# JEFF DAVIS COUNTY UNDERGROUND WATER CONSERVATION DISTRICT

# MANAGEMENT PLAN

# 2013-2018

Adopted November 5, 2013

# DISTRICT MISSION

The Jeff Davis County Underground Water Conservation District will strive to develop, promote, and implement water conservation and management strategies to protect water resources for the benefit of the citizens, economy, and environment of the District.

# TIME PERIOD FOR THIS PLAN

This plan becomes effective upon adoption by the District Board of Directors and approved by the Texas Water Development Board (TWDB) affirming the plan is administratively complete. This plan replaces the existing plan adopted by the District Board of Directors on June 8, 1998. This District management plan will remain in effect until September 1, 2018, or until a revised plan is approved by the TWDB, which ever is earlier.

# STATEMENT OF GUIDING PRINCIPLES

The District recognizes that the groundwater resources of the county are of vital importance. The preservation of this most valuable resource can be managed in a prudent and cost effective manner through education, regulations, and permitting. The greatest threat to prevent the District from achieving the stated mission is inappropriate management, based in part on the lack of understanding of local conditions. A basic understanding of the aquifers and their hydrogeologic properties, as well as a quantification of resources is the foundation from which to build prudent planning measures. The goals of this plan can best be achieved through guidance from the locally elected board members who have an understanding of local conditions as well as technical support from the Texas Water Development Board and qualified consulting agencies. This management plan is intended as a tool to focus the thoughts and actions of those given the responsibility for the execution of the District activities.

## General Description of the District

### History

The citizens of Jeff Davis County through an election created the District, November 2, 1993. The current Board of Directors are Johnny Wofford - Chairman, W. W. McElroy - Vice-Chairman, - Secretary, Bud Coffey, Jim Dyer and Jim Espy. The District Manager is Janet Adams. Jeff Davis County Underground Water Conservation District (JDCUWCD) covers all of Jeff Davis County. The agricultural community dominates the county's economy. The agricultural income is derived mainly from cattle. Tourism and hunting also contribute to the income of the county.

**Location and Extent**

Jeff Davis County, having areal extent of 2258 square miles, with 100 % being in the District is located in west Texas. The county is bounded on the east by Pecos County, on the north by Reeves County, on the west by Culberson County, and on the south by Brewster and Presidio Counties. Fort Davis, which is located on the east side of the county, is the county seat. Valentine, is the only other town in the county, is located in the west portion of the county.

**Topography**

Jeff Davis County is located in the mountains of West Texas. The county has the highest average elevation in the state of Texas with one mile or higher altitudes. The county consists of peaks, canyons, and plateaus.

## Groundwater Resources of Jeff Davis County

In the Jeff Davis County Underground Water Conservation District, the Texas Water Development Board lists several aquifers, which account for the known groundwater resources of the District. These include the Edwards-Trinity (Plateau), the West Texas Bolsons, of which there are several divisions, and the Igneous areas of the District. Due to the lack of scientific study, the aquifers are not well defined geographically. The TWDB also lists a small portion of the Cenozoic Pecos Alluvium Aquifer along the northeaster boundary of the District.

Not included in the table below are two very minor aquifers in Jeff Davis County.

1. Capitan Reef
   - 12,100 acres - Areal Extent
     - 341 estimated acre feet of recharge annually

2. Rustler Aquifer
   - 101,881 acres – Areal Extent
     - 780 estimated acre feet of recharge

## Additional Amount of Natural/Artificial Recharge That Would Feasible Be Achieved

The additional amount of natural or artificial recharge that would be realized from implementation of feasible weather modification would be an 8% increase in rainfall. This would result in a 703.5-acre feet increase in recharge. This data was obtained from the direct gathering of evidence of the High Plains Water District of their weather modification program.

**Water exported out of Jeff Davis County Underground Conservation District is as follows from Jeff Davis County:**

| | |
|---|---|
| **2012** | **1336 acre-feet/year** |
| **2011** | **866 acre-feet/year** |
| **2010** | **796 acre-feet/year** |
| **2009** | **839 acre-feet/year** |
| **2008** | **1070 acre-feet/year** |
| **2007** | **992 acre-feet/year** |
| **2006** | **939 acre-feet/year** |
| **2005** | **983 acre-feet/year** |
| **2004** | **1182 acre-feet/year** |
| **2003** | **1232 acre-feet/year** |
| **2002** | **1282 acre-feet/year** |
| **2001** | **1184 acre-feet/year** |
| **2000** | **1225 acre-feet/year** |
| **1999** | **1073 acre-feet/year** |
| **1998** | **1154 acre-feet/year** |

This data was obtained from meters read by JDCUWCD.

## Groundwater Availability Modeling Estimates

Please refer to Appendix B, C, D

## Historical Groundwater use in Jeff Davis County

Please refer to Appendix A.

## Projected Surface Water Supplies

Please refer to Appendix A.

## Projected Water Demands

Please refer to Appendix A.

## Projected Water Supply Needs

Please refer to Appendix A.

## Projected Water Management Strategies

Please refer to Appendix A.

## Management of Groundwater Supplies

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 the resource user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will identify and engage in such activities and practices, that if implemented would result a reduction of groundwater use. An observation network shall be established and maintained in order to monitor changing storage conditions of groundwater supplies within the District. The District will make regular assessments of water supply and groundwater storage conditions and will report those conditions to the Board and to the public. The district will undertake, as necessary and co-operate with investigations of the groundwater resources within the District and will make the results of investigations available to the public upon adoption of the Board.

The District has rules to regulate groundwater withdrawals by means of production limits. The District may deny a well construction permit or limit groundwater withdrawals in accordance with the guidelines stated in the rules of the District. In making a determination to deny a permit or limit groundwater withdrawals, the District will consider the public benefit against individual hardship after considering all appropriate testimony.

The relevant factors to be considered in making a determination to deny a permit or limit groundwater withdrawals will include:
1) The purpose of the rules of the District
2) The equitable distribution of the resources
3) The economic hardship resulting from grant or denial of a permit or the terms prescribed by the permit

In pursuit of the Districts mission of protecting the resource, the District may require reduction of groundwater withdrawals to amounts, which will not cause harm to the aquifer. To achieve this purpose, the District may, at the Boards discretion amend or revoke any permit after notice and hearing. The determination to seek the amendment or revocation of a permit by the District will be based on aquifer conditions observed by the District. The District will enforce the terms and conditions of permits and the rules of the District by enjoining the permit holder in a court of competent jurisdiction as provide for in TWC 36.102.

## Actions, Procedures, Performance and Avoidance for Plan Implementation

The District will implement the provisions of this plan and will utilize the provision of this 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 provision of this plan.

The District will adopt rules relating to the permitting of wells and the production of groundwater. The rules adopted by the District shall be pursuant to TWC 36 and the provisions of this plan. All rules will be adhered to and enforced. The promulgation and enforcement of the rules will be based on 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 effects or unique local conditions. In granting of discretion to any rule, the Board shall consider the potential for adverse effects on adjacent landowners. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

The District will seek the cooperation in the implementation of the plan and management of groundwater supplies within the District. All activities of the District will be undertaken in co-operation and coordinated with the appropriate state, regional, or local water management entity.

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

The District manager will prepare and present an annual report to the Board of Directors on District performance in regards to achieving management goals and objectives (during last monthly Board of Directors meeting each fiscal year, beginning December 31, 2000). The report will include the number of instances each activity was engaged in during the year, referenced to the expenditure of staff time and budget so that the effectiveness and efficiency of each activity may be evaluated.

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

## GOALS, MANAGEMENT OBJECTIVES And PERFORMANCE STANDARDS

**Goal**

**1.0 Providing the Most Efficient Use of Groundwater.**

Management Objective

1.1 Each year, require meters to be installed on all new production wells.

Performance Standard

1.1a - Each year, provide a report to the Board of Directors indicating the number of meters installed on new wells in the District and the location and ownership.

Management Objective

1.2 All current existing rules and regulations will be reviewed and amended to address the needs of the District every three years.

Performance Standard

1.2a - Each year, report to the Board of Directors the number of changes required to keep District rules updated to District needs.

**Goal**
**2.0 Controlling and Preventing Waste of Groundwater.**

Management Objective
2.1 Each year, investigate all reports of wasteful practices within the District.

Performance Standards
2.1a - Each year, locate all complaint sites on a District map.

2.1b - Each year, provide a report to the Board of Directors indicating the number of complaint sites.

Management Objective
2.2 Each year, register all new wells drilled in the District.

Performance Standards
2.2a - District will maintain files including information on the drilling and completion of all new wells in the District.

2.2b - Annually report to the Board of Directors on the number of new wells registered during the year.

**Goal**
**3.0 Implement management strategies that will address drought conditions.**

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

Performance Standard
3.1a - The District staff will monitor the PDSI and report the number of times the PDSI is less than 1 (mild drought) to the District Board on a quarterly basis.

**Goal**
**4.0 Implement management strategies that will promote water conservation.**

Management Objective
4.1 Disperse educational information yearly regarding the current conservation practices for efficient use of water resources.

Performance Standard
4.1a - Each year, report to the Board of Directors the number of water conservation literature packets handed out.

**Goal**
**5.0 Rainwater Harvesting, Recharge Enhancement, Precipitation Enhancement, and Brush Control where appropriate.**

Management Objective: Rainwater Harvesting
5.1 Provide demonstrations on the rainwater harvesting system installed at District office.

Performance Standards
5.1a - District staff will provide information about rainwater harvesting through demonstrations of the system installed at District office

5.1b – Each year, report to the Board of Directors the number of demonstrations given on rainwater harvesting.

Recharge Enhancement
5.2 Not Applicable – not cost effective

Precipitation Enhancement
5.3 Not Applicable – not cost effective

Brush Control
5.4 Not Applicable – not cost effective

**Goal**
**6.0 Addressing the Desired Future Conditions.**

Management Objective
6.1 Conduct water level measurements at least annually on observation wells within the District

Performance Standards
6.1a Annually evaluate water level trends to insure that the aquifers conditions comply with the desired future conditions of the District

## SB - 1 MANAGEMENT GOALS DETERMINED NOT-APPLICABLE

**Goal**
**1.0 Control and prevention of subsidence.**

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

**Goal**
**2.0 Addressing natural resource issues that impact the use and availability of groundwater or that are impacted by the use of groundwater**

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

**Goal**
**3.0 Addressing conjunctive surface water management issues.**

There is no surface water within the District.

