Edwards Aquifer Authority
2019 Work Plan

2019 Edwards Aquifer Authority Work Plan Budget

HCP Section	Conservation Measure	Table 7.1	Available Budget for 2019	Estimated 2019 Budget	Difference
5.5.1	ASR Leasing & Forbearance	$4,759,000	$4,759,000	$4,759,000*	$0
	ASR O&M	$2,194,000	$2,194,000	$683,347	$1,510,653
5.1.3	RWCP	$1,973,000	$4,507,750	$4,507,750	$0
5.1.2	VISPO	$4,172,000	$4,172,000	$4,172,000	$0
5.1.4	Stage V	$0	$0	$0	$0
6.3.1	Biological Monitoring	$400,000	$400,000	$408,275	($8,275)
5.7.2	Water Quality Monitoring	$200,000	$200,000	$418,113	($218,113)
6.3.3	Ecological Model	$25,000	$0	$0	$0
6.3.4	Applied Research	$450,000	$450,000	$450,000	$0
5.1.1	Refugia	$1,678,597	$1,156,285	$1,156,285	$0
FMA §2.2	Program Management	$750,000	$910,000	$910,000	$0
	Science Review Panel	$100,000	$0	$0	$0
Total		$16,701,597.00	$18,749,035.00	$17,464,770.00	$1,284,265

*Final forbearance and leasing prices are TBD.

5.5.1 Edwards Aquifer Authority and San Antonio Water System Aquifer Storage and Recovery Work Plan

Section 5.5.1 of the Edwards Aquifer Habitat Conservation Plan (EAHCP) assigns acquiring leases and options of water permits for use in the San Antonio Water System (SAWS) Aquifer Storage and Recovery (ASR) to the Edwards Aquifer Authority (EAA). SAWS will operate the ASR infrastructure and retain control of day-to-day operations of the ASR facility related to EAHCP water injection and recovery. The EAA will ensure compliance with EAHCP requirements through management of the Interlocal Contract between the EAA and SAWS for the Use of the Twin Oaks Aquifer Storage and Recovery Project for Contribution to Springflow Protection, which became effective August 14, 2013. The contract outlines the responsibilities of both parties, including administration and implementation.

Long-term Objective:
The objective of SAWS Twin Oaks ASR (ASR now run out of H_2O Oaks facility) system is to deliver 126,000 acre-feet of Edwards Aquifer groundwater. This water is best managed to offset pumping from Edwards Aquifer wells during a repeat of a drought similar to the drought of record and acquire an additional 50,000 acre-feet of agricultural, municipal, industrial groundwater withdrawal rights to either be made available for physical storing in / crediting to the Regional ASR balance or may be forborne.

Target for 2019:
The ASR contract between EAA and SAWS will continue to be implemented. EAA is the leasing agent for ASR leases and will continue providing SAWS with notices of availability of HCP groundwater. As filling nears 126,000 acre-feet, future water acquired by the EAA through contractual agreements with permit holders will be utilized for forbearance purposes during a repeat of a drought of record. During a drought of record, the ASR will be used by SAWS to offset pumping and an additional 50,000 acre-feet of groundwater will go unpumped by permit holders in the region. In year 2019 the total amount of water available from multi-year leases is 16,675 acre-feet. Any additional groundwater secured by EAA above this amount will be used to meet forbearance obligations as outlined in the EAHCP.

ASR Program:
Description of the SAWS ASR: The SAWS Twin Oaks ASR is an underground storage reserve in the Carrizo sand aquifer in southern Bexar County. As a SAWS water management project, it is designed to store Edwards water when demand is less than available supply. The stored water is returned to San Antonio for use when demand is high and Edwards supply is restricted by Critical Period Management and other drought-related limitations.

The capacity and capabilities of the SAWS ASR are such that it can be used to meet SAWS ratepayer expectations and, if operated as described in the EAHCP, will play a significant role as a Phase I activity to protecting the Covered Species at Comal and San Marcos Springs.

Operations: The Edwards Aquifer Habitat Conservation Plan Program Interlocal Contract between the Edwards Aquifer Authority and The San Antonio Water System for the Use of the Twin Oaks Aquifer Storage and Recovery Project for contribution to Springflow Protection, effective August

14, 2013, takes elements of the HCP's ASR flow protection strategy and places them into an operations contract.

Injection: Storage of HCP groundwater shall be at the discretion of SAWS and will be dependent on operating conditions. All HCP groundwater made available to SAWS before June 30th, 2019, will be physically stored or credited as if stored, and will be used to meet any forbearance from the Aquifer should triggers defined in the Interlocal Contract occur in 2019.

Forbearance and Recovery: Forbearance of Edwards Aquifer pumping from certain wells will occur when the ten-year rolling recharge average is less than 500,000 acre-feet and the ten-day average of aquifer levels measured at the J-17 index well drop below 630 feet mean sea level (MSL). The annual amount of water to be recovered from the ASR during a repeat of the drought of record is outlined in Exhibits E & F of the Interlocal Contract. Changes to the Presumptive Forbearance Schedule outlined in Exhibit E may be approved as outlined in Section 5.3 of the Interlocal Contract.

Leasing: In 2019 the total amount of water available is 16,675 acre-feet and 15,924 acre-feet for year 2020. The amount of groundwater withdrawal rights secured by the EAA is enough water to meet the filling goal of 126,000 acre-feet by year 2020. In 2019, the focus by staff will be to acquire 33,325 acre-feet by way of long term (ten-year) forbearance agreements with regional permit holders.

Monitoring:
The EAA will actively manage the Interlocal Contract with SAWS. Status reports and updates will be provided regularly to the Implementing Committee.

ASR Regional Advisory Group: Per section 5.5.1 of the HCP, a 12-person SAWS ASR Regional Advisory Group will meet to advise SAWS as SAWS makes the decisions relating to the operation of the ASR facility relevant to the EAHCP. Membership on the Regional Advisory Group will include: four representatives from the San Antonio Water System, the EAHCP Program Manager; one representative each from the EAA, EAA permit holder for irrigation purposes, small municipal pumpers, the spring cities, environmental interests, industrial pumpers, and downstream interests.

Budget:
Table 7.1
$2,588,057 – Lease Options
$TBD – ASR Forbearance Agreements
$683,347 – O&M
$TBD– Total

Estimated 2019 budget*
$2,588,057 – Lease Options
$3,332,500 – ASR Forbearance Agreements
$683,347 – O&M
$6,603.904 – Total

*Actual expenditures for 2019 will be determined by the terms of the Interlocal Contract depending on the quantity of HCP groundwater physically stored, the amount of active water leases, and the cost of eligible operation and maintenance activities. Budgeted money that is not spent will be placed in the reserve fund.

5.1.3 Regional Water Conservation Program

Long Term Objective:
To reduce withdrawals from the Edwards Aquifer by 10,000 acre-feet, realized through implementation of conservation measures that will conserve 20,000 acre-feet of water.

Background: Conservation is one of four springflow protection measures of the Edwards Aquifer Habitat Conservation Plan (EAHCP) intended to reduce aquifer withdrawals, and subsequently increase aquifer level and springflow. The concept is to reduce aquifer withdrawals by 10,000 acre-feet and the EAHCP contemplates using a Regional Water Conservation Program (RWCP) to achieve this goal.

In order to provide an immediate benefit to the aquifer and springflow, several entities within the EAA jurisdictional area have agreed to make Initial Commitments (ICC) to the EAA Groundwater Trust. The initial contribution of water rights was placed in the Groundwater Trust for a period of ten years (Table 1). An Initial Commitment of 10,000 acre-feet was solicited from EAA permit holders to remain in the EAA Groundwater Trust for a period of ten years.

The Initial Commitment is returned to the permit holders through the implementation of conservation initiatives and technical assistance provided by the EAHCP. As conservation savings accrue, one-half of the savings are realized by the party participating in the RWCP and the other half is placed in the Groundwater Trust for the remaining term of the EAHCP ITP; allowing the original donors to have their donated water returned on a pro-rata basis. Consequently, 20,000 acre-feet of conservation savings are necessary for full return of the Initial Commitments.

Table 1: Initial Commitment Contracts.

Entity	Acre-Feet of Water Donated
San Antonio Water Supply	8,000
City of San Marcos	300
Texas State University	100
TOTAL	**8,400**

These ICC are to be returned to the permit holder at the end of 10 years or when an equal amount is identified as conserved and in reserve by the RWCP. ICC will be returned to the permit holder in a proportion equal to their contribution. As of 2018 the total ICC is 1,061.3 acre-feet.

In late 2015, a leak repair program with SAWS was negotiated and executed, that will fulfill the goal of the 10,000 acre-feet in the EAA Groundwater Trust by 2020. The contract covers the remainder of the ITP and is estimated to conserve almost 20,000 acre-feet accrued over the first five years. The SAWS leak repair program consists of hiring a contractor to expand the number of leaks feasible for system repairs. Regular progress reports from SAWS to EAHCP staff provide number of leaks repaired and an estimate of the overall savings within the time-period of reporting. An annual report is provided to communicate the overall savings realized throughout the year.

Table 2: SAWS – EAA 5-year water savings commitment and fiscal obligation.

Water	2016	2017	2018	2019	2020	Total
Estimated Savings (AF)	4,745	4,745	4,745	4,745	632	19,612
Commitment to the Groundwater Trust (AF)	2,372.5	2,375.5	2,372.5	2,372.5	316	9,806
Payment	$4,507,750	$4,507,750	$4,507,750	$4,507,750	$600,400	$18,631,400

With the payment of $950 per acre-foot of water conserved that has been used as a standard for other RWCP participants, the contract will cost $18,631,400 while sharing the remaining 9,800 acre-feet into the Groundwater Trust necessary to complete the 10,000 acre-foot goal.

Target for 2019:
With the execution and implementation of the contract with SAWS in 2016, the RWCP will have effectively met its conservation goal by 2020. The Regional Water Monitoring Committee submitted a letter communicating to the Implementing Committee in fall of 2017 the finalization of the RWCP. Effort in 2019 will be to monitor, and report upon, the work SAWS continues to implement in association with their contract with EAA for leak repair.

Monitoring:
As part of this contact, SAWS is obligated to transfer to the EAA groundwater trust half of the water saved under this program. SAWS will provide a total of three summary reports capturing and quantifying yearly milestones.

Budget:

Table 7.1:
$1,973,000

Available budget for 2019:
$4,507,750

Estimated 2019 budget:
$4,507,750

5.1.2 Voluntary Irrigation Suspension Program Option

Long-term Objective:
The goal of VISPO is to enroll 40,000 acre-feet (AF) of permitted irrigation rights (base and/or unrestricted) that will remain unused in years of severe drought. Permit holders have the option of enrolling in a five – year or ten – year program and will be compensated based on the amount of water enrolled and the program selected. Table 1 below shows the initial payment scale for the five and ten-year VISPO programs. If the water level at the J-17 index well in San Antonio is at or below 635 feet on October 1 of any year, program participants are contractually obligated to suspend the use of their enrolled water for the following year - beginning on January 1.

Table 1: VISPO Enrollment Options

Years	Fee	1	2	3	4	5
5*	Stand-by	50.00	50.75	51.51	52.28	53.06
	Suspension**	150.00	152.25	154.53	156.84	159.18
10	Stand-by	57.50	57.50	57.50	57.50	57.50
	Suspension**	172.50	172.50	172.50	172.50	172.50

Years	Fee	6	7	8	9	10
5*	Stand-by	N/A	N/A	N/A	N/A	N/A
	Suspension**	N/A	N/A	N/A	N/A	N/A
10	Stand-by	70.20	70.20	70.20	70.20	70.20
	Suspension**	210.60	210.60	210.60	210.60	210.60

*****The amount of each payment escalates at 1.5% annually over the five years of the program.
**Suspension payment is made in addition to stand-by payment.

Table 2: From October 6, 2014, through December 31, 2018, the total enrollment of 40,921 acre-ft. was sustained. Beginning January 1, 2019, over 9,489 acre-ft. of the 5-year agreements expire. The table below reflects the current distribution of enrolled water and is reflective of any amendments made to VISPO agreements.

Program	Atascosa (AF)	Bexar (AF)	Comal (AF)	Hays (AF)	Medina (AF)	Uvalde (AF)	Total (AF)
5-year	354	765	0	0	1,739	12,954	15,812
10-year	0	1,573	0	0	7,953	6,094	15,620
Total	354	2,338	0	0	9,692	19,048	31,432

Table 3: VISPO did not trigger for 2018; therefore, all enrolled water can be used by the permit holders in 2018. The table below reflects total payout by year for enrolled water.

Year	Payment Type	Total Enrolled (AF)	Total
2014	Stand-by	22,388	$1,201,938
2015	Suspension	40,921	$8,677,262
***2016**	Stand-by	40,921	$2,188,500

2017	Stand-by	40,921	$2,209,000
2018	Stand-by	40,921	$2,228,300
		Grand Total	$16,505,000

Target for 2019:
Beginning January 1, 2019, approximately 9,489 acre-feet of enrolled water will have expired and on January 1, 2020, an additional 15,182.12 acre-ft. will expire. The effort to re-enroll participants back into the VISPO forbearance program began in year 2018 and will continue throughout 2019. The re-enrollment effort will also include water under forbearance agreements that will expire in 2020. Throughout 2019 staff will be soliciting permit holders to new 5-year term forbearance agreements. For year 2019, staff will observe J-17 on October 1, 2018 and respond by making payments in a timely fashion and monitor pumping to confirm compliance.

Budget:
Table 7.1:
$4,172,000

Estimated 2019 budget*:
$4,172,000

*2019 VISPO expenses will be determined based on J-17 VISPO trigger levels on October 1, 2018.

5.1.4 Edwards Aquifer Authority Stage V Critical Period Management

Background: Stage V Critical Period Management was developed and included in the Edwards Aquifer Habitat Conservation Plan to help decrease withdrawals and maintain adequate spring flows at both Comal and San Marcos Springs during times of drought. On February 14, 2012, the Edwards Aquifer Authority (EAA) Board of Directors voted to amend its Critical Period Management (CPM) Program to include the new emergency Stage V. Implementation of Stage V results in a reduction of 44% to municipal, industrial and irrigation permit holders in both pools of the Edwards Aquifer who are authorized to withdraw more than 3 acre-feet per year. Stage V became effective as a rule on March 18, 2013 when the Incidental Take Permit was issued by the U.S. Fish and Wildlife Service. Stage V was first triggered in the Uvalde Pool on March 28, 2013, when the 10-day average at the J-27 index well dropped below 840 feet mean sea level. Stage V reductions remained in effect for 798 days and expired on June 4, 2015.

2017 Implementation: EAA staff monitors daily aquifer levels in both the San Antonio and Uvalde Pools of the Edwards Aquifer Region, if at any time, the 10-day average for aquifer or springflow levels in either pool reaches the designated trigger for Stage V, the EAA General Manager will issue a Notice of Commencement for implementation in five newspapers within the EAA jurisdiction. Notice will also be posted at the EAA's office and on the EAA website. All affected permit holders will also be provided written notice of implementation of Stage V and the requirement to reduce pumping by 44%.

Permit Holder Assistance: The EAA provides an online Critical Period Calculator to assist permit holders in calculating CPM reductions as they apply to each individual permit holder's total authorized withdrawal amount throughout the year. EAA staff also assists permit holders through "one-on-one" customer service offerings as may be necessary.

Triggers: The triggers for Stage V in the San Antonio Pool are as follows: the 10-day average at the J-17 index well in San Antonio falls below 625 mean sea level (msl); or the 10-day average at Comal Springs falls below 45 cubic feet per second (cfs); or the 3-day average at Comal Springs falls below 40 cfs. In the Uvalde Pool, Stage V is triggered when the 10-day average at the J-27 index well falls below 840 msl (see attachment I Critical Period Triggers Chart).

Reporting: By rule, permit holders are required to report their annual groundwater use to the EAA by January 31 for all groundwater used the preceding year. Permit holders who use more Edwards groundwater than authorized annually are subject to enforcement action.

6.3.1 Biological Monitoring Program for the Comal and San Marcos Aquatic Ecosystem

Long-term objective:
Since 2000, the Edwards Aquifer Authority (EAA) has undertaken biological monitoring of the Comal and San Marcos spring systems. In 2013, the elements of the program were incorporated into the Biological Monitoring Program (BioMP) for the Edwards Aquifer Habitat Conservation Plan.

