EDWARDS AQUIFER
AUTHORITY

June 7, 2019

Mr. Adam Zerrenner
United States Fish and Wildlife Service
Austin Ecological Services Field Office
107011 Burnet Road, Suite 200
Austin, Texas 78758

RE: Minor amendment to the Voluntary Irrigation Suspension Program Option (EAHCP § 5.1.2.1) flow protection conservation measure of the Edwards Aquifer Habitat Conservation Plan.

Dear Mr. Zerrenner:

On behalf of the City of New Braunfels (CoNB), the City of San Marcos (CoSM), Edwards Aquifer Authority (EAA), the San Antonio Water System (SAWS), and Texas State University (collectively the Permittees of the Incidental Take Permit #TE-63663A-1), I am providing a minor amendment to the *Edwards Aquifer Habitat Conservation Plan* (EAHCP) for your review and approval to modify forbearance rates in the Voluntary Irrigation Suspension Program Option (VISPO) flow protection Conservation Measure (EAHCP § 5.1.2) from 40,000 acre-feet/year (ac-ft/yr) to 41,795 ac-ft/yr. This letter is submitted pursuant to EAHCP § 9.2.1.

The VISPO Conservation Measure operates to minimize and mitigate the impacts of low springflow by suspending the authorized withdrawal of Edwards Aquifer (Aquifer) water from EAA irrigation permit-holders during certain prescribed drought conditions. Irrigation permit-holders that participate in VISPO are financially compensated both to participate in the program (standby fees) and during their time of suspended Aquifer pumping (forbearance payments). Currently, the VISPO forbearance rate is to suspend 40,000 ac-ft/yr of Aquifer water from authorized pumping during the prescribed periods of drought. Aquifer pumping is suspended the following year when the J-17 index well water level is at or below 635 feet-mean sea level (MSL) on an annual trigger date of October 1 (EAHCP § 5.1.2.2).

The amendment to EAHCP § 5.1.2.1 increases the VISPO forbearance rate from 40,000 ac-ft/yr to 41,795 ac-ft/yr (Exhibit 1). Groundwater modeling indicates that this volume increase, in conjunction with the implementation of the three other springflow protection measures (RWCP, SAWS ASR and CPMP Stage V), ensures a modelled 30 cubic feet per second (cfs) daily average of minimum springflow in the Comal Springs system during a repeat of the drought-of-record scenario. EAHCP Table 4-2 defines the long-term average and minimum total Comal discharge management objectives (EAHCP § 4.1.1.1). The minimum total Comal discharge is 30 cfs daily average. Additional details on the groundwater model simulations can be found in the Scientific Evaluation Report (SER) (Exhibit 3).

The Permittees responded to the Strategic Adaptive Management Process set out in Sections 7.13 and 14 of the EAHCP by performing a Nonroutine Adaptive Management Process (Nonroutine AMP) for VISPO in accordance with the Funding and Management (FMA) § 7.12. The request for an additional 1,795 ac-ft/yr of Aquifer water in VISPO was presented in a Nonroutine AMP proposal from the Program Manager to the Science Committee on March 27, 2019 (Exhibit 2). The Science Committee evaluated the proposal and documented their recommendations in a SER dated April 12, 2019 and delivered to the Stakeholder Committee electronically May 1, 2019 (Exhibit 3). The Stakeholder Committee provided their comments and report at a joint meeting with the Implementing Committee May 23, 2019 (Exhibit 4). The May 23, 2019 joint meeting also provided the public the opportunity to comment on this amendment to further ensure transparent implementation of the EAHCP. The Implementing Committee responded by approving the Nonroutine AMP proposal and directing the Program Manager to submit the necessary documentation to the U.S. Fish and Wildlife Service consistent with FMA § 7.12.4.c. All meeting agendas and minutes from this process have been provided herein (Exhibit 5).

The Nonroutine AMP resulted in this request to amend EAHCP § 5.1.2.1 of the. This minor amendment does not modify in any way the Biological Goals or Objectives contained in the EAHCP. Rather, this minor amendment (in conjunction with the other springflow protection measures) ensures the modelled 30 cfs minimum total daily average Comal discharge during a drought-of-record scenario.

The Permittees seek your formal acceptance of this minor amendment request to allow amendments to pages 5-3 and 5-5 of the EAHCP as set out in Exhibit 1 to modify forbearance rates in the VISPO flow projection conservation measure described in EAHCP § 5.1.2 from 40,000 ac-ft/yr to 41,795 ac-ft/yr Your approval of this minor amendment will allow the Permittees to improve the implementation of this critical aspect of the EAHCP. We look forward to your formal acceptance of this minor amendment and appreciate your consideration and response.

Respectfully,

Scott D. Storment
Program Manager
Edwards Aquifer Habitat Conservation Plan

Exhibit 1
Proposed changes to EAHCP p. 5-3

objectives, while recognizing the uncertainty associated with those objectives, Applicants commit to implement a "presumptive" measure that is adequate to achieve the flow-related objectives for attaining the biological goals. If needed, the use of the expanded capacity of the SAWS ASR will be the "presumptive" additional measure to meet the biological objectives with critical period reductions in Stage V beyond those in Phase I, if necessary. (*See* Section 5.5.2).

Applicants will include in the Annual Report a description of the status of implementation of the minimization and mitigation measures and an evaluation of the effectiveness of those measures.

5.1 Edwards Aquifer Authority

5.1.1 Refugia[1]

The EAA will support and coordinate with the USFWS on a series of off-site refugia at USFWS's San Marcos, Uvalde, and Inks Dam facilities. (*See* Section 6.4). The limited geographic distribution of these species leaves the populations vulnerable to extirpation throughout all or a significant part of their range. A series of refugia, with back-up populations at other facilities, will preserve the capacity for these species to be re-established in the event of the loss of population due to a catastrophic event such as the unexpected loss of springflow or a chemical spill.

The support of the refugia will augment the existing financial and physical resources of the Service, and provide supplementary resources for appropriate research activities, as necessary, to house and protect adequate populations of Covered Species and expanded knowledge of their biology, life histories, and effective reintroduction techniques. The use of this support will be limited to the Covered Species in this HCP.

5.1.2 Voluntary Irrigation Suspension Program Option

The EAA will administer the Voluntary Irrigation Suspension Program Option (VISPO) program. As discussed below in Section 5.8, VISPO is intended to minimize and mitigate the impacts of incidental take from low springflows by suspending the use of Aquifer water for irrigation purposes during drought.

The use of Aquifer water for irrigation accounts for over 30 percent of the annual pumping. This use typically occurs between January and July. The concentrated use of the Aquifer can contribute to substantial drawdown in Aquifer levels. This measure will require EAA irrigation permit-holders who voluntarily participate in the program to suspend the use of Aquifer water for irrigation purposes during drought to maintain springflow.

5.1.2.1 Target Volume, Distribution & Eligible Permits

The volume goal for the VISPO program is ~~40,000~~ 41,795 ac-ft/yr. Irrigation permit-holders in Atascosa, Bexar, Comal, and Hays counties will be approached for enrollment in the program first because these counties are closest to the springs where temporarily suspending pumping is

[1] Effective January 21, 2015. A minor administrative amendment to change the language of the EAHCP §5.1.1 and the ITP Condition K to all the development of a Refugia Program with contractors other than the Service.

Exhibit 1
Proposed changes to EAHCP p. 5-5

were held, one in Uvalde, Texas, on December 6, 2010, and one in Castroville, Texas, on December 7, 2010. Approximately 150 persons attended the meetings (approximately 35 in Uvalde and approximately 115 in Castroville).

Following the meetings, all irrigators were contacted again in January 2011 with a letter of inquiry, a list of Frequently Asked Questions and a schedule of payments for the five- and ten-year program options. (Attachment O) Irrigators were asked to indicate whether they were interested in participating in the VISPO program and, if so, whether they were likely to opt for the 5- or 10-year program.

The EARIP received positive written expressions of interest from irrigators in enrolling 17,226 ac-ft of water as indicated in Table 5-2. This level of response is higher than what has been received for similar surveys, particularly when the responses were solicited so far in advance of a commitment to go forward with the VISPO. Additionally, other irrigators contacted the EAA after the requested response deadline to express interest in the program. The positive responses indicate a reasonable likelihood of enrolling the full volume of permits once funding is available and contracted enrollment begins.

TABLE 5-2
ACRE-FEET OF INTEREST IN VISPO BY COUNTY

	Atascosa County	Comal County	Bexar County	Medina County	Uvalde County	Total
		Acre-feet of interest				
5-Yr. Base	200	242	1,186	933	6,258	8,819
5-Yr. Unrestricted	400		527	535	1,664	3,126
						0
10-Yr. Base		40	353	3,354	693	4,440
10-Yr. Unrestricted			266	376	200	842
TOTAL	600	282	2,332	5,197	8,815	17,226

Based on the responses and public input and the financial incentives offered to enrollees, the Applicants believe that: (1) the ~~40,000 ac-ft~~ volume goal will be fully subscribed; and (2) the irrigators who initially opt for the five-year option will continue their participation in the program and that the full ~~40,000 feet~~ volume goal will be subscribed over the requested 15-year term of the ITP. To the extent that the program is not fully subscribed, the Adaptive Management Process will be used to identify alternative measures, perhaps additional pumping cuts, achieve the full springflow protection anticipated from the VISPO program and those measures will be implemented.

5.1.3 Regional Water Conservation Program

Some communities and industries in the Edwards Aquifer region have demonstrated a commitment to water conservation. However, water conservation programs have not been implemented across the region or developed to target exempt domestic wells. The Regional Water Conservation Program will minimize and mitigate the impacts of pumping from the

Exhibit 2

Edwards Aquifer Habitat Conservation Plan
Nonroutine Adaptive Management Proposal
VISPO

To: **EAHCP Committees**
From: **Scott Storment, EAHCP Program Manager**
Date: **March 14, 2019**
Re: **Voluntary Irrigation Suspension Program Option Enrollment Volume Changes**

EAHCP Flow Protection Measures

The EAHCP calls for four Flow Protection Measures to meet short-term and long-term flow objectives for the Comal and San Marcos Springs complexes. The four measures include the Voluntary Irrigation Suspension Program Option (VISPO) (EAHCP § 5.1.2), Regional Water Conservation Program (EAHCP § 5.1.3), SAWS ASR (EAHCP § 5.5.1), and Critical Period Management – Stage V (EAHCP § 5.1.4). These four water management tools layered together are referred to as the "Bottom-Up" package.