## SUMMARY DEFINITIONS

"Board" - the Board of Directors of the Jeff Davis County Underground Water Conservation District.

"District" - the Jeff Davis County Underground Water Conservation District.

"TWDB" - Texas Water Development Board.

"Waste" - as defined by Chapter 36 of the Texas Water Code means any one or more of the following:

1. Withdrawal of groundwater from a groundwater reservoir at a rate and in a amount that causes or threatens to cause intrusion into the reservoir of water unsuitable for agricultural, gardening, domestic, or stock raising purposes;

2. The flowing or producing of wells from a groundwater reservoir if the water produced is not used for a beneficial purpose;

3. Escape of groundwater from a groundwater reservoir to any other reservoir or geologic strata that does not contain groundwater;

4. Pollution or harmful alteration of groundwater in a groundwater reservoir by salt water or by other deleterious matter admitted from another stratum or from the surface of the ground;

5. Willfully or negligently causing, suffering, or allowing groundwater to escape into a river, creek, natural watercourse, depression, lake, reservoir, drain, sewer, street, highway, road, or road ditch, or onto any land other than that of the owner of the well unless such discharge is authorized by permit, rule, or order issued by the commission under Chapter 26 of the Texas Water Code;

6. Groundwater pumped for irrigation that escapes as irrigation tail water onto land other than that of the owner of the well unless permission has been granted by the occupant of the land receiving the discharge.

7. For water produced from an artesian well "waste" has the meaning assigned by Section 11.205 of the Texas Water Code.

# Appendix

# A

# Estimated Historical Water Use And 2012 State Water Plan Datasets:

## Jeff Davis County Underground Water Conservation District

by Stephen
Allen Texas Water Development Board
Groundwater Resources Division
Groundwater Technical Assistance
Section stephen.allen@twdb.texas.gov
(512) 463-7317
February 7, 2013

**GROUNDWATER MANAGEMENT PLAN DATA:**

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

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

The five reports included in part 1 are:

1. Estimated Historical Water Use (checklist Item 2)
   from the TWDB Historical Water Use Survey (WUS)
2. Projected Surface Water Supplies (checklist Item 6)
3. Projected Water Demands (checklist Item 7)
4. Projected Water Supply Needs (checklist Item 8)
5. Projected Water Management Strategies (checklist Item 9)
   reports 2-5 are from the 2012 State Water Plan (SWP)

Part 2 of the 2-part package is the groundwater availability model (GAM) report. The District should have received, 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 updated Historical Water Use and 2012 State Water Planning data available as of 2/7/2013. Although it does not happen frequently, neither of these datasets are static and are subject to change pending the availability of more accurate data (Historical Water Use data) or an amendment to the 2012 State Water Plan (2012 State Water Planning data). District personnel must review these datasets and correct any discrepancies in order to ensure approval of their groundwater management plan.

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

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

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

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

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

Groundwater and surface water historical use estimates are currently unavailable for calendar years 2005, 2011 and 2012. TWDB staff anticipates the calculation and posting of these estimates at a later date.

## JEFF DAVIS COUNTY

All values are in acre-feet/year

| Year | Source | Municipal | Manufacturing | Steam Electric | Irrigation | Mining | Livestock | Total |
|---|---|---|---|---|---|---|---|---|
| 1974 | GW | 192 | 12 | 0 | 692 | 0 | 728 | 1,624 |
| | SW | 0 | 0 | 0 | 100 | 0 | 0 | 100 |
| 1980 | GW | 229 | 0 | 0 | 26,000 | 0 | 643 | 26,872 |
| | SW | 0 | 0 | 0 | 0 | 0 | 34 | 34 |
| 1984 | GW | 261 | 0 | 0 | 2,274 | 0 | 475 | 3,010 |
| | SW | 27 | 0 | 0 | 38 | 0 | 25 | 90 |
| 1985 | GW | 284 | 0 | 0 | 2,028 | 0 | 508 | 2,820 |
| | SW | 30 | 0 | 0 | 41 | 0 | 26 | 97 |
| 1986 | GW | 280 | 0 | 0 | 3,094 | 0 | 377 | 3,751 |
| | SW | 25 | 0 | 0 | 31 | 0 | 19 | 75 |
| 1987 | GW | 264 | 0 | 0 | 2,273 | 0 | 296 | 2,833 |
| | SW | 17 | 0 | 0 | 253 | 0 | 15 | 285 |
| 1988 | GW | 330 | 0 | 0 | 4,272 | 0 | 333 | 4,935 |
| | SW | 0 | 0 | 0 | 754 | 0 | 17 | 771 |
| 1989 | GW | 363 | 0 | 0 | 1,603 | 0 | 520 | 2,486 |
| | SW | 32 | 0 | 0 | 19 | 0 | 27 | 78 |
| 1990 | GW | 330 | 0 | 0 | 2,924 | 0 | 513 | 3,767 |
| | SW | 24 | 0 | 0 | 325 | 0 | 27 | 376 |
| 1991 | GW | 305 | 0 | 0 | 2,226 | 0 | 523 | 3,054 |
| | SW | 12 | 0 | 0 | 0 | 0 | 28 | 40 |
| 1992 | GW | 317 | 0 | 0 | 2,419 | 0 | 520 | 3,256 |
| | SW | 15 | 0 | 0 | 269 | 0 | 27 | 311 |
| 1993 | GW | 352 | 0 | 0 | 173 | 0 | 456 | 981 |
| | SW | 25 | 0 | 0 | 93 | 0 | 24 | 142 |
| 1994 | GW | 378 | 0 | 0 | 191 | 0 | 440 | 1,009 |
| | SW | 72 | 0 | 0 | 75 | 0 | 23 | 170 |
| 1995 | GW | 455 | 0 | 0 | 173 | 0 | 376 | 1,004 |
| | SW | 53 | 0 | 0 | 93 | 0 | 20 | 166 |
| 1996 | GW | 386 | 0 | 0 | 173 | 0 | 376 | 935 |
| | SW | 38 | 0 | 0 | 93 | 0 | 20 | 151 |
| 1997 | GW | 365 | 0 | 0 | 173 | 0 | 360 | 898 |

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

Groundwater and surface water historical use estimates are currently unavailable for calendar years 2005, 2011 and 2012. TWDB staff anticipates the calculation and posting of these estimates at a later date.

| Year | Source | Municipal | Manufacturing | Steam Electric | Irrigation | Mining | Livestock | Total |
|---|---|---|---|---|---|---|---|---|
| 1997 | SW | 38 | 0 | 0 | 93 | 0 | 19 | 150 |
| 1998 | GW | 309 | 0 | 0 | 173 | 0 | 527 | 1,009 |
| | SW | 47 | 0 | 0 | 93 | 0 | 28 | 168 |
| 1999 | GW | 398 | 0 | 0 | 173 | 0 | 563 | 1,134 |
| | SW | 92 | 0 | 0 | 93 | 0 | 30 | 215 |
| 2000 | GW | 433 | 0 | 0 | 169 | 0 | 482 | 1,084 |
| | SW | 15 | 0 | 0 | 0 | 0 | 25 | 40 |
| 2001 | GW | 336 | 0 | 0 | 224 | 0 | 514 | 1,074 |
| | SW | 35 | 0 | 0 | 0 | 0 | 27 | 62 |
| 2002 | GW | 344 | 0 | 0 | 1,924 | 0 | 489 | 2,757 |
| | SW | 36 | 0 | 0 | 0 | 0 | 26 | 62 |
| 2003 | GW | 477 | 0 | 0 | 2,725 | 0 | 361 | 3,563 |
| | SW | 50 | 0 | 0 | 45 | 0 | 19 | 114 |
| 2004 | GW | 303 | 0 | 0 | 3,438 | 0 | 377 | 4,118 |
| | SW | 31 | 0 | 0 | 0 | 0 | 20 | 51 |
| 2006 | GW | 405 | 0 | 0 | 3,383 | 0 | 359 | 4,147 |
| | SW | 0 | 0 | 0 | 55 | 0 | 19 | 74 |
| 2007 | GW | 363 | 0 | 0 | 2,113 | 0 | 375 | 2,851 |
| | SW | 5 | 0 | 0 | 95 | 0 | 20 | 120 |
| 2008 | GW | 545 | 0 | 0 | 2,102 | 0 | 470 | 3,117 |
| | SW | 5 | 0 | 0 | 0 | 0 | 25 | 30 |
| 2009 | GW | 620 | 0 | 0 | 1,655 | 0 | 422 | 2,697 |
| | SW | 0 | 0 | 0 | 45 | 0 | 22 | 67 |
| 2010 | GW | 568 | 0 | 0 | 233 | 0 | 444 | 1,245 |
| | SW | 0 | 0 | 0 | 50 | 0 | 23 | 73 |

# Projected Surface Water Supplies
# TWDB 2012 State Water Plan Data

# 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.

## JEFF DAVIS COUNTY

All values are in acre-feet/year

| RWPG | WUG | WUG Basin | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|
| E | FORT DAVIS | RIO GRANDE | 343 | 403 | 444 | 484 | 524 | 565 |
| E | IRRIGATION | RIO GRANDE | 591 | 587 | 584 | 581 | 578 | 574 |
| E | LIVESTOCK | RIO GRANDE | 508 | 508 | 508 | 508 | 508 | 508 |
| E | COUNTY-OTHER | RIO GRANDE | 162 | 159 | 155 | 151 | 150 | 150 |
| | **Sum of Projected Water Demands (acre-feet/year)** | | **1,604** | **1,657** | **1,691** | **1,724** | **1,760** | **1,797** |

# Projected Water Supply Needs TWDB 2012
# State Water Plan Data

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

## JEFF DAVIS COUNTY

All values are in acre-feet/year

| RWPG | WUG | WUG Basin | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|---|---|---|---|---|---|---|---|---|
| E | COUNTY-OTHER | RIO GRANDE | 0 | 3 | 7 | 11 | 12 | 12 |
| E | FORT DAVIS | RIO GRANDE | 569 | 509 | 468 | 428 | 388 | 347 |
| E | IRRIGATION | RIO GRANDE | 2,716 | 2,720 | 2,723 | 2,726 | 2,729 | 2,733 |
| E | LIVESTOCK | RIO GRANDE | 55 | 55 | 55 | 55 | 55 | 55 |
| | **Sum of Projected Water Supply Needs (acre-feet/year)** | | **0** | **0** | **0** | **0** | **0** | **0** |

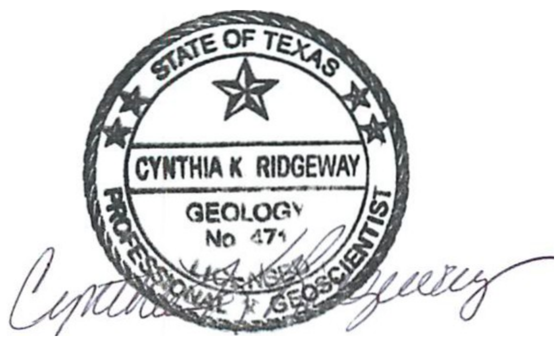
# Projected Water Management Strategies TWDB 2012 State Water Plan Data

# Appendix

# B

**GAM Run 10-036 MAG**
**by Mr. Wade Oliver**

Texas Water Development Board Groundwater Availability Mode ling Section (5 12) 463-3132
June 22, 201 1




Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and 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 June 22, 20 11.