The purpose of the BioMP is "to monitor changes to habitat availability and population abundance of the Covered Species that may result from Covered Activities" (EAHCP § 6.3.1). The BioMP includes: (1) Comprehensive Sampling, (2) any triggered Critical Period monitoring, (3) any high flow triggered monitoring (4) and any EAHCP-specific sampling required by Section 6.4.

Target for 2019:
For 2019, the BioMP for the Comal and San Marcos Aquatic Ecosystems will continue to include Baseline and critical period monitoring along with Disturbance impact assessment and overall Take Determinations. The 2019 BioMP will continue to use the standard operating procedures adopted in 2016 as a result of the Biological Monitoring work group (EAHCP 2016) in addition to what is noted in this document. These standard operating procedures were instituted for biological monitoring program beginning in 2017.

Aquatic Vegetation Mapping
The Contractor will conduct aquatic vegetation mapping in the four long-term monitoring reaches in the Comal Springs system and in the three long-term monitoring reaches in the San Marcos Springs system. The comprehensive mapping is conducted using a GPS unit with real-time differential correction with sub-meter accuracy.

Zebra Mussel Monitoring
The contractor will conduct zebra mussel monitoring using passive techniques in both the Comal and San Marcos Rivers.

Texas wild-rice Mapping
The Contractor will map all Texas wild-rice from Spring Lake downstream to the confluence of the Blanco River on an annual basis. The annual mapping will occur during the summer (July-August). The location of every stand of wild-rice will be recorded using a GPS unit with real-time differential correction with sub-meter accuracy.

Fountain Darter Sampling
The Contractor will conduct drop and dip netting and visual aquatic surveys with SCUBA during the Spring and Fall sampling events. Additional dip net sampling will be conducted during the Summer sampling event. Aquatic vegetation as per Task 2 will be mapped in the reaches prior to drop and dip net activities.

Drop Net Sampling
Drop netting will be used to sample fountain darters in identified reaches of the rivers in specific aquatic vegetation types that have been selected through stratified random sampling. Fountain darters will be identified, counted, measured, examined for condition and returned to the river at

the point of collection. Other fish will be identified and released, or preserved and identified in a laboratory. Live ramshom snails will be counted, measured, and destroyed. Exotic Asian snails and Asian clam will be identified, general abundance recorded, then destroyed. Furthermore, the vegetation type, height, areal coverage, substrate type, mean column velocity, velocity at 15 centimeters (cm) above the bottom, water temperature, conductivity, and dissolved oxygen levels will be recorded at each location.

Dip Net Sampling
The Contractor will conduct dip net timed surveys, as well as presence/absence surveys in specified sections throughout the spatial extent of both systems. Fountain darters collected by dip net monitoring will be examined for condition. Timed surveys will be conducted in all habitat types within each section, moving upstream during the sampling process, up to a depth of 1.4 m, with prime darter habitat receiving the most effort.

Presence/absence surveys will be conducted by taking 4 dip net sweeps at 50 permanent sample site locations within the 4 representative reaches at Comal Springs (Upper Spring reach (5 locations), Landa Lake reach (20 locations), Old Channel reach (20 locations), and New Channel reach (5 locations)), and the 50 permanent sample site locations within the three representative reaches in San Marcos Springs (Spring Lake Dam reach (15 locations), City Park reach (20 locations), and I-35 reach (15 locations)).

Visual Fountain Darter survey
Visual aquatic surveys will be conducted using SCUBA in a fixed location in Landa Lake to identify fountain darters at depths deeper than conventional sampling methods allow.

Comal Springs Invertebrate Sampling
The Contractor will conduct sampling for Comal Springs invertebrates during the Spring and Fall sampling events.

- One drift net each will be placed over the main spring orifice of Spring Run 1, Spring Run 3, and Spring Run 7 at Comal Springs. All endangered invertebrates will be identified and counted in the field, and returned to the orifice they were collected upon completion of the 24-hour sample period. All other invertebrates will be preserved and transported to an off-site laboratory for taxonomic classification. Coordination with the USFWS San Marcos Aquatic Resources Center (ARC) will take place each time to assist with refugia collections when needed.
- The Comal Springs riffle beetle cotton lure standard operating procedure, or a suggested (and EAHCP staff approved) alternate method, and quantitative survey methods will be utilized to conduct Comal Springs riffle beetle sampling in 3 locations (Spring Run 3, western shoreline of Landa Lake, and Spring Island area). Ten springs within each of the 3 locations will be identified by the Contractor.
- The Comal Springs riffle beetle cotton lure standard operating procedure and cotton lure quantitative survey method allow Comal Springs riffle beetles to be identified, counted, and returned to their spring of origin. Other spring invertebrates collected on the lures will also be noted. These include two other riffle beetles (*Microcylloepus* sp.

and *Stenelmis* sp.), Comal Springs dryopid beetles (Stygoparnus comalensis), and Peck's cave amphipod (*Stygobromus pecki*).

In 2018, a Comal Springs riffle beetle Work Group will be convened to provide input on a specific set of questions concerning management of the CSRB as part of implementation of the EAHCP. This Work Group may produce recommendations which will effect the current BioMP. A work plan amendment may follow in late 2018 or early 2019 for inclusion into the new BioMP contract.

Salamander Visual Observations
The Contractor will conduct salamander sampling during each Spring and Fall sampling event. Comal Salamander surveys will be timed and conducted by observation from the surface or dive mask and snorkel at Spring Run l, Spring Run 3, Spring Island spring runs, and at the eastern outfall at Spring Island.

San Marcos salamander surveys follow the quantitative sampling method described in Nelson, J. (M.S. Thesis, Texas State University, 1993). Observations for the San Marcos salamander will be done by dive mask and snorkel or SCUBA for three, 5-minute timed surveys per area. San Marcos salamanders will be counted, measured and the overall substrate where they were found documented.

- In both systems, sampling will require turning over rocks in the sample site for set periods of time in order to expose the salamanders and obtain a visual count. Whenever possible, all rocks will be returned to their original location. For this monitoring, salamanders will only be observed and no collections will occur.

Comal Springs Discharge Measurements
The Contractor will conduct discharge measurements on Comal Springs during the Spring and Fall sampling events. Discharge measurements will be conducted at Spring Runs 1, 2, and 3, Upper Spring Run Reach, and the Old Channel below Elizabeth Street and will be used to establish the contributions of each major spring run to total discharge in the river and to establish the relative proportion of water flowing in the Old and New Channels.

Water Quality Sampling
The Contractor will maintain and download existing thermistors located throughout each system. Standard water quality parameters (water temperature, conductivity compensated to 25 ^{0} C, pH, dissolved oxygen, water depth at sampling point, and observations of local conditions) will be sampled during drop net sampling and fish community sampling activities.

Fixed Station Photography
The Contractor will photo document each established, fixed station photograph site. Photographs involve an upstream, across, and downstream picture of the reach and capture key changes in the habitat in the reach.

Macroinvertebrate Community Assessment
The macroinvertebrate community assessment will be conducted using rapid bioassessment (RBA) protocol as described in “Surface Water Quality Monitoring Procedures, Volume 2:

Methods for Collecting and Analyzing Biological Assemblage and Habitat Data." TCEQ RG-416. 2014. The RBAs will be conducted in 5 reaches in the Comal and 4 reaches in the San Marcos at the drop-net fountain darter sites. One composite sample will be collected from each reach (i.e. 9 samples total across both systems). Macroinvertebrate community assessments will be conducted during comprehensive and critical period sampling events.

Fish Community Sampling

SAN MARCOS SYSTEM
Two locations within Spring Lake associated with San Marcos Salamander surveys (Big Riverbed and Hotel Area) will be sampled for fish as well as one location just upstream of the dam near the eastern spillway. All three locations will involve SCUBA transect surveys. Three additional SCUBA transects are in each river section (Upper, Mid, and Lower) of the San Marcos River, located in representative deep areas where seining has proven to be inefficient. The exact location of the SCUBA transects within each section may change slightly based on conditions at the time of the sampling event.

COMAL SYSTEM
Three locations within Landa Lake will be sampled via SCUBA transect surveys. In particular, one of the SCUBA transects in Landa Lake will be in the same location as the ongoing fountain darter belt transect survey. In addition, SCUBA transects will be conducted within the Upper Spring Run, Old Channel, and New Channel sections of the Comal River.
In addition to SCUBA surveys, three locations (Upper Spring Run, New Channel, and Old Channel) will be sampled via seines to evaluate and track fish populations in the Comal River. Fish within each transect will be identified, measured, examined for disease, and native fish returned to the river. Exotics will be removed from the system as per scientific permit. In addition to collected data on fish, each seine haul will include data on the velocity, depth, substrate composition, in-stream coverage, climatic conditions, and mesohabitat typing of the site at the time of the observation.

EAHCP Habitat Baseline and Disturbance Determination
This determination is intended to fulfill Section M 1a and 2a of the Incidental Take Permit.

Document Baseline Habitat Conditions
For the covered HCP species, the Contractor will use January 1 of the contract year GIS mapping, bio-monitoring data and other existing sources to establish occupied habitat for the HCP Covered Species. Specific to Item M (la and 2a) of the ITP, only occupied habitat within the Comal and San Marcos Springs/River ecosystems will be included.

Document HCP Mitigation Areal Extent Per Project
The Contractor will work with staff and contractors from the City of New Braunfels, City of San Marcos and Texas State University, coordinating through EAA staff, to describe in GIS map form, representing a snapshot in time on December 31 of the contract year, the areal extent of all direct HCP mitigation and restoration activities in the Comal and San Marcos springs systems.

If GIS files of the project/affected areas are unavailable, the Contractor will either: l) map those areas directly with high grade GPS in real-time, or 2) use existing areal imagery to pinpoint and outline locations with subsequent, supplemental GPS ground truth mapping. The Contractor will ensure that areas represented on all maps are representative of actual mitigation, not concept areas.

Assessment of Net Disturbance
The Contractor will evaluate the baseline maps versus the HCP project maps and quantify the area of direct disturbance that may have potential effects from mitigation and restoration activities as described in Item M (la and 2a) of the ITP. The focus will be on quantifying the direct impacts (removal of non-native vegetation, etc.) via areal coverage of habitat, but will also describe potential indirect impacts (turbidity, etc.) qualitatively. This analysis will not extend beyond comparisons of areal coverage of occupied habitat.

Annual "Take" Estimate
The Contractor shall estimate Take for each of the Covered Species utilizing the information generated by Subtask 12.1, 12.2 and 12.3, the information and guidance in Chapters 4 and 6 of the HCP, the Biological and Conference Opinion issued by USFWS, and any other relevant information. The purpose of this Take estimation is to ensure compliance with Section H of the ITP.

CRITICAL PERIOD SAMPLING
The Critical Period Monitoring component will be performed on both systems and be based upon established flow trigger levels for each system. The type and extent of sampling conducted is dependent on the respective trigger level and is designed to be duplicative of full biomonitoring sampling and will include species-specific sampling based on the flow triggers.

High/Low Flow Monitoring
The Contractor will conduct high flow critical period monitoring only after the following triggering criteria are met:

a) The daily average flow exceeds 385 cubic feet per second (cfs) in the San Marcos aquatic ecosystem or 500 cfs in the Comal aquatic ecosystem (total flow through the ecosystem as measured at the USGS gauging station located immediately downstream of the ecosystem); and
b) After conducting a joint visual inspection of the aquatic ecosystem with the Contractor, EAA staff determines that high flow critical period monitoring is warranted and approved.

Before high flow critical period monitoring is conducted, the sampling parameters must be recommended by the Contractor and pre-approved by EAA staff, based on professional judgment, and may include any parameter from the full biomonitoring sampling, with the exception of gill net sampling.

The Comal and San Marcos springs systems flow-based triggers are associated with specific sampling parameters.

San Marcos System Sampling
Low flow Critical Period Monitoring for the San Marcos River triggers at 120 cfs, with Texas wild-rice vulnerable stand monitoring as described in Task 3 of the Comprehensive Sampling Program. Monitoring will occur at 5 cfs declines or a maximum of once per week. The first Full Sampling Event is triggered at 100 cfs, with subsequent declining Full Sampling Events triggering at 85, 60, 25, and 100 cfs for a total of five declining Full Sampling Events. In addition, two recovery Full Sampling Events would be conducted as the system rebounds from the low-flow period. Between Full Sampling Events, habitat evaluations, per every 5 cfs decline, would be conducted again not to exceed weekly monitoring.

Comal System Sampling
Low flow Critical Period Monitoring for the Comal River triggers at 200 cfs. This triggers the first Full Sampling Event with 4 subsequent Full Sampling Events being triggered at 150, 100, 50, and 10-0 cfs, respectively. Two recovery Full Sampling Events are scheduled as the flows rebound and stabilize from drought conditions. The Comal system also has habitat evaluations scheduled between Full Sampling Events; however, at 10 cfs increments again not to exceed weekly observation. An additional component for the Comal system is the detailed riffle beetle habitat evaluation and spring orifice condition documentation that is triggered at 120 cfs and continued at 10 cfs increments during decline.

A review of historic flow records indicates that the lower the flow, the lower the chance an even lower flow event will occur, thus reducing the chances of a complete decline and recovery as outlined above. Typically, both systems rebound from drought conditions due to a tropical depression rainfall event or some other weather pattern that produces a large amount of rainfall over the watershed. Flows typically come up rapidly and require a period of stabilization before the collection of biological data is meaningful.

Gill Net Evaluation
In addition to the full sampling activities outlined in 14.1 and 14.2, the Contractor will conduct gill net evaluations in the immediate vicinity of the fountain darter SCUBA surveys in Spring Lake and Landa Lake. The Spring Lake evaluation will be triggered at 85 cfs and lower triggers. The Landa Lake assessment will be triggered at 100 cfs and lower triggers. The survey is designed to examine exotic fish concentrations and stomach content analyses with respect to predation of listed species. The number of each species (native and non-native) collected in the gill net and the data will be recorded and converted to catch per unit effort.

Water Quality Grab Sampling
The Contractor will collect water quality grab samples at the established triggers in Subtasks 14.1 and 14.2 at 18 stations longitudinally distributed in the San Marcos system and 12 stations longitudinally distributed in the Comal system. The samples will be from the surface, mid-depth and near bottom.

EAHCP Low Flow Sampling

To protect the Covered Species, Chapter 6 of the EAHCP contains specific flow requirements for both systems that trigger sampling events. This sampling is in addition to the Comprehensive and Critical Period components and consists of an increased frequency of sampling for aquatic vegetation, Texas wild-rice mapping, as well as additional sampling of fountain darters, Comal Springs riffle beetles, and salamanders.

Budget:

Table 7.1:
$400,000

Available budget for 2019:
$408,275

Estimated 2019 budget:
$408,275*

*2019 EAHCP BioMP will be performed by an outside contractor selected in the fall of 2018; estimated annual costs for the BioMP is TBD. The cost of any Critical Period monitoring component of the BioMP, as established by the former EAA Variable Flow Study, will continue to be paid by the EAA.

5.7.2 Water Quality Monitoring Program Strategy for Comal Springs and San Marcos Springs

This workplan details the sampling strategy and protocols for surface water quality monitoring in 2019 for the Edwards Aquifer Habitat Conservation Plan (EAHCP) document (Section 5.7.2) implemented by the Edwards Aquifer Authority (EAA), utilizing a third party contractor. The goal of the water quality monitoring program, first implemented in 2013, is to detect water quality impairments that may negatively impact the listed species. If certain constituents of concern are detected at levels indicating the potential for adverse effects, the Implementing Committee member with jurisdictional authority will be consulted to identify sources and consider Best Management Practices (BMPs) to reduce and/or eliminate the constituents of concern. If necessary, additional testing could be included in the current or following year to assist in determining the source of contamination and the Science Committee could be consulted to assist with BMP identification and source determination.

Target for 2019:

In 2015, the EAHCP received the *National Academy of Sciences (NAS) Report 1* (2015) containing recommendations for EAHCP's Monitoring, Modeling and Applied Research programs, including the Expanded Water Quality Monitoring Program. From *Report 1*, a list of water quality monitoring recommendations was presented to the NAS Recommendation Review Work Group (NAS Work Group). Based on the NAS Work Group assessment, at its February 18, 2016, meeting, the Implementing Committee convened the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group (WQWG) to carry out a holistic review of the Expanded Water Quality Monitoring Program, considering the recommendations of NAS, the NAS Work Group, the input of the Science Committee, the Permittees, and subject matter experts. The purpose of the WQWG was to produce a final report for review by the Implementing Committee, developed through a consensus-based decision-making process. The WQWG held meetings from March to May 2016. This work plan reflects inclusion of the changes recommended by the WQWG.