The "Bottom-Up" package was originally evaluated by HDR to understand whether the Flow Protection Measures could meet EAHCP flow objectives (HDR 2011 – Appendix K EAHCP). The analysis was conducted by simulating spring discharge using the MODFLOW groundwater model. The minimum flow objective was examined by simulating the period from 1947-1960 which included the Drought of Record (DOR). The long-term flow objective was examined by simulating the period from 1947- 2000. Since the Flow Protection Measures composing the "Bottom-Up" package were still in development, HDR made assumptions regarding geographic distribution of enrolled water in the various programs. Results from the HDR analysis indicated the Phase I Flow Protection Measures were not adequate to meet minimum and long-term average flow objectives in the Comal system. However, minimum and long-term average flow objectives were achieved in the San Marcos system.

Over the course of implementing Phase I of the EAHCP, the original MODFLOW model used by HDR was reconstructed by EAA staff with several improvements (herein referred to as EAA model). Changes made to the model along with calibration and validation results are described in detail by Liu et al. (2017). Additionally, further comment on model construction and its use can be found in the review by the Groundwater Model Advisory Panel (Appendix - Liu et al. 2017), the National Academies of Sciences (NAS) Reports 1-3 covering the EAHCP (NAS 2015; NAS 2017; NAS 2018), Strategic Adaptive Management Process Model Runs Inputs and Assumptions by Pence (2018a), and technical presentations delivered to the NAS Panel and EAHCP Science Committee (www.eahcp.org).

Edwards Aquifer Habitat Conservation Plan
Nonroutine Adaptive Management Proposal
VISPO

National Academies of Sciences Review of EAHCP Springflow Protection

The model and its outputs were reviewed by the NAS to make their determination on whether the EAHCP Flow Protection Measures would be adequate to achieve the EAHCP minimum flow objectives. The model runs the panel evaluated to make its determination were essentially HDR's DOR inputs run with the updated EAA model. The minimum flow in the Comal system from this model run was 29.7 cfs. Minimum flow objectives were met for the San Marcos system. Despite not meeting 30.0 cfs, the NAS panel concluded the Flow Protection Measures would be "effective" at meeting the minimum flow related objectives citing the conservative nature of the low flow estimates during calibration and validation (modeled values at low flows were mostly lower than measured values), empirical evidence from the 2014 drought, and overall model performance during calibration and validation runs.

Final Phase I Model Runs

Modeling efforts continued after the NAS consensus report to understand the level of Flow Protection Measure expansion required to achieve a minimum modeled value of 30.0 cfs in the Comal during a repeat of the DOR. Following the process outlined by Pence (2018b), the EAA model was used to simulate the DOR scenario with Flow Protection Measures represented in the model "as-implemented" over the first six years of the program. The pumping and springflow protection forbearance specifics (location and volume) are found in Pence (2018a). Model runs using "as-implemented" programs represented in the EAA model produced minimum flow values of 29.1 cfs in the Comal system.

The 29.1 cfs model run assumed 40,000 ac·ft yr^{-1} are forborne during a year that VISPO is triggered. This is the annual number represented in the EAHCP. Actual enrollment in the VISPO during 2019 is 40,921 ac·ft yr^{-1}. When this actual enrollment volume of water was included in the model runs, minimum flows in the Comal were 29.6 cfs. VISPO forbearance was increased until minimum flows at the Comal system were equal to 30.0 cfs. The VISPO forbearance number that achieved this minimum flow rate was 41,795 ac·ft yr^{-1}.

Edwards Aquifer Habitat Conservation Plan
Nonroutine Adaptive Management Proposal
VISPO

Nonroutine Adaptive Management Proposal

This proposal seeks to change VISPO forbearance from 40,000 ac·ft yr^{-1} to 41,795 ac·ft yr^{-1}. This is the only change to this EAHCP Program. All other stipulations regarding the program are as previously implemented.

This Nonroutine AMP proposal relates to the following sections of the EAHCP

This proposal affects Section 5.1.2 of the EAHCP.

Fiscal Impact

Table 1 displays the financial impact of the proposed changes assuming VISPO triggers three times between 2020 – 2028.

Table 1. Proposed costs of VISPO Adaptive Management with three trigger events.

VISPO Program	Rate	Acre-feet	Standby and Trigger Years (2020-2028)	Cost
Standby	$54	1,795.00	9	$872,370
Forbearance	$160	1,795.00	3	$861,600
				$1,733,970

Edwards Aquifer Habitat Conservation Plan
Nonroutine Adaptive Management Proposal
VISPO

References

Liu, A, N Troshanov, J Winterle, A Zhang, S Eason, 2017. Updates to the MODFLOW Groundwater Model of the San Antonio Segment of the Edwards Aquifer. Available at: https://data.edwardsaquifer.org/documents/2017_Liu-etal_UpdatestotheMODFLOWGroundwaterModeloftheSanAntonioSegmentoftheEdwardsAquifer.pdf.pdf

HDR, 2011. Evaluation of Water Management Programs and Alternatives for Springflow Protection of Endangered Species at Comal and San Marcos Springs. Available at: http://eahcp.org/wp-content/uploads/2019/02/Appendix-K.pdf

NAS, 2015. Review of the Edwards Aquifer Habitat Conservation Plan Report 1. Available at: http://eaahcp.org/administration/science-review-panel/

NAS, 2016. Review of the Edwards Aquifer Habitat Conservation Plan Report 2. Available at: http://eaahcp.org/administration/science-review-panel/

NAS, 2018. Review of the Edwards Aquifer Habitat Conservation Plan Consensus Report. Available at: http://eaahcp.org/administration/science-review-panel/

Pence, 2018a. SAMP Model Runs Inputs and Assumptions. Memo to EAHCP Committees, June 21, 2018.

Pence, 2018b. EAHCP Strategic Adaptive Management Process. Memo to EAHCP Committees, May 11, 2018.

Science Committee of the
Edwards Aquifer Habitat Conservation Plan

Scientific Evaluation Report:
Nonroutine Adaptive Management Proposal for the EAHCP VISPO

April 12, 2019

Introduction

According to the Funding and Management Agreement, the Adaptive Management Science Committee (Science Committee) is tasked with evaluation of all Nonroutine Adaptive Management (AMP) proposals. These evaluations result in a "Scientific Evaluation Report" (SER) for presentation to the Stakeholder Committee. The Stakeholder Committee considers this report in their decision whether to recommend the Nonroutine AMP proposal to the Implementing Committee for final approval.

This SER is issued in response to the Nonroutine AMP proposal submitted by the Program Manager, dated March 14, 2019 related to the EAHCP Voluntary Irrigation Suspension Program Option (VISPO).

The SER was discussed and developed at the March 27, 2019 Science Committee meeting. EAHCP staff will seek approval of this SER shortly after and the report will be presented to the Stakeholder Committee at its meeting on May 23, 2019.

Nonroutine Adaptive Management Proposal

On March 14, 2019 the EAHCP Program Manager submitted a Nonroutine AMP Proposal to the Science, Stakeholder and Implementing Committees. It involves modifications to the EAHCP VISPO.

Scientific Evaluation of the Nonroutine Adaptive Management Proposal

The purpose of this report is to provide the Science Committee's evaluation of the proposed modifications to the EAHCP VISPO to meet EAHCP flow objectives. The EAHCP calls for four Flow Protection Measures to meet short-term and long-term flow objectives for the Comal and San Marcos springs complexes. The four measures include the VISPO, Regional Water Conservation Program, SAWS Aquifer Storage and Recovery (ASR), and Critical Period Management – Stage V.

The modeling analysis of these four Flow Protection Measures to support the EAHCP was performed using a layered approach to consecutively evaluate addition of each conservation measure on springflows. This layered approach is referred to as the "Bottom-Up" package. Table 1 describes the maximum amount of water conserved through each of the Flow Protection Measures for a given year. Details of these measures can be found in the HCP, its appendices, and other associated documents (Table 1).

Tables 2 and 3 show the minimum and long-term average flow related objectives included in the EAHCP.

Table 1. Maximum annual volume (ac·ft yr^{-1}) of groundwater that can be conserved with EAHCP Flow Protection Measures.

Flow Protection Measure	Maximum Annual Volume Conserved	EAHCP Section
VISPO	40,000	5.1.2
RWCP	10,000	5.1.3
SAWS ASR FORBEARANCE	46,300	5.5.1
EAA FORBEARANCE OF SAWS ASR LEASES	50,000	5.5.1
STAGE I - V	44% Permit Reduction	5.1.4

Table 2. Long-term average and minimum total Comal discharge management objectives (Table 4-2 of EAHCP)

Description	Total Comal Discharge (cfs)[a]	Time-step
Long-term average	225	Daily average
Minimum	30[b]	Daily average

[a]Assumes a minimum of a 50-year modeling period that includes the drought of record
[b]Not to exceed six months in duration followed by 80 cfs (daily average) flows for 3 months

Table 3. Long-term average and minimum total San Marcos discharge management objectives (Table 4-13 of EAHCP)

Description	Total San Marcos Discharge (cfs)[a]	Time-step
Long-term average	140	Daily average
Minimum	45[b]	Daily average

[a]Assumes a minimum of a 50-year modeling period that includes the drought of record
[b]Not to exceed six months in duration followed by 80 cfs (daily average) flows for 3 months

The “Bottom-Up” package was originally evaluated by HDR to understand whether the Flow Protection Measures could meet EAHCP flow objectives (HDR 2011 – Appendix K EAHCP). The HDR Bottom-up analysis was conducted by simulating spring discharge over the period of 1947-2000 using the MODFLOW groundwater model developed by Lindgren et al. (2004). These model results indicated the Phase I Flow Protection Measures were not adequate to meet minimum and long-term average springflows in the Comal system. However, minimum and long-term average flow objectives were achieved in the San Marcos system.

During Phase I of the EAHCP, the original MODFLOW model used by HDR was reconstructed with several significant improvements (herein referred to as EAA model). Changes made during model construction along with calibration and validation results are described in detail by Liu et al. (2017). Additionally, further comment on model construction and its use can be found in the review by the EAA-appointed Groundwater Model Advisory Panel (Appendix Liu et al. 2017), the National Academies of Sciences (NAS) Reports 1-3 covering the EAHCP (NAS 2015; NAS 2017; NAS 2018), SAMP model inputs and assumptions by Pence (2018), and technical presentations delivered to the NAS panel and EAHCP Science Committee (www.eachp.org).

The EAA model and its outputs were reviewed by the NAS panel to make their determination on whether the EAHCP Flow Protection Measures would be adequate to achieve the EAHCP flow objectives. The panel concluded the measures would be "effective" at meeting the flow objectives citing the conservative nature of the low flow estimates, empirical evidence from the 2014 drought, and the EAA model's ability to match observations during validation runs – especially during periods of low flow.

