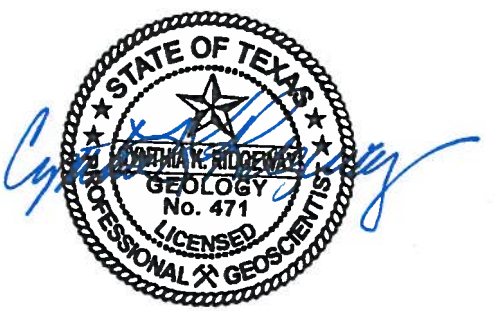
GAM Run 11-010: Model Runs for the Carrizo-Wilcox, Queen City, and Sparta Aquifers in Groundwater Management Area 11

by Wade Oliver
Texas Water Development Board
Groundwater Resources Division
Groundwater Availability Modeling Section
(512) 936-2386
July 30, 2012



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 July 30, 2012.

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GAM RUN 11-010: MODEL RUNS FOR THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 11

by Wade Oliver
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(512) 936-2386
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EXECUTIVE SUMMARY:

This report describes the results of three predictive simulations using the groundwater availability model for the northern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers. The pumping amounts and distributions for each of the simulations were provided to the Texas Water Development Board as MODFLOW Well Package files for direct use in the model. In each of the scenarios, pumping in Anderson, Cherokee, and Houston counties was increased over the amount necessary to achieve the current desired future conditions as detailed in GAM Task 10-009. The differences between the scenarios reflect differences in the timing and distribution of the additional pumping.

In each of the scenarios, an additional 5,000 acre-feet per year was pumped from the Queen City Aquifer and 40,000 acre-feet per year was pumped from the Carrizo-Wilcox Aquifer for each year of the 51-year predictive simulations. In Scenario A, an additional 60,000 acre-feet per year was also pumped from the Carrizo-Wilcox Aquifer (for a total increase of 100,000 acre-feet per year) between 2030 and 2034 to evaluate the impact of increased pumping due to drought conditions. Scenario B is the same as Scenario A except the peak pumping rate was applied at the end of the simulation between 2056 and 2060. In Scenario C, the additional pumping associated with a 5-year drought (that is, the additional 60,000 acre-feet per year) was distributed throughout the simulation as an additional 6,000 acre-feet of pumping each year.

Results indicate that the additional pumping described above will result in an increase in drawdown from 17 feet (the current desired future condition) to approximately 28

feet in Groundwater Management Area 11 for each of the scenarios. Drawdowns are reported by county and aquifer.

REQUESTOR:

Mr. Roy Rodgers of Neches and Trinity Valleys Groundwater Conservation District

DESCRIPTION OF REQUEST:

Mr. Roy Rodgers requested that the Texas Water Development Board evaluate the impact of additional pumping above the amount estimated to achieve the current desired future condition of 17 feet of drawdown. Three pumping scenarios were provided to the Texas Water Development Board as MODFLOW Well Package files for direct use in the Groundwater Availability Model. The request as well as a detailed description of each of the scenarios is included in Appendix A.

METHODS:

In order to estimate the impact of potential additional pumping, the groundwater availability model for the northern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers was used. As part of the request, three MODFLOW Well Package files were provided to the Texas Water Development Board containing three different pumping scenarios between 2010 and 2060. A detailed description of the scenarios is included in Appendix A.

In each of the scenarios, all pumping outside of the project area in Anderson, Cherokee, and Houston counties was kept at the same level as in Groundwater Availability Modeling (GAM) Task 10-009 (Oliver, 2010). This pumping is also reflected in the draft managed available groundwater report GAM Run 10-016 MAG (Shi and Oliver, 2010). These runs achieved the desired future condition for the aquifers in Groundwater Management Area 11 of an average drawdown of 17 feet between 2010 and 2060. For all three scenarios, 5,000 acre-feet per year of pumping was added to the Queen City Aquifer and 40,000 acre-feet per year of pumping was added to the Carrizo-Wilcox Aquifer. For Scenario A, an additional 60,000 acre-feet of pumping was applied each year to the Carrizo-Wilcox Aquifer (totaling an increase of 100,000 acre-feet per year) for 5 years from 2030 to 2034 to evaluate the impact of increased pumping associated with a drought. In Scenario B, this same drought-specific pumping was instead applied between 2056 and 2060. For Scenario C, the additional pumping

associated with the drought was distributed evenly between 2010 and 2060 (that is, about 6,000 acre-feet per year).

After running the groundwater availability model for each of the above three scenarios, the average drawdown in each aquifer by county was calculated using the same methods as in GAM Task 10-009 (Oliver, 2010). In addition, the pumping for each scenario was extracted from the model to verify that the pumping delivered as part of the request matched the accompanying description in Appendix A.

PARAMETERS AND ASSUMPTIONS:

- Version 2.01 of the groundwater availability model for the northern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers was used for this analysis. See Fryar and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model.
- The model includes eight layers that generally correspond to the following geologic units where they exist in the subsurface:
    - Sparta Aquifer (Layer 1)
    - Weches confining unit (Layer 2)
    - Queen City Aquifer (Layer 3)
    - Reklaw confining unit (Layer 4)
    - Carrizo Aquifer (Layer 5)
    - Upper Wilcox Aquifer (Layer 6)
    - Middle Wilcox Aquifer (Layer 7)
    - Lower Wilcox Aquifer (Layer 8)
- A portion of Layer 8 in the Sabine uplift area, though active in the model, is outside the extent of the Lower Wilcox unit of the Carrizo-Wilcox Aquifer as described in Kelley and others (2004). Because of this, results for Layer 8 in this area were not included in the drawdown calculations. See GAM Task 10-009 for additional details (Oliver, 2010).
- Cells were assigned to individual counties and groundwater conservation districts as shown in the September 14, 2009 version of the cell assignment model grid for the northern portion of the Carrizo-Wilcox, Queen City, and Sparta aquifers.

- Recharge rates were based on average (1961 to 1990) precipitation (Kelley and others, 2004) throughout each 51-year simulation. This includes the periods when pumping was increased to simulate drought conditions.

RESULTS:

Table 1 below shows the total pumping in the Carrizo-Wilcox, Queen City, and Sparta aquifers by scenario in the areas where pumping was increased relative to GAM Task 10-009. During the simulated drought conditions (2030 to 2034 for Scenario A; 2056 to 2060 for Scenario B), notice that the pumping in Cherokee and Houston counties increases significantly relative to the non-drought years in the simulation. The pumping information provided for this analysis did not include an increase in pumping in Anderson County due to simulated drought conditions. Also, as described above, pumping in the Sparta Aquifer was not changed from GAM Task 10-009. The additional pumping in the Queen City Aquifer of 5,000 acre-feet per year was distributed into Anderson, Cherokee, and Houston counties as approximately 2,000, 1,000, and 2,000 acre-feet per year, respectively.

