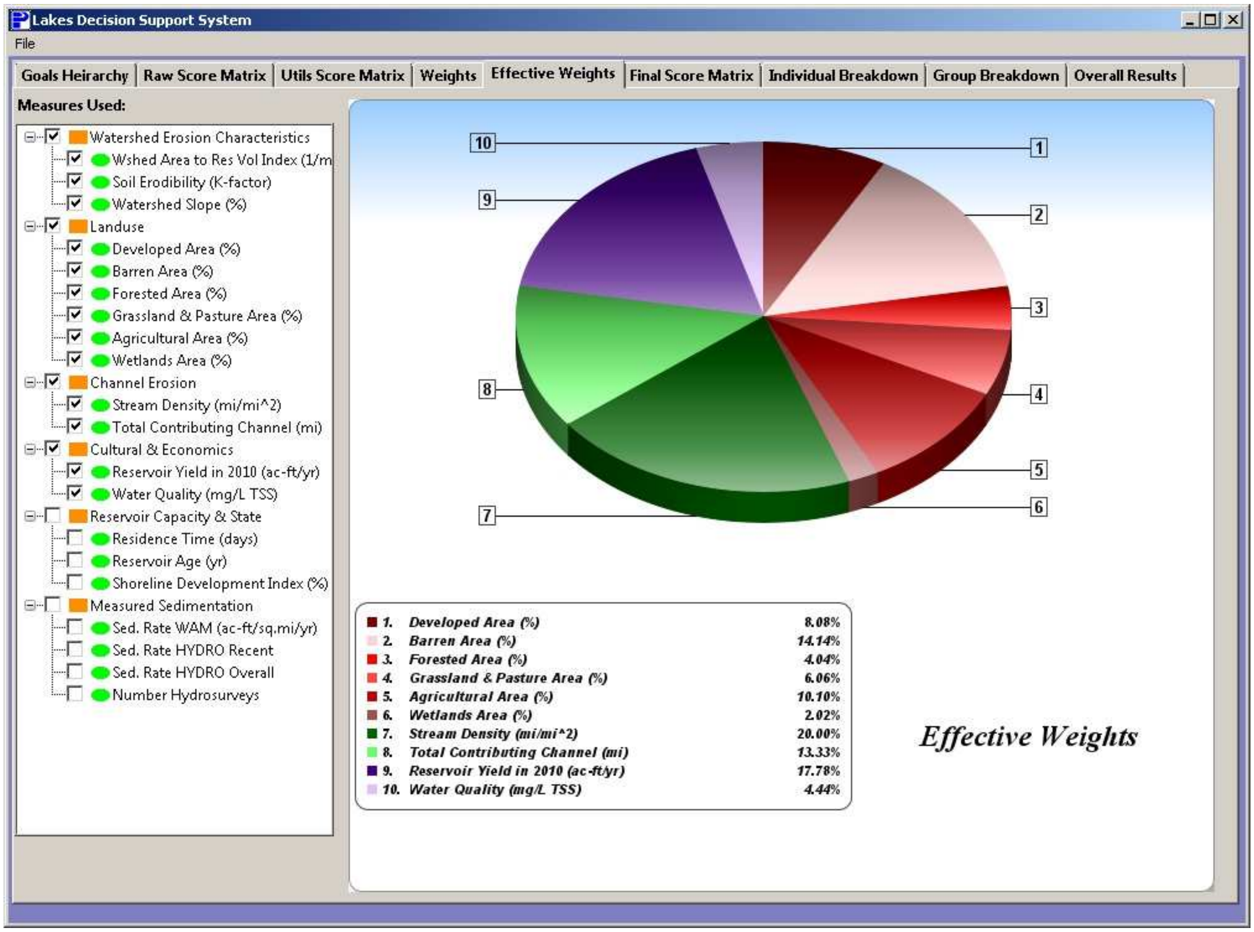
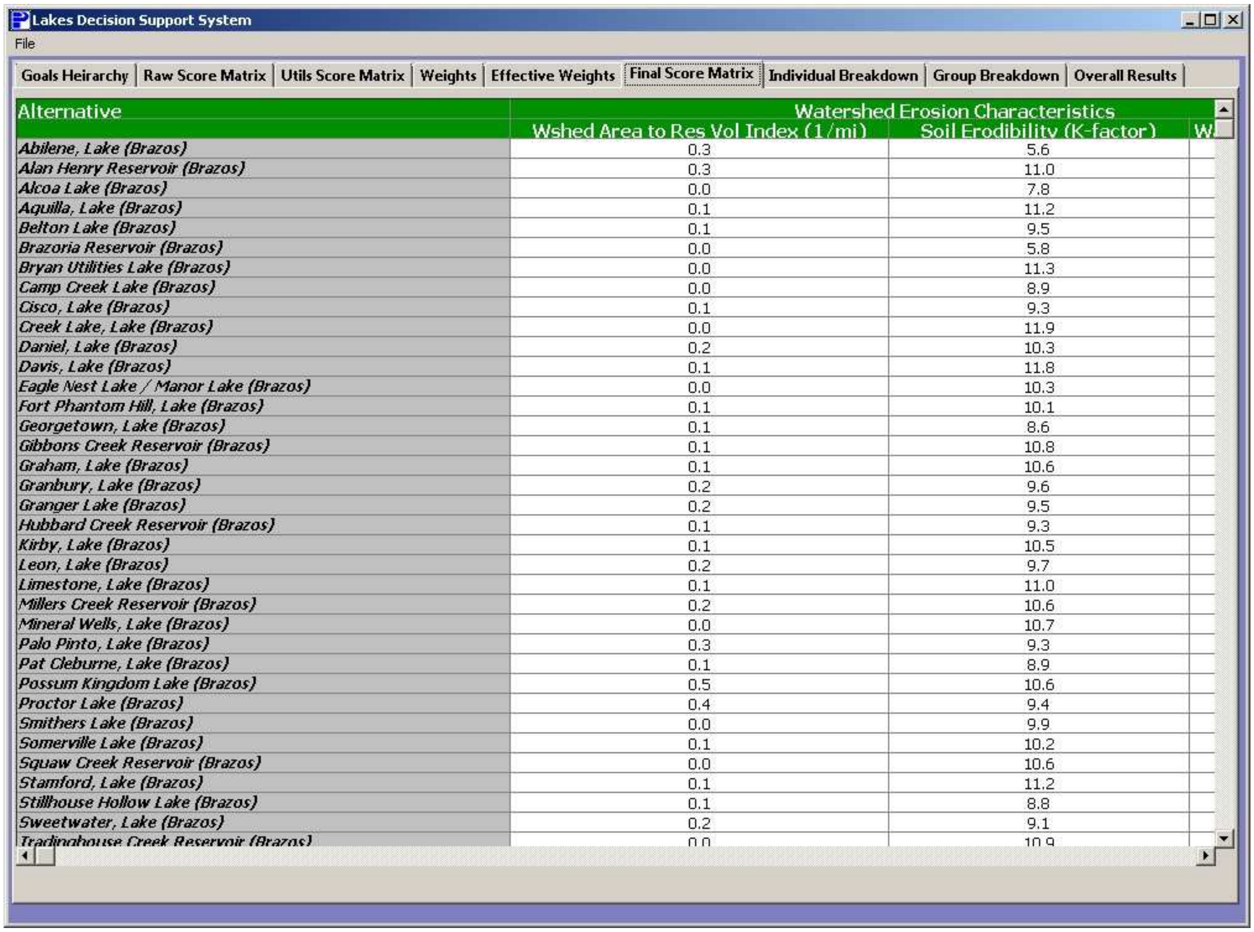


Figure 8.8 Excluding Measures from the Ranking Analysis

After the weights are developed, the final ranking scores are automatically calculated and are available on the Final Score Matrix tab (Figure 8.9). The final scores are the Util Score Matrix values weighted by the effective weights of the individual measures. The final score for an Alternative is the sum of the scores for each measure where the maximum possible score for each measure is its respective percentage effective weight. As a result the final scores are normalized so that the maximum total score is 100, as shown in Figure 8.10.



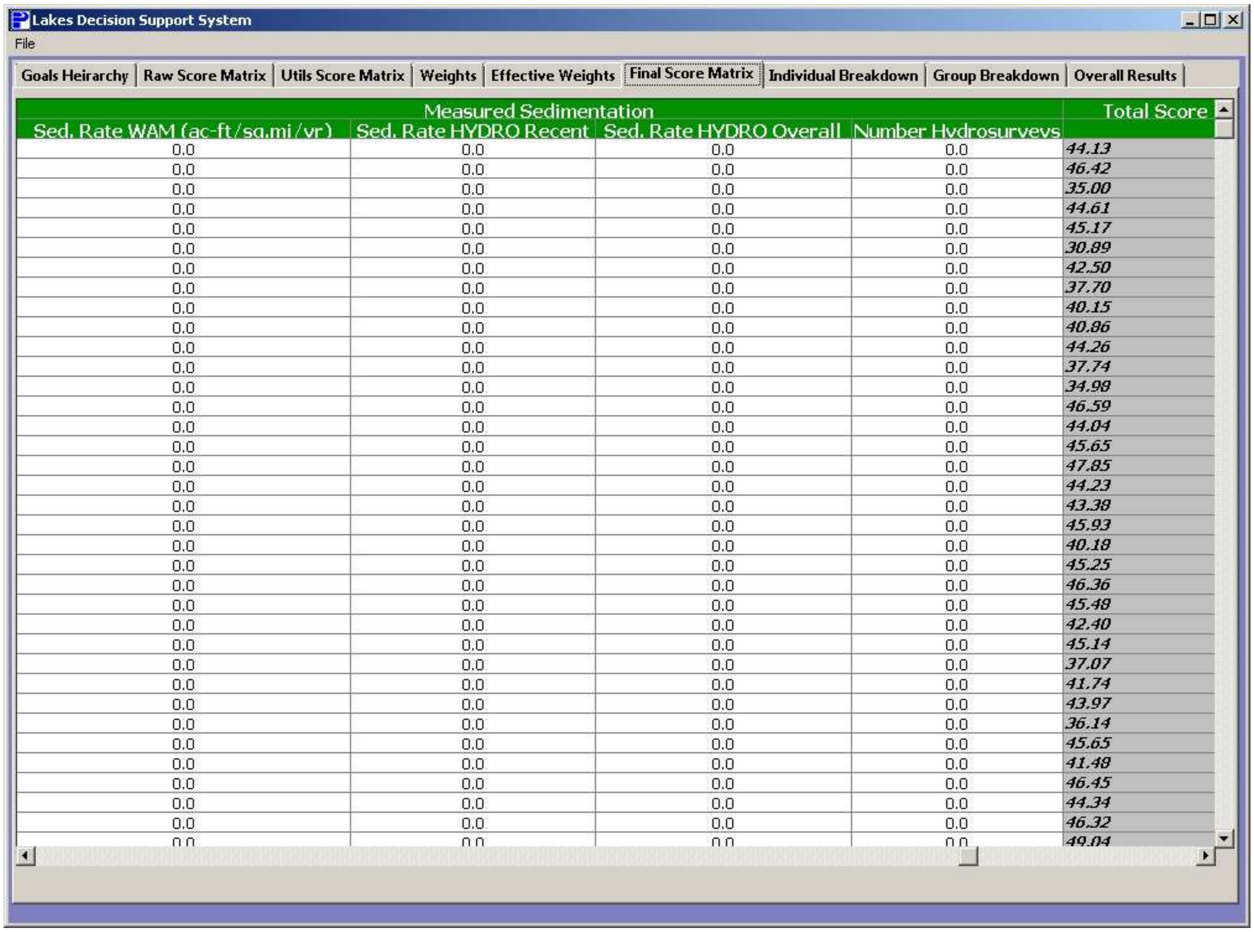
Lakes Decision Support System

File

Goals Heirarchy | Raw Score Matrix | Utils Score Matrix | Weights | Effective Weights | Final Score Matrix | Individual Breakdown | Group Breakdown | Overall Results

Alternative	Watershed Erosion Characteristics		
	Wshed Area to Res Vol Index (1/mi)	Soil Erodibility (K-factor)	W
Abilene, Lake (Brazos)	0.3	5.6	
Alan Henry Reservoir (Brazos)	0.3	11.0	
Alcoa Lake (Brazos)	0.0	7.8	
Aquilla, Lake (Brazos)	0.1	11.2	
Belton Lake (Brazos)	0.1	9.5	
Brazoria Reservoir (Brazos)	0.0	5.8	
Bryan Utilities Lake (Brazos)	0.0	11.3	
Camp Creek Lake (Brazos)	0.0	8.9	
Cisco, Lake (Brazos)	0.1	9.3	
Creek Lake, Lake (Brazos)	0.0	11.9	
Daniel, Lake (Brazos)	0.2	10.3	
Davis, Lake (Brazos)	0.1	11.8	
Eagle Nest Lake / Manor Lake (Brazos)	0.0	10.3	
Fort Phantom Hill, Lake (Brazos)	0.1	10.1	
Georgetown, Lake (Brazos)	0.1	8.6	
Gibbons Creek Reservoir (Brazos)	0.1	10.8	
Graham, Lake (Brazos)	0.1	10.6	
Granbury, Lake (Brazos)	0.2	9.6	
Granger Lake (Brazos)	0.2	9.5	
Hubbard Creek Reservoir (Brazos)	0.1	9.3	
Kirby, Lake (Brazos)	0.1	10.5	
Leon, Lake (Brazos)	0.2	9.7	
Limestone, Lake (Brazos)	0.1	11.0	
Millers Creek Reservoir (Brazos)	0.2	10.6	
Mineral Wells, Lake (Brazos)	0.0	10.7	
Palo Pinto, Lake (Brazos)	0.3	9.3	
Pat Cleburne, Lake (Brazos)	0.1	8.9	
Possum Kingdom Lake (Brazos)	0.5	10.6	
Proctor Lake (Brazos)	0.4	9.4	
Smithers Lake (Brazos)	0.0	9.9	
Somerville Lake (Brazos)	0.1	10.2	
Squaw Creek Reservoir (Brazos)	0.0	10.6	
Stamford, Lake (Brazos)	0.1	11.2	
Stillhouse Hollow Lake (Brazos)	0.1	8.8	
Sweetwater, Lake (Brazos)	0.2	9.1	
Tradinghouse Creek Reservoir (Brazos)	0.0	10.9	

Figure 8.9 Final Score Matrix



Measured Sedimentation				Total Score
Sed. Rate WAM (ac-ft/sq.mi/yr)	Sed. Rate HYDRO Recent	Sed. Rate HYDRO Overall	Number Hydrosurveys	
0.0	0.0	0.0	0.0	44.13
0.0	0.0	0.0	0.0	46.42
0.0	0.0	0.0	0.0	35.00
0.0	0.0	0.0	0.0	44.61
0.0	0.0	0.0	0.0	45.17
0.0	0.0	0.0	0.0	30.89
0.0	0.0	0.0	0.0	42.50
0.0	0.0	0.0	0.0	37.70
0.0	0.0	0.0	0.0	40.15
0.0	0.0	0.0	0.0	40.86
0.0	0.0	0.0	0.0	44.26
0.0	0.0	0.0	0.0	37.74
0.0	0.0	0.0	0.0	34.98
0.0	0.0	0.0	0.0	46.59
0.0	0.0	0.0	0.0	44.04
0.0	0.0	0.0	0.0	45.65
0.0	0.0	0.0	0.0	47.85
0.0	0.0	0.0	0.0	44.23
0.0	0.0	0.0	0.0	43.38
0.0	0.0	0.0	0.0	45.93
0.0	0.0	0.0	0.0	40.18
0.0	0.0	0.0	0.0	45.25
0.0	0.0	0.0	0.0	46.36
0.0	0.0	0.0	0.0	45.48
0.0	0.0	0.0	0.0	42.40
0.0	0.0	0.0	0.0	45.14
0.0	0.0	0.0	0.0	37.07
0.0	0.0	0.0	0.0	41.74
0.0	0.0	0.0	0.0	43.97
0.0	0.0	0.0	0.0	36.14
0.0	0.0	0.0	0.0	45.65
0.0	0.0	0.0	0.0	41.48
0.0	0.0	0.0	0.0	46.45
0.0	0.0	0.0	0.0	44.34
0.0	0.0	0.0	0.0	46.32
0.0	0.0	0.0	0.0	49.04

Figure 8.10 Final Total Scores

The last 3 tabs are for illustrating the final ranking results and examining the influence of each individual Measure on the ranking. The Individual Breakdown tab provides a chart illustrating the amount of the final score for each Alternative that is attributable to each individual Measure and is shown in Figure 8.11. The number 1 subcategory, shown in light grey, is the remainder between the maximum possible score of 100 and the actual final score for and individual Alternative.

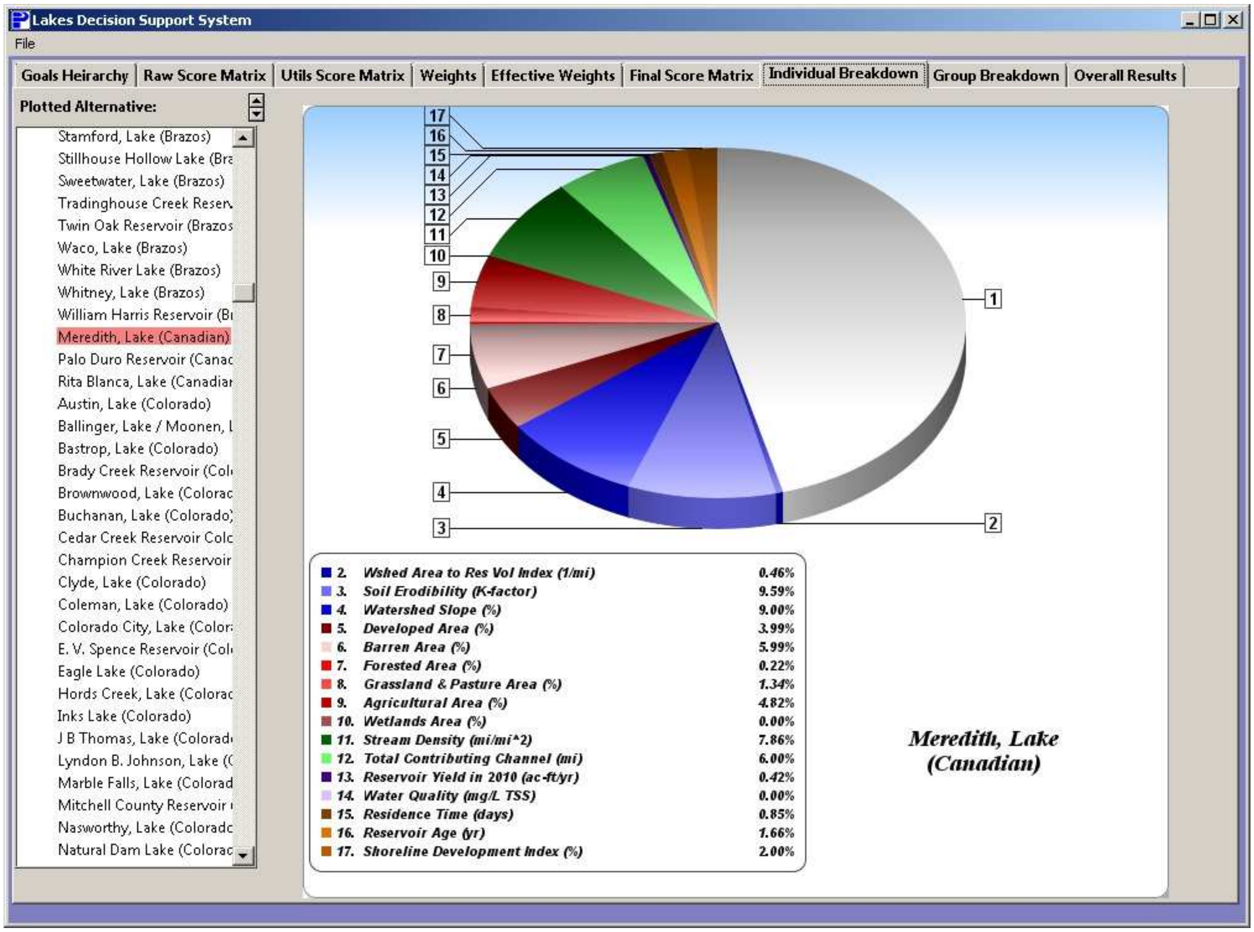


Figure 8.11 Individual Breakdown Tab

A similar breakdown illustrating the effect of individual Measures on the final ranking scores for Alternatives are shown on the Group Breakdown tab illustrated in Figure 8.12. Each Alternative is represented as a bar on the bar chart where the bar height, or final score, is shown and the part of the final score attributable to each measure is shown as a colored band on the bar.

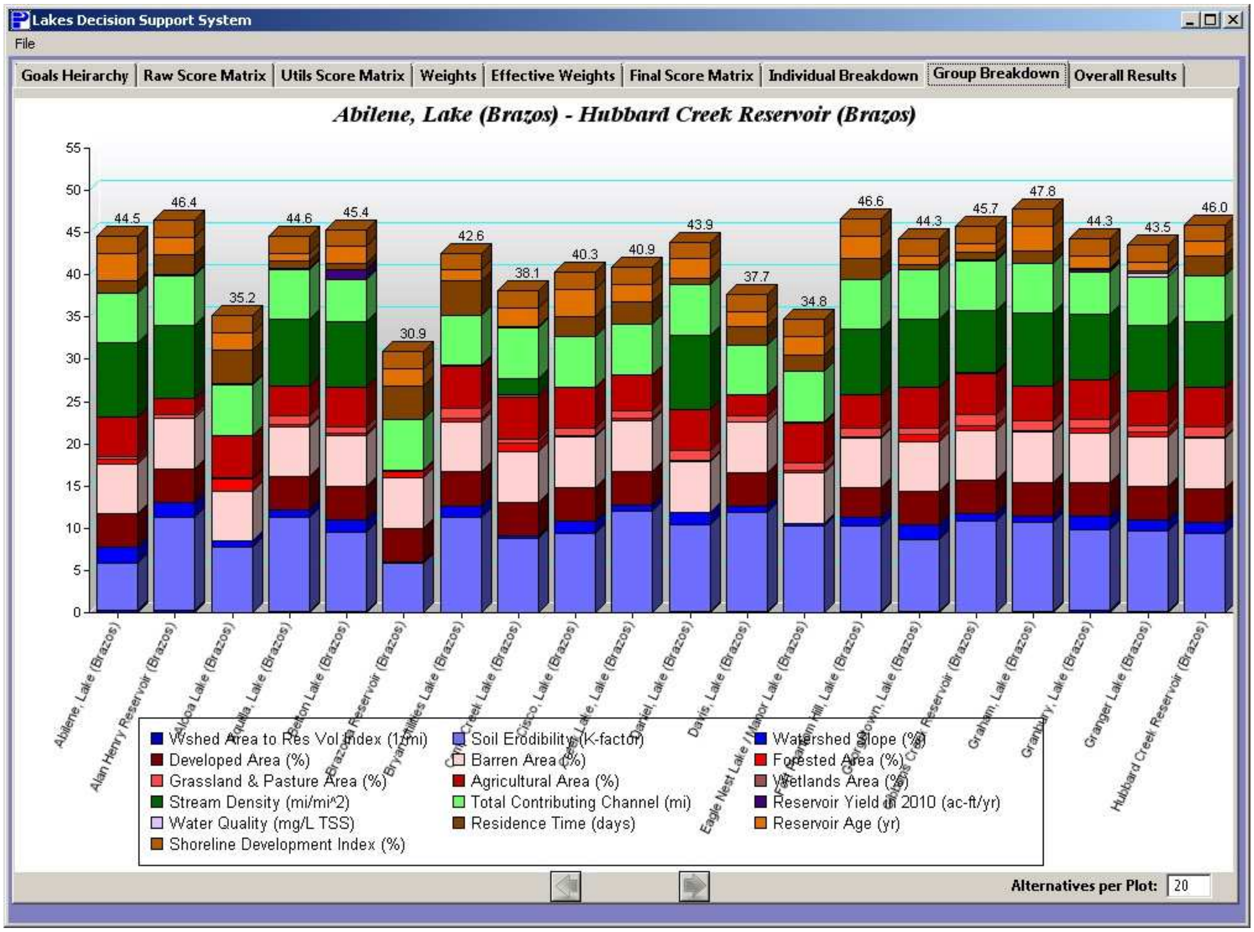


Figure 8.12 Group Breakdown Tab

The final rankings are shown in the bar chart on the Overall Results tab shown in Figure 8.13.

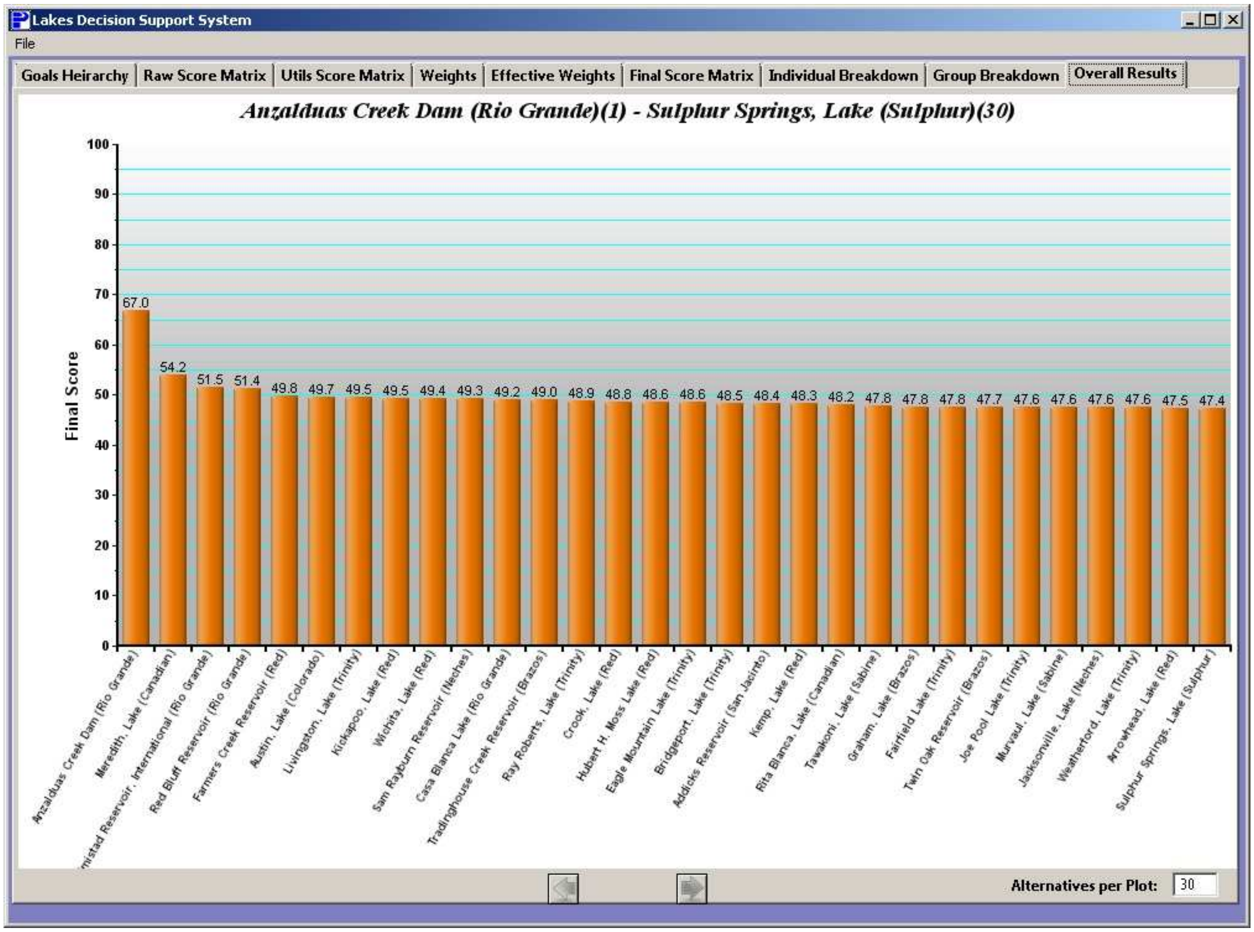


Figure 8.13 Final Rankings Bar Chart

8.2 RANKING EXERCISE WITH DSS TOOL

The framework that was developed to construct the decisions support system is depicted in Figure 8.14.

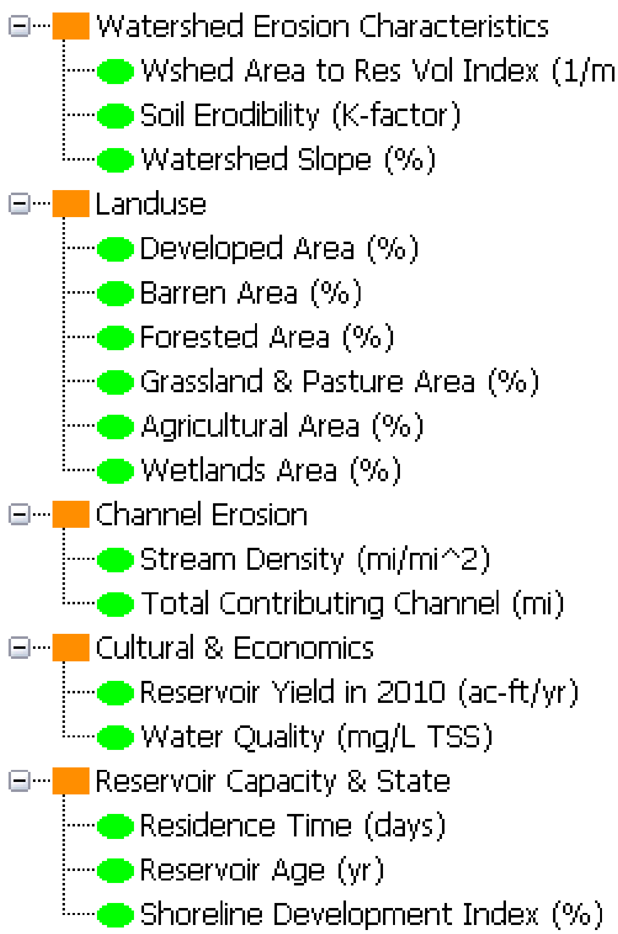


Figure 8.14 Schematic outline of the Decision Support System

The following orders of operation were established by the project team to guide the development of all numeric values used to rank the importance and weight of each criteria and measure listed in Figure 8.14.

- All reservoirs were scored based on a scale of 0 to 100 points. The higher the point total assigned to a reservoir, the more at risk the reservoir is for excessive contributions from sediment and thus loss of firm yield of water supply.
- All data for each measure must be converted into a common unitized value called Utils as detailed above.
- The five different subcategories of criteria were initially deliberated by the project team to establish weighting factors for each. The proposed weighting factors were derived using best professional judgment in response to the question: Rank the five subcategories (expressed as percents) to define (weight) which subcategory has the greatest to the least impact on exacerbating the potential for sediment delivery to any given reservoir.
- The measures associated with each criteria subcategory were deliberated by the project team to establish weighting factors independent of the measures in other subcategories. The proposed weighting factors for each measure were derived using best professional judgment in an effort to define (weight) which measure has the greatest to the least impact on exacerbating the potential for sediment contribution, delivery or retention to any given reservoir.
- Missing data in the database must be addressed. For example, in the case where reservoir impoundment year was not available, the mean of all available impoundment ages was used to

derive a mean age of 55 years. Therefore, 1956 (2011-55=1956) was used as the mean year for reservoir impoundment dates that were not available.

- The subcategory of Measured Sedimentation was not integrated into the initial step of prioritization and weighting. Comparable, quantitative measured sedimentation data was not expected to be available for all reservoirs. The data associated with this subcategory was compiled in the database for comparison purposes only. Therefore, this subcategory was not weighted and used to complete the draft run ranking the reservoirs.

8.2.1 Procedure and Results

Following these orders of operation described above a facilitated discussion among the project team was conducted to establish a recommended (default run) scenario for ranked reservoirs most at risk from sedimentation using the DSS. The outcomes of the project team discussion that created the default run are summarized below.

8.3.2 Defining Individual Utils for each Measure

The Util conversion curves were prepared for each measure to convert the raw score from and individual measure, in whatever units constitute the measure, to Utils. For this analysis, the convention followed is that a high Util scores indicates a high potential risk from sedimentation and a low Util score represents a low sedimentation risk. As a result, Alternatives with high ranking scores are the reservoirs most susceptible to sedimentation. Each Util conversion curve was developed according to this convention so that the range of raw scores corresponding to the normalized Util range of 0.0 to 1.0 would equal or exceed the range of values found in the raw scores for the tested reservoirs. In a few cases, there are quantitative methods to derive the Util conversion curve, however in most instances the curve must be derived qualitatively from the best professional judgment of the project team.

8.3.3 Recommended Weighting of Subcategories

To establish weights for each subcategory the project team focused on the question: Rank the five subcategories (expressed as percents) to define (weight) which subcategory has the greatest to the least impact on exacerbating the potential for sediment delivery to any given reservoir. Based on the definitions of each subcategory outlined in Section 4 of the report, Table 8.2 summarizes the recommended weighting for each of the five subcategories that influence sediment delivery and retention, as well as reservoir response to sediment loading. The individual weights display the relative importance the project team believes the attributes of each subcategory has on exacerbating the potential for sediment delivery to any given reservoir. The project team weighted the 3 subcategories – Watershed Erosion Characteristics (0.45), Landuse (0.20), and Channel Erosion (0.15) – that directly influence sediment availability and delivery as the most important factors.

Table 8.1 Recommended Weights for Five Subcategories

Measure	Weight
Watershed Erosion Characteristics	0.45
Landuse	0.20
Channel Erosion	0.15
Cultural & Economics	0.10
Reservoir Capacity & State	0.10
Measured Sedimentation	0.00
TOTAL	1.00

8.3.4 Recommended Weighting of Measures

The recommended weights established by the project team are summarized below by subcategory.

Watershed Erosion Characteristics Measure: Of the key characteristics that define Watershed Erosion Characteristics, the Watershed Area to Reservoir Volume Index was considered just as important as the characteristics that influence soil erosion which include soil erodibility (K-factor) and watershed slope. However, the project team considered soil erodibility to have a greater influence on the amount of potential erosion than watershed slope. The recommended weights for the three measures that define Watershed Erosion Characteristics are provided in Table 8.2.

Table 8.2 Recommended weights of watershed erosion measures

Measure	Recommended Weight
Watershed Area to Reservoir	0.50
Soil Erodibility (K-factor)	0.30
Watershed Slope (%)	0.20
TOTAL	1.00

Landuse Measure: Landuse was aggregated into 6 major categories which were considered sufficient for the assessment objectives of evaluating sediment loading potential. The basis for weighting one landuse category in relation to another was derived from the following tenet: given the same size of land parcel, rank each landuse category based on the potential for contributing sediment loading from rainfall runoff. The recommended weights for the six measures that define landuse are provided in Table 8.3.

Table 8.3 Recommended Weights of Landuse Measures

Measure	Recommended Weight
Developed Area	0.20
Barren Area	0.30
Forested Area	0.10
Grassland and Pasture	0.10
Agricultural Areas	0.25
Wetlands	0.05
TOTAL	1.00

Channel Erosion Measure: Quantifying stream density is a more effective analogue than simply using stream channel length to estimate the potential availability of sediment from stream channels that may be delivered to a given reservoir. Therefore stream density was weighted more than contributing channel length. The greater the stream density in a watershed, the greater potential availability of sediment there is from streams that may be delivered to a reservoir, regardless of the size of a reservoir's watershed. The recommended weights for the stream density and total contributing channel length are provided in Table 8.4.

Table 8.4 Recommended Weights of Channel Erosion Measures

Measure	Recommended Weight
Stream Density	0.60
Total Contributing Channel	0.40
TOTAL	1.00

Cultural and Economics Measure: The size of a reservoir has a major influence on its ability to maintain firm yield or volume despite the continuous contributions of sediment loading over the life of operations. The recommended weights for reservoir yield in 2010 and TSS concentrations used as a surrogate for water quality are provided in Table 8.5.

Table 8.5 Recommended weights of cultural and economic measures

Measure	Recommended Weight
Reservoir Yield in 2010	0.80
Water Quality (mg/L TSS)	0.20
TOTAL	1.00

Reservoir Capacity and State: The physical characteristics and daily to seasonal management of reservoir water volume has a direct relationship on the overall sediment budget within a given reservoir. The project team felt that the flow through the reservoir and the age of the reservoir were the more significant factors within this measure category. The recommended weights for the three different measures used to quantify reservoir capacity and state measures are provided in Table 8.6.

Table 8.6 Recommended weights of reservoir capacity and state measures

Measure	Recommended Weight
Residence Time	0.40
Reservoir Age	0.40
Shoreline Development Index	0.20
TOTAL	1.00

8.3 INSIGHTS FROM PROFESSIONAL JUDGMENT

The DSS tool allows the user to consider multiple data sources and measures to aid in the decision-making process of ranking reservoirs at risk from excessive sedimentation across the state. While the professional judgment evaluations that were applied to the different categories and measures can be modified, the default run of the DSS provides valuable insight as to which categories and measures have the most direct effect on sediment loading to a reservoir.

The relative weights applied to the different measures provide direction on which natural and anthropogenic characteristics (measures) within a watershed influence sediment loading to a reservoir. Consequently, these weights also provide suggestions for which watershed characteristics could be targeted by watershed management implementation to mitigate future sedimentation of reservoirs. Once a draft list of the ranked "at-risk" reservoirs is established, the insights gleaned from the DSS database, the weighting of categories and measures, and the geospatial distribution of the most at-risk reservoirs can be used to develop approaches for preparing watershed management plans aimed at sediment management and maintaining reservoir capacity.

9.0 SYNTHESIS OF RESULTS

The information developed through activities described in previous chapters of this report can be generalized as three knowledge bases (see Figure 9.1). These are

1. Empirical sedimentation rates collected from TCEQ WAM, and TWDB hydrosurvey sedimentation rates
2. Data related to sedimentation risk, such as soil erodibility, reservoir residence time, etc.
3. Professional judgment, i.e. the collection of weights and utility conversion functions assigned by the project team to the risk-related data via the DSS tool.

By integrating the information in these knowledge bases, multiple sets of rankings for sedimentation risk can be obtained. In this chapter, a summary of these rankings is presented and approaches for synthesizing them to identifying reservoirs most at-risk for sedimentation for future studies are suggested.

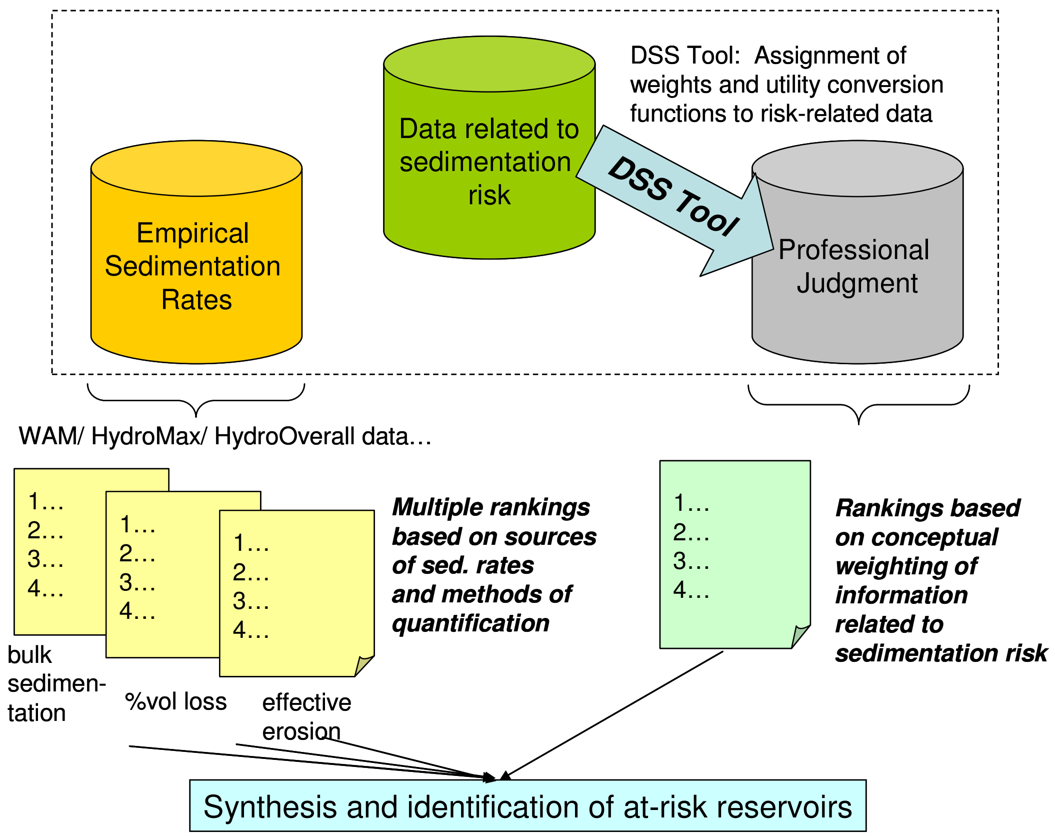


Figure 9.1 Synthesis of rankings from knowledge bases developed in this research

9.1 RANKINGS FROM EMPIRICAL SEDIMENTATION DATA AND FROM CRITERIA WEIGHTING/PROFESSIONAL JUDGMENT

From the above-mentioned three knowledge bases, four categories of reservoir rankings for sedimentation risk were produced:

1. Bulk sedimentation rate (ac-ft/yr)
2. Percent loss in volume (%/year)

3. Effective erosion rate (ac-ft/sq-mi/yr)
4. Professional judgment (via criteria-weighting with the DSS tool)

Because data for sedimentation rates were obtained in three different ways – i.e. WAM sedimentation rates, hydrosurvey overall rates, hydrosurvey maximum rates – the project team calculated separate sets of ranking for of for them. This resulted in a total of ten rankings (3 for bulk sedimentation rate + 3 for percent loss in volume + 3 for effective erosion rate + 1 for professional judgment). These rankings are presented in this chapter for the reader to consider when identifying reservoirs most at-risk for sedimentation. Two suggested approaches for synthesizing these rankings is presented at the end of this chapter.

Table 9.1 contains the ten sets of rankings. To facilitate comparison on an equal basis, the ranks were converted to percentile-rank values using the formula:

percentile rank value = [1 - rank/(# reservoir with observations)] x 100%

This conversion was done because of the unequal number of ranked reservoirs for hydrosurvey sedimentation rates (109 reservoirs) and WAM rates and DSS rankings (194 reservoirs). Note that with the conversion, higher sedimentation rates resulted in higher percentile rank values. Reservoirs ranked high for sedimentation risk in the DSS tool resulted in higher percentile-rank values.

Some reservoirs possess special conditions that may need additional consideration when identifying for reservoirs that are at-risk for sedimentation. Such reservoirs are mostly cooling ponds, storage facilities and reservoirs with no water supply function. The special conditions are listed in Table 9.1.

