CLEAR FORK GROUNDWATER CONSERVATION DISTRICT

MANAGEMENT PLAN

ADOPTED AUGUST 31, 2015

DISTRICT MISSION

The Clear Fork Groundwater Conservation District is committed to establish and protect the water rights of local landowners, and preserve this resource for generations to come.

TIME PERIOD FOR THIS PLAN

This plan becomes effective upon the adoption by the Board of Directors of the Clear Fork Groundwater Conservation District and certification by the Texas Water Development Board (TWDB). This is a ten-year plan and will remain in effect for the ten years, or until a revised plan is certified, whichever is earlier.

STATEMENT OF GUIDING PRINCIPLES

The citizens of Fisher County recognize the vital importance of the groundwater to the economy and longevity of the county. Being the primary water resource; the district recognizes the need to conserve and protect the quantity and the quality of groundwater through prudent and cost effective management. The goals of this plan can be best achieved through guidance from locally elected board members who have an understanding of local conditions as well as technical support from knowledgeable agencies. Management planning should be based upon an awareness of the hydrogeologic properties of the specific aquifers within the District as well as quantification of existing and future resource data. This management plan is intended only as a reference tool to provide guidance in the execution of district activities, but should allow flexibility in achieving its goals.

GENERAL DESCRIPTION

The District was created by the citizens of Fisher County through election in November, 2002. Directors are elected with Fisher County Commissioner's precincts, with a director from within each of the four precincts. Additionally, one director is elected as an at-large position from the entire county. The Clear Fork Groundwater Conservation District has the same real extent as that of Fisher County, Texas. The county has a diverse economy, with agriculture and industry all represented. Livestock operations include cattle, goats, and hogs. Crops include cotton, sorghum, wheat, hay, pecans, and some fruits and vegetables. One of the major industries is National Gypsum, which began operations in Fisher County in 1935. Oil and gas production have been a part of Fisher County for several decades. Communities in the county include Roby, Busby, Claytonville, Eskota, Hobbs, Longworth, McCaulley, Palava, Rotan, Royston, and Sylvester. The main tourist attraction is the diverse hunting opportunities in Fisher County.

LOCATION AND EXTENT

The Clear Fork Groundwater Conservation District shares a boundary with Fisher County. Fisher County is on U.S. Highway 180 west of Abilene in the Rolling Plains region of central West Texas. The county is bordered on the north by Kent and Stonewall counties, on the east by Jones County, on the south by Nolan County, and on the west by Scurry County. Its center point is 32°45' north latitude and 100°23' west longitude. Roby is the county seat; Rotan, the county's largest town, is 225 miles west of Dallas, 65 miles northwest of Abilene and 125 miles southeast of Lubbock. In addition to U.S. 180 the county's transportation needs are served by State highways 70 and 92.

Soils range from red to brown, with loamy surface layers and clayey or loamy subsoils. Between 51 percent and 60 percent of the land in the county is considered prime farmland. The vegetation, typical of the Rolling Prairies, features medium-height to tall grasses, mesquite, and cacti. Cedar, cottonwood, and pecan trees also grow along streams. Many species of wildflowers bloom in the spring and early summer, including daisies, buttercups, tallow weed, Indian blanket, baby's breath, prairie lace, wild verbena, belladonna, and hollyhock. Texas bluebells thrive in low places.

The climate is subtropical and sub-humid, with cool winters and hot summers. Temperatures range in January from an average low of 28° F to an average high of 56°, and in July from 70° to 96°. The average annual rainfall measures twenty-two inches, and the average relative humidity is 73 percent at 6 A.M. and 40 percent at 6 P.M. The average annual snowfall is five inches.

The growing season averages 222 days, with the last freeze in early April and the first freeze in early November. The agricultural economy centers around cattle, livestock products and hunting, but 60 percent of the annual agricultural income is from crops, especially cotton, wheat, sorghum, and hay. Petroleum, natural gas, gypsum, rock, and sand and gravel are also produced in the county. *

*Taken from "FISHER COUNTY." Handbook of Texas Online. <http:www.tshautexas.edu/handbook/online/view/NN/hcn4.html> [Accessed Mon Nov 22 9:35 US/Central 2004.] by Hooper Shelton

TOPOGRAPHY AND DRAINAGE

Fisher County covers 897 square miles of grassy, rolling prairies. The elevation ranges from 1,800 to 2,400 feet. The northern third of the county is drained by the Double Mountain Fork of the Brazos River, and the southern two-thirds is drained by the Clear Fork of the Brazos. *(Source: USDA Natural Resources Conservation Service, Abilene Field Office)*

*Taken from "FISHER COUNTY." Handbook of Texas Online. <http:www.tshautexas.edu/handbook/online/view/NN/hcn4.html> [Accessed Mon Nov 22 9:35 US/Central 2004.] by Hooper Shelton

SURFACE WATER RESOURCES OF CLEAR FORK G.C.D.

There is no reliable surface water within the district, with the exception of a few livestock tanks. Based on reported existing surface water rights holders within Fisher County, a total of 915 acre feet of water is permitted by the TCEQ mainly for irrigation use by landowners within the county.

GROUNDWATER RESOURCES

THE BLAINE AQUIFER

The Blaine Aquifer consists of water stored in cavities of gypsum and limestone rock. This aquifer is typically encountered from surface exposure to depths of 100 feet below the ground surface and has a saturated thickness less than 200 feet. Recharge occurs via open cavities and infiltration. The Blaine Aquifer water is high in total dissolved solids, typically about 3,000 mg/l, due to sulfates and chlorides. This salinity is too high for public water supply use without expensive treatment. However, it can and has been used to irrigate cotton. The high solids results from the natural dissolving of the gypsum and associated rock of the aquifer, therefore there are no feasible methods to reduce the dissolved solids levels.

DOCKUM GROUP AQUIFERS

The Dockum Group Aquifers are present in the southwest corner of the county.. The sediments are primarily sandstones, conglomerates and sandy shales. The formation also contains beds of gypsum, anhydrite, halite, and dolomite. In Fisher County the yields of wells range from less than 30 gal/min to as much as 200 gal/min, depending on saturated thickness, and average about 35 gal/min. Water quality is good to fair . The water is usually slightly saline with higher salinity in some locations. Irrigation wells completed in the Dockum Group formations have had yields as high as 700 GPM in the past. Current yields are generally lower.

SEYMOUR AQUIFER

The Seymour Formation is the only significant source of groundwater in Fisher County. The formation is present in the north one-third of Fisher County, stretching from east to west. The Seymour Aquifer contains discontinuous beds of poorly sorted gravel, conglomerate, sand and silty clay deposited during the Quaternary Period by eastward-flowing streams. Individual accumulations vary greatly in thickness, although most of the Seymour is less than 100 feet thick. Materials forming the Seymour aquifer are unconsolidated alluvial sediments of non-marine origin deposited on the erosional surface of Permian beds. In Fisher County the well yields range from less than 30 gal/min to as much as 200 gal/min, depending on saturated thickness, and average about 35 gal/min. The water quality is generally good.

STATUTORILY REQUIRED TABLES

MODELED AVAILABLE GROUNDWATER - Appendix A, TWDB Letter, December 9, 2011, Re: Modeled available groundwater estimates for the Blaine, Dockum, Ogallala, and Seymour aquifers in GMA 6.

AMOUNT OF GROUNDWATER BEING USED – Appendix B, Estimated Historical Water Use and 2012 State Water Plan Datasets, February 4, 2015, TWDB

RECHARGE FROM PRECIPITATION - Appendix C, GAM Run 14-007, July 25, 2014, Clear Fork Groundwater Conservation District Management Plan, TWDB.

DISCHARGE FROM THE AQUIFERS TO SPRINGS, LAKES & STREAMS – Appendix C, GAM Run 14-007, July 25, 2014, Clear Fork Groundwater Conservation District Management Plan, TWDB.

FLOW INTO THE DISTRICT AQUIFERS – Appendix C, GAM Run 14-007, July 25, 2014, Clear Fork Groundwater Conservation District Management Plan, TWDB.

FLOW OUT OF THE DISTRICTAQUIFERS – Appendix C, GAM Run 14-007, July 25, 2014, Clear Fork Groundwater Conservation District Management Plan, TWDB.

FLOW BETWEEN DISTRICT AQUIFERS – Appendix C, GAM Run 14-007, July 25, 2014, Clear Fork Groundwater Conservation District Management Plan, TWDB.

PROJECTED SURFACE WATER SUPPLIES – Appendix B, Estimated Historical Water Use and 2012 State Water Plan Datasets, February 4, 2015, TWDB

PROJECTED TOTAL WATER DEMAND – Appendix B, Estimated Historical Water Use and 2012 State Water Plan Datasets, July 7, 2015, TWDB

PROJECTED WATER SUPPLY NEEDS - Appendix B, Estimated Historical Water Use and 2012 State Water Plan Datasets, February 4, 2015, TWDB

WATER MANAGEMENT STRATEGIES – There are none. See Appendix B, Estimated Historical Water Use and 2012 State Water Plan Datasets, February 4, 2015, TWDB

MANAGEMENT OF GROUNDWATER SUPPLIES

Brush Management: The eradication of mesquite and salt cedar from areas of moderate to heavy brush canopy would yield additional groundwater supplies.

Potential Demand and Supply

Based on current calculations and projections it is obvious that issues will arise when demands exceed supplies. The District will use all regulatory statutes available to encourage the cities of Roby and Rotan, and the Water Supply Corporations in the District to develop conservation plans and additional surface water supplies. The District will also encourage additional water supplies through groundwater conservation education programs at the school and community levels.

The District will manage the supply of groundwater within the District in order to conserve the resource while seeking to maintain the economic viability of all resource user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will continue to identify and engage in such activities and practices, that if implemented, would result in the conservation and protection of the groundwater. The observation and monitoring network will continue to be reviewed and maintained in order to monitor changing conditions of groundwater within the District. The District will undertake investigations of the groundwater resources within the District and will make the results of those investigations available to the public.

The District has adopted rules to regulate the groundwater withdrawals by means of spacing and production limits. The relevant factors to be considered in making the determination to grant a permit or limit groundwater withdrawal will include:

1. The purpose of the District and its rules;
2. The equitable conservation and preservation of the resource, and;
3. The economic hardship resulting from granting or denying a permit or the terms prescribed by the rules.

In pursuit of the District mission of conserving and protecting the resource, the District will enforce the terms and conditions of permits and rules of the District by enjoining the permit holder in a court of competent jurisdiction, as provided for in TWC §36.102, if necessary.

ACTIONS, PROCEDURES, PERFORMANCES AND AVOIDANCE FOR PLAN IMPLEMENTATION

The District will implement the provisions of the plan and will utilize the provisions of the plan as a guidepost for determining the direction or priority for all District Activities. All operations of the District, all agreements entered into by the District, and any additional planning efforts in which the District may participate will be consistent with the provisions of the plan.

The District has adopted rules relating to the implementation of this plan. The rules adopted by the District are pursuant to TWC §36 and the provisions of this plan. All rules will be adhered and enforced. The promulgation and enforcement of the rules will be based upon the best technical evidence available.

The District shall treat all citizens with equality. Citizens may apply to the District for discretion in enforcement of the rules on grounds of adverse economic effect or unique local characteristics. In granting discretion to any rule, the Board shall consider the potential for adverse effect on adjacent landowners and aquifer conditions. The exercise of said discretions by the Board shall not be construed as limiting the power of the board.

The methodology that the District will use to trace its progress on an annual basis in achieving its management goals will be as follows:

The District Manager will prepare and present an annual report to the Board of Directors on the District performance in regards to achieving management goals and objectives during the first monthly Board of Directors meeting each fiscal year. This report will include the number of instances each activity was engaged in during the year.

The annual report will be maintained on file at the District office.

GOALS, MANAGEMENT OBJECTIVES AND PERFORMANCE STANDARDS

GOAL 1.0 – Providing for the most efficient use of groundwater

1.1 **Management Objective -** Each year, on four (4) or more occasions, the District will disseminate educational information relating to conservation practices for the efficient use of water resources. These will include but are not limited to publications from the Texas Water Development Board, the Texas Commission on Environmental Quality, Texas Cooperative Extension Service, the Texas Water Resource Institute, and other resources.

1.1a **Performance Standard -** Number of occasions, annually, the District disseminated educational information related to conservation practices for the efficient use of groundwater.

1.1b **Performance Standard** – Number of educational literature packets that have been distributed will be reported to the board in the annual report.

1.2 **Management Objective -** The District will adopt and enforce rules regarding the spacing of all new wells drilled within the District to limit the areas of overlapping cones of depression.

1.2a **Performance Standard** - The number of wells drilled each year in compliance with the spacing rules will be reported to the Board annually.

1.3 **Management Objective -** The District will implant a district-wide voluntary monitoring network to evaluate groundwater availability. Wells will be monitored for static level at least annually.

1.3a **Performance Standard** – The number of wells involved in the project, and respective static levels, will be reported to the Board of Directors annually. Well will be placed on a well numbering grid map for reference.

GOAL 2.0 – Controlling and preventing waste of groundwater

2.1 **Management Objective** – Report to the Board on a monthly basis any and all reported wasteful practices and non-beneficial use of groundwater in the district. Investigate and determine how to handle each reported waste within five (5) working days.

2.1a **Performance Standard** – Monthly reports of wasteful practices will be summarized in the annual report to the Board of Directors. Summaries shall include all relevant dates, information, and any remedial action taken by the District (if applicable).

GOAL 3.0 – Addressing Drought Conditions

3.1 Management Objective – The District will monitor the Palmer Drought Severity Index (PDSI) by Texas Climatic Division. If PDSI indicates that the District will experience severe drought conditions, the District will notify all public water suppliers within the District

3.1a Performance Standard – The District staff will monitor the PDSI and report findings and actions to the District Board on a quarterly basis.