Table 2 shows the increase in pumping in the Carrizo-Wilcox and Queen City aquifers relative to GAM Task 10-009 in each of the areas shown in Table 1 to more clearly show how pumping was modified. In Scenario C, notice that the spatial distribution of the pumping increase is different than in scenarios A and B. For example, pumping in Anderson County is significantly less in Scenario C than in non-drought years in scenarios A and B. Alternatively, while less than 2,000 acre-feet per year of additional pumping was applied in Houston County in scenarios A and B in non-drought years, pumping is increased by over 17,500 acre-feet per year throughout the simulation in Scenario C.

In Table 3, the average drawdown in the model by county is shown for GAM Task 10-009 and for each scenario. The overall average drawdown in Groundwater Management Area 11 increases from 17 feet to approximately 28 feet due to the increase in pumping in scenarios A, B, and C. This drawdown through time is shown in Figure 1. For the individual counties shown in Table 3, drawdown increases are most significant in Anderson, Cherokee, and Houston counties – where the additional pumping was applied. The drawdowns by county in Scenario C are somewhat different than in scenarios A and B. This is primarily due to the spatial change in pumping distribution between the scenarios.

Appendix B contains the drawdown for each county and layer of the model by scenario. The drawdown in GAM Task 10-009 and the overall drawdowns in the model are also shown. Appendix C contains the same information as Appendix B, but is organized by aquifer unit to more clearly show the changes in drawdown between model scenarios.

Appendix D contains the increase in drawdown by scenario for each county and layer relative to GAM Task 10-009 due to the increased pumping. As expected, the largest drawdown increases are in those areas where the additional pumping was applied (that is, Anderson, Cherokee, and Houston counties). Nearby areas such as Angelina, Henderson, Nacogdoches, and Trinity counties also show increased drawdown, but to a lesser degree.

LIMITATIONS:

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

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

A key aspect of using the groundwater model to evaluate 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.

REFERENCES:

Fryar, D., Senger, R., Deeds, N., Pickens, J., Jones, T., Whallon, A. J., and Dean, K. E., 2003, Groundwater Availability Model for the Northern Carrizo-Wilcox Aquifer: contract report to the Texas Water Development Board, 529 p.

Kelley, V. A., Deeds, N. E., Fryar, D. G., and Nicot, J. P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: contract report to the Texas Water Development Board, 867 p.

Oliver, W., 2010, Texas Water Development Board, GAM Task 10-009 Model Run Report, 11 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.

Shi, J., and Oliver, W., 2010, Texas Water Development Board, Draft GAM Run 10-016 MAG Report, 17 p.

TABLE 1: PUMPING IN THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS IN ANDERSON, CHEROKEE, AND HOUSTON COUNTIES FOR EACH SCENARIO COMPARED TO GAM TASK 10-009. PUMPING IN ANDERSON COUNTY IS LIMITED TO NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (GCD). ALL VALUES ARE IN ACRE-FEET PER YEAR.

County	*Groundwater Conservation District*	*Time Period*	*GAM Task 10-009*	*Scenario A*	*Scenario B*	*Scenario C*
Anderson	Neches and Trinity Valleys GCD	2010 - 2029	28,133	67,547	67,547	49,133
Anderson	Neches and Trinity Valleys GCD	2030 - 2034	28,133	67,547	67,547	49,133
Anderson	Neches and Trinity Valleys GCD	2035 - 2055	28,133	67,547	67,547	49,133
Anderson	Neches and Trinity Valleys GCD	2056 - 2060	28,133	67,547	67,547	49,133
Cherokee	Neches and Trinity Valleys GCD	2010 - 2029	33,977	37,675	37,675	44,476
Cherokee	Neches and Trinity Valleys GCD	2030 - 2034	33,977	56,635	37,675	44,476
Cherokee	Neches and Trinity Valleys GCD	2035 - 2055	33,977	37,675	37,675	44,476
Cherokee	Neches and Trinity Valleys GCD	2056 - 2060	33,977	37,675	56,635	44,476
Houston	No District	2010 - 2029	6,662	8,574	8,574	26,162
Houston	No District	2030 - 2034	6,662	49,654	8,574	26,162
Houston	No District	2035 - 2055	6,662	8,574	8,574	26,162
Houston	No District	2056 - 2060	6,662	8,574	49,654	26,162

TABLE 2: INCREASE IN PUMPING RELATIVE TO GAM TASK 10-009 IN THE CARRIZO-WILCOX AND QUEEN CITY AQUIFERS IN ANDERSON, CHEROKEE, AND HOUSTON COUNTIES FOR EACH SCENARIO. PUMPING WAS NOT CHANGED FROM GAM TASK 10-009 IN THE SPARTA AQUIFER. PUMPING IN ANDERSON COUNTY IS LIMITED TO NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (GCD). ALL VALUES ARE IN ACRE-FEET PER YEAR.

County	*Groundwater Conservation District*	*Time Period*	*Scenario A*	*Scenario B*	*Scenario C*
Anderson	Neches and Trinity Valleys GCD	2010 - 2029	39,414	39,414	20,999
Anderson	Neches and Trinity Valleys GCD	2030 - 2034	39,414	39,414	20,999
Anderson	Neches and Trinity Valleys GCD	2035 - 2055	39,414	39,414	20,999
Anderson	Neches and Trinity Valleys GCD	2056 - 2060	39,414	39,414	20,999
Cherokee	Neches and Trinity Valleys GCD	2010 - 2029	3,699	3,699	10,500
Cherokee	Neches and Trinity Valleys GCD	2030 - 2034	22,659	3,699	10,500
Cherokee	Neches and Trinity Valleys GCD	2035 - 2055	3,699	3,699	10,500
Cherokee	Neches and Trinity Valleys GCD	2056 - 2060	3,699	22,659	10,500
Houston	No District	2010 - 2029	1,912	1,912	19,500
Houston	No District	2030 - 2034	42,992	1,912	19,500
Houston	No District	2035 - 2055	1,912	1,912	19,500
Houston	No District	2056 - 2060	1,912	42,992	19,500

TABLE 3: AVERAGE DRAWDOWN IN THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS BY SCENARIO COMPARED TO GAM TASK 10-009. RESULTS ARE IN FEET AND ARE SHOWN BY COUNTY AND FOR GROUNDWATER MANAGEMENT AREA (GMA) 11 AS A WHOLE. ANDERSON COUNTY IS SHOWN SEPARATED INTO THE PORTIONS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*GAM Task 10-009*	*Scenario A*	*Scenario B*	*Scenario C*
Anderson (ACUWCD)	15	52	51	41
Anderson (NTVGCD)	16	68	68	56
Angelina	11	15	14	17
Bowie	0	0	0	0
Camp	19	19	19	19
Cass	8	8	8	8
Cherokee	18	55	57	58
Franklin	11	11	11	11
Gregg	35	35	35	35
Harrison	9	9	9	9
Henderson	23	29	29	27
Hopkins	-26	-26	-26	-26
Houston	8	31	35	38
Marion	16	16	16	16
Morris	21	21	21	21
Nacogdoches	4	10	9	13
Panola	2	2	2	2
Rains	-8	-8	-8	-8
Red River	-4	-4	-4	-4
Rusk	12	15	15	16
Sabine	10	10	10	10
San Augustine	3	3	3	4
Shelby	1	1	1	1
Smith	68	70	70	69
Titus	8	8	8	8
Trinity	6	12	11	15
Upshur	44	44	44	44
Van Zandt	14	15	15	15
Wood	59	59	59	59
GMA 11 Average*	**17**	**28**	**28**	**29**

*The average drawdowns over GMA 11 as a whole are very similar for scenarios A, B, and C: 28.1, 28.4, and 28.6 feet, respectively.