For 2019, the contractors will use the same sampling locations used in 2017 as shown in the attached figures. However, changes in springflow, surface water runoff, land use, site security and access may dictate minor modification to sample collection locations and schedules as sampling efforts progress. Any minor changes resulting from these factors that are necessary because of safety or equipment concerns will be noted in the field sample sheets and dedicated field books. Should logistics or safety issues require any significant changes to this workplan, the sampling contractors shall report those issues to the EAA. Subsequently, the EAA will present those changes to the Science and Implementing Committees for review and approval as needed prior to their implementation. An overview of the approved Scope of Work can be seen in **Table 1** below.

Table 1. Overview of the Approved Scope of Work

Sampling Method	Frequency
Surface Water Passive Sampling	• February, April, June, August, October, and December ○ Add Pharmaceutical Personal Care Products membrane only at the bottom of the channel in both systems

Stormwater Sampling	• Reduced to one sampling event per year
	  ○ Test only for Integrated Pest Management Plan chemicals in odd numbered years at the Comal River system (Upper Springs and New Channel)
	  ○ Test full suite in even numbered years as currently done in both systems
	• Add two samples to the rising limb of the hydrograph for a total of five samples per location
	  ○ Priority given to locations at tributary outflows

Sediment Sampling	Biennially in even numbered years from both systems
Fish Community Sampling	Biennially in odd years from both systems

COMAL SPRINGS

Comal Springs discharges an average of 291 cubic feet second (cfs) into Landa Lake, located within the city of New Braunfels, Texas. Comal Springs is considered a spring complex with multiple discharge points along the 4,500-foot reach of Landa Lake. The springs issue from the Edwards Group limestone along the 4,500-foot section of the northeast-southwest trending escarpment formed by the Comal Springs Fault. Landa Lake forms the headwaters of the Comal River which flows approximately two miles before entering the Guadalupe River.

Discharge measurements have been collected from Comal Springs since 1933, and the EAA has been collecting water quality samples for more than ten years. EAA collects samples from Spring 1, Spring 3, and Spring 7 on a biannual basis during normal flow conditions and more frequently when dictated by research interests. Spring 1, Spring 3, and Spring 7 discharge into Landa Lake and make up part of the Comal Springs complex. Figure 1 indicates these historical groundwater sampling locations. Water quality samples are collected and analyzed for filed parameters including dissolved oxygen (DO), pH, conductivity, temperature and alkalinity[1]. Samples are also submitted to the EAA contract laboratory for analysis of cations, anions, nutrients, metals, VOCs, SVOCs, herbicides and pesticides, bacteria, TOC, PCBs, and phosphorous.

[1] Field alkalinity analysis will be conducted within seven days of sample collection.

Sampling Methods

All samples will be collected following the EAA's *Field Sampling Plan* or contractor's established methodology upon approval by the EAA. Samples shall be analyzed by a NELAP accredited contract laboratory. To date, no requests to deviate from the EAA's *Field Sampling Plan* have been received or approved.

Surface Water Passive Sampling for Comal Springs

Passive samples are to be collected during the 2019 sampling effort using a passive diffusion type sampling device. Devices will be obtained from Amplified Geochemical Imaging LLC (AGI), or be equivalent to AGI devices in functionality and parameters available for analysis. Sample locations for passive diffusion samples (PDS) are provided in Figure 2, and are listed below.

Upper Springs (near Bleiders Creek);
Upper Landa Lake - (near Spring Island);
Lower Landa Lake - (above outfalls);
Upper Old Channel - (Elizabeth Street); and,
USGS Gauge - (above San Antonio Street Bridge).

The passive sampling effort shall be performed in February, April, June, August, October, and December. The devices shall be installed for a two-week interval at the same locations as the sediment samples. When conducting passive sampling events, the contractor will also sample for pharmaceutical and personal care products (PPCP) using a PPCP-specific diffusion sampler placed at the most downstream sample site (USGS Gauge - above San Antoni Street Bridge). The parameter set for PDS is listed in Appendix A, under *Analytical Parameters for Passive Diffusion Samplers, Comal and San Marcos Springs*, and parameter set for PPCP is listed in Appendix A under *Analytical Parameters for Pharmaceutical Personal Care Products, Comal and San Marcos Springs.*

Stormwater Sampling Program for Comal Springs

One stormwater sampling event will be performed in 2019 to evaluate stormwater and runoff quality from the urban landscape. A stormwater sampling event will be triggered when the flow rate at the U.S. Geological Survey (USGS) Comal Springs gauging station (#08169000) increases by 5% or if there is a 20% change in three of the five water quality parameters measured in the downstream real time water quality monitoring probe. During odd numbered years samples will be collected at Upper Springs (near Blieders Creek) and Upper Old Channel (at Elizabeth Bridge) as indicated in Figure 3. Five stormwater samples will be collected at each location. Sampling times will be spaced to reflect changes in the stream hydrograph (three during initial rise or first flush, one at peak flow, and one during the recession limb).

Stormwater samples will be analyzed using the methods found in Appendix A, under *Analytical Parameters for Storm Water Comal and San Marcos Springs - Even Years or - Odd Years.*

Sediment Sampling for Comal Springs

Because sediment samples are collected only during even years, no sediment samples will be collected at Comal Springs in 2019.

Fish Community Sampling for Comal Springs

Fish collection from the Comal River system will be conducted during odd numbered years in conjunction with routine Biological Monitoring sampling. Fish will be collected at two locations within the Comal River system; one site will be located near the spring orifices or in the far upper reaches of the system, and the second site will be located at the most downstream biomonitoring reach (Lower River Reach).

At each of the two sites, two fish species will be collected. The species will include fountain darters and a predator species such as largemouth bass, warmouth, or rock bass. Fish of the same predator species at each of the four locations should be collected so that the results may be compared. For each sample, whole body organisms will be combined to create a composite sample for tissue analysis. The length, weight, and sex of the individual fish will be recorded prior to creating the homogenate. Tissue analysis will be tested for contaminants using the analytical methods provided in Appendix C.

Real Time Instrument Water Quality Data Logging Program for Comal Springs

Continuous water quality monitoring stations will continue in 2019 at the following locations (Figure 4):

Spring Run 3;
Spring 7;
Landa Lake;
New Channel (below confluence with Dry Comal Creek); and
Old Channel.

Monitoring will be performed using a data logging sonde capable of collecting data on 15-minute intervals. The parameters measured will include temperature, dissolved oxygen, pH, turbidity, and conductivity. These data will be evaluated to identify short-term and long-term water quality variations of the spring system as well as changes in water quality related to storm water runoff. **This monitoring effort will continue to be performed by EAA staff in 2019.**

SAN MARCOS SPRINGS

Located in San Marcos, Texas, on the campus of Texas State University, San Marcos Springs discharges an average of 176 cfs into Spring Lake. The springs issue from the Edwards Group limestone along the northeast-southwest trending escarpment formed by the San Marcos Springs Fault. Spring Lake forms the headwaters of the San Marcos River. Discharge measurements have been collected from San Marcos Springs since 1957, and the EAA has been collecting water quality samples for more than ten years.

EAA collects water quality samples from Deep Spring and Hotel Spring at least biannually, with more frequent sampling based on specific research interests. Both Deep and Hotel springs are in the bed of Spring Lake and make up part of the San Marcos Springs complex. Figure 5 indicates the locations of spring sampling at San Marcos Springs. Water quality samples are collected and analyzed for field parameters including dissolved oxygen (DO), pH, conductivity, temperature and alkalinity[2]. Samples are also submitted to the EAA contract laboratory for analysis of cations, anions, nutrients, metals, VOCs, SVOCs, herbicides and pesticides, bacteria, TOC, PCBs, and phosphorous.

Sampling Methods

All samples will be collected following the EAA's *Field Sampling Plan* or contractor's established methodology upon approval by the EAA. Samples shall be analyzed by a NELAP accredited contract laboratory. To date, no requests to deviate from the EAA's *Field Sampling Plan* have been received or approved.

Surface Water Passive Sampling for San Marcos Springs

Passive samples are to be collected during the 2019 sampling effort using a passive diffusion type sampling device. Devices will be obtained from AGI, or be equivalent to AGI devices in functionality and parameters available for analysis. Sample locations for PDS samples are provided in Figure 6. Specifically, at the following sample points.

Sink Creek;
Spring Lake;
Sessoms Creek;
City Park;
Rio Vista Dam;
IH-35 reach; and,
Capes Dam/Willow Creek.

The passive sampling effort shall be performed in February, April, June, August, October, and December. The devices shall be installed for a two-week interval at the same locations as the

[2] Field alkalinity analysis will be conducted within seven days of sample collection.

sediment samples. Each passive sampling effort will also include a PPCP specific diffusion sampler placed only at the most downstream sample site (Capes Dam/Willow Creek). The parameter set for PDS samples is listed in Appendix A, under *Analytical Parameters for Passive Diffusion Samplers, Comal and San Marcos Springs*, and parameter set for PPCP is listed in Appendix A under *Analytical Parameters for Pharmaceutical Personal Care Products, Comal and San Marcos Springs.*

Stormwater Sampling Program for San Marcos Springs

Stormwater sampling events are performed to evaluate stormwater and runoff quality from the urban landscape. Stormwater samples are collected in the San Marcos Springs area only during even numbered years. As a result, no stormwater sampling will occur at San Marcos in 2019.

Sediment Sampling for San Marcos Springs

Because 2019 is an odd-numbered year, no sediment samples will be collected at San Marcos in 2019.

Fish Community Sampling for San Marcos Springs

Fish from the San Marcos River system will be collected during odd numbered years in conjunction with routine Biological Monitoring sampling. Fish will be collected at two locations within the San Marcos River system; one site will be located near the spring orifices or in the far upper reaches of the system, and the second site will be located at the most downstream biomonitoring reach (IH-35 Reach).

At each of the two sites, two fish species will be collected. The species will include fountain darters and a predator species such as largemouth bass, warmouth, or rock bass. Fountain darters and the same predator species at each of the four locations will be collected so that the results may be compared. The length, weight, and sex of the individual fish will be recorded prior to creating the homogenate. For each sample, whole body organisms will be combined to create a composite sample for tissue analysis. Tissue analysis will be tested for contaminants using the analytical method provided in Appendix C.

Real Time Instrument Water Quality Data Logging Program for San Marcos Springs

Continuous water quality monitoring stations will operate in 2019 at the following locations (Figure 7):

USGS gauging station;
Rio Vista Dam;
Sessom Creek; and
Texas Park and Wildlife Department Fish Hatchery.

Monitoring will be performed using a data logging sonde capable of collecting data at 15-minute intervals. The parameters measured will include temperature, dissolved oxygen, pH, turbidity, and specific conductance. These data will be evaluated to identify short-term and long-term water quality variations of the spring system as well as changes in water quality related to storm water runoff. **Continuous water quality monitoring stations will be operated and maintained by EAA in 2019**.

Monitoring:

Water Quality Monitoring Reporting: The contractors will compile and present sampling results in an annual report to the EAA. The report will include an evaluation of analytical data, discussions of results that exceed comparative or regulatory standards, a discussion of water and sediment quality, laboratory reports and field data sheets, photographs, sampling locations and rationale, description of sampling methods, and a description and rationale for any deviations from the Water Quality Sampling Plan due to logistics or safety issues. The report is to be submitted electronically and will be reviewed internally by EAA. The deadline for submittal to the EAA is December 21, 2019.

Data Compilation, Analyses and Reporting: Data collected as a result of the 2019 EAHCP Water Quality Monitoring Plan will be compiled and analyzed, and the results will be presented to the Implementing Committee by February 15, 2020; prior to inclusion in the annual EAHCP Annual Report, which is required by Sections 6.2.4 and 9.3 of the EAHCP and Section 11.1c of the Implementing Agreement. The report will include an evaluation of all analytical data, including graphs, key photographs and general summary of results.

Funding is requested for maintenance and replacement needs for existing real time instruments, as well as data transmission and web hosting fees. Detail for the real time instruments is listed in Appendix D.

This 2019 Water Quality Work Plan will be reviewed by the Science Committee prior to implementation. The Science Committee will be asked to confirm the need for additions or changes to the Water Quality Work Plan:

Budget:

2018 marks the last year of the current WQ monitoring contract. Over the course of 2018, EAHCP staff will develop a new contract which will be executed in fall 2018. With this said, current estimated budget reflects no changes between contracts. An official budget will be provided once the new contract has been awarded.

Requested workplan Budget: $418,113.00

2020 EAHCP Sampling (Sediment and Passive Sampling) as performed by an outside contractor, annual costs $285,300.00

2019 EAHCP Sampling (Fish Community Sampling) as performed by an outside contractor, annual costs $89,613.00

Real Time Instruments (RTI): $43,200 (see Appendix D)

Justification for Budget Adjustment

The real time water quality data logging instrumentation is in need of funding for maintenance, in addition spare instrumentation is needed to prevent extended down time in the event of catastrophic failure. The instruments also require funding for calibration fluids, batteries, and other incidental costs. Cost details are provided in Appendix D.

Figure 1
Comal Springs Groundwater Sample Location

Most of the historical EAA sampling records for Comal Springs pertains to the locations known as Spring 1, Spring 3, and Spring 7 (spring vents). Other locations at Comal Springs may have a limited sample record.

Samples are collected biannual basis during normal flow conditions and more frequently when dictated by research intrests.

Expanation

Historical Groundwater (Spring) Sample Location

N

Miles 0 0.1 0.2 0.3 0.4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Prepared by:

EDWARDS AQUIFER AUTHORITY

Figure 2
Comal Springs Passive Diffusion Sampler Location

Comal Springs HCP Related Sample Points

Passive Diffusion Sampler (PDS)
Polar Organic Chemical Integrative Sampler (POCIS)

Notes:
PDS devices are to be placed at the locations listed herein, for a two-week time period in the months of February, April, June, August, October, and December.

PDS devices will be from Amplified Geochemical Imaging, LLC, or equivalent and shall provide analyses listed in Appendix A, under Analytical Parameters for Passive Diffusion Samplers, Comal and San Marcos Springs.

One POCIS sampler will be placed at the most downstream sample site, for a four-week time period during the months of February, April, June, August, October, and December.

POCIS device will be from Environmental Sampling Technologies and analyzed by the contracted laboratory for the analyses listed in Appendix A, under Analytical Parameters for Pharmaceutical Personal Care Products, Comal and San Marcos Springs.