GOAL 4.0 – Addressing Conservation

4.1 Management Objective - The district will submit an article regarding water conservation for publication each year to at least one newspaper of general circulation in Fisher County.

4.1a Performance Standard – A copy of the article submitted by the District for publication will be included in the annual report given to the Board of Directors.

GOAL 5.0 – Addressing Recharge Enhancement

5.1 Management Objective - The district will encourage brush removal as a means of recharge enhancement by publishing an article each year and attending at least one Soil & Water Conservation district meeting each year.

5.1a Performance Standard – A copy of the article submitted by the District for publication will be included in the annual report given to the Board of Directors.

GOAL 6.0 – Addressing Rainwater harvesting

6.1 Management Objective - The district prepare a report investigating the possibility of a cooperative agreement with the Roby School District to construct a rainwater harvesting demonstration.

6.1a Performance Standard – The report will be submitted to the Board of Directors by 30 May 2017.

GOAL 7.0 – Addressing Precipitation Enhancement

7.1 Management Objective - The district will participate in an area precipitation enhancement program provided funds are available.

7.1a Performance Standard – The Board of directors will review the evaluation reports prepared by the precipitation enhancement program and summary results pertaining to Fisher County included in the annual report.

GOAL 8.0 – Addressing Brush control

8.1 Management Objective - The district will encourage brush control and Best Management Practices related to brush control where appropriate.

8.1a Performance Standard – The District will have an agenda item in at least one open meeting to discuss Brush control. A District official will meet annually with the Soil and Water Conservation District/Natural Resources Conservation Service Agencies to discuss and support the need for brush control in the Districts, The reports and information will be included in the District Annual report..

GOAL 9.0 – Monitoring Desired Future Conditions

9.1 Management Objective - The district will annually measure the water levels of at least two (2) monitoring wells within each aquifer within the District and will compare the status of the measurements to the Desired Future Condition.

9.1a Performance Standard – The status or the water levels measured and the tracking will be included in the Annual Report.

MANAGEMENT GOALS DETERMINED NOT-APPLICABLE

GOAL – Control and prevention of subsidence

The rigid geologic framework of the region precludes significant subsidence from occurring.

This goal is not applicable to the operations of the District.

GOAL – Conjunctive surface water management issues.

No surface water management entities exist within the District. There are no surface water impoundments within the District except for livestock consumption. The groundwater within the district is used primarily for livestock, domestic and irrigated agriculture.

This goal is not applicable to the operations of the District.

GOAL – Addressing natural resource issues which impact the use and availability of groundwater, and which are impacted by the use of groundwater.

The District has no documented occurrences of endangered or threatened species dependent upon groundwater resources.

This goal is not applicable to the operations of the District.

Adopted this 31st Day of August 2015, at Roby, Texas.

Appendix
A

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.state.tx.us
Phone (512) 463-7847, Fax (512) 475-2053

December 9, 2011

Ms. Belynda Rains
General Manager
Clear Fork Groundwater Conservation District
P.O. Box 279
Roby, TX 79543

Re: Modeled available groundwater estimates for the Blaine, Dockum, Ogallala, and Seymour aquifers in Groundwater Management Area 6

Dear Ms. Rains:

The Texas Water Code, Section 36.1084, Subsection (b), states that the Texas Water Development Board's (TWDB) Executive Administrator shall provide each groundwater conservation district and regional water planning group located wholly or partly in the groundwater management area with the modeled available groundwater in the management area based upon the desired future conditions adopted by the districts. This letter and the attached reports (GAM Run 10-031 MAG, GAM Run 10-056 MAG, GAM Run 10-057 MAG, and GAM Run 10-058 MAG) are in response to this directive.

As noted in the letter received by the TWDB on August 16, 2010, from Mike McGuire of the Rolling Plains Groundwater Conservation District on behalf of Groundwater Management Area 6, desired future conditions were adopted for the Blaine, Dockum, Ogallala, and Seymour aquifers on July 22, 2010. The desired future conditions for the Blaine and Seymour aquifers were modified on July 19, 2011, as noted in the letter from Mr. McGuire received by TWDB on August 1, 2011.

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." This is different from "managed available groundwater," shown in the draft version of the Dockum and Ogallala reports, which was a permitting value and accounted for the estimated use exempt from permitting. This change was made to reflect changes in statute by the 82nd Legislature, effective September 1, 2011. 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 conservation district, and any other subdivision of the aquifer designated by the management area (if applicable).

We encourage open communication and coordination between groundwater conservation districts, regional water planning groups, and the TWDB to ensure that the modeled available groundwater reported in regional water plans and groundwater management plans are not in conflict. We estimated modeled available groundwater that would have to occur to achieve the desired future condition using the best available scientific tools. However, these estimates are based on assumptions of the magnitude and distribution of projected pumping in the aquifer. It is, therefore, important for groundwater conservation districts to monitor whether their management of pumping is achieving their desired future conditions. Districts are encouraged to continue to work with the TWDB to better define available groundwater as additional information may help better assess responses of the aquifer to pumping and its distribution now and in the future.

If you have any questions, please contact Ms. Rima Petrossian of my staff at 512-936-2420 or rima.petrossian@twdb.state.tx.us for further information.

Sincerely,

Melanie Callahan

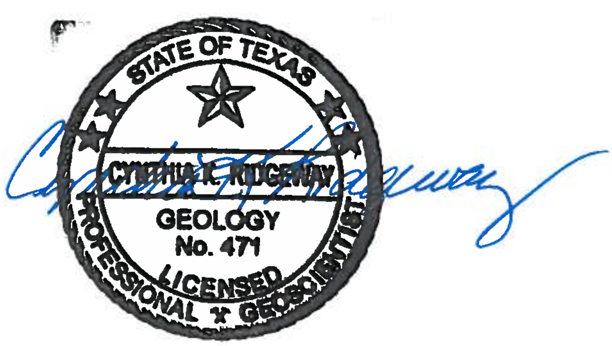
Melanie Callahan
Interim Executive Administrator

Attachments: GAM Run 10-031 MAG
GAM Run 10-056 MAG
GAM Run 10-057 MAG
GAM Run 10-058 MAG

c w/atts.: L'Oreal Stepney, Deputy Director, Office of Water, Texas Commission of Environmental Quality
Kellye Rila, Texas Commission of Environmental Quality
Kelly Mills, Texas Commission of Environmental Quality
Simone Kiel, Freese & Nichols, Inc.
Tom Gooch, Freese & Nichols, Inc.
Kerry Maroney, Biggs & Mathews
David Dunn, HDR Engineering
Stefan Schuster, Daniel B. Stevens and Associates
Jim Conkwright, High Plains UWCD No. 1
Phil Ford, Brazos River Authority
Gary Pitner, Panhandle Regional Planning Commission
Robert E. Mace, Ph.D, P.G., Deputy Executive Administrator, Water Science and Conservation
Cindy Ridgeway, P.G., Groundwater Resources
Rima Petrossian, P.G., Groundwater Resources
Jerry Shi, Ph.D, Groundwater Resources
Wade Oliver, Groundwater Resources
Dan Hardin, Water Resources Planning
Matt Nelson, Water Resources Planning
Temple McKinnon, Water Resources Planning
Doug Shaw, Water Resources Planning
Angela Kennedy, Water Resources Planning
Lann Bookout, Water Resources Planning
Wendy Barron, Water Resources Planning

GAM Run 10-056 MAG: Modeled Available Groundwater for the Blaine Aquifer in Groundwater Management Area 6

by Wade Oliver[1], David Thorkildsen, P.G.[2], and Sarah Backhouse [3]
Texas Water Development Board
Groundwater Resources Division
(512) 463-3132[1]
(512) 936-0871[2]
(512) 936-2387[3]
December 6, 2011



The seals appearing on this document were authorized by Cynthia K. Ridgeway, P.G. 471, and David Thorkildsen, P.G. 705 on December 6, 2011. Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and Interim Director of the Groundwater Resources Division and is responsible for oversight of work performed by employees under her direct supervision.

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GAM RUN 10-056 MAG: MODELED AVAILABLE GROUNDWATER FOR THE BLAINE AQUIFER IN GROUNDWATER MANAGEMENT AREA 6

by Wade Oliver[1], David Thorkildsen, P.G.[2], and Sarah Backhouse [3]
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Groundwater Resources Division
(512) 463-3132[1]
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(512) 936-2387[3]
December 6, 2011

EXECUTIVE SUMMARY:

The modeled available groundwater for the Blaine Aquifer as a result of the desired future conditions adopted by the members of Groundwater Management Area 6 is approximately 238,000 acre-feet per year. This is shown divided by county, river basin, and regional water planning area in Table 4 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 5 through 8. For areas included in the groundwater availability model, the pumping estimates were extracted from Groundwater Availability Modeling Task 11-006, Scenario 9, which meets the desired future conditions adopted by the members of Groundwater Management Area 6. For Clear Fork Groundwater Conservation District and the portions of King County outside of the area where the groundwater availability model is applicable, a water balance approach was used to estimate modeled available groundwater.

REQUESTOR:

Mr. Mike McGuire of Rolling Plains Groundwater Conservation District on behalf of Groundwater Management Area 6

DESCRIPTION OF REQUEST:

In a letter dated August 13, 2010, Mr. McGuire provided the Texas Water Development Board (TWDB) with the desired future conditions of the Seymour and Blaine aquifers in Groundwater Management Area 6. After an analysis using the groundwater availability model for the Seymour and Blaine aquifers, TWDB notified Mr. McGuire on

January 6, 2011 that some desired future conditions were not compatible with one another. In a letter dated July 28, 2011, Mr. McGuire provided the TWDB with amended desired future conditions for the aquifers based on the modeling analysis documented in Groundwater Availability Modeling (GAM) Task 11-006 (Oliver, 2011). The desired future conditions for the Blaine Aquifer, as described in Resolution 2010-005 and amended in Resolution 2011-002, are described below:

1. *The Desired Future Condition for Fisher County, located within the Clear Fork Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 4 feet over the next 50 years*

2. *The Desired Future Condition for that part of Childress County located in Gateway Groundwater Conservation District; Cottle, Foard, and Hardeman Counties, also located within Gateway Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 2 feet over the next 50 years*

3. *The Desired Future Condition for that part of Childress County located in the Mesquite Groundwater Conservation District; Collingsworth and Hall counties, also located within the Mesquite Groundwater Conservation District, is that condition whereby 80 percent of the current volume in storage will remain in 50 years (2060)*

4. *The Desired Future Condition for King, not located within a Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 7 feet over the next 50 years*

5. *Desired Future Conditions for Dickens, Knox, Motley, Stonewall, and Wilbarger Counties, located in GMA-6, are not relevant for joint planning purposes.*

In response to receiving the adopted desired future conditions, the TWDB has estimated the modeled available groundwater for the Blaine Aquifer in Groundwater Management Area 6.

METHODS:

As described in Oliver (2011), the boundary of the Blaine Aquifer in the model was the official boundary during model development in 2004. Though the official boundary of the Blaine Aquifer has since changed, the model is only applicable in areas within this older boundary. The locations of Groundwater Management Area 6, the Blaine Aquifer, and the groundwater availability model cells representing the aquifer are shown in Figure 1. Figure 2 shows the location of the Blaine Aquifer relative to regional water planning areas, river basins, and groundwater conservation districts.

The desired future conditions above cover areas both included in the groundwater availability model and outside of the model. Where applicable, the model was used to estimate modeled available groundwater. In other areas (Fisher County and the non-modeled areas of King County), a water balance approach was used. Each of these methods is described individually below.

Groundwater Availability Modeling Approach

As described above, the TWDB previously completed GAM Task 11-006 using the groundwater availability model for the Seymour and Blaine aquifers to assist the members of Groundwater Management Area 6 in developing desired future conditions (Oliver, 2011). One of the simulations in GAM Task 11-006, Scenario 9, meets each of the desired future conditions above where the model is applicable. Because of this, the results for Scenario 9 were used for developing the modeled available groundwater estimates in these areas. Some additional details about the model simulation are included below:

- We used version 1.01 of the groundwater availability model for the Seymour and Blaine aquifers. See Ewing and others (2004) for assumptions and limitations of the model

- The results presented here were taken directly from the Scenario 9 groundwater availability model simulation in GAM Task 11-006. See Oliver (2011) for additional details about the methods and assumptions associated with the model run.

- The model includes two layers representing the Seymour Aquifer (Layer 1) and the Blaine Aquifer and other Permian sediments (Layer 2).

- The root mean squared error (a measure of the difference between simulated and measured water levels during model calibration) for the entire model for the period of 1990 to 1999 is 19.6 feet for the Seymour Aquifer and 26.4 feet for the Blaine Aquifer. This represents one percent and three percent of the range of measured water levels, respectively (Ewing and others, 2004).

- Average annual recharge conditions were assumed in the simulation based on 1975 to 1999 climate data.

Water Balance Approach

For areas containing the Blaine Aquifer, but not applicable in the groundwater availability model, a water balance approach was used to estimate modeled available groundwater. These areas include Clear Fork Groundwater Conservation District (Fisher County) and portions of King County (Figure 1).

A transient water balance for the saturated portion of an aquifer is described by Freeze and Cherry (1979, p.365):

$$Q(t) = R(t) - D(t) + \frac{dS}{dt}$$

where $Q(t)$ = total rate of groundwater withdrawal

$R(t)$ = total rate of groundwater recharge to the basin

$D(t)$ = total rate of groundwater discharge from the basin

$\frac{dS}{dt}$ = rate of change of storage in the saturated zone of the basin

For this analysis, it is assumed that

$$R(t) = R(r) + R(e)$$

where $R(r)$ = rejected recharge for the basin

$R(e)$ = effective recharge

Effective recharge is the amount of water that enters an aquifer and is available for development (Muller and Price, 1979, p. 5). Rejected recharge is the amount of total (or potential) recharge that discharges from an aquifer because it is overfull and cannot accept more water (Theis, 1940, p. 1). For this analysis, it is assumed that:

$$R(r) \cong D(t)$$

Therefore, the total rate of groundwater withdrawal equals effective recharge plus the change in storage of the aquifer, or

$$Q(t) = R(e) + \frac{dS}{dt}$$

The annual effective recharge was calculated by multiplying the outcrop area by the average precipitation (1971–2000) and the effective recharge rate developed for the

Blaine Aquifer in Ewing and others (2004). This is shown in Table 1. The change in storage in the aquifer is calculated from the change in water levels (the desired future conditions), the aquifer properties that define how much water is released from storage for a given change in water level, and the area covered by the aquifer. The storage properties – specific yield for unconfined areas and storage coefficient for confined areas – were derived from the groundwater availability model. The annual change in storage was then calculated by dividing the total change in storage by 50 years (Table 2).