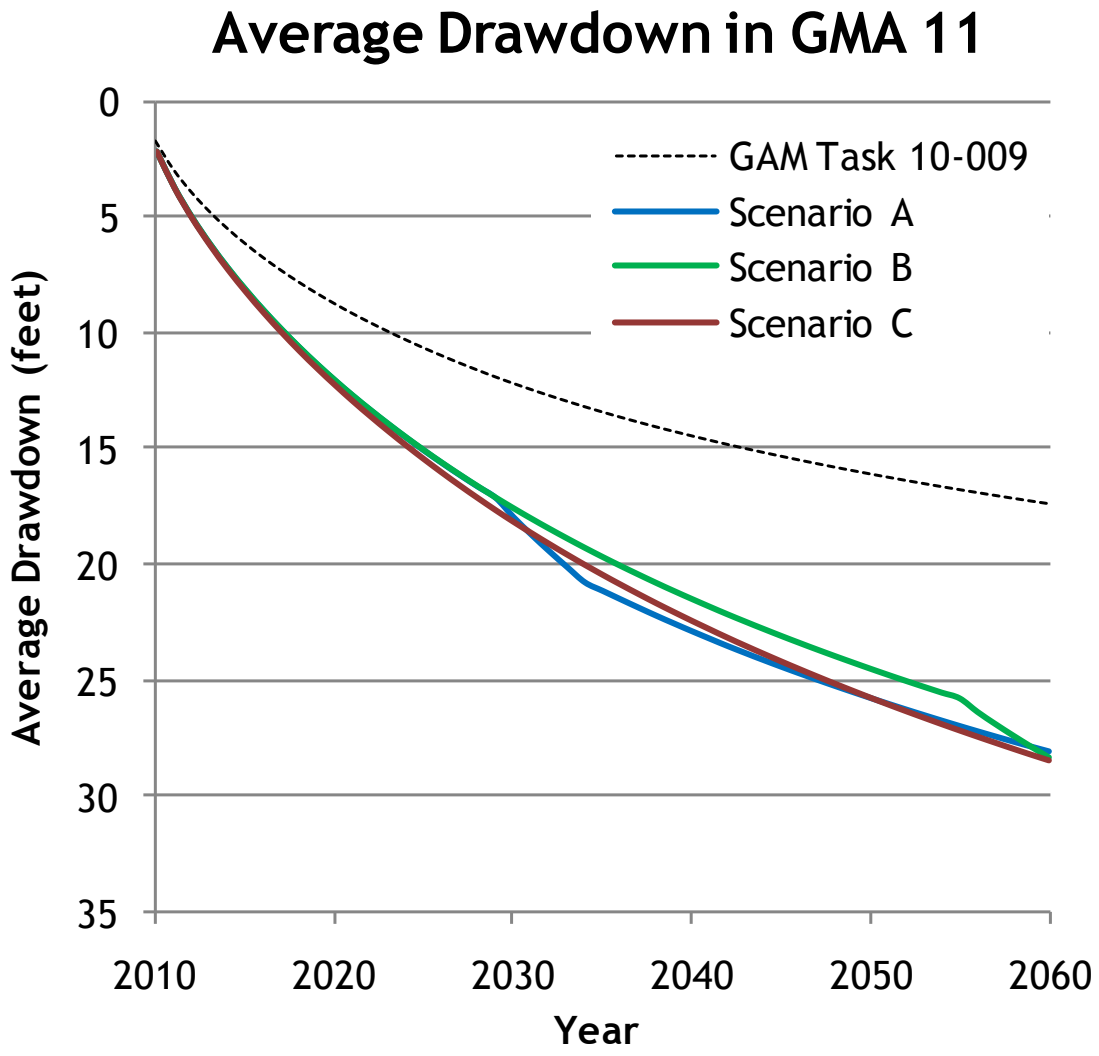


FIGURE 1: AVERAGE DRAWDOWN IN GROUNDWATER MANAGEMENT AREA (GMA) 11 THROUGH TIME FOR EACH SCENARIO AND FOR GAM TASK 10-009.

APPENDIX A: REQUEST FOR GROUNDWATER AVAILABILTY MODEL RUN AND DESCRIPTION OF ADDITIONAL PUMPING IN ANDERSON, CHEROKEE, AND HOUSTON COUNTIES

NECHES & TRINITY VALLEYS
GROUNDWATER CONSERVATION DISTRICT
Protecting and Serving Anderson, Cherokee and Henderson Counties
Phone: (903) 541-4845 Fax: (903) 541-4869
Email: manager@ntvgcd.org www.ntvgcd.org
P.O. Box 1387 212 S. Main St Jacksonville, Texas 75766

June 22, 2011

William R. Hutchison, Ph.D., P.E., P.G.
Director, Groundwater Resources
Texas Water Development Board
PO Box 13231
Austin, TX 78711-3231

Dear Dr. Hutchison:

There has been a petition filed against the GMA-11 DFC. We have been in contact with the parties involved with the petition in an effort to avoid the expense of a hearing and any other legal action. While GMA-11 and this District believe that our DFC will stand on the merits and legality of the DFC adoption, we are willing to consider what impact the petitioner's water desires would have on the DFC, especially in NTVGCD. This District, along with Pineywoods GCD, would have the most potential impact from the petitioner's conceptual project.

At our request, Bill Goodrum from Forester provided us with a description of the proposed project along with a location map and input files for a Groundwater Availability Model that can be used to provide impact data on the current GMA-11 DFCs.

We are providing the Forestar information to you and requesting that TWDB run a GAM for this District using the input data which was used to calculate the GMA-11 DFCs and the new input data provided by Forestar. We are specifically asking for revised drawdown numbers for each aquifer by county for NTVGCD and for GMA-11.

Because there is currently a 90 day extension on the appeal process, we request that this GAM be completed by mid-August, if possible, to give this District and/or GMA-11 time to consider the new drawdown data for possible action.

If you have any questions, please contact me at 903-541-4845 or 903-721-0352 (cell).

