GAM Run 07-15

by Roberto Anaya, P.G.
Texas Water Development Board
Groundwater Availability Modeling Section
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October 30, 2007

EXECUTIVE SUMMARY:

We ran the groundwater availability model for the model for the northern segment of the Edwards (Balcones Fault Zone) Aquifer to simulate natural discharge from Salado Creek in Bell County and aggregated springs and streams in Williamson and Travis counties using distributed pumpage and recharge rates developed by staff at Turner, Collie and Braden, Incorporated. The results show a period of below-average discharge from about 2014 to 2016 followed by above-average discharge from about 2017 to 2020 relative to the period from 2001 to 2010.

REQUESTOR:

Ms. Cheryl Maxwell of the Clearwater Underground Water Conservation District acting on behalf of Groundwater Management Area 8.

DESCRIPTION OF REQUEST:

Ms. Cheryl Maxwell requested we use the groundwater availability model for the northern segment of the Edwards (Balcones Fault Zone) Aquifer to determine projected discharge from model drain cells representing Salado Creek in Bell County and drain cells representing aggregated springs and streams in Williamson and Travis counties for a simulation period beginning 2001 through 2020. Ms. Cheryl Maxwell asked that we use pumpage and recharge model input files developed by staff at Turner, Collie and Braden, Incorporated.

METHODS:

To address the request, we:

- used pumpage and recharge distributions provided to us by staff at Turner, Collie and Braden, Incorporated;

- ran the model for 141 years, starting with a 100-year initial stress period (pre-1980) followed by 21 years of monthly stress periods (1980 to 2000), then 10 years of annual stress periods (2001 to 2010), and ending with 10 years of monthly stress periods (2011 to 2020);

- extracted projected discharge for each stress period for drain cells representing Salado Creek in Bell County, and drain cells representing aggregated springs and streams in Williamson and Travis counties;

- generated a table of discharge from drain cells representing Salado Creek in Bell County and drain cells representing aggregated springs and streams in Williamson and Travis counties for stress periods 254 through 383 (2001 to 2020); and

- generated hydrographs of discharge from drain cells representing Salado Creek in Bell County, and drain cells representing aggregated springs and streams in Williamson and Travis counties for stress periods 254 through 383 (2001 to 2020).

PARAMETERS AND ASSUMPTIONS:

- We used version 1.01 of the groundwater availability model for the northern segment of the Edwards (Balcones Fault Zone) Aquifer.

- See Jones (2003) for a more detailed discussion of assumptions and limitations of the groundwater availability model for the northern segment of the Edwards (Balcones Fault Zone) Aquifer.

- The model consists of one layer representing the northern segment of the Edwards (Balcones Fault Zone) Aquifer and assumes no hydraulic communication with the underlying Trinity Aquifer.

- The model utilizes the Drain package of MODFLOW to simulate discharge from springs and perennial streams with the assumption that the perennial streams are always gaining water from the aquifer.

- 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 32 feet for the steady-state calibration period (Jones, 2003).

- Distributed recharge rates were provided to us by staff at Turner, Collie and Braden, Incorporated and were not verified or analyzed for integrity or quality assurance. For more detailed information regarding distributed recharge rates for this model run, contact Randy Williams at Turner, Collie and Braden, Incorporated at 512-472-4519 or email at randy.williams@tcb.aecom.com.

- Distributed pumpage rates were provided to us by staff at Turner, Collie and Braden, Incorporated and checked against the following county-wide annual pumpage values for 2001 to 2010: (1) 7,500 acre-feet per year for Bell County; (2) 18,012 acre-feet per year for Williamson County: and (3) 5,600 acre-feet per year for Travis County. Our check found that actual annual pumpage for 2001 to 2010 were: (1) 7,509 acre-feet per year for Bell County; (2) 18,331 acre-feet per

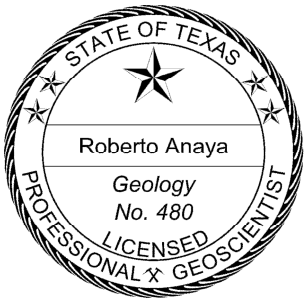
year for Williamson County; and (3) 4,870 acre-feet per year for Travis County. For more detailed information regarding distributed pumpage rates for this model run, contact Randy Williams at Turner, Collie and Braden, Incorporated at 512-472-4519 or email at randy.williams@tcb.aecom.com.