As shown in the equation above, the estimated annual groundwater withdrawal consistent with the desired future conditions (modeled available groundwater) is the sum of the annual effective recharge and the annual volume of water released from storage (Table 3). Some additional details about estimating modeled available groundwater using the water balance approach are included below:

- The average annual precipitation for each area shown in Table 1 was determined from the Texas Climatic Atlas (Narasimhan and others, 2008) which is the average for the years 1971 to 2000.
- Annual effective recharge is 1.6 percent of annual precipitation (Ewing and others, 2004).
- Outcrop areas are calculated as unconfined areas of the aquifer and subcrop areas are calculated as confined areas of the aquifer.
- Specific yield of the aquifer is estimated to be 0.15 and the storage coefficient is estimated to be 0.01 (Ewing and others, 2004).
- The specified average water-level decline is assumed to be uniform across the aquifer.

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. 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 Blaine Aquifer in Groundwater Management Area 6 as a result of the above desired future conditions is approximately 238,000 acre-feet per year between 2010 and 2060. Table 4 contains the modeled available groundwater subdivided by county, regional water planning area, and river basin for use in the regional water planning process. Tables 5, 6, 7, and 8 show the modeled available groundwater for the Blaine Aquifer summarized by county, regional water planning area, river basin, and groundwater conservation district, respectively, within Groundwater Management Area 6. Note that tables 4 through 8 include the estimated modeled available groundwater using both the groundwater availability model (from Oliver, 2011) and the water balance approach described in this report.

LIMITATIONS:

The groundwater model used in developing estimates of modeled available groundwater is the best available scientific tool that can be used to estimate the pumping that will achieve the desired future conditions. Although the groundwater model used in this analysis is the best available scientific tool for this purpose, it, like all models, has limitations. 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 develop estimates of modeled available groundwater is the need to make assumptions about the location in the aquifer where future pumping will occur. 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 condition of the groundwater resources in the area that relate to the adopted desired future condition.

As described above, different assumptions were used for the water balance approach used for the Clear Fork Groundwater Conservation District (Fisher County) and portions of King County (Figure 1). For example, this approach does not consider impacts to the aquifer from neighboring areas or evaluate whether individual conditions are physically compatible.

Given these limitations, users of this information are cautioned that the modeled available groundwater numbers should not be considered a definitive, permanent description of the amount of groundwater that can be pumped to meet the adopted desired future condition. Because the application of these models 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 as well as whether or not they are achieving their desired future conditions. 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 these modeled available groundwater numbers given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future.

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TABLE 1: CALCULATION OF ESTIMATED ANNUAL EFFECTIVE RECHARGE FOR AREAS NOT INCLUDED IN THE GROUNDWATER AVAILABILITY MODEL FOR THE BLAINE AQUIFER. NOTE THAT THIS CALCULATION ONLY APPLIED TO OUTCROP AREAS.

County	*Basin*	*Outcrop/ Subcrop*	*Average Annual Precipitation (inches - feet)*	*Effective recharge rate (percent)*	*Area (acres)*	*Estimated Annual Effective Recharge (acre-feet per year)*
Fisher	Brazos	Outcrop	23 – 1.9	1.6	112,853	3,431
King	Brazos	Outcrop	24 – 2.0	1.6	130,527	4,177
King	Red	Outcrop	24 – 2.0	1.6	65,336	2,091
Total					**308,716**	**9,699**

TABLE 2: CALCULATION OF THE ESTIMATED ANNUAL VOLUME OF STORAGE DECLINE CONSISTENT WITH THE DESIRED FUTURE CONDITIONS FOR AREAS NOT INCLUDED IN THE GROUNDWATER AVAILABILITY MODEL FOR THE BLAINE AQUIFER.

County	*Basin*	*Outcrop/ Subcrop*	*Specified 50-year Water-Level Decline (feet)*	*Estimated Storage Coefficient (unitless)*	*Area (acres)*	*Estimated Annual Volume of Storage Decline (acre-feet per year)*
Fisher	Brazos	Outcrop	4	0.15	112,853	1,354
Fisher	Brazos	Subcrop	4	0.01	346,200	277
King	Brazos	Outcrop	7	0.15	130,527	2,741
King	Brazos	Subcrop	7	0.01	42,446	59
King	Red	Outcrop	7	0.15	65,336	1,372
King	Red	Subcrop	7	0.01	7,282	10
Total					**704,644**	**5,814**

TABLE 3: CALCULATION OF THE ESTIMATED PUMPING CONSISTENT WITH THE DESIRED FUTURE CONDITIONS FOR AREAS NOT INCLUDED IN THE GROUNDWATER AVAILABILITY MODEL FOR THE BLAINE AQUIFER. ALL VALUES ARE IN ACRE-FEET PER YEAR.

County	Basin	Outcrop/ Subcrop	Estimated Annual Effective Recharge	Estimated Annual Volume of Storage Decline	Estimated Pumping in Non-Modeled Areas
Fisher	Brazos	Outcrop	3,431	1,354	4,785
Fisher	Brazos	Subcrop	-	277	277
King	Brazos	Outcrop	4,177	2,741	6,918
King	Brazos	Subcrop	-	59	59
King	Red	Outcrop	2,091	1,372	3,463
King	Red	Subcrop	-	10	10
Total			**9,699**	**5,814**	**15,513**

TABLE 4: MODELED AVAILABLE GROUNDWATER FOR THE BLAINE AQUIFER IN GROUNDWATER MANAGEMENT AREA 6. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, REGIONAL WATER PLANNING AREA, AND RIVER BASIN.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Childress	A	Red	15,206	15,206	15,206	15,206	15,206	15,206
Collingsworth	A	Red	185,376	185,376	185,376	185,376	185,376	185,376
Cottle	B	Red	4,469	4,469	4,469	4,469	4,469	4,469
Fisher	G	Brazos	5,062	5,062	5,062	5,062	5,062	5,062
Foard	B	Red	23	23	23	23	23	23
Hall	A	Red	11,509	11,509	11,509	11,509	11,509	11,509
Hardeman	B	Red	5,198	5,198	5,198	5,198	5,198	5,198
King	B	Brazos	6,977	6,977	6,977	6,977	6,977	6,977
		Red	3,863	3,863	3,863	3,863	3,863	3,863
Total			**237,684**	**237,684**	**237,684**	**237,684**	**237,684**	**237,684**

TABLE 5: MODELED AVAILABLE GROUNDWATER FOR THE BLAINE AQUIFER BY COUNTY FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

County	Year					
	2010	2020	2030	2040	2050	2060
Childress	15,206	15,206	15,206	15,206	15,206	15,206
Collingsworth	185,376	185,376	185,376	185,376	185,376	185,376
Cottle	4,469	4,469	4,469	4,469	4,469	4,469
Fisher	5,062	5,062	5,062	5,062	5,062	5,062
Foard	23	23	23	23	23	23
Hall	11,509	11,509	11,509	11,509	11,509	11,509
Hardeman	5,198	5,198	5,198	5,198	5,198	5,198
King	10,841	10,841	10,841	10,841	10,841	10,841
Total	**237,684**	**237,684**	**237,684**	**237,684**	**237,684**	**237,684**

TABLE 6: MODELED AVAILABLE GROUNDWATER FOR THE BLAINE AQUIFER BY REGIONAL WATER PLANNING AREA FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Region	Year					
	2010	2020	2030	2040	2050	2060
A	212,091	212,091	212,091	212,091	212,091	212,091
B	20,531	20,531	20,531	20,531	20,531	20,531
G	5,062	5,062	5,062	5,062	5,062	5,062
Total	**237,684**	**237,684**	**237,684**	**237,684**	**237,684**	**237,684**

TABLE 7: MODELED AVAILABLE GROUNDWATER FOR THE BLAINE AQUIFER BY RIVER BASIN FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Basin	Year					
	2010	2020	2030	2040	2050	2060
Brazos	12,039	12,039	12,039	12,039	12,039	12,039
Red	225,644	225,644	225,644	225,644	225,644	225,644
Total	**237,684**	**237,684**	**237,684**	**237,684**	**237,684**	**237,684**

TABLE 8: MODELED AVAILABLE GROUNDWATER FOR THE BLAINE AQUIFER BY GROUNDWATER CONSERVATION DISTRICT (GCD) FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

District	Year					
	2010	2020	2030	2040	2050	2060
Clear Fork GCD	5,062	5,062	5,062	5,062	5,062	5,062
Gateway GCD	16,786	16,786	16,786	16,786	16,786	16,786
Mesquite GCD	204,995	204,995	204,995	204,995	204,995	204,995
No District	10,841	10,841	10,841	10,841	10,841	10,841
Total	**237,684**	**237,684**	**237,684**	**237,684**	**237,684**	**237,684**

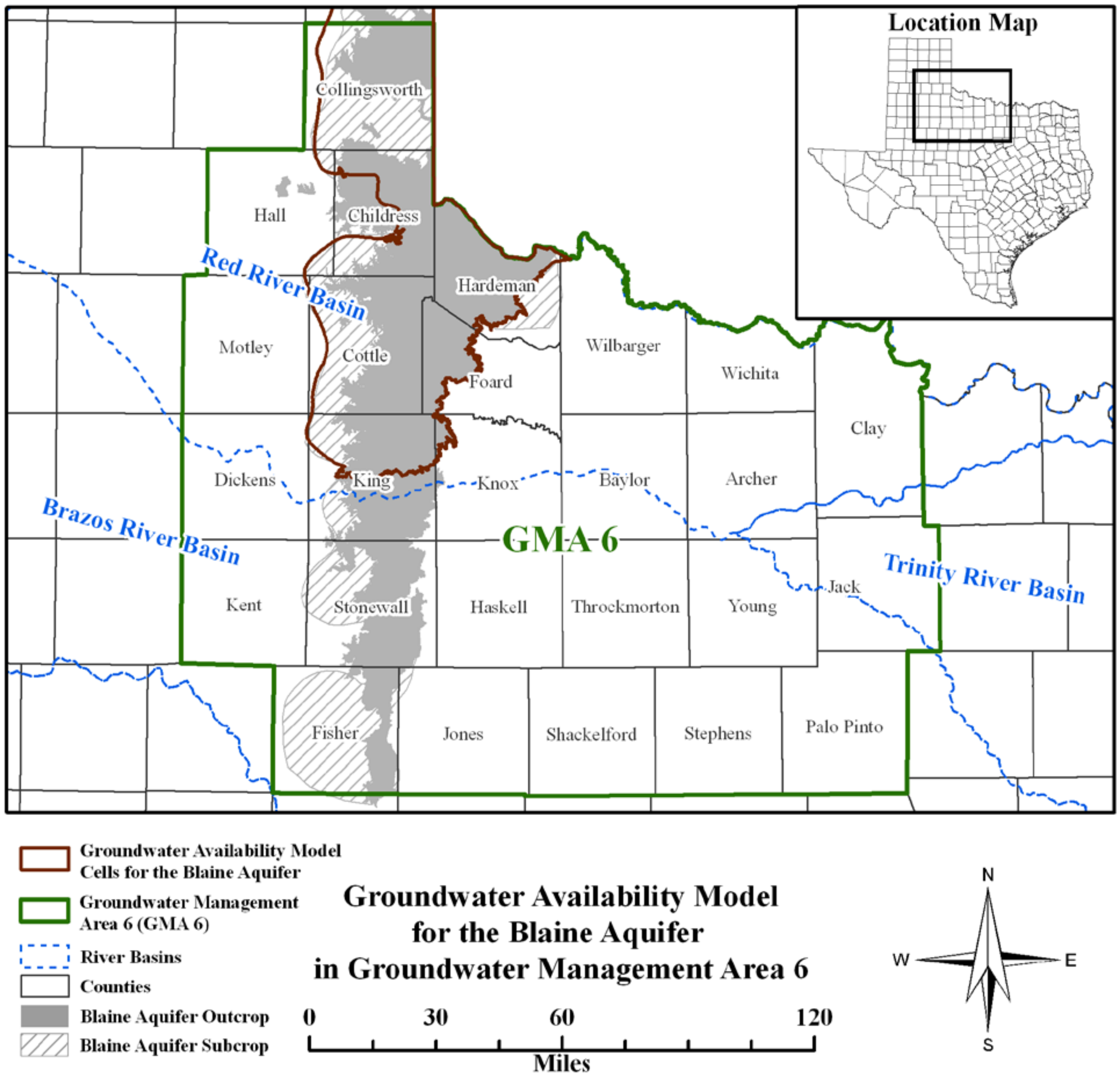

FIGURE 1: MAP SHOWING GROUNDWATER MANAGEMENT AREA 6, THE BOUNDARY OF THE BLAINE AQUIFER ACCORDING TO THE 2007 STATE WATER PLAN (TWDB, 2007), AND THE GROUNDWATER AVAILABILITY MODEL CELLS THAT REPRESENT THE AQUIFER.