Sincerely,

Roy J. Rodgers
General Manager

Bill Hutchinson

FORESTAR

William B. Goodrum, Sr.
V.P. Environmental
Local office: 1607 S. Chestnut, Suite R, Lufkin, TX 75901
Corporate Office: 6300 Bee Cave Road, Bldg. Two, Suite 500
Austin, TX 78746-5149
1.936.366.0800

June 8, 2011

Mr. Roy Rodgers
General Manager
Neches and Trinity Groundwater Conservation District
PO Box 1387
Jacksonville, Texas 75766

Subject: Proposed Production Data

Dear Mr. Rogers:

Thank you for meeting with us last week. As requested, we are forwarding a description of the groundwater production we discussed along with a map and input files for the Groundwater Availability Model. The data provide the location, aquifer layers, volume and period of the proposed production. Data for three scenarios are provided.

Please feel free to call me at (936) 366-0800 with any questions or to discuss this further.

Sincerely,

W B Goodrum, Sr.

William B. Goodrum, Sr.
Vice President, Environmental

cc: Marty Harris, Campbell Group
Ed McCarthy

Encl: Groundwater Production Proposed for Modeling, with attachments

Groundwater Production Proposed for Modeling

Project Description:

A conjunctive use project that would provide annual production of 40,000 acre-feet per year of groundwater from Anderson, Cherokee and Houston counties from the Carrizo-Wilcox aquifer is being considered. A well production and collection system would be developed in phases and would be sized to provide a peak production rate of 100,000 acre-feet per year during drought conditions. The project could provide groundwater for beneficial uses on-site, within the Groundwater Management Area 11 (GMA 11), within the Region I Water Planning Area or within adjacent water planning regions. The general area of the proposed production is shown in **Attachment 1**.

Groundwater Modeling Scenarios:

Because conjunctive use projects are designed to provide peak production capacity during relatively brief periods, the timing of the peak production will have an impact on modeling results showing groundwater levels in 2060. There is a great deal of uncertainty about when conditions will be similar to, or worse than, those in a repeat of the drought of record. To provide a range of possible 2060 conditions, three scenarios are recommended for Groundwater Availability Model (GAM) runs.

All three scenarios assume production as described in the project description in addition to groundwater production assumed in the GAM run reported in the document titled, "GAM Task 10-009 Model Run Report," dated September 3, 2010 prepared by the Texas Water Development Board (TWDB).

Scenario A – Peak Production from 2030-2034

Scenario A assumes peak production in the middle of the 51-year simulation period, from 2030-2034.

Key assumptions for the scenario include:

- MODFLOW files used in GAM Task 10-009, as provided by the TWDB provided regional pumping and distribution estimates, recharge values, starting head conditions and all other model parameters;
- Additional pumping of 40,000 acre-foot per year for 51 years (2010-2060) from the Carrizo aquifer and upper and middle units of the Wilcox aquifer;
- An additional 60,000 acre-feet per year for 5 years (2030-2034) from the Carrizo aquifer and upper and middle units of the Wilcox aquifer was simulated to provide ability for potential conjunctive use with other sources during extreme drought conditions;
- Total pumping distributed within the Carrizo, upper and middle units of the Wilcox aquifers based on transmissivity;
- An additional 5,000 acre-feet per year pumping from the Queen City aquifer during a 51-year pumping simulation; and
- Pumping was distributed on Forestar and Crown properties in Anderson, Cherokee and Houston counties as shown in **Attachment 2.**

Scenario B – Peak Production from 2056-2060

In this scenario, peak production is assumed to occur at the end of the 51-year simulation period. In such a scenario, the groundwater level would not have time to recover once pumping returns back to 40,000 acre-feet per year. Key assumptions for the scenario include:

- MODFLOW files used in GAM Task 10-009, as provided by the TWDB provided regional pumping and distribution estimates, recharge values, starting head conditions and all other model parameters;
- Additional pumping of 40,000 acre-foot per year for 51 years (2010-2060) from the Carrizo aquifer and upper and middle units of the Wilcox aquifer;
- An additional 60,000 acre-feet per year for 5 years (2056-2060) from the Carrizo aquifer and upper and middle units of the Wilcox aquifer was simulated to provide ability for potential conjunctive use with other sources during extreme drought conditions;
- Total pumping was distributed within the Carrizo, upper and middle units of the Wilcox aquifers based on transmissivity;
- An additional 5,000 acre-feet per year pumping from the Queen City aquifer during a 51-year pumping simulation; and
- Pumping was distributed on Forestar and Crown properties in Anderson, Cherokee and Houston counties as shown in **Attachment 2.**

Scenario C – Rolling Average

In this scenario, the average additional pumping for Scenario A and Scenario B, over the simulation period, was used. Key assumptions for the scenario include:

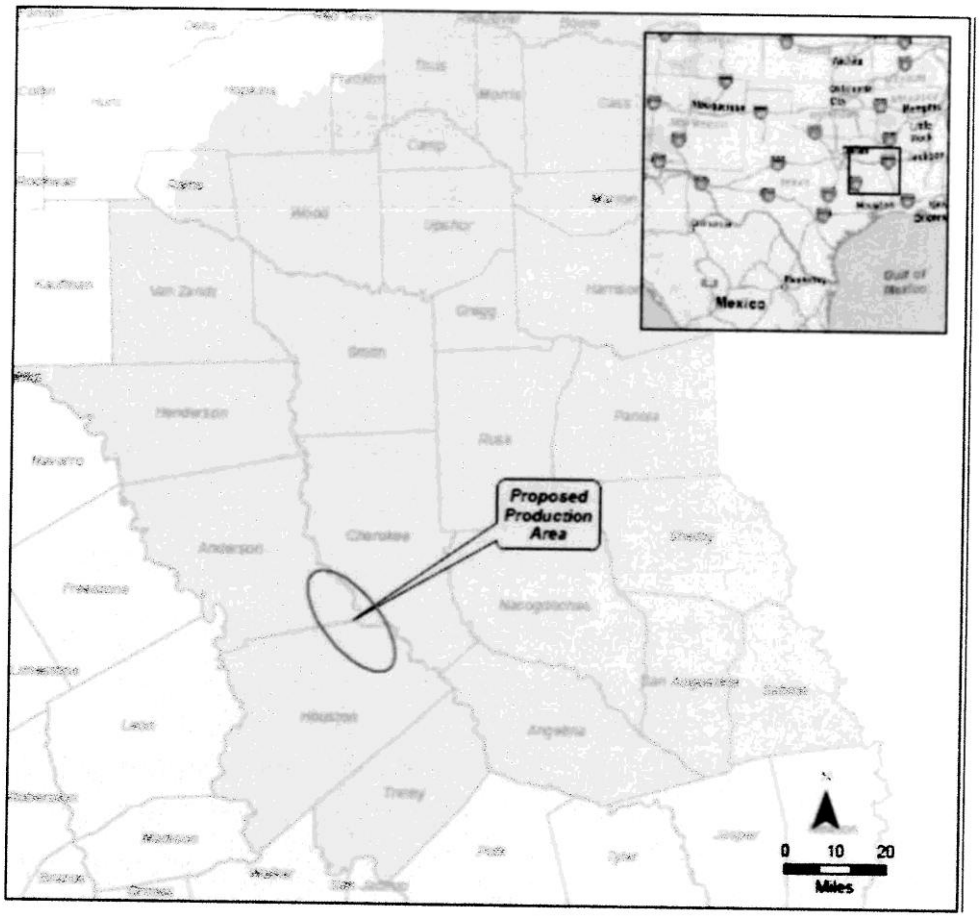
- MODFLOW files used in GAM Task 10-009, as provided by the TWDB provided regional pumping and distribution estimates, recharge values, starting head conditions and all other model parameters;
- Additional pumping of 46,000 acre-feet per year for 51 years (2010-2060) from the Carrizo aquifer and upper and middle units of the Wilcox aquifer. The 46,000 acre-feet per year reflects an annualized average over the 51-year simulation period of 40,000 acre-feet per year, normally, with 100,000 acre-feet per year for five years;
- Total pumping was distributed within the Carrizo, upper and middle units of the Wilcox aquifers based on transmissivity;
- An additional 5,000 acre-feet per year pumping from the Queen City aquifer during a 51-year pumping simulation; and
- Pumping was distributed on Forestar and Crown properties in Anderson, Cherokee and Houston counties as shown in **Attachment 2.**

