DUVAL COUNTY

GROUNDWATER CONSERVATION DISTRICT

MANAGEMENT PLAN

Plan Adopted: ___________________________

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I. DISTRICT MISSION

The Duval County Groundwater Conservation District mission is to conserve and prevent waste and pollution of ground water resources, while addressing the needs of the district's citizens and maintaining the health of our environment for the present and for future generations.

II. DISTRICT INFORMATION

A. Creation.

The District is a groundwater conservation district created under and essential to accomplish the purpose of Section 59, Article XVI of the Texas Constitution. It was created as part of S.B. No. 1847 passed by the Texas Legislature in May of 2005. A confirmation election was held in the county on July 25, 2009 which confirmed the District's legal standing. The District is run by a five member Board of Directors. These directors are elected by the voters of the District and serve four year terms. One director is elected at large from within the District and the other four directors are elected one from each of the four county commissioners' precincts. The District encompasses all of Duval County and is located within Groundwater Management Area 16 and Regional Water Planning Group N.).

B. Purpose for the District

The purpose for the district, as per Texas Water Code 36, Section 36.0015, is to provide for the conservation, preservation, protection, recharging and prevention of waste of groundwater and of groundwater reservoirs or their subdivisions and to control subsidence caused by the withdrawal of water from those reservoirs. It has an obligation under Texas Water code 36.107 to develop a groundwater management plan that will state how the District will meet that purpose. Under Texas Water code 36c Section 36.101, the District has the authority to adopt and enforce rules that the District feels are needed to carry out that purpose.

C. Duval County

1. Resource Information

Duval County is in south central Texas about fifty miles inland from the Gulf of Mexico and seventy-three miles north of the Rio Grande. It is bordered by Webb, La Salle, McMullen, Live Oak, Jim Wells, Brooks, and Jim Hogg counties. San Diego, the county seat and most populous town, is on the Texas Mexican Railroad at the intersection of State highways 44 and 359 and Farm road 1329, about fifty-two miles west of Corpus Christi and eighty miles east of Laredo. The county's center point is nine miles northwest of Benavides at 27º 42'north latitude and 98º 30' west longitude. State Highway 44 passes through the county from east to west, and State Highway 16 crosses from north to south. Two highways cross the county diagonally: U.S. Highway 59 and State Highway 359. The county comprises 1,795 square miles of nearly level to undulating terrain with an elevation ranging from 250 to 800 feet above sea level. The northern part of the county drains into the Nueces River, while the central and southern parts drain into the Laguna Madre through Baffin Bay[1]. Northern Duval County is characterized by loamy cracking or crumbly clayey soils, deep to moderately deep, that overlie indurated caliche. Western Duval County is characterized by deep soils and well-drained dark soils with loamy surface layers and clayey sub soils. The vegetation consists of small trees, shrubs, and cacti, with large areas of brush. The county's mineral resources include caliche, clay, salt domes, sandstone, uranium, oil, and gas. The climate is subtropical-sub humid. The average minimum temperature is 43º F in January, and the average maximum temperature is 98º in July. The growing season averages 298 days annually. The rainfall averages about twenty-four inches. Less than 1 percent of the land in Duval County is considered prime farmland. Duval County's climate has likely remained unchanged for centuries, but beginning in the late nineteenth century cattle ranching, which was the county's main industry, and farming have had significant effects on the county's vegetation and water supply. Overgrazing led to the destruction of the watershed and clogged the springs that fed the county's streams, most of which are now intermittent, and, in combination with the suppression of grass fires, allowed mesquite to become dominant (*1).

2. Demographics

Duval County is a county located in the U.S. of Texas. As of the 2010 census its population was 11,782.(*2) As of the census (*3) of 2000, there were 13, 120 people, 4,350 households, and 3,266 families residing in the county. The population density was 7 people per square mile (3/km^2). The racial makeup of the county was 80.22% White, 0.54% Black or African American, 0.53% Native American, 0.11% Asian, 0.03% Pacific Islander, 15.46% from other races and 3.11% from two or more races. 87.99% of the population was Hispanic or Latino of any race.

There were 4,350 households out of which 36.80% had children under the age of 18 living with them, 53.20% were married couples living together, 16.80% had a female householder with no husband present, and 24.90% were non-families. 22.90% of all households were made up of individuals and 11.70% had someone living alone who was 65 years of age or older. The average household size was 2.88 and the average family size was 3.40.

1*[1] Citation

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Martin Donell Kohout, "DUVAL COUNTY," *Handbook of Texas Online* (http://tshaonline.org/handbook/online/articles/hdc11), accessed March 13, 2012. Published by the Texas State Historical Association

In the county, the population was spread out with 29.5% under the age of 18, 9.50% from 18 to 24, 26.40% from 25 to 44, 20.60% from 45 to 64, and 14.00% who were 65 years of age or older. The median age was 34 years. For every 100 females there were 100.70 males. For every 100 females age 18 and over, there were 102.90 males.

The median income for a household in the county was $22,416, and the median income for a family was $26,014. Males had a median income of $25,601 versus $16,250 for females. The per capita income for the county was $11,324. About 23.00% of families and 27.20% of the population were below the poverty line, including 35.90% of those under age 18 and 25.30% of those age 65 or over.

Historical Populations

Census	Pop.	%+/-
1870	1,083	–
1880	5,732	429.3%
1890	7,598	32.6%
1900	8,483	11.6%
1910	8,864	5.7%
1920	8,251	-8.0%
1930	12,191	47.8%
1940	20,565	68.7%
1950	15,643	-23.9%
1960	13,398	-14.4%
1970	11,722	-12.5%
1980	12,517	6.8%
1990	12,918	3.2%
2000	13,120	1.6%
2010	11,782	-10.2%

U.S. Decennial Census[*]4
Texas Almanac: 1850-2010[*]5

1. Communities

Cities

- Benavides
- Freer
- **San Diego**

Unincorporated areas

- Concepcion
- Ramirez
- Realitos
- Rios
- Sejita

References

2.^United States Census Bureau. "2012 Census Data" (http://2010.census.gov/2010census/data/). Retrieved 15 January 2012.
3.^"American Fact Finder" (http://factfinder.census.gov). United States Census Bureau. http://factfinder.census.gov. Retrieved 2008-01-31.
4.^U.S. Decennial Census (http://census.gov/prod/www/abs/decennial/)
5.^Texas Almanac: County Population History 1850-2010 (http://www.texasalmanac.com/sites/default/files/images/topics/ctypophistweb2010.pdf)

External Links

- Duval County (http://www.tshaonline.org/handbook/online/articles/DD/hcd11.html) from the *Handbook of Texas Online*

3. Aquifers: Two aquifers underlay the District.

(a) Gulf Coast Aquifer, considered a major aquifer, underlays most of the District. The Gulf Coast aquifer forms a wide belt along the Gulf of Mexico from Florida to Mexico. In Texas, the aquifer provides water to all or parts of 54 counties and extends from the Rio Grande northeastward to the Louisiana-Texas border. Municipal and irrigation uses account for 90 percent of the total pumpage from the aquifer. The Greater Houston metropolitan area is the largest municipal user, where well yields average about 1,600 gal/min.

The aquifer consists of complex interbedded clays, silts, sands, and gravels of Cenozoic age, which are hydrologically connected to form a large, leaky artesian aquifer system. This system comprises four major components consisting of the following generally recognized water-producing formations. The deepest is the Catahoula, which contains ground water near the outcrop in relatively restricted sand layers. Above the Catahoula is the Jasper aquifer, primarily contained within the Oakville Sandstone. The Burkeville confining layer separates the Jasper from the overlying Evangeline aquifer, which is contained within the Fleming and Goliad sands. The Chicot aquifer, or upper component of the Gulf Coast aquifer system, consists of the Lissie, Willis, Bentley, Montgomery, and Beaumont formations, and overlying alluvial deposits. Not all formations are present throughout the system, and nomenclature often differs from one end of the system to the other. Maximum total sand thickness ranges from 700 feet in the south to 1,300 feet in the northern extent.

Water quality is generally good in the shallower portion of the aquifer. Ground water containing less than 500 mg/l dissolved solids is usually encountered to a maximum depth of 3,200 feet in the aquifer from the San Antonio River Basin northeastward to Louisiana. From the San Antonio River Basin southwestward to Mexico, quality deterioration is evident in the form of increased chloride concentration and saltwater encroachment along the coast. Little of this ground water is suitable for prolonged irrigation due to either high salinity or alkalinity, or both. In several areas at or near the coast, including Galveston Island and the central and southern parts of Orange County, heavy municipal or industrial pumpage had previously caused an up dip migration, or saltwater intrusion, of poor-quality water into the aquifer. Recent reductions in pumpage here have resulted in a stabilization, and in some cases, even improvement of ground-water quality.

Years of heavy pumpage for municipal and manufacturing use in portions of the aquifer have resulted in areas of significant water-level decline. Declines of 200 feet to 300 feet have been measured in some areas of eastern and southeastern Harris and northern Galveston counties. Other areas of significant water-level declines include the Kingsville area in Kleberg County and portions of Jefferson, Orange, and Wharton counties. Some of these declines have resulted in compaction of dewatered clays and significant land surface subsidence. Subsidence is generally less than 0.5 foot over most of the Texas coast, but has been as much as nine feet in Harris and surrounding counties. As a result, structural damage and flooding have occurred in many low-lying areas along Galveston Bay in Baytown, Texas City, and Houston. Conversion to surface-water use in many of the problem areas has reversed the decline trend. *6

(*6) References

Baker, E.T., Jr., 1979, Stratigraphic and hydrogeologic framework of part of the Coastal Plain of Texas: TDWR Rept. 236, 43 p.

Guyton, WE, and Associates, 1972, Ground-water conditions in Anderson, Cherokee, Freestone, and Henderson counties, Texas: TWDB Rept. 150, 80 p.

McCoy, T.W, 1990, Evaluation of ground-water resources in the Lower Rio Grande Valley, Texas: TWDB Rept. 316, 48 p.