Expanation

▲ Passive Diffusion Sampler Location

N

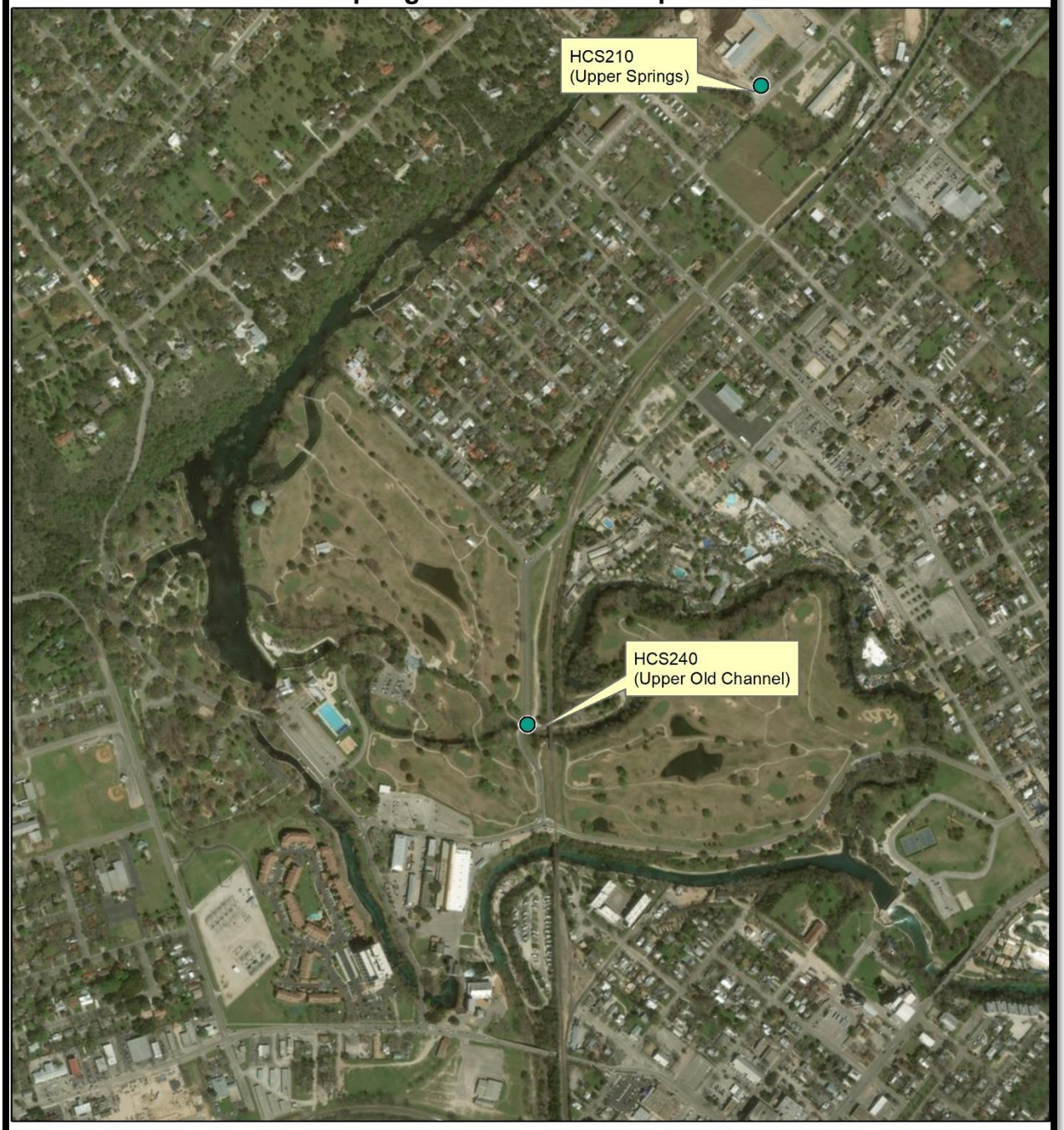
Miles
0 0.1 0.2 0.3 0.4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Prepared by:

EDWARDS AQUIFER AUTHORITY

Figure 3
Comal Springs Stormwater Sample Location



Comal Springs HCP Stormwater

Analytical Parameter List (HCP)

Stormwater = Atrazine, azoxystrobin, bifenthrin, chlorothanlonil, diclofop-methyl, indoxacarb, iprodione, oxadiazon, prodiamine, thiophanate-methyl, mancozeb, foramsulfuron, and trifloxysulfuron.

Stormwater samples collected annually.

Expanation

Stormwater Sample Location

N

Miles

0 0.1 0.2 0.3 0.4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Prepared by:

EDWARDS AQUIFER AUTHORITY

Figure 4
Comal Springs Real Time Water Quality Station Location

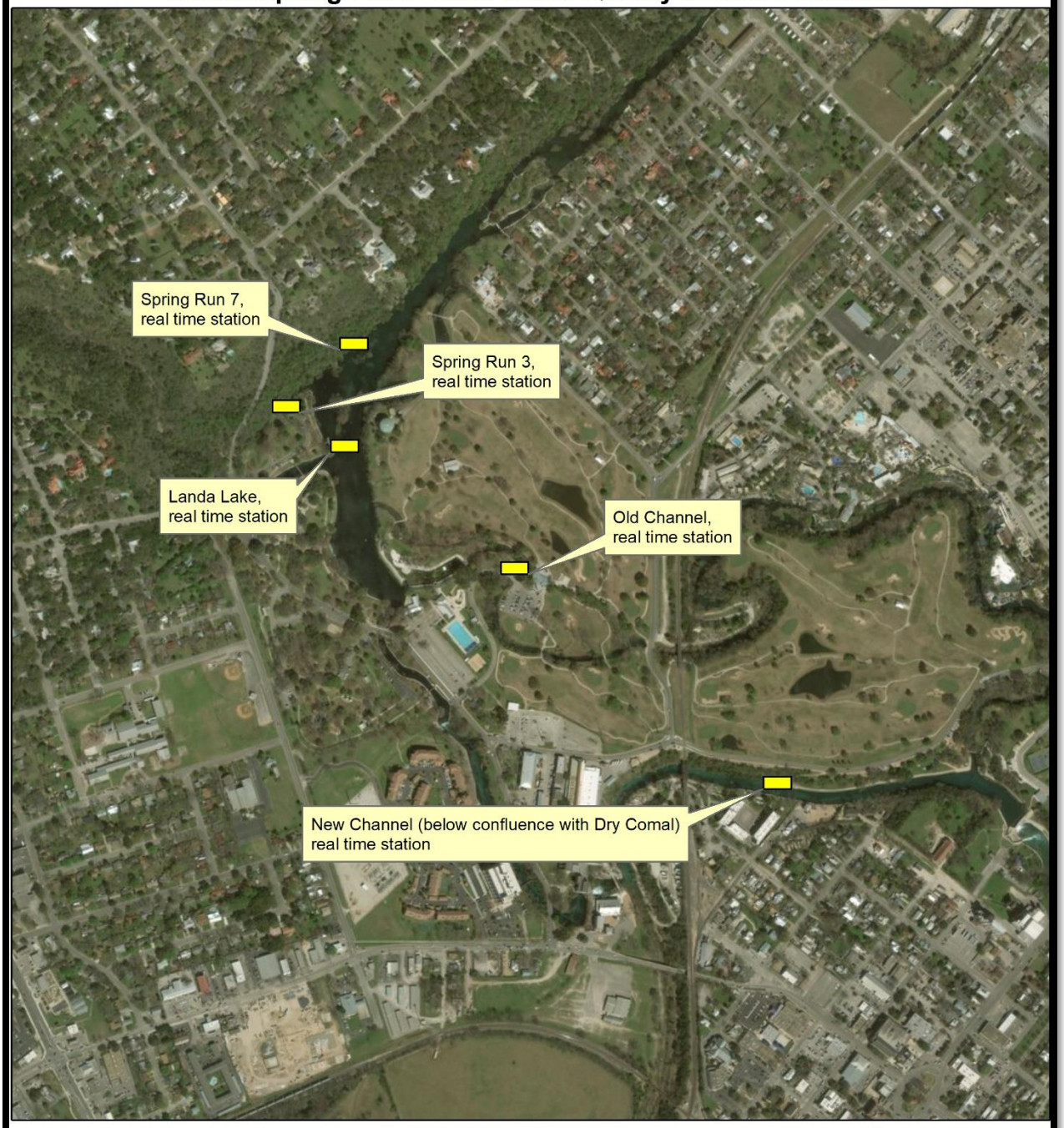


Figure 5
San Marcos Springs Groundwater Sample Location

Most of the historical EAA sampling records for San Marcos Springs pertains to the locations known as Hotel and Deep (spring vents). Other locations at Comal Springs may have a limited sample record.

Samples are collected biannual basis during normal flow conditions and more frequently when dictated by research intrests.

Expanation

★ Historical Groundwater (Spring) Sample Location

N

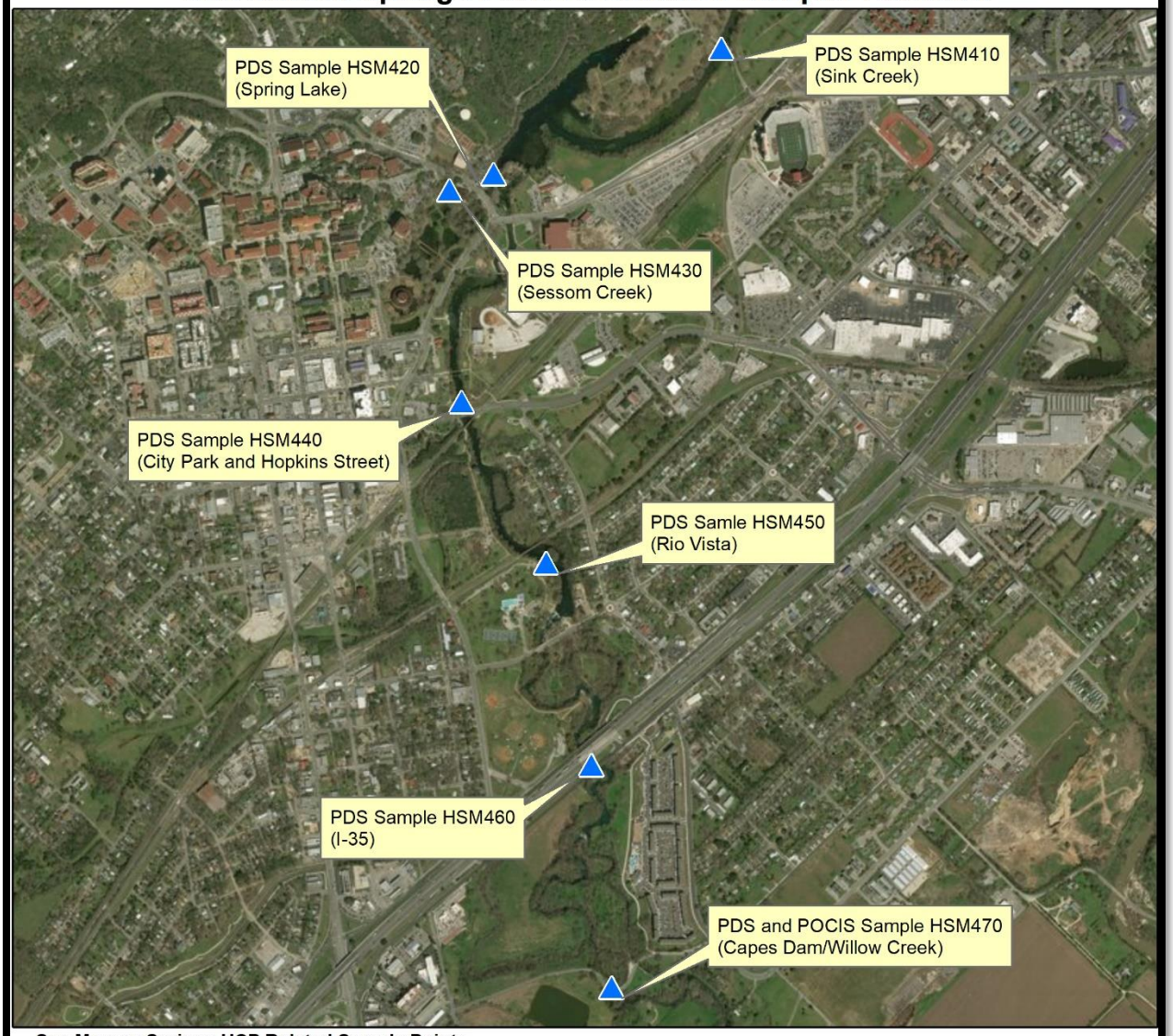
Miles 0 0.1 0.2 0.3 0.4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Prepared by:

EDWARDS AQUIFER AUTHORITY

Figure 6
San Marcos Springs Passive Diffusion Sampler Location



San Marcos Springs HCP Related Sample Points

Passive Diffusion Sampler (PDS)
Polar Organic Chemical Integrative Sampler (POCIS)

Notes:
PDS devices are to be placed at the locations listed herein, for a two-week time period in the months of February, April, June, August, October, and December.

PDS devices will be from Amplified Geochemical Imaging, LLC, or equivalent and shall provide analyses listed in Appendix A, under Analytical Parameters for Passive Diffusion Samplers, Comal and San Marcos Springs.

One POCIS sampler will be placed at the most downstream sample site, for a four-week time period during the months of February, April, June, August, October, and December.

POCIS device will be from Environmental Sampling Technologies and analyzed by the contracted laboratory for the analyses listed in Appendix A, under Analytical Parameters for Pharmaceutical Personal Care Products, Comal and San Marcos Springs.

Expanation

▲ Passive Diffusion Sampler Location

N

Miles
0 0.1 0.2 0.3 0.4

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Prepared by:

EDWARDS AQUIFER AUTHORITY

Figure 7
San Marcos Springs Real Time Water Quality Sataion Locations

Appendix A

Analytical Parameters for Assessing Water Quality from Stormwater Comal and San Marcos Springs – Even Years

Analyses
Volatile Organic Compounds (VOCs)
Semi-volatile Organic Compounds (SVOCs)
Organochlorine Pesticides
Polychlorinated Biphenyls (PCBs)
Organophosphorous Pesticides
Herbicides
Metals (Al, Sb, As, Ba, Be, B, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, V, and Zn)
General Chemistry (GWQP) Total Alkalinity (as CaCO3), Bicarbonate Alkalinity (as CaCO3), Carbonate Alkalinity (as CaCO3); (Cl, Br, NO_3, SO_4, Fl, pH, TDS, TSS, Ca, Mg, Na, K, Si, Sr, CO_3,)), and Total Suspended
Phosphorus (total)
Total Organic Carbon (TOC),
Dissolved Organic Carbon (DOC)
Kjeldahl Nitrogen
Bacteria Testing (*E coli*)
Caffeine

Method	**Method Description**	**Protocol**
8260B	Volatile Organic Compounds	(GC/MS) SW846
8270C	Semivolatile Organic Compounds	(GC/MS) SW846
8081B	Organochlorine Pesticides	(GC) SW846
8082A	Polychlorinated Biphenyls (PCBs)	by Gas Chromatography SW846
8141A	Organophosphorous Pesticides	(GC) SW846
8151A	Herbicides	(GC) SW846
6010B	Metals	(ICP) SW846
6020	Metals	(ICP/MS) SW846
7470A	Mercury	(CVAA) SW846
300.0	Anions,	Ion Chromatography
340.2	Fluoride	MCAWW
365.4	Phosphorus,	Total EPA
9040C	pH	SW846
9060	Organic Carbon,	Total (TOC) SW846
SM 2320B	Alkalinity	SM
SM 2540C	Solids,	Total Dissolved (TDS) SM
SM 2540D	Solids, Total Suspended (TSS)	SM
351.2	Nitrogen, Total Kjeldahl	MCAWW
1694	Caffeine	

Protocol References:
EPA = US Environmental Protection Agency
MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.
SM = "Standard Methods For The Examination Of Water And Wastewater",
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Analytical Parameters for Assessing Water Quality from Stormwater Comal Springs – Odd Years

Analyses
Atrazine
Azoxystrobin
Bifenthrin
Chlorothanlonil
Diclofop-methyl
Indoxacarb
Iprodione
Oxadiazon
Analyses

Prodiamine
Thiophanate-methyl
Mancozeb
Foramsulfuron
Trifloxysulfuron

Method	Method Description	Protocol
EPA 8270D	Atrazine	(GC/MS/MS) SW846
EPA 8321B	Azoxystrobin	(LC – MS/MS) SW846
EPA 8081B	Bifenthrin	(GC-ECD) SW846
EPA 8081B	Chlorothanlonil	(GC-ECD) SW846
EPA 8270D	Diclofop-methyl	(GC/MS/MS) SW846
EPA 8321B	Indoxacarb	(LC – MS/MS) SW846
EPA 8081B	Iprodione	(GC-ECD) SW846
EPA 8081B	Oxadiazon	(GC-ECD) SW846
EPA 8081B	Prodiamine	(GC-ECD) SW846
EPA 8321B	Thiophanate-methyl	(LC – MS/MS) SW846
EPA 630.1	Mancozeb	(GC)
DuPont Method	Foramsulfuron	LC-MS
DuPont Method	Trifloxysulfuron	LC-MS

Protocol References:
EPA = US Environmental Protection Agency
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Number of required QA/QC Samples for Stormwater Sampling, and Sediment Sampling

QA/QC Samples (Duplicates/EQ Blanks)	Equip. Blanks	Duplicates	Total
Comal Surface Water=	2	2	4
San Marcos Surface Water=	2	2	4
Comal Storm Water=	2	4	6
San Marcos Storm Water=	2	6	8
Comal Sediments=	1	1	2
San Marcos Sediments=	1	1	2
Total Costs QA/QC Samples	**10**	**16**	**26**

Analytical Parameters for Passive Diffusion Samplers, Comal and San Marcos Springs

PDS devices are to be placed at the locations listed Figures 2 and 6, for a two-week time period in the months of February, April, June, August, October, and December.
PDS devices will be from Amplifed Geochemical Imagaing, LLC, or equivalent and shall provide analyses for the following: TPH, BTEX, 1,3,5 and 1,2,4-trimethylbenzene, MTBE, phenanthrene, naphthalene1-methyl naphthalene, octane, cis and trans-1,2,-dichloroethene, 1,1-dichloroethane, chloroform, 1,1,1-trichloroethane, 1,2-dichloroethane, carbon tetrachloride, trichloroethene, tetrachloroethene, chlorobenzene, 1,4-dichlorobenzene, 1,1,2-trichloroethane, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,3-dichlorobenzene, and 1,2-dichlorobenzene.