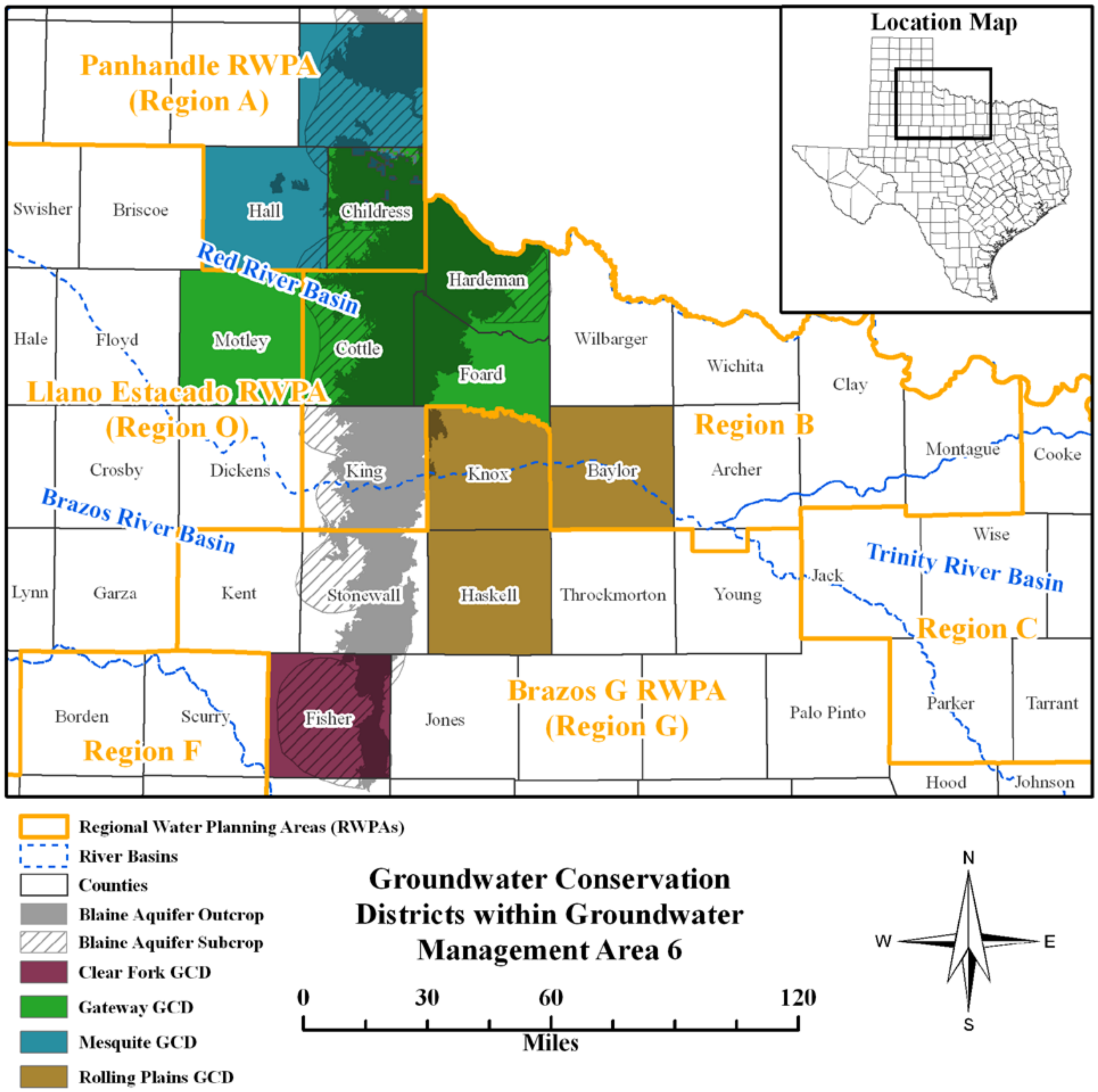

FIGURE 2: MAP SHOWING GROUNDWATER CONSERVATION DISTRICTS, REGIONAL WATER PLANNING AREAS, COUNTIES, AND RIVER BASINS IN AND NEIGHBORING GROUNDWATER MANAGEMENT AREA 6.

GAM Run 10-057 MAG

By Mohammad Masud Hassan, P.E. and Wade Oliver

Edited and finalized by Jerry Shi to reflect statutory changes
Effective September 1, 2011

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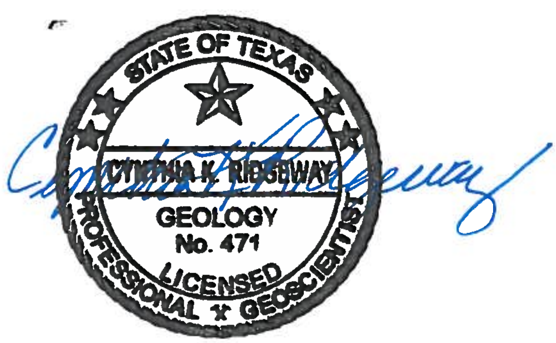
December 7, 2011



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 7, 2011.

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EXECUTIVE SUMMARY:

The modeled available groundwater for the Dockum Aquifer as a result of the desired future conditions adopted by the members of Groundwater Management Area 6 is approximately 15,700 acre-feet per year between 2010 and 2060. This is shown divided by county, regional water planning area, and river basin 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 pumping that achieves the desired future conditions was determined iteratively by adjusting the pumping in each county until the water level declines after 50 years matched the water level declines specified for each county.

REQUESTOR:

Mr. Mike McGuire of the Rolling Plains Groundwater Conservation District on behalf of Groundwater Management Area 6.

DESCRIPTION OF REQUEST:

In a letter dated August 13, 2010, Mr. Mike McGuire of Rolling Plains Groundwater Conservation District provided the Texas Water Development Board (TWDB) with the desired future conditions of the Dockum Aquifer adopted by the members of Groundwater Management Area 6. The desired future conditions of the Dockum Aquifer in Groundwater Management Area 6, as described in Resolution No. 2010-003, are:

> *"The Desired Future Condition for Fisher County, located in the Clear Fork Groundwater Conservation District is that condition whereby the total decline in water levels will be no more than 25 feet over the next 50 years*
>
> *The Desired Future Condition for Motley County, located in the Gateway Groundwater Conservation District is that condition whereby the total decline in water levels will be no more than 40 feet over the next 50 years*
>
> *The Desired Future Condition for Dickens & Kent Counties, not located within a Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 40 feet over the next 50 years"*

In response to receiving the adopted desired future conditions, the Texas Water Development Board has estimated the modeled available groundwater for the Dockum Aquifer in Groundwater Management Area 6.

METHODS:

The location of Groundwater Management Area 6, the Dockum Aquifer, and the groundwater model cells that represent the aquifer are shown in Figure 1. The Texas Water Development Board previously completed Groundwater Availability Modeling (GAM) Task 10-025 (Oliver, 2010a), which the members of Groundwater Management Area 6 used when developing their desired future conditions. Though no model simulation in GAM Task 10-025 meets the desired future conditions specified, the methods and assumptions used here are the same as described in that report. Specifically, the pumping in the Dockum Aquifer for the “base” scenario in GAM Task 10-025 was adjusted iteratively in each county within Groundwater Management Area 6 until the water level declines in the model matched the water level declines specified as desired future conditions. The pumping in the simulation that achieved the desired future conditions was then divided by county, regional water planning area, river basin, and groundwater conservation district. These areas are shown in Figure 2.

The historical-calibration period of the model ends in 1997 while the predictive simulation documented here begins in 2010. To determine the appropriate level of pumping between 1998 and 2009, the interim period leading up to the predictive simulation, a preliminary analysis of water levels in several selected wells in Groundwater Management Area 6 was performed. Based on this analysis, the pumping levels and distribution for the last year of the historical-calibration portion of the model were determined to be appropriate for the interim period. Pumping was therefore, held constant at 1997 levels between 1998 and 2009

PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the modified groundwater model for the Dockum Aquifer are described below:

- The methods and assumptions for the model simulation documented here are the same as described in GAM Task 10-025 (Oliver, 2010a).

- The modified version the groundwater model for the Dockum Aquifer described in Oliver and Hutchison (2010) was used for this analysis. This model is an update to the previously developed groundwater availability model for the Dockum Aquifer described in Ewing and others (2008), which was completed in order to more effectively simulate predictive conditions. See Oliver and Hutchison (2010) and Ewing and others (2008) for assumptions and limitations of the model.

- The model includes two active layers which represent the upper and lower portions of the Dockum Aquifer (Layers 2 and 3, respectively). Layer 1, which is active in version 1.01 of the model documented in Ewing and others (2008), was inactivated in the modified model as described in Oliver and Hutchison (2010). Note that Groundwater Management Area 6 does not contain the upper portion of the Dockum Aquifer.

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the lower portion of the Dockum Aquifer between 1980 and 1997 is 53 feet (Oliver and Hutchison, 2010). This represents 2.5 percent of the hydraulic head drop across the model area.

- The MODFLOW General-Head Boundary package was used to simulate flow between the Dockum Aquifer and overlying aquifers. The water levels in the overlying aquifers were applied as described in Oliver (2010a) using GAM Run 09-023 (Oliver, 2010b) for the southern portion of the Ogallala Aquifer.

- Cells were assigned to individual counties and groundwater conservation districts as shown in the September 14, 2009 version of the file that associates the model grid to political and natural boundaries for the Dockum Aquifer.

- The recharge used for the model run represents average recharge as described in Ewing and others (2008).

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 November 30, 2010, 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 Dockum Aquifer in Groundwater Management Area 6 consistent with the desired future conditions is approximately 15,700 acre-feet per year between 2010 and 2060. 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 is also summarized by county, regional water planning area, river basin, and groundwater conservation district as shown in tables 2, 3, 4, and 5, respectively. In Table 5, note that the modeled available groundwater is totaled both including and excluding areas outside of a groundwater conservation district.

LIMITATIONS:

The groundwater model used in developing estimates of modeled available groundwater is the best available scientific tool that can be used to estimate the pumping that will achieve the desired future conditions. Although the groundwater model used in this analysis is the best available scientific tool for this purpose, it, like all models, has limitations. 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 develop estimates of modeled available groundwater is the need to make assumptions about the location in the aquifer where future pumping will occur. 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 condition of the groundwater resources in the area that relate to the adopted desired future condition(s).

Given these limitations, users of this information are cautioned that the modeled available groundwater numbers should not be considered a definitive, permanent description of the amount of groundwater that can be pumped to meet the adopted desired future condition. 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 as well as whether or not they are achieving their desired future conditions. Because of the limitations of the model and the assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine the modeled available groundwater numbers given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future.

REFERENCES:

Ewing, J.E., Jones, T.L., Yan, T., Vreugdenhil, A.M., Fryar, D.G., Pickens, J.F., Gordon, K., Nicot, J.P., Scanlon, B.R., Ashworth, J.B., Beach, J., 2008, Groundwater Availability Model for the Dockum Aquifer – Final Report: contract report to the Texas Water Development Board, 510 p.

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Oliver, W., Hutchison, W.R., 2010, Modification and recalibration of the Groundwater Availability Model of the Dockum Aquifer: Texas Water Development Board, 114 p.

Table 1. Modeled available groundwater for the Dockum Aquifer in Groundwater Management Area 6. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Dickens	O	Brazos	2,126	2,126	2,126	2,126	2,126	2,126
		Red	1,584	1,584	1,584	1,584	1,584	1,584
Fisher	G	Brazos	2,880	2,880	2,880	2,880	2,880	2,880
Kent	G	Brazos	6,250	6,250	6,250	6,250	6,250	6,250
Motley	O	Red	2,860	2,860	2,860	2,860	2,860	2,860
Total			**15,700**	**15,700**	**15,700**	**15,700**	**15,700**	**15,700**

Table 2. Modeled available groundwater for the Dockum Aquifer summarized by county in Groundwater Management Area 6 for each decade between 2010 and 2060. Results are in acre-feet per year.

County	Year					
	2010	2020	2030	2040	2050	2060
Dickens	3,710	3,710	3,710	3,710	3,710	3,710
Fisher	2,880	2,880	2,880	2,880	2,880	2,880
Kent	6,250	6,250	6,250	6,250	6,250	6,250
Motley	2,860	2,860	2,860	2,860	2,860	2,860
Total	**15,700**	**15,700**	**15,700**	**15,700**	**15,700**	**15,700**

Table 3. Modeled available groundwater for the Dockum Aquifer summarized by regional water planning area in Groundwater Management Area 6 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
G	9,130	9,130	9,130	9,130	9,130	9,130
O	6,570	6,570	6,570	6,570	6,570	6,570
Total	**15,700**	**15,700**	**15,700**	**15,700**	**15,700**	**15,700**

Table 4. Modeled available groundwater for the Dockum Aquifer summarized by river basin in Groundwater Management Area 6 for each decade between 2010 and 2060. Results are in acre-feet per year.

River Basin	Year					
	2010	2020	2030	2040	2050	2060
Brazos	11,256	11,256	11,256	11,256	11,256	11,256
Red	4,444	4,444	4,444	4,444	4,444	4,444
Total	**15,700**	**15,700**	**15,700**	**15,700**	**15,700**	**15,700**

Table 5. Modeled available groundwater for the Dockum Aquifer summarized by groundwater conservation district (GCD) in Groundwater Management Area 6 for each decade between 2010 and 2060. Results are in acre-feet per year.