RESULTS:

Discharge from the model drain cells representing Salado Creek in Bell County and aggregated natural springs and streams in Williamson and Travis counties (Figure 1) is listed in Table 1 for each annual stress period beginning with stress period number 254 to 263 (2001 to 2010) and for each monthly stress period beginning with stress period number 264 to 383 (2011 to 2020). The hydrographs (Figures 2, 3, and 4) show a period of below-average discharge from about 2014 to 2016 followed by above-average discharge from about 2017 to 2020 relative to the period from 2001 to 2010.

REFERENCES:

Jones, I. C., 2003, Groundwater availability modeling: Northern Segment of the Edwards Aquifer: Texas Water Development Board, Report 358, 75 p.



The seal appearing on this document was authorized by Roberto Anaya, P.G. on October 30, 2007.

Table 1. Discharge from model drain cells representing Salado Creek in Bell County and aggregated natural springs and streams in Williamson and Travis counties.

Time period	Stress period number	Salado Creek discharge (acre-feet per year)	Williamson County discharge (acre-feet per year)	Travis County discharge (acre-feet per year)
2001	254	23,744	38,166	2,386
2002	255	19,709	31,071	1,871
2003	256	22,153	36,481	2,313
2004	257	22,338	36,884	2,354
2005	258	17,939	27,759	1,654
2006	259	23,592	39,540	2,597
2007	260	11,798	15,338	1,273
2008	261	7,921	7,707	1,040
2009	262	16,412	23,865	1,256
2010	263	11,143	13,460	1,140
JAN2011	264	3,928	1,120	1,082
FEB2011	265	11,317	12,818	1,059
MAR2011	266	14,081	18,427	1,059
APR2011	267	7,868	7,221	1,047
MAY2011	268	17,170	25,202	1,079
JUN2011	269	16,837	24,831	1,200
JUL2011	270	6,696	5,515	1,103
AUG2011	271	3,801	1,028	1,046
SEP2011	272	22,188	34,555	1,169
OCT2011	273	7,857	6,500	1,047
NOV2011	274	6,336	3,276	1,010
DEC2011	275	3,218	249	946
JAN2012	276	1,653	0	869
FEB2012	277	7,816	3,621	829
MAR2012	278	9,427	8,406	815
APR2012	279	26,766	44,173	1,879
MAY2012	280	28,254	47,820	3,019
JUN2012	281	15,376	19,012	1,133
JUL2012	282	11,147	12,673	1,155
AUG2012	283	4,084	1,254	1,098
SEP2012	284	9,088	7,703	1,046
OCT2012	285	1,801	0	947
NOV2012	286	21,899	30,415	964
DEC2012	287	21,623	32,224	1,561
JAN2013	288	8,689	7,169	1,034
FEB2013	289	11,032	10,953	1,044
MAR2013	290	9,064	8,558	1,037
APR2013	291	17,869	25,855	1,070
MAY2013	292	18,074	26,491	1,340
JUN2013	293	9,027	8,977	1,120
JUL2013	294	8,102	7,120	1,099
AUG2013	295	14,550	20,076	1,095
SEP2013	296	15,191	20,917	1,098
OCT2013	297	34,914	65,977	4,163

Time period	Stress period number	Salado Creek discharge (acre-feet per year)	Williamson County discharge (acre-feet per year)	Travis County discharge (acre-feet per year)
NOV2013	298	14,893	16,390	1,240
DEC2013	299	25,764	41,011	2,316
JAN2014	300	11,311	11,349	1,293
FEB2014	301	5,624	2,444	1,234
MAR2014	302	2,489	135	1,132
APR2014	303	6,619	3,047	1,054
MAY2014	304	8,766	7,761	996
JUN2014	305	3,641	698	928
JUL2014	306	3,957	933	867
AUG2014	307	3,619	684	804
SEP2014	308	4,733	1,358	753
OCT2014	309	5,207	2,138	713
NOV2014	310	5,686	2,674	689
DEC2014	311	2,496	0	656
JAN2015	312	7,221	3,451	654
FEB2015	313	19,330	26,453	724
MAR2015	314	8,705	7,497	775
APR2015	315	9,374	9,251	803
MAY2015	316	24,357	39,157	1,748
JUN2015	317	22,829	35,736	2,058
JUL2015	318	11,899	13,607	1,092
AUG2015	319	15,693	22,011	1,128
SEP2015	320	9,321	9,389	1,115
OCT2015	321	4,178	1,150	1,051
NOV2015	322	4,177	889	977
DEC2015	323	4,496	944	907
JAN2016	324	6,106	2,373	851
FEB2016	325	8,560	6,603	825
MAR2016	326	2,618	0	781
APR2016	327	1,379	0	731
MAY2016	328	5,978	1,574	704
JUN2016	329	4,355	1,139	683
JUL2016	330	3,320	357	656
AUG2016	331	4,667	1,307	635
SEP2016	332	1,306	0	593
OCT2016	333	2,306	0	568
NOV2016	334	6,118	1,967	555
DEC2016	335	8,195	5,623	571
JAN2017	336	4,875	1,532	587
FEB2017	337	9,179	8,018	624
MAR2017	338	16,240	21,225	712
APR2017	339	50,359	108,272	6,327
MAY2017	340	35,106	59,471	3,755
JUN2017	341	33,494	56,827	3,685
JUL2017	342	13,309	12,767	1,342
AUG2017	343	9,060	7,067	1,276
SEP2017	344	30,682	52,596	2,719
OCT2017	345	47,280	99,658	6,435