Analytical Parameters for Pharmaceutical Personal Care Products, Comal and San Marcos Springs

PPCP diffusion samplers are to be placed at the locations listed Figures 2 and 6, for a four-week time period in the months of February, April, June, August, October, and December.
17-a-Estradiol, 17-a-Ethynylestradiol, 17-b-Estradiol, Diethylstilbestrol, Epitestosterone, Estriol, Estrone, Progesterone, Testosterone, Bisphenol A, Diclofenac, Gemfibrozil, Ibuprofen, Iopromide, Naproxen, Salicylic Acid, Triclosan, Acetaminophen, Amoxicillin, Atenolol, Atorvastatin, Azithromycin, Caffeine, Carbamazepine, Ciprofloxacin, Cotinine, DEET, Diazepam, Fluoxetine, Galaxolide (HHCB), Meprobamate, Methadone, Oxybenzone, Phenytoin (Dilantin), Praziquantel, Primidone, Quinoline, Sucralose, Sulfamethoxazole, TCEP, TCPP, TDCPP, and Trimethoprim

Appendix B

Analytical Parameters for Assessing Water Quality from Sediment Sample Locations, Comal and San Marcos Springs

Analyses
Volatile Organic Compounds (VOCs)
Semi-volatile Organic Compounds (SVOCs)
Organochlorine Pesticides
Polychlorinated Biphenyls (PCBs)
Organophosphorous Pesticides
Herbicides
Metals (Al, Sb, As, Ba, Be, B, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, V, and Zn)
General Chemistry Total Alkalinity (as CaCO3), Bicarbonate Alkalinity (as CaCO3), Carbonate Alkalinity (as
Phosphorus (total)
Total Organic Carbon (TOC),
Dissolved Organic Carbon (DOC)
Bacteria Testing (*E coli*)

Method	**Method Description**	**Protocol**
8260B	Volatile Organic Compounds	(GC/MS) SW846
8270C	Semivolatile Organic Compounds	(GC/MS) SW846
8081B	Organochlorine Pesticides	(GC) SW846
8082A	Polychlorinated Biphenyls (PCBs)	by Gas Chromatography SW846
8141A	Organophosphorous Pesticides	(GC) SW846
8151A	Herbicides	(GC) SW846
6010B	Metals	(ICP) SW846
6020	Metals	(ICP/MS) SW846
7470A	Mercury	(CVAA) SW846
300.0	Anions,	Ion Chromatography
340.2	Fluoride	MCAWW
365.4	Phosphorus,	Total EPA
9040C	pH	SW846
9060	Organic Carbon,	Total (TOC) SW846
SM 2320B	Alkalinity	SM
SM 2540C	Solids,	Total Dissolved (TDS) SM
SM 2540D	Solids, Total Suspended (TSS)	SM

Protocol References:
EPA = US Environmental Protection Agency
MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.
SM = "Standard Methods For The Examination Of Water And Wastewater",
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Appendix C

Analytical Parameters for Assessing Water Quality from Tissue Samples, Comal and San Marcos Springs

Analyses
Polychlorinated Biphenyls (PCBs)
Polycyclic Aromatic Hydrocarbons (PAHs)
Polybrominated Diphenyl Ethers (PBDEs)
Semi-volatile Organic Compounds (SVOCs)
Metals
Pharmaceutical Personal Care Products (PPCPs)

Method	**Method Description**	**Protocol**
8082A	Polychlorinated Biphenyls (PCBs)	GC SW846
8270D	Polycyclic Aromatic Hydrocarbons (PAHs)	GC MS SIM SW846
8270D	Polybrominated Diphenyl Ethers (PBDEs)	GC MS SW846
8270D	Semivolatile Organic Compounds	GC/MS SIM SW846
1631	Metals	CVAA, ICPMS, AA SW846
6010C	Metals	CVAA, ICPMS, AA SW846
6020A	Metals	CVAA, ICPMS, AA SW846
7742	Metals	CVAA, ICPMS, AA SW846
Not Available	Pharmaceutical Personal Care Products (PPCPs)	LC MS/MS

Protocol References:

SM = "Standard Methods For The Examination Of Water And Wastewater",
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Appendix D

Estimated Costs for Addition of a Real Time Water Quality Monitoring Instrument at Comal and San Marcos Springs, and Ongoing Costs for Operation and Maintenance.

Comal Springs (Five Stations)	
One new Eureka Manta+ Probe (equipped to monitor Dissolved Oxygen, Temperature, pH, Specific Conductance, and Turbidity)	$7,000
Maintenance Costs for repairs and supplies (calibration standards, batteries, etc.)	$9,500
Annual Data contract to include cellular data fees and web hosting at Netronix website	$2,900
Emergency funds	$2,500
Total =	**$21,900**

San Marcos Springs (Four Stations)	
One new Eureka Manta+ Probe (equipped to monitor Dissolved Oxygen, Temperature, pH, Specific Conductance, and Turbidity)	$7,000
Maintenance Costs for repairs and supplies (calibration standards, batteries, etc.)	$9,500
Annual Data contract to include cellular data fees and web hosting at Netronix website	$2,300
Emergency funds	$2,500
Total =	**$21,300**
Grand Total =	***$43,200***

6.3.3 Ecological Modeling

Long-term Objective
The development of a mechanistic ecological model (Ecomodel) is assigned to the Edwards Aquifer Authority (EAA) per section 6.3.3 of the Edwards Aquifer Habitat Conservation Plan (EAHCP). The purpose of the Ecomodel is to evaluate potential adverse effects to Covered Species and their critical habitat, and to the extent such effects are determined to occur, quantify their magnitude and develop alternate strategies.

Target for 2019
The EAA will train staff to operate the Ecomodel to identify and describe ecological responses. The Ecomodel operator should be able to predict specific ecological responses of the Comal and San Marcos aquatic ecosystems, and associated Covered Species, to various environmental factors in order to assist in understanding the interrelationships between various ecological factors affecting the dynamics of these ecosystems and covered species. In addition, the Ecomodel will allow consideration of potential threshold levels for the two aquatic ecosystems relative to potential environmental stressors, and quantify impacts. This information will help with management decisions and with mitigation design, implementation and monitoring while aiding with Phase II biological goals and strategies for achievement.

The Ecological Modeling Contract is scheduled to be completed and all deliverables transferred to the EAA by December 31, 2016. There are no contractor work products or expenditures scheduled for 2019.

Budget
There is no proposed budget for 2019.

6.3.4 Applied Research

Section 6.3.4 of the Edwards Aquifer Habitat Conservation Plan (EAHCP) includes Applied Research as a "valuable" component of the Phase I package and states that the "Edwards Aquifer Authority (EAA) will contract for the research activities."

Long Term Objective:
2019 represent the final year for the Applied Research program of the EAHCP. In prior years, the Applied Research program has primarily undertaken study of the Comal Springs riffle beetle, fountain darter, and submerged aquatic vegetation. Much of the information generated as part the program has gone towards creating the Ecological Model (EcoModel) which was completed in 2017.

In addition to finalizing the EcoModel, 2017 represents the first year of a long-term Refugia contract with USFWS. The contract outlines specific research tasks related to species collection methods and techniques, species husbandry, species propagation, species genetics, and species reintroduction methods. It is anticipated that all future research on these topics will take place as part of the Refugia research program and not the Applied Research program.

Target for 2019:
The Applied Research program in 2019 will consist of a continuation of the Sessom Creek sediment export project which began in 2018. In 2019, activities include collection of data on sediment/constituent loading, analysis of data and examine factors contributing to sediment exports and reporting. These three items are summarized below.

Collect data on sediment/constituent loading

We will use a 24-sample ISCO Model 6712 automatic water sampler and targeted grab samples to collect stormwater samples across multiple stormwater hydrographs from Sessom Creek – tributary to the upper San Marcos River. We will sample 12 storm events from May, 2018 to August, 2019. Additionally, we intend to collect one duplicate grab sample from each ISCO sampled storm event; collected simultaneously with an ISCO sample intake. In the event we are unable to sample 12 events, a prorated amount of the analytical bill (Exhibit C) will not be spent. The automatic water sampler will be installed at the point where Sessom Creek flows underneath the Freeman Aquatic Building (FAB) on Texas State University property.

Sample collection will be triggered by a liquid-level sensor that will be set to trigger a pre-programmed sampling routine if stage in the stream rises at least 2 inches. Sampling will occur at 3-minute intervals for the first 6 samples, 5 minute-intervals for the second 6 samples, 10-minute intervals for the third 6 samples, and 30-minute intervals for the final 6 samples, totaling 288 minutes or 4.8 hours per sampling event. Targeted 1-L grab samples will be collected by hand at documented times during the programmed sampling routine and will be used as duplicate samples during analysis.

The intake line will be anchored approximately 6-inches above the streambed to ensure that the sampler is not sampling the coarse bedload. After completion of the programmed auto sampling,

all samples will be moved to an analytical lab in FAB where they will be processed or preserved, as appropriate. Analytical procedures for each analyte are detailed below.

TSS and VSS/NVSS: Bulk 1-L samples will be well-mixed and split for TSS and NVSS analysis by vacuum filtration of up to 500 mL (depending on TSS concentration) of water onto pre-weighed and pre-ashed Pall A/E (1-µm nominal pore) glass fiber filters. Filters are then stored in aluminum foil until drying. TSS is determined by weighing the filter after drying it at 50ºC (Standard Methods 2540 D), where change in mass equals the amount of sediment in the filtered volume. NVSS is then determined by heating the filter to the organic-combustion point in a muffle furnace at 550ºC and then weighing again to calculate the mass of organic matter lost (Standard Methods 2540 E).

Nutrients: Well-mixed splits of samples will be analyzed for Total Nitrogen (TN) and Total Phosphorous (TP) concentrations. If nutrient analysis cannot be conducted within 48 hours of collection, 125 mL total nutrient samples will be preserved with 188 µL of H_2SO_4 and stored in HDPE bottles at 4ºC until analysis. Total N will be digested with alkaline potassium persulfate and subsequently acidified. TN will be quantified as nitrate through second-derivative spectroscopy (Crumpton et al. 1992).
TP is oxidized by potassium persulfate digestion and then determined using the ascorbic acid method (Standard Methods 4500-P E). Remaining sample volumes will be retained until all analyses pass internal QA/QC checks.

Laboratory controls and QA/QC: Quality Assurance and Control practices include the use of calibration standards, certified reference materials, spiked samples, pseudo-replicate and duplicate sample analysis, and blanks. Duplicate samples will be collected manually during storm events, whenever possible. However, the "flashy" nature of the system is such that many storm hydrographs may return to baseflow conditions before personnel can reach the creek for sampling. At least one pseudo-replicate sample will be analyzed for each set of 24 samples, and will consist of a second independent set of analyses. As appropriate, blanks and check standards are inserted randomly into each batch of analyses, and standards plus blanks are run at the beginning and end of each batch. Chain of custody form will be used to trace each sample from collection to final analysis.

Stream Discharge: Stream discharge volumes are required to calculate constituent exports. Pressure transducers (Measurement Specialties, TruBlue Model 585, or similar) will be used to collect real-time stage (water depth) data at one-minute increments at the downstream end of the Sessom Creek watershed, just inside a box culvert before Sessom Creek discharges into the San Marcos River. Discharge at low flows will be measured directly using either a SonTek FlowTracker Handheld-ADV or a SonTek FlowTracker2 Handheld-ADV. Discharge will also be logged using a stream radar system recently installed in Sessom Creek by the NOAA National Severe Storms Laboratory. Once calibrated across a range of hydrologic conditions, this system can provide real-time highly accurate discharge data that can serve as a back-up and/or primary data source for this project.

Rainfall: We will use MRMS radar-derived precipitation data (when available) for the watershed to derive daily/event rainfall amount and intensity. In addition, we will deploy two Hobo RG3

tipping bucket Rain Gauge Data Loggers (Onset Computers) at the downstream end and in the upper half of the watershed.

Calculate sediment/constituent loading curves

Discharge data will be combined with constituent concentration data to calculate loads entering the San Marcos River. The concentration of each constituent will be treated as an average concentration value for the time period in which is it was collected. This concentration is then multiplied by the discharge values across that interval, and then summed across the time interval to calculate total mass per sample interval. Mass per sample intervals are then summed to calculate an event load for each constituent. The US Geological Survey's Load Estimator (LOADEST) tool will be employed to evaluate and choose the best of several established regression models incorporating various functions of streamflow, decimal time, and other user-specified variables (Runkel et al., 2004).

A rating curve, comprised of a fitted relationship between flow and entrained constituent concentration, will be prepared based upon project monitoring data and additional historic data collected by the Pi's. Historic data will be incorporated with monitoring data collected during this project to improve the rating curve relating instantaneous discharge to instantaneous constituent export.

Analyze data and examine factors contributing to sediment exports

Multivariate analysis of basic environmental data is proposed to explain some of the observed variation in entrained constituent concentration among similar sized storm runoff events in Sessom Creek. Multivariate analysis incorporating meteorological data (i.e., rainfall amount, intensity, and timing) and hydrological data (i.e., time since last rainfall, runoff amount, runoff intensity) as explanatory variables and suspended sediment load as the response variable will be conducted using methods similar to those outlined by Gellis (ibid.). Principal component A-3 analysis (PCA) may be applied to determine which storm event characteristics vary most among measured storm events. Resulting PCA scores, or factors, can be used to compare individual storms measured during the study via means testing (i.e., t-test, ANOVA). Correlations and/or regressions between different contributing factors (i.e., PCA scores) may also be examined (Townend, 2002).

Monitoring:
EAHCP staff receives monthly status reports from selected contractors and will visit with selected contractors on-site to evaluate the progress and methodology compliance of Applied Research projects.

Reporting: The contractor will provide quarterly progress reports to the EAA Chief Science Officer via email describing activities of sampling/laboratory/analysis. Progress reports should include photographs. The draft report for the project is due November 1, 2019. EAA will return the draft to the TEXAS STATE by November 15, 2019. The final report is due to the EAA by December
31,2019.

Budget:
Table 7.1:
$450,000

Available budget for 2018:
$450,000

Estimated 2018 budget:
$67,416*

*Unspent money from 2018, and all preceding years (currently approximately $2.2 million), will be reserved for future research the Science Committee and Implementing Committee feel is necessary to better understand the Covered Species and how the EAHCP can best protect their habitat.

5.1.1 Refugia

Introduction

The U.S. Fish and Wildlife Service's (USFWS) San Marcos Aquatic Resources Center (SMARC) and Uvalde National Fish Hatchery (UNFH) will provide refugia, salvage, reintroduction, and monitoring services in fulfillment of the Refugia Contract (Contract # 16-822-HCP) between the Edwards Aquifer Authority (EAA) and the USFWS.

This annual work plan and associated cost estimate have been developed per the requirements of contract number 16-822-HCP for the Implementation of the Refugia Program under the EAHCP. The tasks and subtasks that follow provide the details for the services to be performed in 2019, which provide for the maintenance of a refugia population of the Covered Species (Table 1) including the salvage, propagation, and restocking of the species, if species-specific habitat triggers occur and species are extirpated, plus research conducted on the Covered Species.

Table 1: Eleven species identified in the EAHCP and listed for coverage under the ITP.

Common Name	**Scientific Name**	**ESA Status**
Fountain darter	*Etheostoma fonticola*	Endangered
Comal Springs riffle beetle	*Heterelmis comalensis*	Endangered
San Marcos gambusia	*Gambusia georgei*	Endangered*
Comal Springs dryopid beetle	*Stygoparnus comalensis*	Endangered
Peck's Cave amphipod	*Stygobromus pecki*	Endangered
Texas wild-rice	*Zizania texana*	Endangered
Texas blind salamander	*Eurycea rathbuni*	Endangered
San Marcos salamander	*Eurycea nana*	Threatened
Edwards Aquifer diving beetle	*Haideoporus texanus*	Petitioned
Comal Springs salamander	*Eurycea* sp.	Petitioned
Texas troglobitic water slater	*Lirceolus smithii*	Petitioned

*The San Marcos gambusia was last collected in the wild in 1983, and may already be extinct.