Muller, DA., and Price, R.D., 1979, Ground-water availability in Texas, estimates and projections through 2030: TDWR Rept. 238, 77 p.

Sandeen, WM., and Wesselman, J.B., 1973, Ground-water resources of Brazoria County, Texas: TWDB Rept. 163,205 p.

Shafer, G.H., 1968, Ground-water resources of Nueces and San Patricio counties, Texas: TWDB Rept. 73,137 p.

___________, 1970, Ground-water resources of Aransas County, Texas: TWDB Rept. 124, 83 p.

Shafer, G.H., and Baker, E.T.,Jr., 1973, Ground-water resources of Kleberg, Kenedy, and southern Jim Wells counties, Texas: TWDB Rept. 173,69 p.

Thorkildsen, D., 1990, Evaluation of water resources of Fort Bend County, Texas: TWDB Rept. 321, 21 p.

Thorkildsen, D., and Quincy, R., 1990, Evaluation of water resources of Orange and eastern Jefferson counties, Texas: TWDB Rept. 320, 34 p.

Wesselman, lB., 1967, Ground-water resources of Jasper and Newton counties, Texas: TWDB Rept. 59,167 p.

Wesselman, lB., and Aronow, S., 1971, Ground-water resources of Chambers and Jefferson counties, Texas: TWDB Rept. 133,183 p.

(b) Yegua-Jackson, considered a minor aquifer, underlays the District only along a small area along the northwest part of the District.

The Yegua-Jackson aquifer is a Tertiary age aquifer that extends from the Rio Grande northeastward to the Louisiana border, as shown in Figure 65. These aquifers are mainly used in the northern half of the aquifer extent, and the groundwater produced from these aquifers is used for municipal, industrial, irrigation, domestic, and livestock purposes.

The Yegua Formation consists principally of thin beds of sand, clay, silt with some lignite in the outcrop, and is up to 1,000 feet thick in the fresh to slightly saline sections of the formation. Individual units within the Yegua Formation are generally not consistent from one area to another, although in many areas a basal sand unit is often the most productive unit within the aquifer. The Yegua thickens significantly in the down-dip direction. Down-dip (south and southeast direction from the outcrop), the sand and sandstone units within the Yegua pinch out in the subsurface. The Jackson Group consists of up to 1,500 feet of mainly clay, lacking many productive sand units, and also thickens significantly in the down-dip direction.

Groundwater is found mainly under artesian conditions in the Yegua-Jackson aquifer. Recharge to these aquifers is through the infiltration of precipitation on the outcrop areas. Groundwater then moves down-dip from the outcrops. Historically, discharge from these aquifers was through the upwards leakage of groundwater to overlying formations. Currently, much of the discharge is to wells.

The Yegua-Jackson aquifer generally yields small to moderate quantities of fresh groundwater to wells near the outcrop. The Yegua tends to be the more productive of the two units, yielding up to 500 gpm to wells. Wells in the Jackson tend to yield less than 50 gpm. The porosity of sandstones and sands of these aquifers probably ranges from about 5 to 20 percent. Transmissivities of these aquifers range from less than 1,000 gpd/ft to 40,000 gpd/ft. Transmissivities in the Jackson are generally much less, though wells producing from some of the few sandy units in the Jackson can have transmissivities up to 14,000 gpd/ft. Storage coefficients may be as high as $1 \times 10\text{-}^{3}$, and unconfined specific yields are approximately 0.25. Specific capacities for the Yegua range from about 1 gpm/ft to nearly 15 gpm/ft. The average hydraulic conductivity of the sand units is about 20 to

50 gallons per day/ft squared. However, these estimates of transmissivity may be much lower in the down-dip areas where much of the brackish groundwater is present because in these areas the sand units tend to pinch out in the subsurface.

In East Texas, these aquifers contain mostly fresh water in the outcrop areas. In Central Texas the aquifer contains both fresh and slightly-saline water in and near the outcrop. In South Texas even the outcrop areas contain slightly- to moderately-saline groundwater, with little fresh water present. In all areas, groundwater in the aquifer becomes highly mineralized down-dip, although due to the lack of wells producing from these areas, few chemical analytical data are available to illustrate this change. Fresh groundwater is generally found at depths of less than 1,000 feet. Slightly - to moderately-saline groundwater is found at distances of a few miles down-dip from the outcrop at depths on the order of 1,500 feet, although in South Texas slightly- to moderately-saline groundwater is found in the outcrop at depths of generally less than 1,000 feet. Saline groundwater in the Yegua-Jackson aquifer (greater than 10,000 mg/L) is usually found 10 to 15 miles below the outcrop where depths are on the order of 2,500 feet.

Summary

The Yegua-Jackson aquifer may be a source for brackish groundwater in the future. These aquifers contain some slightly- to moderately-saline groundwater in the outcrop areas in Central to South Texas, and groundwater becomes highly mineralized very quickly in the down-dip direction throughout its extent in Texas. The drawbacks to using this aquifer as a source of brackish groundwater is that the transmissivities in the portions of the aquifer containing brackish water may be significantly lower than the favorable transmissivities reported above.

Availability- LOW to HIGH- Due to the large number of planning regions that the Yegua-Jackson aquifer crosses, availabilities by region vary widely, ranging from low to high. Availabilities are low in the down-dip portion of the aquifer. Most of the rest of the regions have average availabilities, with regions in Central Texas being considered moderate to high.

Productivity- LOW- Much of the brackish groundwater present in the Yegua-Jackson aquifer occurs at depth in the down-dip portion of this aquifer, where transmissivities are much lower than in the fresh water section. This results in a low productivity for the aquifer.

Source Water Production Cost- MODERATE to HIGH- Much of the brackish water present in this aquifer occurs at greater depths in the down-dip portions of the aquifer. Wells installed in these areas will be deeper and less productive, thus increasing the relative cost of producing from these areas. Only where brackish groundwater is found in and near the outcrop areas will relative costs be moderate. *7

Summary of Brackish Water In the Yegua-Jackson Aquifer			
Region	*Availability*	*Productivity*	*Source Water Production Cost*
G- Brazos	Moderate	Low	Moderate to High
H-Region H	Moderate	Low	Moderate
1- East Texas	Moderate	Low	Moderate
K- Lower Colorado	Moderate to High	Low	Moderate to High
L- South Central Texas	Moderate to High	Low	Moderate to High
M- Rio Grande	High	Low	Moderate
N- Coastal Bend	Low	Low	Moderate to High
p- Lavaca	Low	Low	High

(*7) LBG-Guyton Associates –Report section 3.2.20 of the "Brackish Groundwater Manual for Texas Regional Water Planning Group" prepared for the Texas Water Development Board, February2003, by LBG- Guyton Associates.

4. Groundwater Resources of Duval County, Texas

(Abstract by G. H. Shafer, United States Geological Survey)

The geologic formations that yield fresh to moderately saline water in Duval County are, from oldest to youngest, the Catahoula Tuff, Oakville Sandstone, and Goliad Sand. All other geologic formations underlying the county are not known to yield water to wells or they yield only saline water.

About 5.3 mgd (million gallons per day) of ground water was used in 1970. Of this amount 0.6 mgd was pumped from the Catahoula Tuff, 0.7 mgd from the Oakville Sandstone, and 4.0 mgd from the Goliad Sand. Most of the large ground-water supplies are obtained from wells in the Goliad Sand.

During 1931-69, water levels declined as much as 55 feet in the artesian zone of the Goliad Sand in the east-central and southeastern parts of the county, as a result of pumping for irrigation, public supply, and industrial use. Changes in water levels in wells in the Catahoula Tuff have been relatively small. Probably only slight changes in water levels have occurred regionally in the Oakville Sandstone.

The ground water is characteristically high in dissolved solids, chloride, and hardness. Most of the water sampled does not meet the quality standards of the U.S. Public Health Service for drinking water, although water having chemical constituents in excess of the standards is used in the county for drinking. Water from the Goliad Sand is more suitable for irrigation than water from the Oakville Sandstone and Catahoula Tuff; however, water from any of the three aquifers should be used with careful management and as a supplement to rainfall.

The ground-water resources of the county are only partly developed. A total of 23 mgd (6 mgd from the Catahoula, 7 mgd from the Oakville, and 10 mgd from the Goliad) of fresh to slightly saline water is available, on a long-term basis without depleting the supply. This total is slightly more than four times as much water as was used for all purposes in 1970.

III. MODELED AVAILABLE GROUNDWATER AND ADOPTION OF DESIRED FUTURE CONDITION

Modeled available groundwater is defined in the Texas Water code, Section 36.001, subsection (25) as "the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under Section 36.108." For use in the regional water planning process, modeled available groundwater estimates have been reported by aquifer, county, river basin, regional water planning area, groundwater district and any other subdivision of the aquifer designated by the management area. The modeled available water in Groundwater Management Area 16 is also based upon the desired future condition adopted by the districts within GMA 16. The following data is based on GAM Run 10-047

MAG: Groundwater Management Area 16 Model Runs to Estimate Drawdowns under Assumed Future Pumping for the Gulf Coast Aquifer. Dated December 8, 2011.

Refer to Appendix A.

IV. GROUNDWATER AVAILABILITY MODELING

Texas State Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, groundwater conservation districts shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

> The annual amount of recharge from precipitation to groundwater resources within the District. For each aquifer within the District, the annual volume of water that discharges from these aquifers to springs and surface water bodies. The annual volume of flow into and out of the district within each aquifer and between aquifers in the District.

The following data is based on GAM Run 11-001 Duval County Groundwater Conservation District, dated June 15, 2011.

Tables 1 through 2 summarize the groundwater availability model data required by the statute, and figures 1 through 2 show the area of each model from which the values in the respective Tables were extracted.

Refer to Appendix B.

V. HISTORICAL WATER USE AND STATE WATER PLAN DATA

The following report provided by the Texas Water Development Board represents the most updated Historical Water use Data for the District. The report will be periodically reviewed and updated to include the most recent data available.