During Phase I, the EAA model was also used by EAA staff to reconstruct a Bottom-Up analysis using the same inputs and assumptions as the original HDR (2011) analysis. A difficulty encountered in reconstructing the Bottom-Up analysis is that the original analysis was conducted under the Edwards Aquifer Recovery Implementation Program (EARIP) prior to EAA taking on project management of the EAHCP and the original model files were not archived. Fortunately, EAA staff were able to obtain the archived files from a more recent Bottom-Up analysis by HDR (2015), which included a baseline analysis of the original 2011 model with a table of pumping rates for baseline conditions and for each of the Bottom-Up layers. Using this table of specified pumping reductions for each Bottom-Up layer, EAA staff was able to repeat the analysis and obtain minimum flow estimates for Comal and San Marcos Springs that were very similar to those reported in the original HDR (2011) report.

The next use of the Bottom-Up package by EAA staff was to conduct the Nonroutine Adaptive Management Model Runs described in the following section. For this analysis, the pumping assumptions were specified in the Pence (2018) memorandum. This process required EAA staff to reconstruct the baseline pumping and each of Bottom-Up layer pumping input files from scratch. During this process, it was discovered that the previous EAA Bottom-Up analysis that was intended to use the HDR (2011) pumping assumptions did not include 6,000 acre-feet of exempt federal pumping. Adding federal pumping to the analysis caused the estimated minimum flow for Comal Springs to drop by 6 cfs compared to the earlier analysis. Further analysis showed that adjustments to the schedule for SAWS ASR pumping forbearance, as described below, could be used to increase the estimated minimum flow at Comal Springs by the same amount as was lost by the addition of exempt federal pumping.

Nonroutine Adaptive Management Model Runs

Minimum Flow Objectives

The EAA MODFLOW model was executed with pumping and flow protection conservation measures previously described in Pence (2018). Briefly, geographic location and volume of forborne water via Flow Protection Measures are based on actual program enrollments, according to county and type of use. The annual base case pumping prior to any stage restrictions is 592,454 ac·ft yr^{-1} and is distributed geographically in the same manner as the HDR runs.

During development and testing of the model, it became apparent that a modified schedule of the SAWS ASR forbearance could increase minimum computed springflows during Drought of Record (DOR) simulations. In the HDR model runs, SAWS ASR pumping forbearance were guided by a schedule included in the Interlocal Agreement between EAA and SAWS for use of the ASR facility for springflow protection. This schedule was adjusted to maximize springflow benefit in accordance with SAWS guidance regarding the amount of Edwards water that could reasonably be forborne during any monthly stress period in a DOR scenario.

Limitations on monthly forbearance rates stem from the total pipeline capacity and the fact that forbearance cannot exceed what normal demand for Edwards water would be from the four pumping stations where the forbearance schedule is implemented. The first limitation is that total forbearance in any calendar year cannot exceed 46,300 ac·ft yr^{-1}. The limitation of monthly demand varies by month. The maximum reasonable forbearance rate for January is 3,500 acre-feet but this can be gradually increased to a maximum of 5,600 acre-feet for the high demand months of May through September. Revisions from the original schedule made in the current model scenario increase forbearance rates at the beginning of the year 1956, leading up to the period of minimum flow in August 1956, and decrease rates after September when the springflows start to recover. Table 4 displays changes to the SAWS forbearance schedule for the model runs discussed below.

Table 4. SAWS ASR forbearance representation in MODFLOW Drought of Record simulations.

Month In 1956	HDR (2011) (ac·ft)	Nonroutine AMP Runs (ac·ft)
January	1700	3200
February	1400	3500
March	1100	4500
April	2200	4500
May	3800	5600
June	5600	5600
July	5600	5600
August	5600	5600
September	5600	3000
October	5200	2000
November	4700	1700
December	3800	1500

Figure 1 displays MODFLOW model output for San Marcos and Comal springs with all Flow Protection Measures applied, minimum flow objectives for both systems, and modeled SAWS ASR forbearance. Minimum flows from the model simulation were 29.1 cfs in Comal and 48.1 cfs in San Marcos, both during the month of August 1956.

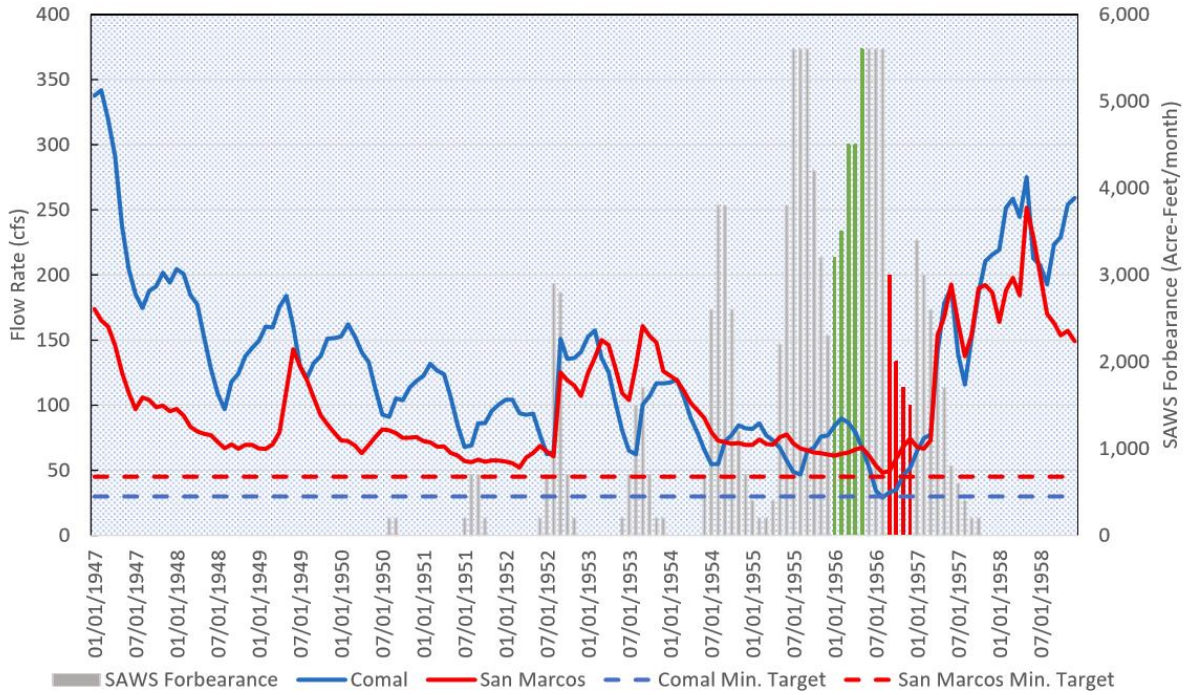

Figure 1. MODFLOW output for Drought of Record simulations at San Marcos and Comal springs. The green bars represent SAWS forbearance in excess of the original forbearance amounts shown in the Interlocal Agreement between EAA and SAWS for use of the ASR facility for the purpose of springflow protection. The red bars represent SAWS forbearance less than the original forbearance amounts shown in the contract.

To evaluate how much additional forbearance was needed to achieve the 30.0 cfs minimum flow objective at Comal Springs, forbearance through the VISPO was increased in the MODFLOW simulation from 40,000 ac·ft yr^{-1} until the flow objective was met. VISPO forbearance of 41,795 ac·ft yr^{-1} achieves the desired minimum of 30.0 cfs. Minimum flows for the San Marcos system with the adjusted VISPO number are 48.3 cfs. Results for the increased VISPO scenario are shown in Figure 2.

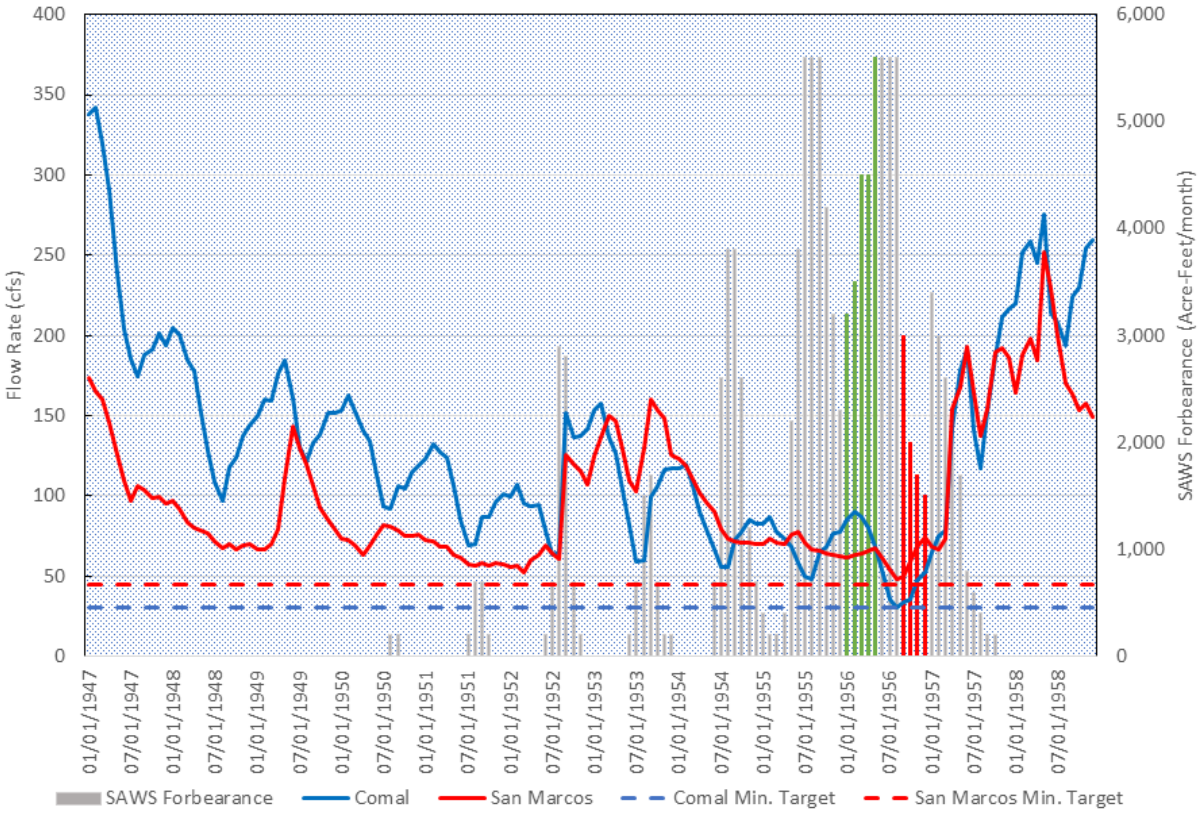

Figure 2. Same as Figure 1 with VISPO adjusted to 41,795 ac·ft yr^{-1}.