Long-term Objective

Background: Section 5.1.1 of the EAHCP requires the EAA to provide a series of refugia, with back-up populations, to preserve the capacity for these species to be re-established in the event of the loss of population due to a catastrophic event.

The concept of refugia is to house and protect adequate populations of the Covered Species and to conduct research activities to expand knowledge of their habitat requirements, biology, life histories, and effective reintroduction techniques. Actions and funding contained within this work plan will be limited to the Covered Species listed in the EAHCP and those associated species that have significant impact on the Covered Species such as predators, competitors, pathogens, parasites, food, cover, and shelter.

2019 Assumptions

As work plans are developed almost a year prior to implementation, it is possible that methods described herein may be contingent on the status of the current year's activities or authorization from the HCP process. If conditions change, this work plan may need to be amended to accommodate realized outcomes.

- Target numbers for the standing and refugia stocks to be housed at both the UNFH and SMARC are established by the USFWS-EAA Refugia Contract (Contract # 16-822-HCP).
- Species capture rates are expected to be similar to historic values.
- Mortality rates of specimens held in captivity are expected to be similar to historic values.
- Target species collection numbers from the 2018 work plan are expected to be reached.
- Construction and renovation will not be interrupted or unexpectedly delayed due to weather, equipment, procurement related delays, or other unforeseen issues.
- Staff members remain employed at the two Service facilities throughout the performance period.

Target for 2019 (Deliverables and Methods by Task):

Task 1. Refugia Operations

Standing Stocks The existing stocks at the SMARC and UNFH will be considered standing stocks under the executed contract (Contract # 16-822-HCP) and will be held in Service facilities until EAA specific Refugia and Quarantine facilities are complete and functional. USFWS staff will take all appropriate steps to collect and maintain standing/refugia stocks at their respective target captive population size in order to provide refugia for all the Covered Species. Table 2 displays the target species numbers.

Table 2. Species target refugia numbers and census.

Species	Standing Stock	Refugia Stock	Salvage Stock	Anticipated SMARC census (1/1/2019)	Anticipated SMARC census (12/31/2019)	Anticipated UNFH census (1/1/2019)	Anticipated UNFH census (12/31/2019)
Fountain Darter (Comal)	1000	1000 including specimens within the standing stock	2000	400	600	100	300
Fountain Darter (San Marcos)	1000	1000 including specimens within the standing stock	2500	600	600	500	600
Texas Wild-Rice	430	430 including specimens within the standing stock	1500	232	246	121	180
Texas Blind Salamander	500	500 including specimens within the standing stock	500	60	80	15[1]	25[1]
San Marcos Salamander	500	500 including specimens within the standing stock	500	300	325	250	325
Comal Springs Salamander	500	500 including specimens within the standing stock	500	70	95	30	85
Peck's Cave Amphipod	500	500 including specimens within the standing stock	500	250	310	100	160
Comal Springs Riffle Beetle	500	500 including specimens within the standing stock	500	175	200	100	150
Comal Springs Dryopid Beetle	500	500 including specimens within the standing stock	500	*	*	*	*
Edwards Aquifer Diving Beetle	500	500 including specimens within the standing stock	500	*	*	*	*
Texas Troglobitic Water Slater	500	500 including specimens within the standing stock	500	*	*	*	*

[1]transfer of Texas blind salamanders to UNFH is contingent upon completion of facilities construction and tank system set-up

*catch rates and hatchery survival are uncertain given the rarity of the species

Collection: In 2019, we will collect Covered Species as required to reach and maintain target standing and refugia stock numbers as shown in Table 2. Species collections will be coordinated with other ongoing HCP activities (e.g. Biological Monitoring Program) so that collections for refugia do not adversely impact other efforts. Species specific collections will be carried out through a variety of passive and active collection methods. Prior to collections, Hazard Analysis Critical Control Point (see Appendix A 2017 Work Plan) will be conducted to minimize aquatic invasive species transfer. Collection efforts will be documented and reported to EAA. Captured specimens will be divided between the SMARC and UNFH facilities in order to ensure redundancy and to expedite the obligation to establish and maintain two refugia populations at separate locations. All species will be held in respective quarantine areas until their health has been assessed. Once it is determined that specimens are free from pathogens, parasites, and invasive species they will be incorporated into the general refugia population. USFWS will share reports, including test results, produced as part of the quarantine process. Species-specific collection plans generally follow those detailed within the 2018 Work Plan; however, collection efforts vary based upon collection and knowledge gained during the previous year's collection efforts. The following sections briefly describe planned 2019 collection, maintenance, and propagation efforts for each species.

Fountain Darters:

Collection: Fountain darters will be collected primarily using dip nets and SCUBA divers in deeper locations (greater than wading depth) to obtain and maintain target numbers (N = 1,000 per river). Historically, approximately 20% of the fountain darters collected annually succumb to natural mortality. If unusual mortality events occur, they will be thoroughly investigated and summary reports will be conveyed to the EAA as part of the monthly reports. As a result, fish collections will target additional fish so that as individuals perish the remainder within the captive population should not decrease below the target number between collection events. Specimens will be collected along a longitudinal gradient. Approximately equal proportions of fish from upper and lower reaches in the Comal (upper = above Landa Lake dam; lower = below Landa Lake dam) and San Marcos (upper = Spring Lake, Middle = Spring Lake dam to Rio Vista dam, lower = below Rio Vista dam to Capes dam) rivers will be collected.

Due to the detection of largemouth bass virus in Comal fountain darters throughout the Comal River habitat, all Comal fountain darters will be maintained in quarantine facilities in consideration of other species located on the two stations.

Fountain darters will be collected primarily during the spring and fall to minimize thermal stress during capture and transport. As part of quarantine procedures, a subset of fish (N = 60) will be sent to the southwest regional Fish Health Unit or equivalent facility for pathogen (bacteria, virus, and parasite) testing prior to specimen incorporation into the general refugia population following standardized methods outlined within USFWS and AFS-FHS (2016) and AFS-FHS (2005); reports will be provided to EAA.

Maintenance: Water quality (i.e., temperature, pH, dissolved oxygen, total dissolved gasses) will be monitored and recorded weekly. Fountain darters will be fed live foods reared or purchased. Ponds will be utilized to produce zooplankton and amphipods. Ponds will be managed to maintain idealized zooplankton assemblages and densities. Amphipods will be collected from other managed ponds and raceways. Black worms will be purchased when necessary along with other food resources (i.e. blood worms, black worms, brine shrimp, etc.) if

the need arises. Food items are not routinely examined for pathogens. However, if they are suspect and tested for pathogens all diagnostic results will be conveyed to the EAA within monthly reports.

Propagation: Standing and refugia stocks for each river will be maintained to discourage reproduction unless HCP triggers occur. Fish will be maintained by their geographical locations. If reintroduction is warranted, subsets from each geographical location will be communally spawned. Subset groups will be culled to an equal number of progeny prior to release.

Texas wild rice:

Collection: Texas wild rice tillers will be collected from specific San Marcos River reaches (Fig. 1), with a break during summer months when wild rice does not fare well due to heat stress. In 2019 collections for SMARC will target stands that are not already part of the refugia population or require supplementation. Collections for UNFH will continue to build their refugia numbers and representative locations. The refugia populations will reflect the wild populations in both their respective proportion and genetic diversity that was historically documented within San Marcos River (Table 3; Wilson et al. 2016). During tiller collection, the GPS coordinates, area coverage, and depth of the stand or individual plant will be recorded so the exact location of the clone is known. For larger stands, tillers will be collected at the beginning, middle and end of the stand, or every 20% of the stand's total length for the largest stands. Tiller collection will be done by wading and SCUBA diving. Texas wild rice seeds from the river will also be collected monthly or when available and stored at both facilities. Seed stocks will be replaced every six months when seeds are available. Please note that during the 2017 Texas wild rice survey no plants were found in Section E, I, J, and K. Plants were found in sections G and H. All sections will be re-evaluated during the 2018 Texas wild rice survey.

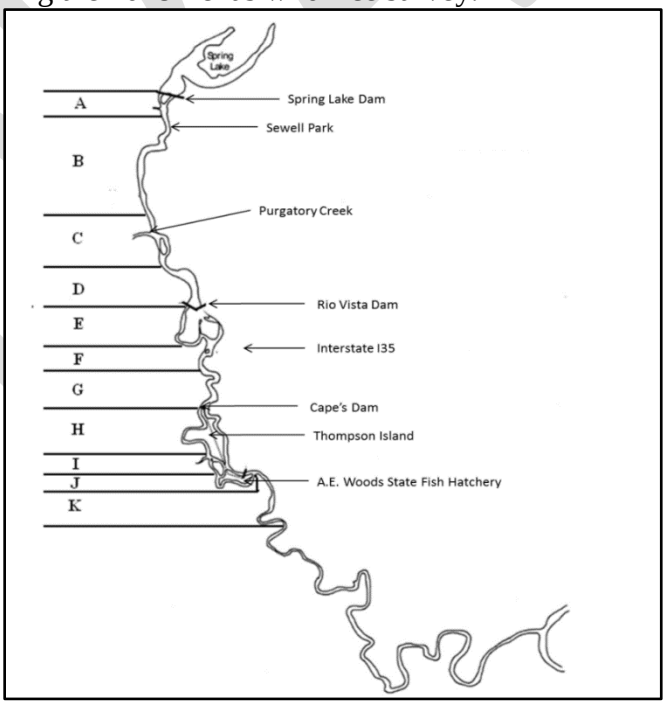


Figure 1 Letters define designated San Marcos River reaches where Texas wild rice is collected for refugia populations.

Maintenance: Once tillers have been successfully rooted they will be tagged and maintained so that their collection location is known.

Propagation: Plants will be maintained so sexual reproduction does not occur within the refugia population, unless HCP triggers occur. If reintroduction is warranted, seeds and tillers from each geographical location will be produced. Plants produced from seeds and tillers would be transplanted back within their original geographic location.

Table 3. The number of Texas wild rice plants to be collected in 2019, plus the anticipated census (accounting for mortality) at the end of 2019. Each San Marcos River reach is denoted by a letter and the proportion of specimens per reach is estimated from Wilson et al. (2016). Based on Wilson et al. (2016) no plants will be collected from sections I, L, M (, shaded rows). No plants were observed in sections E, I, J, and K (*) during 2017; these sections will be re-evaluated in 2018. Projected numbers are based on an anticipated mortality of 20% for newly acquired plants and 10% for mature refugia stock**.

River Section	Anticipated Census Jan 2019	Number of plants targeted in 2019	Anticipated 2019 EOY Census
SMARC			
A	27	5	28
B	101	15	103
C	41	5	41
D	10	5	13
E*	5	0	4
F	27	5	28
G	7	10	14
H	5	5	8
I**	-	-	-
J*	7	0	6
K*	2	0	1
L**	-	-	-
M**	-	-	-
UNFH			
A	22	10	28
B	41	25	57
C	21	20	35
D	9	5	12
E*	0	0	0
F	20	15	30
G	4	10	11
H	4	5	7
I**	-	-	-
J*	0	0	0
K*	0	0	0
L**	-	-	-
M**	-	-	-

Texas blind salamanders:

Collection: Texas blind salamanders will be collected through the use of nets and traps. Traps will be deployed quarterly for approximately 12 consecutive days with traps checked every 2-4 days to collect Texas blind salamander individuals from Primers Fissure, Johnson's well, Rattlesnake cave, and Rattlesnake well (Table 5). To avoid oversampling these habitats, only 1/3 of salamanders observed from each of these locations will be collected during quarterly sampling events. Concurrently, salamanders will also be collected from a driftnet on Diversion Springs in Spring Lake fished throughout the year. Periodically collections will be made from Spring Lake Outflow with a driftnet. Specimens from these two sites will all be kept, given the assumption that any Texas blind salamander leaving a spring orifice that enters a stream or lake environment will ultimately succumb to predation. These sites will be checked for specimens up to three times per week when applicable. All specimens will be transported live and maintained in the SMARC or UNFH refugia. When not being checked by Texas State staff, nets on Sessom Creek and Texas State Artesian Well will be check by us; when these nets are being checked by Texas State staff, live Texas blind salamanders are transferred to SMARC according to their permits.

Maintenance: Specimens will be marked by collection location. As part of quarantine procedures, all salamanders of each species will be non-lethally cotton swabbed. These samples will be sent to the southwest regional Fish Health Unit to screen for *Batrachochytrium dendrobatidis* (Bd, commonly referred to as chytrid fungus) and *Batrachochytrium salamandrivorans* (Bsal) prior to specimen incorporation into the general refugia population. Chytrid testing will occur in batches where groups of five swabs will be pooled for analysis. Duplicate individual swabs will be retained in case further testing is warranted. All salamanders will be held in quarantine for at least 30 days and until test results have returned. Chytrid (Bd) fungus has caused mortalities in amphibian species; however, some species appear to have innate immunity. Previous tests of wild caught salamanders at SMARC (both Texas Blind and San Marcos) have almost always tested positive for Bd. Clinically, the salamanders appear normal and do not have any lesions or signs of disease. Positive testing for Bsal will be treated more cautiously as it has not yet been documented in this area (or anywhere in North America); these salamanders would remain in quarantine until further study and recommendations from FWS Fish Health. Salamander tank and system maintenance such as acid washing and system sterilization will occur annually or as needed to ensure proper system function. Water quality will be monitored and recorded weekly. Salamanders will be fed live foods reared or purchased. Ponds will be utilized to produce amphipods. Amphipods will be collected from other managed ponds and raceways. Black worms will be purchased when necessary along with other food resources (i.e. blood worms, brine shrimp, etc.) if the need arises.

Propagation: Standing and refugia stocks will be maintained to encourage reproduction. Salamanders will be marked with visible elastomers, coded by their geographical locations. All progeny will be maintained separately by generations. If reintroduction is warranted, an attempt will be made to produce offspring from each geographical location.

San Marcos salamanders:

Collection: San Marcos salamanders will be collected up to quarterly from below Spring Lake dam and with SCUBA teams in Spring Lake (Table 5). The drift net on Diversion Springs will be checked routinely and specimens will be kept from this location. Collection efforts will be coordinated with the HCP Biological Monitoring Program. All specimens will be transported live and maintained in the SMARC and UNFH refugia. Historically, approximately 30% of the San Marcos salamanders collected annually succumb to natural mortality. As a result, salamander collections will target additional specimens so that as individuals perish the remainder within the captive population should not decrease below the target number between collection events.

Maintenance: As part of quarantine procedures, all salamanders of each species will be non-lethally cotton swabbed. These samples will be sent to the southwest regional Fish Health Unit to screen for *Batrachochytrium dendrobatidis* (Bd, commonly referred to as chytrid fungus) and *Batrachochytrium salamandrivorans* (Bsal) prior to specimen incorporation into the general refugia population. Chytrid testing will occur in batches where groups of five swabs will be pooled for analysis. Duplicate individual swabs will be retained in case further testing is warranted. All salamanders will be held in quarantine for at least 30 days and until test results have returned. Chytrid (Bd) fungus has caused mortalities in amphibian species; however, some species appear to have innate immunity. Previous tests of wild caught salamanders at SMARC (both Texas Blind and San Marcos) have almost always tested positive for Bd. Clinically, the salamanders appear normal and do not have any lesions or signs of disease. Positive testing for Bsal will be treated more cautiously as it has not yet been documented in this area (or anywhere in North America); these salamanders would remain in quarantine until further study and recommendations from FWS Fish Health. Salamander tank and system maintenance such as acid washing and system sterilization will occur annually or as needed to ensure proper system function. Water quality will be monitored and recorded weekly. Salamanders will be fed live foods reared or purchased. Ponds will be utilized to produce amphipods. Amphipods will be collected from other managed ponds and raceways. Black worms will be purchased when necessary along with other food resources (i.e. blood worms, brine shrimp, etc.) if the need arises.

Propagation: Standing and refugia stocks will be maintained to discourage reproduction, unless specific needs arise for F1 generations. All progeny will be maintained separately by generation. If reintroduction is warranted, pair-wise and group mating will be employed to produce offspring. Stocking will occur once juveniles have reached 30 mm total length.

***Comal Springs salamanders*:**

Collection: Comal Springs salamanders will be collected up to quarterly from Comal Spring Runs 1-3 and Spring Island and surrounding areas (Table 5) by hand with dipnets using snorkelers. Close coordination with the HCP biological monitoring program will take place to ensure that to the degree practicable, refugia collections do not overlap with specific HCP long-term monitoring locales. In the event overlap of sampling areas is unavoidable, Comal salamanders for refugia will be collected at a rate of no more than 10% of salamanders observed in those specific locales per daily sampling trip. A SCUBA team will be used for a portion of

these collection efforts if necessary. Annual natural mortality will be recorded.