Groundwater Conservation District	**Year**					
	2010	**2020**	**2030**	**2040**	**2050**	**2060**
Clear Fork GCD	2,880	2,880	2,880	2,880	2,880	2,880
Gateway GCD	2,860	2,860	2,860	2,860	2,860	2,860
Total (excluding non-district areas)	**5,740**	**5,740**	**5,740**	**5,740**	**5,740**	**5,740**
No District	9,960	9,960	9,960	9,960	9,960	9,960
Total (including non-district areas)	**15,700**	**15,700**	**15,700**	**15,700**	**15,700**	**15,700**

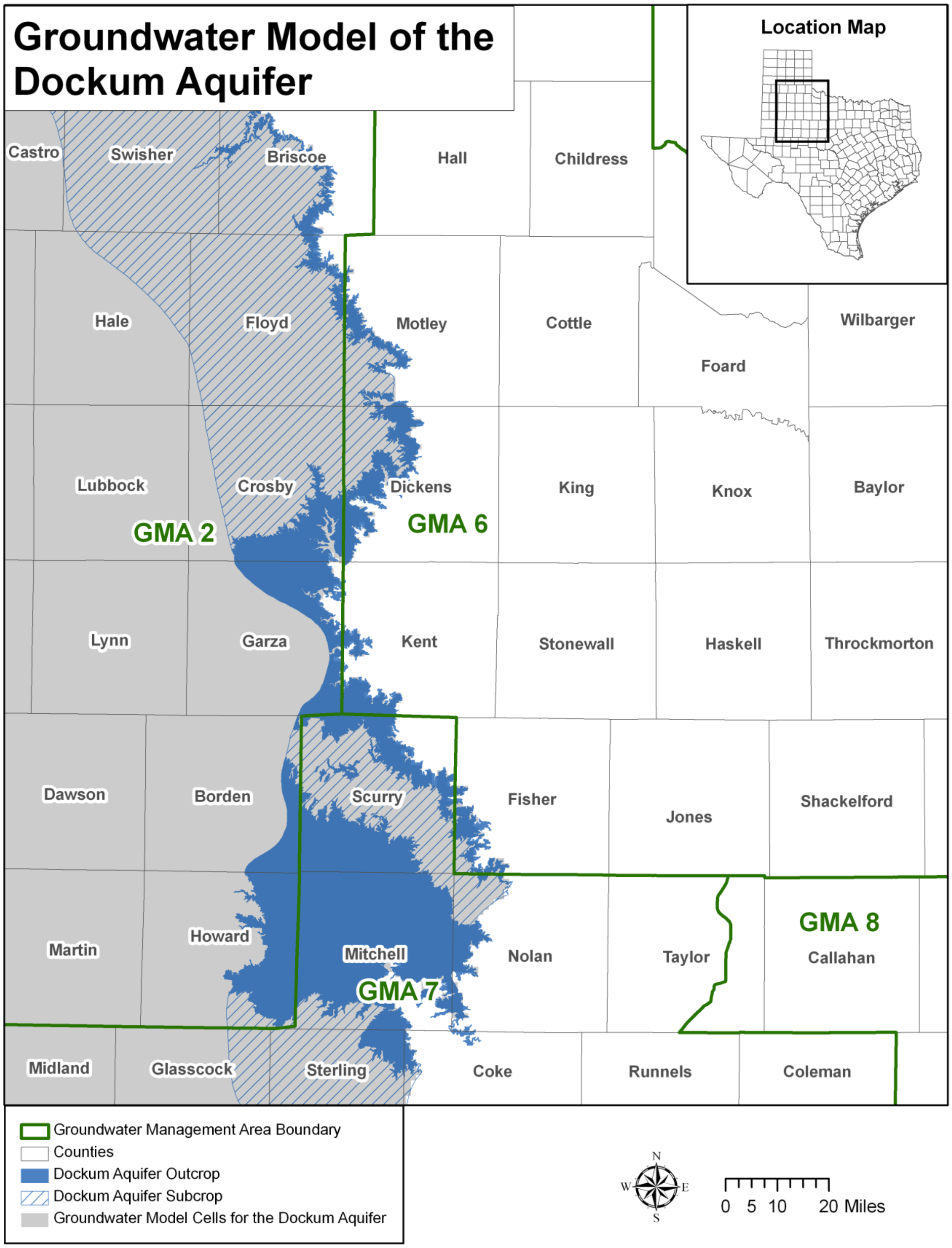

Figure 1: Map showing the areas covered by the groundwater model for the Dockum Aquifer.

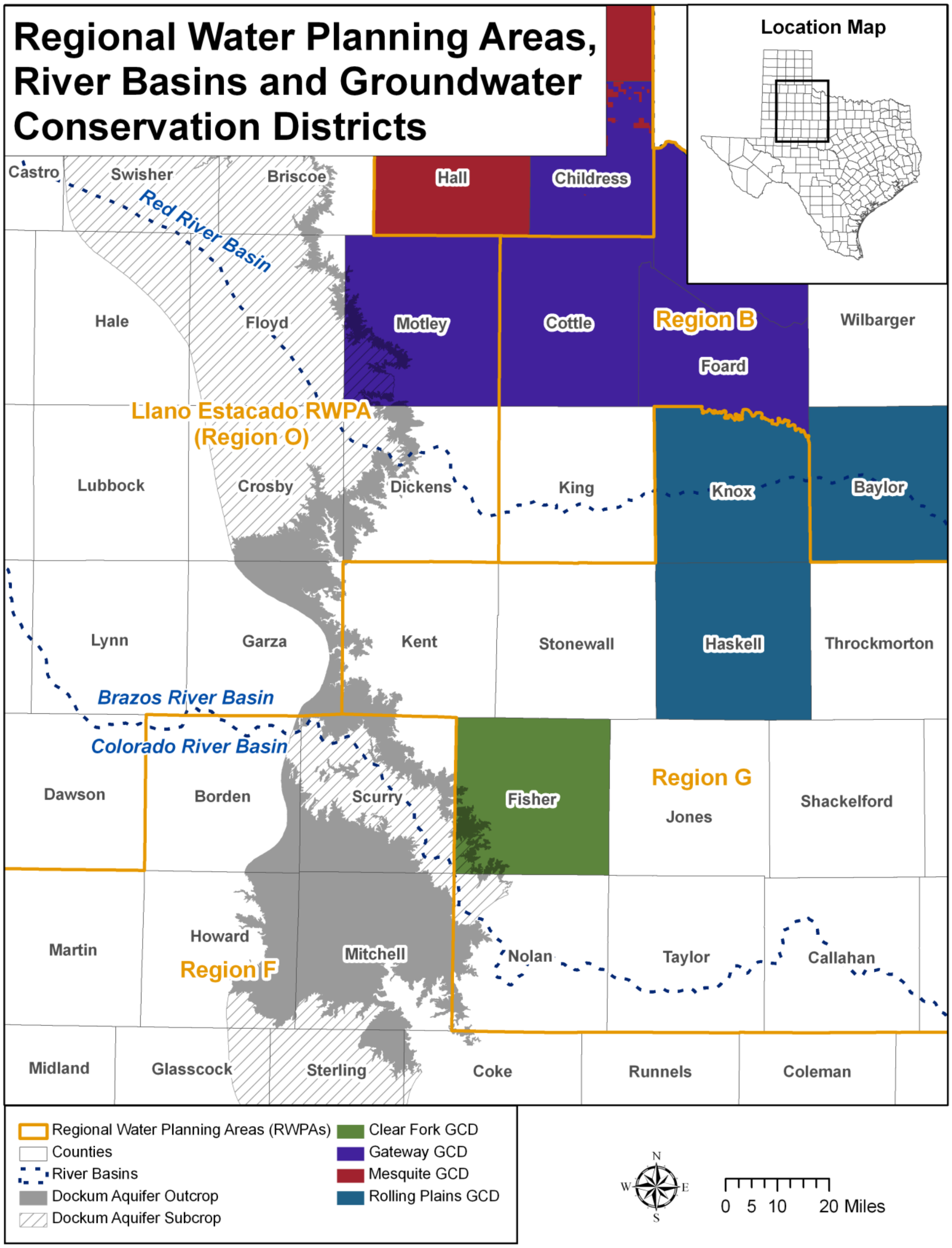

Figure 2: Map showing regional water planning areas (RWPAs), groundwater conservation districts (GCDs), counties, and river basins in Groundwater Management Area 6.

GAM Run 10-058 MAG: Modeled Available Groundwater for the Seymour Aquifer in Groundwater Management Area 6

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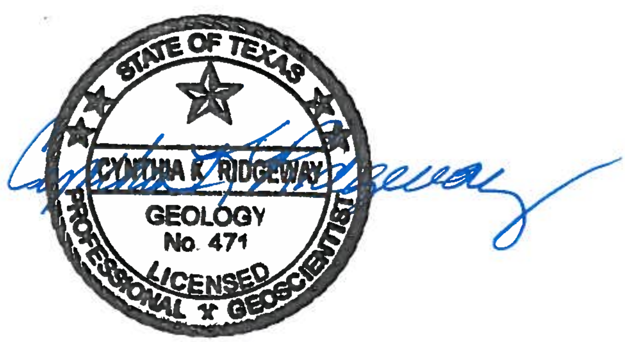
December 7, 2011



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 7, 2011.

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GAM RUN 10-058 MAG: MODELED AVAILABLE GROUNDWATER FOR THE SEYMOUR AQUIFER IN GROUNDWATER MANAGEMENT AREA 6

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December 7, 2011

EXECUTIVE SUMMARY:

The modeled available groundwater for the Seymour Aquifer as a result of the desired future conditions adopted by the members of Groundwater Management Area 6 declines from approximately 174,000 acre-feet per year to 148,000 acre-feet per year between 2010 and 2060. This is shown divided by county, river basin, and regional water planning area in Table 1 for use in the regional water planning process. Modeled available groundwater is summarized by county, regional water planning area, river basin, geographic area, and groundwater conservation district in tables 2 through 6. The estimates were taken from Scenario 9 of Groundwater Availability Modeling Task 11-006, which meets each of the desired future conditions adopted by the groundwater conservation districts within Groundwater Management Area 6.

REQUESTOR:

Mr. Mike McGuire of Rolling Plains Groundwater Conservation District on behalf of Groundwater Management Area 6

DESCRIPTION OF REQUEST:

In a letter dated August 13, 2010, Mr. McGuire provided the Texas Water Development Board (TWDB) with the desired future conditions of the Seymour and Blaine aquifers in Groundwater Management Area 6. After an analysis using the groundwater availability model for the Seymour and Blaine aquifers, TWDB notified Mr. McGuire on January 6, 2011 that some desired future conditions were not compatible with one another. In a letter dated July 28, 2011, Mr. McGuire provided the TWDB with amended desired future conditions for the aquifers based on the modeling analysis documented in Groundwater Availability Modeling (GAM) Task 11-006 (Oliver, 2011). The desired future conditions for the Seymour Aquifer, as described in Resolution 2010-005 and amended in Resolution 2011-002, are described below:

1. *The Desired Future Condition for Pod 1 in Collingsworth and Childress Counties, Pod 2 in Hall County and that part of Pod 3 in Hall County, all located in the Mesquite Groundwater Conservation District, is that condition whereby 50 percent of the current volume in storage will remain in 50 years (2060)*

2. *That part of Pod 1 in Childress County that is located in Gateway Groundwater Conservation District is considered not relevant for planning purposes*

3. *The Desired Future Condition for that part of Pod 3 in Motley County and that part of Pod 4 in Childress, Foard, and Hardeman counties, located in Gateway Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 1 foot over the next 50 years (2060)*

4. *The Desired Future Condition for that part of Pod 4 in Wichita and Wilbarger counties, not located within a Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 1 foot over the next 50 years (2060)*

5. *The Desired Future Condition for Pod 5 in Archer, Clay, Wichita and Wilbarger counties, not located within a Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 2 feet over the next 50 years (2060)*

6. *The Desired Future Condition for Pod 6, that part of Pod 7 in Baylor, Knox and Haskell Counties, and that part of Pod 8 in Baylor County, located in Rolling Plains Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 18 feet over the next 50 years (2060)*

7. *The Desired Future Condition for that part of Pod 7 in Stonewall County is that condition whereby the total decline in water levels will be no more than 24 feet over the next 50 years (2060)*

8. *The Desired Future Condition for that part of Pod 8 in Throckmorton and Young Counties, none of which are located in a Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 3 feet over the next 50 years (2060)*

9. *The Desired Future Condition for Pods 9 and 10 in Kent and Stonewall counties, not located within a Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 4 feet over the next 50 years (2060)*

10. *The Desired Future Condition for that part of Pod 11 in Fisher County, located in Clear Fork Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 1 foot over the next 50 years (2060)*

11. *The Desired Future Condition for that part of Pod 11 in Jones and Stonewall Counties, and Pods 12, 13, 14, and 15, located in Jones County, not located within a Groundwater Conservation District, is that condition whereby the total decline in water levels will be no more than 1 foot over the next 50 years (2060)*

In response to receiving the adopted desired future conditions, the TWDB has estimated the modeled available groundwater for the Seymour Aquifer in Groundwater Management Area 6.

METHODS:

The Seymour Aquifer is divided into distinct, isolated areas informally referred to as “pods.” The locations of each of the pods in the Seymour Aquifer are shown in Figure 1. The geographic areas referenced in each of the 11 desired future conditions, numbered in the same way as they are above, are shown in Figure 2. Figure 3 shows the location of the aquifer relative to regional water planning areas, river basins, and groundwater conservation districts.

As described above, the TWDB previously completed GAM Task 11-006 using the Groundwater Availability Model for the Seymour and Blaine aquifers to assist the members of Groundwater Management Area 6 in developing desired future conditions (Oliver, 2011). One of the simulations in GAM Task 11-006, Scenario 9, meets each of the desired future conditions for both the Seymour and Blaine aquifers. Because of this, the results of Scenario 9 were used for developing the modeled available groundwater estimates shown in this report.

PARAMETERS AND ASSUMPTIONS:

- We used version 1.01 of the groundwater availability model for the Seymour and Blaine aquifers. See Ewing and others (2004) for assumptions and limitations of the model.
- The results presented here were taken directly from the Scenario 9 groundwater availability model simulation in GAM Task 11-006. See Oliver (2011) for additional details about the methods and assumptions associated with the model run.
- The model includes two layers representing the Seymour Aquifer (Layer 1) and the Blaine Aquifer and other Permian sediments (Layer 2).
- The root mean squared error (a measure of the difference between simulated and measured water levels during model calibration) for the entire model for the period of 1990 to 1999 is 19.6 feet for the Seymour Aquifer and 26.4 feet for the Blaine Aquifer. This represents one percent and three percent of the range of measured water levels, respectively (Ewing and others, 2004).
- Average annual recharge conditions were assumed in the simulation based on 1975 to 1999 climate data.