Long-Term Average Flow Objectives

HDR evaluated the ability of the Flow Protection Measures to meet the long-term average flow objective by modeling the period of 1947-2000 assuming an annual base case pumping of 593,240 ac·ft yr^{-1} prior to application of any conservation measures (see Pence 2018 or HDR 2011 for a description of HDR total pumping). Results from HDR indicated long-term average flow of 196 cfs in the Comal system, a 29 cfs deficit from the 225 cfs objective. The same analysis in San Marcos indicated a long-term average of 155 cfs exceeding the long-term flow objective of 140 cfs.

The 1947-2000 model period was not simulated with the EAA model for two primary reasons. First, unlike the HDR model, the EAA model was not calibrated to the 1947-2000 time period. The EAA model used a much more recent hydrologic record (2001-2011) for parameterization and calibration and was specifically built to accurately predict periods of low flows at Comal and San Marcos springs. It would not be expected to perform a multi-decade simulation as well as the HDR model calibrated over the time period in question. Second, using the total annual pumping offered in the HDR analysis dictates the long-term flow objectives are unachievable regardless of the model selected.

Examining the model from a mass balance perspective:

$$Recharge - Pumping - Springflow = \Delta Storage \quad (1)$$

If we consider a sufficiently long time period such that change in storage is negligible:

$$Recharge = Pumping + Springflow \quad (2)$$

If we insert the long-term average flow objectives (Comal: 225 cfs = 163,000 ac·ft yr^{-1}; San Marcos: 140 cfs = 101,355 ac·ft yr^{-1}), estimated long-term average outflow from other minor springs (80,000 ac·ft yr^{-1} - see Liu et al. 2017), and long-term average recharge (779,000 ac·ft yr^{-1}) into the above equation, the amount available for long-term average pumping is approximately 434,000 ac·ft yr^{-1} (Liu et al. 2017; EAA 2018a; EAA 2018b). By assuming 592,454 ac·ft yr^{-1} of annual pumping as the base case (before any permit restrictions) in the long-term simulation, the long-term average flow objectives cannot be reached.

To understand the ability to meet EAHCP long-term flow objectives over the remainder of the ITP, empirical data were examined. Using Equation 2 and fixing total springflow (San Marcos + Comal + minor springs) at the long-term averages discussed above (344,355 ac·ft yr^{-1}), recharge will equal pumping plus 344,355 ac·ft yr^{-1}. Given there are nine years remaining on the current ITP, we can examine the previous 41 years of the empirical hydrologic record and make conservative assumptions about the next nine years to estimate the fifty-year long-term average.

Recharge, including estimated interformational flows (estimated at 75,000 ac·ft yr^{-1}), over the past 41 years has been slightly over the long-term average at 908,000 ac·ft yr^{-1} (EAA 2018a; Liu et al. 2017). Over the same time period, total pumping estimates have averaged 410,000 ac·ft yr^{-1} (EAA 2018b). If we assume the following nine years are simultaneously the highest nine years of pumping ever recorded (none of which have occurred under management of the EAA) and the lowest 9 years of recharge ever recorded, the fifty-year average recharge would still exceed average total pumping plus long-term flow objectives (EAA 2018a, EAA 2018b).

It is important to note this synthetic combination of extreme pumping and recharge could not occur under EAA stage restrictions and EAHCP Flow Protection Measures. There appears to be no present threat of violating long-term springflow averages written into the EAHCP. However, more realistic terms should be constructed in future evaluations of these goals.

80 cfs footnote

Both springflow objective tables found in the EAHCP (Tables 1 and 2) contain a footnote on the minimum daily average flow objective that states “Not to exceed six months in duration followed by 80 cfs (daily average) flows for 3 months”.

The purpose of the flow pulse requirement was two fold: 1) an attempt to return flow to Spring Run 3 for macroinvertebrates and salamanders, which does not occur at flows less than 80 cfs according to data and the HCP, and 2) to accommodate another Fountain Darter spawn in the Old Channel ERPA by increasing flows and thereby maintaining suitable temperatures for a spawn to occur.

Under the proposed AMP, flows would not go below the minimum daily average flow objectives or “maintain” it for six-months. However, both systems would experience varying amounts of time between the minimum objective and the 80 cfs threshold identified.

Figures 3 and 4 display the DOR MODFLOW simulation for Comal and San Marcos springs, respectively, as shown in Figure 2 with total system flow (blue line), time steps with flow under 80 cfs (bar graph), and six-month moving averages when instantaneous flow was under 80 cfs (red lines). In the Comal during the ten-year DOR simulation, there are six instances where flow dips below and recovers above 80 cfs. The first three instances occur for 2 to 3 months and 6-month average flows remain over 80 cfs. The latter three instances have flows under 80 cfs for 6-11 months and 6-month average flows dip as low as 40 cfs.

In San Marcos during the ten-year DOR simulation, there are four instances where flow dips below and recovers above 80 cfs. The instances are lengthier (7-33 months) than the Comal and all four result in 6 month moving averages less than 80 cfs.

Figure 5 displays frequency graphs of maximum consecutive months under flows from 30 – 100 cfs for both spring systems. At Comal Springs, the lowest prolonged flows for 6 consecutive months is 53 cfs and under. For San Marcos, the lowest flows experienced for 6 consecutive months is 58 cfs and under. This proposed flow regime does not trigger the 80 cfs pulse requirement.

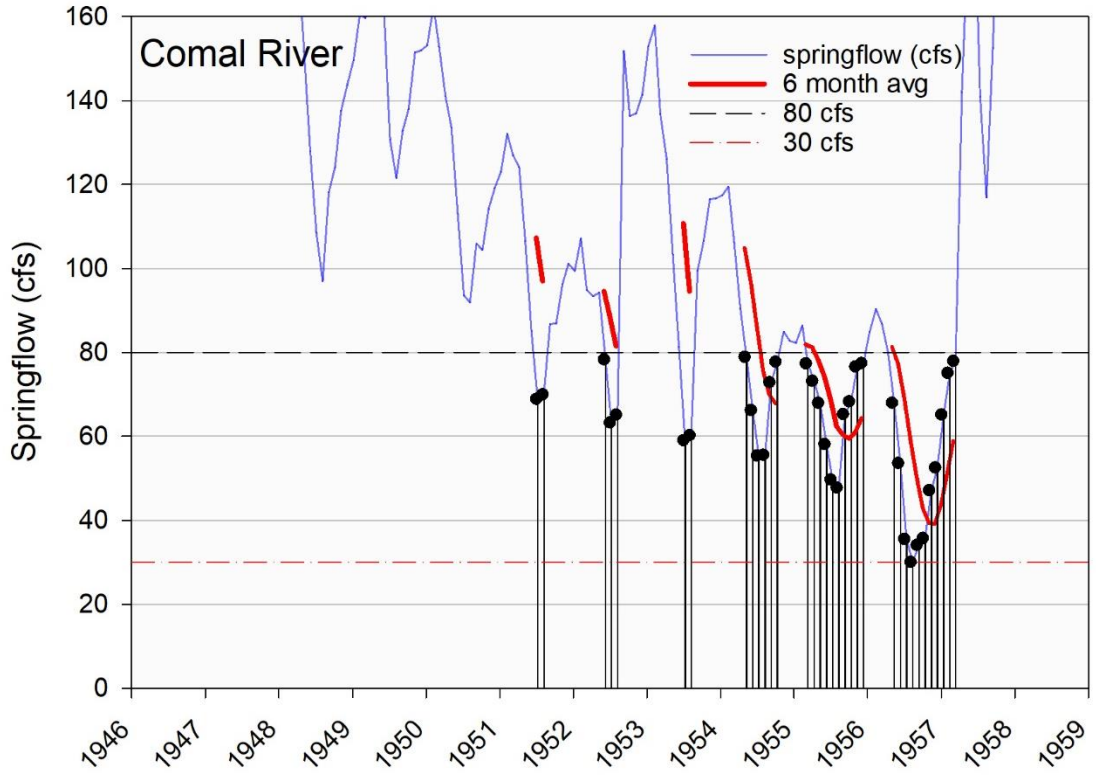

Figure 3. Comal Springs Drought of Record MODFLOW simulation shown in Figure 2 with periods of less than 80 cfs shown with bars. Other selected thresholds and statistics are shown.

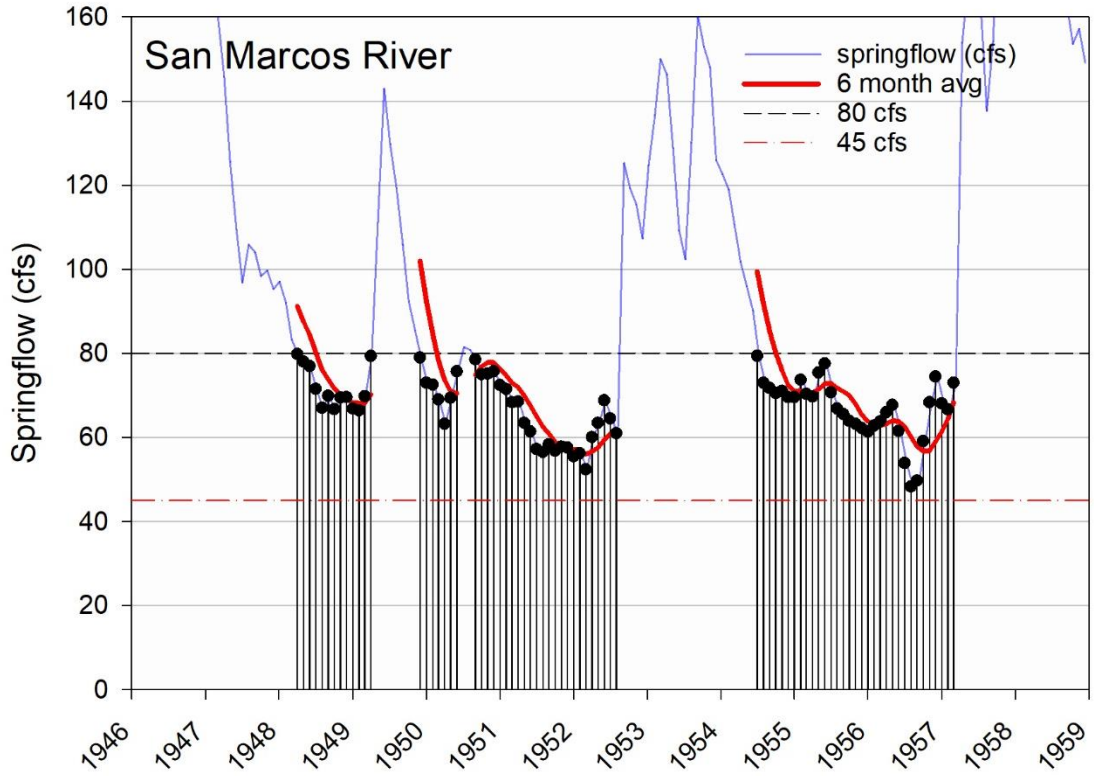

Figure 4. San Marcos Springs Drought of Record MODFLOW simulation shown in Figure 2 with periods of less than 80 cfs shown with bars. Other selected thresholds and statistics are shown.