Table 9.1 Summary of rankings for sedimentation risk derived from the empirical sedimentation rates and professional judgment of risk-related data

				Percentile rank based on loss in total volume/yr, i.e. Bulk Sedimentation Rate (ac-ft/yr)			Percentile rank based on %loss in volume/yr (%/yr)			Percentile rank based on Effective Watershed Erosion Rate (ac-ft/yr/sq-mi watershed)			Percentile rank based on Professional Judgment	
RES_NUM	RES_NAME	BASIN_NAME	REGION NAME	WAM	HYDRO MAX	HYDRO OVERALL	WAM	HYDRO MAX	HYDRO OVERALL	WAM	HYDRO MAX	HYDRO OVERALL	Criteria Weighting	Special Conditions?
1	ABILENE; LAKE	Brazos	G	48%			89%			68%			44%	
2	ALAN HENRY RESERVOIR	Brazos	O	39%	90%	94%	24%	97%	98%	8%	68%	79%	74%	
3	ALCOA LAKE	Brazos	G	13%			19%			62%			8%	
4	AMISTAD RESERVOIR; INTERNATIONAL	Rio Grande	J	99%	97%	98%	78%	35%	46%	21%	17%	20%	98%	
5	AMON G. CARTER; LAKE	Trinity	B	76%			94%			97%			82%	
6	ANAHUAC; LAKE	Trinity	H	64%	6%	6%	75%	6%	6%	16%	8%	9%	59%	
7	AQUILLA; LAKE	Brazos	G	86%	64%	64%	94%	91%	92%	97%	80%	78%	50%	
8	ARLINGTON; LAKE	Trinity	C	70%	52%	43%	84%	81%	61%	89%	85%	63%	71%	
9	ARROWHEAD; LAKE	Red	B	45%	76%	83%	15%	53%	66%	12%	71%	82%	87%	
10	ATHENS; LAKE	Neches	I	18%	35%	38%	18%	52%	67%	52%	93%	95%	9%	
11	AUSTIN; LAKE	Colorado	K	33%	6%	6%	43%	6%	6%	43%	8%	9%	95%	Used as part of system operations; no individual yield total available; has constant water surface elevation;
12	B A STEINHAGEN LAKE	Neches	I	65%	79%	80%	60%	95%	95%	10%	32%	36%	62%	
13	BALLINGER; LAKE / MOONEN; LAKE	Colorado	F	47%			90%			40%			31%	
14	BALMORHEA; LAKE	Rio Grande	E	8%	21%	26%	14%	83%	90%	24%	99%	99%	3%	
15	BARDWELL; LAKE	Trinity	C	71%	51%	60%	81%	76%	87%	92%	84%	88%	67%	
16	BASTROP; LAKE	Colorado	K	18%			26%			73%			25%	
17	BAYLOR; LAKE	Red	A	49%			88%			90%			18%	
18	BELTON LAKE	Brazos	G	88%	87%	73%	51%	54%	29%	49%	49%	34%	55%	
19	BENBROOK; LAKE	Trinity	C	46%	28%	31%	32%	19%	23%	24%	24%	33%	45%	
20	BOB SANDLIN; LAKE	Cypress	D	48%	64%	70%	21%	41%	44%	60%	89%	91%	54%	
21	BONHAM; LAKE	Red	C	36%	18%	22%	61%	44%	54%	83%	64%	73%	21%	
22	BRADY CREEK RESERVOIR	Colorado	F	45%			52%			13%			32%	
23	BRANDY BRANCH COOLING POND	Sabine	D	7%			7%			40%			6%	
24	BRAZORIA RESERVOIR	Brazos	H	11%			9%			67%			2%	Off-channel reservoir; used for industrial water supply; temporary storage facility only
25	BRIDGEPORT; LAKE	Trinity	C	84%	74%	63%	45%	33%	25%	60%	51%	45%	91%	
26	BROWNWOOD; LAKE	Colorado	F	77%	56%	61%	62%	43%	47%	47%	33%	43%	53%	
27	BRYAN UTILITIES LAKE	Brazos	G	3%			3%			3%			34%	
28	BUCHANAN; LAKE	Colorado	K	85%	93%	92%	33%	38%	41%	13%	37%	44%	34%	
29	CADDO LAKE	Cypress	D	72%			75%			19%			63%	
30	CALAVERAS LAKE	San Antonio	L	55%			45%			87%			74%	
31	CANYON LAKE	Guadalupe	L	82%	67%	54%	43%	28%	22%	49%	40%	27%	36%	
32	CASA BLANCA LAKE	Rio Grande	M	56%	6%	6%	76%	6%	6%	71%	8%	9%	94%	
33	CEDAR BAYOU GENERATING POND	Trinity-San Jacinto	H	3%			3%			3%			12%	Used as a cooling pond for power plant; no significant drainage area
34	CEDAR CREEK RESERVOIR COLORADO	Colorado	K	24%	33%	35%	11%	24%	30%	73%	99%	99%	30%	Used as part of system operations; no individual yield volume available; off-channel cooling
35	CEDAR CREEK RESERVOIR TRINITY	Trinity	C	93%	84%	85%	60%	36%	34%	92%	74%	69%	85%	
36	CHAMPION CREEK RESERVOIR	Colorado	F	37%			38%			29%			69%	
37	CHEROKEE; LAKE	Sabine	I	62%	53%	44%	69%	81%	60%	72%	78%	60%	65%	
38	CHOKE CANYON RESERVOIR	Nueces	N	74%	6%	6%	25%	6%	6%	10%	8%	9%	29%	
39	CISCO; LAKE	Brazos	G	14%			31%			31%			23%	
40	CLYDE; LAKE	Colorado	G	23%			55%			46%			10%	
41	COLEMAN; LAKE	Colorado	F	40%	22%	28%	40%	25%	32%	16%	23%	29%	49%	
42	COLETO CREEK RESERVOIR	Guadalupe	L	65%			81%			55%			48%	

				Percentile rank based on loss in total volume/yr, i.e. Bulk Sedimentation Rate (ac-ft/yr)			Percentile rank based on %loss in volume/yr (%/yr)			Percentile rank based on Effective Watershed Erosion Rate (ac-ft/yr/sq-mi watershed)			Percentile rank based on Professional Judgment	
RES_NUM	RES_NAME	BASIN_NAME	REGION NAME	WAM	HYDRO MAX	HYDRO OVERALL	WAM	HYDRO MAX	HYDRO OVERALL	WAM	HYDRO MAX	HYDRO OVERALL	Criteria Weighting	Special Conditions?
43	COLORADO CITY; LAKE	Colorado	F	50%			59%			32%			81%	
44	CONROE; LAKE	San Jacinto	H	88%	70%	78%	53%	27%	37%	90%	70%	81%	57%	
45	CORPUS CHRISTI; LAKE	Nueces	N	93%	93%	89%	82%	92%	82%	19%	30%	25%	18%	
46	CREEK LAKE; LAKE	Brazos	G	26%			47%			75%			26%	
47	CROOK; LAKE	Red	D	53%	26%	24%	89%	79%	64%	85%	58%	55%	93%	
48	CYPRESS SPRINGS; LAKE	Cypress	D	25%	44%	50%	13%	48%	51%	24%	87%	89%	60%	
49	DANIEL; LAKE	Brazos	G	24%			44%			19%			47%	
50	DAVIS; LAKE	Brazos	G	26%			58%			49%			16%	
51	DIVERSION; LAKE	Red	B	61%			73%			82%			42%	
52	DUNLAP; LAKE	Guadalupe	L	53%			93%			52%			41%	Used for hydroelectric power purposes
53	E. V. SPENCE RESERVOIR	Colorado	F	96%	6%	6%	77%	6%	6%	43%	8%	9%	35%	
54	EAGLE LAKE	Colorado	K	29%			54%			69%			5%	
55	EAGLE MOUNTAIN LAKE	Trinity	C	58%	69%	47%	32%	56%	24%	21%	56%	31%	92%	
56	EAGLE NEST LAKE / MANOR LAKE	Brazos	H	3%			3%			3%			7%	
57	ELECTRA; LAKE	Red	B	29%	29%	32%	66%	94%	96%	82%	90%	93%	32%	
58	ELLISON CREEK RESERVOIR	Cypress	D	22%			24%			35%			15%	
59	FAIRFIELD LAKE	Trinity	C	41%	49%	55%	39%	70%	81%	83%	99%	99%	85%	
60	FALCON RESERVOIR; INTERNATIONAL	Rio Grande	M	98%	99%	97%	63%	93%	35%	29%	53%	22%	9%	87% of watershed in Mexico
61	FARMERS CREEK RESERVOIR	Red	B	63%	38%	42%	87%	69%	83%	88%	66%	77%	97%	
62	FOREST GROVE RESERVOIR	Trinity	C	22%			28%			26%			52%	
63	FORK RESERVOIR; LAKE	Sabine	D	94%	92%	94%	70%	51%	65%	99%	91%	94%	78%	
64	FORT PHANTOM HILL; LAKE	Brazos	G	62%	32%	36%	55%	23%	31%	57%	31%	42%	76%	
65	GEORGETOWN; LAKE	Brazos	G	16%	31%	15%	12%	34%	17%	8%	34%	17%	43%	
66	GIBBONS CREEK RESERVOIR	Brazos	G	28%	19%	23%	26%	21%	27%	26%	36%	47%	61%	
67	GILMER; LAKE	Cypress	D	20%			35%			35%			51%	
68	GONZALES (H-4); LAKE	Guadalupe	L	61%			97%			52%			77%	Used for hydroelectric power purposes
69	GRAHAM; LAKE	Brazos	G	73%	39%	45%	82%	47%	59%	85%	46%	57%	89%	
70	GRANBURY; LAKE	Brazos	G	90%	79%	83%	86%	80%	89%	64%	44%	56%	46%	
71	GRANGER LAKE	Brazos	G	91%	55%	56%	96%	77%	75%	93%	50%	52%	36%	
72	GRAPEVINE; LAKE	Trinity	C	87%	65%	74%	74%	50%	61%	78%	54%	61%	81%	
73	GREENBELT LAKE	Red	A	77%			80%			76%			83%	
74	GULF COAST WATER AUTHORITY RESERVOIR	San Jacinto-Brazos	H	3%	6%	6%	3%	6%	6%	3%	8%	9%	5%	Off-channel reservoir; No significant drainage area
75	HALBERT; LAKE	Trinity	C	41%	14%	17%	85%	49%	62%	98%	71%	80%	28%	
76	HORDS CREEK; LAKE	Colorado	F	32%	17%	21%	73%	66%	80%	60%	45%	56%	31%	
77	HOUSTON COUNTY LAKE	Trinity	I	52%	28%	30%	76%	57%	70%	88%	67%	78%	70%	
78	HOUSTON; LAKE	San Jacinto	H	83%	57%	65%	71%	46%	55%	31%	22%	26%	58%	
79	HUBBARD CREEK RESERVOIR	Brazos	G	67%	6%	6%	34%	6%	6%	31%	8%	9%	65%	
80	HUBERT H. MOSS LAKE	Red	C	51%	6%	6%	65%	6%	6%	82%	8%	9%	92%	
81	IMPERIAL RESERVOIR	Rio Grande	F	52%			91%			47%			40%	Off-channel reservoir
82	INKS LAKE	Colorado	K	3%	24%	29%	3%	59%	72%	3%	62%	72%	57%	
83	J B THOMAS; LAKE	Colorado	F	59%	29%	33%	29%	16%	18%	12%	15%	18%	80%	
84	JACKSONVILLE; LAKE	Neches	I	21%	36%	39%	21%	55%	68%	35%	86%	90%	84%	
85	JIM CHAPMAN LAKE	Sulphur	D	87%	73%	81%	59%	39%	48%	87%	73%	84%	68%	
86	JOE POOL LAKE	Trinity	C	80%			57%			89%			88%	
87	JOHNSON CREEK RESERVOIR	Cypress	D	12%			16%			35%			13%	
88	KEMP; LAKE	Red	B	96%	82%	86%	95%	56%	69%	96%	43%	54%	90%	
89	KICKAPOO; LAKE	Red	B	49%	60%	69%	37%	64%	78%	40%	72%	83%	97%	
90	KIRBY; LAKE	Brazos	G	34%			68%			66%			24%	
91	KURTH; LAKE	Neches	I	7%	13%	17%	8%	22%	28%	52%	99%	99%	27%	

				Percentile rank based on loss in total volume/yr, i.e. Bulk Sedimentation Rate (ac-ft/yr)			Percentile rank based on %loss in volume/yr (%/yr)			Percentile rank based on Effective Watershed Erosion Rate (ac-ft/yr/sq-mi watershed)			Percentile rank based on Professional Judgment	
RES_NUM	RES_NAME	BASIN_NAME	REGION NAME	WAM	HYDRO MAX	HYDRO OVERALL	WAM	HYDRO MAX	HYDRO OVERALL	WAM	HYDRO MAX	HYDRO OVERALL	Criteria Weighting	Special Conditions?
92	LAVON LAKE	Trinity	C	76%	6%	6%	35%	6%	6%	57%	8%	9%	80%	
93	LEON; LAKE	Brazos	G	28%			31%			11%			56%	
94	LEWIS CREEK RESERVOIR	San Jacinto	H	14%			22%			78%			25%	Industrial cooling water reservoir; no firm yield
95	LEWISVILLE LAKE	Trinity	C	92%	94%	84%	56%	75%	38%	84%	88%	64%	69%	
96	LIMESTONE; LAKE	Brazos	G	89%	81%	82%	72%	63%	71%	85%	69%	74%	73%	
97	LIVINGSTON; LAKE	Trinity	H	74%	59%	67%	11%	13%	15%	9%	16%	19%	96%	
98	LOMA ALTA LAKE	Nueces-Rio Grande	M	3%			3%			3%			2%	Used as a water storage facility only; no significant drainage area
99	LOST CREEK RESERVOIR	Trinity	C	27%			42%			58%			20%	
100	LYNDON B. JOHNSON; LAKE	Colorado	K	3%	46%	39%	3%	31%	26%	3%	14%	16%	26%	
101	MACKENZIE RESERVOIR	Red	O	91%			97%			78%			58%	
102	MARBLE FALLS; LAKE	Colorado	K	3%	25%	19%	3%	88%	72%	3%	52%	44%	39%	
103	MARTIN LAKE	Sabine	I	60%	77%	40%	49%	94%	33%	75%	96%	62%	66%	
104	MEDINA LAKE	San Antonio	L	75%	6%	6%	41%	6%	6%	60%	8%	9%	62%	
105	MEREDITH; LAKE	Canadian	A	95%	88%	93%	65%	37%	45%	16%	19%	22%	99%	
106	MILLERS CREEK RESERVOIR	Brazos	B	70%	47%	52%	90%	86%	93%	78%	57%	65%	59%	
107	MINERAL WELLS; LAKE	Brazos	G	34%	6%	6%	70%	6%	6%	98%	8%	9%	33%	
108	MITCHELL COUNTY RESERVOIR	Colorado	F	13%			12%			43%			19%	Used as part of system operation with other reservoirs; no individual yield volume available; off-channel reservoir
109	MONTICELLO RESERVOIR	Cypress	D	19%	48%	53%	16%	78%	88%	35%	95%	99%	14%	
110	MOUNTAIN CREEK LAKE	Trinity	C	39%			49%			68%			53%	
111	MURVAUL; LAKE	Sabine	I	71%	44%	51%	85%	69%	83%	94%	76%	85%	84%	
112	NACOGDOCHES; LAKE	Neches	I	32%	36%	37%	30%	44%	50%	38%	61%	70%	71%	
113	NASWORTHY; LAKE	Colorado	F	12%	20%	25%	20%	60%	74%	8%	39%	49%	43%	
114	NAVARRO MILLS LAKE	Trinity	C	86%	54%	62%	91%	74%	85%	93%	60%	68%	63%	
115	NEW TERRELL CITY LAKE	Trinity	C	27%	12%	14%	48%	17%	19%	62%	20%	24%	22%	Off-channel reservoir
116	NORTH FORK BUFFALO CREEK RESERVOIR	Red	B	38%			58%			80%			11%	
117	NORTH LAKE	Trinity	C	8%			9%			21%			11%	Off-channel reservoir
118	O' THE PINES; LAKE	Cypress	D	54%	80%	79%	23%	58%	58%	19%	75%	75%	68%	
119	O. C. FISHER LAKE	Colorado	F	82%	58%	66%	83%	62%	76%	49%	29%	41%	49%	
120	O. H. IVIE RESERVOIR	Colorado	F	80%			37%			21%			28%	
121	OAK CREEK RESERVOIR	Colorado	F	44%			42%			29%			66%	
122	OLNEY/ LAKE COOPER; LAKE	Red	B	31%		6%	67%	0%	6%	82%		9%	17%	Off-channel reservoir
123	PALESTINE; LAKE	Neches	I	73%	91%	87%	36%	71%	56%	52%	86%	76%	64%	
124	PALO DURO RESERVOIR	Canadian	A	75%			77%			29%			55%	
125	PALO PINTO; LAKE	Brazos	G	57%	78%	72%	72%	99%	97%	35%	82%	67%	55%	
126	PAT CLEBURNE; LAKE	Brazos	G	51%	6%	6%	64%	6%	6%	69%	8%	9%	13%	
127	PAT MAYSE LAKE	Red	D	78%	43%	50%	66%	26%	36%	95%	59%	67%	70%	
128	PEACOCK SITE 1A TAILINGS RESERVOIR	Cypress	D	3%			3%			3%			3%	Used as part of system operations; no individual yield total available; No significant drainage area
129	PINKSTON RESERVOIR	Neches	I	10%			18%			16%			8%	
130	POSSUM KINGDOM LAKE	Brazos	G	90%	95%	95%	50%	89%	86%	11%	38%	37%	30%	
131	PROCTOR LAKE	Brazos	G	64%	40%	41%	64%	40%	43%	21%	21%	23%	42%	
132	RAY HUBBARD; LAKE	Trinity	C	68%	89%	88%	27%	61%	49%	70%	99%	92%	41%	
133	RAY ROBERTS; LAKE	Trinity	C	72%	61%	71%	23%	18%	20%	56%	48%	58%	94%	
134	RED BLUFF RESERVOIR	Rio Grande	F	97%			95%			35%			4%	
135	RED DRAW RESERVOIR	Colorado	F	9%			10%			43%			4%	Used as part of system operation with other reservoirs; no individual yield volume available; off-channel reservoir
136	RICHLAND-CHAMBERS RESERVOIR	Trinity	C	98%	96%	96%	80%	73%	63%	99%	92%	89%	77%	

				Percentile rank based on loss in total volume/yr, i.e. Bulk Sedimentation Rate (ac-ft/yr)			Percentile rank based on %loss in volume/yr (%/yr)			Percentile rank based on Effective Watershed Erosion Rate (ac-ft/yr/sq-mi watershed)			Percentile rank based on Professional Judgment	
RES_NUM	**RES_NAME**	**BASIN_NAME**	**REGION NAME**	**WAM**	**HYDRO MAX**	**HYDRO OVERALL**	**WAM**	**HYDRO MAX**	**HYDRO OVERALL**	**WAM**	**HYDRO MAX**	**HYDRO OVERALL**	**Criteria Weighting**	**Special Conditions?**
137	RIVER CREST LAKE	Sulphur	D	3%			3%			3%			1%	Off-channel reservoir; used for stream turbine, condenser-cooling purposes by Texas Power and Light Company; No significant drainage area
138	SAM RAYBURN RESERVOIR	Neches	I	79%	68%	77%	10%	14%	16%	16%	26%	33%	93%	
139	SANTA ROSA LAKE	Red	B	47%			79%			26%			75%	
140	SMITHERS LAKE	Brazos	H	23%			30%			63%			10%	
141	SOMERVILLE LAKE	Brazos	G	66%	83%	68%	44%	85%	52%	29%	65%	51%	60%	
142	SOUTH TEXAS PROJECT RESERVOIR	Colorado	K	9%			7%			43%			0%	Used as part of system operation with other reservoirs; no individual yield volume available; off-channel reservoir
143	SQUAW CREEK RESERVOIR	Brazos	G	36%	37%	16%	14%	20%	14%	60%	79%	40%	29%	
144	STAMFORD; LAKE	Brazos	G	56%	71%	48%	52%	96%	57%	38%	83%	50%	75%	
145	STILLHOUSE HOLLOW LAKE	Brazos	G	81%	62%	57%	56%	32%	28%	54%	35%	30%	48%	
146	STRIKER; LAKE	Neches	I	57%	42%	49%	84%	90%	94%	65%	57%	66%	73%	
147	SULPHUR SPRINGS DRAW STORAGE RESERVOIR	Colorado	F	84%			98%			43%			86%	Has zero yield; Located in non-contributing area of the Colorado Basin
148	SULPHUR SPRINGS; LAKE	Sulphur	D	35%	63%	72%	46%	98%	99%	56%	99%	99%	86%	
149	SWEETWATER; LAKE	Brazos	G	35%			62%			38%			72%	
150	TAWAKONI; LAKE	Sabine	D	94%	85%	90%	53%	29%	39%	95%	81%	87%	89%	
151	TEXANA; LAKE	Lavaca	P	81%	50%	59%	63%	30%	39%	47%	25%	32%	44%	
152	TEXOMA; LAKE	Red	C	99%	98%	99%	86%	84%	77%	65%	47%	48%	78%	
153	TOLEDO BEND RESERVOIR	Sabine	I	89%			13%			21%			79%	
154	TOWN LAKE	Colorado	K	43%		6%	87%		6%	43%		9%	37%	Used as part of system operations; no individual yield total available; has constant water surface elevation
155	TRADINGHOUSE CREEK RESERVOIR	Brazos	G	37%			38%			70%			95%	
156	TRAVIS; LAKE	Colorado	K	44%	75%	75%	8%	19%	21%	8%	42%	46%	40%	
157	TRINIDAD LAKE	Trinity	C	30%			68%			70%			35%	Off-channel reservoir
158	TWIN BUTTES RESERVOIR	Colorado	F	78%			57%			13%			86%	
159	TWIN OAK RESERVOIR	Brazos	G	42%			46%			73%			86%	
160	TYLER; LAKE	Neches	I	30%	16%	20%	20%	15%	17%	29%	28%	38%	56%	
161	UPPER NUECES LAKE	Nueces	L	3%			3%			3%			7%	Off-channel reservoir
162	VALLEY LAKE	Red	C	21%			28%			80%			23%	
163	VICTOR BRAUNIG LAKE	San Antonio	L	25%	6%	6%	25%	6%	6%	86%	8%	9%	15%	
164	WACO; LAKE	Brazos	G	69%	72%	61%	48%	68%	42%	19%	41%	28%	54%	
165	WALTER E LONG; LAKE	Colorado	K	19%			17%			73%			27%	
166	WAXAHACHIE; LAKE	Trinity	C	46%	23%	28%	79%	65%	79%	92%	77%	86%	19%	
167	WEATHERFORD; LAKE	Trinity	C	38%	34%	34%	54%	67%	73%	52%	55%	59%	88%	
168	WELSH RESERVOIR	Cypress	D	15%	41%	46%	22%	82%	91%	35%	94%	96%	14%	
169	WHITE RIVER LAKE	Brazos	O	85%	50%	58%	96%	87%	94%	26%	18%	21%	51%	
170	WHITE ROCK LAKE	Trinity	C	66%	15%	18%	98%	42%	50%	94%	29%	39%	11%	
171	WHITNEY; LAKE	Brazos	G	95%	86%	91%	74%	45%	53%	91%	63%	71%	39%	
172	WICHITA; LAKE	Red	B	58%			88%			72%			96%	
173	WINTERS; LAKE / NEW WINTERS; LAKE	Colorado	F	31%			61%			52%			79%	
174	WORTH; LAKE	Trinity	C	43%	21%	27%	51%	31%	40%	58%	43%	53%	46%	
175	WRIGHT PATMAN LAKE	Sulphur	D	92%	66%	76%	93%	72%	84%	63%	27%	35%	61%	
176	ADDICKS RESERVOIR	San Jacinto	H	59%			29%			78%			90%	No water supply function
177	ANZALDUAS CHANNEL DAM	Rio Grande	M	97%			99%			47%			99%	No water supply function; 93% of watershed area is in Mexico
178	BARKER RESERVOIR	San Jacinto	H	63%			34%			78%			22%	No water supply function
179	BIVINS LAKE	Red	A	79%			99%			60%			21%	No water supply function
180	BUFFALO LAKE	Red	A	68%			92%			16%			76%	No water supply function
181	CAMP CREEK LAKE	Brazos	G	10%			15%			67%			16%	No water supply function; off-channel reservoir

				Percentile rank based on loss in total volume/yr, i.e. Bulk Sedimentation Rate (ac-ft/yr)			Percentile rank based on %loss in volume/yr (%/yr)			Percentile rank based on Effective Watershed Erosion Rate (ac-ft/yr/sq-mi watershed)			Percentile rank based on Professional Judgment	
RES_NUM	RES_NAME	BASIN_NAME	REGION NAME	WAM	HYDRO MAX	HYDRO OVERALL	WAM	HYDRO MAX	HYDRO OVERALL	WAM	HYDRO MAX	HYDRO OVERALL	Criteria Weighting	Special Conditions?
182	COFFEE MILL LAKE	Red	C	40%			78%			76%			20%	No water supply function
183	DELTA LAKE	Nueces-Rio Grande	M	3%			3%			3%			1%	No water supply function except for pumped storage; no significant drainage area
184	HAWKINS; LAKE	Sabine	D	15%			27%			40%			38%	No water supply function
185	HOLBROOK; LAKE	Sabine	D	11%			19%			24%			52%	No water supply function
186	J.D. MURPHREE WILDLIFE IMPOUNDMENT	Neches-Trinity	I	60%			71%			38%			45%	No water supply function
187	KIOWA; LAKE	Trinity	C	16%			40%			56%			4%	No water supply function
190	NATURAL DAM LAKE	Colorado	F	55%			47%			43%			47%	Located in non-contributing area of the Colorado Basin
191	QUITMAN; LAKE	Sabine	D	17%			39%			35%			82%	No water supply function
192	RITA BLANCA; LAKE	Canadian	A	42%			69%			8%			91%	No water supply function
193	SAN ESTEBAN LAKE	Rio Grande	E	69%			92%			64%			38%	No water supply function
194	TRUSCOTT BRINE LAKE	Red	G	54%			36%			97%			12%	No water supply function
195	WILLIAM HARRIS RESERVOIR	Brazos	H	3%			3%			3%			6%	No water supply function; off-channel reservoir
196	WINNSBORO; LAKE	Sabine	D	20%			41%			46%			72%	No water supply function

9.2 A SUGGESTED METHOD FOR IDENTIFYING RESERVOIRS MOST AT RISK FOR SEDIMENTATION

A variety of methods can be used to synthesize the different rankings to identify the reservoirs that are most at-risk for sedimentation. Instead of creating a single authoritative list, the project team is providing the following method for consideration.

One way of defining the susceptibility of a reservoir to sedimentation risk is to track how many ways it is impacted. As discussed earlier in this report, sedimentation affects reservoir yield, water quality; and is related to surface erosion and other criteria. Therefore the number of times a reservoir has a high ranking for each of the four categories – i.e., I) loss in total volume, II) percent loss in volume, III) sediment erosion, IV) professional judgment/criteria weighting – reflects the range and degree of the impact of sedimentation.

To account for the multiple effects, a scoring system was set up where for each of the categories. Rankings that are higher than 90^{th}-percentile were assigned with a score of 1; while rankings that were below 90^{th} percentile but greater than 67-th percentile were assigned a score of 0.5. For categories I to III, if a reservoir has WAM, 'Hydro Max', and 'Hydro Overall' rankings, the highest rank out of the three was used.

To demonstrate the scoring, Alan Henry Reservoir (Brazos Basin) was used as an example. From Table 9.1, the reservoir has the following statistics:

Percentile ranks for bulk sedimentation rate (ac-ft/yr) – [maximum rank is highlighted in bold]:
WAM 39%
HYDRO MAX 90%
HYDRO OVERALL 94%

Percentile ranks for percent loss in volume/year (%/yr) – [maximum rank is highlighted in bold]:
WAM 24%
HYDRO MAX 97%
HYDRO OVERALL 98%

Percentile ranks for effective erosion rate (ac-ft/sq-mi/yr) – [maximum rank is highlighted in bold]:
WAM 8%
HYDRO MAX 68%
HYDRO OVERALL 79%

Percentile ranks for criteria weighting (ac-ft/sq-mi/yr) – [maximum rank is highlighted in bold]:
Criteria Weighting 74%

For Alan Henry Reservoir, two categories (bulk sedimentation and % loss in volume) have >90% percentile rankings and two categories have >67% percentile rankings (effective erosion and professional judgment/criteria weighting). This gives a total score of 2 x 1 + 2 x 0.5 = **3**.

For comparison, Belton Lake (also in Brazos Basin) has the following statistics:

Percentile ranks for bulk sedimentation rate (ac-ft/yr) – [maximum rank is highlighted in bold]:
WAM 88%
HYDRO MAX 87%

HYDRO OVERALL 73%

Percentile ranks for percent loss in volume/year (%/yr) – [maximum rank is highlighted in bold]:
WAM 51%
HYDRO MAX 54%
HYDRO OVERALL 29%

Percentile ranks for effective erosion rate (ac-ft/sq-mi/yr) – [maximum rank is highlighted in bold]:
WAM 49%
HYDRO MAX 49%
HYDRO OVERALL 34%

Percentile ranks for criteria weighting (ac-ft/sq-mi/yr) – [maximum rank is highlighted in bold]:
Criteria Weighting 55%

For Belton Lake, no category has a ranking >90% percentile and one category (bulk sedimentation rate) has a ranking >67% percentile. This gives a total score of 1 x 0.5 = **0.5**.

Under this method, Alan Henry Reservoir is considered more at risk than Belton Lake for sedimentation.

Scores were computed for all the reservoirs. The team highlighted major TX reservoirs that have scores greater than 2.5 and they are show in Table 9.2. There are in total twenty of these reservoirs. Some of the reservoirs in the list, such as Lake Kemp (TWDB, 2011) and Lake Granger (TSSWCB, 2011), are known for sedimentation issues – thus providing a level of validation for this method. Reservoir maps of these twenty reservoirs can be found in Appendix C for reference.

Table 9.2. List of reservoirs that have two scores higher than or equal to 2.5.

				Does Reservoir hava a high rank in each of the following categories? (score 1 for >90th percentile, 0.5 for >67th percentile)				Summary	
RES NUM	RES_NAME	BASIN NAME	REGION NAME	Category I: Loss in total volume/yr	Category II: Loss in % volume/yr	Category III: Effective Watershed Erosion Rate	Category IV: Criteria Weighting	Score	Explanation for identification as at-risk reservoir
88	KEMP; LAKE	Red	B	1	1	1	0.5	3.5	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
2	ALAN HENRY RESERVOIR	Brazos	O	1	1	0.5	0.5	3	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
5	AMON G. CARTER; LAKE	Trinity	B	0.5	1	1	0.5	3	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
63	FORK RESERVOIR; LAKE	Sabine	D	1	0.5	1	0.5	3	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
71	GRANGER LAKE	Brazos	G	1	1	1	0	3	Total Vol Loss;%Vol Loss;Erosion;
136	RICHLAND-CHAMBERS RESERVOIR	Trinity	C	1	0.5	1	0.5	3	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
148	SULPHUR SPRINGS; LAKE	Sulphur	D	0.5	1	1	0.5	3	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
4	AMISTAD RESERVOIR; INTERNATIONAL	Rio Grande	J	1	0.5	0	1	2.5	Total Vol Loss;%Vol Loss;Criteria Weighting;
7	AQUILLA; LAKE	Brazos	G	0.5	1	1	0	2.5	Total Vol Loss;%Vol Loss;Erosion;
15	BARDWELL; LAKE	Trinity	C	0.5	0.5	1	0.5	2.5	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
35	CEDAR CREEK RESERVOIR TRINITY	Trinity	C	1	0	1	0.5	2.5	Total Vol Loss;Erosion;Criteria Weighting;
89	KICKAPOO; LAKE	Red	B	0.5	0.5	0.5	1	2.5	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
95	LEWISVILLE LAKE	Trinity	C	1	0.5	0.5	0.5	2.5	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
101	MACKENZIE RESERVOIR	Red	O	1	1	0.5	0	2.5	Total Vol Loss;%Vol Loss;Erosion;
103	MARTIN LAKE	Sabine	I	0.5	1	1	0	2.5	Total Vol Loss;%Vol Loss;Erosion;
111	MURVAUL; LAKE	Sabine	I	0.5	0.5	1	0.5	2.5	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
114	NAVARRO MILLS LAKE	Trinity	C	0.5	1	1	0	2.5	Total Vol Loss;%Vol Loss;Erosion;
144	STAMFORD; LAKE	Brazos	G	0.5	1	0.5	0.5	2.5	Total Vol Loss;%Vol Loss;Erosion;Criteria Weighting;
150	TAWAKONI; LAKE	Sabine	D	1	0	1	0.5	2.5	Total Vol Loss;Erosion;Criteria Weighting;
171	WHITNEY; LAKE	Brazos	G	1	0.5	1	0	2.5	Total Vol Loss;%Vol Loss;Erosion;

9.3 DISCUSSION ON TOP TWENTY RESERVOIRS

The list of twenty reservoirs shown in Table 9.2 is by no means authoritative and reflects the weighting preferences of the team. Alternative rankings can be produced either by adjusting the weights and util conversion functions in the DSS tool; or by changing the method of integrating the rankings from sedimentation rates. Stakeholders are encouraged to use their best professional judgment and local knowledge when identifying the most at-risk reservoirs in their region. The list was provided as a reference and illustration of how the knowledge bases can be utilized to identify reservoirs impacted by sedimentation.

10.0 BMP MATRIX

To facilitate watershed planning-level activities associated with reducing sedimentation into at-risk and other reservoirs, stormwater quality structural Best Management Practices (BMPs) with applicability in Texas were identified. Although sedimentation also occurs within streams and reservoirs, typical types of BMPs were identified only for the drainage basins or contributing watersheds prior to entering receiving water bodies. While hundreds of BMPs are currently in use nationwide, this study focused on landscape-based structural BMPs with multi-dimensional functions and benefits, including: water quality, water conservation, habitat, aesthetics, air quality, and flood control. This approach optimizes the cost-benefit ratio for selected BMPs.

In recognition of current and anticipated water quality and Municipal Separate Storm Sewer Systems (MS4) permit requirements, the following Green Infrastructure or Low Impact Development (LID) tools were included: Bioretention, Vegetated Swales, Green Roofs, Permeable Pavement, and Infiltration Trenches/Dry Wells. Agencies managing at-risk reservoirs may wish to consider additional LID tools not specifically investigated for this project, including: Level Spreaders, Vegetated Filter Strips, and Cisterns. Vegetated Buffers are included in Conservation Buffers discussed below.

These Green Infrastructure techniques fall under the category of de-centralized or distributed BMPs with multiple facilities required throughout a site or watershed, whereas centralized BMPs typically consist of either a single or small number of regional BMPs within a watershed. Centralized BMPs investigated in this study include: Stormwater Wetlands, Wet Ponds, Extended Detention, and Retention-Irrigation systems.

The final category of BMPs includes site-wide BMPs such as Soil Amendments/Conservation Tillage and Trees/Native Grasses/Conservation (Vegetated) Buffers. While these types of BMPs are often associated with agricultural and rural operations, they may also be applied within other land uses in a watershed (i.e., Open Spaces, Bare Soil, Urban Grass Lands, etc.) and are also considered LID techniques. Although this study did not address non-structural BMPs, agencies managing at-risk reservoirs may also be interested in effective non-structural agricultural BMPs, including: Crop Nutrient Management, Integrated Pest Management, Irrigation Water Management, Grazing Management, and Animal Feeding Operations Management. Sediment/Erosion Control, which is primarily associated with construction-phase activities, is also applicable for other land uses (i.e., Bare Soil, etc.) within a watershed.

The focus of this study is to investigate and summarize available research, monitoring data, and design guidelines related to regional characteristics that influence sedimentation into reservoirs rather than to develop new data. Table 10.1 summarizes the suite of landscape-based BMPs investigated for this study. Unlike traditional BMP applicability charts, this table identifies ranges of watershed characteristics where each BMP may be applied and can readily be expanded into the fuzzy logic used in geographical information systems (GIS) decision support system (DSS) activities. For example, rather than indicating that Bioretention is only applicable on Type A and Type B soils, Type C soils are noted to be acceptable and Type D soils to be allowable due to abilities to customize designs for clay soils and include gravel storage layers with underdrains.

Table 10.1 also includes typical BMP removal rates of TSS, the indicator pollutant used for this study. While not specifically quantified, most of these BMPs also perform well for other target pollutants, such as nutrients (Phosphorous and Nitrogen), pathogenic bacteria, and metals that affect water quality and treatment costs. The watershed characteristics and land use data is tied to the land use categories used throughout this project. Depth to seasonally high groundwater levels is also included as an important driver in selecting various BMPs. For example, high groundwater tables are ideal for Stormwater Wetlands but not appropriate for Permeable Pavement or Bioretention due to potential for pollutant migration from the BMPs into groundwater. Planning-level costs are provided for construction and annual Operations and Maintenance (O&M) and general comments are included regarding level of O&M and typical O&M activities. Due to the wide variability in planning-level cost ranges and data sources, costs are not converted to a common dollar, but may be adjusted as needed by users of this table.

Based on regional characteristics and land use within the contributing watershed area as well as preferences for centralized, de-centralized, and site-level BMPs, various agencies may select differing types of BMPs to achieve common sediment reduction goals for reservoirs. While this table is intended to provide planning guidelines for regional watershed improvements projects, hydrologic and water quality modeling and detailed watershed management studies are needed to accurately plan for improving water quality and decreasing sedimentation in at-risk reservoirs.

Table 10.1. BMP Characteristics and Selection Matrix.

Landscape-Based BMP	Type of BMP	Total Suspended Solids (TSS) Removal	Watershed/Regional Characteristics										Planning-Level Costs						Level of O&M	O&M Comments
			Soil Types			Depth to SH Water Table	Land Use			Land Slope (%)			New Dvlpt. ($/ impervious ac)	Retrofit ($/ impervious ac)	Volume-Based $/ CY Storage	Area-Based $/Acre of Facility	O&M[3] ($/ impervious ac)	O&M[4] ($/5-acre facility)		
			Ideal	Accept - able	Allow-able		Ideal	Accept - able	Allow-able	Ideal	Accept - able	Allow-able								
Extended Detention	Centralized	75[EA]	ABCD			>5	com/ res	ag/ os/ ugrs	ind/ trans/ bs	0-3	3-7	7-10	---	---	5 - 10	---	---	2,020	low - med	shallow detention basin mowing w/ structural components
Retention-Irrigation	Centralized	100[EA]	AB	C	D	>5	com/ res	ag/ os/ ugrs	ind/ trans/ bs	0-3	3-7	7-10	---	---	5 - 10	---	---	2,020	high	irrigation system, vegetation maintenance, detention/retention basin
Stormwater Wetlands	Centralized	68[CPR]	D	C	AB	0-2	os/ ag/ ugrs	res/ com/ trans	f/ ind/ bs	0-2	2-5	5-8	---	---	---	26,000 - 55,000	---	2,630	med - high	vegetation maintenance, periodic sediment removal
Wet Ponds	Centralized	65[CPR]	D	C	AB	>5	os/ ugrs/ ag	res/ comm/ trans	f/ ind/ bs	0-3	3-7	7-10	---	---	5 - 10	---	---	3,090	med - high	periodic sediment removal, vegetation
Bioretention	Distributed/ De-Centralized	85[CPR]	AB	C	D	>5	res/ com/ trans	os/ ugrs	f/ ag/ ind/ bs	0-3	3-7	7-12	110,000	160,000	---	---	3,100	---	med - high	similar to high-end vegetation w/ structural components
Green Roofs	Distributed/ De-Centralized	Preventative BMP	ABCD			0+	com/ ind	res		0+			250,000	500,000	---	---	4,000	---	med	vegetation maintenance, irrigation, inspections
Infiltration Trenches/ Dry Wells	Distributed/ De-Centralized	95[CPR]	A	B	C	>4	com/ res	trans	ind/ bs	0-5	5-10	10-15	110,000	160,000	---	---	2,900	---	med	sediment removal
Permeable Pavement	Distributed/ De-Centralized	93[EA]	AB	C	D	>3	com/ trans	res	ind/ bs	0-2	2-3	3-5	110,000	160,000	---	---	2,400	---	med	requires vaccuum sweeping equipment twice per year
Vegetated Swales	Distributed/ De-Centralized	70[EA]	ABCD			>5	res/ os/ ugrs/ ag/ trans	com	f/ ind/ bs	0-5	5-10	10-15	110,000	160,000	---	---	3,100	---	low - med	similar to vegetation
Soil Amendments/ Conservation Tillage	Site-Wide	Preventative BMP	ABCD			0+	ag/ bs/ os/ ugrs	res	trans/ comm/ ind	0-5	5-10	10-15	50,000	50,000	---	---	3,100	---	low	mowing, vegetation maintenance, aeration, amending/deep tilling for clogging
Sediment/ Erosion Control (Prevents TSS)	Site-Wide	80 - 99[NC]	ABCD			0+	ag/ bs	os/ ugrs/ res	trans/ comm/ ind	0+			---	---	---	0 - 8,000 (Construction + O&M/ac)		---	high	inspection and modify to continue functioning, monitoring, operating active treatment systems
Trees/ Native Grasses/ Conservation (Vegetated) Buffers	Site-Wide	80 - 94[NC]	ABCD			0+	ag/ bs/ os/ ugrs	res/ trans	comm/ ind/ f	0+			15,000	18,000	---	---	1,800	---	low	pruning, mulching, irrigation

Notes:

1. Land Use Categories refer to:
- *Agriculture = ag*
- *Bare Soil = bs (may also include construction sites)*
- *Commercial/Industrial/Transportation = com/ind/trans (Brownfields excluded for these purposes)*
- *Forested = f*
- *Low and High Intensity Residential = res*
- *Open Space/Grasslands = os*
- *Urban/Recreational Grasses = ugrs*

2. TSS Removal rates based on the National Pollutant Removal Database/Other Sources Summarized by Cost and Pollutant Removal of Storm-water Treatment Practices (CPR) and the Edwards Aquifer Authority Technical Guidance Manual (EA). EA rates based on sizing methodology in Manual.

3. Construction and O&M costs per impervious acre treated are in 2009 dollars from Planning-Level Cost Estimates for Green Stormwater Infrastructure in Urban Watersheds. Bioretention construction costs used for Vegetated Swales.

4. Stormwater wetlands construction costsin 1999 dollars from EPA Storm Water Technology Fact Sheet Storm Water Wetlands.

5. Volume-based construction costs in $/cubic yard based in approximately 2006 dollars from Costs of Urban Stormwater Practices by Narayanan and Pitt, University of Alabama.

6. O&M costs per five-acre facility are in 2011 dollars from North Carolina State University's Determining Inspection and Maintenance Costs for Structural BMPs in North Carolina. Dry detention basin costs for 0.8 to 2.0-acre facilities listed for Retention-Irrigation and Extended Detention basins. Bioretention O&M costs used for Vegetated Swales and Soil Amendments/Conservation Tillage, although actual costs may be lower due to lack of structural components.

7. Level of O&M includes consideration for specialized and/or heavy equipment as a higher level of O&M. Edwards Aquifer Authority Technical Guidance Manual considered as starting point for consistency for those BMPs included in the Manual.

8. Depth to Seasonally High Groundwater Table (SHWT) based on minimum clearance of two feet below bottom of stormwater facility and SHWT as well as typical stormwater facility depths.

9. Construction costs for Soil Amendments/Conservation Tillage in 2005 dollars from Fairfax County LID BMP Fact Sheet.

10. Sediment/Erosion Control BMP includes Vegetative/Cover options only, such as: Preserve Natural Vegetation, Wood Fiber, Straw, Seed + Mulch, Permanent Vegetation, and Degradable Blankets. Costs do not encompass Sod or Blankets/Mats or include Sediment Basins, Filter Fabric, or Other Structural Measures associated with Construction-Phase BMPs.

11. Sediment/Erosion Control BMP cost includes construction and O&M from Modeling Cost-effectiveness of Standard and Alternative Sediment and Turbidity Control Systems on Construction Sites: a Case Study from NC (NC) by North Carolina State University.

11.0 CONCLUSIONS

This study provided a comprehensive overview of the available and accessible data to characterize and manage sedimentation risk in major Texas reservoirs. The key contributions are the development of four knowledge bases where future sedimentation research and watershed protection plans may be built upon. These are:

1. a detailed identification and quantification of sedimentation risk-related criteria to address various aspects of sedimentation related issues – ranging from watershed erosion characteristics to cultural and economics;
2. a substantive compilation, analysis and consolidation of available empirical sedimentation rates from TCEQ WAM and TWDB hydrographic surveys;
3. a versatile decision support system tool for stakeholders and interested parties to contribute their professional knowledge on sedimentation by assigning weights and utilities to risk-related criteria and then using them to generate rankings. The tool also contains a built-in set of recommended weights and utilities for users to use as reference; and,
4. an informative Best Management Practices (BMP) matrix that lists commonly-used landscape-based structural BMPs that meet current and anticipated MS4 permit requirements along with their efficiency, costs (planning level) and applicability in different watershed environments.

In the process of this study, the team identified limitations to available datasets that can be improved upon in future studies. It was noted that current measurement and analytical methods for determining empirical sedimentation rates were uncertain and highly dependent on the quantification approach. For this reason, risk-related criteria data as well as professional knowledge was used to supplement the information. In the end, a simple and practical approach was used to synthesize rankings of sedimentation risk from the different knowledge bases to help identify the reservoirs that are most at risk in Texas. A the top 20 list of at-risk reservoirs was presented in Chapter 9.

Future studies may adopt more rigorous approaches to synthesize the information in the knowledge bases for a variety of applications. For instance, statistical studies on correlations between sedimentation rates and risk-related criteria measures (e.g. soil erodibility, channel lengths) can be used to analyze relative impacts among different criteria. Sedimentation rates, risk-related criteria measures, professional knowledge and BMPs can be connected mechanistically via a model framework to support watershed protection planning. The information developed through this research will be useful for future studies on reservoir sedimentation at state, regional and local levels.

11.1 RECOMMENDATIONS

While this study identifies at-risk reservoirs in the State and provides a planning tool for agencies managing Texas' reservoirs and water supply, future efforts are needed to develop detailed watershed management studies and plans for improving water quality and decreasing sedimentation in at-risk reservoirs. As a starting point, selecting reservoirs from the top twenty are ideal candidates for a pilot project aimed at identifying appropriate landscape-based structural BMPs and hydrologic and water quality modeling to assess the effect and impact of watershed-scale implementation of a consistent BMP program. While modeling efforts may also include non-structural BMPs, an emphasis on structural BMPs such as those listed in Table 10.1 are suggested. Furthermore, Table 10.1 serves as a starting point in the planning process for selecting appropriate BMPs for the pilot project. Unlike traditional BMP applicability charts, this table identifies ranges of watershed characteristics where each BMP may be applied and can readily be expanded into the fuzzy logic used in GIS and DSS activities. Given the large quantity of GIS data compiled and developed for this project, Table 10.1 facilitates identification of recommended locations for various BMPs. Developing a watershed management plan for individual reservoirs most at-risk from sedimentation is the most practical method for ensuring implementation of solutions that will maintain reservoir volume. Watershed management plans targeted at sediment management will also provide corollary benefits of improving water quality since BMPs for sediment will also reduce other pollutants of concern.