Attachments:

Attachment 1 – Map showing proposed production area in Anderson, Cherokee and Houston counties

Attachment 2 – Compact disc (CD) with MODFLOW ".wel files" (also called "well packages") for each scenario, i.e., information showing the model cells, production periods, and production periods

Attachment 1



APPENDIX B: AVERAGE DRAWDOWN IN THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS BY COUNTY FOR EACH SCENARIO

TABLE B-1: AVERAGE DRAWDOWN IN FEET FOR GAM TASK 10-009 IN EACH COUNTY BY LAYER OF THE GROUNDWATER AVAILABILITY MODEL. THE AVERAGE DRAWDOWN FOR GROUNDWATER MANAGEMENT AREA (GMA) 11 AS A WHOLE IS ALSO SHOWN. ANDERSON COUNTY IS SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*Layer 1*	*Layer 2*	*Layer 3*	*Layer 4*	*Layer 5*	*Layer 6*	*Layer 7*	*Layer 8*	*Overall Average*
Anderson (ACUWCD)			1	12	35	26	12	5	15
Anderson (NTVGCD)	-2	1	7	15	36	26	11	4	16
Angelina	10	11	16	22	42	5	-18	-3	11
Bowie						21	0		0
Camp			12	0	18	17	39		19
Cass			8	6	10	7	7		8
Cherokee	7	14	11	11	32	32	15	10	18
Franklin				-16	-3	7	19		11
Gregg			7	11	42	49	56	79	35
Harrison			0	2	24	13	5	4	9
Henderson			4	15	41	32	27	15	23
Hopkins				-22	-12	-15	-28		-26
Houston	2	1	2	15	35	12	2	-2	8
Marion			17	11	21	15	15		16
Morris			13	10	29	25	23		21
Nacogdoches	3	3	11	10	14	11	-10	-6	4
Panola			-11	-19	11	2	1	4	2
Rains						7	-10	-5	-8
Red River							-4		-4
Rusk		-46	-15	-2	6	6	23	21	12
Sabine	5	5	7	15	24	13	6	5	10
San Augustine	-4	-4	-3	11	20	9	-3	-2	3
Shelby			-18	-19	23	-3	3	1	1
Smith	-5	-5	11	34	103	118	92	76	68
Titus			-1	-3	31	14	5		8
Trinity	5	4	4	12	33	-3	-7	-1	6
Upshur	-5	-5	5	17	56	66	66	97	44
Van Zandt			7	11	31	13	17	11	14
Wood	-5	-7	-2	36	110	83	55	114	59
GMA 11 Average	**3**	**4**	**7**	**15**	**38**	**26**	**15**	**11**	**17**

TABLE B-2: AVERAGE DRAWDOWN IN FEET FOR SCENARIO A IN EACH COUNTY BY LAYER OF THE GROUNDWATER AVAILABILITY MODEL. THE AVERAGE DRAWDOWN FOR GROUNDWATER MANAGEMENT AREA (GMA) 11 AS A WHOLE IS ALSO SHOWN. ANDERSON COUNTY IS SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*Layer 1*	*Layer 2*	*Layer 3*	*Layer 4*	*Layer 5*	*Layer 6*	*Layer 7*	*Layer 8*	*Overall Average*
Anderson (ACUWCD)			1	22	80	78	71	60	52
Anderson (NTVGCD)	-2	2	8	35	94	107	111	61	68
Angelina	10	12	17	26	50	12	-12	1	15
Bowie						21	0		0
Camp			12	0	18	17	39		19
Cass			8	6	10	7	7		8
Cherokee	7	14	12	21	64	87	93	60	55
Franklin				-16	-3	7	19		11
Gregg			7	11	42	49	56	80	35
Harrison			0	2	24	13	5	4	9
Henderson			4	17	46	38	36	24	29
Hopkins				-22	-12	-15	-28		-26
Houston	2	2	4	32	73	58	50	24	31
Marion			17	11	21	15	15		16
Morris			13	10	29	25	23		21
Nacogdoches	3	3	11	13	20	19	1	4	10
Panola			-11	-19	11	2	1	4	2
Rains						7	-10	-5	-8
Red River							-4		-4
Rusk		-45	-15	-2	7	7	28	29	15
Sabine	5	5	7	15	24	13	6	5	10
San Augustine	-4	-4	-3	11	21	9	-3	-2	3
Shelby			-18	-19	23	-3	3	1	1
Smith	-5	-5	11	34	104	120	96	81	70
Titus			-1	-3	31	14	5		8
Trinity	5	5	5	20	48	8	0	3	12
Upshur	-5	-5	5	17	56	66	67	98	44
Van Zandt			7	11	31	13	17	12	15
Wood	-5	-7	-2	36	110	83	55	114	59
GMA 11 Average	**4**	**4**	**8**	**20**	**51**	**42**	**31**	**26**	**28**