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## EXECUTIVE SUMMARY:

The estimated total pumping from the Igneous Aquifer that achieves the desired future conditions adopted by the members of Groundwater Management Area 4 is approximately 11,300 acre-feet per year. This is summarized by county, regional water planning area, and river basin as shown in Table 1. The estimated managed available groundwater for the Igneous Aquifer, the amount available for permitting, is approximately 10,100 acre-feet per year (Table 4). The total pumping estimates were determined by adjusting pumping in the aquifer to achieve the specified desired future conditions. The managed available groundwater was determined by subtracting estimated exempt pumping from the total pumping in each district.

## REQUESTOR:

Ms. Janet Adams of Jeff Davis County Underground Water Conservation District and Presidio County Underground Water Conservation District on behalf of Groundwater Management Area 4

## DESCRIPTION OF REQUEST:

In a letter dated August 13, 2010 and received August 18, 2010, Ms. Adams provided the Texas Water Development Board (TWDB) with the desired future conditions of the Igneous Aquifer adopted by the members of Groundwater Management Area 4. The desired future conditions for the Igneous Aquifer, as described in Resolution No. R 2010-01 and adopted August 13, 2010, are shown below:

| Groundwate r Conse rvation District* | De sire d Future Condition (fe e t of |
|---|---|
| Brewster County GCD | 10 |
| Culberson County GCD | 66 |
| Jeff Davis County | 20 |
| Presidio County UWCD | 14 |

*Note that "GCD" refers to Groundwater Conservation District and "UWCD" refers to Underground Water Conservation District

In response to receiving the adopted desired future conditions, the Texas Water Development Board has estimated the managed available groundwater for the Igneous Aquifer within Groundwater Management Area 4.

## METHODS:

Groundwater Management Area 4 contains a portion of the Igneous Aquifer, a minor aquifer in Texas according to the 2007 State Water Plan (TWDB, 2007). The location of Groundwater Management Area 4, the Igneous Aquifer, and the groundwater availability model cells that represent the aquifer are shown in Figure 1.

The Texas Water Development Board previously completed several predictive groundwater availability model simulations of the Igneous Aquifer to assist the members of Groundwater Management Area 4 in developing desired future conditions. As stated in Resolution No. R 2010-01, the members of Groundwater Management Area 4 considered Groundwater Availability Modeling (GAM) Task 10-026 (Oliver, 2010a) and GAM Task 10-028 (Oliver, 2010b). Using the same methods as in these previous simulations, the amount of pumping from the Igneous Aquifer in each district was adjusted to match the adopted desired future conditions.

One change from the previous simulations, however, is what is reported as the boundary between Jeff Davis County Underground Water Conservation District and Presidio County Underground Water Conservation District. The boundaries of these districts now coincide with the boundaries of Jeff Davis and Presidio counties, respectively, as shown in Figure 2. Previously a portion of Jeff Davis County Underground Water Conservation District was shown as located in Presidio County. This change was made due to a finding in Attorney General Opinion No. GA-0792, released subsequent to the above reports, relating to the jurisdiction of each of the groundwater conservation districts.

**PARAMETERS AND ASSUMPTIONS:**

The parameters and assumptions for the model run using the groundwater availability model for the Igneous and parts of the West Texas Bolsons aquifers are described below:

- We used Version 1.01 of the groundwater availability model for the Igneous and parts of the West Texas Bolsons aquifers. See Beach and others (2004) for assumptions and limitations of the model.

- The model includes three layers representing the Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat portions of the West Texas Bolsons Aquifer (Layer 1), the Igneous Aquifer (Layer 2), and the underlying Cretaceous and Permian units (Layer 3). Also note that some areas of Layer 2 in the model, outside the boundary of the Igneous Aquifer, are active in order to allow flow between the West Texas Bolsons Aquifer of Layer 1 and the underlying Permian units of Layer 3.

- The Igneous Aquifer boundary used in the groundwater availability model run was the boundary around which the model was developed. This boundary is both a generalized (or smoothed) and somewhat smaller version of the official boundary of the Igneous Aquifer according to the 2007 State Water Plan (TWDB, 2007). A comparison of these two boundaries is shown in Figure 1.

- Cells were assigned to individual counties, river basins, regional water planning areas, and groundwater conservation districts as shown in the August 3, 2010 version of the file that associates the model grid to political and natural boundaries for the Igneous Aquifer. Note that some minor adjustments were made to the file to better reflect the relationship of model cells to political boundaries.

- See GAM Task 10-026 (Oliver, 2010a) and GAM Task 10-028 (Oliver, 2010b) for a full description of the methods and assumptions used in the groundwater availability model simulation. Note that the simulations in the above reports were over a period of 50 years whereas the period from 2010 through 2060 (inclusive) is 51 years. Since there is no meaningful change in the annual pumping through the predictive simulation, the first year of the predictive model run is referred to in the results below as 2010, though it comes from the stress period in the simulation for the year 2011.

### Determining Managed Available Groundwater

As defined in Chapter 36 of the Texas Water Code, "managed available groundwater" is the amount of water that may be permitted. The pumping output from groundwater availability models, however, represents the total amount of pumping from the aquifer. The total pumping includes uses of water both subject to permitting and exempt from permitting. Examples of exempt uses include domestic, livestock, and oil and gas exploration. Each district may also exempt additional uses as defined by its rules or enabling legislation.

Since exempt uses are not available for permitting, it is necessary to account for them when determining managed available groundwater. To do this, the Texas Water Development Board developed a standardized method for estimating exempt use for domestic and livestock purposes based on projected changes in population and the distribution of domestic and livestock wells in the area. Because other exempt uses can vary significantly from district to district, and there is much higher uncertainty associated with estimating use due to oil and gas exploration, estimates of exempt pumping outside domestic and livestock uses have not been included. The districts were encouraged to evaluate the estimates of exempt pumping and, if desired, provide updated estimates. Once established, the estimates of exempt pumping were subtracted from the total pumping output from the groundwater availability model to yield the estimated managed available groundwater for permitting purposes.

## RESULTS:

The estimated total pumping from the Igneous Aquifer in Groundwater Management Area 4 that achieves the above desired future conditions is approximately 11,300 acre-feet per year. This pumping 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). Note that the portion of the aquifer in Groundwater Management Area 4 is located entirely within the Far West Texas Regional Water Planning Area (Region E) and the Rio Grande Basin.

The total pumping estimates for the Igneous Aquifer are also summarized by groundwater conservation district as shown in Table 2. Table 3 contains the estimates of exempt pumping for the Igneous Aquifer in each of the groundwater conservation districts due to domestic and livestock uses. The managed available groundwater for each of the districts, the difference between the total pumping in each district (Table 2) and the estimated exempt use (Table 3) is shown in Table 4. The managed available groundwater for the Igneous Aquifer in Groundwater Management Area 4 is approximately 10,100 acre-feet per year.

**LIMITATIONS:**

Managed available groundwater numbers included in this report are the result of subtracting the estimated future exempt use from the estimated total pumping that would achieve the desired future condition adopted by the groundwater conservation districts in the groundwater management area. These numbers, therefore, are the result of (1) running the groundwater model to estimate the total pumping required to achieve the desired future condition and (2) estimating the future exempt use in the area.

The groundwater model used in developing estimates of total pumping is the best available scientific tool that can be used to estimate the pumping that will achieve the desired future condition. 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 total pumping 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.

In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in developing these total pumping estimates. Those assumptions also need to be considered and compared to actual future data when evaluating compliance with the desired future condition.

In the case of TWDB's estimates of future exempt use, key assumptions were made as to the pattern of population growth relative to the need for domestic wells or supplied water, per capita use from domestic wells, and livestock uses of water. In the case of district estimates of future exempt use, including exempt use associated with the exploration of oil and gas, the assumptions are specific to that district. In either case, these assumptions need to be considered when reviewing future data related to exempt use.

Given these limitations, users of this information are cautioned that the total pumping 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 managed 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 AND ASSOCIATED MODEL RUNS:

Beach, J.A., Ashworth, J.B., Finch, Jr., S.T., Chastain-Howley, A., Calhoun, K., Urbanczyk, K.M., Sharp, J.M., and Olson, J., 2004, Groundwater availability model for the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat) aquifers: contract report to the Texas Water Development Board, 208 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., 2010a, GAM Task 10-026: Texas Water Development Board, GAM Task 10-026 Report, 7 p.

Oliver, W., 2010b, GAM Task 10-028: Texas Water Development Board, GAM Task 10-028 Report, 8 p.

Texas Water Development Board, 2007, Water for Texas – 2007—Volumes I-III; Texas Water Development Board Document No. GP-8-1, 392 p.