12.0 REFERENCES

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Appendix **A** DSS input table

RES_NUM	RES_NAME	BASIN_NAME	REGION_NAME	DAM_IMPOUND_DATE	DAM_IMPOUND_YEAR	DAM_LAT	DAM_LONG	WSHD_KFACT	WSHD_DEVELOPED_PCT	WSHD_BARREN_PCT	WSHD_FOREST_PCT	WSHD_SHRUBGRASSPASTURE_PCT	WSHD_AGRI_PCT	WSHD_WETLANDS_PCT	PCT_MX	WSHD_3RDSTREAM_MILES	WSHD_ALLSTREAM_MILES	WSHD_AREA_ACRES	WSHD_MSI_INV_MILE	WSHD_PCP_IN	WSHD_AREA_RES_VOLUME_INDEX	WSHD_SLOPE_PCT	WSHD_TMP_C	RES_AREA_ACRES	RES_FLOW_CFS	RES_PERIM_MILES	RES_SLD	RES_YIELD_ACFT_PER_YR	RES_STORAGE_ACFT	RES_TIME_DAYS	RES_TSS_MEDIAN_MGL	NHDPLUS_NOTES	SEDRATE_WAM	WAM_NOTES	SEDRATE_HYDRO_MAX	SEDRATE_HYDRO_OVERALL	NUM_HYDRO_SURVEYS
1	ABILENE; LAKE	Brazos	G	8/1/1921	1921	32.23	-99.88	0.15878904	0.6635402	2.481168	28.61189	61.022091	6.0411573	0.20109937	0	2.875	85.09375	66575.131	0.027477479	26.179913	27.648399	0.74009465	17.254248	407.72387	6.96	6.4	2.2488115	1088	7900	572.25814			0.49	Original units were in ac-ft/yr.			0
2	ALAN HENRY RESERVOIR	Brazos	O					0.30878293	0.48304778	1.4080858	0.005195304	35.374303	62.377224	0.039924767	0	53.2	313.84375	935396.9	0.036188182	19.901495	32.3695	0.7176186	15.623284	2732.9855	47.24	89.60625	12.161182	22500	94808	1011.8339			0.02	Original units were in ac-ft/yr.	1.248383093	1.2484422	1
3	ALCOA LAKE	Brazos	G	1/13/1953	1953	30.57	-97.04	0.219	0.004052245	1.6316862	73.060514	12.23431	0.40233544	0.41838593	0	0	5.8375	5480.7973	0	36.004326	1.1489852	0.23519838	19.550674	894.52147	1.96	13.35625	3.1684386	7800	15650	4025.6165			0.37	Original units were in ac-ft/yr.		0	0
4	AMISTAD RESERVOIR; INTERNATIONAL	Rio Grande	J	5/31/1968	1968	29.43	-101.05	0.17427659	0.35641699	1.3408724	7.9144922	51.834937	0.39590055	0.053316177	37.865631	9605.25	51023.147	64179575	0.095227613	13.584015	66.818495	1.1176728	16.431367	41259.185	8298.75	654.85	22.873765	1067310	3151267	191.44616	4	Significant portion of watershed is in Mexico, where no data is available.	0.12	Original units were in ac-ft./sq. mi./yr.	0.063083241	0.063080514	1
5	AMON G. CARTER; LAKE	Trinity	B	5/31/1956	1956	33.46	-97.86	0.2870148	0.80169826	0.60501606	20.280093	70.602504	3.8861971	0.050207821	0	19.84375	113.16875	70687.706	0.17862035	32.199728	11.652852	0.48841161	17.892362	1608.656	18.59	29.94375	5.2970093	2108	19902	539.74852	5		2.07	Original units were in ac-ft./sq. mi./yr.			0
6	ANAHUAC; LAKE	Trinity	H	12/31/1952	1952	29.77	-94.68	0.30034335	2.1067601	1.3625755	56.777011	21.3947	4.2706321	11.947842	0	257.22375	941.105	758202.32	0.21586241	50.733366	70.46857	0.19049368	19.356426	5016.2392	102.42	13.2125	1.3235856	14326	35300	173.7657			0.1	Original units were in ac-ft./sq. mi./yr.	0	0	1
7	AQUILLA; LAKE	Brazos	G	4/29/1983	1983	31.91	-97.2	0.31634361	2.0407224	0.83913296	13.556761	49.450824	30.415602	0.091505486	0	37.575	170.8625	164569.96	0.14527788	34.649233	11.973913	0.28239349	18.798552	3115.9988	66.01	48.85625	6.2098003	12437	45092	344.4006	9		2.07	Original units were in ac-ft/yr.	1.668882263	1.2029834	3
8	ARLINGTON; LAKE	Trinity	C	3/31/1957	1957	32.72	-97.19	0.31085446	23.804712	0.019177148	14.101934	52.42908	6.9008724	0.00578875	0	17.58125	77.4	91478.658	0.12228721	34.150887	7.7472081	0.29730586	18.19351	1910.1246	44.67	24.00625	3.8971724	8333	38740	437.23789	10		1.3	Original units were in ac-ft./sq. mi./yr.	1.777595337	0.76148182	3
9	ARROWHEAD; LAKE	Red	B	10/31/1966	1966	33.76	-98.35	0.31738947	0.31778673	0.18267956	2.5773894	80.438966	10.529661	0.64658022	0	120.625	565.82688	347826.52	0.22066106	29.412936	4.8354986	0.24770172	17.807461	13748.943	86.75	109.59375	6.6314312	30197	235997	1371.5484	7		0.07	Original units were in ac-ft./sq. mi./yr.	1.385961783	1.3859087	1
10	ATHENS; LAKE	Neches	I	11/1/1962	1962	32.2	-95.72	0.2056387	1.9979169	0.63658224	35.850752	42.720655	7.4623325	0.60016346	0	0	13.50625	14663.974	0	40.345011	1.634454	0.21980756	18.664686	1465.3349	15.42	26.71875	4.9522645	6064	29435	962.39597			0.26	Original units were in ac-ft./sq. mi./yr.	4.1	4.1154717	1
11	AUSTIN; LAKE	Colorado	K	12/31/1939	1939	30.29	-97.78	0.22264972	18.476774	0.71498448	55.864116	21.254634	0.058892707	0.061439668	0	22.2875	103.78125	58182.691	0.2437354	32.570122	8.7547285	1.2530731	19.885472	1406.0296	3005.54	51.84375	9.8096908	Sys. Op.	21804	3.6575291	3		0.22	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Colorado Basin)	0	0	2
12	B A STEINHAGEN LAKE	Neches	I	4/16/1951	1951	30.76	-94.15	0.32637621	1.3199152	3.8265521	65.480793	19.435403	1.0408685	8.0042295	0	686.9075	3333.7762	2053108.6	0.21288124	45.387712	100.58718	0.41767316	18.784641	9503.6728	5440.38	212.49375	15.465236	Sys. Op.	66966	6.2058211	15		0.04	Original units were in ac-ft./sq. mi./yr.	0.250393236	0.20130045	2
13	BALLINGER; LAKE / MOONEN; LAKE	Colorado	F					0.25732937	0.39656577	2.971071	3.4104102	54.996302	37.133649	0.16227983	0	53.6	178.26875	147818.93	0.23072029	25.049838	70.798578	0.44301677	17.591889	948.88465	13.14	14.60625	3.3642492	0	6850	262.82661			0.2	Original units were in ac-ft./sq. mi./yr.			0
14	BALMORHEA; LAKE	Rio Grande	E	12/31/1917	1917	30.95	-103.67	0.21007483	0	0.0228579	0.062412513	92.0472	0	0.004533404	0	0	5.8	4660.4074	0	14.67584	2.4078821	0.84787328	17.470238	560.92921	0.1	5.0375	1.5090971		6350	32014.583			0.13	Original units were in ac-ft./sq. mi./yr.	5.96	5.51	1
15	BARDWELL; LAKE	Trinity	C	11/20/1965	1965	32.27	-96.61	0.30720059	7.1987073	0.12677656	9.3199578	57.16048	19.759447	0.27522955	0	5.63125	90.65	92575.559	0.038704328	36.970803	6.5852651	0.28548828	18.508124	3246.9647	85.9	27.125	3.3774358	8567	46122	270.70052	12		1.39	Original units were in ac-ft./sq. mi./yr.	1.749617639	1.7481098	1
16	BASTROP; LAKE	Colorado	K	4/30/1964	1964	30.15	-97.29	0.27728351	1.4243656	0.16235284	72.681399	7.7918592	0.44417895	0.7713831	0	0	7.5	5667.1147	0	36.174255	1.1207292	0.28645243	19.795002	845.10039	2.87	17.475	4.2650014	Sys. Op.	16590	2914.3293			0.69	Original units were in ac-ft./sq. mi./yr.			0
17	BAYLOR; LAKE	Red	A	12/31/1949	1949	34.47	-100.37	0.38245122	0	0.14824223	0.030353436	50.638475	47.943088	0.060532835	0	0	24.49375	25135.559	0	20.701132	8.9442242	0.27914235	16.460972	130.96585	1.88	6.925	4.2933559	0	9220	2472.5621			1.33	Original units were in ac-ft./sq. mi./yr.			0
18	BELTON LAKE	Brazos	G	3/8/1954	1954	31.08	-97.48	0.26710708	1.3856437	0.99997685	19.449223	67.523094	8.393452	0.042435864	0	390.625	1715.2956	1461728.9	0.17003733	31.106287	11.018895	0.55758911	18.295097	12352.798	814.21	159.075	10.154894	211856	435225	269.49551	5		0.25	Original units were in ac-ft/yr.	0.608789197	0.19293889	4
19	BENBROOK; LAKE	Trinity	C	9/29/1952	1952	32.65	-97.43	0.23259812	4.1502551	3.7852729	9.6291831	74.955926	5.035791	0.000107172	0	66.7	255.35563	206779.02	0.20524398	32.754134	7.9208956	0.50938308	17.757467	3671.9859	134.95	38.225	4.4756193	6834	85648	319.97678	10		0.13	Original units were in ac-ft./sq. mi./yr.	0.176476692	0.17770602	1
20	BOB SANDLIN; LAKE	Cypress	D	8/8/1977	1977	33.07	-95	0.25876652	0.63547783	1.0352092	41.2093	42.684779	2.1072015	0.88571025	0	25.53125	115.1625	83192.473	0.19527161	44.167497	1.3607666	0.31621406	17.320322	8567.1434	172.86	88.23125	6.7633297	60430	200579	585.01241			0.36	Original units were in ac-ft./sq. mi./yr.	3.447568866	2.891587	2
21	BONHAM; LAKE	Red	C	11/30/1969	1969	33.65	-96.13	0.32741653	1.6599196	0.059722303	18.742365	69.487968	2.8679874	0.24597048	0	0	25.6	16906.95	0	43.536624	5.0307453	0.29402952	17.120395	872.28198	16.89	20.1	4.828628	5340	11026	329.12621			0.85	Original units were in ac-ft./sq. mi./yr.	1.022392056	1.0370411	1
22	BRADY CREEK RESERVOIR	Colorado	F	1/7/1963	1963	31.14	-99.39	0.23307448	0.44260733	0.43671758	3.6236814	79.064418	15.715428	0.006524814	0	78.21875	396.64125	335515.97	0.14833674	25.223223	37.814299	0.38648194	18.362579	1633.3665	52.75	24.175	4.244053	0	29110	278.22354	7.5		0.08	Original units were in ac-ft./sq. mi./yr.			0
23	BRANDY BRANCH COOLING POND	Sabine	D	6/20/1983	1983	32.43	-94.48	0.2648037	0.9766455	9.5162433	34.078272	8.3065435	0	1.1897325	0	0	5.1625	2567.9191	0	47.181633	0.28546511	0.628495	17.930018	1146.569	2.97	18.71875	3.9222286	11000	29513	5009.9228			0.2	Original units were in ac-ft./sq. mi./yr.			0
24	BRAZORIA RESERVOIR	Brazos	H	5/1/1954	1954	29.06	-95.52	0.16440869	0.040704739	0.014070474	33.594885	7.8093074	0	4.093791	0	0	6.3875	2033.6773	0	53.91955	0.30369457	0.028945322	20.460096	1873.0588	1.52	7.55	1.2377342	Pass-through	21970	7287.1985		Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0.48	Original data are missing or highly out of range. A suggested replacement rate is used.(Suggest using average rate for basin (0.48). This is the average excluding 10.57 Camp Creek Lake rate.)			0
25	BRIDGEPORT; LAKE	Trinity	C	4/1/1932	1932	33.22	-97.83	0.28707381	0.21477377	0.043003488	16.334143	77.326826	3.418095	0.10486607	0	161.10625	868.05625	680843.52	0.15056227	31.154833	6.0991782	0.40465626	17.759437	11917.892	184.28	135.1875	8.7860354	Sys. Op.	366236	1001.9752	5		0.36	Original units were in ac-ft./sq. mi./yr.	0.655396987	0.27910652	3
26	BROWNWOOD; LAKE	Colorado	F	7/31/1933	1933	31.83	-99	0.25979594	1.0409697	0.69566076	6.9060583	79.637556	10.137961	0.014185293	0	186.78125	1002.5188	750951.26	0.15826052	27.371862	18.74587	0.49228982	17.922208	6644.6636	185.63	145.29375	12.64639	29712	131429	356.95804	9		0.24	Original units were in ac-ft./sq. mi./yr.	0.265987859	0.24734598	2
27	BRYAN UTILITIES LAKE	Brazos	G	10/23/1975	1975	30.7	-96.45	0.31679906	0.14859797	0.66143581	21.734307	60.791841	0.10743243	0.60125	0	0	4.15	2925.7277	0	38.790556	0.63038316	0.53465372	19.765642	761.08456	1.78	11.425	2.9382984	85	15227	4312.8909			0	Original units were in ac-ft/yr.			0
28	BUCHANAN; LAKE	Colorado	K	5/20/1937	1937	30.75	-98.41	0.22631716	0.65501626	0.50665219	14.01338	75.310771	8.4716015	0.013729548	0	891.35937	5017.0781	3687196.5	0.15381816	26.287438	13.661215	0.53993835	18.288469	21888.594	1933.6	128.39375	6.157311	381545	885507	230.887	5.5		0.08	Original units were in ac-ft./sq. mi./yr.	0.334236151	0.26388462	2
29	CADDO LAKE	Cypress	D	12/31/1914	1914	32.69	-94.05	0.27458095	0.76629999	1.2305309	69.977565	18.865985	1.2960892	5.4910611	0	329.2825	1371.5	1194865.9	0.17534788	46.705638	65.554582	0.24758991	17.750399	25437.028	2034.55	199.625	8.8805097	10000	59800	14.818592	6		0.11	Original units were in ac-ft./sq. mi./yr.			0
30	CALAVERAS LAKE	San Antonio	L	1/31/1969	1969	29.27	-98.3	0.29043567	1.8876777	0.27229969	15.076207	63.03246	10.032419	0.48969721	0	2.875	50.4375	39834.375	0.045923069	29.702157	2.0678831	0.37508709	20.55781	3212.3699	56.92	50.64375	6.3397076	37000	63200	559.79152			1.07	Original units were in ac-ft/yr.			0
31	CANYON LAKE	Guadalupe	L	6/16/1964	1964	29.85	-98.2	0.18898929	2.0787088	0.52853127	49.396187	44.260062	2.5015943	0.021347541	0	244.2625	1259.8044	915792.3	0.16971134	30.775022	7.9322036	0.76556786	18.061195	8278.0301	329.76	96.29375	7.5091493	88107	378781	579.11437	4		0.25	Original units were in ac-ft/yr.	0.391480388	0.1410558	2
32	CASA BLANCA LAKE	Rio Grande	M	12/31/1949	1949	27.53	-99.44	0.30184227	1.0038042	1.2494827	1.1505733	93.830139	0.80586651	0.054995235	0	17.73125	113.78125	75043.432	0.1503411	21.653212	12.310275	0.41363387	22.40336	1047.7268	4.1	19.9	4.3619953	0	20000	2459.3496			0.61	Original units were in ac-ft./sq. mi./yr.	0	0	0
33	CEDAR BAYOU GENERATING POND	Trinity-San Jacinto	H	5/1/1972	1972	29.75	-94.81	0.337	0	0.03	7.43	6.42	0.23	14.74	0	0	1.575	1116.9163	0	51.615355	0.26650354	0.005	20.166	2589.6644	1.4	12.5125	1.7445302	Cooling	13750	4951.6369			0	Original data are missing or highly out of range. A suggested replacement rate is used.(no significant drainage area)			0
34	CEDAR CREEK RESERVOIR COLORADO	Colorado	K					0.310455	0.84502	1.75	27.8	37.48	2.12	0.22251	0	0	6.68125	8846.3725	0	38.755512	0.40649206	0.309	20.37	2391.9801	4.47	18.56875	2.693767	Sys. Op.	71400	8053.132		Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0.69	Original units were in ac-ft./sq. mi./yr.	5.96	5.51	1
35	CEDAR CREEK RESERVOIR TRINITY	Trinity	C	7/2/1965	1965	32.18	-96.06	0.31152321	3.470828	0.20847289	15.042961	65.321983	6.5745214	3.1176238	0	138.05625	682.04375	589033.74	0.14913067	40.070112	2.9976228	0.20212307	18.051983	32583.315	608.12	269.275	10.584115	175000	644686	534.482	10		1.39	Original units were in ac-ft./sq. mi./yr.	1.430324862	0.94199283	2
36	CHAMPION CREEK RESERVOIR	Colorado	F	2/28/1959	1959	32.28	-100.86	0.27422611	0.52955603	0.74040807	0.41851308	46.779499	50.133794	0.001273868	0	4.74375	105.69375	113021.06	0.026706286	22.964385	8.9097027	0.42884352	17.513396	1107.0321	6.03	20.73125	4.4208067	0	41618	3479.6697			0.15	Original units were in ac-ft./sq. mi./yr.			0
37	CHEROKEE; LAKE	Sabine	I	10/1/1948	1948	32.36	-94.6	0.28126641	2.1768239	3.0369282	46.339668	34.671994	2.8320627	7.4889096	0	16.86875	97.79375	102341.16	0.10487781	46.151399	8.6042842	0.29186995	18.016213	3775.7702	118.44	52.46875	6.0583462	28885	39023	166.11023	4		0.67	Original units were in ac-ft./sq. mi./yr.	1.620199147	0.68116901	4
38	CHOKE CANYON RESERVOIR	Nueces	N	10/12/1982	1982	28.48	-98.24	0.25012628	0.55727504	0.40193234	24.868065	62.951198	10.268902	0.20878671	0	1038.875	4868.82	3489997.7	0.18940403	25.613563	16.46879	0.46148445	20.323211	19728.893	722.33	108.40625	5.4759453	168299	695262	485.27394	9		0.04	Original units were in ac-ft/yr.	0	0	1
39	CISCO; LAKE	Brazos	G	9/7/1923	1923	32.44	-98.98	0.26287618	1.6447609	0.087431884	8.5677686	81.059165	3.9693203	0.029943654	0	0	15.3375	17050.271	0	26.874284	6.3567286	0.55481087	17.935864	536.21867	4.19	16.35625	5.0115137	1340	8800	1058.8703	4		0.16	Original units were in ac-ft/yr.			0
40	CLYDE; LAKE	Colorado	G	11/30/1969	1969	32.31	-99.47	0.27617994	0.82138224	0.11518091	0.49828827	62.079995	34.176212	0.15797018	0	0	16.30625	24858.801	0	25.715685	14.188892	0.45411948	17.849307	402.78176	5.67	8.73125	3.0867231	500	5748	511.10229			0.23	Original units were in ac-ft./sq. mi./yr.			0
41	COLEMAN; LAKE	Colorado	F	4/30/1966	1966	32.03	-99.46	0.25273928	0.68738782	0.59480481	4.6133982	72.778041	19.833515	0.13014197	0	34.40625	251.69375	195008.64	0.11226246	26.036768	15.994804	0.53103669	17.581058	1823.6377	27.19	26.325	4.373763	0	40000	741.69425	5		0.1	Original units were in ac-ft./sq. mi./yr.	0.154298951	0.15546124	1
42	COLETO CREEK RESERVOIR	Guadalupe	L	8/31/1979	1979	28.72	-97.15	0.28348815	0.59328817	0.13543616	23.625477	68.31256	5.5011872	0.81227976	0	111.3625	618.1125	315638.08	0.22449188	34.329192	33.36205	0.39171333	21.042325	2693.4486	85.35	81.29375	11.113707	20848	31040	183.35481			0.28	Original units were in ac-ft/yr.			0
43	COLORADO CITY; LAKE	Colorado	F	4/30/1949	1949	32.31	-100.9	0.30623827	0.88768211	0.73074375	0.34318081	67.953871	29.256902	0.024932125	0	40.525	182.60625	216267.12	0.11922946	20.128313	22.535741	0.31559736	17.403854	1257.7664	11.55	26.75	5.3515543		31485	1374.3452	10		0.17	Original units were in ac-ft./sq. mi./yr.			0
44	CONROE; LAKE	San Jacinto	H	1/31/1973	1973	30.35	-95.56	0.25409159	2.3240735	1.4484019	53.340609	29.446113	1.1106522	4.9536245	0	90.0625	542.3875	284166.49	0.20166113	44.683913	2.2401049	0.4038422	19.597743	19714.067	270.26	189.55625	9.5786904	79800	416188	776.39353	7		1.37	Original units were in ac-ft./sq. mi./yr.	1.360764736	1.3596988	1
45	CORPUS CHRISTI; LAKE	Nueces	N	4/26/1958	1958	28.04	-97.86	0.23854834	0.40678308	0.8827264	12.79998	80.595566	4.5882497	0.19056663	0	1701.6369	8711.8088	7029369.8	0.15402867	24.21943	89.749954	0.38616208	20.989803	18799.777	2322.93	233.3875	12.076953	Sys. Op.	256961	55.770588	15		0.11	Original units were in ac-ft/yr.	0.228326812	0.10708422	2
46	CREEK LAKE; LAKE	Brazos	G	6/30/1952	1952	31.45	-96.98	0.33559479	0.88981951	0.20428945	12.908481	63.401766	14.79951	0.045972369	0	0	10.06875	8871.5773	0	35.210485	3.4650269	0.28926731	19.155493	553.51604	3.55	15.225	4.5914339	9991	8400	1192.9577			0.74	Original units were in ac-ft/yr.			0
47	CROOK; LAKE	Red	D	12/31/1923	1923	33.72	-95.56	0.31891561	4.2800013	0.044042992	16.109935	62.575416	9.1473834	4.1327605	0	11.28125	60.0875	40693.314	0.17639458	45.587741	14.519658	0.26452113	17.23186	1055.14	36.92	13.31875	2.9091397	1000	9195	125.56372	28		0.96	Original units were in ac-ft./sq. mi./yr.	0.881016289	0.44500313	3
48	CYPRESS SPRINGS; LAKE	Cypress	D	7/7/1970	1970	33.05	-95.14	0.26017779	0.5860986	0.11893624	43.793052	42.784696	2.3273767	2.2429496	0	10.78125	48.36875	47035.026	0.14584743	43.918844	2.2797559	0.34324261	17.271534	3227.1962	55.29	48.14375	6.0128916	10737	67689	617.22802	6		0.13	Original units were in ac-ft./sq. mi./yr.	2.504467527	2.2234139	2
49	DANIEL; LAKE	Brazos	G	6/30/1949	1949	32.64	-98.86	0.29018115	0.002019674	0.028479512	9.3163041	84.23075	4.4810387	0	0	1.73125	82.025	53882.563	0.020443846	28.286822	18.736626	0.49807688	17.697092	909.34779	13.25	17.08125	4.0189332	175	9435	359.00472			0.11	Original units were in ac-ft/yr.			0
50	DAVIS; LAKE	Brazos	G	12/31/1959	1959	33.52	-99.74	0.33169065	0.92291029	0.1526821	0.19821425	44.060625	51.300739	0.20007941	0	0	27.00625	24893.89	0	25.359307	14.974857	0.23649014	17.641548	494.21075	3.21	8.275	2.6409979	0	5454	856.61215			0.25	Original units were in ac-ft/yr.			0
51	DIVERSION; LAKE	Red	B	12/31/1924	1924	33.82	-98.93	0.33399037	0.003537204	0.52087012	0.44457083	92.735738	1.3551874	0.20350275	0	19.475	137.06875	79364.317	0.15613607	26.579541	7.7911917	0.1910659	17.401333	3284.0305	129.38	39.525	4.8935545	Sys. Op.	33420	130.23072	7.4		0.84	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Red Basin)			0
52	DUNLAP; LAKE	Guadalupe	L	12/31/1928	1928	29.65	-98.06	0.19693262	6.6788993	1.3013299	62.189978	26.313957	2.7378975	0.044407049	0	46.6875	202.2125	149204.7	0.19909905	34.139485	82.968939	0.68640534	19.591677	291.58435	438.89	6.7875	2.8202258	Hydro	5900	6.7775145			0.26	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Guadalupe Basin)			0
53	E. V. SPENCE RESERVOIR	Colorado	F	12/15/1968	1968	31.89	-100.51	0.26019749	1.3743968	1.1555695	0.61869355	79.048318	17.523312	0.015272913	0	441.55	2183.1237	5594234	0.050221575	17.550127	35.481887	0.25979348	16.447958	6681.7294	465.39	72.925	6.329773	560	517272	560.37152	11		0.22	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Colorado Basin)	0	0	1
54	EAGLE LAKE	Colorado	K	12/31/1900	1900	29.57	-96.4	0.324308	6.23	0	17.06135	48.04	12.01135	6.39	0	0	0.55625	16420.152	0	41.290158	5.6116555	0.005	20.218	936.52938	9.99	5.29375	1.227323	Sys. Op.	9600	484.48448			0.55	Original units were in ac-ft./sq. mi./yr.			0
55	EAGLE MOUNTAIN LAKE	Trinity	C	2/28/1934	1934	32.87	-97.49	0.32421857	3.0529154	0.69409261	15.749823	69.541923	7.4199587	0.45438152	0	142.51875	878.1625	478744.68	0.18941707	33.675365	8.6064914	0.59656317	17.792178	8710.4645	328.95	92.75625	7.0514538	108500	182500	279.70943	11		0.12	Original units were in ac-ft./sq. mi./yr.	0.803691697	0.17406308	4
56	EAGLE NEST LAKE / MANOR LAKE	Brazos	H	2/23/1949	1949	29.22	-95.63	0.28986645	0	0.024534474	14.640916	45.400589	5.863689	13.721444	0	0	8.5625	14729.952	0	48.170295	2.6848119	0.040232511	20.441496	2915.8435	11.04	19.6125	2.576956	0	18000	822.01087			0	Original units were in ac-ft/yr.			0
57	ELECTRA; LAKE	Red	B	6/19/1950	1950	33.97	-99.02	0.33270759	0.13364464	0.37385477	0.80802475	84.760605	6.6101845	0.92880925	0	0	10.91875	10583.523	0	27.835967	6.1718533	0.27107775	17.179202	654.82925	1.36	11.5375	3.1989233	462	5626	2085.6189			0.84	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Red Basin)	3.810914998	3.7868204	1
58	ELLISON CREEK RESERVOIR	Cypress	D	1/31/1943	1943	32.91	-94.72	0.27968704	3.3356222	6.7972837	59.274774	20.325433	0.57527384	1.9941029	0	0	22.54375	27454.643	0	45.148695	3.6467324	0.24683415	18.511416	1366.4927	35.6	19.66875	3.7751068	13857	24700	349.80103			0.18	Original units were in ac-ft./sq. mi./yr.			0
59	FAIRFIELD LAKE	Trinity	C	12/31/1969	1969	31.81	-96.04	0.26286086	0.53582137	0.21077001	57.414684	30.91361	0.97957881	0.80485562	0	3.3875	30.4625	23455.49	0.091893727	39.957414	1.7422561	0.48409883	19.082452	2169.5852	19.54	31.04375	4.7287022	1567	44169	1139.6386			0.85	Original data are missing or highly out of range. A suggested replacement rate is used.(Suggest using average rate for basin (0.85). This is the average excluding 6.31 Fairfield Lake rate.)	5.96	5.51	2
60	FALCON RESERVOIR; INTERNATIONAL	Rio Grande	M	8/31/1953	1953	26.55	-99.15	0.10581345	0.15368639	0.19420234	0.37279818	11.89432	0.20715294	0.016338074	86.90616	749.32938	3769.8675	24664531	0.01933085	21.295405	30.494152	0.10955724	22.345913	80689.79	11846.45	449.35	11.223585	Sys. Op.	2653636	112.93466	10	Significant portion of watershed is in Mexico, where no data is available.	0.15	Original data are missing or highly out of range. A suggested replacement rate is used.(Suggest using Report 268 number (0.15) instead of negative rate from hydrosurvey)	0.696386902	0.092944322	2
61	FARMERS CREEK RESERVOIR	Red	B	5/31/1961	1961	33.88	-97.65	0.33133035	0.40750687	0.050033391	22.355806	65.181602	7.8751169	0.039714474	0	11	82.4125	58588.932	0.11946156	34.015233	8.9634373	0.49023969	17.632515	1359.0796	10.57	24.55	4.7248192	1260	21445	1022.8812	5		1.28	Original units were in ac-ft./sq. mi./yr.	1.147341462	1.1516762	1
62	FOREST GROVE RESERVOIR	Trinity	C	12/31/1980	1980	32.22	-95.96	0.26254638	2.8056222	1.0113792	35.798936	53.900313	4.8073644	0.57500862	0	7.43125	35.6125	35842.635	0.13192072	40.218193	5.8685473	0.42367846	18.564651	291.58435	33.87	5.9	2.451467	8583	20038	298.27256			0.14	Original units were in ac-ft./sq. mi./yr.			0
63	FORK RESERVOIR; LAKE	Sabine	D	6/29/1979	1979	32.8	-95.54	0.28391232	0.79351713	0.140121	19.862916	62.744529	4.3408258	2.958444	0	91.28125	515.5175	307094.66	0.18912998	43.329949	1.6655372	0.2608327	17.42635	27159.352	383.14	318.31875	13.704357	173035	604927	796.01198	4		3.7	Original units were in ac-ft./sq. mi./yr.	3.89424775	3.8933648	1
64	FORT PHANTOM HILL; LAKE	Brazos	G	10/30/1938	1938	32.62	-99.66	0.28442091	12.225573	0.56924611	7.1998122	56.204031	20.604465	0.27619253	0	57.2125	260.3375	210939.03	0.17257784	25.05988	9.8822965	0.38223515	17.969637	2473.5248	31.94	28.7125	4.0960855	7348	70030	1105.4099	10		0.33	Original units were in ac-ft/yr.	0.236731815	0.23549209	1
65	GEORGETOWN; LAKE	Brazos	G	3/3/1980	1980	30.67	-97.72	0.24171237	0.33858782	0.4425261	38.378144	58.450577	1.4153824	0.007749815	0	37.31875	200.74187	157980.65	0.15030529	32.179067	14.075692	0.62804542	18.510457	1111.9742	79.34	20.50625	4.3630987	Sys. Op.	36823	233.99205	3		0.02	Original units were in ac-ft/yr.	0.287722233	0.03045809	2
66	GIBBONS CREEK RESERVOIR	Brazos	G	12/31/1981	1981	30.61	-96.06	0.30351105	0.61446445	1.077798	26.468625	62.326284	0.81897765	4.3039561	0	20.70625	107.40625	54504.033	0.24172628	42.605123	5.5734638	0.30711361	19.741154	2466.1117	43.98	32.125	4.589791	6310	32084	367.79635			0.14	Original units were in ac-ft/yr.	0.328888254	0.32759511	1
67	GILMER; LAKE	Cypress	D			32.77	-94.98	0.26202858	0.44970202	0.138247	54.465032	38.136974	2.5891471	3.0929382	0	11.25	47.99375	24214.35	0.29561793	44.50899	6.245551	0.50077955	17.507213	128.4948	26.94	2.4875	1.5569564	6180	12720	238.04751			0.18	Original data are missing or highly out of range. A suggested replacement rate is used.(Suggest using average rate for basin (0.18). This is the average excluding 0.00 Gilmer Lake rate.)			0
68	GONZALES (H-4); LAKE	Guadalupe	L	12/31/1931	1931	29.49	-97.62	0.30499108	2.9242011	0.28422479	27.915668	52.691939	15.121191	0.24126382	0	74.571875	332.24688	244456.16	0.19409982	33.966639	123.38793	0.37588649	20.012183	229.808	617.71	13.43125	6.2862262	Hydro	6500	5.3052133			0.26	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Guadalupe Basin)			0
69	GRAHAM; LAKE	Brazos	G	12/31/1929	1929	33.11	-98.61	0.29868116	1.0483492	0.046347496	4.9804977	72.435071	19.031589	0.002732092	0	11.98125	153.3875	141230.61	0.053978942	29.647184	10.237628	0.25588155	17.836494	2448.8143	38.01	39	5.5916866	4400	45260	600.33105	7		0.95	Original units were in ac-ft/yr.	0.548498578	0.5477576	1
70	GRANBURY; LAKE	Brazos	G	9/15/1969	1969	32.37	-97.68	0.27114147	1.3505068	0.18243074	22.829793	67.99093	5.5910619	0.011115081	0	319.55438	1591.2231	1038889.3	0.1957161	31.452256	26.618791	0.5767698	17.958837	7914.7852	1625.69	168.36875	13.42759	64462	128046	39.710231	7		0.41	Original units were in ac-ft/yr.	0.494224266	0.47336319	2
71	GRANGER LAKE	Brazos	G	1/21/1980	1980	30.7	-97.3	0.26729081	2.0822639	0.95195277	25.787169	53.208141	16.095185	0.01515225	0	95.45625	433.7375	313081.28	0.19399848	33.614055	19.555823	0.50088902	19.246798	4198.3204	236.59	51.625	5.6529926	Sys. Op.	52525	111.9293	16		1.53	Original units were in ac-ft/yr.	0.625724696	0.42611038	3
72	GRAPEVINE; LAKE	Trinity	C	7/3/1952	1952	32.95	-97.05	0.29633718	1.8771573	0.034165051	16.126381	69.563571	9.4470367	0.12738967	0	129.79375	826.90312	443979.91	0.18601224	35.137261	8.8440157	0.5708292	17.692106	6587.8294	144.67	73.3875	6.4151537	18000	164702	573.97704	8.4		0.77	Original units were in ac-ft./sq. mi./yr.	0.729635857	0.69011918	4
73	GREENBELT LAKE	Red	A	12/5/1966	1966	35	-100.89	0.28593728	0.33926908	1.8782062	0.021131894	62.18615	34.638678	0.046710411	0	24.73125	216.86687	201104.49	0.078248382	21.293754	11.088935	0.51237416	14.33311	1018.0742	15.26	15.5125	3.4494371	8854	59500	1965.7875	5		0.76	Original units were in ac-ft./sq. mi./yr.			0
74	GULF COAST WATER AUTHORITY RESERVOIR	San Jacinto-Brazos	H	12/31/1947	1947	29.44	-94.98	0.336	1.39	0.05	21.12	8.78	0	36.95	0	0	5.33125	790.73721	0	48.981103	0.3549921	0	20.394	854.98461		7.35	1.7834639	98805	7308			Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0	Original data are missing or highly out of range. A suggested replacement rate is used.(no significant drainage area)	0	0	1
75	HALBERT; LAKE	Trinity	C	12/31/1921	1921	32.07	-96.4	0.32575241	4.9058292	0.27850945	20.930909	63.114723	0.78331045	0.10698642	0	0	6.99375	8371.9302	0	37.72931	4.5527869	0.26128926	18.233171	597.99501	6.41	11.2125	3.2531929	0	6033	474.51443			2.36	Original units were in ac-ft./sq. mi./yr.	1.376467231	1.3569012	1
76	HORDS CREEK; LAKE	Colorado	F	4/7/1948	1948	31.85	-99.56	0.22362548	0	1.122277	5.9117835	89.223859	2.0320819	0.16743383	0	2.96875	41.4625	31684.346	0.059618349	25.867945	18.288401	0.59012884	17.219689	474.44232	4.41	11.20625	3.6502679	0	5684	649.81481			0.36	Original units were in ac-ft./sq. mi./yr.	0.52534859	0.52042037	1