Time period	Stress period number	Salado Creek discharge (acre-feet per year)	Williamson County discharge (acre-feet per year)	Travis County discharge (acre-feet per year)
NOV2017	346	32,078	51,656	3,458
DEC2017	347	17,629	20,433	1,518
JAN2018	348	17,413	22,804	1,481
FEB2018	349	33,632	61,678	3,906
MAR2018	350	19,560	27,127	1,665
APR2018	351	18,174	26,161	1,549
MAY2018	352	18,322	27,353	1,580
JUN2018	353	26,461	46,130	3,097
JUL2018	354	15,991	22,911	1,507
AUG2018	355	13,488	18,550	1,444
SEP2018	356	40,502	83,275	5,380
OCT2018	357	29,183	48,214	3,343
NOV2018	358	16,121	19,494	1,537
DEC2018	359	12,256	13,978	1,468
JAN2019	360	5,886	3,421	1,355
FEB2019	361	14,671	19,249	1,299
MAR2019	362	4,230	1,747	1,196
APR2019	363	21,098	33,147	1,214
MAY2019	364	16,479	23,841	1,255
JUN2019	365	21,213	34,555	1,889
JUL2019	366	16,551	24,776	1,369
AUG2019	367	31,051	58,484	3,861
SEP2019	368	22,063	33,700	2,045
OCT2019	369	39,837	80,101	5,397
NOV2019	370	21,995	30,519	1,855
DEC2019	371	22,814	34,443	2,008
JAN2020	372	16,711	22,783	1,528
FEB2020	373	18,881	28,467	1,587
MAR2020	374	11,440	14,012	1,449
APR2020	375	18,372	28,827	1,471
MAY2020	376	9,076	10,142	1,367
JUN2020	377	23,745	41,003	2,131
JUL2020	378	14,002	19,905	1,369
AUG2020	379	14,675	21,699	1,356
SEP2020	380	10,526	12,894	1,309
OCT2020	381	55,014	126,723	7,440
NOV2020	382	31,355	50,413	3,247
DEC2020	383	35,405	63,890	4,238