Table 1. Estimated total annual pumping for the Igneous Aquifer in Groundwater Management Area 4. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin.

| County | Re gional Wate r Planning Are a | Basin | Ye ar | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| Brewster | E | Rio | 2,586 | 2,586 | 2,586 | 2,585 | 2,583 | 2,581 |
| Culberson | E | Rio | 99 | 99 | 99 | 99 | 99 | 99 |
| Jeff Davis | E | Rio | 4,584 | 4,584 | 4,584 | 4,584 | 4,584 | 4,584 |
| Presidio | E | Rio | 4,064 | 4,064 | 4,064 | 4,064 | 4,063 | 4,063 |
| **Total** | | | **11,333** | **11,333** | **11,333** | **11,332** | **11,329** | **11,327** |

Table 2. Estimated total annual pumping for the Igneous Aquifer summarized by groundwater conservation district (GCD) in Groundwater Management Area 4 for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

| Groundwate r Conse rvation District | Ye ar | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| Brewster County GCD | 2,586 | 2,586 | 2,586 | 2,585 | 2,583 | 2,581 |
| Culberson County GCD | 99 | 99 | 99 | 99 | 99 | 99 |
| Jeff Davis County | 4,584 | 4,584 | 4,584 | 4,584 | 4,584 | 4,584 |
| Presidio County UWCD | 4,064 | 4,064 | 4,064 | 4,064 | 4,063 | 4,063 |
| **Total** | **11,333** | **11,333** | **11,333** | **11,332** | **11,329** | **11,327** |

Table 3. Estimates of annual exempt use for the Igneous Aquifer in Groundwater Management Area 4 by groundwater conservation district (GCD) for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

| Groundwate r Conse rvation District | Source | Ye ar | | | | | |
|---|---|---|---|---|---|---|---|
| | | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| Brewster County GCD | TA | 193 | 197 | 198 | 199 | 202 | 203 |
| Culberson County GCD | TA | 11 | 12 | 12 | 12 | 12 | 12 |
| Jeff Davis County | TA | 332 | 336 | 336 | 336 | 336 | 336 |
| Presidio County UWCD | D | 694 | 718 | 749 | 725 | 712 | 705 |
| **Total** | | **1,230** | **1,263** | **1,295** | **1,272** | **1,262** | **1,256** |

TA = Estimated exempt use calculated by TWDB and accepted by district D = Estimated exempt use provided by the district

Table 4. Estimates of annual managed available groundwater for the Igneous Aquifer in Groundwater Management Area 4 by groundwater conservation district (GCD) for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

| **Groundwate r Conse rvation District** | **Ye ar** | | | | | |
|---|---|---|---|---|---|---|
| | **2010** | **2020** | **2030** | **2040** | **2050** | **2060** |
| Brewster County GCD | 2,393 | 2,389 | 2,388 | 2,386 | 2,381 | 2,378 |
| Culberson County GCD | 88 | 87 | 87 | 87 | 87 | 87 |
| Jeff Davis County | 4,252 | 4,248 | 4,248 | 4,248 | 4,248 | 4,248 |
| Presidio County UWCD | 3,370 | 3,346 | 3,315 | 3,339 | 3,351 | 3,358 |
| **Total** | **10,103** | **10,070** | **10,038** | **10,060** | **10,067** | **10,071** |

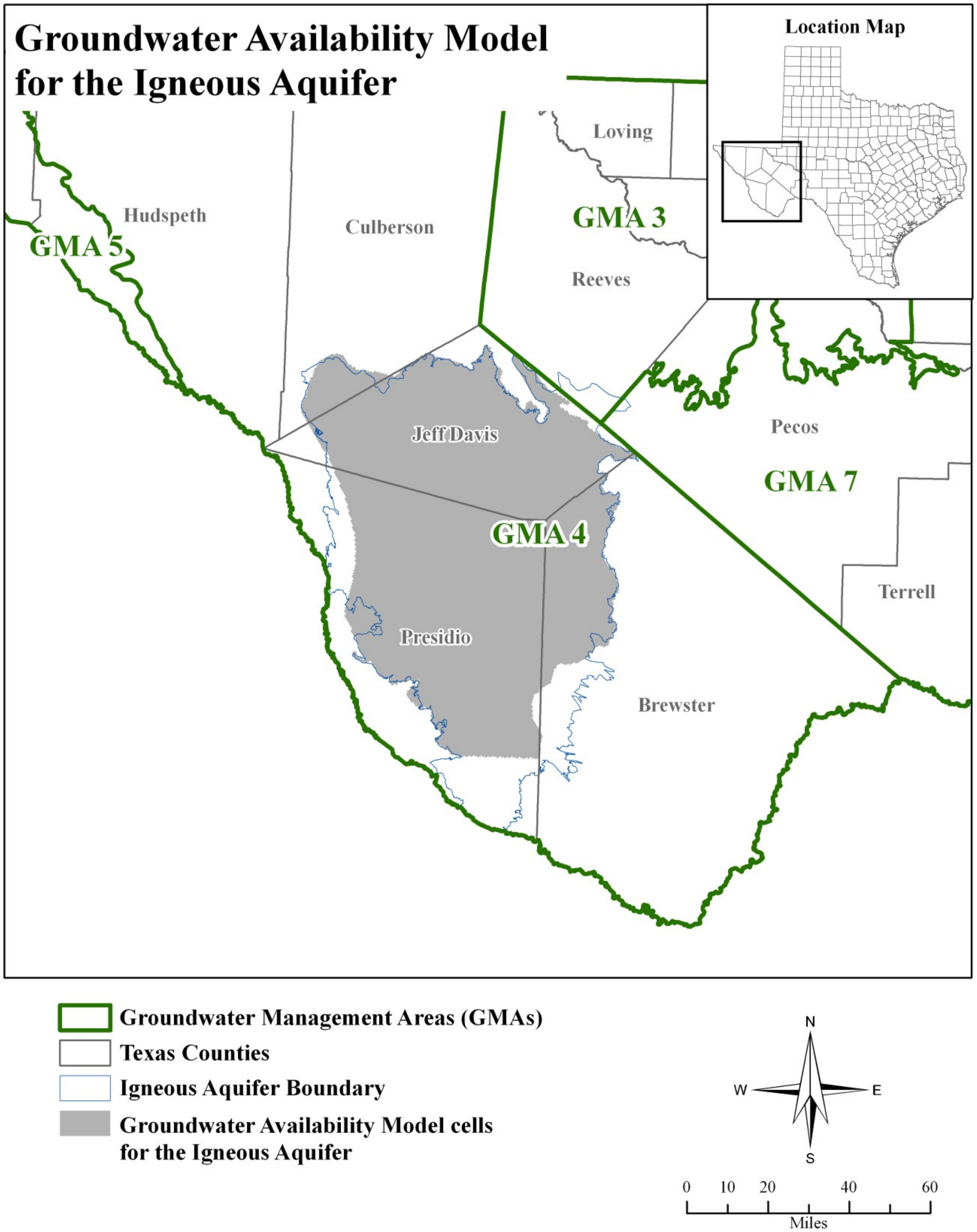


Figure 1. Map showing the areas covered by the groundwater availability model for the Igneous Aquifer.

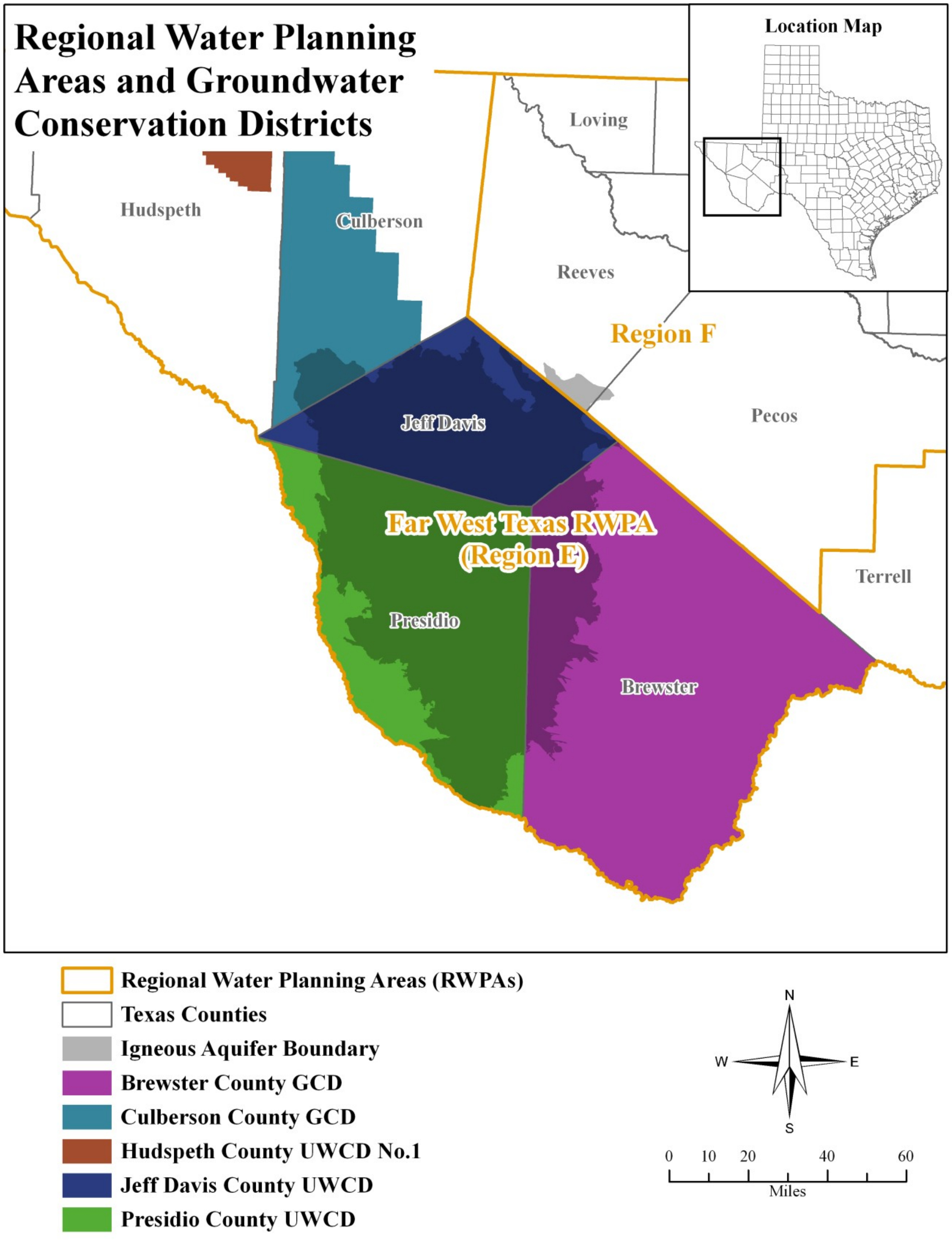


Figure 2. Map showing regional water planning areas (RWPAs), counties, and groundwater conservation districts (GCDs) in Groundwater Management Area 4. UWCD refers to Underground Water Conservation District

# Appendix

# C

# GAM Run 10-037 MAG


**by Mr. Wade Oliver**

Texas Water Development Board
Groundwater Availability Modeling Section
(512) 463-3132


June 22, 2011


Cynthia K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and 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 June 22, 2011.