RES_NUM	RES_NAME	BASIN_NAME	REGION_NAME	DAM_IMPOUND_DATE	DAM_IMPOUND_YEAR	DAM_LAT	DAM_LONG	WSHD_KFACT	WSHD_DEVELOPED_PCT	WSHD_BARREN_PCT	WSHD_FOREST_PCT	WSHD_SHRUBGRASSPASTURE_PCT	WSHD_AGRI_PCT	WSHD_WETLANDS_PCT	PCT_MX	WSHD_3RDSTREAM_MILES	WSHD_ALLSTREAM_MILES	WSHD_AREA_ACRES	WSHD_MSI_INV_MILE	WSHD_PCP_IN	WSHD_AREA_RES_VOLUME_INDEX	WSHD_SLOPE_PCT	WSHD_TMP_C	RES_AREA_ACRES	RES_FLOW_CFS	RES_PERIM_MILES	RES_SLD	RES_YIELD_ACFT_PER_YR	RES_STORAGE_ACFT	RES_TIME_DAYS	RES_TSS_MEDIAN_MGL	NHDPLUS_NOTES	SEDRATE_WAM	WAM_NOTES	SEDRATE_HYDRO_MAX	SEDRATE_HYDRO_OVERALL	NUM_HYDRO_SURVEYS
77	HOUSTON COUNTY LAKE	Trinity	I			31.4	-95.6	0.25793383	0.76714094	3.9458462	46.586792	40.089606	3.2132149	1.1448789	0	2.4	47.1375	30705.561	0.049733069	42.377234	5.8867547	0.53877971	18.737838	1262.7085	25.58	17.6875	3.5315963	3500	17113	337.28711	3		1.26	Original units were in ac-ft./sq. mi./yr.	1.188438711	1.189411	1
78	HOUSTON; LAKE	San Jacinto	H	4/9/1954	1954	29.92	-95.13	0.28574335	6.899192	2.0094081	57.978796	26.854422	2.08587	2.9885474	0	457.50125	1974.925	1523112.8	0.19112226	46.568508	38.778311	0.22273346	19.613335	11134.568	1697.65	160.49375	10.791395	168000	128863	38.269625	20		0.16	Original units were in ac-ft./sq. mi./yr.	0.134924847	0.13484571	1
79	HUBBARD CREEK RESERVOIR	Brazos	G	12/18/1962	1962	32.82	-98.96	0.26170442	0.59853241	0.15280817	6.3884107	84.758516	5.2188548	0.032748464	0	193.9	966.6125	678025.28	0.18196296	26.987611	6.9937858	0.52640363	17.992187	13447.475	170.94	140.56875	8.600517	17325	318067	938.0998	5		0.16	Original units were in ac-ft/yr.	0	0	1
80	HUBERT H. MOSS LAKE	Red	C	4/30/1966	1966	33.77	-97.21	0.28071297	0.12696115	0.084374174	22.700352	69.120441	5.079651	0.001230997	0	6.84375	47.8625	44422.875	0.098025381	36.166426	6.0580408	0.54969153	17.059332	1126.8005	9.16	23.4875	4.9644303	4500	24058	1324.153			0.84	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Red Basin)	0	0	1
81	IMPERIAL RESERVOIR	Rio Grande	F	12/31/1915	1915	31.26	-102.84	0.222607	0.75	3.61	0.02	95.09	0.07183	0.00663	0	10.70625	10.70625	157428.36	0.04327185	12.714961	86.08288	0.06	17.925	568.34237	879.02	5.25625	1.5643256	0	6000	3.4413324			0.24	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Rio Grande Basin)			0
82	INKS LAKE	Colorado	K	6/30/1938	1938	30.73	-98.38	0.19284366	1.774754	0.32438439	61.018768	22.994123	0.074265478	0.089458005	0	4.99125	38.82875	31686.323	0.10022788	29.631684	7.1233215	1.0460094	18.512057	780.85299	1942.86	20.025	5.0844506	Sys. Op.	14594	3.7871017	5		0	Original units were in ac-ft./sq. mi./yr.	1.010222716	1.0188328	1
83	J B THOMAS; LAKE	Colorado	F	7/31/1952	1952	32.58	-101.13	0.29152385	0.12844536	1.5306791	0.003382062	62.421667	35.410302	0.067572805	0	181.98125	964.84375	974534.19	0.11881756	19.56499	15.991971	0.51675644	16.776534	7114.1638	52.08	73.48125	6.1811708	0	199931	1935.4559			0.06	Original units were in ac-ft./sq. mi./yr.	0.041386856	0.041581161	1
84	JACKSONVILLE; LAKE	Neches	I	6/30/1957	1957	31.9	-95.3	0.29449941	4.3411757	0.71774486	48.636947	36.663596	3.0432005	1.8462595	0	6.36875	35.43125	25653.492	0.15796424	43.818786	2.7777228	0.58338665	18.901599	1158.9242	27	23.54375	4.9068667	6200	30300	565.78704	2		0.18	Original units were in ac-ft./sq. mi./yr.	2.420718082	2.4324945	1
85	JIM CHAPMAN LAKE	Sulphur	D	9/28/1991	1991	33.33	-95.63	0.32962273	2.1225416	0.22678149	15.147854	52.843247	19.746409	5.1794742	0	69.1375	374.63125	311229.22	0.14134627	43.212876	3.2936474	0.15066341	17.170915	17878.074	295.02	78.75625	4.1790812	127983	310019	529.79881			1.17	Original units were in ac-ft./sq. mi./yr.	1.411116019	1.4118396	1
86	JOE POOL LAKE	Trinity	C	1/7/1986	1986	32.64	-96.99	0.31841277	5.1617363	0.24114849	17.444452	53.068985	18.288945	0.52712526	0	18.35	203.14375	150458.76	0.077601418	35.170989	2.7904529	0.39184053	18.427916	6469.2188	73.51	62.64375	5.525963	15333	176900	1213.2646			1.3	Original units were in ac-ft./sq. mi./yr.			0
87	JOHNSON CREEK RESERVOIR	Cypress	D	8/4/1961	1961	32.84	-94.54	0.24322776	0.42800648	0.16419216	85.607711	3.9344764	0.48133861	0.24186398	0	0	4.7375	6867.0584	0	46.087314	2.2306653	0.22632206	18.186335	607.87923	8.04	15.25	4.3885124	1785	10100	633.3437			0.18	Original units were in ac-ft./sq. mi./yr.			0
88	KEMP; LAKE	Red	B	10/1/1922	1922	33.75	-99.14	0.32088625	0.15197708	1.2433822	0.55047593	77.310561	18.964257	0.096630059	0	400.50625	1811.5981	1286683.4	0.1980563	24.131505	15.74592	0.39979639	16.870995	15323.004	114.26	161.7375	9.2703238	90417	268095	1182.9561	7.5		1.75	Original units were in ac-ft./sq. mi./yr.	0.442830249	0.44282627	1
89	KICKAPOO; LAKE	Red	B	2/1/1946	1946	33.66	-98.77	0.32405034	0.14491888	0.19317911	2.358372	80.653984	12.015446	0.16752451	0	27.13125	285.68937	167590.82	0.10300792	27.667758	6.4065094	0.24628734	17.575772	6009.6028	27.35	66.48125	6.0846056	19901	85825	1582.0879	13		0.2	Original units were in ac-ft./sq. mi./yr.	1.398137325	1.3970294	1
90	KIRBY; LAKE	Brazos	G	12/31/1928	1928	32.38	-99.72	0.29622459	1.5712801	0.94643608	17.77111	54.292767	22.367817	0.10542816	0	0	31.8625	27720.281	0	25.441626	11.935145	0.44370797	17.834618	575.75553	2.9	7.45	2.2028928	470	7620	1324.7414			0.47	Original units were in ac-ft/yr.			0
91	KURTH; LAKE	Neches	I					0.320667	0	0.02	39.76	1.28	0.01	22.05	0	2.08125	2.08125	1569.1191	0.8439552	44.400001	0.3485699	0.062	18.699	728.96086	1.98	10.44375	2.7444827	18421	14769	3760.625			0.26	Original data are missing or highly out of range. A suggested replacement rate is used.(Suggest using average sedimentation rate of all major reservoirs (0.26))	5.96	5.51	1
92	LAVON LAKE	Trinity	C	9/14/1953	1953	33.03	-96.48	0.30993182	2.732464	0.047501548	16.971492	52.721187	20.280624	0.88039127	0	62.4875	514.28125	491390.79	0.080912795	40.338758	3.6323	0.28470622	17.471881	10726.844	492.67	62.775	4.3003804	104000	443844	454.20129			0.31	Original units were in ac-ft./sq. mi./yr.	0	0	1
93	LEON; LAKE	Brazos	G	4/30/1954	1954	32.36	-98.67	0.27365028	2.4756549	0.37224084	7.7854978	79.427652	8.0698699	0.009161197	0	36.84375	216.9125	165180.55	0.14192404	27.672857	20.511372	0.47808588	17.511527	1544.4086	60.37	30.0375	5.4229902	5945	26421	220.64912	7.5		0.05	Original units were in ac-ft/yr.			0
94	LEWIS CREEK RESERVOIR	San Jacinto	H	2/12/1969	1969	30.43	-95.54	0.27434513	1.6442951	0.6796595	28.803076	38.474619	2.1888441	2.8278674	0	0	4.58125	3309.2352	0	46.172726	0.66201654	0.4725463	19.600408	941.47149	3.11	12.28125	2.8398482	0	16400	2658.6281			0.77	Original data are missing or highly out of range. A suggested replacement rate is used.(average for San Jacinto Basin)			0
95	LEWISVILLE LAKE	Trinity	C	11/1/1954	1954	33.05	-96.96	0.29443589	4.2203083	0.012212207	12.034843	61.350454	16.041667	0.67313525	0	148.2125	976.08125	618468.93	0.1524818	37.341366	3.7300411	0.41987864	17.528086	26319.194	479.16	253.925	11.105173	7702	543988	572.37795	12		0.89	Original units were in ac-ft./sq. mi./yr.	2.979146589	0.82453688	4
96	LIMESTONE; LAKE	Brazos	G	10/16/1978	1978	31.32	-96.32	0.31076146	1.4929801	1.2672838	25.611459	62.312669	4.4633237	0.98410211	0	84	597.9875	431730.65	0.12379909	38.413765	6.8093128	0.28975518	18.741943	12501.061	348.19	134.98125	8.5655677	63519	208015	301.19828	9		0.96	Original units were in ac-ft/yr.	1.2856572	1.059325	2
97	LIVINGSTON; LAKE	Trinity	H	10/31/1968	1968	30.61	-95.01	0.30100232	9.9337193	1.0308962	32.935307	44.099509	3.7702908	5.0869828	0	1442.6531	6873.2106	4527978.2	0.20272563	40.350706	8.5285341	0.35041998	18.717833	80721.914	7545.26	597.61875	14.923979	1344000	1741867	116.3898	19		0.03	Original units were in ac-ft./sq. mi./yr.	0.049486038	0.049435179	1
98	LOMA ALTA LAKE	Nueces-Rio Grande	M	12/31/1964	1964	25.98	-97.38		27.21	2.82	3.02	52.78	2.64	3.9	0	0	0.70625	637.53187	0	26.626772	0.078929814	0.005	23.153	563.40026	0.08	4.875	1.4572103	Storage	26500	167005.21		No flow direction in coastal plains. Watershed delineation results are inaccurate.	0	Original data are missing or highly out of range. A suggested replacement rate is used.(no significant drainage area)			0
99	LOST CREEK RESERVOIR	Trinity	C			33.14	-98.07	0.2502281	4.5005909	0.041623278	8.1259064	82.669747	1.794135	0	0	0	23.0875	20324.417	0	30.966342	5.5748818	0.60115198	17.549728	121.08163	5.34	4.7625	3.0708033	1440	11961	1129.2767			0.34	Original units were in ac-ft./sq. mi./yr.			0
100	LYNDON B. JOHNSON; LAKE	Colorado	K	5/31/1951	1951	30.55	-98.33	0.19850052	0.57287894	0.42195905	27.293913	70.542705	0.70093619	0.011745691	0	677.29625	4285.9188	3176440	0.13567164	26.279716	91.66498	0.718798	18.278877	6365.4345	2574.53	145.25625	12.917455	Sys. Op.	113690	22.263756	6		0	Original units were in ac-ft./sq. mi./yr.	0.037891008	0.019470968	3
101	MACKENZIE RESERVOIR	Red	O	4/30/1974	1974	34.54	-101.43	0.35149762	0.44770607	0.04602378	0.001120656	27.52732	71.601112	0.043140969	0	15.61875	166.25625	629948.21	0.01577584	18.676829	44.514405	0.21406465	13.875953	274.28697	33.41	9.25625	3.9654149	0	46429	700.62718	5		0.77	Original units were in ac-ft./sq. mi./yr.			0
102	MARBLE FALLS; LAKE	Colorado	K	7/31/1951	1951	30.55	-98.25	0.2215986	5.3812136	1.1939583	57.650702	33.755723	0.48681854	0.010234436	0	16.275	93.09375	52728.087	0.19639483	29.513918	26.945859	0.81210406	18.92948	580.69764	2597.52	16.34375	4.8120798	Sys. Op.	6420	1.2460924	5		0	Original units were in ac-ft./sq. mi./yr.	0.655647961	0.27746072	2
103	MARTIN LAKE	Sabine	I	4/1/1974	1974	32.27	-94.55	0.28681143	1.2627724	2.7814562	51.703157	32.159525	1.8600351	4.5229372	0	6.76875	72.1625	85476.468	0.050386358	46.437467	3.733354	0.23812861	18.011095	5503.0368	98.91	64.925	6.2096467	25000	75116	382.88326			0.73	Original units were in ac-ft./sq. mi./yr.	5.84	0.73517896	2
104	MEDINA LAKE	San Antonio	L	5/7/1913	1913	29.54	-98.93	0.18048744	1.5298287	0.65529869	61.649975	32.648324	1.8196826	0.021227415	0	108.50625	642.16375	399472.04	0.17283012	29.821489	5.1427892	0.89581559	18.237104	5322.6498	159.99	73.94375	7.1910725	0	254843	803.0711	5		0.36	Original units were in ac-ft/yr.	0	0	1
105	MEREDITH; LAKE	Canadian	A	1/28/1965	1965	35.7	-101.55	0.26983304	0.18827709	0.23639066	11.000896	84.730269	3.50495	0.006857819	0	3061.5837	13687.101	11612879	0.16774798	16.717925	48.873972	1.2756553	11.635629	16338.608	1114.54	132.2125	7.3387339	69750	779556	352.6353	5		0.1	Original units were in ac-ft./sq. mi./yr.	0.090576729	0.084152328	2
106	MILLERS CREEK RESERVOIR	Brazos	B	7/1/1974	1974	33.42	-99.36	0.29922697	0.033810731	0.15247577	0.11389528	60.621733	37.120919	0.22858754	0	36.71875	250.73688	154057.85	0.15165444	26.425418	18.123894	0.26700516	17.674582	1695.1429	19.91	26.1	4.4977312	0	27888	706.18785	20		0.77	Original units were in ac-ft/yr.	0.826967066	0.82658928	1
107	MINERAL WELLS; LAKE	Brazos	G	1/31/1944	1944	32.81	-98.04	0.301882	14.82	0.1	10	68.46	4.73	0	0	0	5.45	4349.0546	0	32.024804	2.0196111	0.615	17.923	17.297376	1.17	1.06875	1.8232329	2505	7065	3044.391			2.97	Original units were in ac-ft/yr.	0	0	1
108	MITCHELL COUNTY RESERVOIR	Colorado	F	11/30/1991	1991	32.27	-101.1	0.29307153	2.5534297	1.0913223	0.12894629	92.59246	3.5144401	0.077375967	0	0	13.9125	10857.81	0	20.282379	1.3064893	0.37197997	17.389726	976.06624	0.65	7.95625	1.8068617	Sys. Op.	27266	21148.628			0.22	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Colorado Basin)			0
109	MONTICELLO RESERVOIR	Cypress	D	8/9/1972	1972	33.08	-95.04	0.28350834	0.69050137	10.865464	29.272213	45.733402	1.0890689	1.6666595	0	0	18.49375	23127.828	0	45.480076	2.1841883	0.076781185	17.220412	2004.0246	24.17	24.04375	3.8107181	6098	34740	724.64832			0.18	Original units were in ac-ft./sq. mi./yr.	5.81	5.51	1
110	MOUNTAIN CREEK LAKE	Trinity	C	3/31/1937	1937	32.73	-96.94	0.29959717	44.722562	0.027728492	15.549959	27.833956	3.7649873	0.82340852	0	4.24375	53.5625	37644.527	0.071729698	35.742037	5.4074287	0.34985829	18.374978	2458.6985	91.9	19.96875	2.8572904	6400	22840	125.30105			0.49	Original units were in ac-ft./sq. mi./yr.			0
111	MURVAUL; LAKE	Sabine	I	11/1/1957	1957	32.03	-94.42	0.30766399	0.47107313	0.57416488	59.382937	29.77619	1.2381582	3.8628191	0	10.4	88.85625	75579.898	0.087554425	47.051156	6.4770022	0.34419431	18.087489	3454.5332	87.48	35.75625	4.3163179	21792	38284	220.63919	8		1.6	Original units were in ac-ft./sq. mi./yr.	1.558584999	1.5558992	1
112	NACOGDOCHES; LAKE	Neches	I	7/14/1976	1976	31.58	-94.82	0.30340799	0.40556293	1.2491875	62.957549	25.730058	1.2048047	4.9785455	0	12.0375	79.21875	62738.82	0.12208183	44.759311	5.2082698	0.33046167	18.445254	2092.9825	67.31	20.7875	3.2238558	9459	39521	296.02096			0.19	Original units were in ac-ft./sq. mi./yr.	0.959202888	0.9565409	1
113	NASWORTHY; LAKE	Colorado	F	3/28/1930	1930	31.38	-100.47	0.23440767	4.8890585	0.51884488	2.7464063	87.857336	1.5998163	0.002251467	0	8.1	46.59375	67787.677	0.07603006	21.570969	23.13058	0.39741085	18.005754	1406.0296	181.83	38.15625	7.2197905	0	9615	26.659861	15		0.02	Original units were in ac-ft./sq. mi./yr.	0.339993583	0.33939867	1
114	NAVARRO MILLS LAKE	Trinity	C	3/15/1963	1963	31.95	-96.7	0.30821661	0.73506045	0.23716657	9.3078449	54.366696	29.952461	0.13019241	0	25.89375	270.7375	204660.09	0.080503147	35.58475	12.029615	0.33404359	18.605262	4751.8364	162.47	24.93125	2.5660757	19400	55817	173.2078	16		1.56	Original units were in ac-ft./sq. mi./yr.	0.913416098	0.91401744	1
115	NEW TERRELL CITY LAKE	Trinity	C	11/30/1955	1955	32.72	-96.17	0.34080605	1.4207465	0.028144455	12.190462	72.392644	6.4063617	1.9015833	0	0	9.26875	18337.69	0	40.751218	7.0095569	0.18462808	17.790049	822.86091	17.32	7.80625	1.9307915	2283	8583	249.84195		Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0.37	Original units were in ac-ft./sq. mi./yr.	0.104735907	0.099267767	1
116	NORTH FORK BUFFALO CREEK RESERVOIR	Red	B	11/10/1964	1964	33.98	-98.75	0.32932174	0	0.053093011	1.9428004	60.835673	28.922635	0.13178377	0	0	31.79375	21214.491	0	28.454159	4.5195682	0.20812317	17.182497	1579.0034	4.13	20.975	3.7451273	840	15400	1879.9435			0.83	Original units were in ac-ft./sq. mi./yr.			0
117	NORTH LAKE	Trinity	C	3/31/1957	1957	32.94	-96.97	0.332563	26.03	0.03	13.08	47.24	1.27	3.85	0	0	5.38125	4442.9547	0	35.041733	1.5507046	0.255	18.192	778.38194	3.86	9.78125	2.4874487	0	9400	1227.7634		Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0.12	Original units were in ac-ft./sq. mi./yr.			0
118	O' THE PINES; LAKE	Cypress	D	8/21/1957	1957	32.76	-94.49	0.27522549	1.5852842	0.75796261	49.218456	34.148589	1.5528282	6.6578645	0	70.2	382.275	361282.64	0.1236349	45.430269	4.960849	0.22415939	17.836672	18088.114	666.93	177.64375	9.3715071	181869	238933	180.62174	5		0.11	Original units were in ac-ft./sq. mi./yr.	1.433574932	1.1201056	2
119	O. C. FISHER LAKE	Colorado	F	2/1/1952	1952	31.46	-100.48	0.22544209	0.97759613	0.54645362	0.47957072	93.745546	3.8577224	0.007309754	0	133.825	751.85625	963122.86	0.088411065	20.477512	39.755067	0.43567249	17.401897	4331.7573	58.78	38.475	4.1476559	0	79483	681.74003	15		0.25	Original units were in ac-ft./sq. mi./yr.	0.217362706	0.21712718	1
120	O. H. IVIE RESERVOIR	Colorado	F	3/16/1990	1990	31.5	-99.66	0.26528006	1.3356516	1.7992996	2.6032012	63.488796	29.386934	0.011732201	0	345.96937	2012.0013	1757249.9	0.12527234	23.880322	10.400216	0.41376407	18.196415	18167.187	895.21	145.9875	7.6847186	66350	554340	312.19462	6		0.12	Original units were in ac-ft./sq. mi./yr.			0
121	OAK CREEK RESERVOIR	Colorado	F	5/12/1953	1953	32.04	-100.25	0.21831553	0.66739804	0.063830584	7.0605726	81.985544	8.7638702	0.012467855	0	13.90625	167.33125	151606.56	0.058363738	24.395949	12.669304	0.66793017	17.327772	2184.4115	9.9	47.1625	7.1595501	0	39260	1999.3519	6		0.15	Original units were in ac-ft./sq. mi./yr.	1.433574932		0
122	OLNEY/ LAKE COOPER; LAKE	Red	B	12/31/1935	1935	33.44	-98.78	0.31968502	0	0.19389304	2.2147486	84.439058	9.0713019	0.086227876	0	0	18.0375	12956.229	0	28.548946	6.3920774	0.32270476	18.021799	457.14495	2.15	10.10625	3.3536614	961	6650	1559.3992		Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0.84	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Red Basin)		0	0
123	PALESTINE; LAKE	Neches	I	5/1/1962	1962	32.05	-95.43	0.25711882	4.3754571	0.32254544	36.266865	45.885645	3.9075084	4.1044718	0	105.075	611.53312	521790.68	0.12813098	41.751096	4.6154619	0.34057756	18.021371	23400.879	564.2	228.16875	10.582694	220933	370908	331.44178	7		0.26	Original units were in ac-ft./sq. mi./yr.	2.290693433	1.1446222	2
124	PALO DURO RESERVOIR	Canadian	A	5/22/1991	1991	36.36	-102.63	0.35220719	0.67775656	0.065785366	0.001172227	32.744298	66.296988	0.008634658	0	46.3875	337.03375	932939.19	0.031637248	17.969939	50.262315	0.24165652	13.764887	222.39484	26.62	9.4375	4.4900456	3958	60897	1153.3523			0.15	Original units were in ac-ft./sq. mi./yr.			0
125	PALO PINTO; LAKE	Brazos	G	4/16/1964	1964	32.64	-98.26	0.26117925	0.8274448	0.22784816	37.696372	56.582045	3.1443114	0.00309076	0	89.275	536.34375	293071.67	0.19382379	30.186079	35.415148	0.73938308	17.77988	2048.5036	78.94	27.4375	4.3011275	8193	27150	173.3991	7		0.18	Original units were in ac-ft/yr.	1.738834303	0.85282532	2
126	PAT CLEBURNE; LAKE	Brazos	G	8/4/1964	1964	32.28	-97.41	0.24993015	1.4574948	0.23533901	4.3241283	78.975277	11.910287	0.066148156	0	0	64.40625	66147.638	0	33.067551	8.4345052	0.38878658	18.621216	1564.177	26.53	13.5875	2.4375456	5202	25730	488.96375	14		0.57	Original units were in ac-ft/yr.	0	0	3
127	PAT MAYSE LAKE	Red	D	9/28/1967	1967	33.85	-95.55	0.30899491	0.43571729	0.067571436	27.992402	43.892868	14.403999	6.9364667	0	35.80625	164.2875	114512.83	0.19895541	44.787409	3.1809185	0.25532045	17.180466	5802.0343	110.91	56.31875	5.2458879	59750	118110	536.89591	5		1.63	Original units were in ac-ft./sq. mi./yr.	0.911281234	0.91130405	1
128	PEACOCK SITE 1A TAILINGS RESERVOIR	Cypress	D					0.28385242	2.9619383	61.212093	14.541938	2.4498238	0	1.0376432	0	0	1.50625	1121.8584	0	45.164933	0.51839971	0.94959251	18.38791	185.32903	1.4	4.425	2.3062038	Sys. Op.	7100	2556.8452			0	Original data are missing or highly out of range. A suggested replacement rate is used.(no significant drainage area)			0
129	PINKSTON RESERVOIR	Neches	I	10/10/1977	1977	31.7	-94.36	0.24271828	0.21899634	0.1646807	78.639339	12.578904	1.3487104	1.141401	0	0	13.35	9178.4821	0	49.04595	4.0803701	0.25118485	18.275932	521.39235	11.59	13.2125	4.1054316	2031	7380	321.03106			0.1	Original units were in ac-ft./sq. mi./yr.			0
130	POSSUM KINGDOM LAKE	Brazos	G	3/21/1941	1941	32.87	-98.42	0.29862407	0.79258145	0.4908644	2.1818835	55.941311	39.759729	0.092524029	0	1785.1812	7652.7244	9028111.6	0.12581617	23.109519	54.816948	0.35836067	16.570578	16659.845	1266.97	213.2375	11.721529	230750	540340	215.01805	4		0.05	Original units were in ac-ft/yr.	0.334493689	0.20484864	3
131	PROCTOR LAKE	Brazos	G	9/30/1963	1963	31.97	-98.47	0.26524573	0.86752044	0.47499137	11.313283	68.629389	16.99041	0.12348872	0	179.8125	869.26875	656925.44	0.17416258	29.510638	38.863755	0.51759203	17.613317	4670.2916	300.48	45.575	4.7316305	Sys. Op.	55457	93.04969	20		0.12	Original units were in ac-ft/yr.	0.119869309	0.098952096	2
132	RAY HUBBARD; LAKE	Trinity	C	12/1/1968	1968	32.8	-96.5	0.28673296	22.358199	0.069189521	11.238827	38.35024	15.96805	1.0310196	0	42.875	196.625	189287.66	0.14412287	39.004894	1.3738221	0.26981078	17.820548	20897.702	682.46	128.7625	6.3196973	60367	452040	333.94411			0.59	Original units were in ac-ft./sq. mi./yr.	5.96	3.533602	2
133	RAY ROBERTS; LAKE	Trinity	C	6/30/1987	1987	33.35	-97.03	0.31433594	1.7421497	0.005458019	10.971116	61.480671	18.12683	0.20044821	0	81.74375	638.11875	432792.96	0.12017813	37.612519	1.7776654	0.35542986	17.196406	28167.542	200.09	226.71875	9.5844922	219424	798758	2012.6301			0.3	Original units were in ac-ft./sq. mi./yr.	0.568028344	0.5680961	1
134	RED BLUFF RESERVOIR	Rio Grande	F	9/30/1936	1936	31.9	-103.91	0.24323944	0.24418295	0.70002423	9.7827051	87.426097	1.5229394	0.1300853	0	3645.2769	15820.493	13686539	0.1694681	14.798361	155.01551	1.1797624	13.484937	11221.055	747.74	67.725	4.5361594	41199	289670	195.31115	14		0.18	Original units were in ac-ft./sq. mi./yr.			0
135	RED DRAW RESERVOIR	Colorado	F	12/31/1985	1985	32.23	-101.37	0.218818	0.93	0.11	0.05	88.64	0	0.1	0	0	4.23125	2918.3145	0	19.420473	1.1214011	0.846	17.312	323.70804	0.17	7.41875	2.9255676	Sys. Op.	8538	25321.029			0.22	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Colorado Basin)			0
136	RICHLAND-CHAMBERS RESERVOIR	Trinity	C	11/12/1987	1987	31.95	-96.14	0.32509449	1.7903821	0.20737824	16.812547	57.082919	18.129945	0.1666968	0	222.3	1284.1225	927812.74	0.15245097	36.705967	2.7577107	0.28563745	18.357806	42462.588	975.81	192.65	6.6331822	222625	1103816	570.30286	5.9		3.3	Original units were in ac-ft./sq. mi./yr.	3.95585697	2.2616024	2
137	RIVER CREST LAKE	Sulphur	D	11/30/1953	1953	33.38	-95.14	0.319	0	0	3.99	30.58	0.76	14.93	0	0.73125	0.73125	378.07123	1.2306748	44.480316	0.17719874	0.184	17.263	538.68972	866.27	3.775	1.1539945	8635	7000	4.07398		Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0	Original data are missing or highly out of range. A suggested replacement rate is used.(no significant drainage area)			0
138	SAM RAYBURN RESERVOIR	Neches	I	3/29/1965	1965	31.05	-94.06	0.27726864	1.9213675	2.818007	59.686927	21.884739	1.324386	6.6221147	0	512.6	2726	1940864.2	0.16804845	46.81682	2.2287349	0.33737066	18.414341	111281.44	2589.37	713.99375	15.185853	820000	2857076	556.29071	5		0.1	Original units were in ac-ft./sq. mi./yr.	0.189666952	0.18961702	1
139	SANTA ROSA LAKE	Red	B	12/31/1929	1929	33.94	-99.26	0.32533376	0.2367201	0.17916872	0.43266236	70.377654	26.142787	0.51169945	0	58.9875	299.55563	207559.87	0.18082883	25.333414	58.856588	0.18808786	17.032459	1648.1929	24.68	27.78125	4.8551641	3075	11570	236.35366			0.14	Original units were in ac-ft./sq. mi./yr.			0
140	SMITHERS LAKE	Brazos	H	10/15/1957	1957	29.48	-95.63	0.2779539	11.930939	0.36339046	8.6107868	36.580311	24.468523	3.6461028	0	0	16.48125	14881.18	0	44.433013	2.6108434	0.048217595	20.35281	2342.559	11.16	20.525	3.008805	0	18700	844.7954			0.38	Original units were in ac-ft/yr.			0
141	SOMERVILLE LAKE	Brazos	G	1/3/1967	1967	30.31	-96.51	0.28577053	0.64535213	0.81575013	39.084895	53.332651	2.3308286	0.46470607	0	181.975	938.79875	636458.2	0.18192522	36.787403	14.195707	0.36908671	19.715929	12634.498	229.91	89.68125	5.6608129	43149	147095	322.56272	14		0.15	Original units were in ac-ft/yr.	1.044110439	0.3581508	2
142	SOUTH TEXAS PROJECT RESERVOIR	Colorado	K	2/18/1981	1981	28.74	-96.05	0.31765434	0	0	0.33459459	0.93150071	0	0.91699147	0	0	3.58125	3474.3016	0	44.283427	0.056261736	0.054662162	21.297306	6938.719	1.88	26.16875	2.2289456	Sys. Op.	202600	54332.004			0.22	(average for Colorado Basin)			0
143	SQUAW CREEK RESERVOIR	Brazos	G	2/1/1977	1977	32.28	-97.76	0.29970843	1.748663	1.0767498	14.74712	65.625529	8.1336904	0.18641136	0	0	43.18125	40811.924	0	31.631846	0.88458775	0.59619823	18.513893	3086.3462	16.37	36.0375	4.6024437	8810	151367	4661.8324			0.36	Original units were in ac-ft/yr.	1.631417965	0.20999952	2
144	STAMFORD; LAKE	Brazos	G	6/30/1953	1953	33.07	-99.56	0.31660234	1.0424131	0.54896796	0.16161414	46.563823	48.780981	0.27902434	0	48.85625	325.30313	235937.7	0.13175705	25.307371	15.010158	0.21059451	17.77642	4373.7652	26.37	58.10625	6.233777	5675	51570	985.96416	20		0.19	Original units were in ac-ft/yr.	1.739320672	0.35611811	3
145	STILLHOUSE HOLLOW LAKE	Brazos	G	2/19/1968	1968	31.01	-97.51	0.24729667	1.0637286	0.87715239	21.354361	71.801896	3.3053961	0.015608846	0	207.9625	1043.0619	845016.87	0.15659241	30.355119	12.171721	0.68812587	18.217594	6328.3687	238.7	63.16875	5.6339442	Sys. Op.	227771	481.08314	2		0.27	Original units were in ac-ft/yr.	0.297746141	0.15981126	2
146	STRIKER; LAKE	Neches	I	5/1/1957	1957	31.93	-94.97	0.29278811	1.0296059	1.4829473	48.308703	36.433707	2.0509601	8.868807	0	18.0125	138.6875	118889.07	0.096401353	44.92178	23.033897	0.34540817	18.102333	1949.6614	127.54	20.45625	3.2870217	20183	16934	66.940241			0.44	Original units were in ac-ft./sq. mi./yr.	0.834658343	0.83460166	1
147	SULPHUR SPRINGS DRAW STORAGE RESERVOIR	Colorado	F					0.2607755	0.39117916	0.15902612	0.033481764	63.1457	35.982213	0.10144857	0	16.4375	158.63875	1165010.4	0.008977533	17.442995	477.95583	0.1914208	15.210526	232.27905	68.31	8.43125	3.9250309	0	7997	59.02241			0.22	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Colorado Basin)			0
148	SULPHUR SPRINGS; LAKE	Sulphur	D	7/24/1973	1973	33.17	-95.61	0.33520658	1.319322	0.095303895	10.269777	78.212386	3.4986623	2.4284527	0	3.4625	50.9	44981.086	0.048979112	44.968071	8.2731106	0.11870882	17.276346	1798.9271	50.12	12.25625	2.0502507	9800	17838	179.43585			0.3	Original units were in ac-ft./sq. mi./yr.	5.96	5.51	0
149	SWEETWATER; LAKE	Brazos	G	12/31/1930	1930	32.44	-100.3	0.25648729	1.1092025	0.19764727	14.080292	68.023917	15.627457	0.020479468	0	11.95	66.46875	73251.918	0.10380062	24.852757	24.018371	0.71115652	17.315061	679.53979	7.66	14.4875	3.9431395	1026	10006	658.57594	8		0.19	Original units were in ac-ft/yr.			0
150	TAWAKONI; LAKE	Sabine	D	10/30/1960	1960	32.81	-95.9	0.30846371	3.1991992	0.11496038	15.455552	49.784334	19.041781	3.9944649	0	90.61875	590.2125	485428.88	0.11878006	41.32508	1.7932303	0.19142282	17.367475	37577.315	568.39	200.9375	7.3545189	229807	888126	787.77516	11		1.72	Original units were in ac-ft./sq. mi./yr.	1.736917276	1.7365379	1
151	TEXANA; LAKE	Lavaca	P	5/31/1980	1980	28.89	-96.57	0.30836683	0.47725635	0.37517051	28.480098	48.345797	17.201984	3.3799811	0	214.0375	1079.7937	903651.02	0.15070935	40.009728	19.346243	0.18227778	20.598815	9698.8861	596.46	141.325	10.181557	74500	153246	129.53346			0.24	Original units were in ac-ft./sq. mi./yr.	0.17711618	0.1741022	2
152	TEXOMA; LAKE	Red	C	10/31/1943	1943	33.81	-96.57	0.31898165	0.90297373	0.50253354	5.6539343	57.070699	33.913446	0.18422213	0	5851.0819	27550.397	20420950	0.18231034	27.117791	26.626343	0.47420004	16.077041	85706.029	4528.86	650.38125	15.762259	138700	2516225	280.11393	6		0.43	Original units were in ac-ft./sq. mi./yr.	0.552958282	0.32874479	3
153	TOLEDO BEND RESERVOIR	Sabine	I	10/3/1966	1966	31.17	-93.56	0.28931377	1.9231771	1.782756	57.844783	22.659853	1.9481624	8.4116487	0	967.475	4769.8637	3464710.9	0.17767397	47.616028	2.5413406	0.28875785	17.92259	164925.54	5721.34	1268.5375	22.162334	750000	4472900	394.15366	4		0.12	Original units were in ac-ft./sq. mi./yr.			0
154	TOWN LAKE	Colorado	K					0.24908047	25.73461	0.56881945	42.170628	29.934417	0.47936296	0.036067682	0	37.15625	156.5	100609.94	0.23498603	32.657168	52.830526	0.76436651	19.658147	481.85549	3049.39	17.71875	5.727048	Sys. Op.	6248	1.0330044	4		0.22	Original data are missing or highly out of range. A suggested replacement rate is used.(average for Colorado Basin)		0	4

RES_NUM	RES_NAME	BASIN_NAME	REGION_NAME	DAM_IMPOUND_DATE	DAM_IMPOUND_YEAR	DAM_LAT	DAM_LONG	WSHD_KFACT	WSHD_DEVELOPED_PCT	WSHD_BARREN_PCT	WSHD_FOREST_PCT	WSHD_SHRUBGRASSPASTURE_PCT	WSHD_AGRI_PCT	WSHD_WETLANDS_PCT	PCT_MX	WSHD_3RDSTREAM_MILES	WSHD_ALLSTREAM_MILES	WSHD_AREA_ACRES	WSHD_MSI_INV_MILE	WSHD_PCP_IN	WSHD_AREA_RES_VOLUME_INDEX	WSHD_SLOPE_PCT	WSHD_TMP_C	RES_AREA_ACRES	RES_FLOW_CFS	RES_PERIM_MILES	RES_SLD	RES_YIELD_ACFT_PER_YR	RES_STORAGE_ACFT	RES_TIME_DAYS	RES_TSS_MEDIAN_MGL	NHDPLUS_NOTES	SEDRATE_WAM	WAM_NOTES	SEDRATE_HYDRO_MAX	SEDRATE_HYDRO_OVERALL	NUM_HYDRO_SURVEYS
155	TRADINGHOUSE CREEK RESERVOIR	Brazos	G	7/5/1968	1968	31.55	-96.98	0.30716624	0.32625279	0.19768543	10.322983	67.017162	10.949169	0.26833167	0	1.41875	34.69375	25462.479	0.035453266	35.165525	2.3793313	0.31219471	19.015304	1882.943	10.22	24.58125	4.0192176	4120	35110	1732.0246			0.59	Original units were in ac-ft/yr.			0
156	TRAVIS; LAKE	Colorado	K	9/9/1940	1940	30.39	-97.9	0.22943421	1.3902107	0.70555974	43.54523	48.156168	4.3974621	0.039216341	0	275.5575	1370.5863	1117339.8	0.1569199	30.86294	3.2909657	0.72980538	18.650071	17927.495	2980.16	298.6875	15.827539	Sys. Op.	1113902	188.44366	3		0.02	Original units were in ac-ft./sq. mi./yr.	0.420561741	0.31078196	2
157	TRINIDAD LAKE	Trinity	C					0.331635	0.85735	0.37	50.75	34.25	5.05	3.87	0	16.08125	16.08125	18135.064	0.56422429	39.087796	9.5964907	0.011	17.963	704.25033	2975.62	9.8125	2.6234469	3067	6200	1.0504814		Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0.59	Original units were in ac-ft./sq. mi./yr.			0
158	TWIN BUTTES RESERVOIR	Colorado	F	1/23/1963	1963	31.37	-100.51	0.23700406	0.34264829	0.31514638	0.8145242	91.81386	6.3773249	0.01180525	0	245.0625	1337.2312	2398315.1	0.065016215	19.424114	44.242272	0.38470955	17.514774	8391.6986	153.5	64.025	4.9588479	0	177850	584.14359	12		0.08	Original units were in ac-ft./sq. mi./yr.			0
159	TWIN OAK RESERVOIR	Brazos	G	12/31/1982	1982	31.2	-96.46	0.30739814	0.70121605	0.3074549	41.648739	48.55494	3.2160353	0.35403773	0	1.21875	39.00625	30024.292	0.025828127	37.244392	3.2489494	0.31155855	19.322692	1378.848	24.21	26.96875	5.1529836	2725	30319	631.38493			0.69	Original units were in ac-ft/yr.			0
160	TYLER; LAKE	Neches	I	11/22/1966	1966	32.21	-95.17	0.2475322	2.5928138	1.0776382	47.41731	34.971297	3.3476823	4.2117172	0	8.3875	75.31875	71181.916	0.074974559	44.438503	3.1879502	0.32525685	17.799953	4798.7864	76.37	72.75	7.4511521	35458	73256	483.60918	4.5		0.15	Original units were in ac-ft./sq. mi./yr.	0.206860292	0.20644368	1
161	UPPER NUECES LAKE	Nueces	L	3/31/1948	1948	28.77	-99.82	0	0.67	2.55	2.71	62.03	13.78	4.84	0	0.54375	0.54375	259.46065	1.3334565	21.346457	0.16370171	0.059	21.47	2.4710538	294.38	0.725	3.2722995	0	5200	8.9057228		Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0	Original data are missing or highly out of range. A suggested replacement rate is used.(no significant drainage area)			0
162	VALLEY LAKE	Red	C	12/31/1960	1960	33.64	-96.35	0.31615742	1.3669071	0.31414748	14.992577	59.605667	3.7851716	0.33586148	0	0	6.9375	5515.8862	0	41.779583	1.1034598	0.015915241	17.089025	993.36362	6.2	22.75	5.1213378	0	16400	1333.6022			0.81	Original units were in ac-ft./sq. mi./yr.			0
163	VICTOR BRAUNIG LAKE	San Antonio	L	12/31/1962	1962	29.24	-98.37	0.24962404	3.7388238	0.23691704	12.292299	54.074135	7.1584771	0.24004127	0	0	6.49375	5987.3633	0	28.526995	0.74126721	0.32560215	20.67134	1289.8901	8.55	13.99375	2.7644829	12000	26500	1562.6218			1.03	Original units were in ac-ft/yr.	0	0	0
164	WACO; LAKE	Brazos	G					0.2777232	1.2887874	0.66853955	19.270743	66.50555	10.20817	0.044460144	0	205.30625	1186.3938	1056816.1	0.12361006	32.31909	23.987135	0.49128642	18.338093	6948.6032	480.33	60.9875	5.1909664	79869	144546	151.71918	9		0.11	Original units were in ac-ft/yr.	0.41375214	0.15531082	2
165	WALTER E LONG; LAKE	Colorado	K	1/31/1967	1967	30.28	-97.59	0.31967698	4.4704736	0.55091302	28.399018	38.629632	8.1702046	0.14528002	0	0	9.5375	6062.4833	0	32.500428	0.58603529	0.24495272	20.139616	1213.2874	3.06	16.90625	3.4436705	0	33940	5591.9662			0.69	Original units were in ac-ft./sq. mi./yr.			0
166	WAXAHACHIE; LAKE	Trinity	C	11/30/1956	1956	32.34	-96.8	0.31296594	0.78057006	0.43299128	10.276271	63.06084	21.713796	0.046232781	0	0	14.1625	19553.448	0	36.540223	5.951548	0.32154505	18.846156	652.3582	14.97	12.7625	3.5452661	2667	10779	363.02021	6		1.39	Original units were in ac-ft./sq. mi./yr.	1.571581316	1.5850777	1
167	WEATHERFORD; LAKE	Trinity	C	3/31/1957	1957	32.77	-97.67	0.31444152	0.62232532	0.00825166	18.494675	69.107228	9.2453977	0.001813402	0	10.78125	79.53125	69429.198	0.098804797	32.857876	12.217007	0.43486778	17.279763	1124.3295	33.93	10.51875	2.2257351	2750	18645	277.04649	7.5		0.26	Original units were in ac-ft./sq. mi./yr.	0.802224783	0.61351612	3
168	WELSH RESERVOIR	Cypress	D	9/29/1975	1975	33.04	-94.83	0.27021003	0.21906602	0.53382979	29.86408	55.398073	2.4460951	2.6192663	0	0	16.03125	15794.976	0	45.664798	2.8116102	0.1971153	17.58509	1262.7085	19.02	25.65625	5.1226864	3739	18431	488.55393			0.18	Original units were in ac-ft./sq. mi./yr.	5.025990754	5.0370336	1
169	WHITE RIVER LAKE	Brazos	O	10/31/1963	1963	33.45	-101.06	0.32824368	0.59636201	0.11480658	0.003057581	22.514782	76.09713	0.045164256	0	252.49375	497.9875	1944196.9	0.082634507	18.927562	213.47387	0.40981732	14.338348	914.2899	98.23	13.54375	3.1779943	2431	29880	153.35946	6		0.14	Original units were in ac-ft/yr.	0.077383182	0.077258279	1
170	WHITE ROCK LAKE	Trinity	C	12/31/1910	1910	32.81	-96.72	0.31149487	68.810289	0.035067572	5.2183072	16.318847	7.3715825	0.000345663	0	0	50.45625	63943.458	0	37.956409	23.299451	0.31217224	18.206839	993.36362	55.33	8.975	2.0203959	5083	9004	82.0444	14		1.58	Original units were in ac-ft./sq. mi./yr.	0.210252973	0.20877973	1
171	WHITNEY; LAKE	Brazos	G					0.24242241	1.8450259	0.7643687	22.891728	63.431072	5.7138833	0.11290046	0	213.46625	1028.3162	858346.72	0.15824046	32.362339	5.0892361	0.5436218	18.430847	23124.121	2001.28	237.1875	11.066628	18336	553344	139.39958	7		1.38	Original units were in ac-ft/yr.	1.016604609	1.016277	1
172	WICHITA; LAKE	Red	B	12/31/1901	1901	33.84	-98.53	0.30662952	1.3776368	0.31769354	2.9986054	73.619371	17.79492	0.48164887	0	27.35	116.1375	81488.434	0.21355632	28.064934	19.096465	0.13080446	17.549992	2046.0325	15.2	23.45625	3.6792429	Sys. Op.	14000	464.36404	38		0.65	Original units were in ac-ft./sq. mi./yr.			0
173	WINTERS; LAKE / NEW WINTERS; LAKE	Colorado	F					0.29191264	0.091397133	1.0757129	5.4726266	72.489918	18.739924	0.01293844	0	11.81875	58.3125	43769.034	0.17181285	25.799061	17.14822	0.4372754	17.847413	640.00293	3.89	11.325	3.1761673	0	8374	1085.3192			0.26	Original units were in ac-ft./sq. mi./yr.			0
174	WORTH; LAKE	Trinity	C	6/30/1914	1914	32.79	-97.41	0.2205519	9.1875647	0.38804368	29.295587	50.365405	3.3027764	0.061455138	0	21.35	67.59375	60388.353	0.22495505	33.390626	8.0867153	0.4744958	17.90637	3444.649	358.45	56.675	6.8513347	Sys. Op.	24500	34.459711	12		0.35	Original units were in ac-ft./sq. mi./yr.	0.434659966	0.4355646	2
175	WRIGHT PATMAN LAKE	Sulphur	D	6/27/1956	1956	33.3	-94.16	0.31196844	1.588476	0.19158697	28.158479	48.22559	9.9766853	9.2517857	0	551.30625	2484.2313	1826860.9	0.19201647	45.917275	54.068346	0.19349476	17.276087	29417.895	2584.19	274.51875	11.355921	180000	110853	21.627043	14		0.4	Original units were in ac-ft./sq. mi./yr.	0.195545438	0.19567065	1
176	ADDICKS RESERVOIR	San Jacinto	H	12/1/1948	1948	29.79	-95.62	0.33283085	20.047563	1.4902169	12.5643	47.73143	13.329534	4.5076175	0	7.78125	65.1875	76485.045	0.064732727	43.928863	1.2496773	0.098196424	20.072385	16756.216	68.38	26.95	1.477158	No WS	200800	1480.5011			0.77	Original data are missing or highly out of range. A suggested replacement rate is used.(no water supply function; suggest using San Jacinto Basin average)			0
177	ANZALDUAS CHANNEL DAM	Rio Grande	M					0.30384578	0.060886612	0.41405419	0.13883497	4.864413	1.0756515	0.002379339	93.361245	182.075	599.5425	10212129	0.011344493	22.216422	2408.6529	0.039235141	22.793935	195.21325	13060.32	2.55	1.2949162	No WS	13910	0.53696681		Significant portion of watershed is in Mexico, where no data is available.	0.24	Original data are missing or highly out of range. A suggested replacement rate is used.(no water supply function; suggest using Rio Grande Basin average)			0
178	BARKER RESERVOIR	San Jacinto	H	2/3/1945	1945	29.77	-95.64	0.32984547	11.03807	1.3199293	15.316638	47.764968	18.095147	6.0289344	0	0	66.71875	92642.277	0	42.828334	1.4542798	0.12382569	20.149031	15641.77	82.82	22.6875	1.2870631	No WS	209000	1272.2873			0.77	Original data are missing or highly out of range. A suggested replacement rate is used.(no water supply function; suggest using San Jacinto Basin average)			0
179	BIVINS LAKE	Red	A	12/31/1926	1926	35.03	-102.02	0.34951548	0.16925308	0.012455183	0	35.269871	64.267633	0.16571615	0	0	81.43125	538239.99	0	17.747259	344.8983	0.032487219	13.357458	9.8842151	20.31	2.93125	6.6151228	No WS	5120	127.09667			0.36	Original units were in ac-ft./sq. mi./yr.			0
180	BUFFALO LAKE	Red	A	6/9/1938	1938	34.92	-102.1	0.3283105	0.36059137	0.11857835	0	34.991114	64.358484	0.0000769	0	167.09375	366.25625	1151807.8	0.092306278	17.306526	208.2037	0.30995895	13.516967	3101.1725	42.99	19.7875	2.5210654	No WS	18150	212.85473	13		0.1	Original units were in ac-ft./sq. mi./yr.			0
181	CAMP CREEK LAKE	Brazos	G	11/30/1948	1948	31.06	-96.28	0.249286	1.03	1.75	55.83	23.69	0.28	16.86	0	2.85	2.85	1744.564	1.039463	38.388977	0.81766218	0.079	19.574	7.4131613	75.45	0.6875	1.7915425	No WS	7000	46.774906		Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0.48	Original data are missing or highly out of range. A suggested replacement rate is used.(Suggest using average rate for basin (0.48). This is the average excluding 10.57 Camp Creek Lake rate.)			0
182	COFFEE MILL LAKE	Red	C	2/26/1968	1968	33.73	-95.95	0.32824741	0.035604968	0.006838378	38.133256	51.744592	1.3140832	4.4177357	0	0	34.1875	25471.622	0	43.388009	10.44604	0.26761816	17.081534	664.71346	24.92	8.59375	2.3649481	No WS	8000	161.85126			0.75	Original units were in ac-ft./sq. mi./yr.			0
183	DELTA LAKE	Nueces-Rio Grande	M	12/31/1939	1939	26.43	-97.93		0	0.25	3.67	54.46	41.58	0	0	0	0.66875	432.43441	0	24.862992	0.10133915	0.005	22.86	2394.4511	0.56	13.40625	1.9438398	No WS	14000	12604.167		No flow direction in coastal plains. Watershed delineation results are inaccurate.	0	Original data are missing or highly out of range. A suggested replacement rate is used.(no water supply function; no significant drainage area)			0
184	HAWKINS; LAKE	Sabine	D	8/1/1962	1962	32.61	-95.25	0.22271283	0.58040184	0.1295481	86.074901	5.6407461	0.9393609	0.27900466	0	5.5125	25.95	14414.151	0.24333837	42.33591	3.9773358	0.59635123	17.469576	642.47398	16.72	14.39375	4.0290469	No WS	11890	358.52522			0.2	Original units were in ac-ft./sq. mi./yr.			0
185	HOLBROOK; LAKE	Sabine	D	9/15/1962	1962	32.68	-95.55	0.26194793	1.14183	0.36743804	31.203173	51.856476	5.3470865	1.1919107	0	3.075	14.13125	8574.5566	0.22818364	41.830482	3.5208696	0.37967983	17.468769	662.24241	10.05	11.31875	3.1206576	No WS	7990	400.82504			0.13	Original units were in ac-ft./sq. mi./yr.			0
186	J.D. MURPHREE WILDLIFE IMPOUNDMENT	Neches-Trinity	I					0.33465127	8.7532638	0.15889491	14.184309	25.598625	42.814823	7.0079976	0	30.78125	248.75188	317477.28	0.061691405	56.051422	32.549755	0.033703246	19.905335	24549.919	401.84	69.05	3.1267618	No WS	32000	40.14865			0.19	Original data are missing or highly out of range. A suggested replacement rate is used.(no water supply function; use average for Neches Basin (0.19))			0
187	KIOWA; LAKE	Trinity	C	3/31/1968	1968	33.55	-97.01	0.3127474	6.9073666	0.004116774	30.304779	54.482157	3.1061624	0	0	0	11.56875	10791.092	0	37.13942	5.0576923	0.32921594	17.093014	506.56602	4.86	12.51875	3.9463816	No WS	7000	726.16598			0.3	Original units were in ac-ft./sq. mi./yr.			0
190	NATURAL DAM LAKE	Colorado	F			32.21	-101.62	0.304523	0.52444726	0.29609858	0.045582508	57.889372	39.581501	0.17133788	0	16.675	53.96875	194266.83	0.054615793	18.468598	11.681789	0.21220924	17.212979	2367.2695	79.7	57.18125	8.3384616	No WS	54560	345.13593			0.22	Original data are missing or highly out of range. A suggested replacement rate is used.(no water supply function; suggest using Colorado Basin average)			0
191	QUITMAN; LAKE	Sabine	D	5/15/1962	1962	32.85	-95.43	0.30486117	0.62389637	0.17933291	16.729832	72.476297	4.0191925	1.0187585	0	1.80625	36.40625	18617.413	0.061731891	42.60293	8.2097788	0.33507579	17.417644	798.15037	23.22	13.2	3.3150319	No WS	7440	161.54177			0.18	Original units were in ac-ft./sq. mi./yr.			0
192	RITA BLANCA; LAKE	Canadian	A	9/30/1941	1941	36.02	-102.49	0.29083177	0.29064445	0.10262264	1.4323681	78.819415	19.300193	0	0	265.10625	611.675	1052005.2	0.16034416	15.87994	285.24468	0.52557006	11.783137	301.46856	89.62	8.475	3.4631782	No WS	12100	68.069813			0.02	Original units were in ac-ft./sq. mi./yr.			0
193	SAN ESTEBAN LAKE	Rio Grande	E					0.21371211	0.30259788	0.064040444	0.63686177	98.972481	0	0	0	21.3125	193.725	281939.82	0.048098224	16.54153	49.280738	0.84168078	15.105189	37.065807	5.47	1.99375	2.3234863	No WS	18770	1730.0198			0.42	Original units were in ac-ft./sq. mi./yr.			0
194	TRUSCOTT BRINE LAKE	Red	G	5/11/1987	1987	33.79	-99.83	0.32666719	0	2.6991351	0.59200439	77.865722	14.396885	0	0	0	23.93125	17999.156	0	24.74488	0.53129954	0.39046321	16.974341	1638.3087	1.28	12.29375	2.1549771	No WS	111147	43778.604			2.23	Original units were in ac-ft./sq. mi./yr.			0
195	WILLIAM HARRIS RESERVOIR	Brazos	H	10/1/1947	1947	29.24	-95.56	0.342121	0.26	0.00262	36.24	27.83	0.07	32.04	0	0	16.3375	8480.6565	0	52.136221	3.0243127	0.031	20.38	1519.6981	6.36	10.375	1.8882765	No WS	9200	729.29769		Reservoir area << immediate NHD catchment. Watershed area is overestimatad	0	Original units were in ac-ft/yr.			0
196	WINNSBORO; LAKE	Sabine	D	9/17/1962	1962	32.88	-95.34	0.28831526	0.95488351	0.22011971	18.226221	68.606082	2.9645669	3.2457974	0	3.0625	29.8875	19197.617	0.10150323	42.587776	7.7758406	0.33141923	17.379145	882.1662	22.23	17.1125	4.0878448	No WS	8100	183.70445			0.23	Original units were in ac-ft./sq. mi./yr.			0