Included also is information for the District on the Projected Surface Water Supplies, Projected Water Demands, Projected Water Supply Needs and Projected Water Management Strategies, as of July 27, 2012, based on the 2012 State Water Plan For Texas.

Refer to Appendix C.

VI. PURPOSE OF GROUNDWATER MANAGEMENT PLAN

Purpose of The Plan: The purpose of this management plan is to help the District achieve its mission, while considering the needs of neighboring groundwater districts, coordinating its efforts with surface water management entities in the district area and complying with state mandated laws and regulations.

VII. Actions, Procedures, Performance and Avoidance for District Implementation of Management Plan

The District is currently operating on the basis of a set of rules that were adopted by the District on February 16, 2010. Notice of the public hearing on the proposed adoption and implementation of the Duval County Groundwater Conservation District Rules was published on January 24, 2010 in the Duval County Free Press newspaper. A public hearing on the proposed rules was held on February 16, 2010 following duly posted notice of such a hearing. A copy of these rules is currently available for viewing by the public at the District office. These rules will set up for viewing by the public in the District's official webpage, which will be set up by December 31, 2012.

The District's rules are promulgated under the District's statutory authority (primarily Senate Bill 1847 and Texas Water Code Chapter 36) to achieve the following objectives: To provide for conserving, preserving, protecting and recharging of the groundwater or of a groundwater reservoir or its subdivisions in order to control subsidence, prevent degradation of water quality or prevent waste of groundwater. The District's orders, rules, regulations, requirements, resolutions, policies, guidelines or similar measures have been implemented to fulfill these objectives.

The District will amend these rules as necessary to comply with changes to Chapter 36 of the Texas Water Code and to insure that these rules address the current needs of the District and its citizens.

VIII. TIME PERIOD FOR THIS PLAN

Time Period for This Plan: This plan becomes effective upon adoption by the Duval County Groundwater District Board of Directors and certification as administratively complete by the Texas Water Development board. The plan remains in effect until revised by the District. This plan will be reviewed by the District Board of Directors at least every five years and updated or revised as needed based on current conditions and needs. All amendments or revisions to this plan will be submitted to the Texas Water Development Board for approval.

IX. PLAN APPROVAL REQUIREMENTS

A. Public Hearing

Evidence of required public hearings notice and Board meeting to review input is included.

B. Board Resolution

A certified copy of the resolution by the Board of directors, adopting this plan is included.

C. Coordination with Surface Water Management Entities.

Evidence that all surface water entities in the District boundaries were notified is included in the form of a copy of the cover letter transmitting a copy of the Plan to the Nueces River Authority and the South Texas Watermasters Program.

D. Coordination with other Groundwater Districts

Evidence that other districts in the area were made aware of this plan is included in the form of a copy of the cover letter transmitting a copy of this plan to Groundwater Management Area 16, as “Appendix H”.

X. MANAGEMENT GOALS, OBJECTIVES AND PERFORMANCE STANDARDS

A. Efficient use of groundwater

Goal: Provide the most efficient use of groundwater.

1. Management Objective: The District will encourage the efficient use of groundwater by informing the public about the need for and methods of groundwater use efficiency.

   a) Performance Standard: The District will publish one article in a local publication media or will acquire and distribute one informational bulletin on groundwater efficiency at least once annually.

B. Control and Prevent Waste

Goal: Control and prevent waste of groundwater.

1. Management Objective: The District will address and attempt to control the waste of groundwater resources.
   a) Performance Standard: The District will adopt a set of rules that address the waste of groundwater within the District by no later than the end of 2012.

b) Performance Standard: The District will conduct a thorough review of these adopted rules at least annually to assure that they are current and that they are being enforced as intended. This annual review will be recorded in the official minutes of the District's meetings.

c) Performance Standard: The District will develop or acquire an informational bulleting that addresses and explains the need for the prevention of waste in groundwater. A copy of this bulleting will be delivered to each entity that drills a well within the District.

C. Control and Prevent Subsidence

Goal: Control and prevent subsidence.

1. Management Objective: Monitor possible subsidence problems that might occur within the District.
    a) Performance Standard: The District will investigate any reports of subsidence occurrence or of potential subsidence problems within the county. The month following such a report or annually if no such report or occurrence is noted, a briefing will be presented to the District Board to determine what, if any, course of action is needed. This briefing will be recorded in the official minutes of the District's meetings.

D. Conjunctive Surface Water Management Issues

Goal: To review and address any conjunctive surface water management issues.

1. Management Objective: The District will participate in the regional water planning process by reviewing current issues and by maintaining contact with the Region N Regional Water Planning Group.
    a) Performance Standard: A representative of the District will attend at least one or as many meetings as deemed needed per year of the Region N Regional Water Planning Group. Following any such meeting attendance, a report will be given by the District representative to the District Board of Directors and such report will be recorded in the official meeting minutes for the District.
2. Management Objective: The District will participate and co-ordinate Its efforts with all surface water entities that have jurisdiction or operate within the District boundaries.
    a) Performance Standard: Letters will be sent to the Nueces River Authority and to the South Texas Watermasters Program, introducing the District and indicating the Districts desire to cooperate with these surface water entities. These letters will be sent by March 30,2012.
    b) Following initial contact with each of the surface water entities, the District will review their response and decide what further contact is needed and what cooperative efforts will be planned. This decision

will be noted in the District's meeting minutes by no later than July 31,2013.

E. Natural Resource Issues

Goal: To address natural resource issues that impact or are impacted by the use of groundwater within the District.

The District is sensitive to all issues that involve our natural resources, including both biotic, such as plants, animals (both wildlife and domestic), fossil fuels such as oil, natural gas and coal and abiotic such as soil, water, air and heavy metals such as uranium. Some of these, such as water, we can impact directly, some of the others we can impact only indirectly.

1. Management Objective: Monitor soil salinity levels on soils that are irrigated with the use of groundwater.
   a) Performance Standard: Conduct or obtain at least one annual soil salinity test from each, an irrigated cropland field and an irrigated pasture within the District. Monitor salinity changes annually and maintain a log of such soil salinity test results.
2. Management Objective: Monitor groundwater quality within the District.
   a) Performance Standard: The District will conduct or will arrange to have water in selected wells tested for salinity (total salts) and for Nitrate (NO_3). Starting in 2013, at least one new well drilled each year will be tested. Test results will be kept on file with the District.
   b) Performance Standard: The District will partner with the local County Agricultural Extension Service office to participate or sponsor an annual water well sample testing day conducted by the Extension Service. Test results will be recorded and maintained by the District.
3. Management Objective: Maintain vigilance on activities dealing with potential pollution and governmental regulations that impact groundwater.
   a) Performance Standard: The District will review all correspondence or reports that it receives pertaining to injection well permitting and land treatment facilities. Such reviews will be recorded in the minutes of the District meetings.

F. Drought Conditions

Goal: To address drought conditions within and beyond the District boundaries.

Drought has been a frequent historical occurrence in the area of the Duval County Groundwater Conservation District. The District feels that this will not change in the future and so we must be prepared. Historically the area of Duval County has, overall, not experienced severe groundwater shortages during drought. This situation could change due to increased water demands or due to an exceptional prolonged drought, although it is not anticipated. The Texas Water Development Board drought page will be used as a source of reference information to keep tract of drought conditions: **http://www.twdb.state.tx.us/data/drought/**

1. Management Objective: Maintain vigilance and monitor groundwater levels to determine what effect droughts are having on groundwater tables within the District.
   a) Performance Standard: The District will monitor changes in groundwater levels that occur annually and historically by reviewing water level measurements conducted annually by the Texas Water Development Board. This annual review will be discussed with the District Board of Directors and the findings will be recorded in the District's meeting minutes.
   b) Performance Standard: The District will initiate its own groundwater level monitoring system by starting an annual water level measurement on at least one new well that is drilled each year within the District, starting in 2013.
2. Management Objective: Monitor the Palmer Drought Severity Index conditions for Duval County and correlate to groundwater levels within the District.
   a) Performance Standard: Each month the District will download the most recent Palmer Drought Severity Index, review it and keep it on file.
   b) Performance Standard: At least annually, a report will be made to the District Board of Directors on the most recent Drought Severity Index conditions and the conditions that occurred throughout the last year and will be compared to groundwater levels in the District. This annual review will be recorded in the District's official meeting minutes.

G. Conservation

Goal: Conserve groundwater resources.

1. Management Objective: The District will address and will encourage the conservation of the groundwater resources within the district and elsewhere.
   a) Performance Standard: The District will adopt a set of rules that address the conservation of groundwater resources by no later than the end of 2012.
   b) Performance Standard: The District will conduct a thorough review of the District rules at least annually to assure that the rules are current and that they are being enforced as intended to conserve water. This review will be recorded in the official minutes of the District meetings prior to the end of each year.
   c) The District will develop or will acquire an informational bulletin that address and explains the need for conservation of groundwater. A copy of

this bulletin will be delivered to each entity that drills a well within the District.

d) At least one informational article that addresses conservation of our groundwater will be made available for public viewing by one of the following: 1. Submit article to a local newspaper publication. 2. Conduct a public presentation. 3. Present exhibits at local events. 4. Publicize in the District webpage.

H. Recharge Enhancement

Goal: Recharge enhancement.

No known cost-effective method of recharge enhancement has been noted for the area of the Duval County Groundwater Conservation District. The District plans no action on this state listed goal. This goal is not applicable for the purpose of recharge enhancement.

I. Rainwater Harvesting

Goal: Rainwater harvesting.

The District does not consider this item to be a groundwater issue, other than its use to help cut down on the use of groundwater where applicable. The District does feel that rainwater harvesting has a use within the District. Rainwater harvesting can be used to provide water for domestic use, to provide drinking water for wildlife and domestic livestock in areas where groundwater is difficult to obtain or is lacking. The technique can also be used to help reduce the amount of groundwater that is used where groundwater is available.