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# EXECUTIVE SUMMARY:

The estimated total pumping from the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer that achieves the desired future conditions adopted by the members of Groundwater Management Area 4 declines from approximately 51,000 acre- feet per year to 50,000 acre-feet per year between 2010 and 2060. This is summarized by county, regional water planning area, and river basin as shown in Table 1. The estimated managed available groundwater for these portions of the West Texas Bolsons Aquifer, the amount available for permitting, is shown in Table 4. The total pumping estimates were taken from a previously completed model simulation for the aquifer documented in Groundwater Availability Modeling (GAM) Task 10-028. The managed available groundwater was determined by subtracting estimated exempt pumping due to domestic and livestock uses from the total pumping in each district.

# REQUESTOR:

Ms. Janet Adams of Jeff Davis County Underground Water Conservation District and Presidio County Underground Water Conservation District on behalf of Groundwater Management Area 4.

# DESCRIPTION OF REQUEST:

In a letter dated August 13, 2010 and received August 18, 2010, Ms. Adams provided the Texas Water Development Board (TWDB) with the desired future conditions of the West Texas Bolsons Aquifer adopted by the members of Groundwater Management Area 4. The desired future conditions for the West Texas Bolsons Aquifer, as described in Resolution No. R 2010-01 and adopted August 13, 2010, are shown below:

| Groundwater Conservation District* | Desired Future Condition (feet of drawdown) |
|---|---|
| Culberson County GCD | 78 |
| Jeff Davis County UWCD | 72 |
| Presidio County UWCD | 72 |

*Note that "GCD" refers to Groundwater Conservation District and "UWCD" refers to Underground Water Conservation District.

In response to receiving the adopted desired future conditions, the Texas Water Development Board has estimated the managed available groundwater for the West Texas Bolsons Aquifer within Groundwater Management Area 4.

# METHODS:

Groundwater Management Area 4 contains the West Texas Bolsons Aquifer, a minor aquifer in Texas according to the 2007 State Water Plan (TWDB, 2007). The location of Groundwater Management Area 4, the West Texas Bolsons Aquifer, and the groundwater availability model cells that represent the aquifer are shown in Figure 1.

It should be noted that this report only addresses the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer. The managed available groundwater for the Presidio-Redford Bolson and Upper Salt Basin, for which Groundwater Management Area 4 designated separate desired future conditions, will be included in separate reports. The remaining portions of the aquifer were either designated as not relevant for the purpose of joint planning by the members of Groundwater Management Area 4 or are small enough as to have a negligible effect on the results presented in this report.

The Texas Water Development Board previously completed several predictive groundwater availability model simulations of the Igneous Aquifer to assist the members of Groundwater Management Area 4 in developing desired future conditions. As stated in Resolution No. R 2010-01, the members of Groundwater Management Area 4 considered Groundwater Availability Modeling (GAM) Task 10-026 (Oliver, 2010a) and GAM Task 10-028 (Oliver, 2010b). The desired future conditions above for the West Texas Bolsons Aquifer match each of the simulations in the above reports, as the changes among the simulations were only applied to the underlying Igneous Aquifer. Therefore, the results shown below are taken from "Scenario 3" in GAM Task 10-028 since this scenario most closely matches the desired future conditions for the underlying Igneous Aquifer adopted by the members of Groundwater Management Area 4.

One change from the previous simulations, however, is what is reported as the boundary between Jeff Davis County Underground Water Conservation District and Presidio County Underground Water Conservation District. The boundaries of these districts now coincide with the boundaries of Jeff Davis and Presidio counties, respectively, as shown in Figure 2. Previously, a portion of Jeff Davis County Underground Water Conservation District was shown as located in Presidio County. This change was made due to a finding in Attorney General Opinion No. GA-0792, released subsequent to the above reports, relating to the jurisdiction of each groundwater conservation district.

## PARAMETERS AND ASSUMPTIONS:

The parameters and assumptions for the model run using the groundwater availability model for the Igneous and parts of the West Texas Bolsons aquifers are described below:

- We used Version 1.01 of the groundwater availability model for the Igneous and parts of the West Texas Bolsons aquifers. See Beach and others (2004) for assumptions and limitations of the model.
- The model includes three layers representing the Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat portions of the West Texas Bolsons Aquifer (Layer 1), the Igneous Aquifer (Layer 2), and the underlying Cretaceous and Permian units (Layer 3).

- Cells were assigned to individual counties, river basins, regional water planning areas, and groundwater conservation districts as shown in the August 3, 2010 version of the file that associates the model grid to political and natural boundaries for the

Igneous and West Texas Bolsons aquifers. Note that some minor adjustments were made to the file to better reflect the relationship of model cells to political boundaries.

- See GAM Task 10-026 (Oliver, 2010a) and GAM Task 10-028 (Oliver, 2010b) for a full description of the methods and assumptions used in the groundwater availability model simulation. Note that the simulations in the above reports were over a period of 50 years whereas the period from 2010 through 2060 (inclusive) is 51 years. Since the changes in annual pumping through the predictive simulation are relatively small, the first year of the predictive model run is referred to in the results below as 2010, though it comes from the stress period in the simulation for the year 2011.

## Determining Managed Available Groundwater

As defined in Chapter 36 of the Texas Water Code, "managed available groundwater" is the amount of water that may be permitted. The pumping output from groundwater availability models, however, represents the total amount of pumping from the aquifer. The total pumping includes uses of water both subject to permitting and exempt from permitting. Examples of exempt uses include domestic, livestock, and oil and gas exploration. Each district may also exempt additional uses as defined by its rules or enabling legislation.

Since exempt uses are not available for permitting, it is necessary to account for them when determining managed available groundwater. To do this, the Texas Water Development Board developed a standardized method for estimating exempt use for domestic and livestock purposes based on projected changes in population and the distribution of domestic and livestock wells in the area. Because other exempt uses can vary significantly from district to district, and there is much higher uncertainty associated with estimating use due to oil and gas exploration, estimates of exempt pumping outside domestic and livestock uses have not been included. The districts were encouraged to evaluate the estimates of exempt pumping and, if desired, provide updated estimates. Once established, the estimates of exempt pumping were subtracted from the total pumping output from the groundwater availability model to yield the estimated managed available groundwater for permitting purposes.

## RESULTS:

The estimated total pumping from the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer in Groundwater Management Area 4 that achieves the above desired future conditions declines from approximately 51,000 acre-feet per year in 2010 to 50,000 acre-feet per year in 2060. This pumping 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). Note that the aquifer is located entirely within the Far West Texas Regional Water Planning

Area (Region E) and the Rio Grande Basin.

The total pumping estimates for the Igneous Aquifer are also summarized by groundwater conservation district as shown in Table 2. Table 3 contains the estimates of exempt pumping for the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer in each groundwater conservation district due to domestic and livestock uses.

The managed available groundwater for each of the districts, the difference between the total pumping in the district (Table 2) and the estimated exempt use (Table 3) is shown in Table 4.

## LIMITATIONS:

Managed available groundwater numbers included in this report are the result of subtracting the estimated future exempt use from the estimated total pumping that would achieve the desired future condition adopted by the groundwater conservation districts in the groundwater management area. These numbers, therefore, are the result of (1) running the groundwater model to estimate the total pumping required to achieve the desired future condition and (2) estimating the future exempt use in the area.

The groundwater model used in developing estimates of total pumping is the best available scientific tool that can be used to estimate the pumping that will achieve the desired future condition. 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 total pumping 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.

In addition, certain assumptions have been made regarding future precipitation, recharge, and streamflow in developing these total pumping estimates. Those assumptions also need to be considered and compared to actual future data when evaluating compliance with the desired future condition.

In the case of TWDB's estimates of future exempt use, key assumptions were made as to the pattern of population growth relative to the need for domestic wells or supplied water, per capita use from domestic wells, and livestock uses of water. In the case of district estimates of future exempt use, including exempt use associated with the exploration of oil and gas, the assumptions are specific to that district. In either case, these assumptions need to be considered when reviewing future data related to exempt use.

Given these limitations, users of this information are cautioned that the total pumping 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 managed 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 AND ASSOCIATED MODEL RUNS:

Beach, J.A., Ashworth, J.B., Finch, Jr., S.T., Chastain-Howley, A., Calhoun, K., Urbanczyk, K.M., Sharp, J.M., and Olson, J., 2004, Groundwater availability model for the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat) aquifers: contract report to the Texas Water Development Board, 208 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., 2010a, GAM Task 10-026: Texas Water Development Board, GAM Task 10-026 Report, 7 p.

Oliver, W., 2010b, GAM Task 10-028: Texas Water Development Board, GAM Task 10-028 Report, 8 p.

Texas Water Development Board, 2007, Water for Texas – 2007—Volumes I-III; Texas Water Development Board Document No. GP-8-1, 392 p.