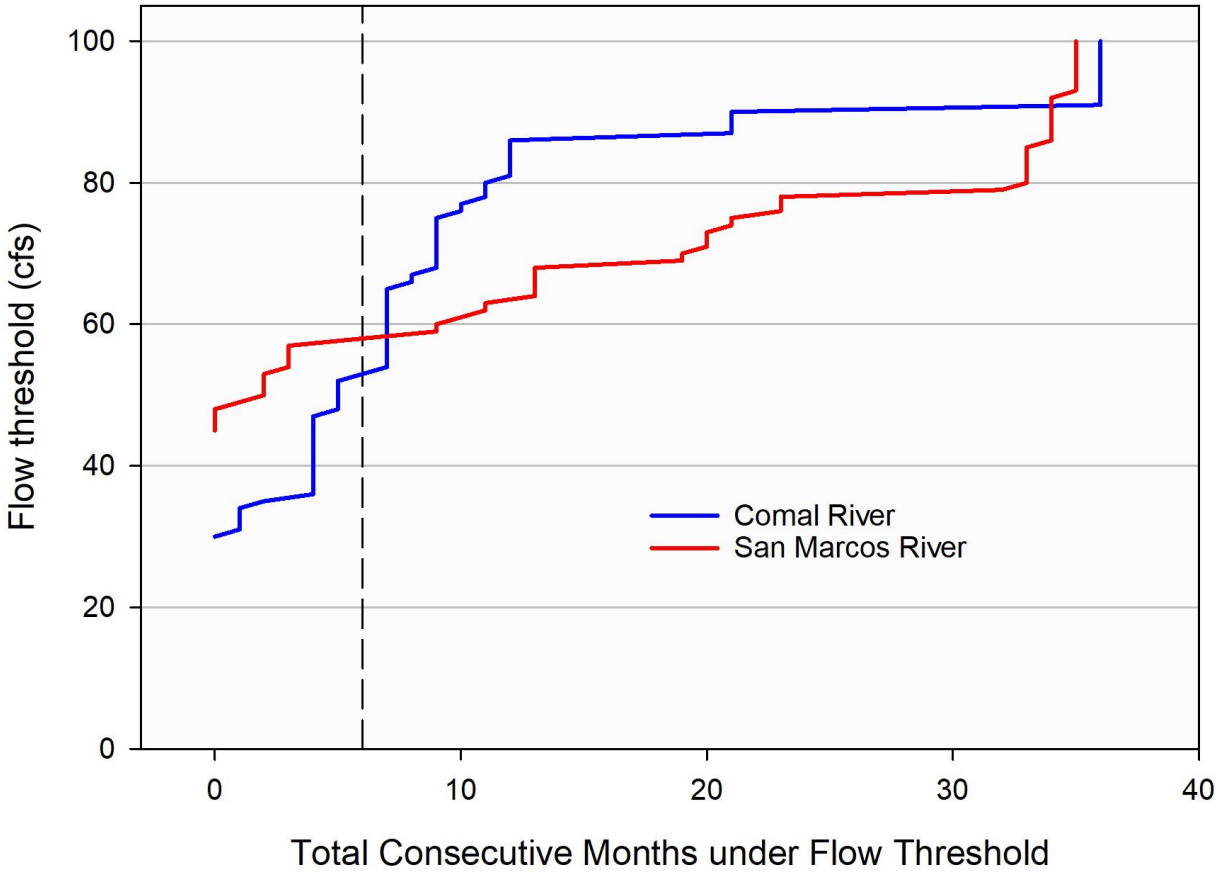

Figure 5. Frequency distributions displaying consecutive months less than flow thresholds. The vertical line is placed at 6 consecutive months.

Citations

Lindgren, R, A Dutton, S Hovorka, S Worthington, and S Painter. 2004. Conceptualization and simulation of the Edwards Aquifer, San Antonio Region, Texas: U.S. Geological Survey Scientific Investigations Report 2004-5277, 143 p.

Liu, A, N Troshanov, J Winterle, A Zhang, S Eason, 2017. Updates to the MODFLOW Groundwater Model of the San Antonio Segment of the Edwards Aquifer. Available at: https://data.edwardsaquifer.org/documents/2017_Liu-etal_UpdatestotheMODFLOWGroundwaterModeloftheSanAntonioSegmentoftheEdwardsAquifer.pdf.pdf

HDR, 2011. Evaluation of Water Management Programs and Alternatives for Springflow Protection of Endangered Species at Comal and San Marcos Springs. Available at: http://eahcp.org/wp-content/uploads/2019/02/Appendix-K.pdf

EAA, 2018a. 2017 Groundwater Recharge. Available at: https://www.edwardsaquifer.org/science-and-maps/research-and-scientific-reports/hydrologic-data-reports

EAA, 2018b. 2017 Groundwater Discharge and Usage. Available at: https://www.edwardsaquifer.org/science-and-maps/research-and-scientific-reports/hydrologic-data-reports

NAS, 2015. Review of the Edwards Aquifer Habitat Conservation Plan Report 1. Available at: http://eaahcp.org/administration/science-review-panel/

NAS, 2016. Review of the Edwards Aquifer Habitat Conservation Plan Report 2. Available at: http://eaahcp.org/administration/science-review-panel/

NAS, 2018. Review of the Edwards Aquifer Habitat Conservation Plan Consensus Report. Available at: http://eaahcp.org/administration/science-review-panel/

Pence, 2018. SAMP Model Runs Inputs and Assumptions. Memo to EAHCP Committees, June 21, 2018.

Summary of Science Committee Discussion of the Proposal

Overview

At the March 27, 2019 Science Committee, EAHCP Chief Science Officer Chad Furl provided a comprehensive presentation, *Nonroutine Adaptive Management: VISPO Flow Protection Measure* to the Science Committee. This presentation covered (1) the background to the AMP built into the EAHCP, (2) the history of Springflow Protection Measures and Flow Objectives, (3) the findings of MODFLOW output; and finally, (4) the elements of the Nonroutine AMP proposal itself.

The following sections provide a summary of the Science Committee's discussion of the Nonroutine AMP proposal, organized according to the main themes that emerged over the course of the discussion. This section concludes with the final motions (including associated final recommendations) made by the Science Committee concerning the Nonroutine AMP proposal and this Scientific Evaluation Report.

At the end of this section, are written comments submitted April 4, 2019 by Dr. Conrad Lamon of the Science Committee.

Science Committee Discussion

Public Comment:

Myron Hess, EAHCP Stakeholder Committee Chair, advised the Science Committee to expand the title of the VISPO proposal to include language that expresses that the effort to modify the flow protection measure is within the context of Phase II of the EAHCP and is intended to maintain compliance for the remainder of the program. Additionally, Mr. Hess recommended that a portion of the proposal include more information on ASR program and the changes that have been made by providing the process to which the modeling results were used and analyzed.

VISPO Nonroutine AMP

Dr. Chad Furl provided the Committee an overview of the Nonroutine AMP proposal and process to approve the modifications to VISPO. Dr. Furl reminded the Committee that the overall intent of the proposal is to achieve the minimum flow objective of 30.0 cfs at Comal Springs written into the HCP.

Dr. Charles Kreitler questioned if the updated SAMP DOR model run takes into account the modifications to both the VISPO and ASR Program. Dr. Furl confirmed that the latest model run includes both program updates, "as-implemented" forbearance measures, and 6,000 acre-feet per year of federal pumping to achieve 30.0 cfs at Comal Springs.

Dr. Jack Sharp asked, considering the additional 1,795 acre-feet in VISPO forbearance, how sensitive is the model to actual pumping locations. Mr. Jim Winterle responded that

there is some sensitivity to locations. For example, the springs respond quickly from the effects of forbearance in Bexar County. This response is delayed from forbearance in Uvalde County.

Dr. Sharp asked how the increase in VISPO forbearance was determined. Mr. Winterle explained that the change in forbearance results in an almost linear rate of increase in springflow. The forbearance number was simply adjusted until the minimum flow objectives were met. Increasing ASR forbearance rather than VISPO was considered but was determined to be too expensive.

Dr. Conrad Lamon asked if there has been any attempt to run the model with actual inputs rather than assumed scenarios. Dr. Furl explained that the model was calibrated in 2011 with the most recent hydrologic data at that time and then validated with hydrologic data from 2011-2015. Mr. Winterle added that the model was also validated with DOR data. The Liu et.al report captures the results of those model runs. Dr. Lamon expressed concerns over the lack of an uncertainty analysis conducted in development of the model. Mr. Winterle explained that the program is engaged with the USGS to conduct more formal uncertainty analysis, but the results of the uncertainty analysis will not be available until the end of the year. Dr. Lamon advocated that the results on the uncertainty analysis would provide a financial benefit to the program.

Dr. Jacquelyn Duke asked if refinements and adjustments can be made after the proposed modifications have already been approved. Dr. Furl clarified that the proposal is a solution for Phase II and the modifications will stay for the reminder of the permit. However, efforts to update models and review flow protection measures will continue.

Dr. Lamon further commented on details surrounding uncertainty analysis in the MODFLOW model.

Dr. Tom Arsuffi commented that the current issue regarding flow protection can be solved using the best available scientific data. Hopefully, further research and the product of the uncertainty analysis can provide information to help refine the model.

Dr. Kreitler commented that the EAA agreed to have a minimum flow of 30.0 cfs as a USFWS requirement. The modifications proposed will achieve the obligation.

Chad Norris asked if the additional VISPO water is currently under contract with EAA. Dr. Furl clarified that 40,000 acre-feet is what was stated in the EAHCP, and the 40,921 acre-feet is the amount currently under contract.