1. Management Objective: Promote the use of rainwater harvesting.

a) Performance Standard: The District will partner USDA-NRCS and the County AgriLife Extension Service office within the District to publicize and promote rainwater harvesting during at least one annual public event.

b) Performance Standard: The District will help distribute informational materials on rainwater harvesting by posting the information on the District website.

J. Precipitation Enhancement

This goal is not currently applicable. No action is planned by the District on this item at the present time.

K. Brush Control

Goal: Brush control.

The District feels that brush control can be an effective land treatment practice that can result in more grass production which can in turn help catch and hold rainwater so that it infiltrates into the ground rather than runoff as surface water or evaporate. In general, brush control is expensive and its benefits can be short lived, especially if not accompanied with other management practices.

1. Management Objective: Promote the use of brush control.

   a) Performance Standard: Sponsor or co-sponsor at least one annual demonstration or field day on brush control with the USDA-NRCS, the local Agua Poquita Soil and Water Conservation District and/or the Agricultural Extension Service office.

L. Addressing The Desired Future Conditions Adopted by The District

Goal: To address and monitor the status of the Desired Future Conditions Adopted by the District.

1. Management Objective: Monitor groundwater pumping changes in the District.
   a) Performance Standard: The District will review groundwater pumping figures within the District to determine compliance with the Desired Future Condition. An annual report of the data will be compiled by October of the following year.
   b) Performance Standard: Every five years the District will review the pumping figures for the prior five years within the district, to determine if the Desired Future Condition is still applicable. The first review will be made by October 2017.
2. Management Objective: Monitor groundwater levels within the District.
   a) Performance Standard: The district will annually review groundwater well measurements conducted by the Texas Water Development Board to determine long term trends. The annual review will be noted in the official minutes of the District meetings.
   b) Performance Standard: The District will initiate a groundwater monitoring system by starting an annual water level measurement on at least one new well annually, starting in 2013.

XI. TRACKING PROGRESS IN ACHIEVING PLAN GOALS

A. Self Analysis

District Self Analysis – The district will prepare an annual report which will review any actions the District has taken during the past year to accomplish its Management Plan Goals. The report will be submitted to the District board of Directors by January of each year starting with 2013.

B. Public Evaluation

Public Evaluation – The annual report noting actions taken and accomplishments on the District's Management Plan Goals will be kept on file by the District for review by the public as requested. The District's Management Plan will be posted on the official webpage for view by the public. The webpage will set up by December31, 2012.

APPENDIX LIST

APPENDIX

A. GAM RUN 10-047 MAG: Groundwater Management Area 16 Model Runs to Estimate Drawdowns Under Assumed Future Pumping For The Gulf Coast Aquifer.
B. GAM RUN 11-001: Duval County Groundwater District Management Plan.
C. Estimated Historical Water Use and 2012 State Water Plan Datasets: Duval County Groundwater District.

APPENDIX A

GAM RUN 10-047 MAG: Groundwater Management Area 16 Model Runs to Estimate Drawdown Under Assumed Future Pumping For The Gulf Coast Aquifer

GAM Run 10-047 MAG: Groundwater Management Area 16 Model Runs to Estimate Drawdowns under Assumed Future Pumping for The Gulf Coast Aquifer

by Mohammad Masud Hassan, P.E.
Texas Water Development Board
Groundwater Availability Modeling Section

Edited and finalized by Marius Jigmond to reflect statutory changes
effective September 1, 2011
(512) 463-8499

December 8, 2011

Cynthia K. Ridgeway, the Manager of the Groundwater Availability Modeling Section and Interim Director of the Groundwater Resources Division, is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on December 8, 2011.

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GAM Run 10-047 MAG: Groundwater Management Area 16 Model Runs to Estimate Drawdowns under Assumed Future Pumping for The Gulf Coast Aquifer

by Mohammad Masud Hassan, P.E.
Texas Water Development Board
Groundwater Availability Modeling Section

Edited and finalized by Marius Jigmond to reflect statutory changes effective September 1, 2011
(512) 463-8499

December 8, 2011

EXECUTIVE SUMMARY:

The modeled available groundwater for the Gulf Coast Aquifer as a result of the desired future condition adopted by the members of Groundwater Management Area 16 is approximately 358,100 acre-feet per year. This is summarized by county, regional water planning area, and river basin as shown in Table 1 for use in the regional water planning process. Modeled available groundwater is summarized by county, regional water planning area, river basin, and groundwater conservation district in tables 2 through 5. The estimates were extracted from Groundwater Availability Modeling (GAM) Run 09-008, Scenario 10, which Groundwater Management Area 16 used as the basis for developing their desired future condition for the Gulf Coast Aquifer.

REQUESTOR:

Mr. Scott Bledsoe III of Live Oak Underground Water Conservation District on behalf of Groundwater Management Area 1

DESCRIPTION OF REQUEST:

In a letter dated May 30, 2010 and received September 2, 2010, Mr. Scott Bledsoe provided the Texas Water Development Board (TWDB) with the desired future condition of the Gulf Coast Aquifer adopted by the members of Groundwater Management Area (GMA) 16. The desired future condition for the

Gulf Coast Aquifer in Groundwater Management Area 16, as shown in Resolution No. R2010-001, is as follows:

> *"[...]*
>
> *The authorized voting representatives of the [Groundwater Management Area] 16 Districts hereby establish a desired future condition of the Gulf Coast [Aquifer] of a [Groundwater Management Area]-wide average drawdown of approximately 94 feet through 2060 consistent with scenario 10 of GAM [Run] 09-008 by the vote reflected in the above recitals.*
>
> *The authorized voting representatives of the [Groundwater Management Area] 16 Districts hereby decline to establish a desired future condition of the Carrizo-Wilcox, and the Yegua-Jackson aquifer slivers, finding them to not be relevant for purposes of [Groundwater Management Area] 16 joint planning at this time by the vote reflected in the above recitals.*
>
> *[...]"*

In response to receiving the adopted desired future condition, the Texas Water Development Board has estimated the modeled available groundwater for the Gulf Coast Aquifer within Groundwater Management Area 16.

METHODS:

The Texas Water Development Board previously completed several predictive groundwater availability model simulations of the Gulf Coast Aquifer to assist the members of Groundwater Management Area 16 in developing a desired future condition. The location of Groundwater Management Area 16, the Gulf Coast Aquifer, and the groundwater availability model cells that represent the aquifer are shown in Figure 1. As described in Resolution No. R2010-001, the management area considered Scenario 10 of Groundwater Availability Modeling (GAM) Run 09-008 when developing a desired future condition for the Gulf Coast Aquifer (Hutchison, 2010). Since the above desired future condition is met in Scenario 10 of GAM Run 09-008, the modeled available groundwater for Groundwater Management Area 16 presented here was taken directly from this simulation. This was then divided by county, regional water planning area, river basin, and groundwater conservation district (Figure 2).

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the groundwater availability model for the Gulf Coast Aquifer are described below:

- We used the Groundwater Management Area 16 numerical groundwater flow model, version 1.0 for these predictive simulations (Hutchison and others, 2011).

- The groundwater flow model encompasses the footprint of Groundwater Management Area 16 and its underlying aquifer systems. The Groundwater Management Area 16 model includes portions of the Gulf Coast, Yegua-Jackson, Queen City, Sparta, and Carrizo-Wilcox aquifer systems. Layers 1 through 4 represent the Gulf Coast Aquifer System which is comprised of the Chicot Aquifer, Evangeline Aquifer, Burkeville Confining System, and Jasper Aquifer in descending order. Layer 5 is a bulk representation of the Yegua-Jackson Aquifer System, and Layer 6 is a bulk representation of the Queen-City, Sparta, and Carrizo-Wilcox aquifers (Hutchison and others, 2011).

- Please refer to GAM Run 09-008 (Hutchison, 2011) for the model parameters, assumptions, and methods used for the predictive simulation.

Modeled Available Groundwater and Permitting

As defined in Chapter 36 of the Texas Water Code, "modeled available groundwater" is the estimated average amount of water that may be produced annually to achieve a desired future condition. This is distinct from "managed available groundwater," shown in the draft version of this report dated June 7, 2011, which was a permitting value and accounted for the estimated use of the aquifer exempt from permitting. This change was made to reflect changes in statute by the 82nd Texas Legislature, effective September 1, 2011.

Groundwater conservation districts are required to consider modeled available groundwater, along with several other factors, when issuing permits in order to manage groundwater production to achieve the desired future condition(s). The other factors districts must consider include annual precipitation and production patterns, the estimated amount of pumping exempt from permitting, existing permits, and a reasonable estimate of actual groundwater production under existing permits. The estimated amount of pumping exempt from permitting, which the Texas Water Development Board is now required to develop after soliciting input from applicable groundwater conservation districts, will be provided in a separate report.

RESULTS:

The modeled available groundwater for the Gulf Coast Aquifer in Groundwater Management Area 16 consistent with the above desired future condition is approximately 358,100 acre-feet per year. This has been divided by county, regional water planning area, and river basin for each decade between 2010 and 2060 for use in the regional water planning process (Table 1). The modeled available groundwater for the Gulf Coast Aquifer is also summarized by county, regional water planning area, river basin, and groundwater conservation district as shown in tables 2 through 5. In Table 5, the modeled available groundwater both excluding and including areas outside of a groundwater conservation district is shown.

LIMITATIONS:

The groundwater model used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> *"Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."*

A key aspect of using the groundwater model to evaluate the impacts of future pumping is the need to make assumptions about the location in the aquifer where future pumping will occur. In this case, as noted, pumping in each county is evenly distributed. This assumption was necessary, in part, due to the generally large increases in pumping as compared to historic pumping. There is a fair degree of uncertainty in many of these estimates due to the large increases in pumping in areas that had not historically been stressed. As actual pumping changes in the future, it will be necessary to evaluate the amount of that pumping as well as its location in the context of the assumptions associated with this analysis. Evaluating the amount and location of future pumping is as important as evaluating the changes in groundwater levels, spring flows, and other metrics that describe the impacts of that pumping. This analysis does not assess the possible impacts of pumping such as reduced water quality or land surface subsidence.