Maintenance: As part of quarantine procedures, all salamanders of each species will be non-lethally cotton swabbed. These samples will be sent to the southwest regional Fish Health Unit to screen for *Batrachochytrium dendrobatidis* (Bd, commonly referred to as chytrid fungus) and *Batrachochytrium salamandrivorans* (Bsal) prior to specimen incorporation into the general refugia population. Chytrid testing will occur in batches where groups of five swabs will be pooled for analysis. Duplicate individual swabs will be retained in case further testing is warranted. All salamanders will be held in quarantine for at least 30 days and until test results have returned. Chytrid (Bd) fungus has caused mortalities in amphibian species; however, some species appear to have innate immunity. Previous tests of wild caught salamanders at SMARC (both Texas Blind and San Marcos) have almost always tested positive for Bd. Clinically, the salamanders appear normal and do not have any lesions or signs of disease. Positive testing for Bsal will be treated more cautiously as it has not yet been documented in this area (or anywhere in North America); these salamanders would remain in quarantine until further study and recommendations from FWS Fish Health. Salamander tank and system maintenance such as acid washing and system sterilization will occur annually or as needed to ensure proper system function. Water quality will be monitored and recorded weekly. Salamanders will be fed live foods reared or purchased. Ponds will be utilized to produce amphipods. Amphipods will be collected from other managed ponds and raceways. Black worms will be purchased when necessary along with other food resources (i.e. blood worms, brine shrimp, etc.) if the need arises.

Propagation: Standing and refugia stocks will be maintained in gender-mixed set groups to allow for reproduction. All progeny will be maintained separately by generation. If reintroduction is warranted, pair-wise and group mating will be employed to produce offspring. Stocking will occur once juveniles have reached 30 mm total length.

Comal Springs riffle beetle:

Collection: Comal Spring riffle beetle collection in Spring Runs 1-3 and around Spring Island will be up to six targeted events in 2019 (Table 5). No collections will occur during months when HCP monitoring is scheduled. Riffle beetles will be collected with cotton lures. Cotton lures will be deployed in a variety of locations (Spring Runs 1, 2, 3, N = 5-15 lures per spring run; western shore of Landa Lake, N = 5 lures; Spring Island and associated Spring Lake habitats N = 15-20 lures) following EAHCP standard operating procedures (Hall 2016). Coordination with the HCP biological monitoring program will take place to ensure that to the degree practicable, refugia collections do not overlap with specific HCP long-term monitoring locales. In the event overlap of specific routine sampling locations is unavoidable, Comal Springs riffle beetles for refugia will be collected at a rate of no more than 25% of beetles observed per lure in those specific locales per daily sampling trip. In order to reduce impacts on wild populations of Comal Spring riffle beetles we have reduced collection efforts, thus the build up to target standing stock populations will be slower.

Maintenance: Specimens will not be maintained by collection location. Comal Springs riffle beetles will be maintained within custom built aquatic holding units and fed detrital matter and matured biofilms colonized on cotton lures.

Propagation: Propagation methods for this species are being developed.

Peck's Cave amphipod:

Collection: Peck's Cave amphipod collection will occur up to five times annually (Table 5). Adult Peck's cave amphipods will be collected with drift nets and by hand collection at variety of locations (drift nets: Spring Run 3, N = 2; Spring Island and associated Spring Lake habitats: hand collection). Historically, approximately 50% of the Peck's Cave amphipod collected annually succumb to natural mortality. Collections will continue build up to target Standing stock numbers.

Maintenance: Specimens will not be maintained by collection location. Peck's Cave amphipods will be maintained within custom built aquatic holding units and fed commercial flake fish feeds.

Propagation: Propagation methods for this species are being developed as part of standard refugia operations.

Comal Springs dryopid beetle:

Collection: Comal Springs dryopid beetles will be collected through the use of cotton lures concurrently with Comal Spring riffle beetle lure collections (Table 5). In addition to cotton lures, wooden dowel rods will concurrently be tested as a lure technique for dryopid beetles. Comal Springs dryopid beetles will also be collected from wooden debris found around Spring Island. We will also continue testing conditioned wood lures deployed over spring up-wellings to collect dryopid beetles. Bottle traps and experimental nets will also be deployed into Panther Canyon Well during April and September. These will be checked weekly for a month. We have ceased collection efforts of lures in Sessom Creek as these were not productive during 2017; a new design for Sessom Creek might be revisited at a later date.

Maintenance: Specimens will not be maintained by collection location. Comal Spring dryopid beetle will be maintained within custom built aquatic holding units and fed detrital matter and matured biofilms colonized on cotton lures.

Propagation: Propagation methods for this species are being developed as part of normal refugia operations and research projects.

Edwards Aquifer diving beetle:

Collection: Drift nets will be used to collect Edwards Aquifer diving beetle (Table 5). Drift nets will be set at a variety of locations where the species has been collected in the past (Sessom Creek N = 1; Texas State University Artesian Well N = 1; and Diversion Springs N = 1). Drift nets will be deployed and checked weekly over the course of the year.

Maintenance: Specimens will not be maintained by collection location. Captured specimens will be transferred to the SMARC and housed in custom made aquatic holding systems. Edwards Aquifer diving beetles are predators; they will be fed small invertebrates (e.g.,

ostracods).

Propagation: Propagation methods for this species are to be determined and will be conducted as part of normal refugia operations.

Texas troglobitic water slater:

Collection: Drift nets will be used to collect the Texas troglobitic water slater (Table 5). We intend to set drift nets (Sessom Creek; N = 1, Texas State University Artesian Well N = 1; and Diversion Springs N = 1 to 2) weekly, or as necessary. Drift nets will be checked weekly over the course of the year. We will also employ new lure designs developed for well and cave environments. The lures will be allowed to mature a biofilm for four to six weeks. The success or failure of these trials will be recorded and assessed.

Maintenance: Captured specimens will be transferred to the SMARC and housed in custom made aquatic holding systems. Initially the species will be fed detrital matter and matured biofilms colonized on cotton lures.

Propagation: Propagation methods for this species are to be determined and will be conducted as part of normal refugia operations.

Table 5. A tentative schedule for all species sampling during 2019. Collections listed here are subject to change with extenuating circumstances such as weather, coordination with external partners, and completion of construction projects. EEA and partners will be notified of sampling dates as they become known or changed. Texas wild rice seed collections are not included in this table, given the unpredictable nature of sexual reproduction.

Edward's Aquifer Species Collection Plan 2019			
Date (month)	**Interval**	**Location**	**Target Species**
Continuous	Check nets T and F every week	Diversion Springs	Texas Blind salamander, San Marcos salamander, Edward's Aquifer diving beetle, and troglobitic water slater
January	Check every T & F for 2 consecutive weeks	Rattlesnake Cave & Rattlesnake Well	Texas blind salamander
January	Beginning of month, check and reset lures	Spring Runs	Comal Springs riffle beetle, Comal Springs dryopid beetle
February	Check every T & F for 2 consecutive weeks	Primer's Fissure & Johnson's Well	Texas blind salamander
February	Beginning of month, check and reset lures	Spring Runs, Landa Lake	Comal Springs riffle beetle, Comal Spring dryopid beetle
February	1-day sampling event, hand pick	Landa Lake	Peck's Cave amphipod
February	1-day sampling event	San Marcos River	Texas wild rice
March	1-2 day sampling event	Spring Lake and below dam	San Marcos salamander
March	Beginning of month, retrieve lures	Spring Runs, Landa Lake	Comal Springs riffle beetle, Comal Springs dryopid beetle
March	1-day sampling event	San Marcos River	Texas wild rice

Edward's Aquifer Species Collection Plan 2019			
Date (month)	**Interval**	**Location**	**Target Species**
March	1-day sampling event, hand pick	Landa Lake	Peck's Cave amphipod
April	Check every T & F for 2 consecutive weeks	Rattlesnake Cave & Rattlesnake Well	Texas blind salamander
April	1-day sampling event	San Marcos River	Texas wild rice
April	Throughout month	Panther Canyon	Comal Springs dryopid beetle
April/May	Reset lures after biomonitoring	Spring rungs, Landa Lake	Comal Springs riffle beetle, Comal Springs dryopid beetle
May	Check every T & F for 2 consecutive weeks	Primer's Fissure & Johnson's Well	Texas blind salamander
May	1-2 day sampling event	Comal Springs	Comal Springs salamander
May	1-day sampling event	San Marcos River	Texas wild rice
May	1-day sampling event, hand pick	Landa Lake	Peck's Cave amphipod
May	Check lures (4 weeks after set) and reset	Spring Runs, Landa Lake	Comal Springs riffle beetle, Comal Springs dryopid beetle
June	4-day sampling event	San Marcos River and Comal River	Fountain darters
June	Check and retrieve lures	Spring runs, Landa Lake	Comal Springs riffle beetle, Comal Springs dryopid beetle

Edward's Aquifer Species Collection Plan 2019			
Date (month)	**Interval**	**Location**	**Target Species**
July	Check every T & F for 2 consecutive weeks	Rattlesnake Cave & Rattlesnake Well	Texas blind salamander
August	Check every T & F for 2 consecutive weeks	Primer's Fissure & Johnson's Well	Texas blind salamander
August	Beginning of month set lures	Spring Runs, Landa Lake	Comal Springs riffle beetle, Comal Springs dryopid beetle
August	1-day sampling event, hand pick	Landa Lake	Peck's Cave amphipod
September	1-2 day sampling event	Spring Lake and below dam	San Marcos salamander
September	Beginning of month, check and remove lures	Spring Runs, Landa Lake	Comal Springs riffle beetle, Comal Springs dryopid beetle
September	Throughout month	Panther Canyon	Comal Springs dryopid beetle
October	Check every T & F for 2 consecutive weeks	Rattlesnake Cave & Rattlesnake Well	Texas blind salamander
October	4-day sampling event	San Marcos River and Comal River	Fountain darters
October	1-day sampling event	San Marcos River	Texas wild rice
November	Check every T & F for 2 consecutive weeks	Primer's Fissure & Johnson's Well	Texas blind salamander
November	Beginning of month set lures, if needed	Spring Runs, Landa Lake	Comal Springs riffle beetle, Comal Springs dryopid beetle

Edward's Aquifer Species Collection Plan 2019			
Date (month)	**Interval**	**Location**	**Target Species**
November	1-day sampling event, hand pick	Landa Lake	Peck's Cave amphipod
November	1-day sampling event	San Marcos River	Texas wild rice
November	1-2 day sampling event	Comal Springs	Comal Springs salamander
December	Beginning of month, check and reset lures, if needed	Spring Runs, Landa Lake	Comal Springs riffle beetle, Comal Springs dryopid beetle
December	1-day sampling event	San Marcos River	Texas wild rice

Refugium Stocks:

Collection: Standing Stock numbers contribute to Refugium Stock numbers and collections will continue until Standing stock numbers are attained. In the event that Refugium Stock triggers, outlined in the contract, are reached and Standing Stock are not at full capacity, special targeted collections will be conducted to build up numbers.

Maintenance: Maintenance will be conducted in a similar manner described for standing stocks.

Propagation: Texas blind salamander, Comal Springs riffle beetle, Comal Springs dryopid beetle, Edwards Aquifer diving beetle, and Texas troglobitic water slater may be propagated to further advance culture techniques. Propagation for stocking is not anticipated during 2019.

Salvage Stocks:

Collection: If species-specific salvage triggers defined in the HCP are reached, the SMARC, in consultation with the EAA, will accommodate salvaged organisms no more than two times during the 12-year period. If triggers for multiple species are simultaneously reached, species collections during salvage operations will be prioritized based upon the perceived species-specific effect of reduced river and spring flow and habitat degradation (i.e. EAHCP triggers). Those species that are river obligate species (i.e., fountain darter and Texas wild rice) or that occupy spring orifice and interstitial ground water habitats (i.e., San Marcos and Comal Springs salamander, Peck's Cave amphipod, Comal Springs dryopid beetle) are presumed to be affected first as flows decrease. Those that reside solely within the aquifer (i.e., Edwards Aquifer diving beetle, Texas troglobitic water slater and Texas blind salamander) are presumed to be affected subsequently.

Maintenance: Organisms collected during salvage operations would be maintained at the SMARC for a limited duration (up to one-year) or until their disposition is determined. Research may be suspended or terminated if space is required for salvaged organisms. Research may also be suspended if personnel are directed to collection and maintain salvage stocks.

Propagation: Likewise, production of species would be limited to no more than two times during the 12 year period once species extirpation is determined. Species produced at the SMARC would be held for a limited time (up to one year) or less if stocking is required. Research activities may be suspended or terminated if space is required to house cultured species. Research may also be suspended if personnel are directed to reproduce, maintain, or stock salvage stocks or standing stock progeny.

Construction/Renovation/Infrastructure/Facility:

The renovations at UNFH are anticipated to be completed by December 2018. Construction delays, however, are unpredictable. UNFH staff will install tanks upon the construction completion. After systems are set up, covered species will be moved into the renovated spaces.

After construction is complete (at both sites) the SMARC Center Director will develop and maintain a list of warranty problems during the 1-year warranty period, forwarding items, as they occur, to the Contracting Officer (CO) and the USFWS Project Manager (COR).

As detailed within the EAA contract with the USFWS (Contract No. 16-822-HCP) all invoices from the USFWS to the EAA for the construction services shall be billed on the last business day of the month, sent monthly, and shall provide an itemization of the expenses incurred including all supporting documentation.

All reasonable and practical security measures will be instituted by SMARC and UNFH staff to safeguard EAA refugia facilities, equipment, and species.

Staffing/Labor/Personnel:

The Supervisory Fish Biologists (SFBs) at both the SMARC and UNFH will continue in their duties including, but not limited to: supervising, mentoring, and training lower-graded employees, authorize purchases, oversee facility maintenance and repair, develop and implement budgets, and organize activities that relate to all contract activities. The SFBs will manage and coordinate research, propagation, culture, and field activities related to the refugia. The SFBs are expected to provide proper and efficient use of facilities and staff resources. The SFBs will work with the Center Director to ensure that contractual obligations are met in a timely manner. In coordination with the Center Director, they will prepare all the required written materials required for the reimbursable agreement reporting. Likewise, the SFBs will also prepare oral presentations to be used as briefing statements, outreach presentations, internal reports, work summaries, and technical presentations at professional meetings. The two SFBs will continue to work and communicate regularly with partners, Service personnel and other researchers to effectively meet Service and reimbursable agreement goals.

Under the management of a lead supervisory biologist at both facilities, it is expected that six Biological Science Technicians, three at each station, will continue to assist with the collection, daily upkeep, maintenance, propagation, and research efforts for the ten species at the SMARC and UNFH. This includes maintaining experimental and culture production systems, keeping records along with entering, filing, and collating data. The technicians will also generate basic summary statistics and graphic analyses of data and document program accomplishments through the composition of Standard Operating Procedures (SOPs), reports, and manuscripts.

Permitting:
Both the UNFH and SMARC operate under the USFWS Southwest Region's Federal Fish and Wildlife Permit for Native, Endangered, and Threatened Species Recovery (number TE676811-3) and the Texas Parks and Wildlife Scientific Research Permits (UNFH SPR-1015-222, SMARC SPR-0616-153).

Biosecurity:
Both the UNFH and SMARC operate under the SMARC BioSecurity Plan (2014) (Exhibit E of 16-822-HCP). Specimen Collection, Hazard Analysis Critical Control Points, Quarantine, & Specimen Transfer: San Marcos Aquatic Resources Center Standard Operating Procedure.

Task 2. Research

The Research Plan for 2019 will involve a series of activities ranging from 1) methods to determine a better understanding of factors influencing pupation rates for Comal Springs riffle beetles; 2) conducting a salamander tagging/identification study; 3) investigating methodologies to reduce the loss of salamander eggs to fungus or refining salamander propagation techniques, and 4) evaluating the effect of different nutritional options on Comal Springs riffle beetle survivorship, larvae production and survival . The following section describes the basic components of each of these proposed 2019 activities.