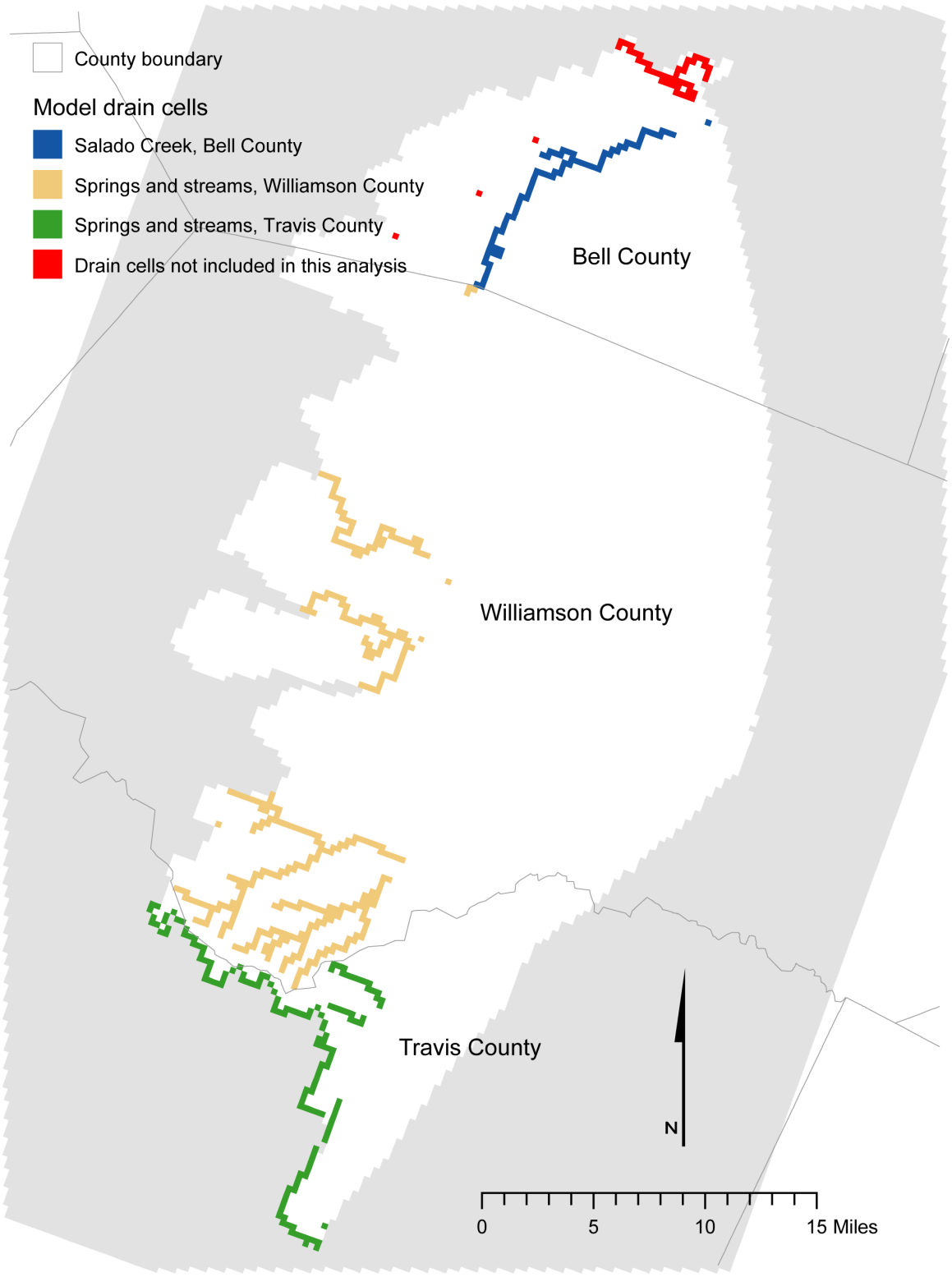


Figure 1: Model drain cells representing Salado Creek discharge in Bell County and natural spring-stream discharge in Williamson and Travis counties