Dr. Duke added that the proposal is a very conservative effort to resolve the concerns regarding 30.0 cfs in Comal Springs.

Dr. Furl presented the long-term flow objectives and results from the empirical hydrologic record.

Chad Norris asked for clarification that although the models indicated that the long-term flow objectives will not be achieved, Dr. Furl was suggesting the mass balance equations

confirm that it is likely that the objectives will be met. Dr. Furl clarified that, based on the springflow data provided by the USGS, it is very likely that the objectives will be achieved using the mass balance equations. Mr. Winterle added that developing a model to analyze the long-term flow objectives was considered, however, the most realistic scenario isn't what was used in the model but rather, what actually occurred. Historical data will illustrate that the long-term flow objectives have been achieved.

Dr. Kreitler clarified that by using the model the long-term flow objectives will not be achieved, however, if you use observed data in a mass balance equation, the objectives will be met.

Dr. Kreitler raised the issue of the increase population in the I35 corridor and the effects it can have on water demand.

Dr. Furl discussed the 80 cfs flow objective and the referenced six month low flow time period footnote included in the EAHCP. Dr. Furl noted that the proposed AMP would authorize fluctuating flow rates between the minimum objective and the 80 cfs threshold without triggering the 80 cfs requirement.

Chad Norris commented that the purpose of the 80 cfs pulse flow requirement and six month minimum springflow time duration was included in the EAHCP with the intent to not subject the invertebrates to drought of record conditions for longer than six months.

Dr. Sharp asked Mr. Winterle the anticipated issues to arise and what, if any, should the models address. Mr. Winterle answered, in regard to applying for a 30-50 year ITP, the models should be prepared for the effects of climate change. Additionally, the primary concern today is the uncertainty of VISPO and maintaining compliance with the springflow protection requirements for the remainder of the ITP. Many of the long-term concerns will be addressed after Phase II and during the rollover period to the second ITP.

Final Motions by the Committee

Dr. Arsuffi made a motion to recommend the Nonroutine AMP proposal as presented. Dr. Sharp seconded. Dr. Conrad Lamon and Doyle Mosier abstained from voting. There were no further comments. All those not abstaining were in favor. Motion passed.

Dr. Weckerly made a motion to endorse the process to prepare and submit this Nonroutine AMP Scientific Evaluation Report via the Science Committee Chair and Vice-Chair to the Stakeholder Committee by May 23, 2019. Dr. Sharp seconded. All were in favor. Motion passed.

This draft of the Scientific Evaluation Report was approved by the Chair and Vice-Chair of the Science Committee for submission to the Stakeholder Committee on April 12, 2019.

EAA MODFLOW model updates

Lamon

March 27, 2019

“Validation results for Comal Springs (Figure 37) are similar in every respect to those of index well J17, which is expected given the strong correlation between observations at the two locations. The model underestimates flow by approximately 30 to 40 cubic feet per second (cfs) for most of the validation period, but does a good job to match the lowest observed flow in August 2014.” -Liu et al, 2017, Uncertainty Analysis section, page 54

Unfortunately, that's not how we determine prediction error. We estimate measures of model fit for a calibrated model, using data that were held out of consideration during the calibration process. We don't chose a point on the validation simulation run where fit was “good” and use that as our estimate. We take a measure that represents the aggregate fit over the entire validation run.

We have three MODFLOW runs to evaluate, two done by the EAA staff with their model (Liu et al, 2017) and one by HDR (HDR, 2011).

```
forbearance<-c(40000,40921,41795)
springflow<-c(29.1,29.6,30)
plot(springflow~forbearance)
abline(lm(springflow~forbearance))
```

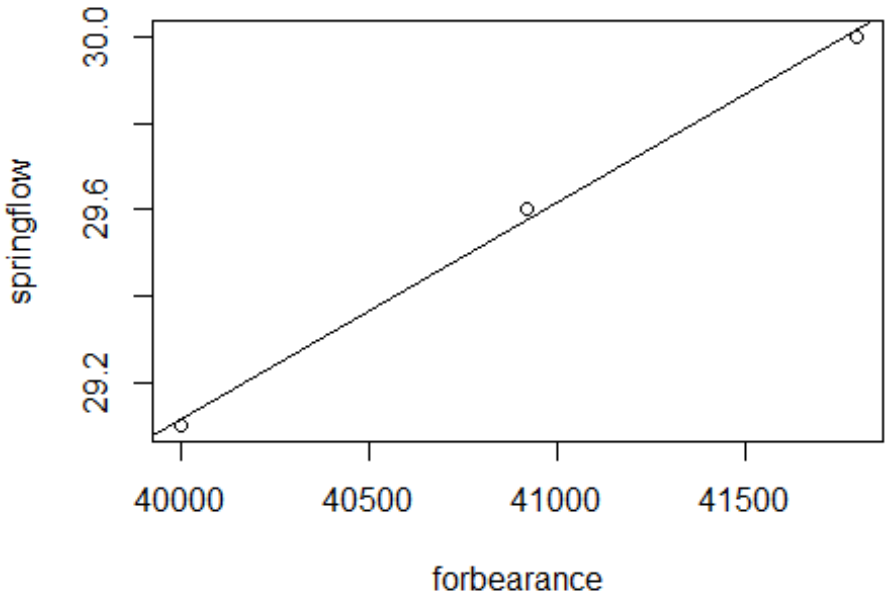

Figure 1 - What we are tempted by the limited data to see with default settings. Change looks big if the y-axis range is small.

So we have three different forbearances that produce three springflow forecasts. Forecast standard deviation is about 8 cfs, sample size is 3 so d.f.= 2. Replot with 90% CI.

```
plot(springflow~forbearance,ylim=c(0,60), xlim=c(39500,42000))
points(x=forbearance,y=springflow+qt(c(0.95),2)*(8/sqrt(2)),pch="?")
points(x=forbearance,y=springflow+qt(c(0.05),2)*(8/sqrt(2)),pch="?")
abline(lm(springflow~forbearance))
```

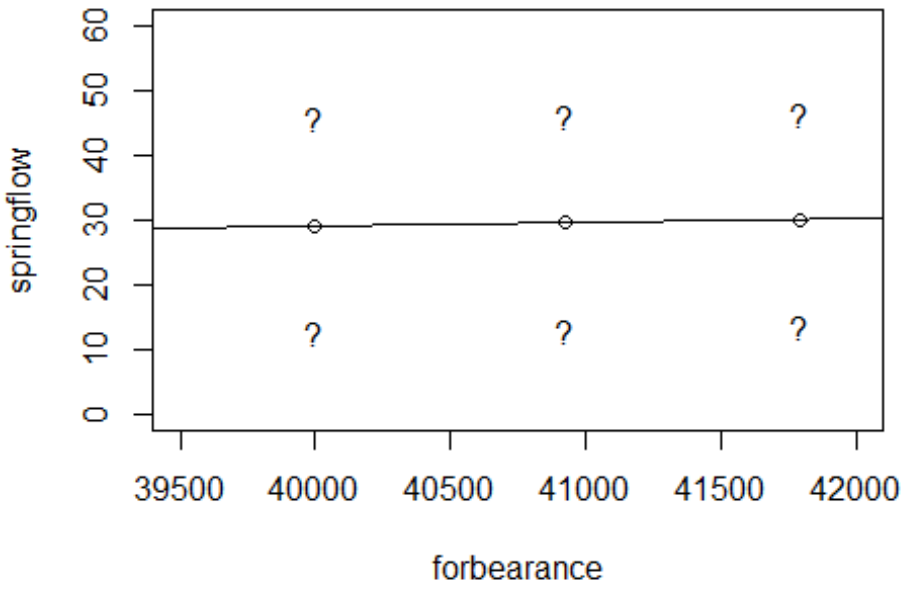

*Figure 2 - Now with the **90%** CI based on a t distribution with 2 d.f and se=8 cfs/. Last time I saw a table it seems the actual sd was higher than the 8 cfs used here. (Jim Winterle said "around ten" in the meeting March 27,2019.)*

Calculate the p(x <= 30|model 2). The probability p(x <= 30|model3)=0.5 because 30 is the center point of the forecast. Use these probabilities to form a ratio p(x <= 30|model3)/p(x <=30|model2). The calculations indicate only a small increase in the probability that mean spring flow during DOR is >= 30. Further, the actions under the third model will only lower the probability from 0.525 to 0.50.

```
pt((30-29.6)/(8/sqrt(2)),2)
```

```
## [1] 0.5249688
```

```
pt((30-29.6)/(8/sqrt(2)),2)/0.5
```

```
## [1] 1.049938
```

Maybe the error distribution of the EAA MODFLOW model is not a *t* distribution, as the quote above mentions a considerable bias. Maybe we shouldn't settle for a 50% probability of "success", but that's for another day.

Question

Regarding the work plan for MODFLOW in Liu et al., in which you plan to run the DOR model for each of the parameter realizations in the ensemble (i.e. if the ensemble has 500 members, this would require 500 model runs):

How many parameters per set in the ensemble? (Winterle:“perhaps a thousand?”“) Well, 500 ”samples" in 1000 dimensions isn’t very many at all.

You use the terminology of a Bayesian analysis in the work plan, but subvert the spirit of the Bayesian approach. It’s better to model each parameter independently. What EAA has described, though, is developing a sampling distribution for mean springflow resulting from DOR conditions, **given** (i.e, *conditional on*) the parameter sets in the ensemble. By modeling a “small” number of realizations of predetermined ensembles of parameters we severely limit the parameter space. Space is big. Further we loose the opportunity to learn about covariance matrix, and the correlation between parameters. Taking advantage of the correlation structure of the parameters lets the data do the talking while serving to confine the parameter space , a goal of using the ensembles , I suppose, since it shortens convergence times. Without a fully Bayesian approach, we have no idea of the likely distributions of each parameter, or indeed if the best set was in the ensemble.

The fully Bayesian approach

The fully Bayesian approach requires (perhaps vague) prior distributions on each model parameter, generating a parameters set from the parameter priors, forecast based on the priors chosen, observing the data and evaluating the likelihood of the parameters (collectively the model likelihood), given the data, and using the likelihood to update the prior distributions of the parameters to posterior (to the data observation) distributions. Posterior parameter distributions are then used as priors to select the second set of independent realizations of the parameters, and process of drawing parameters sets, forecasting with those sets, observing data and updating the parameter priors (using Bayes theorem). Repeat.

A Bayesian alternative to MODFLOW

It may be impractical to run the MODFLOW model enough times to have multiple MCMC chains converge, a problem that gets worse as the number of parameters increases. It is possible (Lamon, 2015) to take advantage of the relationship between flow and J-17 elevation to develop the desired sampling distribution for the mean springflow resulting from DOR conditions. Such a *probability network model* could be used with the DOR scenario inputs for this purpose.