Appendix **B** Sedimentation rates

Reservoir	Basin	Watershed Area (acres)	Watershed Area (sq. mi.)	WAM Sedimentation Rate (ac-ft/sq. mi./yr)	ADJUSTED WAM Rates w/ Replacement Rates (ac-ft./sq. mi./yr)	Sed. Rate Source from WAM Reports [1]	Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	ADJUSTED Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	Hydrosurvey Rate, Overall (ac-ft/sq.mi./yr.)	ADJUSTED Hydrosurvey Rate, Overall (ac-ft/sq. mi./yr)	# of Hydrosurveys [2]	Date of Last Hydrosurvey
ABILENE, LAKE	Brazos	66,575	104	0.49	0.49	0					0	
ADDICKS RESERVOIR	San Jacinto	76,485	119		0.77	RR					n/a	
ALAN HENRY RESERVOIR	Brazos	935,397	1,461	0.02	0.02	3	1.25	1.25	1.25	1.25	1	2005
ALCOA LAKE	Brazos	5,481	9	0.37	0.37	0					0	
AMISTAD RESERVOIR, INTERNATIONAL	Rio Grande	64,179,575	100,248	0.12	0.12	3	0.06	0.06	0.06	0.06	1	2005
AMON G. CARTER, LAKE	Trinity	70,688	110	2.07	2.07	3					0	
ANAHUAC, LAKE	Trinity	758,202	1,184	0.10	0.10	3	-0.06	0.00	-0.06	0.00	1	2006
ANZALDUAS CHANNEL DAM	Rio Grande	10,212,129	15,951		0.24	RR					n/a	
AQUILLA, LAKE	Brazos	164,570	257	2.07	2.07	2	1.67	1.67	1.20	1.20	3	2008
ARLINGTON, LAKE	Trinity	91,479	143	1.30	1.30	2	1.78	1.78	0.76	0.76	3	2007
ARROWHEAD, LAKE	Red	347,827	543	0.07	0.07	0	1.39	1.39	1.39	1.39	1	2001
ATHENS, LAKE	Neches	14,664	23	0.26	0.26	1	4.12	4.12	4.12	4.12	2	1998
AUSTIN, LAKE	Colorado	58,183	91		0.22	RR	-0.46	0.00	-0.57	0.00	2	2008
B A STEINHAGEN LAKE	Neches	2,053,109	3,207	0.04	0.04	1	0.25	0.25	0.20	0.20	2	2003
BALLINGER, LAKE / MOONEN, LAKE	Colorado	147,819	231	0.20	0.20	1					0	
BALMORHEA, LAKE	Rio Grande	4,660	7	0.13	0.13	1	6.01	5.96	6.01	5.51	1	1948
BARDWELL, LAKE	Trinity	92,576	145	1.39	1.39	2	1.75	1.75	1.75	1.75	1	1999
BARKER RESERVOIR	San Jacinto	92,642	145		0.77	RR					n/a	
BASTROP, LAKE	Colorado	5,667	9	0.69	0.69	1					0	
BAYLOR, LAKE	Red	25,136	39	1.33	1.33	0					0	
BELTON LAKE	n/a	1,461,729	2,283	0.25	0.25	2	0.61	0.61	0.19	0.19	4	2003
BENBROOK, LAKE	Trinity	206,779	323	0.13	0.13	2	0.18	0.18	0.18	0.18	1	1998
BIVINS LAKE	Red	538,240	841	0.36	0.36	0					n/a	
BOB SANDLIN, LAKE	Cypress	83,192	130	0.36	0.36	2	3.45	3.45	2.89	2.89	2	2008
BONHAM, LAKE	Red	16,907	26	0.85	0.85	0	1.04	1.04	1.04	1.04	1	2004
BRADY CREEK RESERVOIR	Colorado	335,516	524	0.08	0.08	1					0	
BRANDY BRANCH COOLING POND	Sabine	2,568	4	0.20	0.20	1					0	
BRAZORIA RESERVOIR	Brazos	2,034	3		0.48	RR					0	
BRIDGEPORT, LAKE	Trinity	680,844	1,063	0.36	0.36	2	0.66	0.66	0.28	0.28	3	2000
BROWNWOOD, LAKE	Colorado	750,951	1,173	0.24	0.24	2	0.27	0.27	0.25	0.25	2	1997
BRYAN UTILITIES LAKE	Brazos	2,926	5	0.00	0.00	3					0	
BUCHANAN, LAKE	Colorado	3,687,197	5,759	0.08	0.08	2	0.33	0.33	0.26	0.26	2	
BUFFALO LAKE	Red	1,151,808	1,799	0.10	0.10	0					n/a	
CADDO LAKE	Cypress	1,194,866	1,866	0.11	0.11	3					0	
CALAVERAS LAKE	San Antonio	39,834	62	1.07	1.07	1					0	

Reservoir	Basin	Watershed Area (acres)	Watershed Area (sq. mi.)	WAM Sedimentation Rate (ac-ft/sq. mi./yr)	ADJUSTED WAM Rates w/ Replacement Rates (ac-ft./sq. mi./yr)	Sed. Rate Source from WAM Reports [1]	Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	ADJUSTED Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	Hydrosurvey Rate, Overall (ac-ft/sq.mi./yr.)	ADJUSTED Hydrosurvey Rate, Overall (ac-ft/sq. mi./yr)	# of Hydrosurveys [2]	Date of Last Hydrosurvey
CAMP CREEK LAKE (Devil's Lake)	Brazos	1,745	3	10.57	0.72	0					n/a	
CANYON LAKE	Guadalupe	915,792	1,430	0.25	0.25	3	0.39	0.39	0.14	0.14	2	2000
CASA BLANCA LAKE	Rio Grande	75,043	117	0.61	0.61	3	0.00	0.00	0.00	0.00	1	1978
CEDAR BAYOU GENERATING POND (Dutton Lake)	Trinity-San Jacinto	1,117	2		0.00	RR					0	
CEDAR CREEK RESERVOIR COLORADO	Colorado	8,846	14	0.69	0.69	1	10.39	5.96	10.39	5.51	1	1995
CEDAR CREEK RESERVOIR TRINITY	Trinity	589,034	920	1.39	1.39	2	1.43	1.43	0.94	0.94	2	2005
CHAMPION CREEK RESERVOIR	Colorado	113,021	177	0.15	0.15	1					0	
CHEROKEE, LAKE	Sabine	102,341	160	0.67	0.67	2	1.62	1.62	0.68	0.68	4	2003
CHOKE CANYON RESERVOIR	Nueces	3,489,998	5,451	0.04	0.04	2	-0.07	0.00	-0.07	0.00	1	1993
CISCO, LAKE	Brazos	17,050	27	0.16	0.16	0					0	
CLYDE, LAKE	Colorado	24,859	39	0.23	0.23	1					0	
COFFEE MILL LAKE	Red	25,472	40	0.75	0.75	0					n/a	
COLEMAN, LAKE	Colorado	195,009	305	0.10	0.10	1	0.16	0.16	0.16	0.16	1	2006
COLETO CREEK RESERVOIR	Guadalupe	315,638	493	0.28	0.28	3					0	
COLORADO CITY, LAKE	Colorado	216,267	338	0.17	0.17	1					0	
CONROE, LAKE	San Jacinto	284,166	444	1.37	1.37	2	1.36	1.36	1.36	1.36	1	1996
CORPUS CHRISTI, LAKE	Nueces	7,029,370	10,980	0.11	0.11	3	0.23	0.23	0.11	0.11	2	2002
CREEK LAKE, LAKE	Brazos	8,872	14	0.74	0.74	0					0	
CROOK, LAKE	Red	40,693	64	0.96	0.96	2	0.89	0.89	0.45	0.45	3	2003
CYPRESS SPRINGS, LAKE	Cypress	47,035	73	0.13	0.13	2	2.51	2.51	2.22	2.22	2	2007
DANIEL, LAKE	Brazos	53,883	84	0.11	0.11	3					0	
DAVIS, LAKE	Brazos	24,894	39	0.25	0.25	3					0	
DELTA LAKE	Nueces-Rio Grande	432	1		0.00	RR					n/a	
DIVERSION, LAKE	Red	79,364	124		0.84	RR					0	
DUNLAP, LAKE	Guadalupe	149,205	233		0.26	RR					0	
E. V. SPENCE RESERVOIR	Colorado	5,594,234	8,738		0.22	RR	-0.11	0.00	-0.11	0.00	1	1999
EAGLE LAKE	Colorado	16,420	26	0.55	0.55	1					0	
EAGLE MOUNTAIN LAKE	Trinity	478,745	748	0.12	0.12	2	0.80	0.80	0.17	0.17	4	2008
EAGLE NEST LAKE (Manor Lake)	Brazos	14,730	23	0.00	0.00	3					0	
ELECTRA, LAKE	Red	10,584	17		0.84	RR	3.79	3.79	3.79	3.79	1	1999
ELLISON CREEK RESERVOIR	Cypress	27,455	43	0.18	0.18	3					0	

Reservoir	Basin	Watershed Area (acres)	Watershed Area (sq. mi.)	WAM Sedimentation Rate (ac-ft/sq. mi./yr)	ADJUSTED WAM Rates w/ Replacement Rates (ac-ft./sq. mi./yr)	Sed. Rate Source from WAM Reports [1]	Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	ADJUSTED Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	Hydrosurvey Rate, Overall (ac-ft/sq.mi./yr.)	ADJUSTED Hydrosurvey Rate, Overall (ac-ft/sq. mi./yr)	# of Hydrosurveys [2]	Date of Last Hydrosurvey
FAIRFIELD LAKE	Trinity	23,455	37	6.31	3.70	3	6.33	5.96	5.95	5.51	2	1999
FALCON RESERVOIR, INTERNATIONAL	Rio Grande	24,664,531	38,526	0.15	0.15	1	0.70	0.70	0.09	0.09	2	2005
FOREST GROVE RESERVOIR	Trinity	35,843	56	0.14	0.14	3					0	
FORK RESERVOIR, LAKE	Sabine	307,095	480	3.70	3.70	2	3.89	3.89	3.89	3.89	1	2001
FORT PHANTOM HILL, LAKE	Brazos	210,939	329	0.33	0.33	2	0.24	0.24	0.24	0.24	1	1993
GEORGETOWN, LAKE	Brazos	157,981	247	0.02	0.02	2	0.29	0.29	0.03	0.03	2	2005
GIBBONS CREEK RESERVOIR	Brazos	54,504	85	0.14	0.14	3	0.33	0.33	0.33	0.33	1	2008
GILMER, LAKE	Cypress	24,214	38	0.00	0.18	RR					0	
GONZALES (H-4), LAKE	Guadalupe	244,456	382		0.26	RR					0	
GRAHAM, LAKE	Brazos	141,231	221	0.95	0.95	2	0.55	0.55	0.55	0.55	1	1998
GRANBURY, LAKE	Brazos	1,038,889	1,623	0.41	0.41	2	0.49	0.49	0.47	0.47	2	2003
GRANGER LAKE	Brazos	313,081	489	1.53	1.53	2	0.65	0.65	0.43	0.43	3	2008
GRAPEVINE, LAKE	Trinity	443,980	693	0.77	0.77	2	0.73	0.73	0.69	0.69	4	2002
GREENBELT LAKE	Red	201,104	314	0.76	0.76	0					0	
GULF COAST WATER AUTHORITY RESERVOIR	San Jacinto-Brazos	791	1		0.00	RR	-0.74	0.00	-0.74	0.00	1	2004
HALBERT, LAKE	Trinity	8,372	13	2.36	2.36	2	1.36	1.36	1.36	1.36	1	1999
HAWKINS, LAKE	Sabine	14,414	23	0.20	0.20	1					n/a	
HOLBROOK, LAKE	Sabine	8,575	13	0.13	0.13	1					n/a	
HORDS CREEK, LAKE	Colorado	31,684	49	0.36	0.36	1	0.52	0.52	0.52	0.52	1	1968
HOUSTON COUNTY LAKE	Trinity	30,706	48	1.26	1.26	2	1.19	1.19	1.19	1.19	1	1999
HOUSTON, LAKE	San Jacinto	1,523,113	2,379	0.16	0.16	2	0.13	0.13	0.13	0.13	1	1994
HUBBARD CREEK RESERVOIR	Brazos	678,025	1,059	0.16	0.16	3	-0.20	0.00	-0.20	0.00	1	1997
HUBERT H. MOSS LAKE	Red	44,423	69		0.84	RR	-0.41	0.00	-0.41	0.00	1	1999
IMPERIAL RESERVOIR	Rio Grande	157,428	246		0.24	RR					0	
INKS LAKE	Colorado	31,686	49	0.00	0.00	2	1.02	1.02	1.02	1.02	1	2007
J B THOMAS, LAKE	Colorado	974,534	1,522	0.06	0.06	2	0.04	0.04	0.04	0.04	1	1999
J.D. MURPHREE WILDLIFE IMPOUNDMENT	Neches-Trinity	317,477	496		0.19	RR					n/a	
JACKSONVILLE, LAKE	Neches	25,653	40	0.18	0.18	1	2.43	2.43	2.43	2.43	1	2006
JIM CHAPMAN LAKE	Sulphur	311,229	486	1.17	1.17	3	1.41	1.41	1.41	1.41	1	2007
JOE POOL LAKE	Trinity	150,459	235	1.30	1.30	3					0	
JOHNSON CREEK RESERVOIR	Cypress	6,867	11	0.18	0.18	3					0	
KEMP, LAKE	Red	1,286,683	2,010	1.75	1.75	0	0.44	0.44	0.44	0.44	1	2006

Reservoir	Basin	Watershed Area (acres)	Watershed Area (sq. mi.)	WAM Sedimentation Rate (ac-ft/sq. mi./yr)	ADJUSTED WAM Rates w/ Replacement Rates (ac-ft./sq. mi./yr)	Sed. Rate Source from WAM Reports [1]	Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	ADJUSTED Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	Hydrosurvey Rate, Overall (ac-ft/sq.mi./yr.)	ADJUSTED Hydrosurvey Rate, Overall (ac-ft/sq. mi./yr)	# of Hydrosurveys [2]	Date of Last Hydrosurvey
KICKAPOO, LAKE	Red	167,591	262	0.20	0.20	0	1.40	1.40	1.40	1.40	1	2001
KIOWA, LAKE	Trinity	10,791	17	0.30	0.30	3					n/a	
KIRBY, LAKE	Brazos	27,720	43	0.47	0.47	0					0	
KURTH, LAKE	Neches	1,569	2	22.97	3.70	2	16.49	5.96	16.49	5.51	1	1996
LADY BIRD LAKE/TOWN LAKE	Colorado	100,610	157		0.22	RR	-0.17	0.00	-0.50	0.00	4	2008
LAVON LAKE	Trinity	491,391	768	0.31	0.31	0	-0.22	0.00	-0.22	0.00	1	1965
LEON, LAKE	Brazos	165,181	258	0.05	0.05	0					0	
LEWIS CREEK RESERVOIR	San Jacinto	3,309	5		0.77	RR					0	
LEWISVILLE LAKE	Trinity	618,469	966	0.89	0.89	2	2.98	2.98	0.82	0.82	4	2007
LIMESTONE, LAKE	Brazos	431,731	674	0.96	0.96	2	1.29	1.29	1.06	1.06	2	2002
LIVINGSTON, LAKE	Trinity	4,527,978	7,073	0.03	0.03	3	0.05	0.05	0.05	0.05	1	1991
LOMA ALTA LAKE	Nueces-Rio Grande	638	1		0.00	RR					0	
LOST CREEK RESERVOIR	Trinity	20,324	32	0.34	0.34	3					0	
LOWER RUNNING WATER DRAW WS SCS SITE 2 DAM	Brazos					n/a					n/a	
LOWER RUNNING WATER DRAW WS SCS SITE 3 DAM	Brazos					n/a					n/a	
LYNDON B. JOHNSON, LAKE	Colorado	3,176,440	4,962	0.00	0.00	2	0.04	0.04	0.02	0.02	3	2007
MACKENZIE RESERVOIR	Red	629,948	984	0.77	0.77	0					0	
MARBLE FALLS, LAKE	Colorado	52,728	82	0.00	0.00	2	0.69	0.69	0.28	0.28	2	2007
MARTIN LAKE	Sabine	85,476	134	0.73	0.73	2	5.84	5.84	0.74	0.74	2	1999
MEDINA LAKE	San Antonio	399,472	624	0.36	0.36	2	-0.02	0.00	-0.02	0.00	1	1995
MEREDITH, LAKE	Canadian	11,612,879	18,139	0.10	0.10	2	0.09	0.09	0.08	0.08	2	1995
MILLERS CREEK RESERVOIR	Brazos	154,058	241	0.77	0.77	2	0.83	0.83	0.83	0.83	1	1993
MINERAL WELLS, LAKE	Brazos	4,349	7	2.97	2.97	3	-0.63	0.00	-0.63	0.00	1	1992
MITCHELL COUNTY RESERVOIR	Colorado	10,858	17		0.22	RR					0	
MONTICELLO RESERVOIR	Cypress	23,128	36	0.18	0.18	2	5.82	5.82	5.82	5.51	1	1998
MOUNTAIN CREEK LAKE	Trinity	37,645	59	0.49	0.49	3					0	
MURVAUL, LAKE	Sabine	75,580	118	1.60	1.60	2	1.56	1.56	1.56	1.56	1	1998
NACOGDOCHES, LAKE	Neches	62,739	98	0.19	0.19	1	0.96	0.96	0.96	0.96	1	1994
NASWORTHY, LAKE	Colorado	67,788	106	0.02	0.02	2	0.34	0.34	0.34	0.34	1	1993
NATURAL DAM LAKE	Colorado	194,267	303		0.22	RR					n/a	
NAVARRO MILLS LAKE	Trinity	204,660	320	1.56	1.56	3	0.91	0.91	0.91	0.91	1	2008

Reservoir	Basin	Watershed Area (acres)	Watershed Area (sq. mi.)	WAM Sedimentation Rate (ac-ft/sq. mi./yr)	ADJUSTED WAM Rates w/ Replacement Rates (ac-ft./sq. mi./yr)	Sed. Rate Source from WAM Reports [1]	Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	ADJUSTED Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	Hydrosurvey Rate, Overall (ac-ft/sq.mi./yr.)	ADJUSTED Hydrosurvey Rate, Overall (ac-ft/sq. mi./yr)	# of Hydrosurveys [2]	Date of Last Hydrosurvey
NEW TERRELL CITY LAKE	Trinity	18,338	29	0.37	0.37	2	0.10	0.10	0.10	0.10	1	1997
NOCONA, LAKE/FARMERS CREEK RESERVOIR	Red	58,589	92	1.28	1.28	0	1.15	1.15	1.15	1.15	1	2001
NORTH FORK BUFFALO CREEK RESERVOIR	Red	21,214	33	0.83	0.83	0					0	
NORTH LAKE	Trinity	4,443	7	0.12	0.12	3					0	
O C FISHER LAKE	Colorado	963,123	1,504	0.25	0.25	2	0.22	0.22	0.22	0.22	1	1962
O H IVIE RESERVOIR	Colorado	1,757,250	2,745	0.12	0.12	1					0	
O' THE PINES, LAKE	Cypress	361,283	564	0.11	0.11	2	1.43	1.43	1.12	1.12	3	2009
OAK CREEK RESERVOIR	Colorado	151,607	237	0.15	0.15	1					0	
OLNEY/ LAKE COOPER, LAKE	Red	12,956	20		0.84	RR	0.00	0.00	0.00	0.00	1	2005
PALESTINE, LAKE	Neches	521,791	815	0.26	0.26	1	2.29	2.29	1.14	1.14	2	2003
PALO DURO RESERVOIR	Canadian	932,939	1,457	0.15	0.15	0					0	
PALO PINTO, LAKE	Brazos	293,072	458	0.18	0.18	3	1.74	1.74	0.85	0.85	3	2007
PAT CLEBURNE, LAKE	Brazos	66,148	103	0.57	0.57	2	-0.05	0.00	-0.10	0.00	2	2008
PAT MAYSE LAKE	Red	114,513	179	1.63	1.63	0	0.91	0.91	0.91	0.91	1	2008
PEACOCK SITE 1A TAILINGS RESERVOIR	Cypress	1,122	2		0.00	RR					0	
PINKSTON RESERVOIR	Neches	9,178	14	0.10	0.10	1					0	
POSSUM KINGDOM LAKE	Brazos	9,028,112	14,102	0.05	0.05	2	0.33	0.33	0.20	0.20	3	2005
PROCTOR LAKE	Brazos	656,925	1,026	0.12	0.12	2	0.12	0.12	0.10	0.10	2	2002
QUITMAN, LAKE	Sabine	18,617	29	0.18	0.18	1					n/a	
RAY HUBBARD, LAKE	Trinity	189,288	296	0.59	0.59	3	12.99	5.96	3.53	3.53	2	2005
RAY ROBERTS, LAKE	Trinity	432,793	676	0.30	0.30	3	0.57	0.57	0.57	0.57	1	2008
RED BLUFF RESERVOIR	Rio Grande	13,686,539	21,378	0.18	0.18	3					0	
RED DRAW RESERVOIR	Colorado	2,918	5		0.22	RR					0	
RICHLAND-CHAMBERS RESERVOIR	Trinity	927,813	1,449	3.30	3.30	2	3.96	3.96	2.26	2.26	2	2008
RITA BLANCA, LAKE	Canadian	1,052,005	1,643	0.02	0.02	0					n/a	
RIVER CREST LAKE	Sulphur	378	1		0.00	RR					0	
SAM RAYBURN RESERVOIR	Neches	1,940,864	3,032	0.10	0.10	1	0.19	0.19	0.19	0.19	2	2004
SAN ESTEBAN LAKE	Rio Grande	281,940	440	0.42	0.42	3					n/a	
SANTA ROSA LAKE	Red	207,560	324	0.14	0.14	0					0	
SMITHERS LAKE	Brazos	14,881	23	0.38	0.38	0					0	
SOMERVILLE LAKE	Brazos	636,458	994	0.15	0.15	2	1.04	1.04	0.36	0.36	2	2003
SOUTH TEXAS PROJECT RESERVOIR (Cooling Water Reservoir)	Colorado	3,474	5		0.22	RR					0	

Reservoir	Basin	Watershed Area (acres)	Watershed Area (sq. mi.)	WAM Sedimentation Rate (ac-ft/sq. mi./yr)	ADJUSTED WAM Rates w/ Replacement Rates (ac-ft./sq. mi./yr)	Sed. Rate Source from WAM Reports [1]	Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	ADJUSTED Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	Hydrosurvey Rate, Overall (ac-ft/sq.mi./yr.)	ADJUSTED Hydrosurvey Rate, Overall (ac-ft/sq. mi./yr)	# of Hydrosurveys [2]	Date of Last Hydrosurvey
SQUAW CREEK RESERVOIR	Brazos	40,812	64	0.36	0.36	2	1.63	1.63	0.21	0.21	3	2007
STAMFORD, LAKE	Brazos	235,938	369	0.19	0.19	2	1.74	1.74	0.36	0.36	3	1999
STILLHOUSE HOLLOW LAKE	Brazos	845,017	1,320	0.27	0.27	2	0.30	0.30	0.16	0.16	2	2005
STRIKER, LAKE	Neches	118,889	186	0.44	0.44	1	0.83	0.83	0.83	0.83	1	1996
SULPHUR SPRINGS DRAW STORAGE RESERVOIR	Colorado	1,165,010	1,820		0.22	RR					0	
SULPHUR SPRINGS, LAKE	Sulphur	44,981	70	0.30	0.30	3	19.34	5.96	19.34	5.51	1	1984
SWEETWATER, LAKE	Brazos	73,252	114	0.19	0.19	0					0	
TAWAKONI, LAKE	Sabine	485,429	758	1.72	1.72	2	1.74	1.74	1.74	1.74	1	1997
TEXANA, LAKE	Lavaca	903,651	1,412	0.24	0.24	3	0.18	0.18	0.17	0.17	2	2000
TEXOMA, LAKE	Red	20,420,950	31,898	0.43	0.43	2	0.55	0.55	0.33	0.33	3	2002
TOLEDO BEND RESERVOIR	Sabine	3,464,711	5,412	0.12	0.12	1					0	
TRADINGHOUSE CREEK RESERVOIR	Brazos	25,462	40	0.59	0.59	0					0	
TRAVIS, LAKE	Colorado	1,117,340	1,745	0.02	0.02	2	0.42	0.42	0.31	0.31	2	2008
TRINIDAD LAKE	Trinity	18,135	28	0.59	0.59	3					0	
TRUSCOTT BRINE LAKE	Red	17,999	28	2.23	2.23	0					n/a	
TWIN BUTTES RESERVOIR	Colorado	2,398,315	3,746	0.08	0.08	1					0	
TWIN OAK RESERVOIR	Brazos	30,024	47	0.69	0.69	3					0	
TYLER, LAKE	Neches	71,182	111	0.15	0.15	1	0.21	0.21	0.21	0.21	1	1997
UPPER NUECES LAKE	Nueces	259	0		0.00	RR					0	
VALLEY LAKE	Red	5,516	9	0.81	0.81	0					0	
VICTOR BRAUNIG LAKE	San Antonio	5,987	9	1.03	1.03	1	0.00	0.00	0.00	0.00	1	2002
WACO, LAKE	Brazos	1,056,816	1,651	0.11	0.11	2	0.41	0.41	0.16	0.16	2	1995
WALTER E LONG, LAKE	Colorado	6,062	9	0.69	0.69	1					0	
WAXAHACHIE, LAKE	Trinity	19,553	31	1.39	1.39	3	1.59	1.59	1.59	1.59	1	2000
WEATHERFORD, LAKE	Trinity	69,429	108	0.26	0.26	2	0.80	0.80	0.61	0.61	3	2008
WELSH RESERVOIR	Cypress	15,795	25	0.18	0.18	3	5.04	5.04	5.04	5.04	1	2001
WHITE RIVER LAKE	Brazos	1,944,197	3,037	0.14	0.14	2	0.08	0.08	0.08	0.08	1	1992
WHITE ROCK LAKE	Trinity	63,943	100	1.58	1.58	2	0.21	0.21	0.21	0.21	2	1993
WHITNEY, LAKE	Brazos	858,347	1,341	1.38	1.38	0	1.02	1.02	1.02	1.02	2	2005
WICHITA, LAKE	Red	81,488	127	0.65	0.65	0					0	
WILLIAM HARRIS RESERVOIR	Brazos	8,481	13	0.00	0.00	0					n/a	
WINNSBORO, LAKE	Sabine	19,198	30	0.23	0.23	1					n/a	
WINTERS, LAKE / NEW WINTERS, LAKE	Colorado	43,769	68	0.26	0.26	1					0	

Reservoir	Basin	Watershed Area (acres)	Watershed Area (sq. mi.)	WAM Sedimentation Rate (ac-ft/sq. mi./yr)	ADJUSTED WAM Rates w/ Replacement Rates (ac-ft./sq. mi./yr)	Sed. Rate Source from WAM Reports [1]	Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	ADJUSTED Hydrosurvey Rate, maximum (ac-ft/sq. mi./yr)	Hydrosurvey Rate, Overall (ac-ft/sq.mi./yr.)	ADJUSTED Hydrosurvey Rate, Overall (ac-ft/sq. mi./yr)	# of Hydrosurveys [2]	Date of Last Hydrosurvey
WORTH, LAKE	Trinity	60,388	94	0.35	0.35	3	0.44	0.44	0.44	0.44	2	2001
WRIGHT PATMAN LAKE	Sulphur	1,826,861	2,854	0.40	0.40	3	0.20	0.20	0.20	0.20	1	1997

NOTES

[1] **Sed. Rate from WAM Reports Source Codes**

0 = Sources not reported in WAM reports
1 = Rates from TWDB Report 268, "Erosion and Sedimentation by Water in Texas"
2 = Rates from Hydro/Volumetric Survey
3 = Rates from Other Source/Study (See Notes column for explanation)
RR = Replacement Rate due to missing data and/or highly out of range values

[2] **n/a -** sedimentation rates for reservoirs with no water supply function were not included in the hydrosurvey dataset provided by TWDB

Appendix C Maps of reservoir watersheds

The maps of each major TX reservoir and their associated data are available as individual pdf files in the attached CD under the folder: /AppendixC/Individual_Reservoirs For filenames please refer to the following pages.

Reservoirs are also grouped by their basins, e.g. Colorado, Trinity, San Jacinto, etc., and are compiled into the following pdfs under the folder: /AppendixD/Grouped_by_river_basin.

- Brazos.pdf
- Canadian.pdf
- Colorado.pdf
- Cypress.pdf
- Guadalupe.pdf
- Lavaca.pdf
- Neches.pdf
- Neches-Trinity.pdf
- Nueces.pdf
- Nueces-Rio Grande.pdf
- Red.pdf
- Rio Grande.pdf
- Sabine.pdf
- San Antonio.pdf
- San Jacinto.pdf
- SanJacinto-Brazos.pdf
- Sulphur.pdf
- Trinity.pdf
- Trinity-San Jacinto.pdf

For illustration purposes, reservoir maps of the top 20 reservoirs listed in Table 9.2 have been printed and included in the hard copy delivery of this report.

Table C-1. Index of major Texas reservoirs (> 5000 ac-ft) and their associated basins and planning regions.

RES NUM	RESERVOIR NAME	REGION NAME	BASIN NAME	PDF name
1	ABILENE; LAKE	G	Brazos	1_ABILENE__LAKE_Brazos_G.PDF
2	ALAN HENRY RESERVOIR	O	Brazos	2_ALAN_HENRY_RESERVOIR_Brazos_O.PDF
3	ALCOA LAKE	G	Brazos	3_ALCOA_LAKE_Brazos_G.PDF
4	AMISTAD RESERVOIR; INTERNATIONAL	J	Rio Grande	4_AMISTAD_RESERVOIR__INTERNATIONAL_Rio_Grande_J.PDF
5	AMON G. CARTER; LAKE	B	Trinity	5_AMON_G._CARTER__LAKE_Trinity_B.PDF
6	ANAHUAC; LAKE	H	Trinity	6_ANAHUAC__LAKE_Trinity_H.PDF
7	AQUILLA; LAKE	G	Brazos	7_AQUILLA__LAKE_Brazos_G.PDF
8	ARLINGTON; LAKE	C	Trinity	8_ARLINGTON__LAKE_Trinity_C.PDF
9	ARROWHEAD; LAKE	B	Red	9_ARROWHEAD__LAKE_Red_B.PDF
10	ATHENS; LAKE	I	Neches	10_ATHENS__LAKE_Neches_I.PDF
11	AUSTIN; LAKE	K	Colorado	11_AUSTIN__LAKE_Colorado_K.PDF
12	B A STEINHAGEN LAKE	I	Neches	12_B_A_STEINHAGEN_LAKE_Neches_I.PDF
13	BALLINGER; LAKE / MOONEN; LAKE	F	Colorado	13_BALLINGER__LAKE___MOONEN__LAKE_Colorado_F.PDF
14	BALMORHEA; LAKE	E	Rio Grande	14_BALMORHEA__LAKE_Rio_Grande_E.PDF
15	BARDWELL; LAKE	C	Trinity	15_BARDWELL__LAKE_Trinity_C.PDF
16	BASTROP; LAKE	K	Colorado	16_BASTROP__LAKE_Colorado_K.PDF
17	BAYLOR; LAKE	A	Red	17_BAYLOR__LAKE_Red_A.PDF
18	BELTON LAKE	G	Brazos	18_BELTON_LAKE_Brazos_G.PDF
19	BENBROOK; LAKE	C	Trinity	19_BENBROOK__LAKE_Trinity_C.PDF
20	BOB SANDLIN; LAKE	D	Cypress	20_BOB_SANDLIN__LAKE_Cypress_D.PDF
21	BONHAM; LAKE	C	Red	21_BONHAM__LAKE_Red_C.PDF
22	BRADY CREEK RESERVOIR	F	Colorado	22_BRADY_CREEK_RESERVOIR_Colorado_F.PDF
23	BRANDY BRANCH COOLING POND	D	Sabine	23_BRANDY_BRANCH_COOLING_POND_Sabine_D.PDF
24	BRAZORIA RESERVOIR	H	Brazos	24_BRAZORIA_RESERVOIR_Brazos_H.PDF
25	BRIDGEPORT; LAKE	C	Trinity	25_BRIDGEPORT__LAKE_Trinity_C.PDF
26	BROWNWOOD; LAKE	F	Colorado	26_BROWNWOOD__LAKE_Colorado_F.PDF
27	BRYAN UTILITIES LAKE	G	Brazos	27_BRYAN_UTILITIES_LAKE_Brazos_G.PDF
28	BUCHANAN; LAKE	K	Colorado	28_BUCHANAN__LAKE_Colorado_K.PDF
29	CADDO LAKE	D	Cypress	29_CADDO_LAKE_Cypress_D.PDF
30	CALAVERAS LAKE	L	San Antonio	30_CALAVERAS_LAKE_San_Antonio_L.PDF
31	CANYON LAKE	L	Guadalupe	31_CANYON_LAKE_Guadalupe_L.PDF

RES_NUM	RES_NAME	REGION_NAME	BASIN_NAME	PDF name
32	CASA BLANCA LAKE	M	Rio Grande	32_CASA_BLANCA_LAKE_Rio_Grande_M.PDF
33	CEDAR BAYOU GENERATING POND	H	Trinity-San Jacinto	33_CEDAR_BAYOU_GENERATING_POND_Trinity-San_Jacinto_H.PDF
34	CEDAR CREEK RESERVOIR COLORADO	K	Colorado	34_CEDAR_CREEK_RESERVOIR_COLORADO_Colorado_K.PDF
35	CEDAR CREEK RESERVOIR TRINITY	C	Trinity	35_CEDAR_CREEK_RESERVOIR_TRINITY_Trinity_C.PDF
36	CHAMPION CREEK RESERVOIR	F	Colorado	36_CHAMPION_CREEK_RESERVOIR_Colorado_F.PDF
37	CHEROKEE; LAKE	I	Sabine	37_CHEROKEE__LAKE_Sabine_I.PDF
38	CHOKE CANYON RESERVOIR	N	Nueces	38_CHOKE_CANYON_RESERVOIR_Nueces_N.PDF
39	CISCO; LAKE	G	Brazos	39_CISCO__LAKE_Brazos_G.PDF
40	CLYDE; LAKE	G	Colorado	40_CLYDE__LAKE_Colorado_G.PDF
41	COLEMAN; LAKE	F	Colorado	41_COLEMAN__LAKE_Colorado_F.PDF
42	COLETO CREEK RESERVOIR	L	Guadalupe	42_COLETO_CREEK_RESERVOIR_Guadalupe_L.PDF
43	COLORADO CITY; LAKE	F	Colorado	43_COLORADO_CITY__LAKE_Colorado_F.PDF
44	CONROE; LAKE	H	San Jacinto	44_CONROE__LAKE_San_Jacinto_H.PDF
45	CORPUS CHRISTI; LAKE	N	Nueces	45_CORPUS_CHRISTI__LAKE_Nueces_N.PDF
46	CREEK LAKE; LAKE	G	Brazos	46_CREEK_LAKE__LAKE_Brazos_G.PDF
47	CROOK; LAKE	D	Red	47_CROOK__LAKE_Red_D.PDF
48	CYPRESS SPRINGS; LAKE	D	Cypress	48_CYPRESS_SPRINGS__LAKE_Cypress_D.PDF
49	DANIEL; LAKE	G	Brazos	49_DANIEL__LAKE_Brazos_G.PDF
50	DAVIS; LAKE	G	Brazos	50_DAVIS__LAKE_Brazos_G.PDF
51	DIVERSION; LAKE	B	Red	51_DIVERSION__LAKE_Red_B.PDF
52	DUNLAP; LAKE	L	Guadalupe	52_DUNLAP__LAKE_Guadalupe_L.PDF
53	E. V. SPENCE RESERVOIR	F	Colorado	53_E._V._SPENCE_RESERVOIR_Colorado_F.PDF
54	EAGLE LAKE	K	Colorado	54_EAGLE_LAKE_Colorado_K.PDF
55	EAGLE MOUNTAIN LAKE	C	Trinity	55_EAGLE_MOUNTAIN_LAKE_Trinity_C.PDF
56	EAGLE NEST LAKE / MANOR LAKE	H	Brazos	56_EAGLE_NEST_LAKE___MANOR_LAKE_Brazos_H.PDF
57	ELECTRA; LAKE	B	Red	57_ELECTRA__LAKE_Red_B.PDF
58	ELLISON CREEK RESERVOIR	D	Cypress	58_ELLISON_CREEK_RESERVOIR_Cypress_D.PDF
59	FAIRFIELD LAKE	C	Trinity	59_FAIRFIELD_LAKE_Trinity_C.PDF
60	FALCON RESERVOIR; INTERNATIONAL	M	Rio Grande	60_FALCON_RESERVOIR__INTERNATIONAL_Rio_Grande_M.PDF
61	FARMERS CREEK RESERVOIR	B	Red	61_FARMERS_CREEK_RESERVOIR_Red_B.PDF
62	FOREST GROVE RESERVOIR	C	Trinity	62_FOREST_GROVE_RESERVOIR_Trinity_C.PDF
63	FORK RESERVOIR; LAKE	D	Sabine	63_FORK_RESERVOIR__LAKE_Sabine_D.PDF
64	FORT PHANTOM HILL; LAKE	G	Brazos	64_FORT_PHANTOM_HILL__LAKE_Brazos_G.PDF

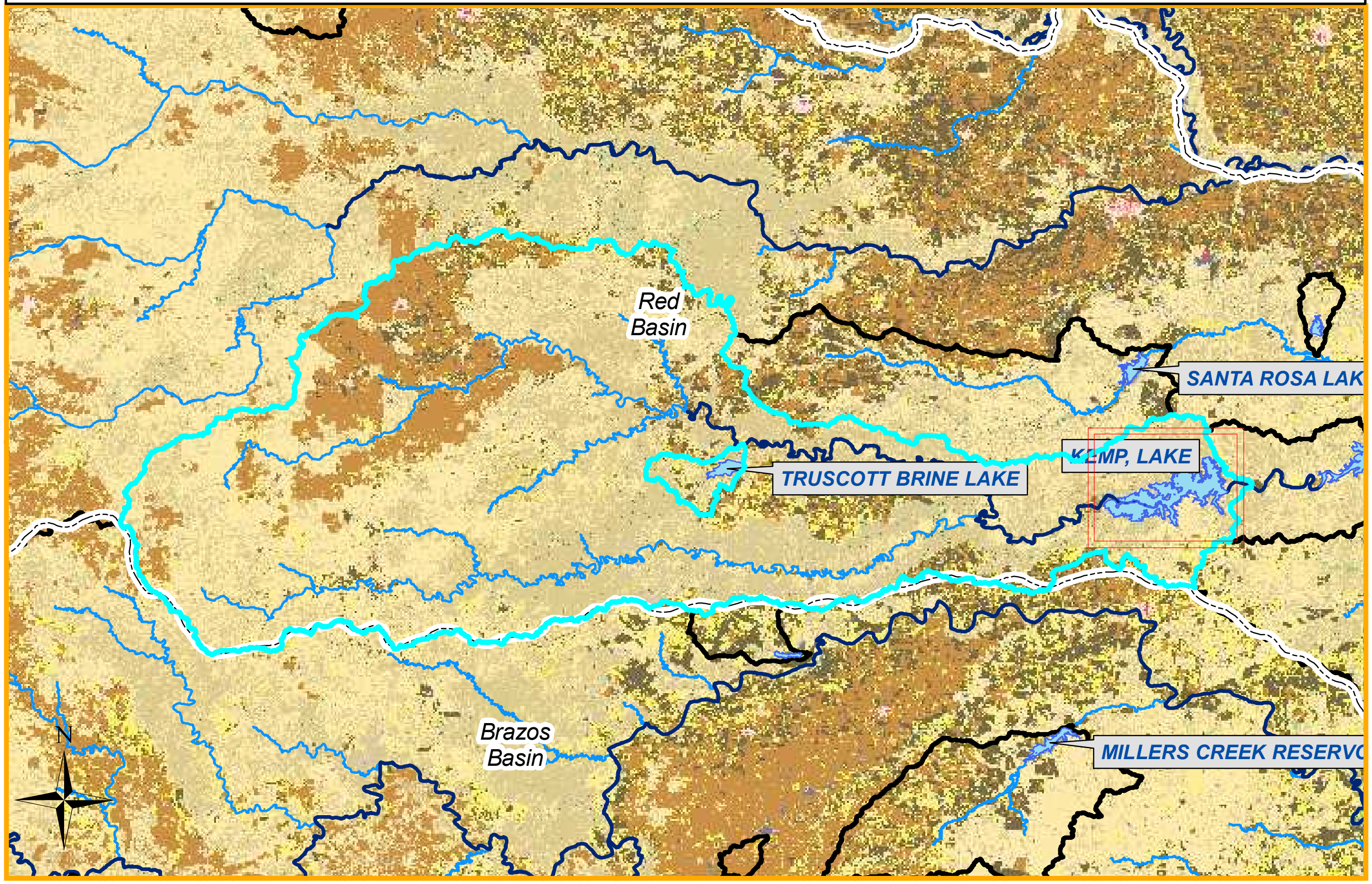
RES_NUM	RES_NAME	REGION _NAME	BASIN_NAME	PDF name
65	GEORGETOWN; LAKE	G	Brazos	65_GEORGETOWN__LAKE_Brazos_G.PDF
66	GIBBONS CREEK RESERVOIR	G	Brazos	66_GIBBONS_CREEK_RESERVOIR_Brazos_G.PDF
67	GILMER; LAKE	D	Cypress	67_GILMER__LAKE_Cypress_D.PDF
68	GONZALES (H-4); LAKE	L	Guadalupe	68_GONZALES_(H-4)__LAKE_Guadalupe_L.PDF
69	GRAHAM; LAKE	G	Brazos	69_GRAHAM__LAKE_Brazos_G.PDF
70	GRANBURY; LAKE	G	Brazos	70_GRANBURY__LAKE_Brazos_G.PDF
71	GRANGER LAKE	G	Brazos	71_GRANGER_LAKE_Brazos_G.PDF
72	GRAPEVINE; LAKE	C	Trinity	72_GRAPEVINE__LAKE_Trinity_C.PDF
73	GREENBELT LAKE	A	Red	73_GREENBELT_LAKE_Red_A.PDF
74	GULF COAST WATER AUTHORITY RESERVOIR	H	San Jacinto-Brazos	74_GULF_COAST_WATER_AUTHORITY_RESERVOIR_San_Jacinto-Brazos_H.PDF
75	HALBERT; LAKE	C	Trinity	75_HALBERT__LAKE_Trinity_C.PDF
76	HORDS CREEK; LAKE	F	Colorado	76_HORDS_CREEK__LAKE_Colorado_F.PDF
77	HOUSTON COUNTY LAKE	I	Trinity	77_HOUSTON_COUNTY_LAKE_Trinity_I.PDF
78	HOUSTON; LAKE	H	San Jacinto	78_HOUSTON__LAKE_San_Jacinto_H.PDF
79	HUBBARD CREEK RESERVOIR	G	Brazos	79_HUBBARD_CREEK_RESERVOIR_Brazos_G.PDF
80	HUBERT H. MOSS LAKE	C	Red	80_HUBERT_H._MOSS_LAKE_Red_C.PDF
81	IMPERIAL RESERVOIR	F	Rio Grande	81_IMPERIAL_RESERVOIR_Rio_Grande_F.PDF
82	INKS LAKE	K	Colorado	82_INKS_LAKE_Colorado_K.PDF
83	J B THOMAS; LAKE	F	Colorado	83_J_B_THOMAS__LAKE_Colorado_F.PDF
84	JACKSONVILLE; LAKE	I	Neches	84_JACKSONVILLE__LAKE_Neches_I.PDF
85	JIM CHAPMAN LAKE	D	Sulphur	85_JIM_CHAPMAN_LAKE_Sulphur_D.PDF
86	JOE POOL LAKE	C	Trinity	86_JOE_POOL_LAKE_Trinity_C.PDF
87	JOHNSON CREEK RESERVOIR	D	Cypress	87_JOHNSON_CREEK_RESERVOIR_Cypress_D.PDF
88	KEMP; LAKE	B	Red	88_KEMP__LAKE_Red_B.PDF
89	KICKAPOO; LAKE	B	Red	89_KICKAPOO__LAKE_Red_B.PDF
90	KIRBY; LAKE	G	Brazos	90_KIRBY__LAKE_Brazos_G.PDF
91	KURTH; LAKE	I	Neches	91_KURTH__LAKE_Neches_I.PDF
92	LAVON LAKE	C	Trinity	92_LAVON_LAKE_Trinity_C.PDF
93	LEON; LAKE	G	Brazos	93_LEON__LAKE_Brazos_G.PDF
94	LEWIS CREEK RESERVOIR	H	San Jacinto	94_LEWIS_CREEK_RESERVOIR_San_Jacinto_H.PDF
95	LEWISVILLE LAKE	C	Trinity	95_LEWISVILLE_LAKE_Trinity_C.PDF
96	LIMESTONE; LAKE	G	Brazos	96_LIMESTONE__LAKE_Brazos_G.PDF
97	LIVINGSTON; LAKE	H	Trinity	97_LIVINGSTON__LAKE_Trinity_H.PDF