TABLE B-3: AVERAGE DRAWDOWN IN FEET FOR SCENARIO B IN EACH COUNTY BY LAYER OF THE GROUNDWATER AVAILABILITY MODEL. THE AVERAGE DRAWDOWN FOR GROUNDWATER MANAGEMENT AREA (GMA) 11 AS A WHOLE IS ALSO SHOWN. ANDERSON COUNTY IS SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*Layer 1*	*Layer 2*	*Layer 3*	*Layer 4*	*Layer 5*	*Layer 6*	*Layer 7*	*Layer 8*	*Overall Average*
Anderson (ACUWCD)			1	22	79	77	69	58	51
Anderson (NTVGCD)	-2	2	8	35	95	107	111	58	68
Angelina	10	12	17	25	50	10	-14	0	14
Bowie						21	0		0
Camp			12	0	18	17	39		19
Cass			8	6	10	7	7		8
Cherokee	7	14	12	20	67	93	102	55	57
Franklin				-16	-3	7	19		11
Gregg			7	11	42	49	56	80	35
Harrison			0	2	24	13	5	4	9
Henderson			4	17	46	38	35	24	29
Hopkins				-22	-12	-15	-28		-26
Houston	2	2	4	31	84	68	61	21	35
Marion			17	11	21	15	15		16
Morris			13	10	29	25	23		21
Nacogdoches	3	3	11	13	19	18	-2	1	9
Panola			-11	-19	11	2	1	4	2
Rains						7	-10	-5	-8
Red River							-4		-4
Rusk		-45	-15	-2	6	7	27	28	15
Sabine	5	5	7	15	24	13	6	5	10
San Augustine	-4	-4	-3	11	21	9	-3	-2	3
Shelby			-18	-19	23	-3	3	1	1
Smith	-5	-5	11	34	104	120	96	81	70
Titus			-1	-3	31	14	5		8
Trinity	5	5	5	18	50	5	-2	2	11
Upshur	-5	-5	5	17	56	66	67	97	44
Van Zandt			7	11	31	13	17	12	15
Wood	-5	-7	-2	36	110	83	55	114	59
GMA 11 Average	**4**	**4**	**7**	**20**	**53**	**42**	**32**	**25**	**28**

TABLE B-4: AVERAGE DRAWDOWN IN FEET FOR SCENARIO C IN EACH COUNTY BY LAYER OF THE GROUNDWATER AVAILABILITY MODEL. THE AVERAGE DRAWDOWN FOR GROUNDWATER MANAGEMENT AREA (GMA) 11 AS A WHOLE IS ALSO SHOWN. ANDERSON COUNTY IS SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*Layer 1*	*Layer 2*	*Layer 3*	*Layer 4*	*Layer 5*	*Layer 6*	*Layer 7*	*Layer 8*	*Overall Average*
Anderson (ACUWCD)			1	20	69	63	52	42	41
Anderson (NTVGCD)	-2	2	8	32	84	89	84	45	56
Angelina	10	12	17	29	56	17	-8	3	17
Bowie						21	0		0
Camp			12	0	18	17	39		19
Cass			8	6	10	7	7		8
Cherokee	7	15	12	23	69	96	98	56	58
Franklin				-16	-3	7	19		11
Gregg			7	11	42	49	56	80	35
Harrison			0	2	24	13	5	4	9
Henderson			4	17	45	36	33	21	27
Hopkins				-22	-12	-15	-28		-26
Houston	2	3	5	35	83	74	68	25	38
Marion			17	11	21	15	15		16
Morris			13	10	29	25	23		21
Nacogdoches	3	4	12	15	23	24	5	7	13
Panola			-11	-19	11	2	1	4	2
Rains						7	-10	-5	-8
Red River							-4		-4
Rusk		-45	-15	-2	7	8	28	30	16
Sabine	5	5	7	15	24	13	6	5	10
San Augustine	-4	-4	-3	11	21	10	-3	-2	4
Shelby			-18	-19	23	-3	4	1	1
Smith	-5	-5	11	34	103	119	95	80	69
Titus			-1	-3	31	14	5		8
Trinity	6	6	6	23	55	14	5	5	15
Upshur	-5	-5	5	17	56	66	67	97	44
Van Zandt			7	11	31	13	17	11	15
Wood	-5	-7	-2	36	110	83	55	114	59
GMA 11 Average	**4**	**5**	**8**	**21**	**53**	**43**	**32**	**25**	**29**

APPENDIX C: AVERAGE DRAWDOWN BY COUNTY FOR EACH LAYER OF GROUNDWATER AVAILABILITY MODEL FOR THE NORTHERN PORTION OF THE CARRIZO-WILCOX, QUEEN CITY, AND SPARTA AQUIFERS IN GROUNDWATER MANAGEMENT AREA 11

TABLE C-1: AVERAGE DRAWDOWN IN FEET FOR THE SPARTA AQUIFER (LAYER 1) IN GROUNDWATER MANAGEMENT AREA (GMA) 11 IN EACH COUNTY BY SCENARIO. THE DRAWDOWN IN GAM TASK 10-009 IS ALSO SHOWN. ALL VALUES ARE IN FEET. NEGATIVE VALUES INDICATE A WATER LEVEL RISE. THE ONLY AREA IN ANDERSON COUNTY CONTAINING THE SPARTA AQUIFER IS WITHIN NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*GAM Task 10-009*	*Scenario A*	*Scenario B*	*Scenario C*
Anderson (NTVGCD)	-2	-2	-2	-2
Angelina	10	10	10	10
Cherokee	7	7	7	7
Houston	2	2	2	2
Nacogdoches	3	3	3	3
Sabine	5	5	5	5
San Augustine	-4	-4	-4	-4
Smith	-5	-5	-5	-5
Trinity	5	5	5	6
Upshur	-5	-5	-5	-5
Wood	-5	-5	-5	-5
GMA 11 Average*	**3**	**4**	**4**	**4**

*Though the county-by-county drawdown is very similar between GAM Task 10-009 and each of the scenarios, the GMA 11 average drawdown shows an increase from 3 to 4 feet. This difference is small and is influenced by rounding. The average drawdowns for GAM Task 10-009 and scenarios A, B, and C are 3.3, 3.7, 3.6, and 3.8 feet, respectively.

TABLE C-2: AVERAGE DRAWDOWN IN FEET FOR THE QUEEN CITY AQUIFER (LAYER 3) IN GROUNDWATER MANAGEMENT AREA (GMA) 11 IN EACH COUNTY BY SCENARIO. THE DRAWDOWN IN GAM TASK 10-009 IS ALSO SHOWN. ALL VALUES ARE IN FEET. NEGATIVE VALUES INDICATE A WATER LEVEL RISE. ANDERSON COUNTY IS SHOWN SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*GAM Task 10-009*	*Scenario A*	*Scenario B*	*Scenario C*
Anderson (ACUWCD)	1	1	1	1
Anderson (NTVGCD)	7	8	8	8
Angelina	16	17	17	17
Camp	12	12	12	12
Cass	8	8	8	8
Cherokee	11	12	12	12
Gregg	7	7	7	7
Harrison	0	0	0	0
Henderson	4	4	4	4
Houston	2	4	4	5
Marion	17	17	17	17
Morris	13	13	13	13
Nacogdoches	11	11	11	12
Panola	-11	-11	-11	-11
Rusk	-15	-15	-15	-15
Sabine	7	7	7	7
San Augustine	-3	-3	-3	-3
Shelby	-18	-18	-18	-18
Smith	11	11	11	11
Titus	-1	-1	-1	-1
Trinity	4	5	5	6
Upshur	5	5	5	5
Van Zandt	7	7	7	7
Wood	-2	-2	-2	-2
GMA 11 Average	**7**	**8**	**7**	**8**

*Though the county-by-county drawdown is very similar between GAM Task 10-009 and each of the scenarios, the GMA 11 average drawdown fluctuates between 7 and 8 feet. This difference is small and is influenced by rounding. The average drawdowns for GAM Task 10-009 and scenarios A, B, and C are 7.0, 7.6, 7.5, and 7.7 feet, respectively.