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. 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 Seymour Aquifer in Groundwater Management Area 6 consistent with the desired future conditions declines from approximately 174,000 acre-feet per year to 148,000 acre-feet per year between 2010 and 2060. Table 1 contains the modeled available groundwater subdivided by county, regional water planning area, and river basin for use in the regional water planning process.

Tables 2, 3, 4, 5, and 6 contain the modeled available groundwater summarized by county, regional water planning area, river basin, geographic area, and groundwater conservation district, respectively. In tables 2, 3, 4, and 6, the results have been subdivided by geographic area as well.

LIMITATIONS:

The groundwater model used in developing estimates of modeled available groundwater is the best available scientific tool that can be used to estimate the pumping that will achieve the desired future conditions. Although the groundwater model used in this analysis is the best available scientific tool for this purpose, it, like all models, has limitations. 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 develop estimates of modeled available groundwater is the need to make assumptions about the location in the aquifer where future pumping will occur. 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 condition of the groundwater resources in the area that relate to the adopted desired future condition.

Given these limitations, users of this information are cautioned that the modeled available groundwater numbers should not be considered a definitive, permanent description of the amount of groundwater that can be pumped to meet the adopted desired future condition. 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 as well as whether or not they are achieving their desired future conditions. 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 these modeled available groundwater numbers given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future.

REFERENCES:

Ewing, J.E., Jones, T.L., Pickens, J.F., Chastain-Howley, A., Dean, K.E., Spear, A.A., 2004, Groundwater availability model for the Seymour Aquifer: Final report prepared for the Texas Water Development Board by INTERA, Inc., 533 p.

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.

Oliver, W, 2011, GAM Task 11-006, Texas Water Development Board GAM Task Report, 26 p.

TABLE 1: MODELED AVAILABLE GROUNDWATER FOR THE SEYMOUR AQUIFER IN GROUNDWATER MANAGEMENT AREA 6. RESULTS ARE IN ACRE-FEET PER YEAR AND ARE DIVIDED BY COUNTY, REGIONAL WATER PLANNING AREA, AND RIVER BASIN.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Archer	B	Red	35	35	35	35	35	35
Baylor	B	Brazos	3,207	3,168	3,168	3,168	3,168	3,168
		Red	681	642	619	619	619	619
Childress	A	Red	716	732	717	712	712	712
Clay	B	Red	787	787	787	787	787	787
Collingsworth	A	Red	17,542	16,010	14,250	13,348	11,329	10,241
Fisher	G	Brazos	2,936	2,935	2,931	2,920	2,915	2,733
Foard	B	Red	4,907	4,906	4,691	4,662	4,662	4,691
Hall	A	Red	12,406	12,020	11,462	10,866	11,085	11,172
Hardeman	B	Red	430	430	430	431	431	431
Haskell	G	Brazos	49,464	46,180	44,575	42,358	42,524	43,617
Jones	G	Brazos	2,918	2,918	2,918	2,918	2,918	2,918
Kent	G	Brazos	1,184	1,181	1,180	1,180	1,179	1,179
Knox	G	Brazos	40,076	37,628	34,244	30,288	28,569	30,979
		Red	2,350	1,591	1,365	1,213	1,136	1,061
Motley	O	Red	1,783	1,776	1,769	1,769	1,685	1,685
Stonewall	G	Brazos	240	233	230	224	215	214
Throckmorton	G	Brazos	115	115	115	115	115	115
Wichita	B	Red	2,240	2,295	2,295	2,288	2,291	2,291
Wilbarger	B	Red	29,263	29,421	29,421	29,421	29,297	28,925
Young	G	Brazos	309	309	258	258	258	258
Total			**173,589**	**165,312**	**157,460**	**149,580**	**145,930**	**147,831**

TABLE 2: MODELED AVAILABLE GROUNDWATER FOR THE SEYMOUR AQUIFER BY COUNTY AND GEOGRAPHIC AREA FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

County	Geographic Area	Year					
		2010	2020	2030	2040	2050	2060
Archer	5	35	35	35	35	35	35
Baylor	6	3,888	3,810	3,787	3,787	3,787	3,787
Childress	1	68	54	54	33	33	33
	2	164	194	179	179	179	179
	3	484	484	484	500	500	500
Clay	5	787	787	787	787	787	787
Collingsworth	1	17,542	16,010	14,250	13,348	11,329	10,241
Fisher	10	2,936	2,935	2,931	2,920	2,915	2,733
Foard	3	4,907	4,906	4,691	4,662	4,662	4,691
Hall	1	12,406	12,020	11,462	10,866	11,085	11,172
Hardeman	3	430	430	430	431	431	431
Haskell	6	49,464	46,180	44,575	42,358	42,524	43,617
Jones	11	2,918	2,918	2,918	2,918	2,918	2,918
Kent	9	1,184	1,181	1,180	1,180	1,179	1,179
Knox	6	42,426	39,219	35,609	31,501	29,705	32,040
Motley	3	1,783	1,776	1,769	1,769	1,685	1,685
Stonewall	7	203	203	203	203	203	203
	9	37	30	27	21	12	11
Throckmorton	8	115	115	115	115	115	115
Wichita	4	334	334	334	334	337	337
	5	1,906	1,961	1,961	1,954	1,954	1,954
Wilbarger	4	29,263	29,421	29,421	29,421	29,297	28,925
Young	8	309	309	258	258	258	258
Total		**173,589**	**165,312**	**157,460**	**149,580**	**145,930**	**147,831**

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

Region	*Geographic Area*	*Year*					
		2010	*2020*	*2030*	*2040*	*2050*	*2060*
A	1	30,016	28,084	25,766	24,247	22,447	21,446
	2	164	194	179	179	179	179
	3	484	484	484	500	500	500
B	3	5,337	5,336	5,121	5,093	5,093	5,122
	4	29,597	29,755	29,755	29,755	29,634	29,262
	5	2,728	2,783	2,783	2,776	2,776	2,776
	6	3,888	3,810	3,787	3,787	3,787	3,787
G	6	91,890	85,399	80,184	73,859	72,229	75,657
	7	203	203	203	203	203	203
	8	424	424	373	373	373	373
	9	1,221	1,211	1,207	1,201	1,191	1,190
	10	2,936	2,935	2,931	2,920	2,915	2,733
	11	2,918	2,918	2,918	2,918	2,918	2,918
O	3	1,783	1,776	1,769	1,769	1,685	1,685
Total		**173,589**	**165,312**	**157,460**	**149,580**	**145,930**	**147,831**

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

Basin	Geographic Area	Year					
		2010	2020	2030	2040	2050	2060
Brazos	6	92,747	86,976	81,987	75,814	74,261	77,764
	7	203	203	203	203	203	203
	8	424	424	373	373	373	373
	9	1,221	1,211	1,207	1,201	1,191	1,190
	10	2,936	2,935	2,931	2,920	2,915	2,733
	11	2,918	2,918	2,918	2,918	2,918	2,918
Red	1	30,016	28,084	25,766	24,247	22,447	21,446
	2	164	194	179	179	179	179
	3	7,604	7,596	7,374	7,362	7,278	7,307
	4	29,597	29,755	29,755	29,755	29,634	29,262
	5	2,728	2,783	2,783	2,776	2,776	2,776
	6	3,031	2,233	1,984	1,832	1,755	1,680
Total		**173,589**	**165,312**	**157,460**	**149,580**	**145,930**	**147,831**

TABLE 5: MODELED AVAILABLE GROUNDWATER FOR THE SEYMOUR AQUIFER BY GEOGRAPHIC AREA FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

Geographic Area	Year					
	2010	2020	2030	2040	2050	2060
1	30,016	28,084	25,766	24,247	22,447	21,446
2	164	194	179	179	179	179
3	7,604	7,596	7,374	7,362	7,278	7,307
4	29,597	29,755	29,755	29,755	29,634	29,262
5	2,728	2,783	2,783	2,776	2,776	2,776
6	95,778	89,209	83,971	77,646	76,016	79,444
7	203	203	203	203	203	203
8	424	424	373	373	373	373
9	1,221	1,211	1,207	1,201	1,191	1,190
10	2,936	2,935	2,931	2,920	2,915	2,733
11	2,918	2,918	2,918	2,918	2,918	2,918
Total	**173,589**	**165,312**	**157,460**	**149,580**	**145,930**	**147,831**

TABLE 6: MODELED AVAILABLE GROUNDWATER FOR THE SEYMOUR AQUIFER BY GROUNDWATER CONSERVATION DISTRICT (GCD) AND GEOGRAPHIC AREA FOR EACH DECADE BETWEEN 2010 AND 2060. RESULTS ARE IN ACRE-FEET PER YEAR.

District	Geographic Area	Year					
		2010	2020	2030	2040	2050	2060
Clear Fork GCD	10	2,936	2,935	2,931	2,920	2,915	2,733
Gateway GCD	2	164	194	179	179	179	179
	3	7,604	7,596	7,374	7,362	7,278	7,307
Mesquite GCD	1	30,016	28,084	25,766	24,247	22,447	21,446
Rolling Plains GCD	6	95,778	89,209	83,971	77,646	76,016	79,444
No District	4	29,597	29,755	29,755	29,755	29,634	29,262
	5	2,728	2,783	2,783	2,776	2,776	2,776
	7	203	203	203	203	203	203
	8	424	424	373	373	373	373
	9	1,221	1,211	1,207	1,201	1,191	1,190
	11	2,918	2,918	2,918	2,918	2,918	2,918
Total		**173,589**	**165,312**	**157,460**	**149,580**	**145,930**	**147,831**

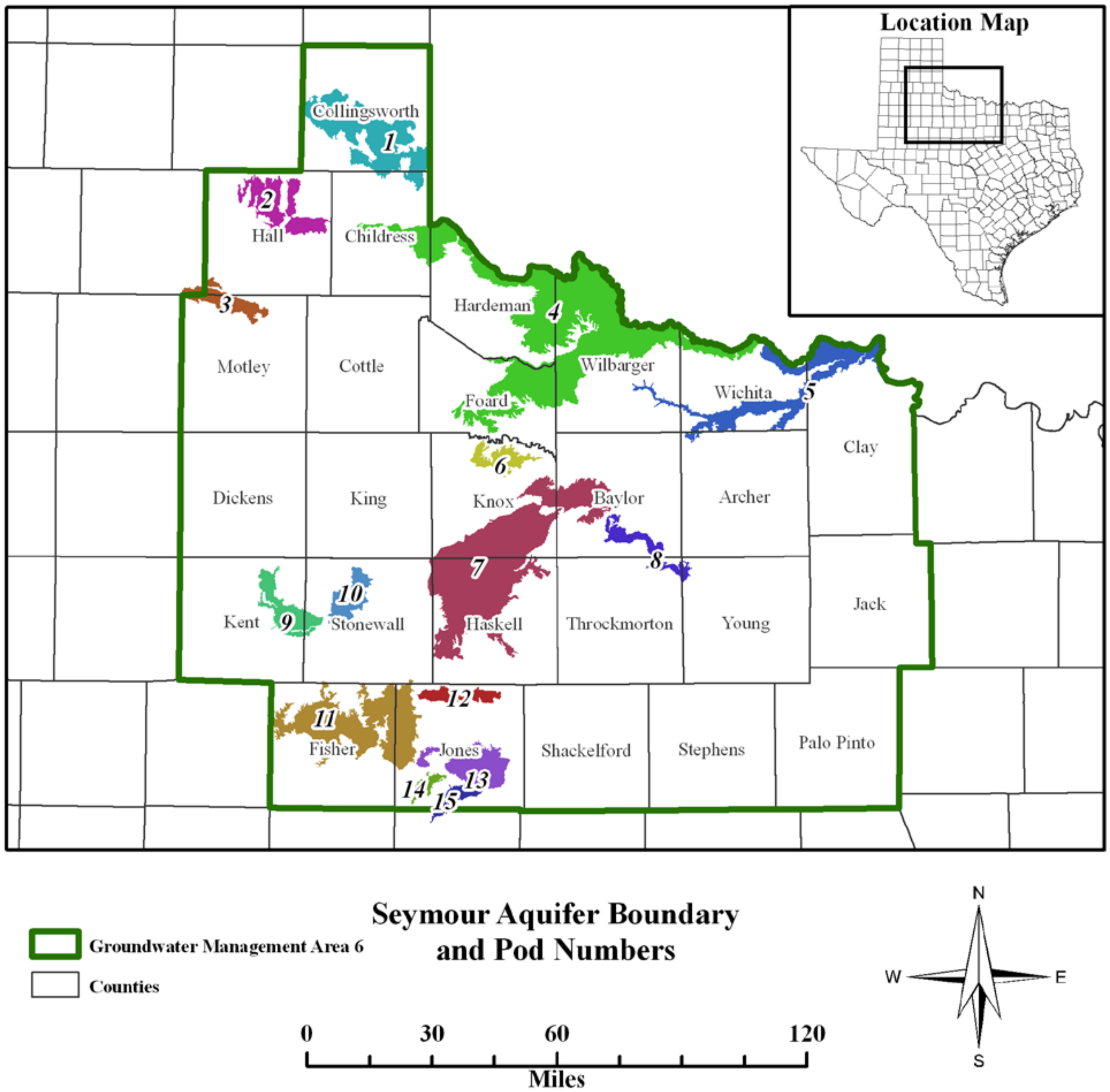

FIGURE 1: MAP SHOWING THE PODS MAKING UP THE SEYMOUR AQUIFER WITHIN GROUNDWATER MANAGEMENT AREA 6.