Table 1. Estimated total annual pumping for the West Texas Bolsons Aquifer in Groundwater Management Area 4. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin.

| County | Regional Water Planning Area | Basin | Year | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Culberson | E | Rio Grande | 35,826 | 35,749 | 35,678 | 35,601 | 35,550 | 35,509 |
| Jeff Davis | E | Rio Grande | 6,074 | 6,055 | 6,055 | 5,989 | 5,960 | 5,942 |
| Presidio | E | Rio Grande | 9,126 | 9,112 | 8,982 | 8,834 | 8,710 | 8,640 |
| **Total** | | | **51,026** | **50,916** | **50,715** | **50,424** | **50,220** | **50,091** |

Table 2. Estimated total annual pumping for the West Texas Bolsons Aquifer summarized by groundwater conservation district (GCD) in Groundwater Management Area 4 for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

| Groundwater Conservation District | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Culberson County GCD | 35,826 | 35,749 | 35,678 | 35,601 | 35,550 | 35,509 |
| Jeff Davis County UWCD | 6,074 | 6,055 | 6,055 | 5,989 | 5,960 | 5,942 |
| Presidio County UWCD | 9,126 | 9,112 | 8,982 | 8,834 | 8,710 | 8,640 |
| **Total** | **51,026** | **50,916** | **50,715** | **50,424** | **50,220** | **50,091** |

Table 3. Estimates of annual exempt use for the West Texas Bolsons Aquifer in Groundwater Management Area 4 by groundwater conservation district (GCD) for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

| Groundwater Conservation District | Source | Year | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Culberson County GCD | TA | 107 | 115 | 118 | 119 | 119 | 119 |
| Jeff Davis County UWCD | TA | 64 | 65 | 65 | 65 | 65 | 65 |
| Presidio County UWCD | TA | 26 | 21 | 18 | 14 | 12 | 12 |
| **Total** | | **197** | **201** | **201** | **198** | **196** | **196** |

TA = Estimated exempt use calculated by TWDB and accepted by district

Table 4. Estimates of annual managed available groundwater for the West Texas Bolsons Aquifer in Groundwater Management Area 4 by groundwater conservation district (GCD) for each decade between 2010 and 2060. Results are in acre-feet per year. UWCD refers to Underground Water Conservation District.

| Groundwater Conservation District | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
| Culberson County GCD | 35,719 | 35,634 | 35,560 | 35,482 | 35,431 | 35,390 |
| Jeff Davis County UWCD | 6,010 | 5,990 | 5,990 | 5,924 | 5,895 | 5,877 |
| Presidio County UWCD | 9,100 | 9,091 | 8,964 | 8,820 | 8,698 | 8,628 |
| **Total** | **50,829** | **50,715** | **50,514** | **50,226** | **50,024** | **49,895** |

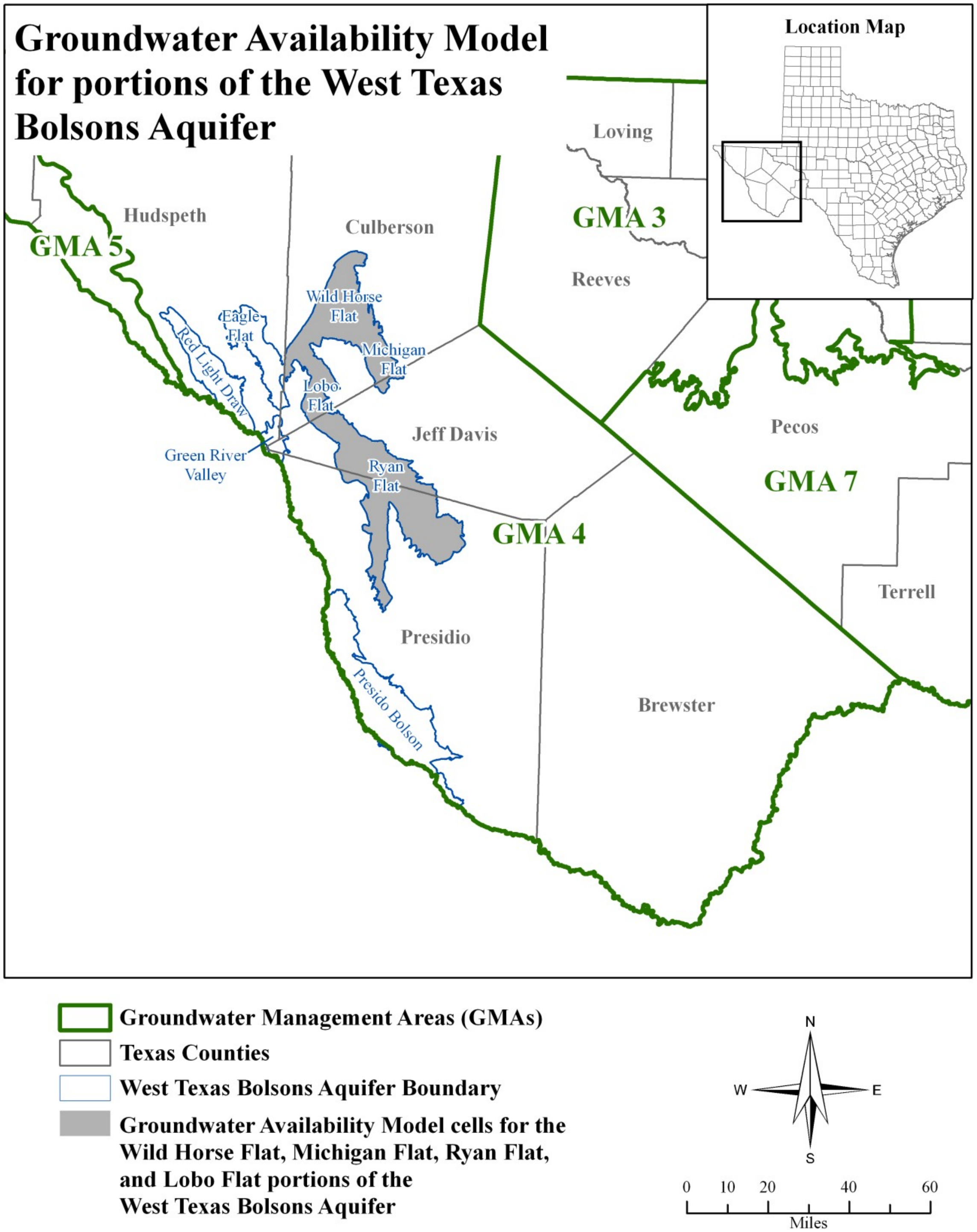


Figure 1. Map showing the areas covered by the groundwater availability model for the Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat portions of the West Texas Bolsons Aquifer.

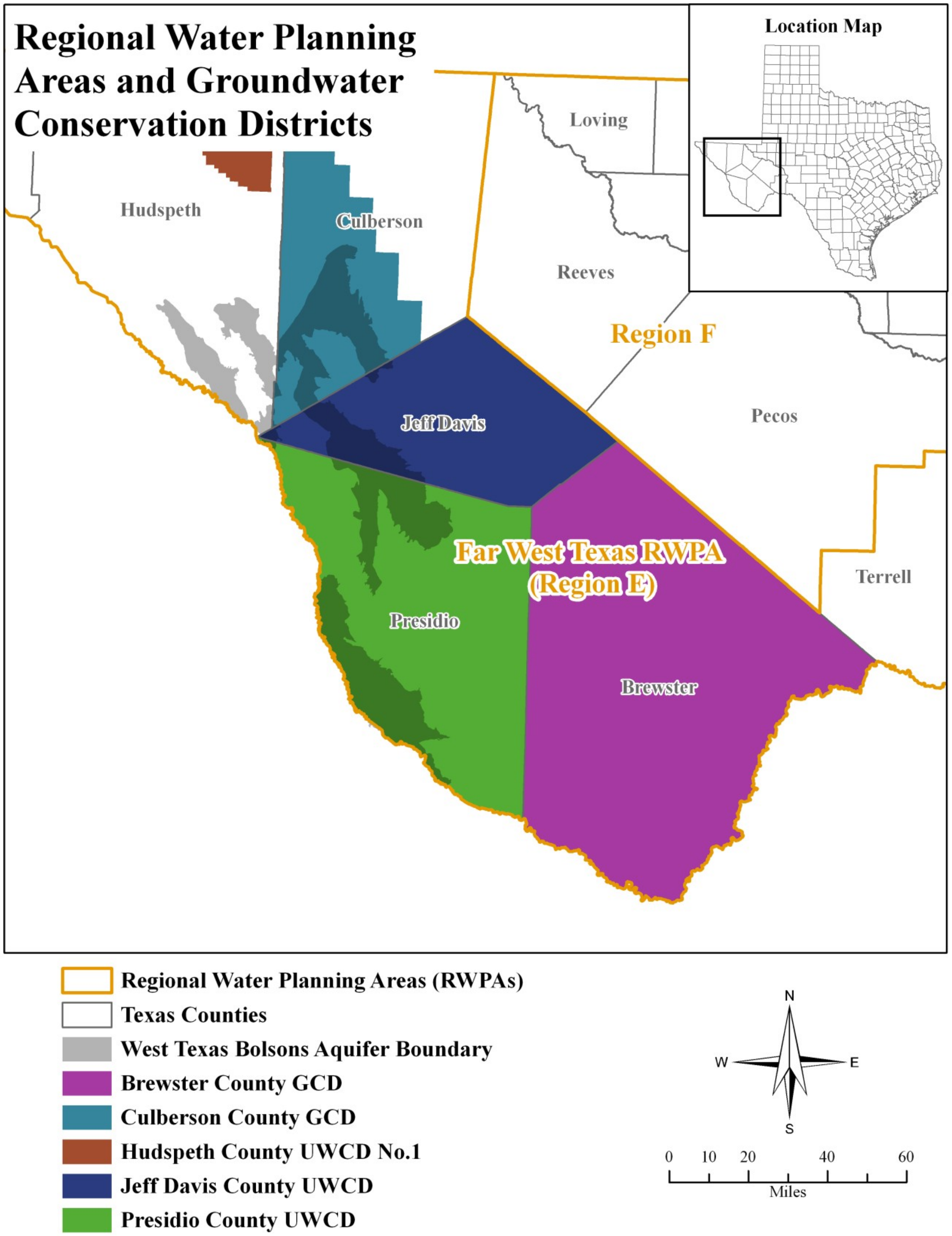


Figure 2. Map showing regional water planning areas (RWPAs), counties, and groundwater conservation districts (GCDs) in Groundwater Management Area 4. UWCD refers to Underground Water Conservation District.

# Appendix

# D

# GAM RUN 12-023: JEFF DAVIS COUNTY UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Marius Jigmond
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8499
August 10, 2012


*CyntMa K. Ridgeway is the Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by Marius Jigmond under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G. 471 on August 10, 2012.*

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# GAM RUN 12-023: JEFF DAVIS COUNTY UNDERGROUND WATER CONSERVATION DISTRICT MANAGEMENT PLAN

by Marius Jigmond
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 463-8499
August 10, 2012

## *EXECUTIVE SUMMARY:*

Texas State Water Code, Section 36.1071, Subsection (h), 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.