RES_NUM	RES_NAME	REGION _NAME	BASIN_NAME	PDF NAME
98	LOMA ALTA LAKE	M	Nueces-Rio Grande	98_LOMA_ALTA_LAKE_Nueces-Rio_Grande_M.PDF
99	LOST CREEK RESERVOIR	C	Trinity	99_LOST_CREEK_RESERVOIR_Trinity_C.PDF
100	LYNDON B. JOHNSON; LAKE	K	Colorado	100_LYNDON_B._JOHNSON__LAKE_Colorado_K.PDF
101	MACKENZIE RESERVOIR	O	Red	101_MACKENZIE_RESERVOIR_Red_O.PDF
102	MARBLE FALLS; LAKE	K	Colorado	102_MARBLE_FALLS__LAKE_Colorado_K.PDF
103	MARTIN LAKE	I	Sabine	103_MARTIN_LAKE_Sabine_I.PDF
104	MEDINA LAKE	L	San Antonio	104_MEDINA_LAKE_San_Antonio_L.PDF
105	MEREDITH; LAKE	A	Canadian	105_MEREDITH__LAKE_Canadian_A.PDF
106	MILLERS CREEK RESERVOIR	B	Brazos	106_MILLERS_CREEK_RESERVOIR_Brazos_B.PDF
107	MINERAL WELLS; LAKE	G	Brazos	107_MINERAL_WELLS__LAKE_Brazos_G.PDF
108	MITCHELL COUNTY RESERVOIR	F	Colorado	108_MITCHELL_COUNTY_RESERVOIR_Colorado_F.PDF
109	MONTICELLO RESERVOIR	D	Cypress	109_MONTICELLO_RESERVOIR_Cypress_D.PDF
110	MOUNTAIN CREEK LAKE	C	Trinity	110_MOUNTAIN_CREEK_LAKE_Trinity_C.PDF
111	MURVAUL; LAKE	I	Sabine	111_MURVAUL__LAKE_Sabine_I.PDF
112	NACOGDOCHES; LAKE	I	Neches	112_NACOGDOCHES__LAKE_Neches_I.PDF
113	NASWORTHY; LAKE	F	Colorado	113_NASWORTHY__LAKE_Colorado_F.PDF
114	NAVARRO MILLS LAKE	C	Trinity	114_NAVARRO_MILLS_LAKE_Trinity_C.PDF
115	NEW TERRELL CITY LAKE	C	Trinity	115_NEW_TERRELL_CITY_LAKE_Trinity_C.PDF
116	NORTH FORK BUFFALO CREEK RESERVOIR	B	Red	116_NORTH_FORK_BUFFALO_CREEK_RESERVOIR_Red_B.PDF
117	NORTH LAKE	C	Trinity	117_NORTH_LAKE_Trinity_C.PDF
118	O' THE PINES; LAKE	D	Cypress	118_O'_THE_PINES__LAKE_Cypress_D.PDF
119	O. C. FISHER LAKE	F	Colorado	119_O._C._FISHER_LAKE_Colorado_F.PDF
120	O. H. IVIE RESERVOIR	F	Colorado	120_O._H._IVIE_RESERVOIR_Colorado_F.PDF
121	OAK CREEK RESERVOIR	F	Colorado	121_OAK_CREEK_RESERVOIR_Colorado_F.PDF
122	OLNEY/ LAKE COOPER; LAKE	B	Red	122_OLNEY__LAKE_COOPER__LAKE_Red_B.PDF
123	PALESTINE; LAKE	I	Neches	123_PALESTINE__LAKE_Neches_I.PDF
124	PALO DURO RESERVOIR	A	Canadian	124_PALO_DURO_RESERVOIR_Canadian_A.PDF
125	PALO PINTO; LAKE	G	Brazos	125_PALO_PINTO__LAKE_Brazos_G.PDF
126	PAT CLEBURNE; LAKE	G	Brazos	126_PAT_CLEBURNE__LAKE_Brazos_G.PDF
127	PAT MAYSE LAKE	D	Red	127_PAT_MAYSE_LAKE_Red_D.PDF
128	PEACOCK SITE 1A TAILINGS RESERVOIR	D	Cypress	128_PEACOCK_SITE_1A_TAILINGS_RESERVOIR_Cypress_D.PDF
129	PINKSTON RESERVOIR	I	Neches	129_PINKSTON_RESERVOIR_Neches_I.PDF
130	POSSUM KINGDOM LAKE	G	Brazos	130_POSSUM_KINGDOM_LAKE_Brazos_G.PDF

RES_NUM	RES_NAME	REGION _NAME	BASIN_NAME	PDF NAME
131	PROCTOR LAKE	G	Brazos	131_PROCTOR_LAKE_Brazos_G.PDF
132	RAY HUBBARD; LAKE	C	Trinity	132_RAY_HUBBARD__LAKE_Trinity_C.PDF
133	RAY ROBERTS; LAKE	C	Trinity	133_RAY_ROBERTS__LAKE_Trinity_C.PDF
134	RED BLUFF RESERVOIR	F	Rio Grande	134_RED_BLUFF_RESERVOIR_Rio_Grande_F.PDF
135	RED DRAW RESERVOIR	F	Colorado	135_RED_DRAW_RESERVOIR_Colorado_F.PDF
136	RICHLAND-CHAMBERS RESERVOIR	C	Trinity	136_RICHLAND-CHAMBERS_RESERVOIR_Trinity_C.PDF
137	RIVER CREST LAKE	D	Sulphur	137_RIVER_CREST_LAKE_Sulphur_D.PDF
138	SAM RAYBURN RESERVOIR	I	Neches	138_SAM_RAYBURN_RESERVOIR_Neches_I.PDF
139	SANTA ROSA LAKE	B	Red	139_SANTA_ROSA_LAKE_Red_B.PDF
140	SMITHERS LAKE	H	Brazos	140_SMITHERS_LAKE_Brazos_H.PDF
141	SOMERVILLE LAKE	G	Brazos	141_SOMERVILLE_LAKE_Brazos_G.PDF
142	SOUTH TEXAS PROJECT RESERVOIR	K	Colorado	142_SOUTH_TEXAS_PROJECT_RESERVOIR_Colorado_K.PDF
143	SQUAW CREEK RESERVOIR	G	Brazos	143_SQUAW_CREEK_RESERVOIR_Brazos_G.PDF
144	STAMFORD; LAKE	G	Brazos	144_STAMFORD__LAKE_Brazos_G.PDF
145	STILLHOUSE HOLLOW LAKE	G	Brazos	145_STILLHOUSE_HOLLOW_LAKE_Brazos_G.PDF
146	STRIKER; LAKE	I	Neches	146_STRIKER__LAKE_Neches_I.PDF
147	SULPHUR SPRINGS DRAW STORAGE RESERVOIR	F	Colorado	147_SULPHUR_SPRINGS_DRAW_STORAGE_RESERVOIR_Colorado_F.PDF
148	SULPHUR SPRINGS; LAKE	D	Sulphur	148_SULPHUR_SPRINGS__LAKE_Sulphur_D.PDF
149	SWEETWATER; LAKE	G	Brazos	149_SWEETWATER__LAKE_Brazos_G.PDF
150	TAWAKONI; LAKE	D	Sabine	150_TAWAKONI__LAKE_Sabine_D.PDF
151	TEXANA; LAKE	P	Lavaca	151_TEXANA__LAKE_Lavaca_P.PDF
152	TEXOMA; LAKE	C	Red	152_TEXOMA__LAKE_Red_C.PDF
153	TOLEDO BEND RESERVOIR	I	Sabine	153_TOLEDO_BEND_RESERVOIR_Sabine_I.PDF
154	TOWN LAKE	K	Colorado	154_TOWN_LAKE_Colorado_K.PDF
155	TRADINGHOUSE CREEK RESERVOIR	G	Brazos	155_TRADINGHOUSE_CREEK_RESERVOIR_Brazos_G.PDF
156	TRAVIS; LAKE	K	Colorado	156_TRAVIS__LAKE_Colorado_K.PDF
157	TRINIDAD LAKE	C	Trinity	157_TRINIDAD_LAKE_Trinity_C.PDF
158	TWIN BUTTES RESERVOIR	F	Colorado	158_TWIN_BUTTES_RESERVOIR_Colorado_F.PDF
159	TWIN OAK RESERVOIR	G	Brazos	159_TWIN_OAK_RESERVOIR_Brazos_G.PDF
160	TYLER; LAKE	I	Neches	160_TYLER__LAKE_Neches_I.PDF
161	UPPER NUECES LAKE	L	Nueces	161_UPPER_NUECES_LAKE_Nueces_L.PDF
162	VALLEY LAKE	C	Red	162_VALLEY_LAKE_Red_C.PDF
163	VICTOR BRAUNIG LAKE	L	San Antonio	163_VICTOR_BRAUNIG_LAKE_San_Antonio_L.PDF

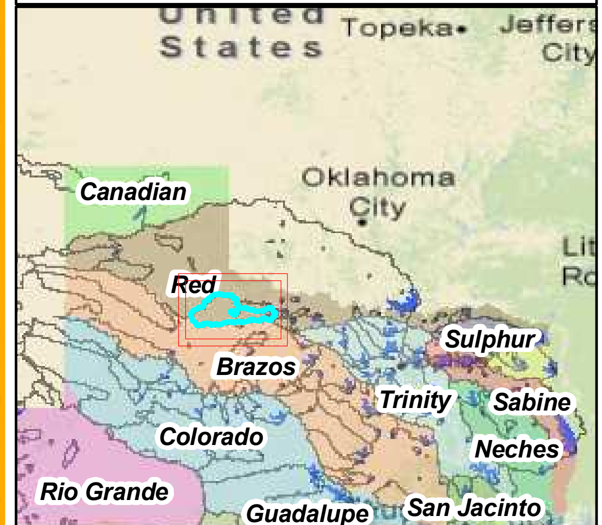
RES_NUM	RES_NAME	REGION _NAME	BASIN_NAME	PDF NAME
164	WACO; LAKE	G	Brazos	164_WACO__LAKE_Brazos_G.PDF
165	WALTER E LONG; LAKE	K	Colorado	165_WALTER_E_LONG__LAKE_Colorado_K.PDF
166	WAXAHACHIE; LAKE	C	Trinity	166_WAXAHACHIE__LAKE_Trinity_C.PDF
167	WEATHERFORD; LAKE	C	Trinity	167_WEATHERFORD__LAKE_Trinity_C.PDF
168	WELSH RESERVOIR	D	Cypress	168_WELSH_RESERVOIR_Cypress_D.PDF
169	WHITE RIVER LAKE	O	Brazos	169_WHITE_RIVER_LAKE_Brazos_O.PDF
170	WHITE ROCK LAKE	C	Trinity	170_WHITE_ROCK_LAKE_Trinity_C.PDF
171	WHITNEY; LAKE	G	Brazos	171_WHITNEY__LAKE_Brazos_G.PDF
172	WICHITA; LAKE	B	Red	172_WICHITA__LAKE_Red_B.PDF
173	WINTERS; LAKE / NEW WINTERS; LAKE	F	Colorado	173_WINTERS__LAKE___NEW_WINTERS__LAKE_Colorado_F.PDF
174	WORTH; LAKE	C	Trinity	174_WORTH__LAKE_Trinity_C.PDF
175	WRIGHT PATMAN LAKE	D	Sulphur	175_WRIGHT_PATMAN_LAKE_Sulphur_D.PDF
176	ADDICKS RESERVOIR	H	San Jacinto	176_ADDICKS_RESERVOIR_San_Jacinto_H.PDF
177	ANZALDUAS CHANNEL DAM	M	Rio Grande	177_ANZALDUAS_CHANNEL_DAM_Rio_Grande_M.PDF
178	BARKER RESERVOIR	H	San Jacinto	178_BARKER_RESERVOIR_San_Jacinto_H.PDF
179	BIVINS LAKE	A	Red	179_BIVINS_LAKE_Red_A.PDF
180	BUFFALO LAKE	A	Red	180_BUFFALO_LAKE_Red_A.PDF
181	CAMP CREEK LAKE	G	Brazos	181_CAMP_CREEK_LAKE_Brazos_G.PDF
182	COFFEE MILL LAKE	C	Red	182_COFFEE_MILL_LAKE_Red_C.PDF
183	DELTA LAKE	M	Nueces-Rio Grande	183_DELTA_LAKE_Nueces-Rio_Grande_M.PDF
184	HAWKINS; LAKE	D	Sabine	184_HAWKINS__LAKE_Sabine_D.PDF
185	HOLBROOK; LAKE	D	Sabine	185_HOLBROOK__LAKE_Sabine_D.PDF
186	J.D. MURPHREE WILDLIFE IMPOUNDMENT	I	Neches-Trinity	186_J.D._MURPHREE_WILDLIFE_IMPOUNDMENT_Neches-Trinity_I.PDF
187	KIOWA; LAKE	C	Trinity	187_KIOWA__LAKE_Trinity_C.PDF
190	NATURAL DAM LAKE	F	Colorado	190_NATURAL_DAM_LAKE_Colorado_F.PDF
191	QUITMAN; LAKE	D	Sabine	191_QUITMAN__LAKE_Sabine_D.PDF
192	RITA BLANCA; LAKE	A	Canadian	192_RITA_BLANCA__LAKE_Canadian_A.PDF
193	SAN ESTEBAN LAKE	E	Rio Grande	193_SAN_ESTEBAN_LAKE_Rio_Grande_E.PDF
194	TRUSCOTT BRINE LAKE	G	Red	194_TRUSCOTT_BRINE_LAKE_Red_G.PDF
195	WILLIAM HARRIS RESERVOIR	H	Brazos	195_WILLIAM_HARRIS_RESERVOIR_Brazos_H.PDF
196	WINNSBORO; LAKE	D	Sabine	196_WINNSBORO__LAKE_Sabine_D.PDF

Reservoir Name = KEMP, LAKE



0 5 10 15 20 25 Miles

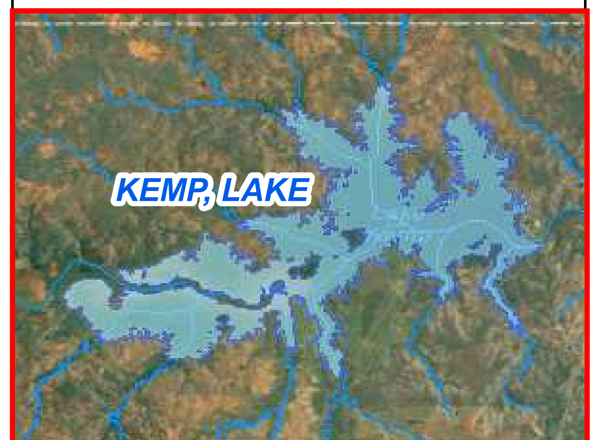
Basin = Red
Region = B



Dam Latitude = 33.75
Dam Longitude = -99.14
Impoundment Date = 1922

Reservoir

Miles



Year 2010 yield (ac-ft/yr) = 90417
Conservation Capacity (ac-ft) = 268095
Average Flow Rate (cfs) = 114.26
Surface Area (acres) = 15323
Perimeter (mi) = 161.74
Shoreline Development Index = 9.27
Residence Time (days) = 1182.96
Median TSS (mg/L) = 7.5

Watershed Area (acres) = 1286683.4	>3rd Order Stream Length (mi) = 400.51	Mean Temperature (deg C) = 16.87
Wshed Area:Res Vol Index (1/m) = 15.75	Total Stream Length (mi) = 1811.6	Mean Precip (in) = 24.13
Watershed Soil Erodibility Index = 0.32	Stream Density (mi/mi^2) = 0.2	Watershed Slope (%) = 0.4

- Low Intensity Residential = 0.1%
- High Intensity Residential = 0%
- Commercial/Industr/Transport = 0.1%
- Urban/Recreational Grasses = 0%
- Total Developed (%) = 0.15

- Bare Rock/Sand/Clay = 1.2%
- Quarries/Strip Mines/Gravel Pits = 0%
- Transitional = 0%
- Total Barren (%) = 1.24

- Deciduous Forest = 0.1%
- Evergreen Forest = 0.2%
- Mixed Forest = 0.2%
- Total Forest (%) = 0.55

- Row Crops = 13.7%
- Small Grains = 5.3%
- Fallow = 0%
- Orchards/Vineyards/Other = 0%
- Total Agricultural (%) = 18.96

- Shrubland = 36.7%
- Grasslands/Herbaceous = 36%
- Pasture/Hay = 4.6%
- Total Shrub/Grass/Pasture (%) = 77.31

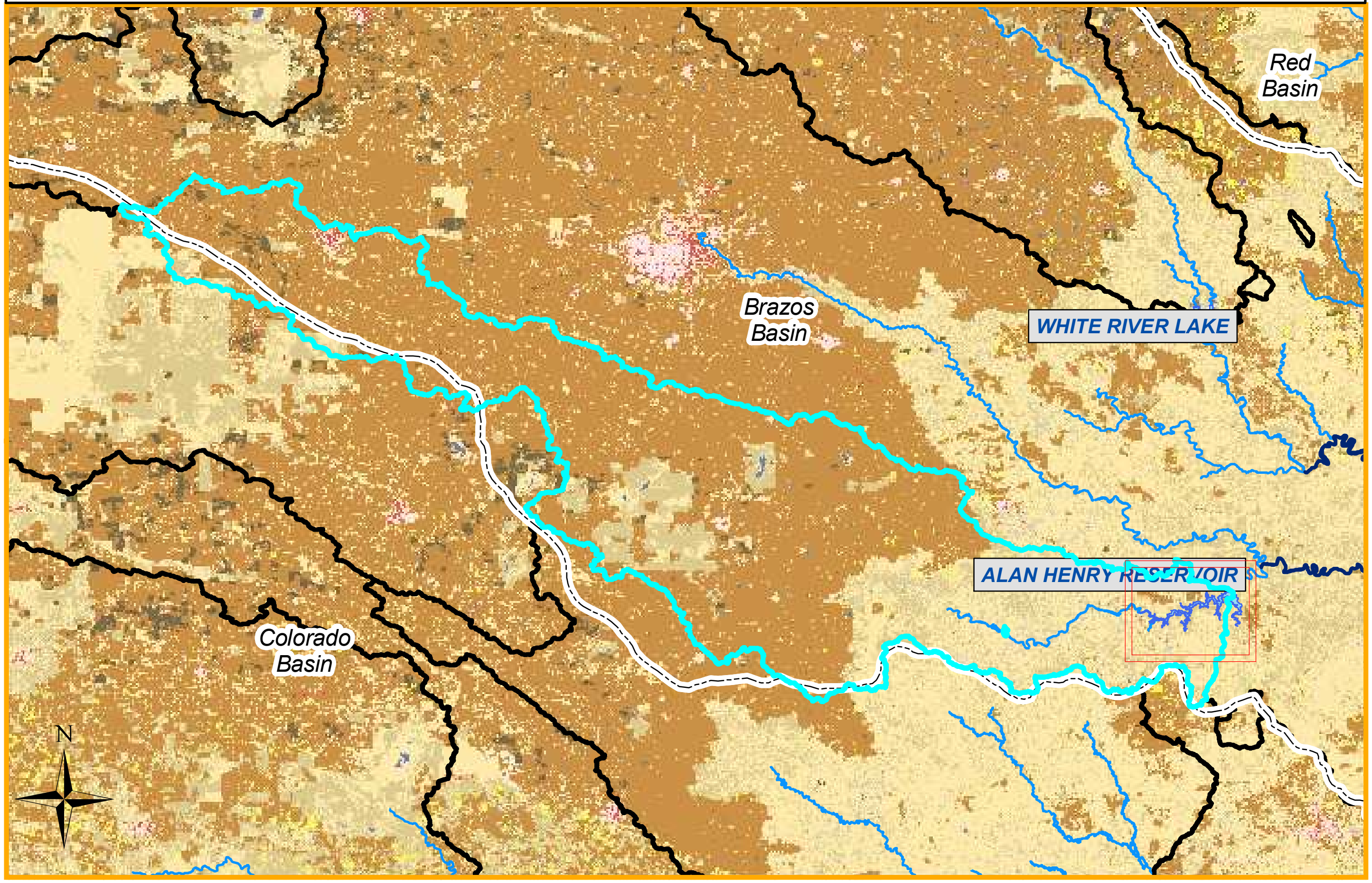
- Woody Wetlands = 0%
- Emergent Herbaceous Wetlands = 0.1%
- Total Wetlands (%) = 0.1

- Open Water = 1.6%

- Portion of watershed in Mexico = 0%

Espey Consultants, Inc, ET - P:\Active\10039.00_WTSHD_Protection_TX_Resrv\GIS\NHDPlus\Projects\ThreePanel\ThreePanel_20110415_1316_Bastrop.mxd

Reservoir Name = ALAN HENRY RESERVOIR



0 2 4 6 8 10
Miles

Basin = Brazos

Region = O

Dam Latitude = n/a
Dam Longitude = n/a
Impoundment Date = n/a

Reservoir

0 0.8 1.6 2.4 3.2
Miles

Watershed Area (acres) = 935396.9
Wshed Area:Res Vol Index (1/m) = 32.37
Watershed Soil Erodibility Index = 0.31

>3rd Order Stream Length (mi) = 53.2
Total Stream Length (mi) = 313.84
Stream Density (mi/mi^2) = 0.04

Mean Temperature (deg C) = 15.62
Mean Precip (in) = 19.9
Watershed Slope (%) = 0.72

Low Intensity Residential = 0.2%
High Intensity Residential = 0%
Commercial/Industr/Transport = 0.3%
Urban/Recreational Grasses = 0%
Total Developed (%) = 0.48

Bare Rock/Sand/Clay = 1.4%
Quarries/Strip Mines/Gravel Pits = 0%
Transitional = 0%
Total Barren (%) = 1.41

Deciduous Forest = 0%
Evergreen Forest = 0%
Mixed Forest = 0%
Total Forest (%) = 0.01

Row Crops = 61.1%
Small Grains = 1%
Fallow = 0.2%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 62.38

Shrubland = 12.3%
Grasslands/Herbaceous = 22.6%
Pasture/Hay = 0.5%
Total Shrub/Grass/Pasture (%) = 35.37

Woody Wetlands = 0%
Emergent Herbaceous Wetlands = 0%
Total Wetlands (%) = 0.04

Open Water = 0.3%

Portion of watershed in Mexico = 0%

Year 2010 yield (ac-ft/yr) = 22500
Conservation Capacity (ac-ft) = 94808
Average Flow Rate (cfs) = 47.24
Surface Area (acres) = 2732.99
Perimeter (mi) = 89.61
Shoreline Development Index = 12.16
Residence Time (days) = 1011.83
Median TSS (mg/L) = n/a

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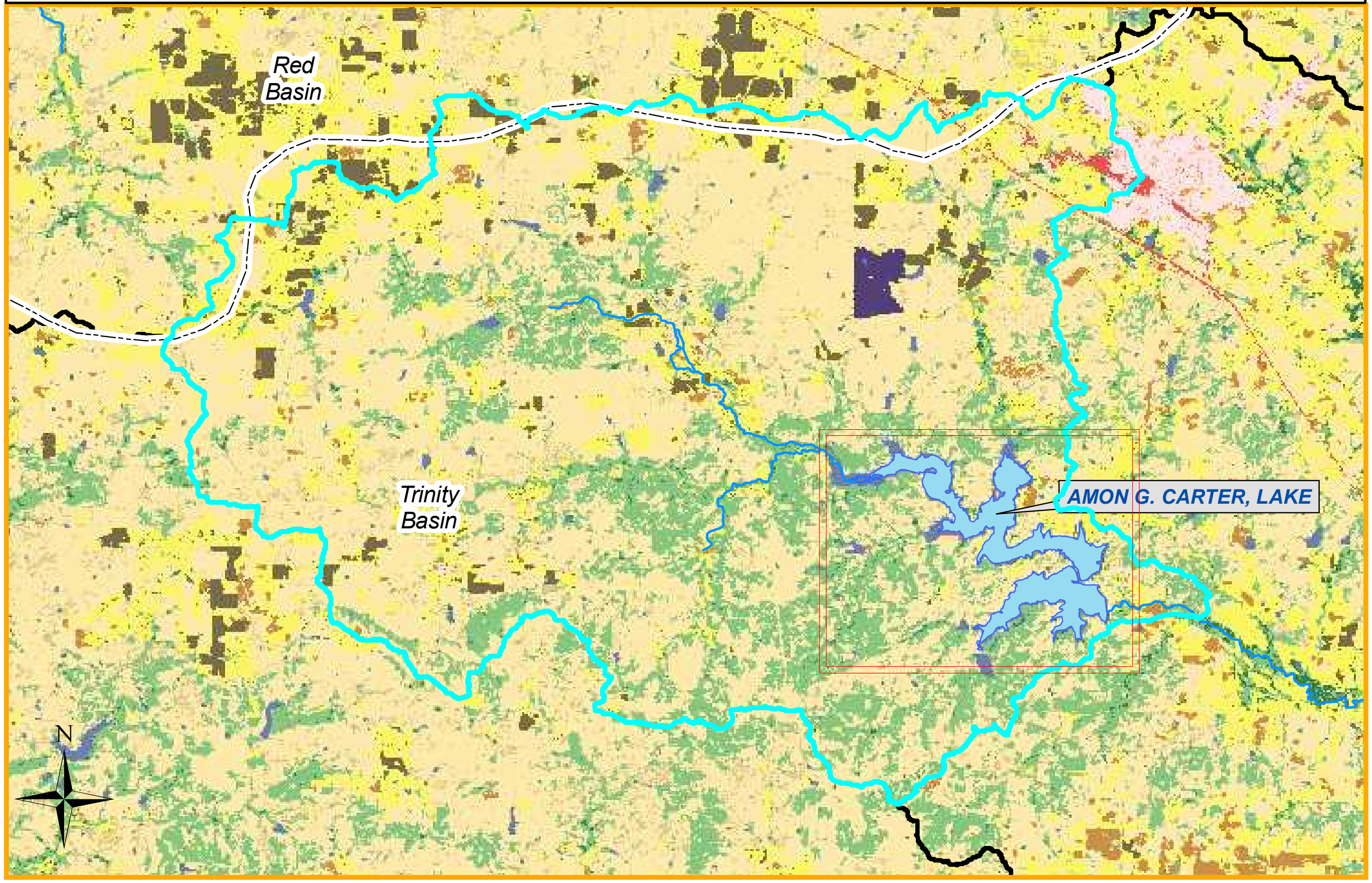
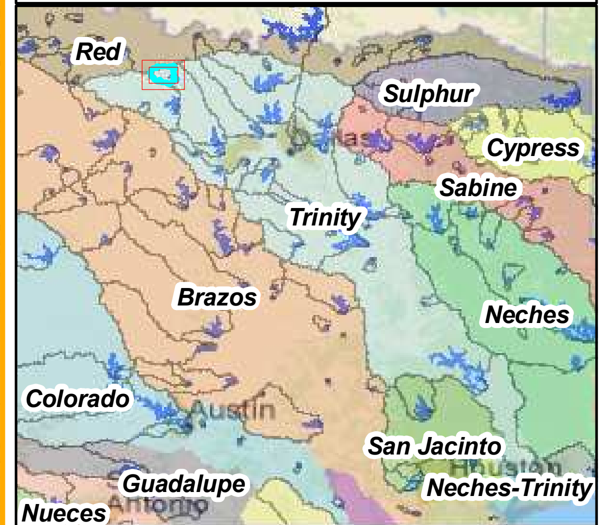
Reservoir Name = AMON G. CARTER, LAKE



0 0.7 1.4 2.1 2.8 3.5
Miles

Basin = Trinity

Region = B



Dam Latitude = 33.46
Dam Longitude = -97.86
Impoundment Date = 1956

Reservoir

0 0.2 0.4
Miles

Year 2010 yield (ac-ft/yr) = 2108
Conservation Capacity (ac-ft) = 19902
Average Flow Rate (cfs) = 18.59
Surface Area (acres) = 1608.66
Perimeter (mi) = 29.94
Shoreline Development Index = 5.3
Residence Time (days) = 539.75
Median TSS (mg/L) = 5

Watershed Area (acres) = 70687.71	>3rd Order Stream Length (mi) = 19.84	Mean Temperature (deg C) = 17.89
Wshed Area:Res Vol Index (1/m) = 11.65	Total Stream Length (mi) = 113.17	Mean Precip (in) = 32.2
Watershed Soil Erodibility Index = 0.29	Stream Density (mi/mi^2) = 0.18	Watershed Slope (%) = 0.49

Low Intensity Residential = 0.5%
High Intensity Residential = 0%
Commercial/Industr/Transport = 0.3%
Urban/Recreational Grasses = 0%
Total Developed (%) = 0.8

Bare Rock/Sand/Clay = 0%
Quarries/Strip Mines/Gravel Pits = 0%
Transitional = 0.6%
Total Barren (%) = 0.61

Deciduous Forest = 19.3%
Evergreen Forest = 0.8%
Mixed Forest = 0.2%
Total Forest (%) = 20.28

Row Crops = 1.2%
Small Grains = 2.7%
Fallow = 0%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 3.89

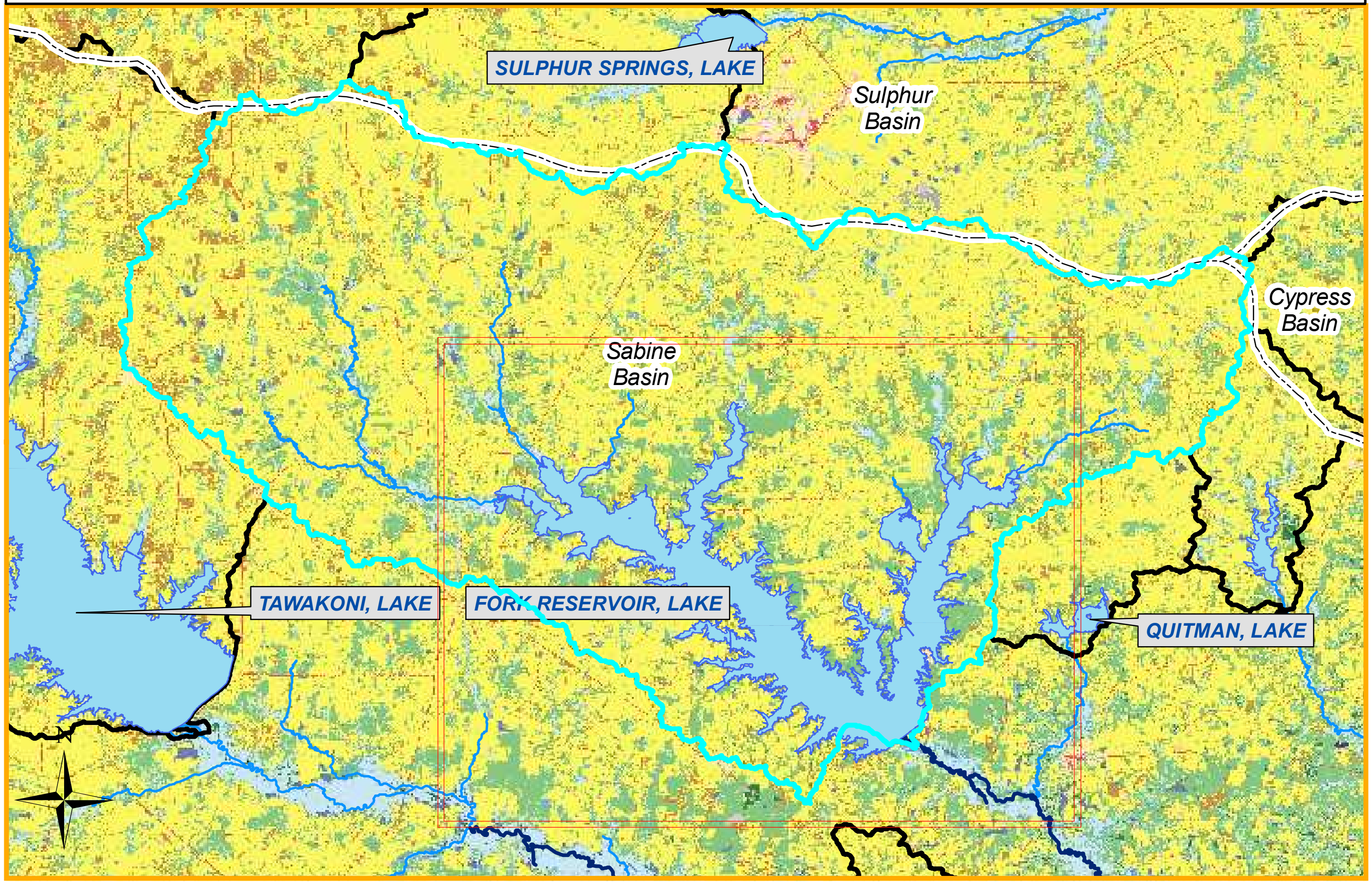
Shrubland = 4.5%
Grasslands/Herbaceous = 53.9%
Pasture/Hay = 12.2%
Total Shrub/Grass/Pasture (%) = 70.6

Woody Wetlands = 0%
Emergent Herbaceous Wetlands = 0%
Total Wetlands (%) = 0.05

Open Water = 3.7%

Portion of watershed in Mexico = 0%

Reservoir Name = FORK RESERVOIR, LAKE



0 1 2 3 4 5
Miles

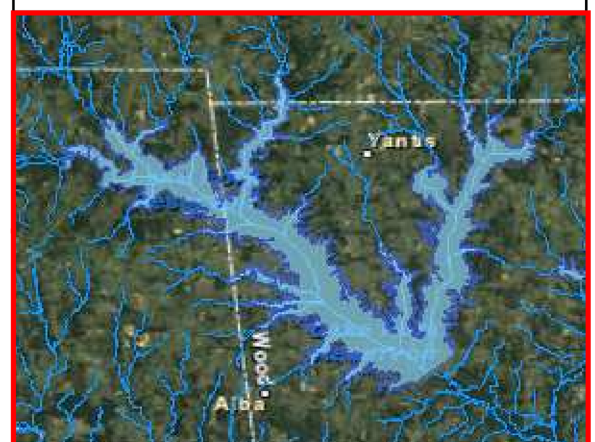
Basin = Sabine

Region = D

Dam Latitude = 32.8
Dam Longitude = -95.54
Impoundment Date = 1979

Reservoir

0 1 2 3 4
Miles



Year 2010 yield (ac-ft/yr) = 173035
Conservation Capacity (ac-ft) = 604927
Average Flow Rate (cfs) = 383.14
Surface Area (acres) = 27159.35
Perimeter (mi) = 318.32
Shoreline Development Index = 13.7
Residence Time (days) = 796.01
Median TSS (mg/L) = 4

Watershed Area (acres) = 307094.66	>3rd Order Stream Length (mi) = 91.28	Mean Temperature (deg C) = 17.43
Wshed Area:Res Vol Index (1/m) = 1.67	Total Stream Length (mi) = 515.52	Mean Precip (in) = 43.33
Watershed Soil Erodibility Index = 0.28	Stream Density (mi/mi^2) = 0.19	Watershed Slope (%) = 0.26

Low Intensity Residential = 0.1%
High Intensity Residential = 0%
Commercial/Industr/Transport = 0.7%
Urban/Recreational Grasses = 0%
Total Developed (%) = 0.79

Bare Rock/Sand/Clay = 0.1%
Quarries/Strip Mines/Gravel Pits = 0%
Transitional = 0%
Total Barren (%) = 0.14

Deciduous Forest = 17%
Evergreen Forest = 0.3%
Mixed Forest = 2.6%
Total Forest (%) = 19.86

Row Crops = 4.3%
Small Grains = 0%
Fallow = 0%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 4.34

Shrubland = 0%
Grasslands/Herbaceous = 0%
Pasture/Hay = 62.7%
Total Shrub/Grass/Pasture (%) = 62.74

Woody Wetlands = 2%
Emergent Herbaceous Wetlands = 1%
Total Wetlands (%) = 2.96

Open Water = 9.1%

Portion of watershed in Mexico = 0%

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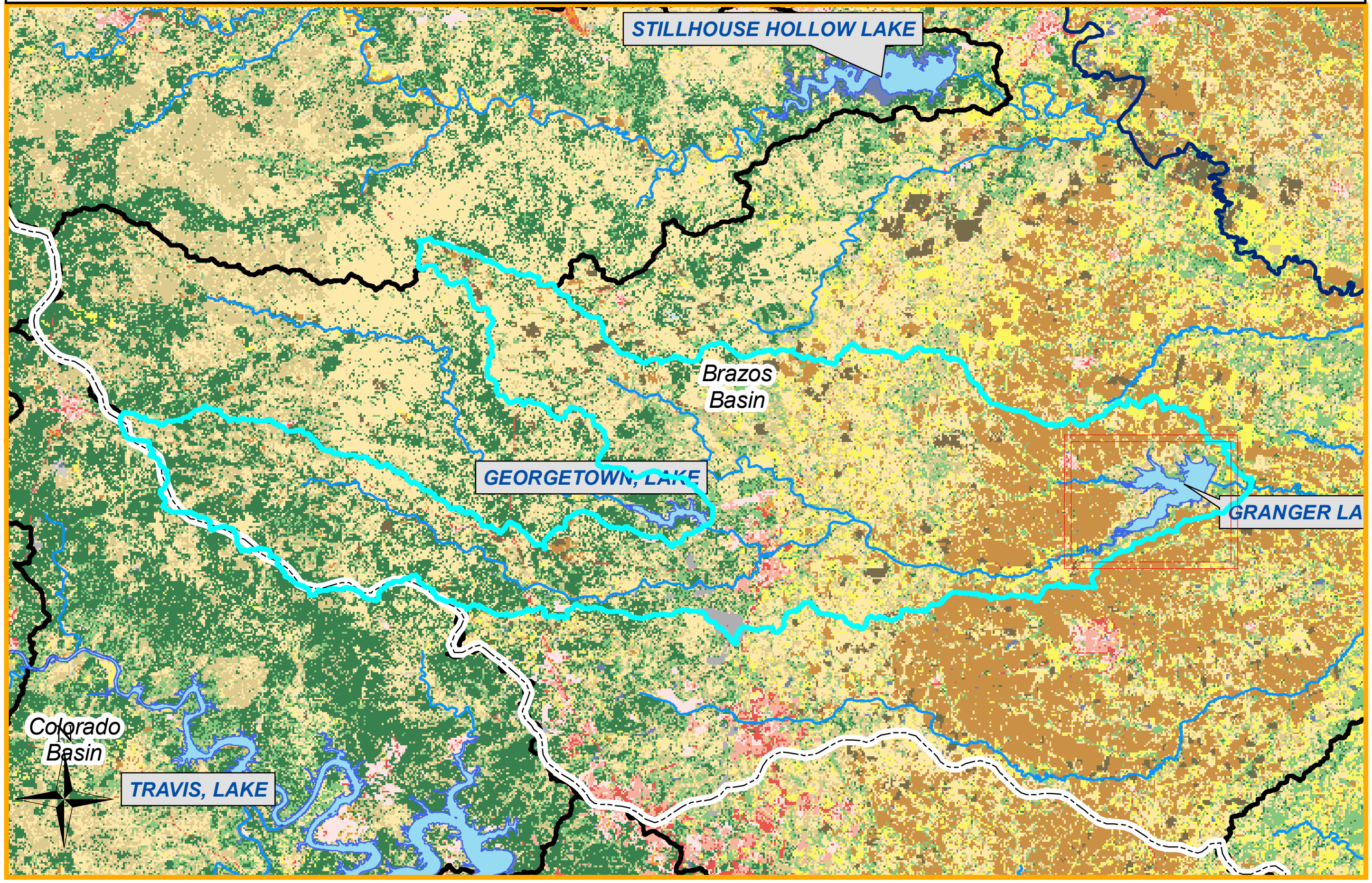
Reservoir Name = GRANGER LAKE



0 1 2 3 4 5
Miles

Basin = Brazos

Region = G

Dam Latitude = 30.7
Dam Longitude = -97.3
Impoundment Date = 1980

Reservoir

0 0.7 1.4 2.1 2.8
Miles

Year 2010 yield (ac-ft/yr) = n/a
Conservation Capacity (ac-ft) = 52525
Average Flow Rate (cfs) = 236.59
Surface Area (acres) = 4198.32
Perimeter (mi) = 51.62
Shoreline Development Index = 5.65
Residence Time (days) = 111.93
Median TSS (mg/L) = 16

Watershed Area (acres) = 313081.28	>3rd Order Stream Length (mi) = 95.46	Mean Temperature (deg C) = 19.25
Wshed Area:Res Vol Index (1/m) = 19.56	Total Stream Length (mi) = 433.74	Mean Precip (in) = 33.61
Watershed Soil Erodibility Index = 0.27	Stream Density (mi/mi^2) = 0.19	Watershed Slope (%) = 0.5

Low Intensity Residential = 0.8%
High Intensity Residential = 0.5%
Commercial/Industr/Transport = 0.7%
Urban/Recreational Grasses = 0.1%
Total Developed (%) = 2.08

Bare Rock/Sand/Clay = 0.4%
Quarries/Strip Mines/Gravel Pits = 0.5%
Transitional = 0%
Total Barren (%) = 0.95

Deciduous Forest = 10.3%
Evergreen Forest = 15.5%
Mixed Forest = 0%
Total Forest (%) = 25.79

Row Crops = 14.1%
Small Grains = 2%
Fallow = 0%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 16.1

Shrubland = 17.3%
Grasslands/Herbaceous = 28.1%
Pasture/Hay = 7.8%
Total Shrub/Grass/Pasture (%) = 53.21