In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in evaluating the impacts of future pumping. Those assumptions also need to be considered and compared to actual future data.

Given these limitations, users of this information are cautioned that the results should not be considered a definitive, permanent prediction of the changes in groundwater storage, streamflow and spring flow. Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor future groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future.

REFERENCES:

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, The U.S. Geological Survey modular ground-water model-user guide to modularization concepts and the ground-water flow process: U.S. Geological Survey Open-File Report 00-92, 121 p.

Hutchison, W.R., Hill, M.E., Anaya, R., Hasan, M.M., Oliver, W., Jigmond, M., Wade, S., and Aschenbach, E., 2011. Groundwater Management Area 16 Groundwater Flow Model: Texas Water Development Board.

Hutchison, W.R., 2011. Draft GAM Run 09-08: Groundwater Management Area 16 Model Runs to Estimate Drawdowns under Assumed Future Pumping for the Gulf Coast Aquifer, June 10, 2011, 45p.

National Research Council, 2007. Models in Environmental Regulatory Decision Making. Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p.

Wilson, J.D. and Naff, R.L., 2004, The U.S. Geological Survey modular ground-water model-GMG linear equation solver package documentation: U.S. Geological Survey Open-File Report 2004-1261, 47 p.

TABLE 1: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER IN GROUNDWATER MANAGEMENT AREA 16. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, REGIONAL WATER PLANNING AREA, AND RIVER BASIN.

County	Regional Water Planning Area	River Basin	Year					
			2010	2020	2030	2040	2050	2060
Bee	N	Nueces	762	762	762	762	762	762
		San Antonio-Nueces	9,898	9,898	9,898	9,898	9,898	9,898
Brooks	N	Nueces-Rio Grande	15,595	15,595	15,595	15,595	15,595	15,595
Cameron	M	Nueces-Rio Grande	48,576	48,576	48,576	48,576	48,576	48,576
		Rio Grande	1,984	1,984	1,984	1,984	1,984	1,984
Duval	N	Nueces	364	364	364	364	364	364
		Nueces-Rio Grande	13,699	13,699	13,699	13,699	13,699	13,699
Hidalgo	M	Nueces-Rio Grande	38,941	38,941	38,941	38,941	38,941	38,941
		Rio Grande	2,985	2,985	2,985	2,985	2,985	2,985
Jim Hogg	M	Nueces-Rio Grande	20,836	20,836	20,836	20,836	20,836	20,836
		Rio Grande	3,578	3,578	3,578	3,578	3,578	3,578
Jim Wells	N	Nueces	3,962	3,962	3,962	3,962	3,962	3,962
		Nueces-Rio Grande	23,924	23,924	23,924	23,924	23,924	23,924
Kenedy	N	Nueces-Rio Grande	51,778	51,778	51,778	51,778	51,778	51,778
Kleberg	N	Nueces-Rio Grande	50,701	50,701	50,701	50,701	50,701	50,701
Live Oak	N	Nueces	11,377	11,377	11,377	11,377	11,377	11,377
		San Antonio-Nueces	57	57	57	57	57	57
McMullen	N	Nueces	510	510	510	510	510	510
Nueces	N	Nueces	946	946	946	946	946	946
		Nueces-Rio Grande	7,884	7,884	7,884	7,884	7,884	7,884

County	**Regional Water Planning Area**	**River Basin**	**Year**					
			2010	**2020**	**2030**	**2040**	**2050**	**2060**
		San Antonio-Nueces	179	179	179	179	179	179
San Patricio	**N**	Nueces	3,868	3,868	3,868	3,868	3,868	3,868
		San Antonio-Nueces	15,145	15,145	15,145	15,145	15,145	15,145
Starr	**M**	Nueces-Rio Grande	3,079	3,079	3,079	3,079	3,079	3,079
		Rio Grande	4,447	4,447	4,447	4,447	4,447	4,447
Webb	**M**	Nueces	82	82	82	82	82	82
		Nueces-Rio Grande	2,445	2,445	2,445	2,445	2,445	2,445
		Rio Grande	475	475	475	475	475	475
Willacy	**M**	Nueces-Rio Grande	20,013	20,013	20,013	20,013	20,013	20,013
Total			**358,090**	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**

TABLE 2: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SUMMARIZED BY COUNTY IN GROUNDWATER MANAGEMENT AREA 16 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. NOTE THAT THE PUMPING AMOUNT SHOWN IN THE TABLE BELOW FOR BEE COUNTY REPRESENTS ONLY THE PORTION OF THE COUNTY WITHIN GROUNDWATER MANAGEMENT AREA 16.

County	Year					
	2010	2020	2030	2040	2050	2060
Bee	10,660	10,660	10,660	10,660	10,660	10,660
Brooks	15,595	15,595	15,595	15,595	15,595	15,595
Cameron	50,560	50,560	50,560	50,560	50,560	50,560
Duval	14,063	14,063	14,063	14,063	14,063	14,063
Hidalgo	41,926	41,926	41,926	41,926	41,926	41,926
Jim Hogg	24,414	24,414	24,414	24,414	24,414	24,414
Jim Wells	27,886	27,886	27,886	27,886	27,886	27,886
Kenedy	51,778	51,778	51,778	51,778	51,778	51,778
Kleberg	50,701	50,701	50,701	50,701	50,701	50,701
Live Oak	11,434	11,434	11,434	11,434	11,434	11,434
McMullen	510	510	510	510	510	510
Nueces	9,009	9,009	9,009	9,009	9,009	9,009
San Patricio	19,013	19,013	19,013	19,013	19,013	19,013
Starr	7,526	7,526	7,526	7,526	7,526	7,526
Webb	3,002	3,002	3,002	3,002	3,002	3,002
Willacy	20,013	20,013	20,013	20,013	20,013	20,013
Total	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**

TABLE 3: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SUMMARIZED BY REGIONAL WATER PLANNING AREA IN GROUNDWATER MANAGEMENT AREA 16 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Regional Water Planning Area	Year					
	2010	2020	2030	2040	2050	2060
M	147,441	147,441	147,441	147,441	147,441	147,441
N	210,649	210,649	210,649	210,649	210,649	210,649
Total	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**

TABLE 4: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SUMMARIZED BY RIVER BASIN IN GROUNDWATER MANAGEMENT AREA 16 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

River Basin	Year					
	2010	2020	2030	2040	2050	2060
Nueces	21,871	21,871	21,871	21,871	21,871	21,871
Nueces-Rio Grande	297,471	297,471	297,471	297,471	297,471	297,471
Rio Grande	13,469	13,469	13,469	13,469	13,469	13,469
San Antonio-Nueces	25,279	25,279	25,279	25,279	25,279	25,279
Grand Total	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**

TABLE 5: MODELED AVAILABLE GROUNDWATER FOR THE GULF COAST AQUIFER SUMMARIZED BY GROUNDWATER CONSERVATION DISTRICT (GCD) IN GROUNDWATER MANAGEMENT AREA 16 FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR. UWCD REFERS TO UNDERGROUND WATER CONSERVATION DISTRICT. ASRCD REFERS TO AQUIFER STORAGE & RECOVERY CONSERVATION DISTRICT.

Groundwater Conservation District	**Year**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Bee GCD	10,600	10,600	10,600	10,600	10,600	10,600
Brush Country GCD	68,846	68,846	68,846	68,846	68,846	68,846
Corpus Christi ASRCD	2,526	2,526	2,526	2,526	2,526	2,526
Duval County GCD	14,063	14,063	14,063	14,063	14,063	14,063
Kenedy County GCD	97,335	97,335	97,335	97,335	97,335	97,335
Live Oak UGCD	11,434	11,434	11,434	11,434	11,434	11,434
Mcmullen GCD	510	510	510	510	510	510
Red Sands GCD	584	584	584	584	584	584
San Patricio GCD	18,367	18,367	18,367	18,367	18,367	18,367
Starr County GCD	7,526	7,526	7,526	7,526	7,526	7,526
Total (excluding non-district areas)	**231,791**	**231,791**	**231,791**	**231,791**	**231,791**	**231,791**
No District	126,299	126,299	126,299	126,299	126,299	126,299
Total (including non-district areas)	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**	**358,090**