The purpose of this report is to provide Part 2 of a two-part package of information to Jeff Davis County Underground Water Conservation District for its groundwater management plan. The groundwater management plan for the Jeff Davis County Underground Water Conservation District is due for approval by the executive administrator of the TWDB before December 16, 2013.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models of the Edwards-Trinity (Plateau) and Pecos Valley aquifers, the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat) aquifers, and the West Texas Bolsons (Red Light Draw,

Green River Valley, and Eagle Flat) Aquifer. Tables 1 through 4 summarize the groundwater availability model data required by the statute, and figures 1 through 3 show the area of each model from which the values in the respective tables were extracted. This model run replaces the results of GAM Run 08-29 (Ridgeway, 2008). GAM Run 12-023 meets current standards set after the release of GAM Run 08-29 and it is based on the most current groundwater district boundaries and water budget extraction methods. If after review of the figures, the Jeff Davis County Underground Water Conservation District determines that the district boundaries used in the assessment do not reflect current conditions, please notify the TWDB immediately.

## *METHODS:*

Groundwater availability models of the Edwards-Trinity (Plateau) and Pecos Valley aquifers (1981 – 2000), the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat) aquifers (1980 – 2000), and the West Texas Bolsons (Red Light Draw, Green River Valley, and Eagle Flat) Aquifer (Steady state) were run for this analysis (Anaya and Jones, 2009, Harbaugh, 1996, Harbaugh and others, 2000). Water budgets for each year of the transient[1] model period were extracted (Harbaugh, 1990), as applicable, and 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 portions of the aquifers located within the district are summarized in this report.

## *PARAMETERS AND ASSUMPTIONS:*

### *Edwards-Trinity (Plateau) and Pecos Valley Aquifers*

- Version 1.01 of the groundwater availability model of the Edwards-Trinity (Plateau) and Pecos Valley aquifers was used for this analysis. See Anaya and Jones (2009) for assumptions and limitations of the model.
- The model has two layers which represent the Edwards portions of the Edwards-Trinity (Plateau) Aquifer and Pecos Valley Aquifer in layer one, and Trinity portions of the Edwards-Trinity (Plateau) Aquifer in layer two. Water budgets for the district have been determined separately for the Edwards-Trinity (Plateau) Aquifer and Pecos Valley Aquifer.

[1] The groundwater availability model of the West Texas Bolsons (Red Light, Green River, and Eagle Flat) Aquifer does not contain a transient simulation due to lack of data when the model was built. The steady-state simulation was used to extract results.

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) is 143 feet for the transient calibration period. This represents 6 percent of the range of measured water levels (Anaya and Jones, 2009).

***Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat) Aquifers***

- Version 1.01 of the groundwater availability model of the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat, and Lobo Flat) aquifers was used. See Beach and others (2004) for assumptions and limitations of the groundwater availability model.

- The model includes three layers representing the West Texas Bolsons Aquifer (layer 1), Igneous Aquifer (layer 2), and Cretaceous and Permian units (layer 3) (Beach and others, 2004, Oliver, 2009).

- Of the three layers, individual water budgets for the district were determined for the West Texas Bolsons Aquifer and Igneous Aquifer (layers 1 and 2).

- The root mean square error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 35 feet for the West Texas Bolsons Aquifer, and 35 feet for the Igneous Aquifer for the transient calibration period. These root mean square errors represent four and three percent, respectively, of the range of measured water levels (Beach and others, 2004).

***West Texas Bolsons (Red Light Draw, Green River Valley, and Eagle Flat) Aquifer***

- Version 1.01 of the groundwater availability model of the West Texas Bolsons (Red Light Draw, Green River Valley, and Eagle Flat) aquifer was used. See Beach and others (2008) for assumptions and limitations of the groundwater availability model.

- The model includes three layers representing the West Texas Bolsons Aquifer (layer 1), Cretaceous and Permian units (layer 2), and Cretaceous and Paleozoic units (layer 3).

- Of the three layers, individual water budgets for the district were determined for the West Texas Bolsons Aquifer (layer 1).

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the groundwater availability model is 56 feet for the West Texas Bolsons Aquifer for the steady-state calibration period. The mean absolute error represents seven percent of the range of measured water levels (Beach and others, 2008).

## *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 runs in the district, as shown in tables 1 through 4. The components of the modified budget include:

- 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 drains (springs).

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

- Flow between aquifers—the flow between aquifers or confining units within the district. 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.

The information needed for the District's management plan is summarized in tables 1 through 4. 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 district or county boundaries, is assigned to one side of the boundary based on the location of the centroid of the model cell. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located (see figures 1 through 3).

**TABLE 1. SUMMARIZED INFORMATION FOR THE EDWARDS-TRINITY (PLATEAU) AQUIFER THAT IS NEEDED FOR JEFF DAVIS COUNTY UNDERGROUND WATER 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 | Edwards-Trinity (Plateau) Aquifer | 14,860 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Edwards-Trinity (Plateau) Aquifer | 0 |
| Estimated annual volume of flow into the district within each aquifer in the district | Edwards-Trinity (Plateau) Aquifer | 5,902 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Edwards-Trinity (Plateau) Aquifer | 20,070 |
| Estimated net annual volume of flow between each aquifer in the district[2] | From Edwards-Trinity (Plateau) Aquifer into Pecos Valley Aquifer | 1,749 |
| | From Edwards-Trinity (Plateau) into other formations | 21 |

[2] The total estimated net annual volume of flow from Edwards-Trinity (Plateau) to Pecos Valley Aquifer and other formations is 1,770 acre-feet per year.

**TABLE 2. SUMMARIZED INFORMATION FOR THE PECOS VALLEY AQUIFER THAT IS NEEDED FOR JEFF DAVIS COUNTY UNDERGROUND WATER 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* | *Results* |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the district | Pecos Valley Aquifer | 361 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Pecos Valley Aquifer | 0 |
| Estimated annual volume of flow into the district within each aquifer in the district | Pecos Valley Aquifer | 0 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Pecos Valley Aquifer | 2,780 |
| Estimated net annual volume of flow between each aquifer in the district | From Edwards-Trinity (Plateau) Aquifer into Pecos Valley Aquifer | 1,749 |

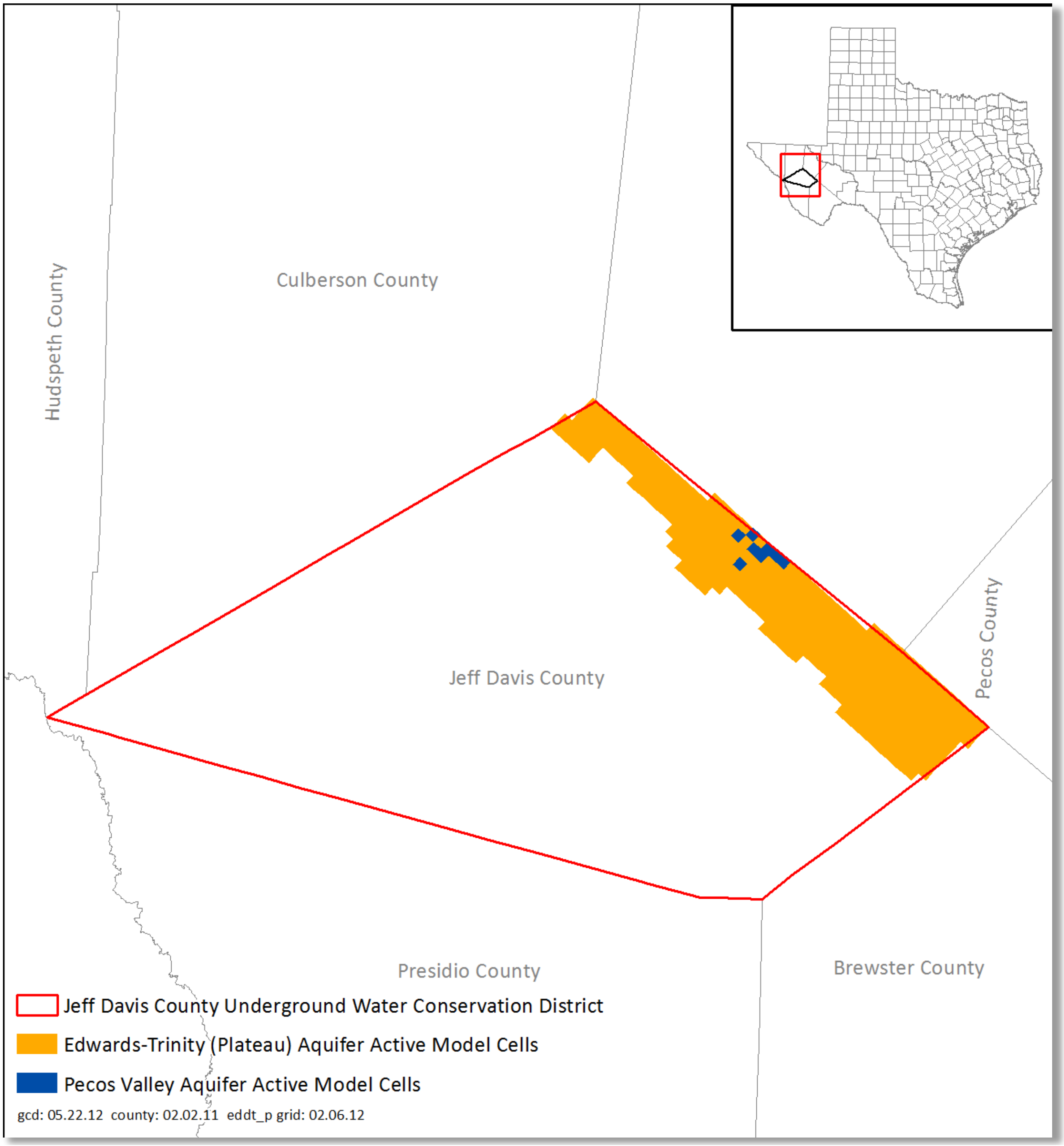


**FIGURE 1. AREA OF THE GROUNDWATER AVAILABILITY MODEL OF THE EDWARDS-TRINITY (PLATEAU) AND PECOS VALLEY AQUIFERS FROM WHICH THE INFORMATION IN TABLES 1 AND 2 WAS EXTRACTED.**

**TABLE 3. SUMMARIZED INFORMATION FOR THE IGNEOUS AQUIFER THAT IS NEEDED FOR JEFF DAVIS COUNTY UNDERGROUND WATER 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* | *Results* |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the district | Igneous Aquifer | 26,043[3] |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Igneous Aquifer | 2,566 |
| Estimated annual volume of flow into the district within each aquifer in the district | Igneous Aquifer | 611 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Igneous Aquifer | 4,322 |
| Estimated net annual volume of flow between each aquifer in the district[4] | From Igneous Aquifer into overlying West Texas Bolsons Aquifer | 1,726 |
| | From Igneous Aquifer into underlying Cretaceous and Permian units | 14,342 |

[3] Recharge applied with the recharge package to the Igneous Aquifer is both direct precipitation recharge and alluvial fan/stream bed recharge.
[4] The total estimated net annual volume of flow from Igneous Aquifer to West Texas Bolsons Aquifer and other formations is 16,068 acre-feet per year.