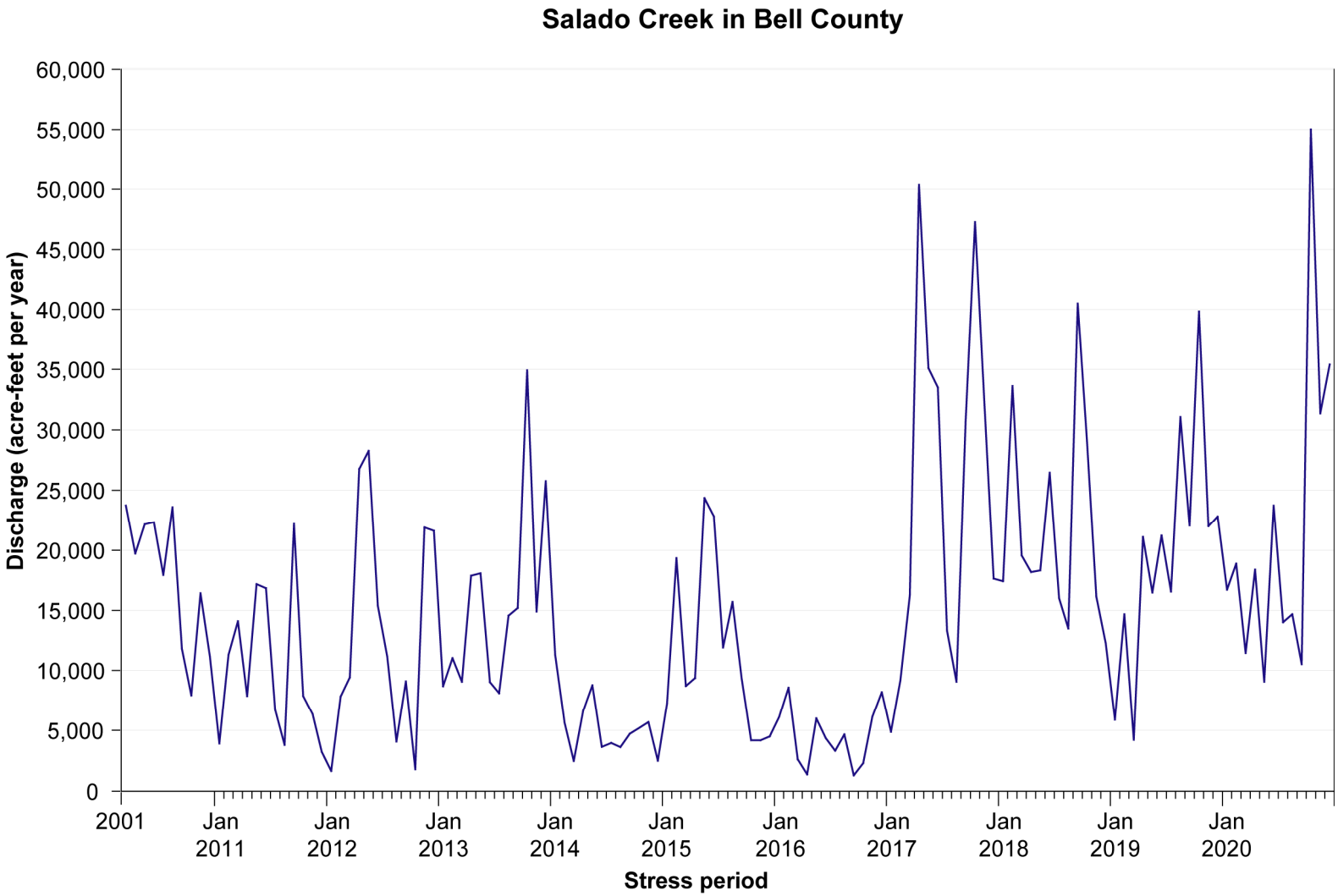


Figure 2: Hydrograph of simulated (2001 to 2020) discharge for Salado Creek in Bell County.