TABLE C-3: AVERAGE DRAWDOWN IN FEET FOR THE CARRIZO UNIT OF THE CARRIZO-WILCOX AQUIFER (LAYER 5) IN GROUNDWATER MANAGEMENT AREA (GMA) 11 IN EACH COUNTY BY SCENARIO. THE DRAWDOWN IN GAM TASK 10-009 IS ALSO SHOWN. ALL VALUES ARE IN FEET. NEGATIVE VALUES INDICATE A WATER LEVEL RISE. ANDERSON COUNTY IS SHOWN SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*GAM Task 10-009*	*Scenario A*	*Scenario B*	*Scenario C*
Anderson (ACUWCD)	35	80	79	69
Anderson (NTVGCD)	36	94	95	84
Angelina	42	50	50	56
Camp	18	18	18	18
Cass	10	10	10	10
Cherokee	32	64	67	69
Franklin	-3	-3	-3	-3
Gregg	42	42	42	42
Harrison	24	24	24	24
Henderson	41	46	46	45
Hopkins	-12	-12	-12	-12
Houston	35	73	84	83
Marion	21	21	21	21
Morris	29	29	29	29
Nacogdoches	14	20	19	23
Panola	11	11	11	11
Rusk	6	7	6	7
Sabine	24	24	24	24
San Augustine	20	21	21	21
Shelby	23	23	23	23
Smith	103	104	104	103
Titus	31	31	31	31
Trinity	33	48	50	55
Upshur	56	56	56	56
Van Zandt	31	31	31	31
Wood	110	110	110	110
GMA 11 Average	**38**	**51**	**53**	**53**

TABLE C-4: AVERAGE DRAWDOWN IN FEET FOR THE UPPER WILCOX UNIT OF THE CARRIZO-WILCOX AQUIFER (LAYER 6) IN GROUNDWATER MANAGEMENT AREA (GMA) 11 IN EACH COUNTY BY SCENARIO. THE DRAWDOWN IN GAM TASK 10-009 IS ALSO SHOWN. ALL VALUES ARE IN FEET. NEGATIVE VALUES INDICATE A WATER LEVEL RISE. ANDERSON COUNTY IS SHOWN SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*GAM Task 10-009*	*Scenario A*	*Scenario B*	*Scenario C*
Anderson (ACUWCD)	26	78	77	63
Anderson (NTVGCD)	26	107	107	89
Angelina	5	12	10	17
Bowie	21	21	21	21
Camp	17	17	17	17
Cass	7	7	7	7
Cherokee	32	87	93	96
Franklin	7	7	7	7
Gregg	49	49	49	49
Harrison	13	13	13	13
Henderson	32	38	38	36
Hopkins	-15	-15	-15	-15
Houston	12	58	68	74
Marion	15	15	15	15
Morris	25	25	25	25
Nacogdoches	11	19	18	24
Panola	2	2	2	2
Rains	7	7	7	7
Rusk	6	7	7	8
Sabine	13	13	13	13
San Augustine	9	9	9	10
Shelby	-3	-3	-3	-3
Smith	118	120	120	119
Titus	14	14	14	14
Trinity	-3	8	5	14
Upshur	66	66	66	66
Van Zandt	13	13	13	13
Wood	83	83	83	83
GMA 11 Average	**26**	**42**	**42**	**43**

TABLE C-5: AVERAGE DRAWDOWN IN FEET FOR THE MIDDLE WILCOX UNIT OF THE CARRIZO-WILCOX AQUIFER (LAYER 7) IN GROUNDWATER MANAGEMENT AREA (GMA) 11 IN EACH COUNTY BY SCENARIO. THE DRAWDOWN IN GAM TASK 10-009 IS ALSO SHOWN. ALL VALUES ARE IN FEET. NEGATIVE VALUES INDICATE A WATER LEVEL RISE. ANDERSON COUNTY IS SHOWN SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*GAM Task 10-009*	*Scenario A*	*Scenario B*	*Scenario C*
Anderson (ACUWCD)	12	71	69	52
Anderson (NTVGCD)	11	111	111	84
Angelina	-18	-12	-14	-8
Bowie	0	0	0	0
Camp	39	39	39	39
Cass	7	7	7	7
Cherokee	15	93	102	98
Franklin	19	19	19	19
Gregg	56	56	56	56
Harrison	5	5	5	5
Henderson	27	36	35	33
Hopkins	-28	-28	-28	-28
Houston	2	50	61	68
Marion	15	15	15	15
Morris	23	23	23	23
Nacogdoches	-10	1	-2	5
Panola	1	1	1	1
Rains	-10	-10	-10	-10
Red River	-4	-4	-4	-4
Rusk	23	28	27	28
Sabine	6	6	6	6
San Augustine	-3	-3	-3	-3
Shelby	3	3	3	4
Smith	92	96	96	95
Titus	5	5	5	5
Trinity	-7	0	-2	5
Upshur	66	67	67	67
Van Zandt	17	17	17	17
Wood	55	55	55	55
GMA 11 Average	**15**	**31**	**32**	**32**

TABLE C-6: AVERAGE DRAWDOWN IN FEET FOR THE LOWER WILCOX UNIT OF THE CARRIZO-WILCOX AQUIFER (LAYER 8) IN GROUNDWATER MANAGEMENT AREA (GMA) 11 IN EACH COUNTY BY SCENARIO. THE DRAWDOWN IN GAM TASK 10-009 IS ALSO SHOWN. ALL VALUES ARE IN FEET. NEGATIVE VALUES INDICATE A WATER LEVEL RISE. ANDERSON COUNTY IS SHOWN SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*GAM Task 10-009*	*Scenario A*	*Scenario B*	*Scenario C*
Anderson (ACUWCD)	5	60	58	42
Anderson (NTVGCD)	4	61	58	45
Angelina	-3	1	0	3
Cherokee	10	60	55	56
Gregg	79	80	80	80
Harrison	4	4	4	4
Henderson	15	24	24	21
Houston	-2	24	21	25
Nacogdoches	-6	4	1	7
Panola	4	4	4	4
Rains	-5	-5	-5	-5
Rusk	21	29	28	30
Sabine	5	5	5	5
San Augustine	-2	-2	-2	-2
Shelby	1	1	1	1
Smith	76	81	81	80
Trinity	-1	3	2	5
Upshur	97	98	97	97
Van Zandt	11	12	12	11
Wood	114	114	114	114
GMA 11 Average	**11**	**26**	**25**	**25**