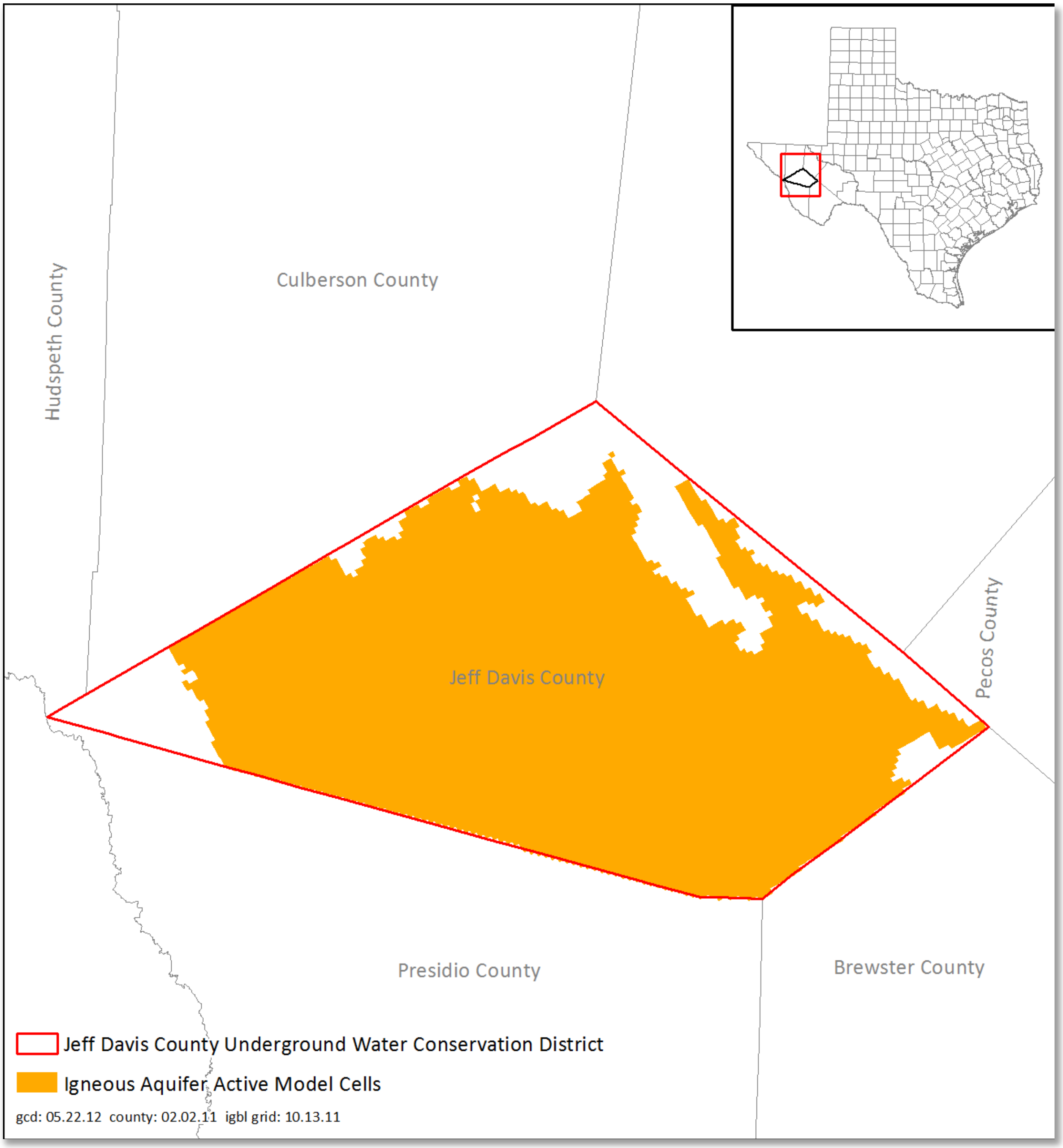


**FIGURE 2. AREA OF THE GROUNDWATER AVAILABILITY MODEL OF THE IGNEOUS AND WEST TEXAS BOLSONS AQUIFERS FROM WHICH THE INFORMATION IN TABLE 3 WAS EXTRACTED.**

**TABLE 4. SUMMARIZED INFORMATION FOR THE WEST TEXAS BOLSONS AQUIFER THAT IS NEEDED FOR JEFF DAVIS COUNTY UNDERGROUND WATER 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* | *Results* |
|---|---|---|
| Estimated annual amount of recharge from precipitation to the district | West Texas Bolsons Aquifer | 153[5] |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | West Texas Bolsons Aquifer | 0 |
| Estimated annual volume of flow into the district within each aquifer in the district | West Texas Bolsons Aquifer | 4,188 |
| Estimated annual volume of flow out of the district within each aquifer in the district | West Texas Bolsons Aquifer | 7,422 |
| Estimated net annual volume of flow between each aquifer in the district[6] | From Igneous Aquifer into overlying West Texas Bolsons Aquifer | 1,726 |
| | From Cretaceous and Permian units into overlying West Texas Bolsons Aquifer | 11 |

[5] It is assumed that precipitation recharge directly to the West Texas Bolsons Aquifer is zero. The recharge package suggests, on average, 153 acre-feet per year from alluvial fan/stream bed infiltration enters the aquifer in the district.

[6] The total estimated net annual volume of flow from Igneous Aquifer and Cretaceous and Permian units to West Texas Bolsons Aquifer is 1,737 acre-feet per year.

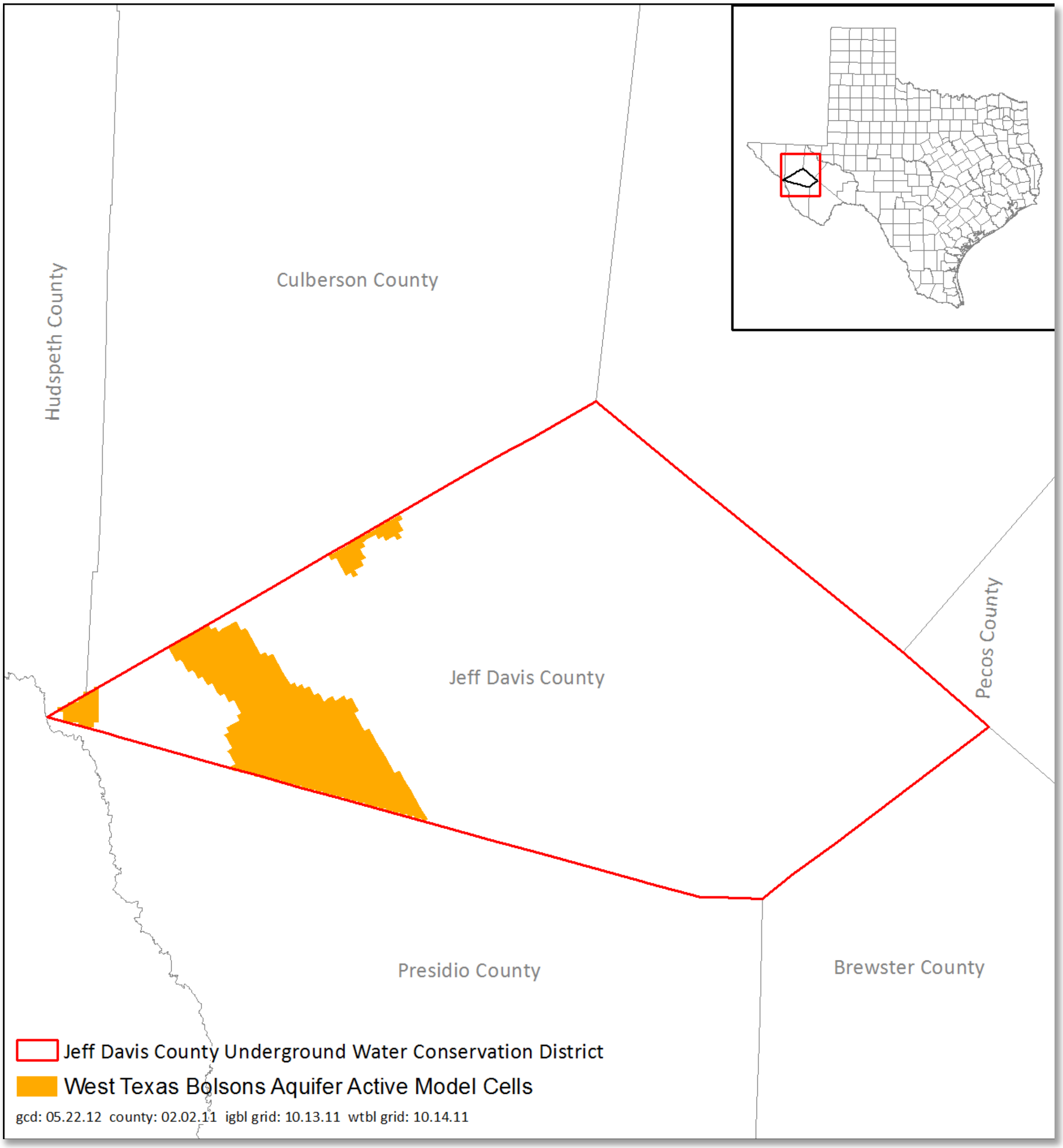


**FIGURE 3. AREA OF THE GROUNDWATER AVAILABILITY MODEL OF THE IGNEOUS AND WEST TEXAS BOLSONS AQUIFERS AND GROUNDWATER AVAILABILITY MODEL OF THE WEST TEXAS BOLSONS AQUIFER FROM WHICH THE INFORMATION IN TABLE 4 WAS EXTRACTED.**

## *LIMITATIONS*

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

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

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

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

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

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