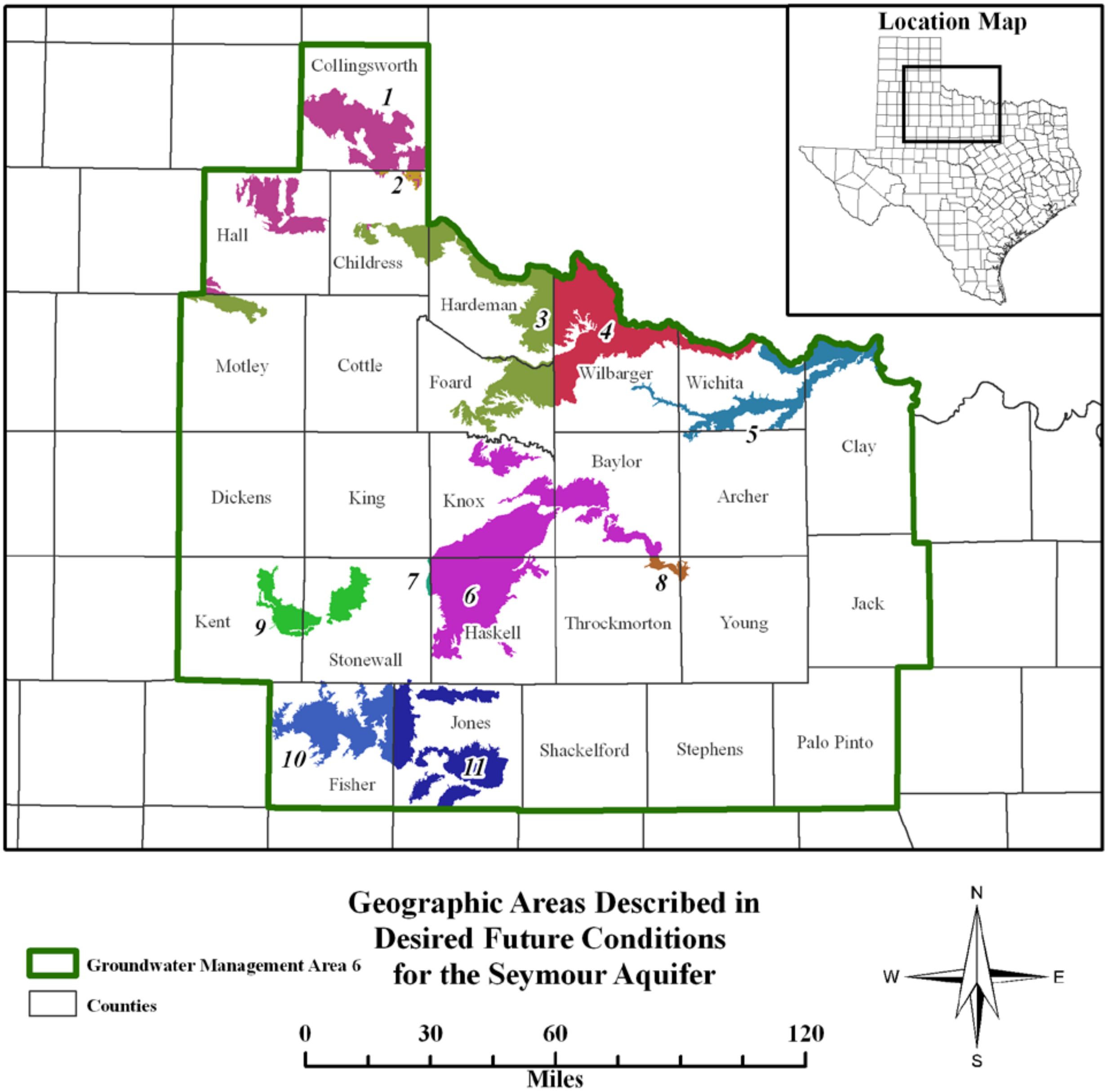

FIGURE 2: MAP SHOWING THE GEOGRAPHIC AREAS DESCRIBED IN THE DESIRED FUTURE CONDITIONS FOR THE SEYMOUR AQUFIER WITHIN GROUNDWATER MANAGEMENT AREA 6.

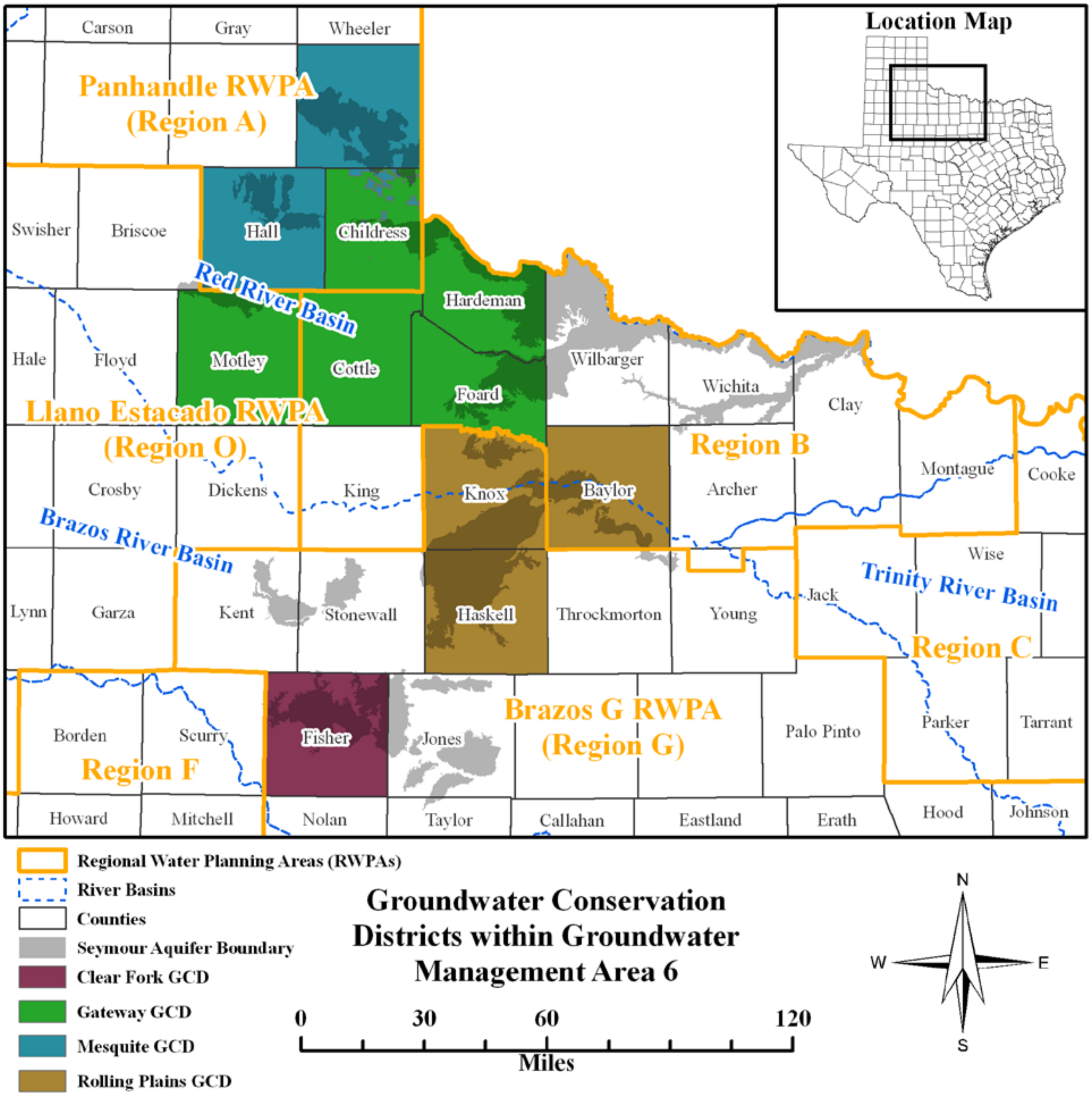

FIGURE 3: MAP SHOWING GROUNDWATER CONSERVATION DISTRICTS, REGIONAL WATER PLANNING AREAS, COUNTIES, AND RIVER BASINS IN AND NEIGHBORING GROUNDWATER MANAGEMENT AREA 6.

Estimated Historical Water Use And 2012 State Water Plan Datasets:

Clear Fork Groundwater Conservation District

by Stephen Allen
Texas Water Development Board
Groundwater Resources Division
Groundwater Technical Assistance Section
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(512) 463-7317
February 4, 2015

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/GMPChecklist0113.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 Texas State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report. The District should have received, or will receive, this report from the Groundwater Availability Modeling Section. Questions about the GAM can be directed to Dr. Shirley Wade, shirley.wade@twdb.texas.gov, (512) 936-0883.

DISCLAIMER:

The data presented in this report represents the most up-to-date WUS and 2012 SWP data available as of 2/4/2015. Although it does not happen frequently, neither of these datasets are static so they are subject to change pending the availability of more accurate WUS data or an amendment to the 2012 SWP. District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

The WUS dataset can be verified at this web address:

http://www.twdb.texas.gov/waterplanning/waterusesurvey/estimates/

The 2012 SWP dataset can be verified by contacting Sabrina Anderson (sabrina.anderson@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 historical use estimates are currently unavailable for calendar year 2013. TWDB staff anticipates the calculation and posting of these estimates at a later date.

FISHER COUNTY

All values are in acre-fee/year

Year	Source	Municipal	Manufacturing	Mining	Steam Electric	Irrigation	Livestock	Total
2012	GW	631	147	14	0	5,290	228	6,310
	SW	327	2	2	0	0	342	673
2011	GW	577	126	216	0	5,462	361	6,742
	SW	297	2	52	0	0	542	893
2010	GW	546	104	88	0	4,393	337	5,468
	SW	235	1	21	0	0	506	763
2009	GW	318	131	114	0	5,348	264	6,175
	SW	326	1	27	0	0	396	750
2008	GW	400	162	139	0	5,274	284	6,259
	SW	328	1	34	0	0	425	788
2007	GW	686	146	0	0	4,057	222	5,111
	SW	365	2	0	0	0	332	699
2006	GW	332	152	0	0	4,990	257	5,731
	SW	129	8	0	0	0	386	523
2005	GW	410	159	0	0	3,470	242	4,281
	SW	136	1	0	0	0	363	500
2004	GW	605	159	0	0	2,844	57	3,665
	SW	528	4	0	0	0	511	1,043
2003	GW	602	159	0	0	2,664	56	3,481
	SW	528	1	0	0	0	501	1,030
2002	GW	202	159	0	0	3,139	58	3,558
	SW	212	1	0	0	32	519	764
2001	GW	100	159	0	0	2,707	59	3,025
	SW	567	14	0	0	27	530	1,138
2000	GW	217	158	0	0	2,446	58	2,879
	SW	578	9	0	0	13	526	1,126

Projected Surface Water Supplies
TWDB 2012 State Water Plan Data

FISHER COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	Source Name	2010	2020	2030	2040	2050	2060
G	IRRIGATION	BRAZOS	BRAZOS RIVER COMBINED RUN-OF-RIVER IRRIGATION	757	757	757	757	758	758
G	LIVESTOCK	BRAZOS	LIVESTOCK LOCAL SUPPLY	585	585	585	585	585	585
G	ROTAN	BRAZOS	COLORADO RIVER MWD LAKE/RESERVOIR SYSTEM	278	271	249	231	222	203
	Sum of Projected Surface Water Supplies (acre-feet/year)			**1,620**	**1,613**	**1,591**	**1,573**	**1,565**	**1,546**

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.

FISHER COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
G	MANUFACTURING	BRAZOS	192	225	255	284	310	336
G	MINING	BRAZOS	375	359	354	349	344	337
G	COUNTY-OTHER	BRAZOS	185	181	155	134	124	97
G	ROTAN	BRAZOS	278	271	249	231	222	203
G	ROBY	BRAZOS	76	75	75	74	74	76
G	IRRIGATION	BRAZOS	2,386	2,314	2,245	2,178	2,113	2,049
G	LIVESTOCK	BRAZOS	585	585	585	585	585	585
G	BITTER CREEK WSC	BRAZOS	117	114	113	111	110	113
	Sum of Projected Water Demands (acre-feet/year)		**4,194**	**4,124**	**4,031**	**3,946**	**3,882**	**3,796**

Projected Water Supply Needs
TWDB 2012 State Water Plan Data

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

FISHER COUNTY

All values are in acre-feet/year

RWPG	WUG	WUG Basin	2010	2020	2030	2040	2050	2060
G	BITTER CREEK WSC	BRAZOS	136	139	140	142	143	140
G	COUNTY-OTHER	BRAZOS	64	68	94	115	125	152
G	IRRIGATION	BRAZOS	2,295	2,367	2,436	2,503	2,569	2,633
G	LIVESTOCK	BRAZOS	0	0	0	0	0	0
G	MANUFACTURING	BRAZOS	148	115	85	56	30	4
G	MINING	BRAZOS	208	224	229	234	239	246
G	ROBY	BRAZOS	255	256	256	257	257	255
G	ROTAN	BRAZOS	0	0	0	0	0	0
	Sum of Projected Water Supply Needs (acre-feet/year)		**0**	**0**	**0**	**0**	**0**	**0**

Projected Water Management Strategies
TWDB 2012 State Water Plan Data

GAM Run 14-007: Clear Fork Groundwater Conservation District Management Plan

by Shirley C. Wade, Ph.D., P.G.
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Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 936-0883
July 25, 2014

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7/25/14

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GAM RUN 14-007: CLEAR FORK GROUNDWATER CONSERVATION DISTRICT MANAGEMENT PLAN

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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h) (Texas Water Code, 2011), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the executive administrator of the Texas Water Development Board (TWDB) 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.

This report—Part 2 of a two-part package of information from the TWDB to the Clear Fork Groundwater Conservation District—fulfills the requirements noted above. Part 1 of the two-part package is the Historical Water Use/State Water Plan data report. The District will receive this data report from the TWDB Groundwater Technical Assistance Section. Questions about the data report can be directed to Mr. Stephen Allen, stephen.allen@twdb.texas.gov, (512) 463-7317.