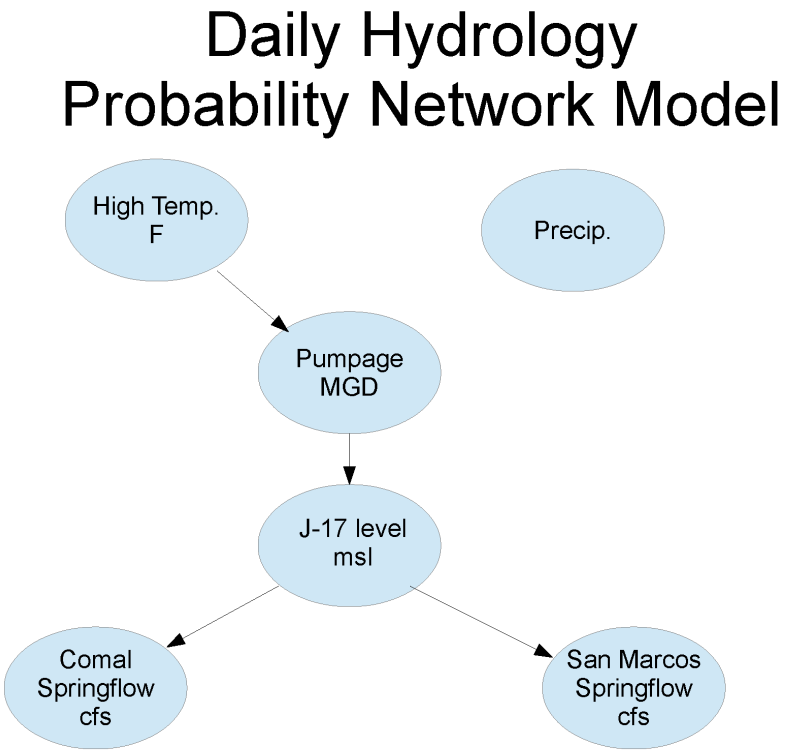

Figure 3 - The Daily Hydrology Probability Network Model of Lamon, 2015. Arrows represent Dynamic Linear Models the afferent node (predictor variable) to the efferent node (response variable). Daily maximum temperature predicts Pumpage, which predicts J-17 level, which then predicts the springflows. Ovals are "nodes", representing probability distributions, conditional on the variables afferent (opposite the arrow point), such that Spring flows are conditional on J-17 level, etc. The time step is daily.

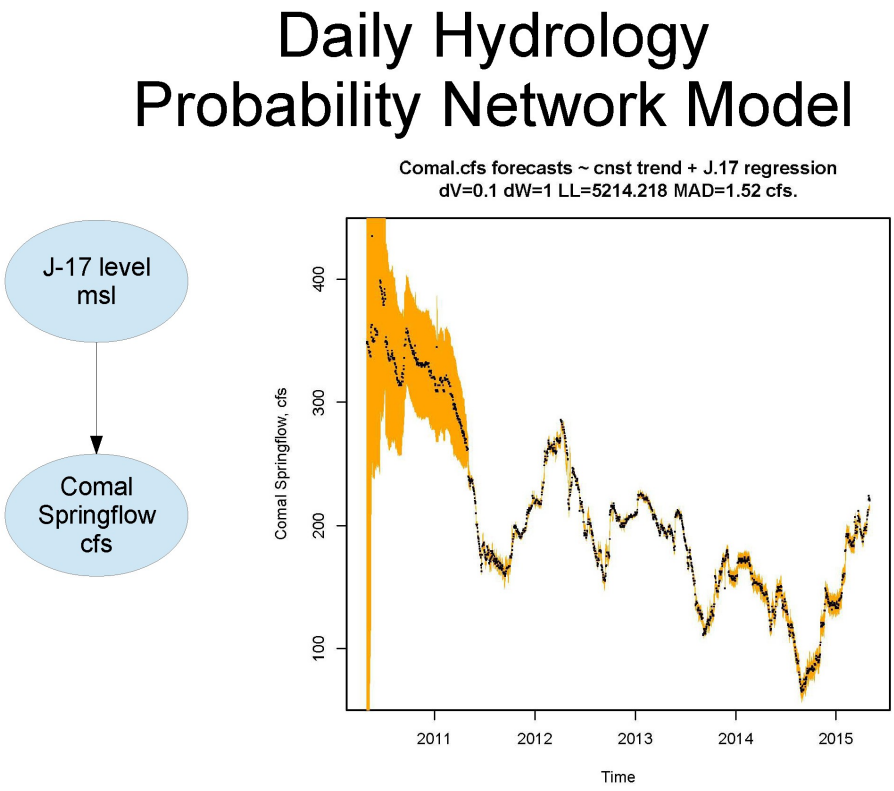

Figure 4 - Dynamic Linear Model predicting daily average Comal springflow as a function of a constant trend and daily average J-17 elevation predictor variable, from Lamon, 2015. This model has a median absolute deviation (MAD) of 1.52 cfs.

Statement

With millions in VISPO payments at stake riding on differences in forecast means of less than 1 cfs, and long term investments in modeling to develop those forecasts, it seems as if we'd be closer to a finished decision tool than a 30-40 cfs bias and 8 cfs mean squared error indicates. This is not meant as an argument against the changes to VISPO. Rather it is meant as an argument for investment in quantification and reduction of uncertainty in the springflow forecasts, and to offer my opinion on a logical course of action by which it may be achieved.

References

Lamon, EC, 2015. Daily Hydrology Probability Network Model, pdf.

Liu, A, N Troshanov, J Winterle, A Zhang, S Eason, 2017. Updates to the MODFLOW Groundwater Model of the San Antonio Segment of the Edwards Aquifer. Available at: https://data.edwardsaquifer.org/documents/2017_Liuetal_UpdatestotheMODFLOWGroundwaterModeloftheSanAntonioSegmentoftheEdwardsAquifer.pdf.

HDR, 2011. Evaluation of Water Management Programs and Alternatives for Springflow Protection of Endangered Species at Comal and San Marcos Springs. Available at: http://eahcp.org/wpcontent/uploads/2019/02/Appendix-K.pdf

Adaptive Management Stakeholder Committee of the Edwards Aquifer Habitat Conservation Plan

Adaptive Management Stakeholder Committee Report: Nonroutine Adaptive Management Proposal for the EAHCP VISPO

May 23, 2019

PREAMBLE

This Adaptive Management Stakeholder Committee Report[1] is issued in response to the Nonroutine Adaptive Management (AMP) proposal ("Proposal") submitted by the Program Manager of the Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan ("EAHCP;" EARIP, 2012), dated March 14, 2019. Having considered the attached Scientific Evaluation Report issued by the Adaptive Management Science Committee ("Science Committee") regarding the Proposal, this report presents the final recommendation of the Adaptive Management Stakeholder Committee ("Stakeholder Committee") concerning the proposed Nonroutine AMP action.

SUMMARY OF THE NONROUTINE AMP PROPOSAL

On March 14, 2019, the Program Manager submitted the attached Proposal to the Science, Stakeholder, and Implementing Committees. The Proposal calls for modifications to the Voluntary Irrigation Suspension Program Option (EAHCP § 5.2.1) to ensure compliance with the EAHCP Phase II flow targets, especially for Comal Springs.

SUMMARY OF STAKEHOLDER COMMITTEE DISCUSSION

At the May 23, 2019 Stakeholder Committee meeting, Chief Science Officer Chad Furl provided a comprehensive presentation, *Proposed Nonroutine Adaptive Management Process Proposal as the mechanism for ensuring compliance with the EAHCP Phase II flow targets,* to the Committee. This presentation covered (1) the AMP process; (2) EAHCP Flow Objectives and Protection Measures (3) MODFLOW modeling and SAMP DOR model run; and (4) the Scientific Evaluation Report issued by the Science Committee in response to the Proposal. Following this presentation, the Stakeholder Committee discussed the merits of the proposal.

This section provides a brief summary of the Stakeholder Committee's discussion of the proposed Nonroutine AMP action, organized by themes that emerged over the course of the Stakeholders' discussion. It also includes the final motions taken by the Committee.

Introduction to Nonroutine AMP

Mr. Myron Hess described the procedure of Nonroutine AMP as it is dictated in the Stakeholder Program Operational Rules and Funding and Management Agreement.

[1] Per the Funding & Management Agreement (2012), the Adaptive Management Stakeholder Committee is responsible for the reviewing of, and making recommendations to the Implementing Committee concerning, proposals submitted through the Nonroutine Adaptive Management Process (AMP).

Presentation on Nonroutine AMP Proposal

Dr. Chad Furl provided the Committee an overview of the Nonroutine AMP proposal and supporting information. Dr. Furl reminded the Stakeholder Committee of Nathan Pence's SAMP Whitepaper that was submitted in 2018 which thoroughly described the process for adaptive management and has served as the guidelines for the nonroutine adaptive management process that is being presented to the committees to date. In summation, the proposal involves a modification to the VISPO Conservation Measure (EAHCP § 5.1.2) to ensure compliance with the EAHCP Phase II flow targets, specifically the 30 cfs minimum flow objectives for the Comal Spring systems. This proposal seeks to change VISPO forbearance from 40,000 ac-ft/yr to 41,795 ac-ft/yr.

Minimum Flows

The modeling for DOR conditions is conservative because still account for 592,000 permitted pumping (assuming permittees pump to max amount) except as limited by critical period pumping limits.

80cfs Pulse

The intent of the 80 cfs pulse was to provide flow relief to the covered species during drought conditions, however multiple model iterations have shown that this flow rate is difficult to attain during DOR. Hess identified the challenge and acknowledged the lack of ability to achieve those 80 cfs flows.

Facilitation of discussion

Myron Hess nominated Doris Cooksey to facilitate the Stakeholder Discussion. There was consensus among the Committee.

Mr. Hess had concerns primarily with the 80 cfs flow rate and how to resolve the issues from either a program management perspective and/or a species protection perspective. Mr. Hess had reservations approving 30 cfs without further addressing 80 cfs throughout Phase II.

Mr. Hess commented that renegotiating flow rates are not a direction that the committee is looking to take. The 80 cfs rate was intended to provide relief to the spring systems and the species. Mr. Hess recommends a process to look at the predicted spring flow regimes as they relate to the species. The primary concern is not resolving issues related to the 80 cfs while moving forward with Phase II flow issues.