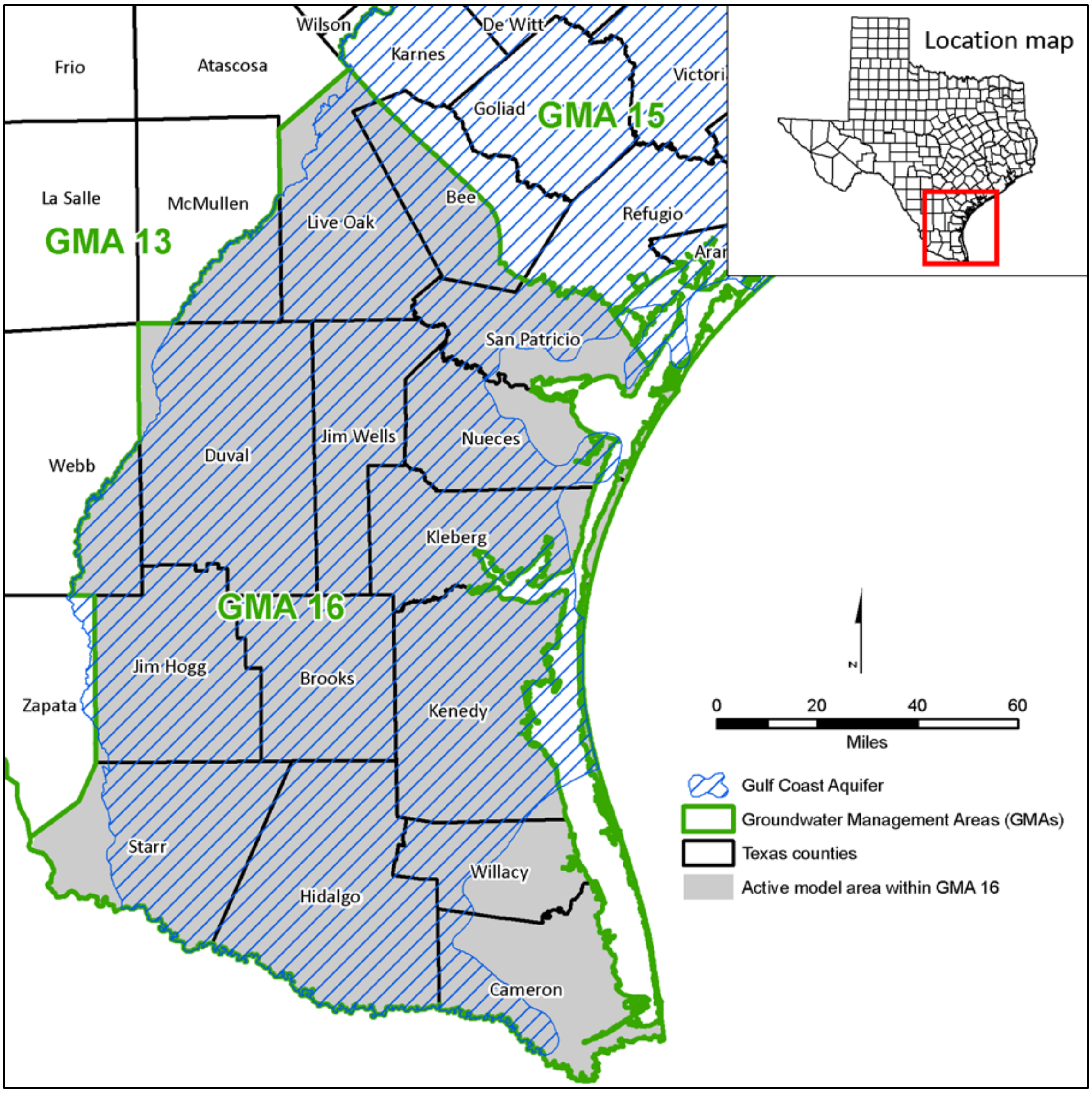

FIGURE 1: MAP SHOWING THE AREAS COVERED BY THE GROUNDWATER MODEL FOR GROUNDWATER MANAGEMENT AREA 16 WHICH INCLUDES THE GULF COAST AQUIFER.

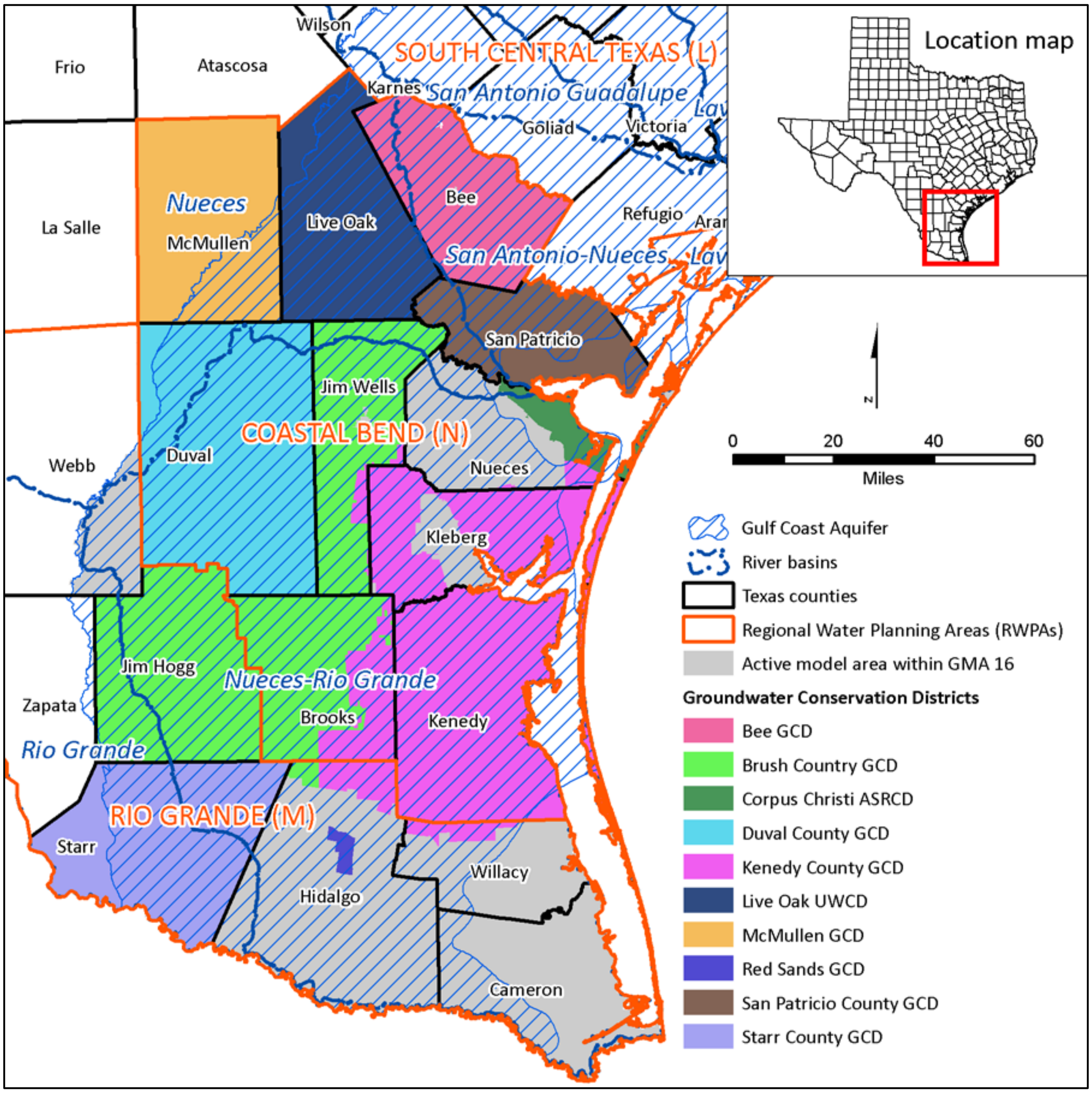

FIGURE 2: MAP SHOWING REGIONAL WATER PLANNING AREAS (RWPAS), GROUNDWATER CONSERVATION DISTRICTS (GCDS), COUNTIES, AND RIVER BASINS IN GROUNDWATER MANAGEMENT AREA 16.

APPENDIX B

GAM RUN 11-001: Duval County Groundwater District Management Plan

GAM Run 11-001: Duval County Groundwater Conservation District Management Plan

by Mohammad Masud Hassan P.E.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-3337
June 15, 2011

Mohammad Masud Hassan is a Hydrologist in the Groundwater Availability Modeling Section of the Texas Water Development Board and is responsible for the work performed in this report. The seal appearing on this document was authorized by Mohammad Masud Hassan, P.E.95699 on June 15, 2011.

GAM RUN 11-001: DUVAL COUNTY GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Mohammad Masud Hassan P.E.
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-3337
June 15, 2011

EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, groundwater conservation districts shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

- the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers; and
- the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The purpose of this report is to provide information to Duval County Groundwater Conservation District for its groundwater management plan. The groundwater management plan for Duval County Groundwater Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before July 25, 2012.

This report discusses the method, assumptions, and results from model runs using the groundwater availability models for the central section of the Gulf Coast Aquifer and the Yegua Jackson Aquifer. Tables 1 through 2 summarize the groundwater

availability model data required by the statute, and figures 1 through 2 show the area of each model from which the values in the respective tables were extracted. If after review of the figures, Duval County Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the Texas Water Development Board immediately.

METHODS:

We ran the groundwater availability model for the central section of the Gulf Coast Aquifer and (1) extracted the water budget for each year of the 1981 through 2000 period and (2)averaged the annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower).

We ran the groundwater availability model for Yegua Jackson Aquifer and (1) extracted water budgets for each year of the 1980 through 1997 period and (2) averaged the annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district for the sections of the Yegua Jackson Aquifer located within the district.

PARAMETERS AND ASSUMPTIONS:

Groundwater Availability model for the central section of the Gulf Coast Aquifer

- Version 1.01 of the groundwater availability model for the central section of the Gulf Coast Aquifer was used for this Analysis. See Chowdhury and others (2004) and Waterstone and others (2003) for assumptions and limitations of the groundwater availability model.

- The model for the central section of the Gulf Coast Aquifer assumes partially penetrating wells in the Evangeline Aquifer due to a lack of data for aquifer properties in the lower section of the aquifer.

- The model includes four layers representing: the Chicot Aquifer (Layer 1), the Evangeline Aquifer (Layer 2), the Burkeville Confining Unit (Layer 3), and the Jasper Aquifer including parts of the Catahoula Formation, as appropriate (Layer 4).

- The mean absolute error (a measure of the difference between simulated and measured water levels) in the entire model for 1999 is 26 feet, which is

4.6 percent of the hydraulic head drop across the model area (Chowdhury and others, 2004).

- Processing Modflow for Windows (PMWIN) version 5.3 (Chiang and Kinzelbach, 2001) was used as the interface to process model output.

Groundwater Availability model for the Yegua-Jackson Aquifer

- Version 1.01 of the groundwater availability model for the Yegua-Jackson Aquifer was used for this analysis. See Deeds and others (2010) for assumptions and limitations of the groundwater availability model.
- This groundwater availability model includes five layers, which generally correspond to (from top to bottom):
    1. outcrop section for the Yegua-Jackson Aquifer and younger overlying units,
    2. the upper portion of the Jackson Group,
    3. the lower portion of the Jackson Group,
    4. the upper portion of the Yegua Group, and
    5. the lower portion of the Yegua Group.
- An overall water budget for the district was determined for the Yegua-Jackson Aquifer (Layer 1 through Layer 5, collectively for the portions that represent the Yegua-Jackson Aquifer).
- The recharge used for the model run represents average recharge as described in Deeds and others (2010).
- As reported in Deeds and others (2010), the mean absolute errors (a measure of the difference between simulated and measured water levels during model calibration) for the Jackson Group (combined upper and lower Jackson units), Upper Yegua, and Lower Yegua portions of the Yegua-Jackson Aquifer for the historical-calibration period of the model are 31.1, 23.9, and 24.5 feet, respectively. These represent 10.3, 5.7 and 6.3 percent of the hydraulic head drop across each model area, respectively.
- Groundwater Vistas Version 5 (Environmental Simulations, Inc. 2007) was used as the interface to process model output.