APPENDIX D: AVERAGE INCREASE IN DRAWDOWN BY SCENARIO RELATIVE TO GAM TASK 10-009

TABLE D-1: AVERAGE INCREASE IN DRAWDOWN IN FEET FOR SCENARIO A RELATIVE TO GAM TASK 10-009 IN EACH COUNTY BY LAYER OF THE GROUNDWATER AVAILABILITY MODEL. ANDERSON COUNTY IS SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*Layer 1*	*Layer 2*	*Layer 3*	*Layer 4*	*Layer 5*	*Layer 6*	*Layer 7*	*Layer 8*	*Overall Average*
Anderson (ACUWCD)			0	10	45	52	59	55	37
Anderson (NTVGCD)	0	1	1	20	58	81	100	57	52
Angelina	0	1	1	4	8	7	6	4	4
Bowie						0	0		0
Camp			0	0	0	0	0		0
Cass			0	0	0	0	0		0
Cherokee	0	0	1	10	32	55	78	50	37
Franklin				0	0	0	0		0
Gregg			0	0	0	0	0	1	0
Harrison			0	0	0	0	0	0	0
Henderson			0	2	5	6	9	9	6
Hopkins				0	0	0	0		0
Houston	0	1	2	17	38	46	48	26	23
Marion			0	0	0	0	0		0
Morris			0	0	0	0	0		0
Nacogdoches	0	0	0	3	6	8	11	10	6
Panola			0	0	0	0	0	0	0
Rains						0	0	0	0
Red River							0		0
Rusk		1	0	0	1	1	5	8	3
Sabine	0	0	0	0	0	0	0	0	0
San Augustine	0	0	0	0	1	0	0	0	0
Shelby			0	0	0	0	0	0	0
Smith	0	0	0	0	1	2	4	5	2
Titus			0	0	0	0	0		0
Trinity	0	1	1	8	15	11	7	4	6
Upshur	0	0	0	0	0	0	1	1	0
Van Zandt			0	0	0	0	0	1	1
Wood	0	0	0	0	0	0	0	0	0
GMA 11 Average	**1**	**0**	**1**	**5**	**13**	**16**	**16**	**15**	**11**

TABLE D-2: AVERAGE INCREASE IN DRAWDOWN IN FEET FOR SCENARIO B RELATIVE TO GAM TASK 10-009 IN EACH COUNTY BY LAYER OF THE GROUNDWATER AVAILABILITY MODEL. ANDERSON COUNTY IS SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*Layer 1*	*Layer 2*	*Layer 3*	*Layer 4*	*Layer 5*	*Layer 6*	*Layer 7*	*Layer 8*	*Overall Average*
Anderson (ACUWCD)			0	10	44	51	57	53	36
Anderson (NTVGCD)	0	1	1	20	59	81	100	54	52
Angelina	0	1	1	3	8	5	4	3	3
Bowie						0	0		0
Camp			0	0	0	0	0		0
Cass			0	0	0	0	0		0
Cherokee	0	0	1	9	35	61	87	45	39
Franklin				0	0	0	0		0
Gregg			0	0	0	0	0	1	0
Harrison			0	0	0	0	0	0	0
Henderson			0	2	5	6	8	9	6
Hopkins				0	0	0	0		0
Houston	0	1	2	16	49	56	59	23	27
Marion			0	0	0	0	0		0
Morris			0	0	0	0	0		0
Nacogdoches	0	0	0	3	5	7	8	7	5
Panola			0	0	0	0	0	0	0
Rains						0	0	0	0
Red River							0		0
Rusk		1	0	0	0	1	4	7	3
Sabine	0	0	0	0	0	0	0	0	0
San Augustine	0	0	0	0	1	0	0	0	0
Shelby			0	0	0	0	0	0	0
Smith	0	0	0	0	1	2	4	5	2
Titus			0	0	0	0	0		0
Trinity	0	1	1	6	17	8	5	3	5
Upshur	0	0	0	0	0	0	1	0	0
Van Zandt			0	0	0	0	0	1	1
Wood	0	0	0	0	0	0	0	0	0
GMA 11 Average	**1**	**0**	**0**	**5**	**15**	**16**	**17**	**14**	**11**

TABLE D-3: AVERAGE INCREASE IN DRAWDOWN IN FEET FOR SCENARIO C RELATIVE TO GAM TASK 10-009 IN EACH COUNTY BY LAYER OF THE GROUNDWATER AVAILABILITY MODEL. ANDERSON COUNTY IS SEPARATED INTO THE AREAS IN ANDERSON COUNTY UNDERGROUND WATER CONSERVATION DISTRICT (ACUWCD) AND NECHES AND TRINITY VALLEYS GROUNDWATER CONSERVATION DISTRICT (NTVGCD).

County	*Layer 1*	*Layer 2*	*Layer 3*	*Layer 4*	*Layer 5*	*Layer 6*	*Layer 7*	*Layer 8*	*Overall Average*
Anderson (ACUWCD)			0	8	34	37	40	37	26
Anderson (NTVGCD)	0	1	1	17	48	63	73	41	40
Angelina	0	1	1	7	14	12	10	6	6
Bowie						0	0		0
Camp			0	0	0	0	0		0
Cass			0	0	0	0	0		0
Cherokee	0	1	1	12	37	64	83	46	40
Franklin				0	0	0	0		0
Gregg			0	0	0	0	0	1	0
Harrison			0	0	0	0	0	0	0
Henderson			0	2	4	4	6	6	4
Hopkins				0	0	0	0		0
Houston	0	2	3	20	48	62	66	27	30
Marion			0	0	0	0	0		0
Morris			0	0	0	0	0		0
Nacogdoches	0	1	1	5	9	13	15	13	9
Panola			0	0	0	0	0	0	0
Rains						0	0	0	0
Red River							0		0
Rusk		1	0	0	1	2	5	9	4
Sabine	0	0	0	0	0	0	0	0	0
San Augustine	0	0	0	0	1	1	0	0	1
Shelby			0	0	0	0	1	0	0
Smith	0	0	0	0	0	1	3	4	1
Titus			0	0	0	0	0		0
Trinity	1	2	2	11	22	17	12	6	9
Upshur	0	0	0	0	0	0	1	0	0
Van Zandt			0	0	0	0	0	0	1
Wood	0	0	0	0	0	0	0	0	0
GMA 11 Average	**1**	**1**	**1**	**6**	**15**	**17**	**17**	**14**	**12**