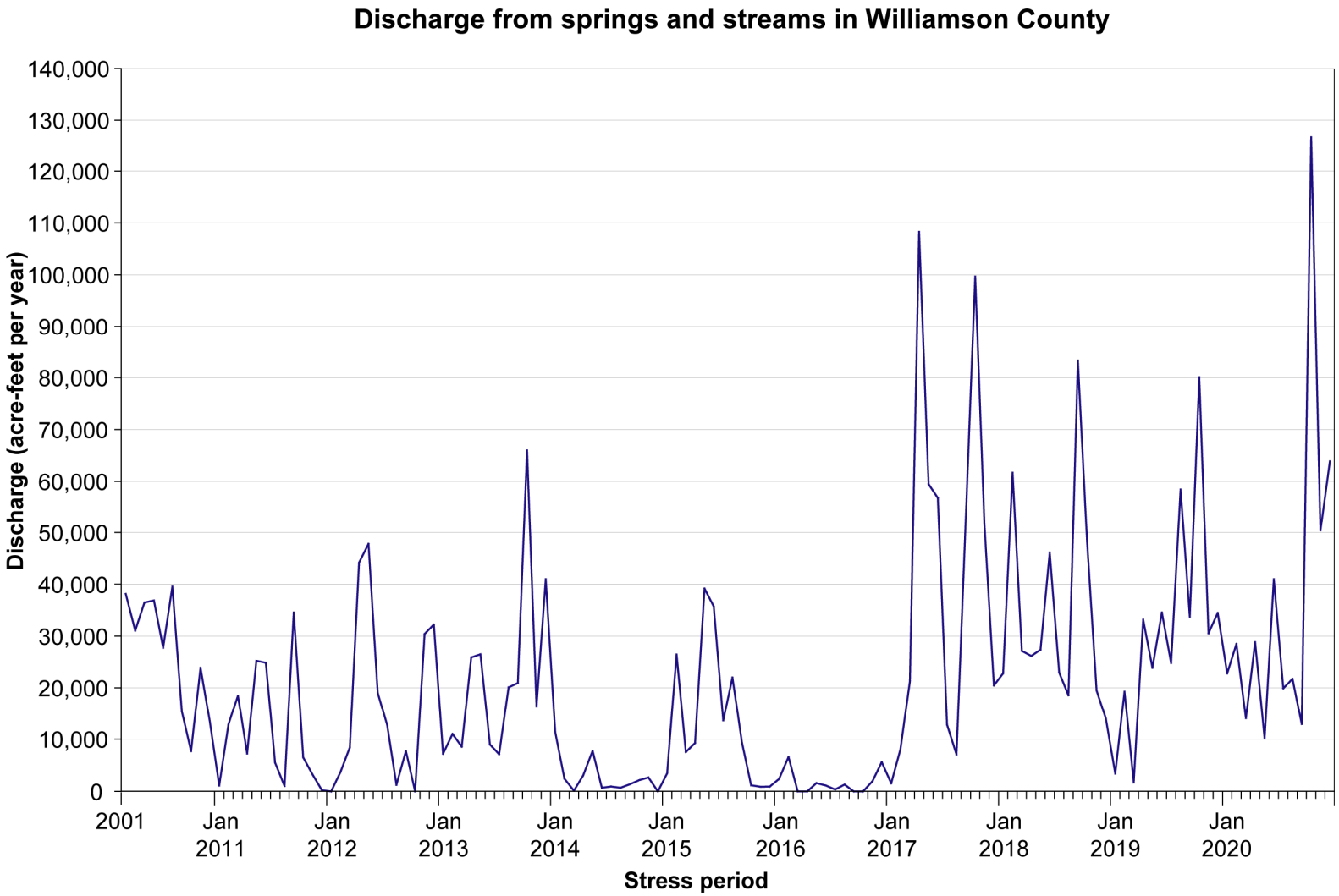


Figure 3: Hydrograph of simulated (2001 to 2020) aggregated natural spring-stream discharge in Williamson County.