- The model results presented in this report were extracted from all areas of the model representing the units comprising the Yegua Jackson Aquifer. For this reason, the reported values may reflect water of quality ranging from fresh to brackish and saline. This is especially true for the subcrop sections of the aquifer in the northwestern part of the District.

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifers according to the groundwater availability models. Selected components were extracted from the groundwater budget for the aquifers located within the district and averaged over the duration of the calibration and verification section of each model run (1981 through 2000 for the central section of the Gulf Coast Aquifer and 1980 through 1997 for the Yegua Jackson Aquifer) in the district as shown in tables 1 through 2. The components of the modified budget shown in tables 1 through 2 include:

- Precipitation recharge—This is the distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.

- Surface water outflow—The total water discharging from the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).

- Flow into and out of district—The lateral flow within the aquifer between the district and adjacent counties.

- Flow between aquifers—The vertical flow between aquifers or confining units. This flow is controlled by the relative water levels in each aquifer or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other aquifer.

The information needed for the District’s management plan is summarized in tables 1 through 2..

TABLE 1: SUMMARIZED INFORMATION FOR THE GULF COAST AQUIFER THAT IS NEEDED FOR DUVAL COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT. THESE FLOWS INCLUDE BRACKISH WATERS.

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Gulf Coast Aquifer	18,536
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Gulf Coast Aquifer	11,543
Estimated annual volume of flow into the district within each aquifer in the district	Gulf Coast Aquifer	3,832
Estimated annual volume of flow out of the district within each aquifer in the district	Gulf Coast Aquifer	10,348
Estimated net annual volume of flow between each aquifer in the district	Not applicable	Not applicable

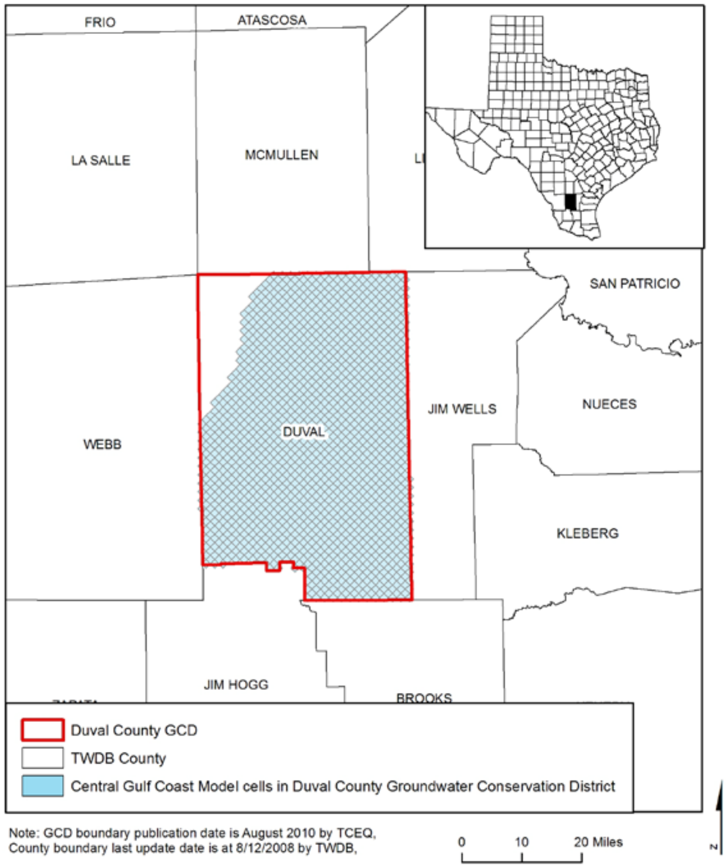

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE GULF COAST AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE YEGUA-JACKSON AQUIFER THAT IS NEEDED FOR DUVAL COUNTY GROUNDWATER CONSERVATION DISTRICT'S GROUNDWATER MANAGEMENT PLAN. ALL VALUES ARE REPORTED IN ACRE-FEET PER YEAR AND ROUNDED TO THE NEAREST 1 ACRE-FOOT.

Management Plan requirement	*Aquifer or confining unit*	*Results*
Estimated annual amount of recharge from precipitation to the district	Yegua-Jackson Aquifer	12
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Yegua-Jackson Aquifer	0
Estimated annual volume of flow into the district within each aquifer in the district	Yegua-Jackson Aquifer	344
Estimated annual volume of flow out of the district within each aquifer in the district	Yegua-Jackson Aquifer	361
Estimated net annual volume of flow between each aquifer in the district	Outflow from the Yegua-Jackson Aquifer to the upper Catahoula Formation	2

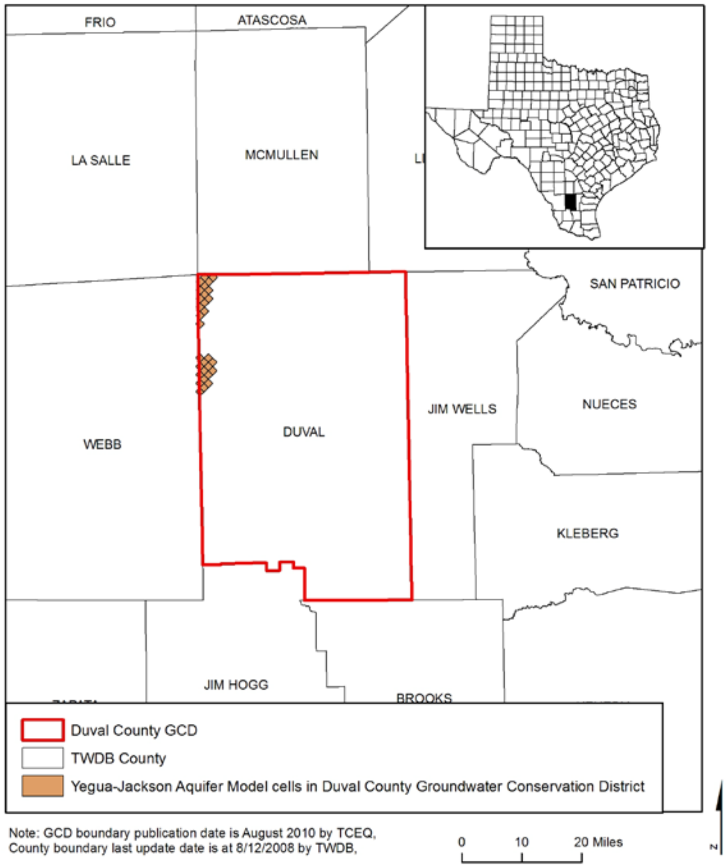

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE YEGUA-JACKSON AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

LIMITATIONS

The groundwater model(s) used in completing this analysis is the best available scientific tool that can be used to meet the stated objective(s). To the extent that this analysis will be used for planning purposes and/or regulatory purposes related to pumping in the past and into the future, it is important to recognize the assumptions and limitations associated with the use of the results. In reviewing the use of models in environmental regulatory decision making, the National Research Council (2007) noted:

> "Models will always be constrained by computational limitations, assumptions, and knowledge gaps. They can best be viewed as tools to help inform decisions rather than as machines to generate truth or make decisions. Scientific advances will never make it possible to build a perfect model that accounts for every aspect of reality or to prove that a given model is correct in all respects for a particular regulatory application. These characteristics make evaluation of a regulatory model more complex than solely a comparison of measurement data with model results."

A key aspect of using the groundwater model to evaluate historic groundwater flow conditions includes the assumptions about the location in the aquifer where historic pumping was placed. Understanding the amount and location of historic pumping is as important as evaluating the volume of groundwater flow into and out of the district, between aquifers within the district (as applicable), interactions with surface water (as applicable), recharge to the aquifer system (as applicable), and other metrics that describe the impacts of that pumping. In addition, assumptions regarding precipitation, recharge, and streamflow are specific to a particular historic time period.

Because the application of the groundwater model was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor groundwater pumping and overall conditions of the aquifer. Because of the limitations of the groundwater model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine this analysis in the future given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. Historic precipitation patterns also need to be placed in context as future climatic conditions, such as dry and wet year precipitation patterns, may differ and affect groundwater flow conditions.

It is important to also note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as district or county boundaries, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located (see figures 1 through 2)

REFERENCES:

Chowdhury, Ali.H., Wade, S., Mace, R.E., and Ridgeway, C., 2004, Groundwater Availability Model of the Central Gulf Coast Aquifer System: Numerical Simulations through 1999- Model Report, 114 p., http://www.twdb.state.tx.us/gam/glfc_c/glfc_c.htm

Deeds, N.E., Yan, T., Singh, A., Jones, T.L., Kelley, V.A., Knox, P.R., Young, S.C., 2010, Groundwater availability model for the Yegua-Jackson Aquifer: Final report prepared for the Texas Water Development Board by INTERA, Inc., 582 p., http://www.twdb.state.tx.us/gam/ygjk/ygjk.htm.

Environmental Simulations, Inc., 2007, Guide to Using Groundwater Vistas Version 5, 381 p.

Chiang, W., and Kinzelbach, W., 2001, Groundwater Modeling with PMWIN, 346 p

LBG-Guyton Associates, 2003, Brackish Groundwater Manual for Texas Regional Water Planning Groups: contract report to the Texas Water Development Board, 188 p., http://www.twdb.state.tx.us/RWPG/rpgm_rpts/2001483395.pdf.

National Research Council, 2007. Models in Environmental Regulatory Decision Making. Committee on Models in the Regulatory Decision Process, National Academies Press, Washington D.C., 287 p.