Woody Wetlands = 0%
Emergent Herbaceous Wetlands = 0%
Total Wetlands (%) = 0.02

Open Water = 1.8%

Portion of watershed in Mexico = 0%

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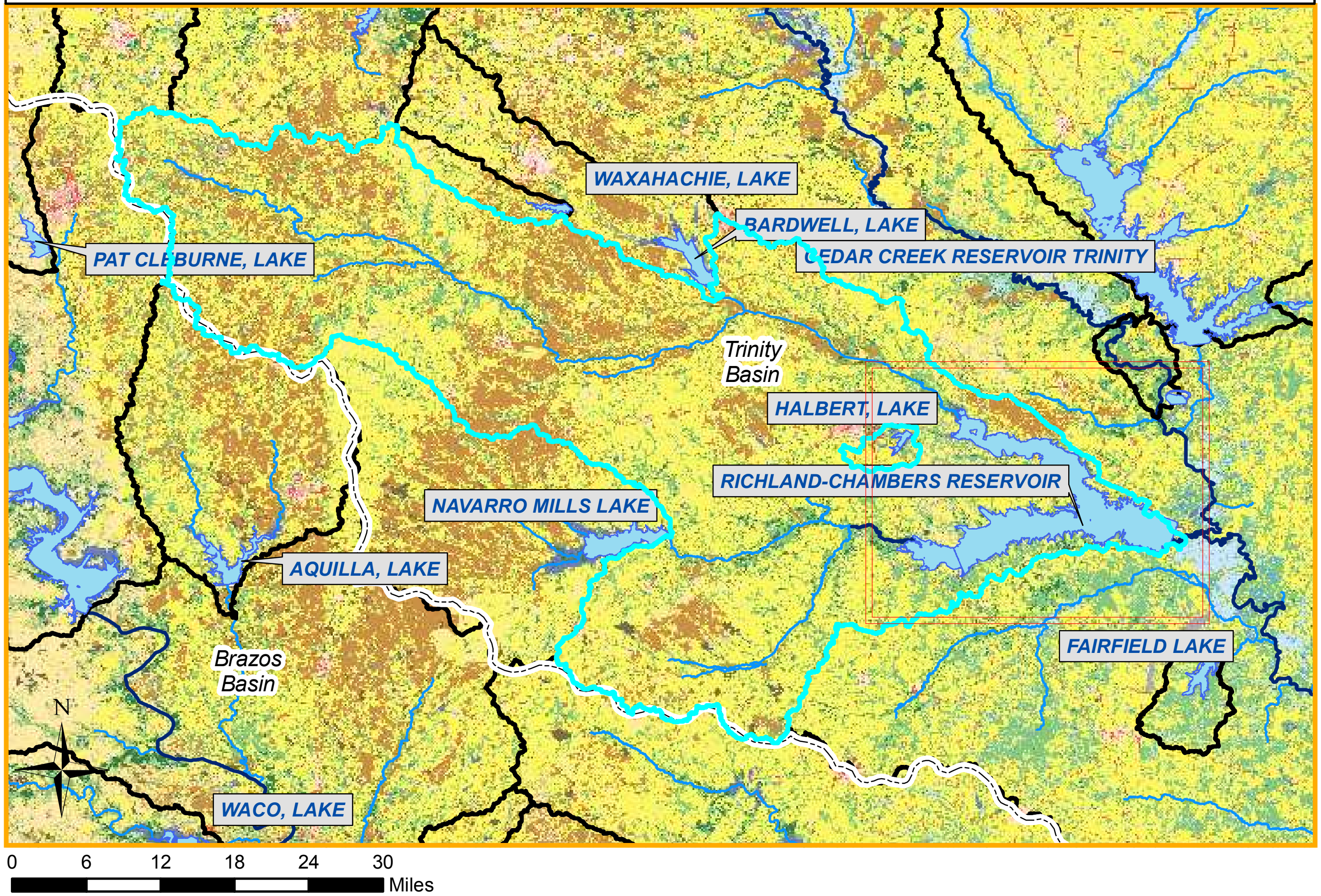
Reservoir Name = RICHLAND-CHAMBERS RESERVOIR



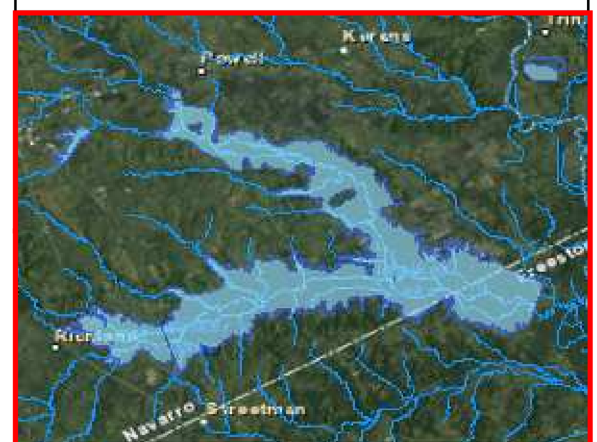
Basin = Trinity

Region = C

Dam Latitude = 31.95
Dam Longitude = -96.14
Impoundment Date = 1987

Reservoir

0 1 2 3 4 Miles



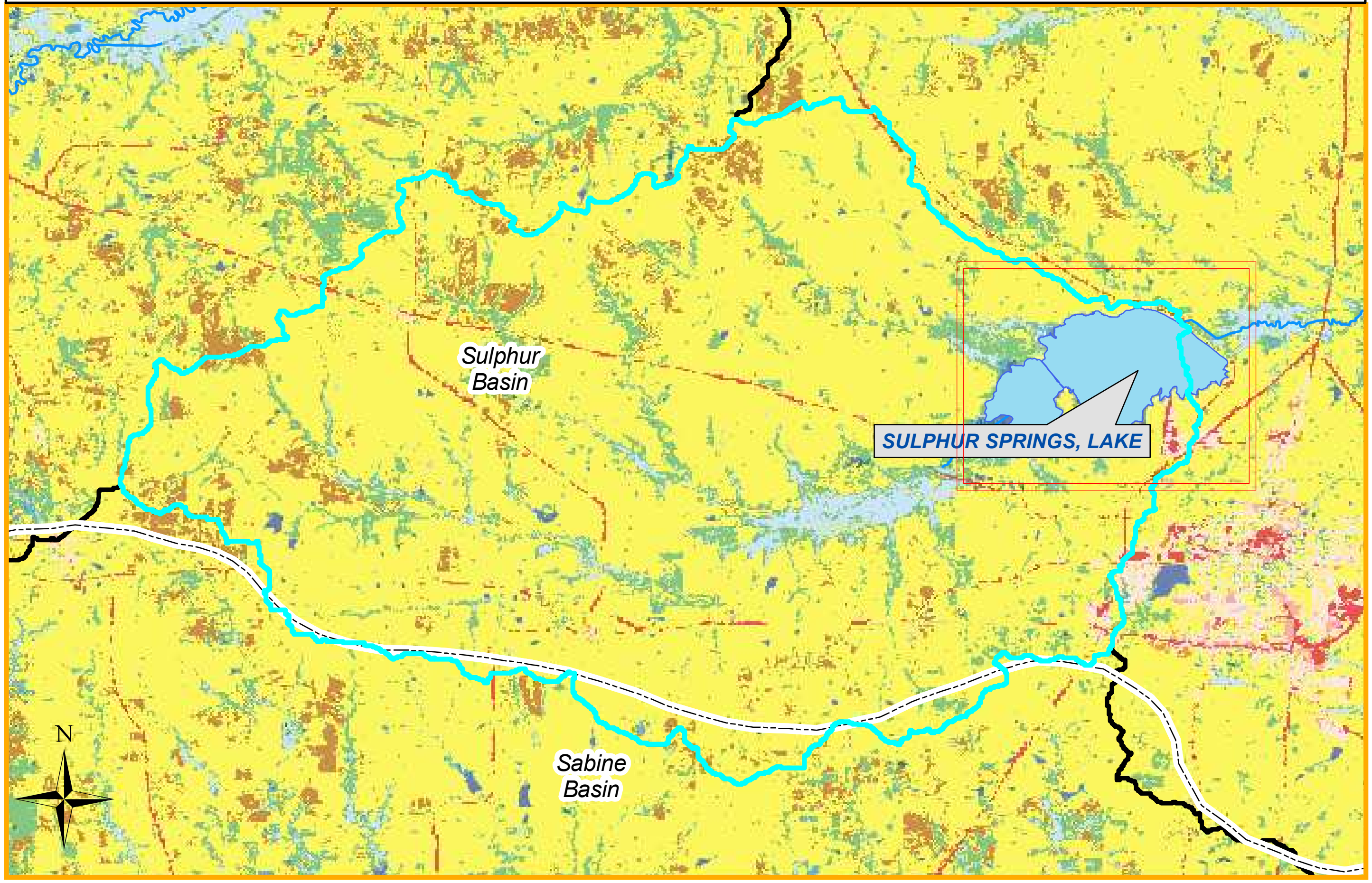
Watershed Area (acres) = 927812.74	>3rd Order Stream Length (mi) = 222.3	Mean Temperature (deg C) = 18.36
Wshed Area:Res Vol Index (1/m) = 2.76	Total Stream Length (mi) = 1284.12	Mean Precip (in) = 36.71
Watershed Soil Erodibility Index = 0.33	Stream Density (mi/mi^2) = 0.15	Watershed Slope (%) = 0.29

Low Intensity Residential = 0.5%	Deciduous Forest = 14.9%	Shrubland = 0.7%
High Intensity Residential = 0.3%	Evergreen Forest = 1.9%	Grasslands/Herbaceous = 4.4%
Commercial/Industr/Transport = 0.9%	Mixed Forest = 0%	Pasture/Hay = 52%
Urban/Recreational Grasses = 0.1%	Total Forest (%) = 16.81	Total Shrub/Grass/Pasture (%) = 57.08
Total Developed (%) = 1.79	Row Crops = 17.8%	Woody Wetlands = 0%
Bare Rock/Sand/Clay = 0.2%	Small Grains = 0.4%	Emergent Herbaceous Wetlands = 0.1%
Quarries/Strip Mines/Gravel Pits = 0%	Fallow = 0%	Total Wetlands (%) = 0.17
Transitional = 0%	Orchards/Vineyards/Other = 0%	Open Water = 5.8%
Total Barren (%) = 0.21	Total Agricultural (%) = 18.13	Portion of watershed in Mexico = 0%

Year 2010 yield (ac-ft/yr) = 222625
Conservation Capacity (ac-ft) = 1103816
Average Flow Rate (cfs) = 975.81
Surface Area (acres) = 42462.59
Perimeter (mi) = 192.65
Shoreline Development Index = 6.63
Residence Time (days) = 570.3
Median TSS (mg/L) = 5.9

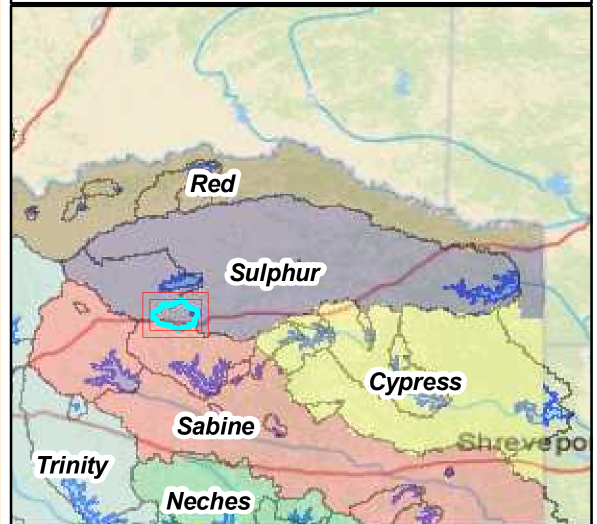
Espey Consultants, Inc, ET - P:\Active\10039.00_WTSHD_Protection_TX_Resrv\GIS\NHDPlus\Projects\ThreePanel\ThreePanel_20110415_1316_Bastrop.mxd

Reservoir Name = SULPHUR SPRINGS, LAKE



Basin = Sulphur

Region = D



Dam Latitude = 33.17
Dam Longitude = -95.61
Impoundment Date = 1973

Reservoir

Year 2010 yield (ac-ft/yr) = 9800
Conservation Capacity (ac-ft) = 17838
Average Flow Rate (cfs) = 50.12
Surface Area (acres) = 1798.93
Perimeter (mi) = 12.26
Shoreline Development Index = 2.05
Residence Time (days) = 179.44
Median TSS (mg/L) = n/a

Watershed Area (acres) = 44981.09
Wshed Area:Res Vol Index (1/m) = 8.27
Watershed Soil Erodibility Index = 0.34

>3rd Order Stream Length (mi) = 3.46
Total Stream Length (mi) = 50.9
Stream Density (mi/mi^2) = 0.05

Mean Temperature (deg C) = 17.28
Mean Precip (in) = 44.97
Watershed Slope (%) = 0.12

Low Intensity Residential = 0.3%
High Intensity Residential = 0%
Commercial/Industr/Transport = 1%
Urban/Recreational Grasses = 0%
Total Developed (%) = 1.32

Bare Rock/Sand/Clay = 0.1%
Quarries/Strip Mines/Gravel Pits = 0%
Transitional = 0%
Total Barren (%) = 0.1

Deciduous Forest = 8.8%
Evergreen Forest = 0.1%
Mixed Forest = 1.4%
Total Forest (%) = 10.27

Row Crops = 3.5%
Small Grains = 0%
Fallow = 0%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 3.5

Shrubland = 0%
Grasslands/Herbaceous = 0%
Pasture/Hay = 78.2%
Total Shrub/Grass/Pasture (%) = 78.21

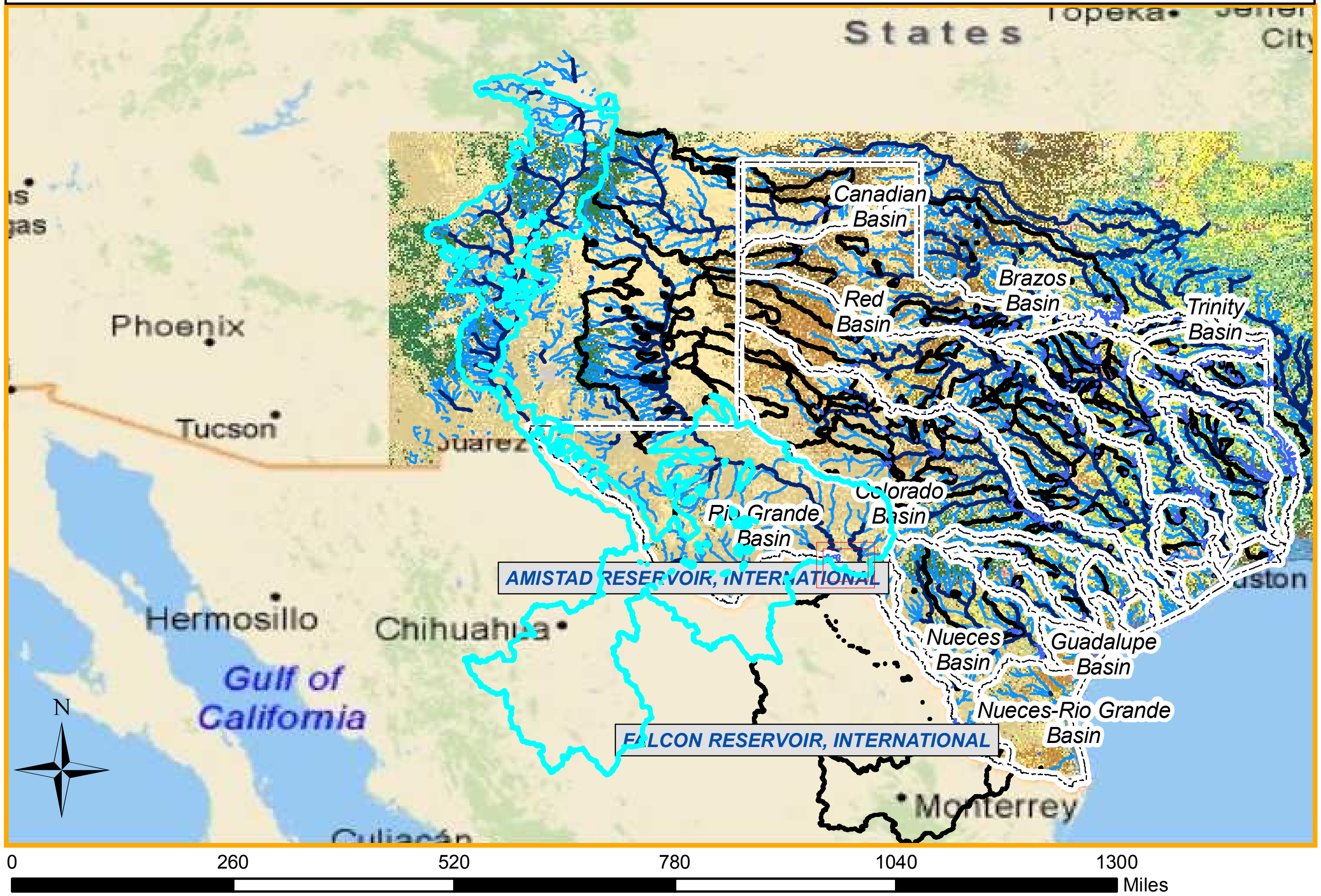
Woody Wetlands = 1.8%
Emergent Herbaceous Wetlands = 0.6%
Total Wetlands (%) = 2.43

Open Water = 4.1%

Portion of watershed in Mexico = 0%

Espey Consultants, Inc, ET - P:\Active\10039.00_WTSHD_Protection_TX_Resrv\GIS\NHDPlus\Projects\ThreePanel\ThreePanel_20110415_1316_Bastrop.mxd

Reservoir Name = AMISTAD RESERVOIR, INTERNATIONAL



Basin = Rio Grande

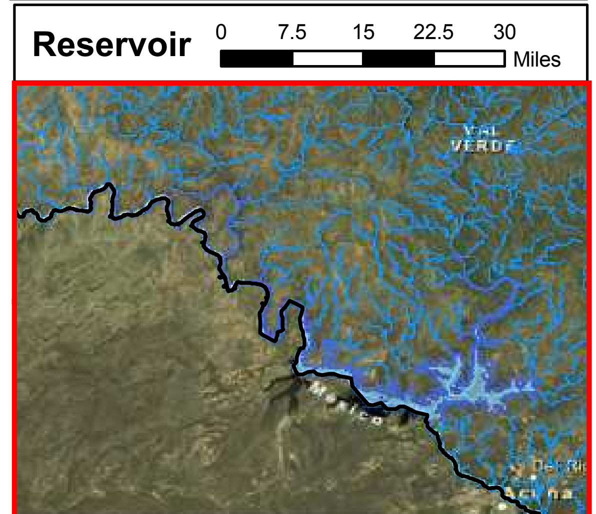
Region = J

Dam Latitude = 29.43

Dam Longitude = -101.05

Impoundment Date = 1968

Reservoir



Year 2010 yield (ac-ft/yr) = 1067310

Conservation Capacity (ac-ft) = 3151267

Average Flow Rate (cfs) = 8298.75

Surface Area (acres) = 41259.18

Perimeter (mi) = 654.85

Shoreline Development Index = 22.87

Residence Time (days) = 191.45

Median TSS (mg/L) = 4

Watershed Area (acres) = 64179575	>3rd Order Stream Length (mi) = 9605.25	Mean Temperature (deg C) = 16.43
Wshed Area:Res Vol Index (1/m) = 66.82	Total Stream Length (mi) = 51023.15	Mean Precip (in) = 13.58
Watershed Soil Erodibility Index = 0.17	Stream Density (mi/mi^2) = 0.1	Watershed Slope (%) = 1.12

- Low Intensity Residential = 0.2%
- High Intensity Residential = 0%
- Commercial/Industr/Transport = 0.2%
- Urban/Recreational Grasses = 0%

Total Developed (%) = 0.36

- Bare Rock/Sand/Clay = 1.3%
- Quarries/Strip Mines/Gravel Pits = 0%
- Transitional = 0%

Total Barren (%) = 1.34

- Deciduous Forest = 0.3%
- Evergreen Forest = 7.5%
- Mixed Forest = 0.1%

Total Forest (%) = 7.91

- Row Crops = 0.4%
- Small Grains = 0%
- Fallow = 0%
- Orchards/Vineyards/Other = 0%

Total Agricultural (%) = 0.4

- Shrubland = 35.1%
- Grasslands/Herbaceous = 16.2%
- Pasture/Hay = 0.5%

Total Shrub/Grass/Pasture (%) = 51.83

- Woody Wetlands = 0%
- Emergent Herbaceous Wetlands = 0%

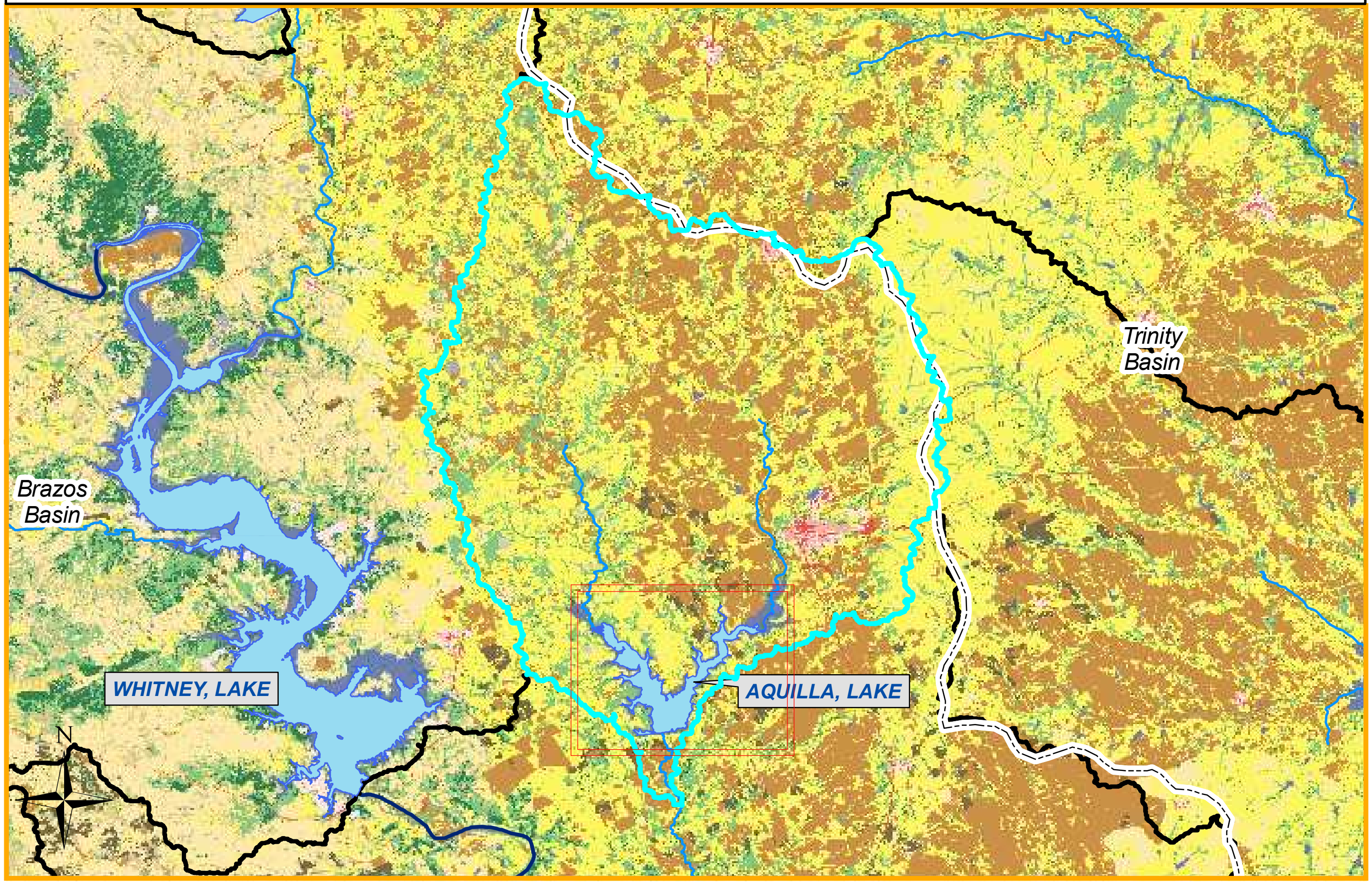
Total Wetlands (%) = 0.05

- Open Water = 0.2%

Portion of watershed in Mexico = 37.9%

Espey Consultants, Inc, ET - P:\Active\10039.00_WTSHD_Protection_TX_Resrv\GIS\NHDPlus\Projects\ThreePanel\ThreePanel_20110415_1316_Bastrop.mxd

Reservoir Name = AQUILLA, LAKE



0 0.8 1.6 2.4 3.2 4
Miles

Basin = Brazos
Region = G

Dam Latitude = 31.91
Dam Longitude = -97.2
Impoundment Date = 1983

Reservoir

0 0.7 1.4 2.1 2.8
Miles

Year 2010 yield (ac-ft/yr) = 12437
Conservation Capacity (ac-ft) = 45092
Average Flow Rate (cfs) = 66.01
Surface Area (acres) = 3116
Perimeter (mi) = 48.86
Shoreline Development Index = 6.21
Residence Time (days) = 344.4
Median TSS (mg/L) = 9

Watershed Area (acres) = 164569.96	>3rd Order Stream Length (mi) = 37.58	Mean Temperature (deg C) = 18.8
Wshed Area:Res Vol Index (1/m) = 11.97	Total Stream Length (mi) = 170.86	Mean Precip (in) = 34.65
Watershed Soil Erodibility Index = 0.32	Stream Density (mi/mi^2) = 0.15	Watershed Slope (%) = 0.28

Low Intensity Residential = 0.6%	Deciduous Forest = 12.3%	Shrubland = 0.1%
High Intensity Residential = 0.5%	Evergreen Forest = 1.2%	Grasslands/Herbaceous = 2.5%
Commercial/Industr/Transport = 0.9%	Mixed Forest = 0%	Pasture/Hay = 46.9%
Urban/Recreational Grasses = 0%	Total Forest (%) = 13.56	Total Shrub/Grass/Pasture (%) = 49.45
Total Developed (%) = 2.04	Row Crops = 29.5%	Woody Wetlands = 0%
Bare Rock/Sand/Clay = 0.6%	Small Grains = 0.9%	Emergent Herbaceous Wetlands = 0.1%
Quarries/Strip Mines/Gravel Pits = 0.2%	Fallow = 0%	Total Wetlands (%) = 0.09
Transitional = 0%	Orchards/Vineyards/Other = 0%	Open Water = 3.6%
Total Barren (%) = 0.84	Total Agricultural (%) = 30.42	Portion of watershed in Mexico = 0%

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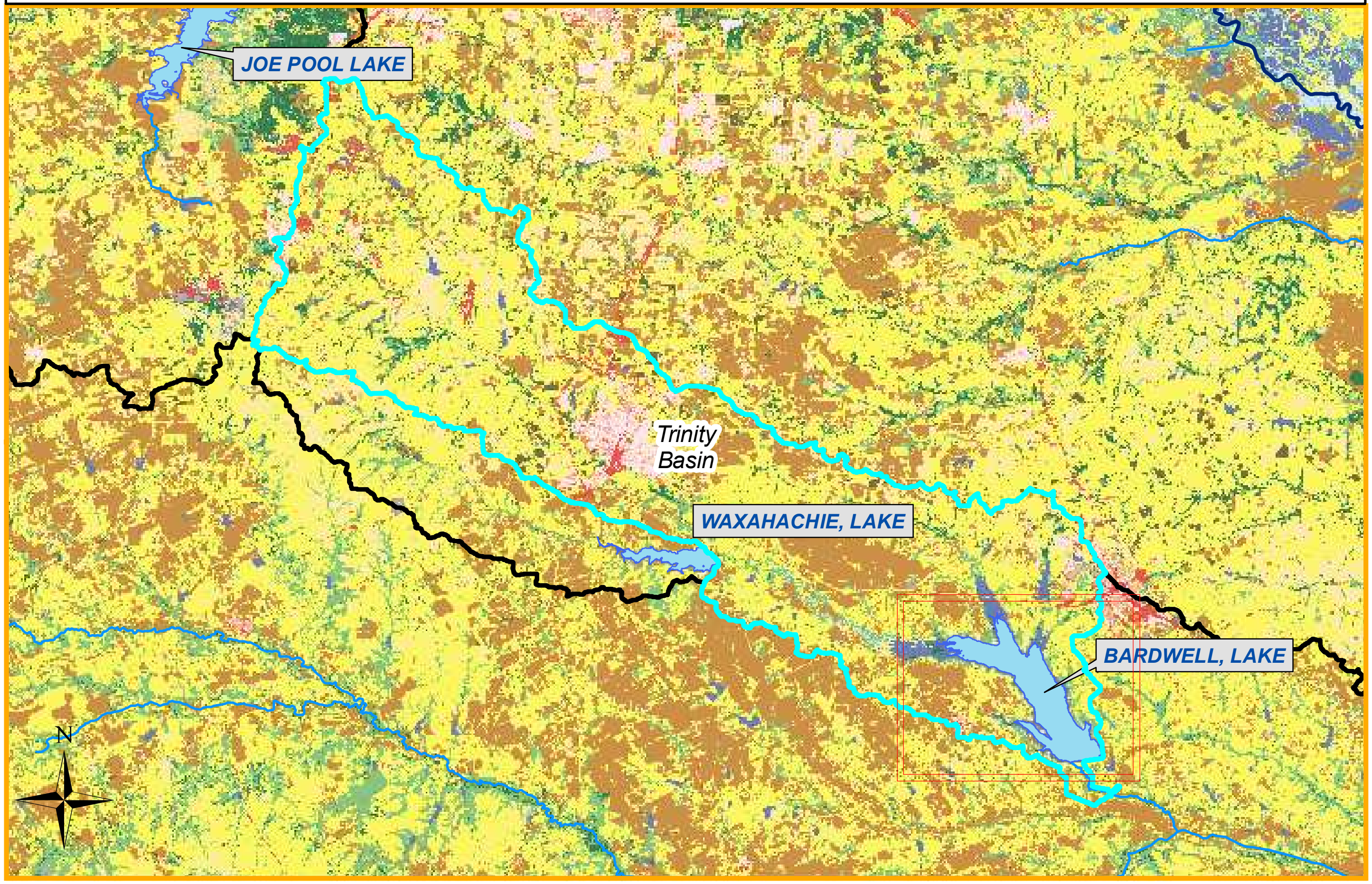
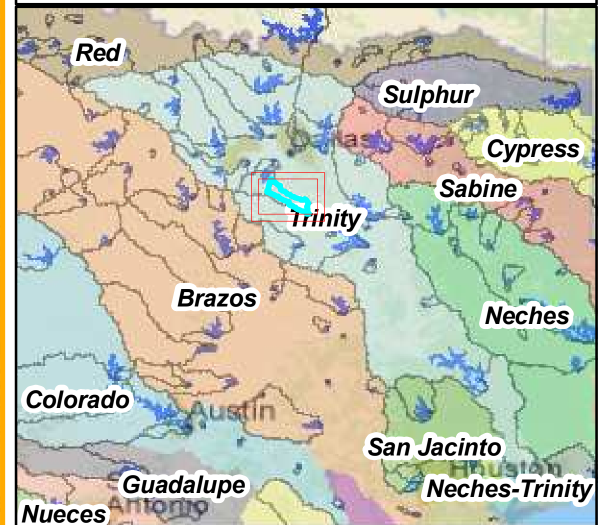
Reservoir Name = BARDWELL, LAKE



0 0.81.62.43.2 4
Miles

Basin = Trinity

Region = C



Dam Latitude = 32.27
Dam Longitude = -96.61
Impoundment Date = 1965

Reservoir

0 0.6 1.2 1.8 2.4
Miles

Year 2010 yield (ac-ft/yr) = 8567
Conservation Capacity (ac-ft) = 46122
Average Flow Rate (cfs) = 85.9
Surface Area (acres) = 3246.96
Perimeter (mi) = 27.12
Shoreline Development Index = 3.38
Residence Time (days) = 270.7
Median TSS (mg/L) = 12

Watershed Area (acres) = 92575.56
Wshed Area:Res Vol Index (1/m) = 6.59
Watershed Soil Erodibility Index = 0.31

>3rd Order Stream Length (mi) = 5.63
Total Stream Length (mi) = 90.65
Stream Density (mi/mi^2) = 0.04

Mean Temperature (deg C) = 18.51
Mean Precip (in) = 36.97
Watershed Slope (%) = 0.29

Low Intensity Residential = 3.6%
High Intensity Residential = 0.8%
Commercial/Industr/Transport = 2.3%
Urban/Recreational Grasses = 0.6%
Total Developed (%) = 7.2

Bare Rock/Sand/Clay = 0.1%
Quarries/Strip Mines/Gravel Pits = 0.1%
Transitional = 0%
Total Barren (%) = 0.13

Deciduous Forest = 5.7%
Evergreen Forest = 2.7%
Mixed Forest = 0.9%
Total Forest (%) = 9.32

Row Crops = 18.6%
Small Grains = 1.1%
Fallow = 0%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 19.76

Shrubland = 0.3%
Grasslands/Herbaceous = 7.8%
Pasture/Hay = 49.1%
Total Shrub/Grass/Pasture (%) = 57.16

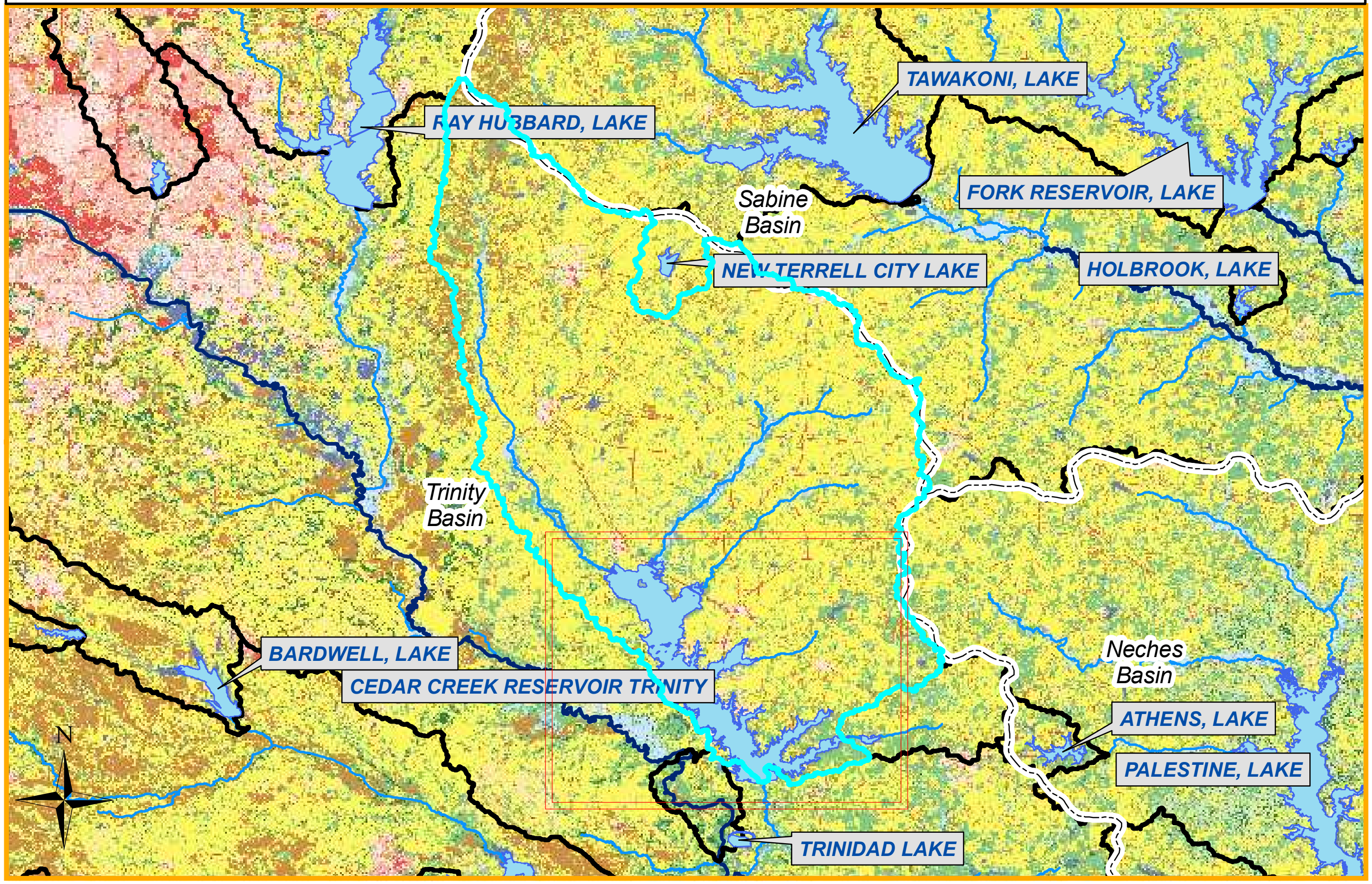
Woody Wetlands = 0.2%
Emergent Herbaceous Wetlands = 0.1%
Total Wetlands (%) = 0.28

Open Water = 6.1%

Portion of watershed in Mexico = 0%

Espey Consultants, Inc, ET - P:\Active\10039.00_WTSHD_Protection_TX_Resrv\GIS\NHDPlus\Projects\ThreePanel\ThreePanel_20110415_1316_Bastrop.mxd

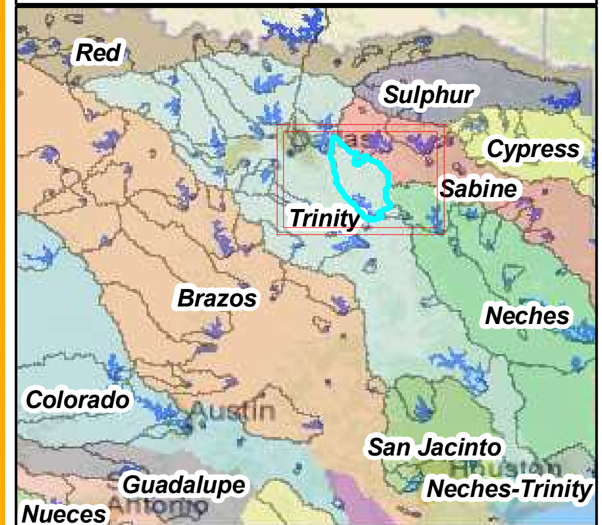
Reservoir Name = CEDAR CREEK RESERVOIR TRINITY



0 4 8 12 16 20 Miles

Basin = Trinity

Region = C



Dam Latitude = 32.18
Dam Longitude = -96.06
Impoundment Date = 1965

Reservoir

0 1 2 3 4 Miles

Year 2010 yield (ac-ft/yr) = 175000
Conservation Capacity (ac-ft) = 644686
Average Flow Rate (cfs) = 608.12
Surface Area (acres) = 32583.32
Perimeter (mi) = 269.27
Shoreline Development Index = 10.58
Residence Time (days) = 534.48
Median TSS (mg/L) = 10

Watershed Area (acres) = 589033.74	>3rd Order Stream Length (mi) = 138.06	Mean Temperature (deg C) = 18.05
Wshed Area:Res Vol Index (1/m) = 3	Total Stream Length (mi) = 682.04	Mean Precip (in) = 40.07
Watershed Soil Erodibility Index = 0.31	Stream Density (mi/mi^2) = 0.15	Watershed Slope (%) = 0.2

Low Intensity Residential = 1.3%
High Intensity Residential = 0.1%
Commercial/Industr/Transport = 1.9%
Urban/Recreational Grasses = 0.1%
Total Developed (%) = 3.47

Bare Rock/Sand/Clay = 0.2%
Quarries/Strip Mines/Gravel Pits = 0%
Transitional = 0%
Total Barren (%) = 0.21

Deciduous Forest = 13.7%
Evergreen Forest = 0.2%
Mixed Forest = 1.1%
Total Forest (%) = 15.04

Row Crops = 6.6%
Small Grains = 0%
Fallow = 0%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 6.57

Shrubland = 0%
Grasslands/Herbaceous = 1.2%
Pasture/Hay = 64.1%
Total Shrub/Grass/Pasture (%) = 65.32

Woody Wetlands = 1.8%
Emergent Herbaceous Wetlands = 1.4%
Total Wetlands (%) = 3.12

Open Water = 6.2%

Portion of watershed in Mexico = 0%

Espey Consultants, Inc, ET - P:\Active\10039.00_WTSHD_Protection_TX_Resrv\GIS\NHDPlus\Projects\ThreePanel\ThreePanel_20110415_1316_Bastrop.mxd

Reservoir Name = KICKAPOO, LAKE

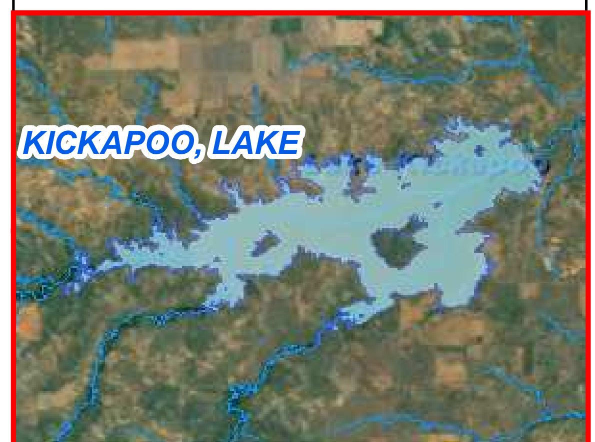
00.511.522.5
Miles

Basin = Red
Region = B

Dam Latitude = 33.66
Dam Longitude = -98.77
Impoundment Date = 1946

Reservoir

0 0.8 1.6 2.4 3.2
Miles



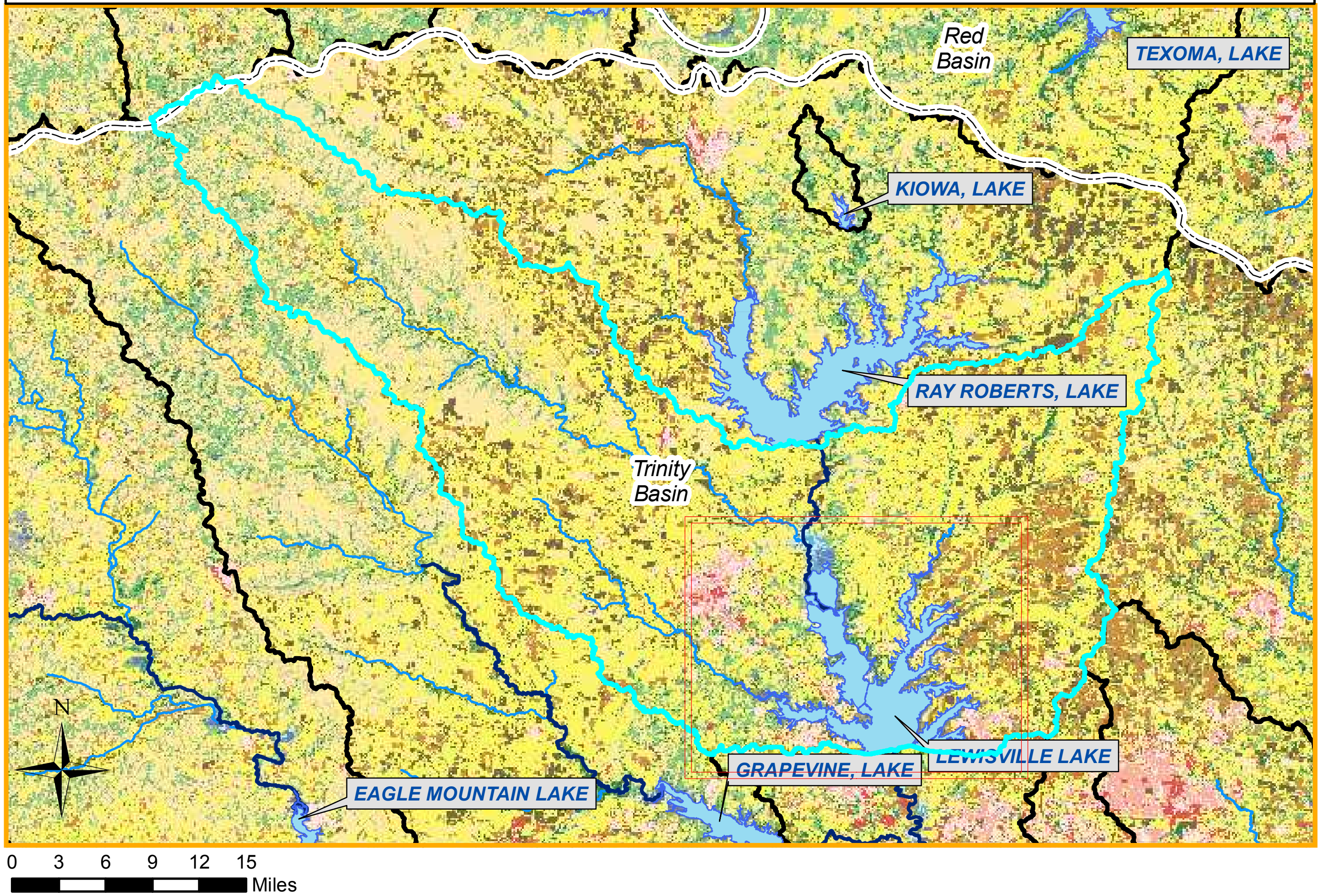
Year 2010 yield (ac-ft/yr) = 19901
Conservation Capacity (ac-ft) = 85825
Average Flow Rate (cfs) = 27.35
Surface Area (acres) = 6009.6
Perimeter (mi) = 66.48
Shoreline Development Index = 6.08
Residence Time (days) = 1582.09
Median TSS (mg/L) = 13

Watershed Area (acres) = 167590.82	>3rd Order Stream Length (mi) = 27.13	Mean Temperature (deg C) = 17.58
Wshed Area:Res Vol Index (1/m) = 6.41	Total Stream Length (mi) = 285.69	Mean Precip (in) = 27.67
Watershed Soil Erodibility Index = 0.32	Stream Density (mi/mi^2) = 0.1	Watershed Slope (%) = 0.25