Final motions by the Committee

- The Stakeholder Committee recommends that the Implementing Committee approve the March 14, 2019 Nonroutine Adaptive Management Proposal VISPO, create a Work Group to address spring-flow related issues raised in the discussion document circulated to the Stakeholder Committee members by Myron Hess on May 22 (for issues not related to federal exempt pumping), and that the

Implementing Committee support the evaluation process and any recommended studies that come out of the Work Group.

- Nathan Pence motioned to recommend the Nonroutine Adaptive Management proposal to the Implementing Committee; Gary Middleton seconded the motion. There was no opposition.

- An expedited process whereby this report on the Stakeholder Committee recommendation on the Nonroutine AMP Proposal would be finalized by the Chair and Vice-Chair of the Stakeholder Committee was presented to the Committee for their consideration. Myron Hess moved approval of that expedited process; Jim Bower seconded the motion. There was no opposition.

NATURE OF STAKEHOLDER COMMITTEE DECISION

Twenty-two members were present at the time of the motion. Votes for both Committee actions concerning the Proposal were by consensus; there were no competing positions.

STAKEHOLDER RECOMMENDATION

By consensus, the Stakeholder Committee recommends the Nonroutine AMP proposal to the Implementing Committee for approval and adoption.

REFERENCES

- Edwards Aquifer Authority, City of New Braunfels, City of San Marcos, City of San Antonio, acting by and through its San Antonio Water System Board of Trustees, and Texas State University – San Marcos. 2012. *Funding and Management Agreement…to Fund and Manage the Habitat Conservation Plan for the Edwards Aquifer Recovery Implementation Program*. http://www.eahcp.org/files/uploads/Funding_and_Management_Agreement_(Appendix_R).pdf

- Edwards Aquifer Recovery Implementation Program (EARIP). 2012. *Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan*. http://www.eahcp.org/files/uploads/ Final%20HCP %20November%202012.pdf

ATTACHMENTS

- Attachment 1: Nonroutine Adaptive Management Proposal

- Attachment 2: *Scientific Evaluation Report: Nonroutine Adaptive Management Proposal*

- Attachment 3: Meeting minutes to be approved at the October 3, 2019 Stakeholder Committee Meeting. A draft will be included in this report TBD.

- Attachment 4: *May 22, 2019 Possible Components of Stakeholder Committee Recommendation from Myron Hess.*

NOTICE OF OPEN MEETING

Available at eahcp.org

As required by Section 7.9.3 of the Funding and Management Agreement (FMA), an interlocal agreement made pursuant to Texas Government Code Chapter 791 by and among the Edwards Aquifer Authority (EAA), the City of New Braunfels (New Braunfels), the City of San Marcos (San Marcos), the City of San Antonio acting by and through its San Antonio Water System (SAWS), Texas State University, and the Guadalupe-Blanco River Authority (GBRA), a meeting of the **Science Committee** for the Edwards Aquifer Habitat Conservation Plan is scheduled for **Wednesday, March 27, 2019 at 9:00 a.m. at the San Marcos Rec Hall** (near Lions Club)**,** 170 Charles Austin Drive, San Marcos, TX 78666**.** Lunch will be provided. All attendees are encouraged to please RSVP to ktolman@edwardsaquifer.org by Friday, March 22nd.

Members of this committee include: Tom Arsuffi, Janis Bush, Jacquelyn Duke, Charles Kreitler, Conrad Lamon, Glenn Longley, Doyle Mosier, Chad Norris, Jackie Poole, Floyd Weckerly and Jack Sharp.

At this meeting, the following business may be considered and recommended for committee action:

1. Call to order.

2. Public comment.

3. Approval of the minutes from the November 11th Science Committee meeting (Attachment 1).

4. Receive report from the Program Manager.
   - Hydrologic update
   - June 27 meeting location update
   - Comal Springs riffle beetle Work Group update
   - Phase II update

5. Discussion and possible action to elect the nomination for the Science Committee Vice-Chair for 2019.

   Purpose: To elect the nomination for the Science Committee Vice-Chair for 2019.
   Action: To possibly elect the Science Committee Vice-Chair for 2019.

6. Presentation, discussion, and possible recommendation of the Nonroutine Adaptive Management proposal related to the VISPO Flow Protection Measure (Attachment 2).

Purpose: To provide the opportunity for the Science Committee to discuss and possibly recommend the Nonroutine Adaptive Management proposal related to the VISPO program to the Stakeholder Committee.

Action: To possibly recommend the Nonroutine Adaptive Management proposal to the Stakeholder Committee.

7. Presentation and possible endorsement of an expedited process to prepare and allow Committee Chairs to submit the Nonroutine Adaptive Management Scientific Evaluation Report to the Stakeholder Committee.

Purpose: To provide the opportunity for the Science Committee to discuss and possibly endorse a process to prepare and allow Committee Chairs to submit the Nonroutine Adaptive Management Scientific Evaluation Report to the Stakeholder Committee

Action: To possibly endorse a process to prepare and allow Committee Chairs to submit the Nonroutine Adaptive Management Scientific Evaluation Report to the Stakeholder Committee.

8. Presentation and discussion of components of the 2020 Edwards Aquifer Authority Work Plan.

Purpose: To provide the Science Committee with the opportunity to comment on scientific components of the 2020 Edwards Aquifer Authority Work Plan.

Action: To obtain input from the Science Committee on the scientific components of the 2020 Edwards Aquifer Authority Work Plan.

9. Presentation and discussion of components of the 2020 City of New Braunfels Work Plan.

Purpose: To provide the Science Committee with the opportunity to comment on scientific components of the 2020 City of New Braunfels Work Plan.

Action: To obtain input from the Science Committee on the scientific components of the 2020 City of New Braunfels Work Plan.

10. Presentation and discussion of components of the 2020 City of San Marcos Work Plan.

Purpose: To provide the Science Committee with the opportunity to comment on scientific components of the 2020 City of San Marcos Work Plan.

Action: To obtain input from the Science Committee on the scientific components of the 2020 City of San Marcos Work Plan.

11. Presentation on the aquatic plant boom assessment in Spring Lake.

Purpose: To provide the Science Committee with the opportunity to review and discuss the proposed methodology for this study.

Action: No action required.

12. Consider future meetings, dates, locations, and agendas.

- Thursday, June 27, 2019 at 9 a.m. at the USFWS San Marcos Aquatic Resources Center (500 E McCarty Ln, San Marcos)

EXHIBIT 5b

Edwards Aquifer Authority

900 E. Quincy
San Antonio, TX 78215
EdwardsAquifer.org

NOTICE OF OPEN MEETING

EAHCP Stakeholder Committee

Myron Hess - Chairman
The EAHCP Stakeholder Committee consists of 27 individuals representing diverse interests throughout the region.
Scott Storment - EAHCP Program Manager

Thursday, May 23, 2019 **10:00 AM** **City of New Braunfels - City Hall**

A meeting of the Stakeholder Committee of the Edwards Aquifer Habitat Conservation Plan will be held on the date, time, and location stated above.

AGENDA

1. Call to Order

2. Public Comment

3. EAHCP Program Manager Announcements

3.1

- Recognition of Con Mims, EAHCP Stakeholder Committee Member
- Hydrologic Update
- SAWS ASR
- Budget Reports
- EAHCP Program Management
- Spring Communities Update

4. Approval of Minutes

4.1 **Approval of previous committee meeting minutes - January 24, 2019**

5. Reports

6. Individual Consideration

6.1 **Consider staff recommendation to approve the EAHCP Nonroutine Adaptive Management Process Proposal as the mechanism for ensuring compliance with EAHCP Phase II flow targets.**

6.2 **Consider staff recommendation to approve the Nonroutine Adaptive Management Process Stakeholder Report and its submission to the Implementing Committee.**

7. Future Meetings

8. Questions from the Public

9. Adjourn

Olivia Ybarra
Habitat Conservation Plan Coordinator

This meeting of the Stakeholder Committee of the Edwards Aquifer Habitat Conservation Plan complies with Section 7.8.4 of the Funding and Management Agreement (FMA), an interlocal agreement made pursuant to Texas Government Code Chapter 791 by and among the Edwards Aquifer Authority (EAA), the City of New Braunfels (New Braunfels), the City of San Marcos (San Marcos), the City of San Antonio acting by and through its San Antonio Water System (SAWS), Texas State University, and the Guadalupe-Blanco River Authority (GBRA).

EXHIBIT 5c

Edwards Aquifer Authority

900 E. Quincy
San Antonio, TX 78215
EdwardsAquifer.org

NOTICE OF OPEN MEETING

EAHCP Implementing Committee

Mark Enders (New Braunfels), Chairman
Robert Mace (Texas State University), Nathan Pence (GBRA),
Roland Ruiz (EAA), Tom Taggart (San Marcos), and Darren Thompson (SAWS)
Scott Storment - EAHCP Program Manager

Thursday, May 23, 2019 | **10:00 AM** | **City of New Braunfels - City Hall**

A meeting of the Implementing Committee of the Edwards Aquifer Habitat Conservation Plan will be held on the date, time, and location stated above.

AGENDA

1. Call to Order

2. Public Comment

3. Approval of Minutes

3.1 Approval of previous committee meeting minutes
- March 21, 2019

4. Reports

4.1 Receive report from Chuck Ahrens, Edwards Aquifer Authority, on 2018 Edwards Aquifer authorized pumping withdrawals.

4.2 Receive report from Scott Storment, EAHCP Program Manager, on Joint Base San Antonio's use of the Edwards Aquifer and the impact on the EAHCP.

5. Individual Consideration

5.1 Consider staff recommendation to approve the EAHCP Comprehensive Phase II Work Plan.

5.2 Consider staff recommendation to approve EAHCP Resolution No. 05-19-001.

5.3 Consider staff recommendation to approve the EAHCP Nonroutine Adaptive Management Process Proposal.

5.4 **Consider recommendation to direct EAHCP Program Manager to submit the necessary documentation regarding the approved Nonroutine Adaptive Management Process Proposal to the U.S. Fish and Wildlife Service on behalf of the Implementing Committee.**

5.5 **Consider staff recommendation to approve the 2020 City of New Braunfels EAHCP Work Plan.**

5.6 **Consider staff recommendation to approve the 2020 City of San Marcos/Texas State University Work Plan.**

5.7 **Consider staff recommendation to approve the 2020 Edwards Aquifer Authority Work Plan.**

5.8 **Consider staff recommendation to approve amendments to the 2019 City of New Braunfels Work Plan and Funding Application.**

6. Future Meetings

7. Questions from the Public

8. Adjourn

Olivia Ybarra
Habitat Conservation Plan Coordinator

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