APPENDIX C

Estimated Historical Water Use and 2012 State Water Plan Datasets: Duval County Groundwater District

Estimated Historical Water Use And 2012 State Water Plan Datasets:

Duval County Groundwater Conservation District

by Stephen Allen
Texas Water Development Board
Groundwater Resources Division
Groundwater Technical Assistance Section
stephen.allen@twdb.texas.gov
(512) 463-7317
July 27, 2012

GROUNDWATER MANAGEMENT PLAN DATA:

This package of water data reports (part 1 of a 2-part package of information) is being provided to groundwater conservation districts to help them meet the requirements for approval of their five-year groundwater management plan. Each report in the package addresses a specific numbered requirement in the Texas Water Development Board's groundwater management plan checklist. The checklist can be viewed and downloaded from this web address:

http://www.twdb.texas.gov/groundwater/docs/GCD/GMPchecklist0911.pdf

The five reports included in part 1 are:

1. Estimated Historical Water Use (checklist Item 2)

   from the TWDB Historical Water Use Survey (WUS)

2. Projected Surface Water Supplies (checklist Item 6)
3. Projected Water Demands (checklist Item 7)
4. Projected Water Supply Needs (checklist Item 8)
5. Projected Water Management Strategies (checklist Item 9)

   reports 2-5 are from the 2012 State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report. The District should have received this report from the Groundwater Availability Modeling Section. Questions about the GAM can be directed to Dr. Shirley Wade, shirley.wade@twdb.texas.gov, or (512) 463-0749 (to contact the Administrative Assistant).

DISCLAIMER:

The data presented in this report represents the most updated Historical Water Use and 2012 State Water Planning data available as of 7/27/2012. Although it does not happen frequently, neither of these datasets are static and are subject to change pending the availability of more accurate data (Historical Water Use data) or an amendment to the 2012 State Water Plan (2012 State Water Planning data). District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The Historical Water Use dataset can be verified at this web address:

http://www.twdb.texas.gov/wrpi/wus/summary.asp

The 2012 State Water Planning dataset can be verified by contacting Wendy Barron (wendy.barron@twdb.texas.gov or 512-936-0886).

For additional questions regarding this data, please contact Stephen Allen (stephen.allen@twdb.texas.gov or 512-463-7317) or Rima Petrossian (rima.petrossian@twdb.texas.gov or 512-936-2420).

Estimated Historical Water Use
TWDB Historical Water Use Survey (WUS) Data

Groundwater and surface water use estimates are currently unavailable for 2005 and 2010. TWDB staff anticipates the calculation and posting of such estimates during the second half of 2012.

DUVAL COUNTY

All values are in acre-feet/year

Year	Source	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
1974	GW	1,137	42	0	2,909	137	1,374	5,599
	SW	0	0	0	0	0	150	150
1980	GW	2,047	25	0	3,000	544	196	5,812
	SW	0	0	0	0	0	1,481	1,481
1984	GW	2,032	0	0	2,517	1,487	129	6,165
	SW	0	0	0	0	0	1,171	1,171
1985	GW	1,840	0	0	2,042	1,948	104	5,934
	SW	0	0	0	0	0	951	951
1986	GW	1,885	0	0	2,000	0	129	4,014
	SW	0	0	0	0	0	1,166	1,166
1987	GW	1,850	0	0	3,000	3,415	107	8,372
	SW	0	0	0	0	0	967	967
1988	GW	1,986	0	0	2,000	3,069	112	7,167
	SW	0	0	0	0	0	1,021	1,021
1989	GW	2,205	0	0	2,233	3,049	111	7,598
	SW	0	0	0	0	0	1,006	1,006
1990	GW	2,090	0	0	2,586	3,049	117	7,842
	SW	0	0	0	0	0	1,060	1,060
1991	GW	1,970	0	0	2,134	3,768	119	7,991
	SW	0	0	0	0	0	1,072	1,072
1992	GW	1,830	0	0	2,759	6,632	98	11,319
	SW	0	0	0	0	0	886	886
1993	GW	1,927	0	0	5,946	7,295	101	15,269
	SW	0	0	0	0	0	910	910
1994	GW	1,967	0	0	6,680	8,621	111	17,379
	SW	0	0	0	0	0	1,004	1,004
1995	GW	2,024	0	0	6,019	8,621	105	16,769
	SW	0	0	0	0	0	937	937
1996	GW	2,089	0	0	6,560	8,621	178	17,448
	SW	0	0	0	0	0	1,606	1,606
1997	GW	1,692	0	0	6,120	7,179	105	15,096
	SW	0	0	0	0	0	941	941

Estimated Historical Water Use
TWDB Historical Water Use Survey (WUS) Data

Groundwater and surface water use estimates are currently unavailable for 2005 and 2010. TWDB staff anticipates the calculation and posting of such estimates during the second half of 2012.

Year	Source	Municipal	Manufacturing	Steam Electric	Irrigation	Mining	Livestock	Total
1998	GW	1,713	0	0	5,150	4,139	88	11,090
	SW	0	0	0	0	0	788	788
1999	GW	2,256	0	0	3,535	4,139	93	10,023
	SW	0	0	0	0	0	838	838
2000	GW	2,320	0	0	4,524	4,544	88	11,476
	SW	0	0	0	0	0	785	785
2001	GW	1,329	0	0	5,170	2,898	37	9,434
	SW	0	0	0	0	0	552	552
2002	GW	1,282	0	0	8,140	2,898	52	12,372
	SW	0	0	0	0	0	749	749
2003	GW	1,366	0	0	3,438	4,036	52	8,892
	SW	0	0	0	0	0	759	759
2004	GW	1,276	0	0	4,259	4,596	53	10,184
	SW	0	0	0	0	0	777	777
2006	GW	1,974	0	0	3,241	1,894	652	7,761
	SW	0	0	0	0	0	72	72
2007	GW	1,906	0	0	2,870	880	679	6,335
	SW	0	0	0	0	0	76	76
2008	GW	2,404	0	0	3,285	403	691	6,783
	SW	0	0	0	0	0	77	77
2009	GW	2,003	0	0	2,092	773	722	5,590
	SW	0	0	0	0	737	80	817

Projected Surface Water Supplies
TWDB 2012 State Water Plan Data

DUVAL COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	Source Name	2010	2020	2030	2040	2050	2060
N	LIVESTOCK	NUECES	LIVESTOCK LOCAL SUPPLY	189	189	189	189	189	189
N	LIVESTOCK	NUECES-RIO GRANDE	LIVESTOCK LOCAL SUPPLY	597	597	597	597	597	597
	Sum of Projected Surface Water Supplies (acre-feet/year)			**786**	**786**	**786**	**786**	**786**	**786**

Projected Water Demands
TWDB 2012 State Water Plan Data

Please note that the demand numbers presented here include the plumbing code savings found in the Regional and State Water Plans.

DUVAL COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
N	FREER	NUECES	645	659	663	655	633	600
N	MINING	NUECES	2,009	2,273	2,441	2,609	2,780	2,933
N	LIVESTOCK	NUECES	210	210	210	210	210	210
N	COUNTY-OTHER	NUECES	89	92	93	92	89	84
N	BENAVIDES	NUECES-RIO GRANDE	326	333	334	330	319	302
N	SAN DIEGO	NUECES-RIO GRANDE	479	482	479	467	449	426
N	COUNTY-OTHER	NUECES-RIO GRANDE	861	887	894	884	855	811
N	MINING	NUECES-RIO GRANDE	3,851	4,357	4,678	5,001	5,328	5,620
N	IRRIGATION	NUECES-RIO GRANDE	4,444	4,365	4,289	4,212	4,138	4,064
N	LIVESTOCK	NUECES-RIO GRANDE	663	663	663	663	663	663
	Sum of Projected Water Demands (acre-feet/year)		**13,577**	**14,321**	**14,744**	**15,123**	**15,464**	**15,713**

Projected Water Supply Needs
TWDB 2012 State Water Plan Data

Negative values (in red) reflect a projected water supply need, positive values a surplus.

DUVAL COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
N	BENAVIDES	NUECES-RIO GRANDE	0	0	0	0	0	0
N	COUNTY-OTHER	NUECES	0	0	0	0	0	0
N	COUNTY-OTHER	NUECES-RIO GRANDE	0	0	0	0	0	0
N	FREER	NUECES	0	0	0	0	0	0
N	IRRIGATION	NUECES-RIO GRANDE	0	0	0	0	0	0
N	LIVESTOCK	NUECES	0	0	0	0	0	0
N	LIVESTOCK	NUECES-RIO GRANDE	0	0	0	0	0	0
N	MINING	NUECES	-635	-903	-1,059	-1,201	-1,347	-1,483
N	MINING	NUECES-RIO GRANDE	-1,103	-1,615	-1,914	-2,185	-2,462	-2,722
N	SAN DIEGO	NUECES-RIO GRANDE	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet/year)		**-1,738**	**-2,518**	**-2,973**	**-3,386**	**-3,809**	**-4,205**

Projected Water Management Strategies
TWDB 2012 State Water Plan Data

DUVAL COUNTY

WUG, Basin (RWPG)

All values are in acre-feet/year

Water Management Strategy	Source Name [Origin]	2010	2020	2030	2040	2050	2060
COUNTY-OTHER, NUECES (N)							
MUNICIPAL WATER CONSERVATION	CONSERVATION [DUVAL]	3	7	11	14	22	32
COUNTY-OTHER, NUECES-RIO GRANDE (N)							
MUNICIPAL WATER CONSERVATION	CONSERVATION [NUECES]	3	6	10	13	22	31
MINING, NUECES (N)							
MINING WATER CONSERVATION	CONSERVATION [DUVAL]	53	120	192	274	365	462
MINING, NUECES-RIO GRANDE (N)							
MINING WATER CONSERVATION	CONSERVATION [DUVAL]	94	212	342	487	649	821
Sum of Projected Water Management Strategies (acre-feet/year)		**153**	**345**	**555**	**788**	**1,058**	**1,346**