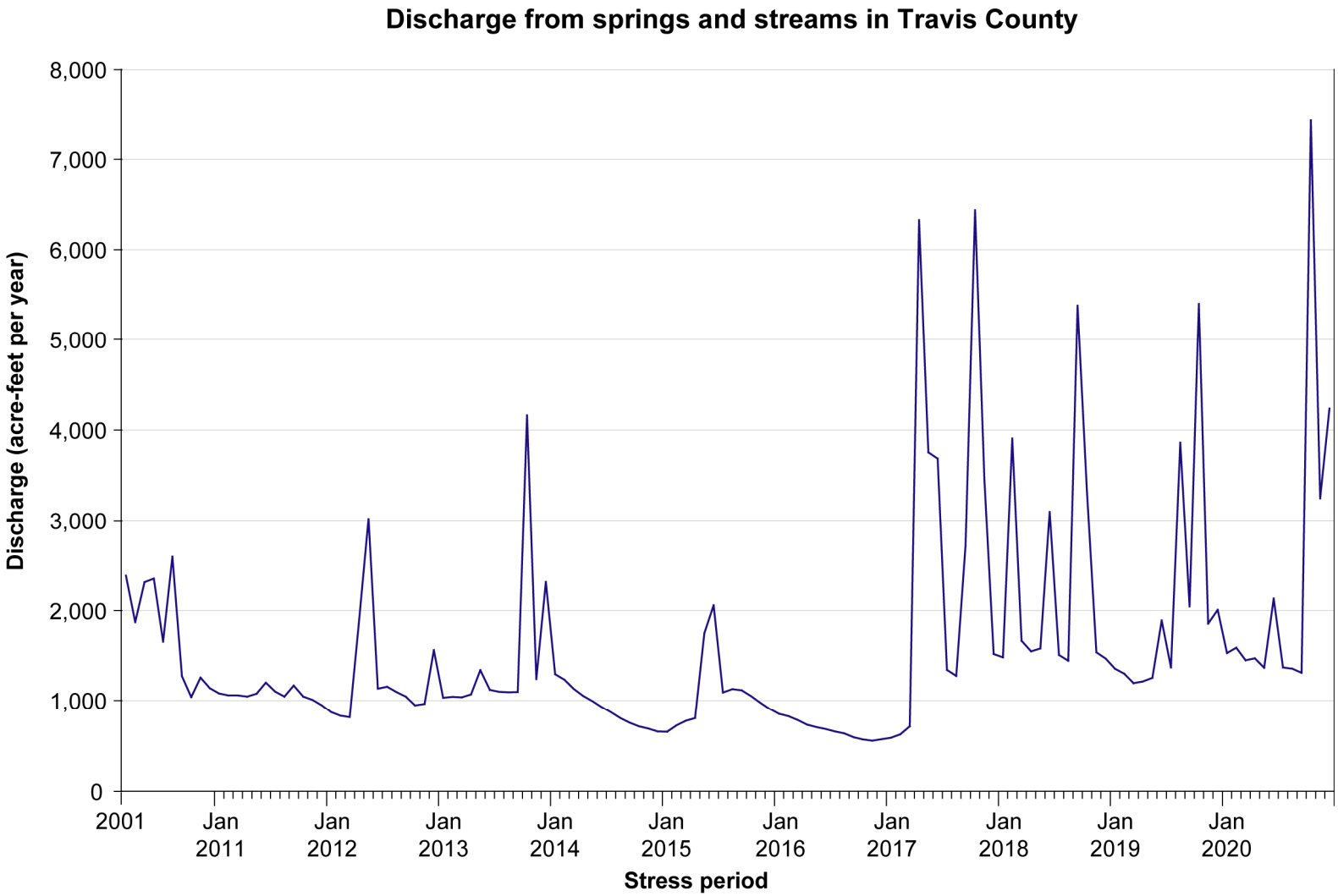


Figure 4: Hydrograph of simulated (2001 to 2020) aggregated natural spring-stream discharge in Travis County.

Appendix A

Groundwater Management Area 8 Simulation Request Specifications for the Northern Segment of the Edwards (Balcones Fault Zone) Aquifer Groundwater Availability Model

May 2, 2007

Clearwater Underground Water Conservation District (UWCD) acting on behalf of GMA-8 requests Texas Water Development Board (TWDB) to perform a projected pumping simulation of the N. Edwards aquifer Groundwater Availability Model (GAM). The N. Edwards aquifer GAM consists of one layer representing both the recharge and artesian zones of the aquifer. In the GAM, the recharge zone of the aquifer is represented as being unconfined (or un-pressurized) and the artesian zone is represented as being confined (or pressurized). The GAM represents streams with Drain Cells. These cells discharge water from the aquifer when the simulated aquifer water-level elevation is higher than the cell elevation. Springs are not represented directly in the GAM; however the aggregated discharge from Drain Cells from a particular creek may be used to represent the discharge from springs located along the same creek. Clearwater UWCD requests the GAM simulation be performed with the following specifications:

1. The simulation period should be for 20 years.
2. The simulation should use monthly time steps (supplied).
3. The simulated climatic conditions should use the supplied historic monthly average precipitation record for the model area for the time period 1940 through 1960 that includes the actual historic drought of record conditions.
4. The simulation should maintain the existing model spatial pumping distribution for Williamson and Travis Counties, but use the supplied spatial pumping distribution for Bell County.
5. The simulation should use the supplied monthly temporal distribution of pumping.
6. Annual pumping should be held constant for each area for which a pumping amount is specified (*i.e.* by County total for the Edwards aquifer).
7. The simulation should incorporate the supplied managed reductions in pumping for Bell County during periods of climatic stress. Climatic stress periods are defined as beginning when a running 2-month average of monthly precipitation values fall below 2.74 inches (the average monthly precipitation) and ending when the 2-month running average is equal to or greater than 2.74 inches.
8. The annual projected pumping to be applied to the Edwards aquifer by County should be as follows (note the projected pumping values for Travis and Williamson Counties are based on Regional Water Plan (RWP) groundwater availability values and TWDB water use survey data):
    a. Bell – 7,500 ac-ft per year
    b. Williamson – 18,012 ac-ft per year
    c. Travis – 5,600 ac-ft per year
9. The results of the GAM simulation should be presented as follows:
    a. The projected discharge of drain cells should be aggregated to simulate the monthly totals spring discharge in;
        i. Salado Creek of Bell County;
        ii. Aggregated as a monthly sum by County for;
            1. Williamson County and ;
            2. Travis County.

b. Hydrographs of the monthly simulated spring discharges for each of the requested representations of spring discharge over the simulation period should be prepared.
c. Additional presentations of GAM simulation results may be requested.