Low Intensity Residential = 0.1%	Deciduous Forest = 1.6%	Shrubland = 29.2%
High Intensity Residential = 0%	Evergreen Forest = 0.7%	Grasslands/Herbaceous = 39.4%
Commercial/Industr/Transport = 0%	Mixed Forest = 0.1%	Pasture/Hay = 12%
Urban/Recreational Grasses = 0%	Total Forest (%) = 2.36	Total Shrub/Grass/Pasture (%) = 80.65
Total Developed (%) = 0.14	Row Crops = 2.3%	Woody Wetlands = 0%
Bare Rock/Sand/Clay = 0.2%	Small Grains = 9.7%	Emergent Herbaceous Wetlands = 0.2%
Quarries/Strip Mines/Gravel Pits = 0%	Fallow = 0%	Total Wetlands (%) = 0.17
Transitional = 0%	Orchards/Vineyards/Other = 0%	Open Water = 4.4%
Total Barren (%) = 0.19	Total Agricultural (%) = 12.02	Portion of watershed in Mexico = 0%

Espey Consultants, Inc, ET - P:\Active\10039.00_WTSHD_Protection_TX_Resrv\GIS\NHDPlus\Projects\ThreePanel\ThreePanel_20110415_1316_Bastrop.mxd

Reservoir Name = LEWISVILLE LAKE



Basin = Trinity

Region = C

Dam Latitude = 33.05

Dam Longitude = -96.96

Impoundment Date = 1954

Reservoir 0 0.9 1.8 2.7 3.6 Miles

Year 2010 yield (ac-ft/yr) = 7702

Conservation Capacity (ac-ft) = 543988

Average Flow Rate (cfs) = 479.16

Surface Area (acres) = 26319.19

Perimeter (mi) = 253.92

Shoreline Development Index = 11.11

Residence Time (days) = 572.38

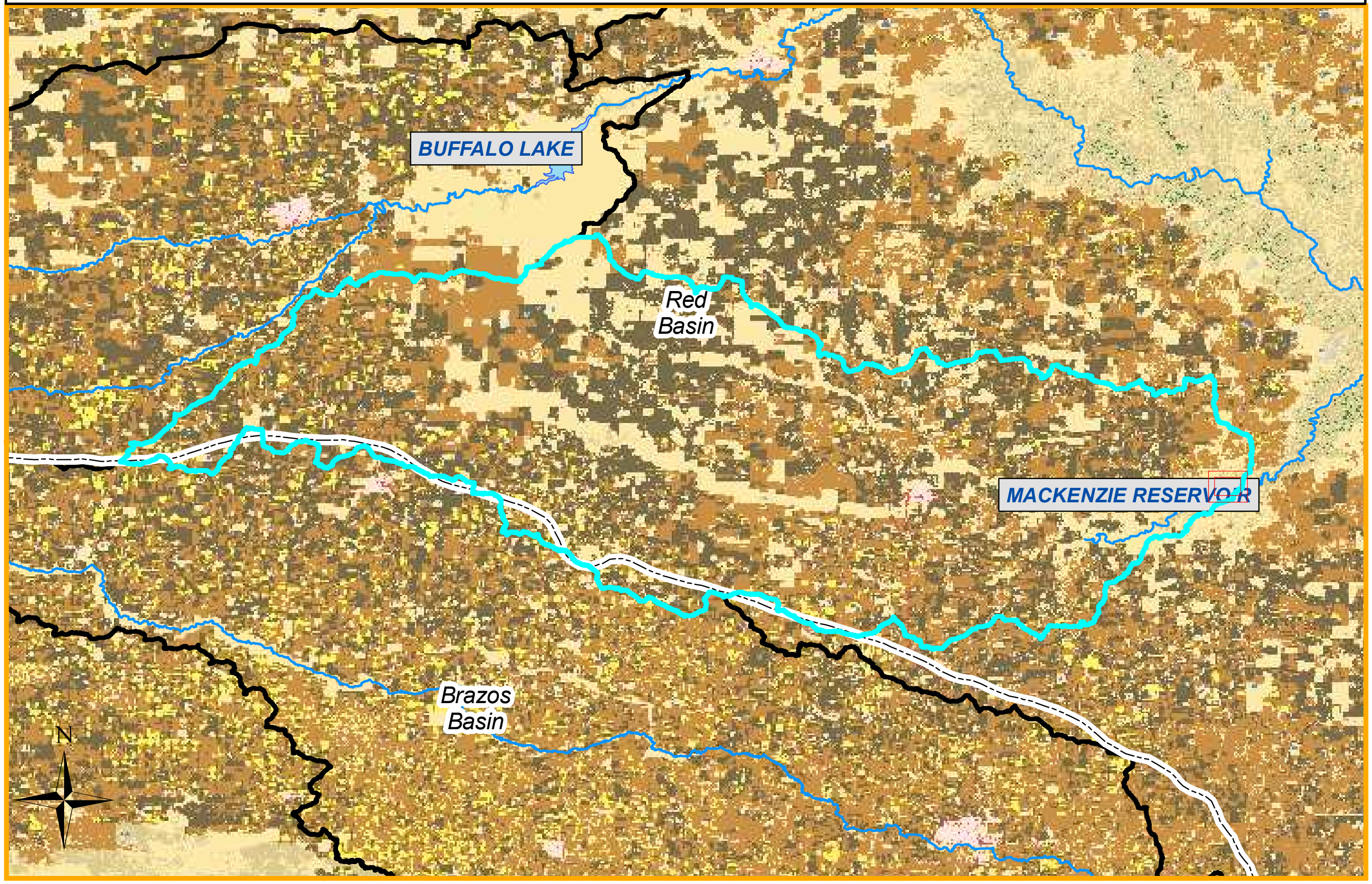
Median TSS (mg/L) = 12

Watershed Area (acres) = 618468.93	>3rd Order Stream Length (mi) = 148.21	Mean Temperature (deg C) = 17.53
Wshed Area:Res Vol Index (1/m) = 3.73	Total Stream Length (mi) = 976.08	Mean Precip (in) = 37.34
Watershed Soil Erodibility Index = 0.29	Stream Density (mi/mi^2) = 0.15	Watershed Slope (%) = 0.42

Low Intensity Residential = 2.7%	Deciduous Forest = 7.2%	Shrubland = 2%
High Intensity Residential = 0.6%	Evergreen Forest = 3.3%	Grasslands/Herbaceous = 17.9%
Commercial/Industr/Transport = 0.6%	Mixed Forest = 1.5%	Pasture/Hay = 41.5%
Urban/Recreational Grasses = 0.3%	Total Forest (%) = 12.03	Total Shrub/Grass/Pasture (%) = 61.35
Total Developed (%) = 4.22	Row Crops = 9.8%	Woody Wetlands = 0.5%
Bare Rock/Sand/Clay = 0%	Small Grains = 6.2%	Emergent Herbaceous Wetlands = 0.2%
Quarries/Strip Mines/Gravel Pits = 0%	Fallow = 0%	Total Wetlands (%) = 0.67
Transitional = 0%	Orchards/Vineyards/Other = 0%	Open Water = 5.6%
Total Barren (%) = 0.01	Total Agricultural (%) = 16.04	Portion of watershed in Mexico = 0%

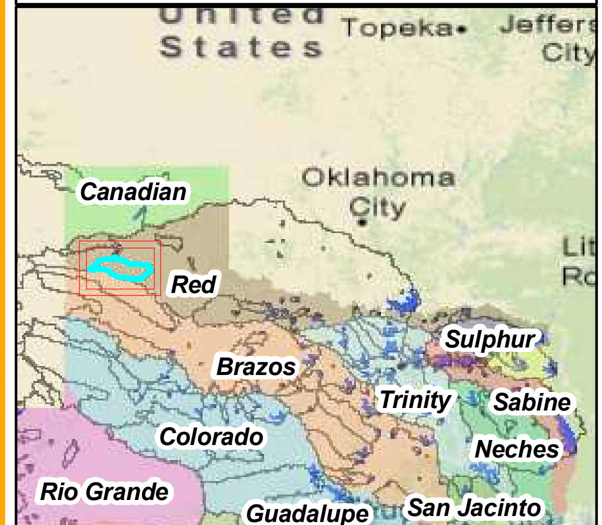
Espey Consultants, Inc, ET - P:\Active\10039.00_WTSHD_Protection_TX_Resrv\GIS\NHDPlus\Projects\ThreePanel\ThreePanel_20110415_1316_Bastrop.mxd

Reservoir Name = MACKENZIE RESERVOIR



Basin = Red

Region = O



Dam Latitude = 34.54
Dam Longitude = -101.43
Impoundment Date = 1974

Reservoir

Miles

Year 2010 yield (ac-ft/yr) = 0
Conservation Capacity (ac-ft) = 46429
Average Flow Rate (cfs) = 33.41
Surface Area (acres) = 274.29
Perimeter (mi) = 9.26
Shoreline Development Index = 3.97
Residence Time (days) = 700.63
Median TSS (mg/L) = 5

Watershed Area (acres) = 629948.21	>3rd Order Stream Length (mi) = 15.62	Mean Temperature (deg C) = 13.88
Wshed Area:Res Vol Index (1/m) = 44.51	Total Stream Length (mi) = 166.26	Mean Precip (in) = 18.68
Watershed Soil Erodibility Index = 0.35	Stream Density (mi/mi^2) = 0.02	Watershed Slope (%) = 0.21

Low Intensity Residential = 0.1%
High Intensity Residential = 0%
Commercial/Industr/Transport = 0.3%
Urban/Recreational Grasses = 0%
Total Developed (%) = 0.45

Bare Rock/Sand/Clay = 0%
Quarries/Strip Mines/Gravel Pits = 0%
Transitional = 0%
Total Barren (%) = 0.05

Deciduous Forest = 0%
Evergreen Forest = 0%
Mixed Forest = 0%
Total Forest (%) = 0

Row Crops = 33.4%
Small Grains = 37.3%
Fallow = 1%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 71.6

Shrubland = 0.5%
Grasslands/Herbaceous = 24.6%
Pasture/Hay = 2.4%
Total Shrub/Grass/Pasture (%) = 27.53

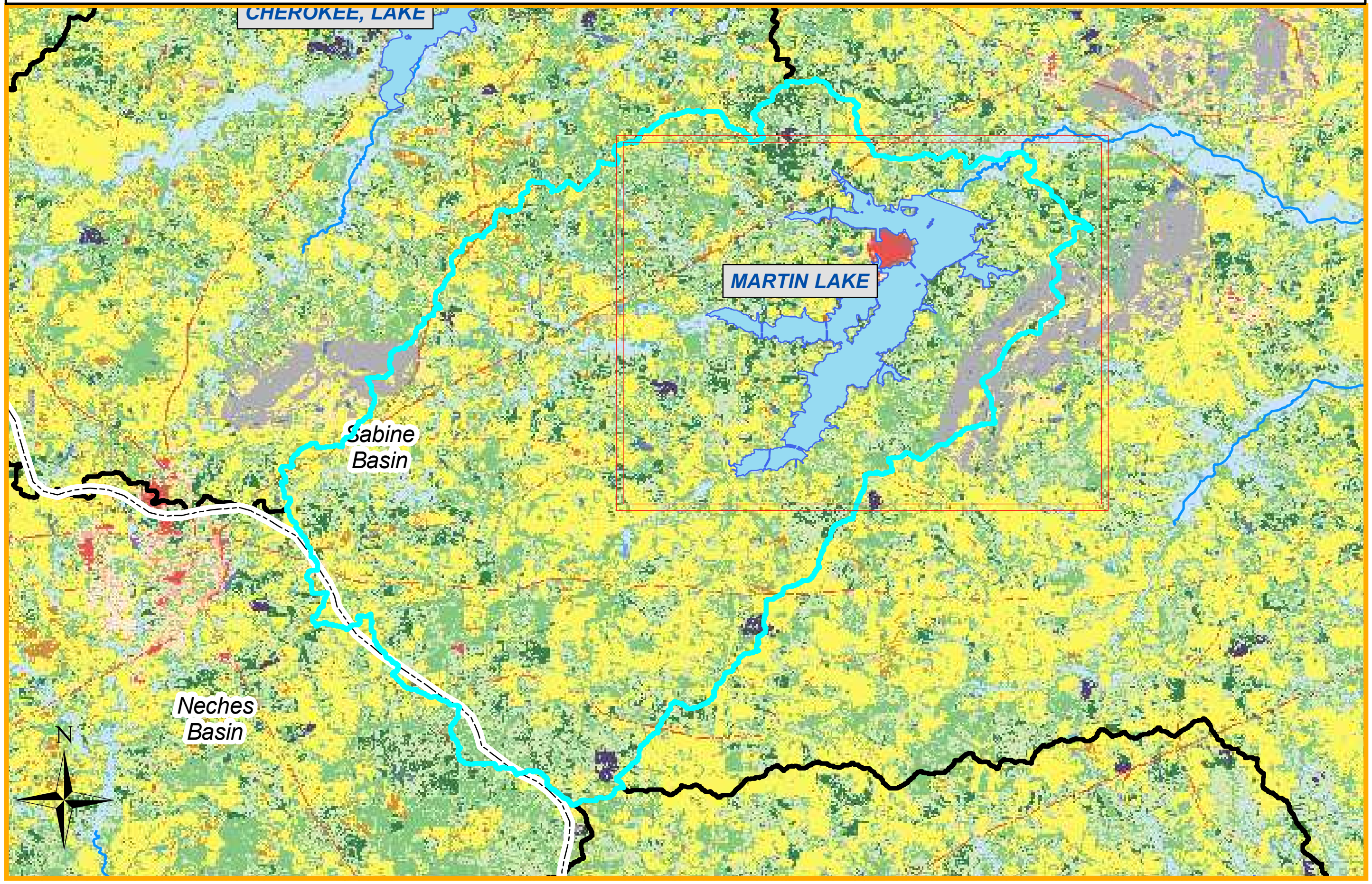
Woody Wetlands = 0%
Emergent Herbaceous Wetlands = 0%
Total Wetlands (%) = 0.04

Open Water = 0.3%

Portion of watershed in Mexico = 0%

Espey Consultants, Inc, ET - P:\Active\10039.00_WTSHD_Protection_TX_Resrv\GIS\NHDPlus\Projects\ThreePanel\ThreePanel_20110415_1316_Bastrop.mxd

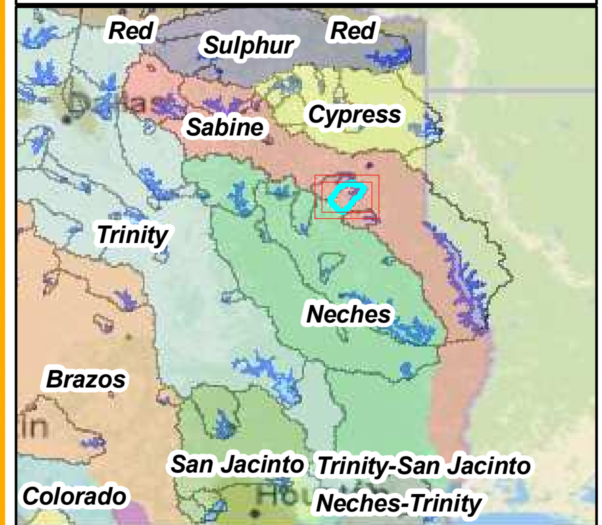
Reservoir Name = MARTIN LAKE



0 0.5 1 1.5 2 2.5
Miles

Basin = Sabine

Region = I



Dam Latitude = 32.27
Dam Longitude = -94.55
Impoundment Date = 1974

Reservoir

0 1 2 3 4
Miles

Year 2010 yield (ac-ft/yr) = 25000
Conservation Capacity (ac-ft) = 75116
Average Flow Rate (cfs) = 98.91
Surface Area (acres) = 5503.04
Perimeter (mi) = 64.92
Shoreline Development Index = 6.21
Residence Time (days) = 382.88
Median TSS (mg/L) = n/a

Watershed Area (acres) = 85476.47	>3rd Order Stream Length (mi) = 6.77	Mean Temperature (deg C) = 18.01
Wshed Area:Res Vol Index (1/m) = 3.73	Total Stream Length (mi) = 72.16	Mean Precip (in) = 46.44
Watershed Soil Erodibility Index = 0.29	Stream Density (mi/mi^2) = 0.05	Watershed Slope (%) = 0.24

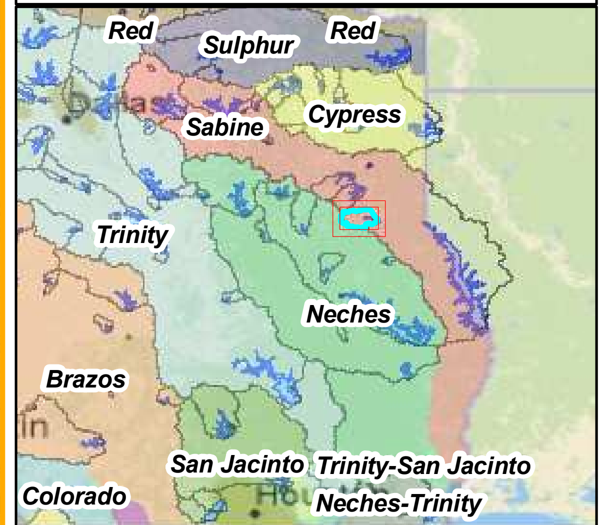
Low Intensity Residential = 0.1%	Deciduous Forest = 23.8%	Shrubland = 0%
High Intensity Residential = 0%	Evergreen Forest = 7.1%	Grasslands/Herbaceous = 0.7%
Commercial/Industr/Transport = 1.2%	Mixed Forest = 20.7%	Pasture/Hay = 31.5%
Urban/Recreational Grasses = 0%	Total Forest (%) = 51.7	Total Shrub/Grass/Pasture (%) = 32.16
Total Developed (%) = 1.26	Row Crops = 1.9%	Woody Wetlands = 3.1%
Bare Rock/Sand/Clay = 0.3%	Small Grains = 0%	Emergent Herbaceous Wetlands = 1.4%
Quarries/Strip Mines/Gravel Pits = 2.1%	Fallow = 0%	Total Wetlands (%) = 4.52
Transitional = 0.4%	Orchards/Vineyards/Other = 0%	Open Water = 5.7%
Total Barren (%) = 2.78	Total Agricultural (%) = 1.86	Portion of watershed in Mexico = 0%

Reservoir Name = MURVAUL, LAKE

0 0.4 0.8 1.2 1.6 2
Miles

Basin = Sabine

Region = I



Dam Latitude = 32.03
Dam Longitude = -94.42
Impoundment Date = 1957

Reservoir

0 0.4 0.8 1.2 1.6
Miles

Year 2010 yield (ac-ft/yr) = 21792
Conservation Capacity (ac-ft) = 38284
Average Flow Rate (cfs) = 87.48
Surface Area (acres) = 3454.53
Perimeter (mi) = 35.76
Shoreline Development Index = 4.32
Residence Time (days) = 220.64
Median TSS (mg/L) = 8

Watershed Area (acres) = 75579.9	>3rd Order Stream Length (mi) = 10.4	Mean Temperature (deg C) = 18.09
Wshed Area:Res Vol Index (1/m) = 6.48	Total Stream Length (mi) = 88.86	Mean Precip (in) = 47.05
Watershed Soil Erodibility Index = 0.31	Stream Density (mi/mi^2) = 0.09	Watershed Slope (%) = 0.34

Low Intensity Residential = 0%
High Intensity Residential = 0%
Commercial/Industr/Transport = 0.5%
Urban/Recreational Grasses = 0%
Total Developed (%) = 0.47

Bare Rock/Sand/Clay = 0%
Quarries/Strip Mines/Gravel Pits = 0%
Transitional = 0.6%
Total Barren (%) = 0.57

Deciduous Forest = 26.2%
Evergreen Forest = 6.5%
Mixed Forest = 26.7%
Total Forest (%) = 59.38

Row Crops = 1.2%
Small Grains = 0%
Fallow = 0%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 1.24

Shrubland = 0%
Grasslands/Herbaceous = 0%
Pasture/Hay = 29.8%
Total Shrub/Grass/Pasture (%) = 29.78

Woody Wetlands = 3.1%
Emergent Herbaceous Wetlands = 0.8%
Total Wetlands (%) = 3.86

Open Water = 4.6%

Portion of watershed in Mexico = 0%

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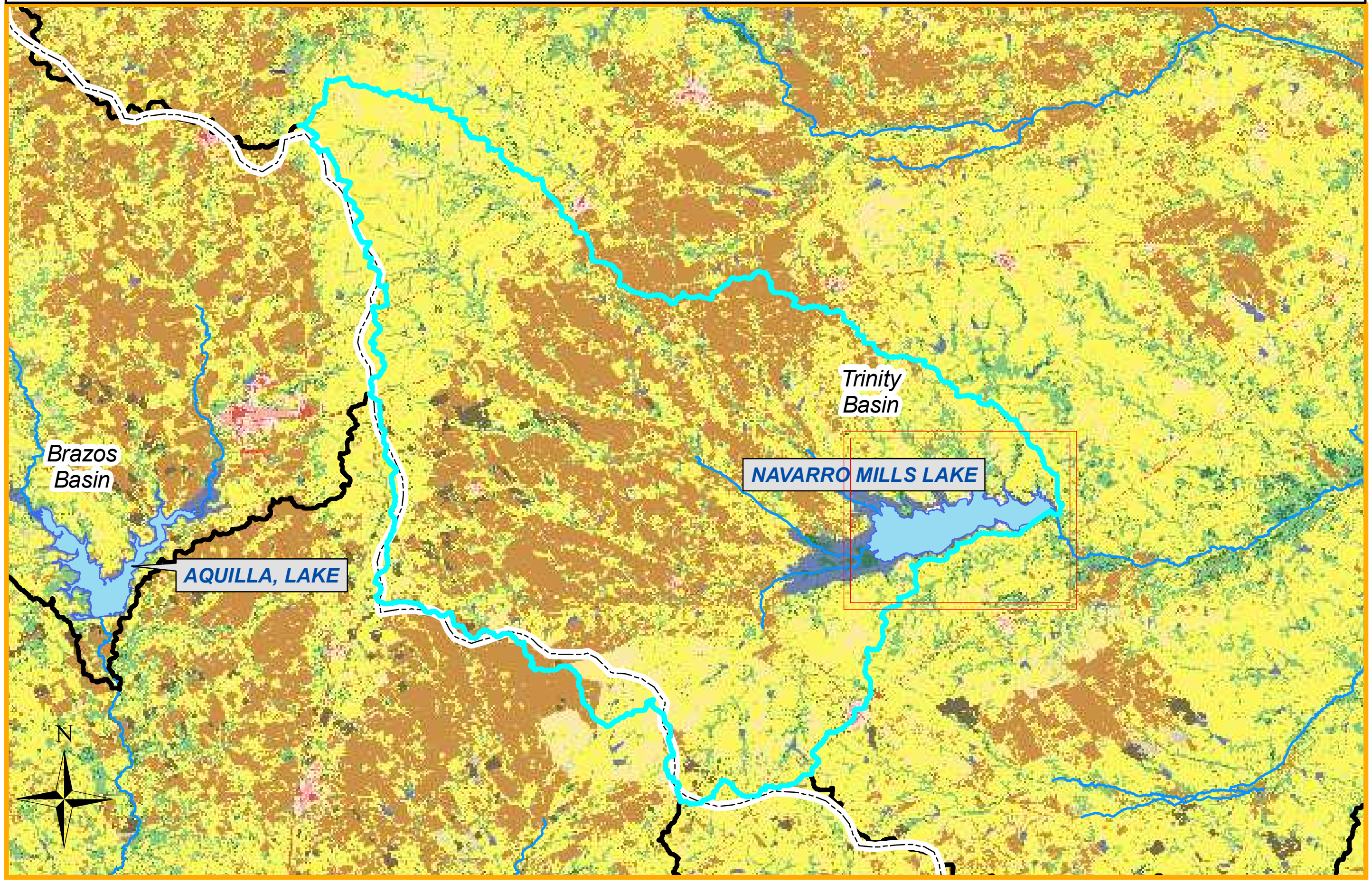
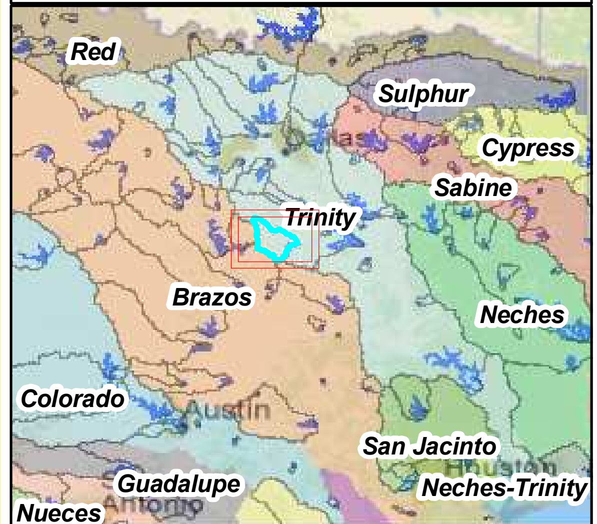
Reservoir Name = NAVARRO MILLS LAKE



00.81.62.43.24
Miles

Basin = Trinity

Region = C



Dam Latitude = 31.95
Dam Longitude = -96.7
Impoundment Date = 1963

Reservoir

0 0.7 1.4 2.1 2.8
Miles

Year 2010 yield (ac-ft/yr) = 19400
Conservation Capacity (ac-ft) = 55817
Average Flow Rate (cfs) = 162.47
Surface Area (acres) = 4751.84
Perimeter (mi) = 24.93
Shoreline Development Index = 2.57
Residence Time (days) = 173.21
Median TSS (mg/L) = 16

Watershed Area (acres) = 204660.09	>3rd Order Stream Length (mi) = 25.89	Mean Temperature (deg C) = 18.61
Wshed Area:Res Vol Index (1/m) = 12.03	Total Stream Length (mi) = 270.74	Mean Precip (in) = 35.58
Watershed Soil Erodibility Index = 0.31	Stream Density (mi/mi^2) = 0.08	Watershed Slope (%) = 0.33

Low Intensity Residential = 0.3%
High Intensity Residential = 0.1%
Commercial/Industr/Transport = 0.4%
Urban/Recreational Grasses = 0%
Total Developed (%) = 0.74

Bare Rock/Sand/Clay = 0.2%
Quarries/Strip Mines/Gravel Pits = 0%
Transitional = 0%
Total Barren (%) = 0.24

Deciduous Forest = 7.9%
Evergreen Forest = 1.4%
Mixed Forest = 0%
Total Forest (%) = 9.31

Row Crops = 28.7%
Small Grains = 1.2%
Fallow = 0%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 29.95

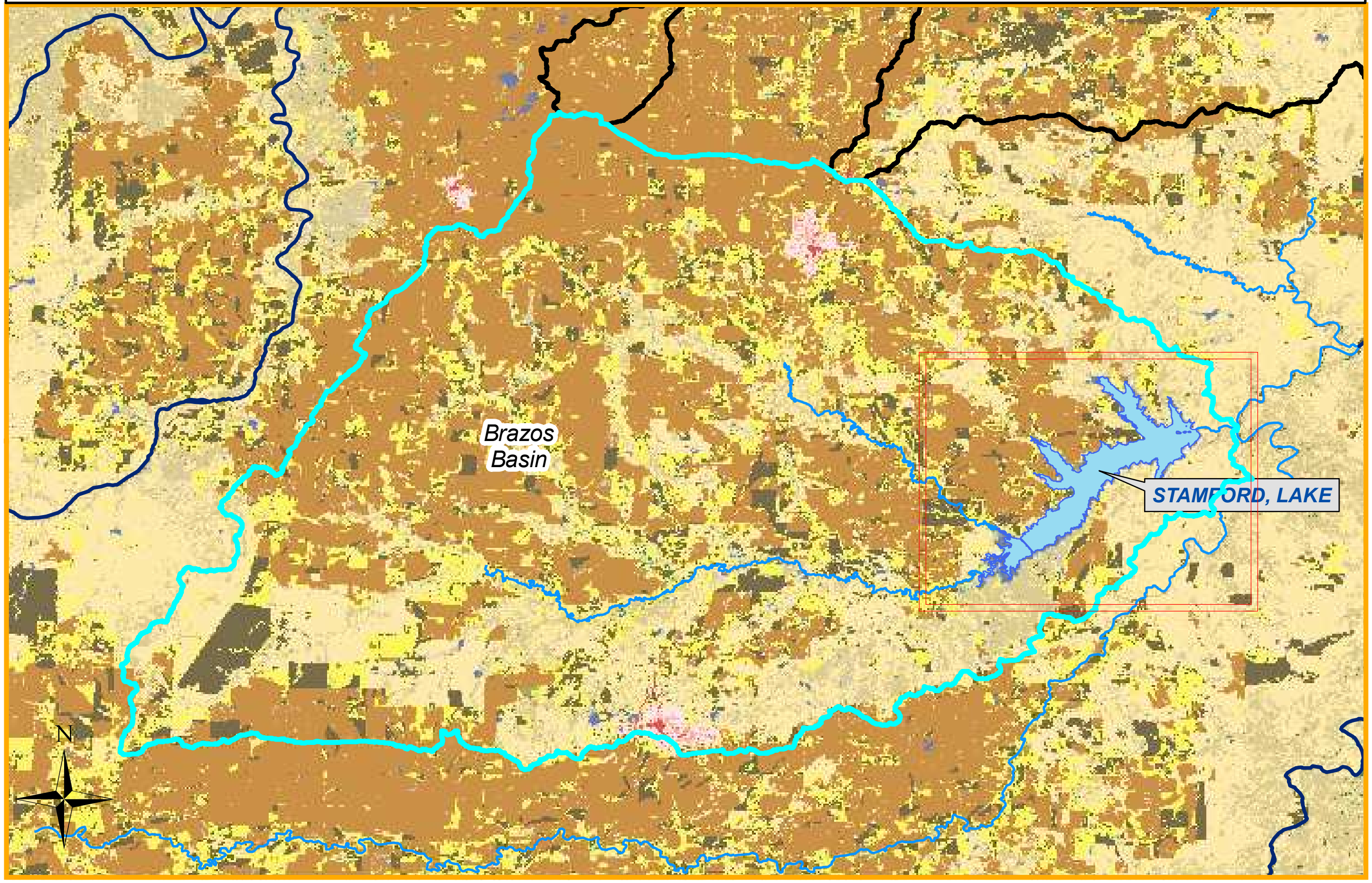
Shrubland = 0.2%
Grasslands/Herbaceous = 5.5%
Pasture/Hay = 48.7%
Total Shrub/Grass/Pasture (%) = 54.37

Woody Wetlands = 0%
Emergent Herbaceous Wetlands = 0.1%
Total Wetlands (%) = 0.13

Open Water = 5.2%

Portion of watershed in Mexico = 0%

Reservoir Name = STAMFORD, LAKE



Basin = Brazos

Region = G

Dam Latitude = 33.07
Dam Longitude = -99.56
Impoundment Date = 1953

Reservoir

0 0.8 1.6 2.4 3.2 Miles

Year 2010 yield (ac-ft/yr) = 5675
Conservation Capacity (ac-ft) = 51570
Average Flow Rate (cfs) = 26.37
Surface Area (acres) = 4373.77
Perimeter (mi) = 58.11
Shoreline Development Index = 6.23
Residence Time (days) = 985.96
Median TSS (mg/L) = 20

Watershed Area (acres) = 235937.7
Wshed Area:Res Vol Index (1/m) = 15.01
Watershed Soil Erodibility Index = 0.32

>3rd Order Stream Length (mi) = 48.86
Total Stream Length (mi) = 325.3
Stream Density (mi/mi^2) = 0.13

Mean Temperature (deg C) = 17.78
Mean Precip (in) = 25.31
Watershed Slope (%) = 0.21

Low Intensity Residential = 0.6%
High Intensity Residential = 0.2%
Commercial/Industr/Transport = 0.2%
Urban/Recreational Grasses = 0%
Total Developed (%) = 1.04

Bare Rock/Sand/Clay = 0.5%
Quarries/Strip Mines/Gravel Pits = 0%
Transitional = 0%
Total Barren (%) = 0.55

Deciduous Forest = 0.1%
Evergreen Forest = 0.1%
Mixed Forest = 0%
Total Forest (%) = 0.16

Row Crops = 39.3%
Small Grains = 9.4%
Fallow = 0%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 48.78

Shrubland = 7.7%
Grasslands/Herbaceous = 22.1%
Pasture/Hay = 16.7%
Total Shrub/Grass/Pasture (%) = 46.56

Woody Wetlands = 0%
Emergent Herbaceous Wetlands = 0.3%
Total Wetlands (%) = 0.28

Open Water = 2.6%

Portion of watershed in Mexico = 0%

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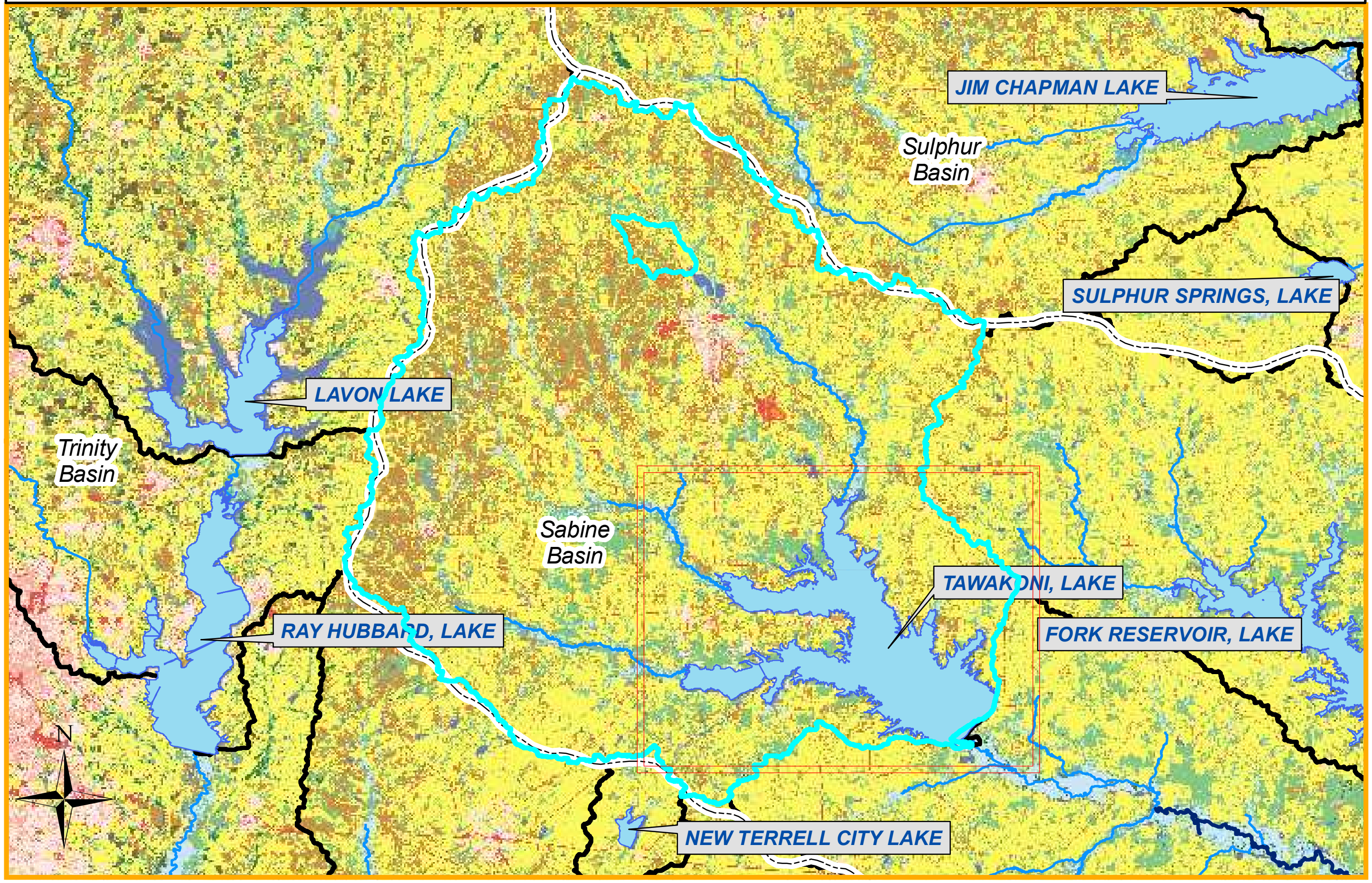
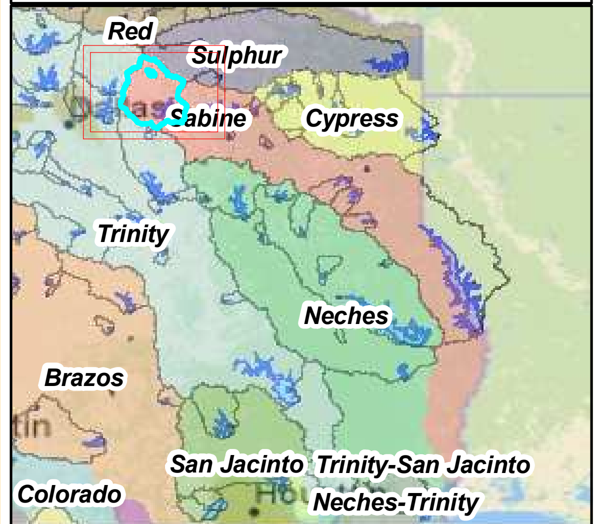
Reservoir Name = TAWAKONI, LAKE



0 3 6 9 12 15 Miles

Basin = Sabine

Region = D



Dam Latitude = 32.81
Dam Longitude = -95.9
Impoundment Date = 1960

Reservoir

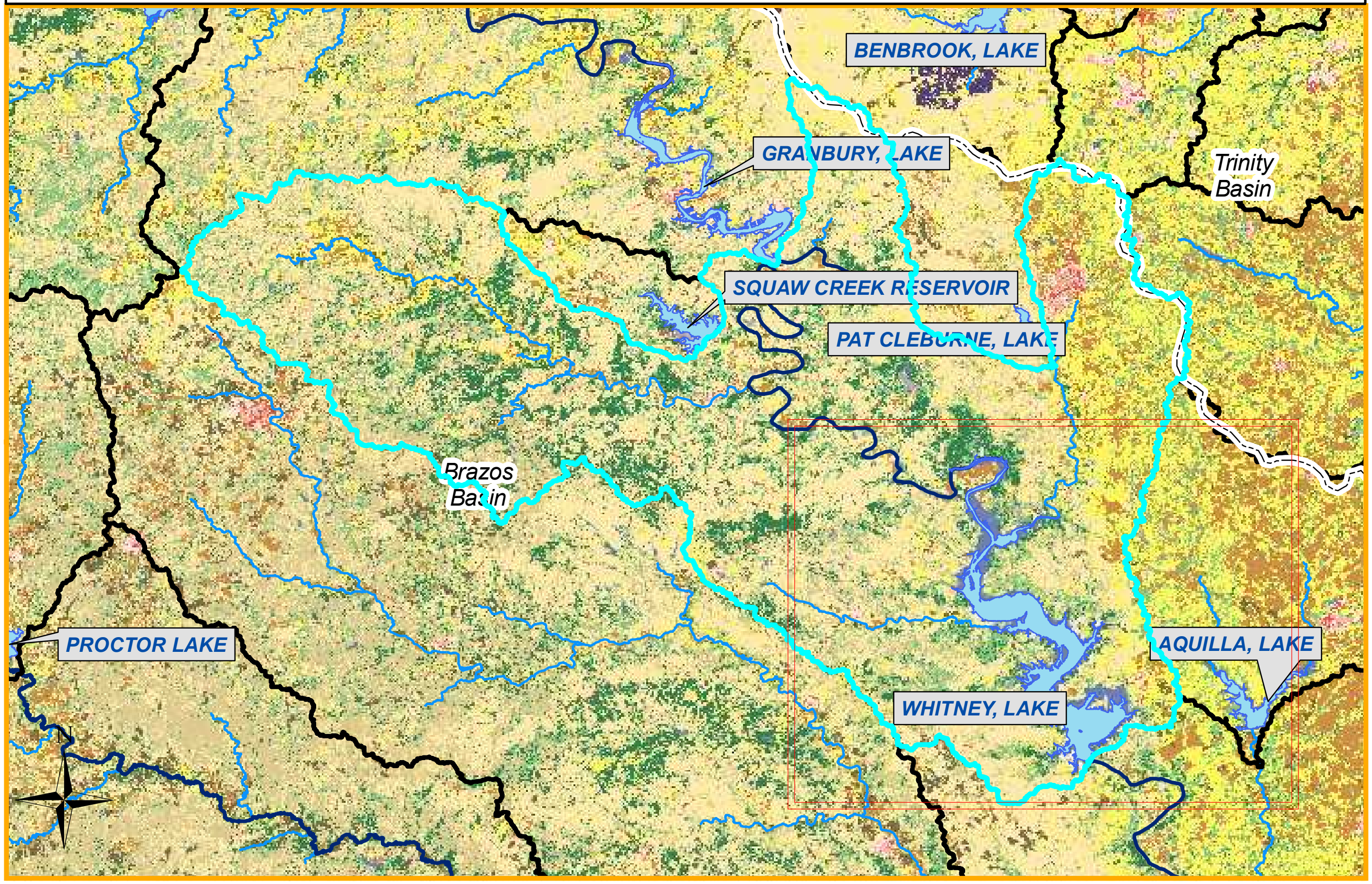
00.81.62.43.2 Miles

Year 2010 yield (ac-ft/yr) = 229807
Conservation Capacity (ac-ft) = 888126
Average Flow Rate (cfs) = 568.39
Surface Area (acres) = 37577.32
Perimeter (mi) = 200.94
Shoreline Development Index = 7.35
Residence Time (days) = 787.78
Median TSS (mg/L) = 11

Watershed Area (acres) = 485428.88	>3rd Order Stream Length (mi) = 90.62	Mean Temperature (deg C) = 17.37
Wshed Area:Res Vol Index (1/m) = 1.79	Total Stream Length (mi) = 590.21	Mean Precip (in) = 41.33
Watershed Soil Erodibility Index = 0.31	Stream Density (mi/mi^2) = 0.12	Watershed Slope (%) = 0.19

Low Intensity Residential = 1.2%	Deciduous Forest = 14.1%	Shrubland = 0%
High Intensity Residential = 0.2%	Evergreen Forest = 0.2%	Grasslands/Herbaceous = 0.1%
Commercial/Industr/Transport = 1.6%	Mixed Forest = 1.1%	Pasture/Hay = 49.7%
Urban/Recreational Grasses = 0.2%	Total Forest (%) = 15.46	Total Shrub/Grass/Pasture (%) = 49.78
Total Developed (%) = 3.2	Row Crops = 19%	Woody Wetlands = 2%
Bare Rock/Sand/Clay = 0.1%	Small Grains = 0%	Emergent Herbaceous Wetlands = 2%
Quarries/Strip Mines/Gravel Pits = 0%	Fallow = 0%	Total Wetlands (%) = 3.99
Transitional = 0%	Orchards/Vineyards/Other = 0%	Open Water = 8.4%
Total Barren (%) = 0.11	Total Agricultural (%) = 19.04	Portion of watershed in Mexico = 0%

Reservoir Name = WHITNEY, LAKE



Basin = Brazos
Region = G

Dam Latitude = n/a
Dam Longitude = n/a
Impoundment Date = n/a

Reservoir

Year 2010 yield (ac-ft/yr) = 18336
Conservation Capacity (ac-ft) = 553344
Average Flow Rate (cfs) = 2001.28
Surface Area (acres) = 23124.12
Perimeter (mi) = 237.19
Shoreline Development Index = 11.07
Residence Time (days) = 139.4
Median TSS (mg/L) = 7

Watershed Area (acres) = 858346.72	>3rd Order Stream Length (mi) = 213.47	Mean Temperature (deg C) = 18.43
Wshed Area:Res Vol Index (1/m) = 5.09	Total Stream Length (mi) = 1028.32	Mean Precip (in) = 32.36
Watershed Soil Erodibility Index = 0.24	Stream Density (mi/mi^2) = 0.16	Watershed Slope (%) = 0.54

Low Intensity Residential = 0.7%
High Intensity Residential = 0.3%
Commercial/Industr/Transport = 0.8%
Urban/Recreational Grasses = 0.1%
Total Developed (%) = 1.85

Bare Rock/Sand/Clay = 0.5%
Quarries/Strip Mines/Gravel Pits = 0.3%
Transitional = 0%
Total Barren (%) = 0.76

Deciduous Forest = 12.2%
Evergreen Forest = 10.6%
Mixed Forest = 0.1%
Total Forest (%) = 22.89

Row Crops = 4.9%
Small Grains = 0.8%
Fallow = 0%
Orchards/Vineyards/Other = 0%
Total Agricultural (%) = 5.71

Shrubland = 13.4%
Grasslands/Herbaceous = 36.9%
Pasture/Hay = 13.2%
Total Shrub/Grass/Pasture (%) = 63.43

Woody Wetlands = 0%
Emergent Herbaceous Wetlands = 0.1%
Total Wetlands (%) = 0.11

Open Water = 5.2%

Portion of watershed in Mexico = 0%

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Appendix D Decision Support Tool

(Decision Support Tool is available in the CD under the folder /AppendixD/)