The groundwater management plan for the Clear Fork Groundwater Conservation District should be adopted by the district on or before July 27, 2015 and submitted to the executive administrator of the TWDB on or before August 26, 2015. The current management plan for the Clear Fork Groundwater Conservation District expires on October 25, 2015.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the Dockum Aquifer and the Seymour and Blaine aquifers. This model run replaces the results of GAM Run 09-017 (Oliver, 2009). GAM Run 14-007 meets current standards set after the release of GAM Run 09-017. Tables 1 and 2 summarize the groundwater availability model data required by statute, and Figures 1 and 2 show the area of the models from which the values in the table were extracted. If after review of the figures, the Clear Fork Groundwater Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB immediately.

The Blaine Aquifer has been designated as a minor aquifer within Clear Fork Groundwater Conservation District; however, at the time the groundwater availability model for the Seymour and Blaine aquifers was developed in 2004 the Permian units within the district were not considered part of the Blaine Aquifer. Consequently the model does not represent the portion of the Blaine Aquifer within the district. If the district would like information for the Blaine Aquifer, they may request it from the Groundwater Technical Assistance Section of the Texas Water Development Board.

METHODS:

In accordance with the provisions of the Texas State Water Code, Section 36.1071, Subsection (h), the groundwater availability models for the Dockum Aquifer (Ewing and others, 2008) and the Seymour and Blaine aquifers (Ewing and others, 2004) were run for this analysis. Clear Fork Groundwater Conservation District water budgets were extracted for the historical model period (1980 through 1999) using ZONEBUDGET Version 3.01 (Harbaugh, 2009). The average 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) for the portion of the aquifer located within the district is summarized in this report.

PARAMETERS AND ASSUMPTIONS:

Dockum Aquifer

- We used version 1.01 of the groundwater availability model for the Dockum Aquifer. See Ewing and others (2008) for assumptions and limitations of the groundwater availability model for the Dockum Aquifer.

- This groundwater availability model includes three layers which generally represent the Ogallala, Edwards-Trinity (High Plains), Edwards-Trinity (Plateau), Pecos Valley, and Rita Blanca aquifers (Layer 1), the upper portion of the Dockum Aquifer (Layer 2), and the lower portion of the Dockum Aquifer (Layer 3).

- The geologic units represented in Layer 1 of the groundwater availability model are only included in the model for the purpose of more accurately representing flow between these units and the Dockum Aquifer. This model is not intended to explicitly simulate flow in these overlying units (Ewing and others, 2008).

- The MODFLOW Drain package was used to simulate both evapotranspiration and springs. Only drain flow from model grid cells representing springs within the district were incorporated into the surface water outflow values shown in Table 1.

- Groundwater in the Dockum Aquifer ranges from fresh to brine in composition (Ewing and others, 2008). Groundwater with total dissolved solids of less than 1,000 milligrams per liter is considered fresh, total dissolved solids of 1,000 to 10,000 milligrams per liter is considered brackish, and total dissolved solids greater than 35,000 milligrams per liter is considered brine.

- The model was run with MODFLOW-2000 (Harbaugh and others, 2000).

Seymour and Blaine Aquifers

- We used version 1.01 of the groundwater availability model for the Seymour and Blaine aquifers. See Ewing and others (2004) for assumptions and limitations of the groundwater availability model.

- This groundwater availability model includes two layers, representing the Seymour (layer 1) and Blaine (layer 2) aquifers. In areas where the Blaine

Aquifer was not designated as an aquifer in 2004 layer 2 of the model roughly represents the various Permian units located in the study area. After the groundwater availability model was released the boundary of the Blaine Aquifer was extended and now includes the Clear Fork Groundwater Conservation District. However, the groundwater availability model for the Seymour and Blaine aquifers does not represent the Blaine Aquifer within the district at this time.

- The model was run with MODFLOW-2000 (Harbaugh and McDonald, 2000).

RESULTS:

A groundwater budget summarizes the amount of water entering and leaving the aquifer according to the groundwater availability model. Selected groundwater budget components listed below were extracted from the model results for the aquifers located within the district and averaged over the duration of the calibration and verification portion of the model run in the district, as shown in Tables 1 and 2.

- Precipitation recharge—The areally 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 springs.

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

- Flow between aquifers—The net vertical flow between the aquifer and adjacent 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.

It is important to 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 a district or county boundary, 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.

TABLE 1: SUMMARIZED INFORMATION FOR THE DOCKUM AQUIFER THAT IS NEEDED FOR THE CLEAR FORK 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	Dockum Aquifer	2,095
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Dockum Aquifer	319
Estimated annual volume of flow into the district within each aquifer in the district	Dockum Aquifer	65
Estimated annual volume of flow out of the district within each aquifer in the district	Dockum Aquifer	98
Estimated net annual volume of flow between each aquifer in the district	Not Applicable[1]	Not Applicable

[1] The Dockum Aquifer Groundwater Availability Model assumes a no-flow boundary condition at the base.

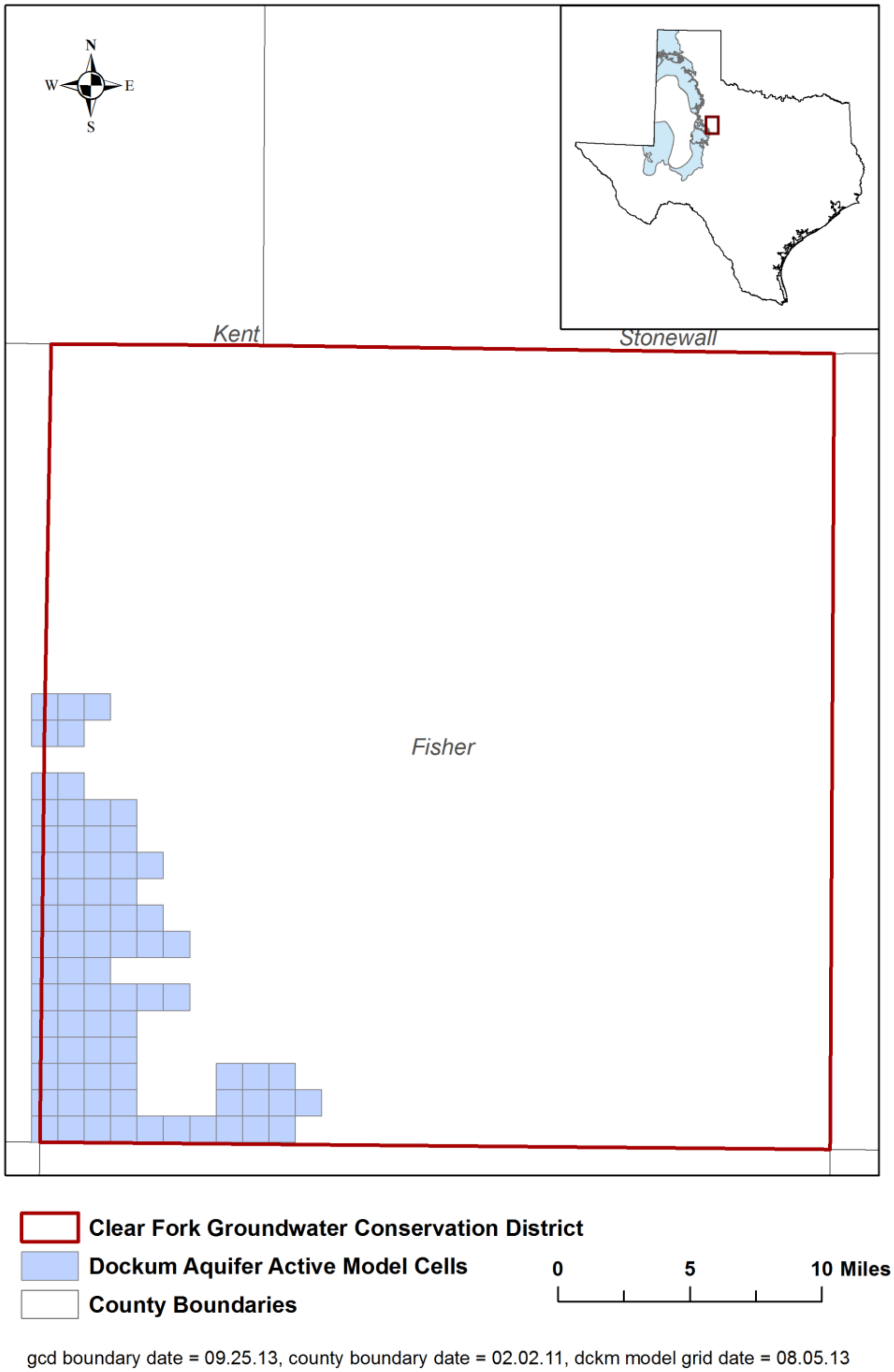

FIGURE 1: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE DOCKUM AQUIFER FROM WHICH THE INFORMATION IN TABLE 1 WAS EXTRACTED (THE DOCKUM AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

TABLE 2: SUMMARIZED INFORMATION FOR THE SEYMOUR AQUIFER THAT IS NEEDED FOR THE CLEAR FORK 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	Seymour Aquifer	12,261
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers	Seymour Aquifer	3,011
Estimated annual volume of flow into the district within each aquifer in the district	Seymour Aquifer	0
Estimated annual volume of flow out of the district within each aquifer in the district	Seymour Aquifer	459
Estimated net annual volume of flow between each aquifer in the district	From underlying Permian units to the Seymour Aquifer	436

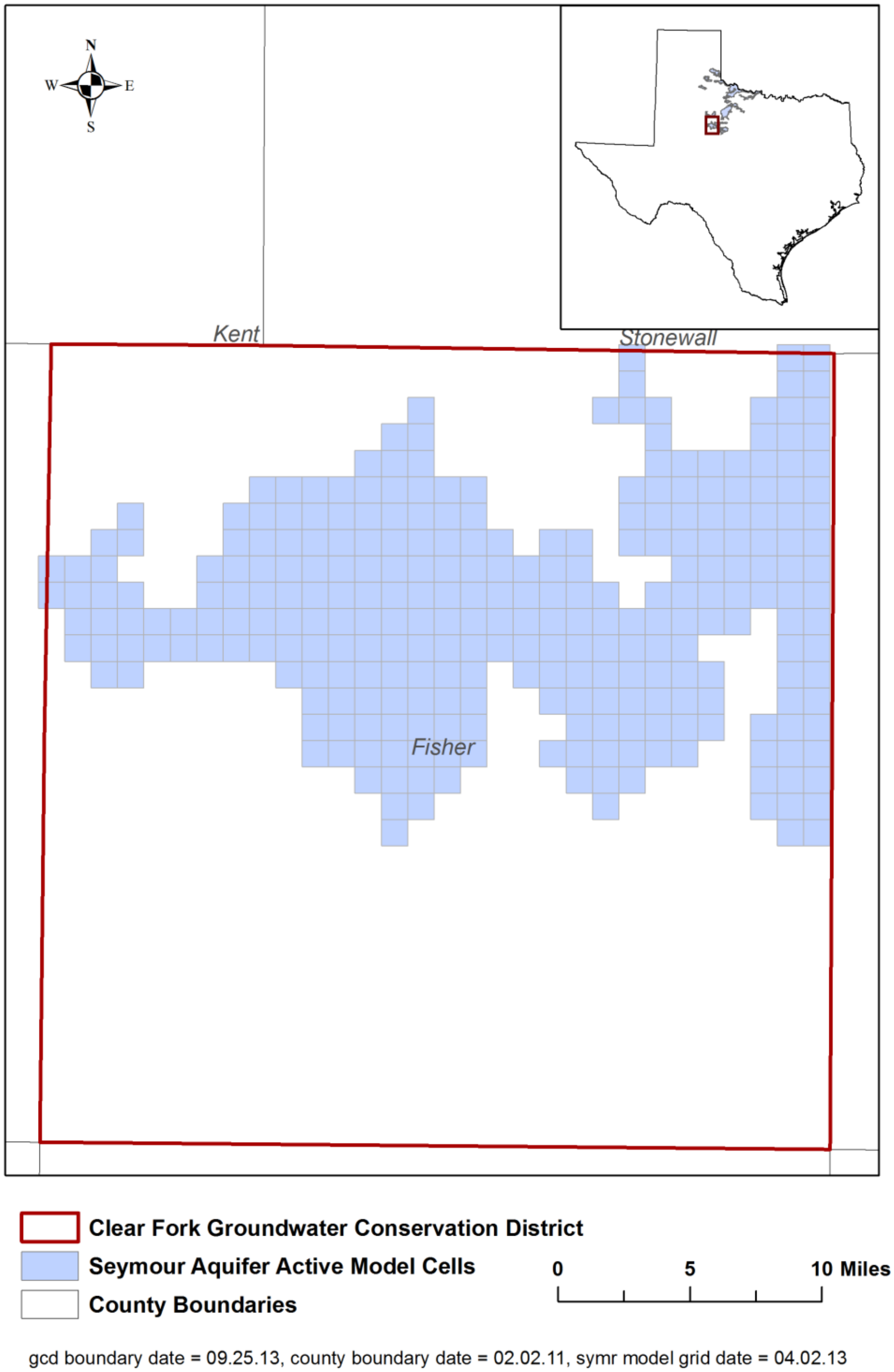

FIGURE 2: AREA OF THE GROUNDWATER AVAILABILITY MODEL FOR THE SEYMOUR AQUIFER FROM WHICH THE INFORMATION IN TABLE 2 WAS EXTRACTED (THE SEYMOUR AQUIFER EXTENT WITHIN THE DISTRICT BOUNDARY).

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 interaction with streams are specific to particular historic time periods.

Because the application of the groundwater models was designed to address regional scale questions, the results are most effective on a regional scale. The TWDB makes no warranties or representations related 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.

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