Project 1:

Title: Environmental influences on pupation rates of Comal Springs riffle beetles

Species: *Stygoparnus comalensis*

Principal/Co-PI: Outside contractor, input by SMARC staff

Overview: Low pupation rate is the primary factor hindering our ability to produce F1 generations of Comal Springs riffle beetles (CSRB). We propose to explore physicochemical and environmental factors that may influence CSRB pupation. Potential factors that may differ between natural habitat and a captive refugiu include temperature, dissolved oxygen, presence of conspecifics, flow rate, light, diet, and habitat complexity. We propose to offer this research, under a request for proposals, to be performed on station by an outside contractor.

Budget: $105,000

Benefit to the Refugia: A better understanding of factors influencing pupation will allow for increased offspring production in captivity, better estimation of production in captivity, more efficient husbandry practices, and better knowledge to create a

reintroduction strategy for this species.

Expected Results: A report on the successes and failures of methodology tested to increase pupation rates.

Project 2:

Title: Long-term marking success of salamander species

Species: *Eurycea nana, Eurycea rathbuni, Eurycea sp.*

Principal: Dr. Lindsay Campbell, Linda Moon, Rachel Wirick

Overview: The objective of the proposed study is to determine the efficacy of various tagging methodologies to best visually mark covered salamanders species for quick identification of captively held salamanders.

Objectives and Methods:

Salamanders will be tagged with several different methods to evaluate the utility of the method as a way to quickly visually identify salamanders. Techniques to be tested include Visible Implant Elastomer tags, Visual Implant Alpha tags, and small passive integrated transponders. Tags and injection sites will be monitored overtime for health, retention, and clarity/readability. The ability to individually mark salamanders would increase specificity of record keeping and allow us to follow information of an individual over its lifetime. Also, for genetic management purposes being able to identify individuals thus knowing the parentage of offsprings is key in many plans. Additionally with the ability to uniquely mark each individual would allow consolidation of specimens, increasing the probability of mating success while simultaneously affording efficiencies in refugia operations by reducing the number of systems needed to maintain the required number of captive salamanders.

Expected Results: The results of the study will be presented as a report to the EAA and potentially submitted as a technical report. If a marking technique(s) is/are successful the Culture Propagation Manual for this species will be updated to include how marking can be effectively used in husbandry practices.

Project 3:

Title: Increasing salamander egg survivorship within a captive setting

Species: *Eurycea nana, Eurycea rathbuni, Eurycea sp.*

Principal: Dr. Lindsay Campbell, Kelsey Anderson, Rachel Wirick

Overview: Examine approved chemical treatments (developed for fish species) to determine the appropriate dose rate required to reduce fungal infections within salamander eggs. While these methods have been tested and approved for fish species little work and standardization has been produced for salamander species. Salamander eggs, like many fish species eggs, can become infected with fungus after they are laid significantly reducing the hatch rate success of a clutch. An effective treatment to reduce loss to fungal infections will increase offspring output thus reducing the time and resources needed to produce organisms in the event they need to be restocked into the

wild.

**Note: This study is contingent on the success of the 2018 salamander reproduction trials. If the proposed methodology in the 2018 experiment fails to produce reliable egg production, this project will be replaced with further refinement of salamander reproduction techniques.

Objectives and Methods:

Eggs will be treated with different dose rates of hydrogen peroxide, sodium chloride, methylene blue, and Ovadine® (an iodophor), the rate of fungal infection will be compared to control eggs not treated. We will also evaluate if the treatments cause other deleterious effects to the eggs such as reduced viability or deformation of larvae.

Expected Information gathered:

1. Effectiveness of fungal infection reduction
2. Correct dose level
3. Egg survivability rate at different treatments and levels

Expected Results: The results of the study will be presented as a report to the EAA and potentially submitted as a journal article. If a method is found to be successful in increasing the survivability of eggs the Culture Propagation Manual for this species will be updated.

Project 4:
Title: Comal Springs riffle beetle nutrition supplementation

Species: *Heterelmis comalensis*

Principal: Dr. Lindsay Campbell, Amelia Everett, Randy Gibson, Makayla Blake

Overview: Evaluate previous studies on Comal Springs riffle beetle (CSRB) gut content analysis to determine if there is potentially a nutritional deficiency in food items offered to captive populations. We will supplemental diet items to CSRB holding containers and then measure levels of survivability and larvae production. Additionally, we will test if supplemental diet items increase survival rates of larvae.

Objectives and Methods:

We will test if adding supplemental diet items such as woody debris, plant roots, or even artificial feed increases survival rates and larval production rates of CSRB. Potentially current food materials will be sent for analysis to ascertain if key nutritional factors are missing compared to diet of wild CSRB. We will also explore the viability of culturing biofilm from direct spring sources, if doing so can be accomplished without introducing non-targeted species to refugia. In addition hatchery produced biofilm versus wild produced biofilm would be compared to assess if CSRB prefer one over the other and have equivalent survivorship. If possible we would like to test if biofilm composition changes when cultured on station and/or in different water types. The benefits to the refugia would be improved CSRB husbandry and production rates.

Expected Results: The results of the study will be presented as a report to the EAA and if warranted update the CSRB Culture Propagation Manual.

Task 3. Species Propagation and Husbandry

Development and refinement of SOPs for animal rearing and captive propagation: Continue to refine SOPs for all species as needed for updates to reflect new protocols that are instituted for each species throughout the year. As new information becomes available about genetic management, further develop draft Captive Propagation Plans for all species.

Task 4. Species Reintroduction

Reintroduction Plan for term of contract:
Continue to refine the Reintroduction Strategy as new information becomes available.

Reintroduction Plan for 2019: None

Any anticipated triggers being prepared for: Given current weather predictions, spring flows, and the Edwards Aquafer water level none are anticipated during the 2019 performance period.

Task 5. Reporting

5.1 Species specific Propagation plans (SOPs): Refine throughout year as needed
5.2 Species specific Genetic Management plans: None during 2019
5.3 Species specific Reintroduction plans: Refine as needed
5.4 2019 EAHCP Annual Program reporting– A year-end report of 2019 activities will be provided to the EAA no later than 1/31/2019.
5.5 Program reporting as required by ITP and TPWD. TPWD Scientific Research Permit Report will be conveyed to the EAA July 31, 2019.
5.6 Descriptions and photographs of procedures from collections to restocking – Photographs and documentation of collection and restocking will be included in the monthly report to the EAA CSO along with the year-end report.
5.7 Summaries of any data analyses, research, or genetic analyses – Research projects and results of collection efforts will be provided to the EAA in the monthly reports, year-end documentation, and stand-alone documents (agreed upon by Center director and HCP CSO).
5.8 Description of terms and conditions of any permits received – As permits are received, their contents will be conveyed to the EAA.
5.9 Monthly electronic reports to HCP CSO: A monthly report of all activities will be provided to the HCP CSO. We anticipate providing the report by the 10th of each month for the previous month's activities.

Task 6. Meetings and Presentations

Planning or coordination meetings:

    - Yearly planning meeting with SMARC and UNFH staff
- Public meetings
    - EAA Board
        - End of year report
        - Present research results
    - Implementing Committee
        - End of year summary
    - Stakeholder Committee
        - End of year summary
    - Science Committee
        - Methods for research projects
        - Present research results

Monitoring:
Monitoring will be conducted through the use of progress reports and site visits to the refugia as well as through collaborative management by the EAHCP CSO.

Budget: Projected 2019 budget.

U.S. Fish and Wildlife Service 2018				
Task		**Task Budget Amount**		**Total Task Budget Amount**
1	**Refugia Operations**			**$ 616,456.85**
	SMARC Refugia & Quarantine Bldgs.			
	*Construction	$	-	
	Equipment & Building Maintenance	$	10,000.00	
	Utilities	$	80,000.00	
	UNFH Renovation Refugia & Quarantine Bldgs.			
	*Construction	$	-	
	Equipment & Building Maintenance	$	10,000.00	
	Utilities	$	75,000.00	
	SMARC Species Husbandry and Collection			
	Fish Biologist (GS-12, 494 hrs)	$	25,907.72	
	Fish Biologist (GS-07, 862 hrs)	$	25,454.86	
	Fish Biologist (GS-07, 842 hrs)	$	24,864.26	
	Fish Biologist (GS-07, 862 hrs)	$	25,454.86	
	Diving	$	7,500.00	
	Weekend Walk Thru	$	7,500.00	
	Other Overtime	$	2,000.00	
	UNFH Species Husbandry and Collection			
	Fish Biologist (GS-11, 776 hrs)	$	33,313.68	
	Fish Biologist (GS-06/07, 902 hrs)	$	25,084.62	
	Fish Biologist (GS-07, 902 hrs)	$	26,203.10	
	Fish Biologist (GS-07, 902 hrs)	$	26,203.10	
	Weekend Walk Thru	$	5,400.00	
	Other Overtime	$	2,000.00	
	Fish Health	$	15,000.00	
	SMARC Reimbursibles	$	50,000.00	
	UNFH Reimbursibles	$	50,000.00	
	Subtotal	*$*	*526,886.20*	
	Admin Cost Subtotal	*$*	*89,570.65*	
2	**Research**			**$ 445,899.87**
	Subcontractor: Increasing CSRB pupation rate	$	105,000.00	
	USFWS Salamander Tagging	$	50,000.00	
	USFWS Salamander Egg Treatment/Reproduction	$	50,000.00	
	USFWS Comal Springs Riffle Beetle Nutrition and Holding	$	176,111.00	

	Fish Biologist (GS-12, 1040 hrs)	*$ 54,546.91*			
	Fish Biologist (GS-07, 1040 hrs)	*$ 30,711.20*			
	Fish Biologist (GS-07, 1060 hrs)	*$ 31,301.80*			
	Fish Biologist (GS-07, 1040 hrs)	*$ 30,711.20*			
	Fish Biologist (GS-11, 1000 hrs)	*$ 42,930.00*			
	Fish Biologist (GS-06/07, 1000 hrs)	*$ 27,810.00*			
	Fish Biologist (GS-07, 1000 hrs)	*$ 29,050.00*			
	Fish Biologist (GS-07, 1000 hrs)	*$ 29,050.00*			
	Subtotal		*$ 381,111.00*		
	Admin costs for Task 2		*$ 64,788.87*		
3	**Species Propagation and Husbandry**		*$ -*	**$**	**-**
	Subtotal		*$ -*		
4	**Species Reintroduction**		*$ -*	**$**	**-**
	Subtotal		*$ -*		
5	**Reporting**			**$**	**79,617.00**
	SMARC Staff		$ 41,069.76		
	Fish Biologist (GS-12, 422 hrs)	*$ 22,122.62*			
	Fish Biologist (GS-07, 156 hrs)	*$ 4,606.68*			
	Fish Biologist (GS-07, 156 hrs)	*$ 4,606.68*			
	Fish Biologist (GS-07, 156 hrs)	*$ 4,606.68*			
	SMARC Staff (GS-11, 110 hrs)	*$ 5,127.10*			
	UNFH Staff		$ 26,978.96		
	Fish Biologist (GS-11, 208 hrs)	*$ 11,161.80*			
	Fish Biologist (GS-06/7, 104 hrs)	*$ 4,388.36*			
	Fish Biologist (GS-07, 156 hrs)	*$ 4,531.80*			
	Fish Biologist (GS-07, 156 hrs)	*$ 4,531.80*			
	UNFH Staff (GS-07, 80 hrs)	*$ 2,415.20*			
	Subtotal		*$ 68,048.72*		
	Admin costs for Task 5		*$ 11,568.28*		
6	**Meetings and Presentations**			**$**	**14,310.00**
	SMARC staff		$ 8,451.83		
	Fish Biologist (GS-12, 124 hrs)	*$ 6,502.85*			
	Fish Biologist (GS-07, 22 hrs)	*$ 649.66*			
	Fish Biologist (GS-07, 22 hrs)	*$ 649.66*			
	Fish Biologist (GS-07, 22 hrs)	*$ 649.66*			
	UNFH Staff		$ 3,778.94		
	Fish Biologist (GS-11, 44 hrs)	*$ 1,888.92*			
	Fish Biologist (GS-06/7, 22 hrs)	*$ 611.82*			
	Fish Biologist (GS-07, 22 hrs)	*$ 639.10*			

Fish Biologist (GS-07, 22 hrs)	*$ 639.10*		
Subtotal		*$*	*12,230.77*
Admin costs for Task 6		*$*	*2,079.23*
TOTAL			**$ 1,156,283.73**

**= Remainder of 2018 construction costs detailed within the 2018 work plan will be applied to 2019. This would occur through an amendment to the 2019 work plan. Budget totals for the construction and renovation projects at UNFH and SMARC are not anticipated to increase.*

Projected (2019) Budget Summarized by Task:

Task 1: $616,456.85
Task 2: $445,899.87
Task 3: $0
Task 4: $0
Task 5: $79,617.00
Task 6: $14,310.00

Projected (2019) Subcontractor Expenses Summarized by Task

Task 1: Southwest Regional Fish Health Unit, Dexter NM $17,000 (Health Diagnostics)
Task 2: Subcontractor, $105,000
Task 3: $0
Task 4: $0
Task 5: $0
Task 6: $0

Timeline of 2019 Milestones (List major deliverables)

January	Continue with species collection
	Subcontract drafted
	2019 Specific Research Study Plans finalized
February	Subcontract executed
July	Submit and renew TPWD permit
September to December	Draft Research Reports
	Draft Annual report

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FMA § 2.2 EAHCP Program Management

Section 2.2 of the Funding and Management Agreement (FMA) assigns "general management and oversight" of the Edwards Aquifer Habitat Conservation Plan (EAHCP) to the Edwards Aquifer Authority (EAA). Section 5.6.5 of the FMA allows the EAA to use EAHCP funds for administrative costs and employee salaries, so long as all incurred costs and salaries are 100% related to "general management and oversight" of the EAHCP.

Long-term Objectives: To manage and oversee day-to-day operations and administration, in coordination with the Applicants, of the EAHCP; resulting in a valid and continued Incidental Take Permit (ITP) from the United States Fish and Wildlife Service (USFWS) for designated Covered Activities. Additionally, to prepare for, gather information to be used in, and implement the Strategic Adaptive Management decision-making process.

Program Management: In 2019, EAHCP staff will continue to coordinate and monitor the work outlined in the Biological Monitoring, Water Quality Monitoring, Applied Research, ASR, VISPO, and Regional Water Conservation Program work plans. The Chief Science Officer and Environmental Scientist will oversee the continued development and operations of the Refugia program which will also include all Refugia research activities. In 2019, the EAHCP staff will also continue to update the EAHCP biological and water quality monitoring databases.

Additionally, in 2019, EAHCP staff will continue the following activities:

Program Manager: The EAHCP Program Manager will execute duties as assigned in the FMA and:

- Serve on the ASR Advisory Committee,
- Facilitate the Adaptive Management Process for all Routine, Nonroutine and Strategic AMP decisions,
- Facilitate and coordinate all meetings of the EAHCP Implementing, Science and Stakeholder Committees and possible Subcommittees and Work Groups as created by the Implementing, Science and Stakeholder Committees.

EAHCP Staff: The EAHCP staff will continue the following activities:

- Prepare for all meetings of the EAHCP Implementing, Science, and Stakeholder Committees, (and possible Subcommittees and Work Groups as created by the Implementing, Science and Stakeholder Committees).
- Prepare materials for all Adaptive Management Process (AMP) activities,
- Procure and execute contracts,
- Oversee contract tracking and compliance,
- Process and pay all contractor's invoices,
- Oversee the City of New Braunfels and San Marcos/Texas State University work plan activities,
- Coordinate 2019 work plan amendments and the development of 2020 work plans and Funding Applications,
- Draft and submit to the USFWS amendments, informational memorandums, and clarifications to the Incidental Take Permit and EAHCP,

- Participate in public outreach initiatives,
- Publish the EAHCP Steward newsletter,
- Enhance the EAHCP.org website,
- Prepare and compile all Permittees' information for the annual report to USFWS, and
- Track and assist EAHCP Permittees with maintaining compliance with secondary implementation permits, such as: U.S. Army Corps of Engineers, Texas Parks and Wildlife Department, Texas Commission on Environmental Quality, General Land Office, and Texas Historical Commission permits.

Adaptive Management Program (AMP): EAHCP staff, under direction of the Program Manager, will manage the adaptive management decision making process as defined in the Funding and Management Agreement. Specifically, Article 7 defines the procedures for the AMP. In 2019, EAHCP staff will initiate the Strategic AMP, which will lead to Phase II activities. Also, EAHCP staff will serve as a liaison to USFWS in the AMP process.

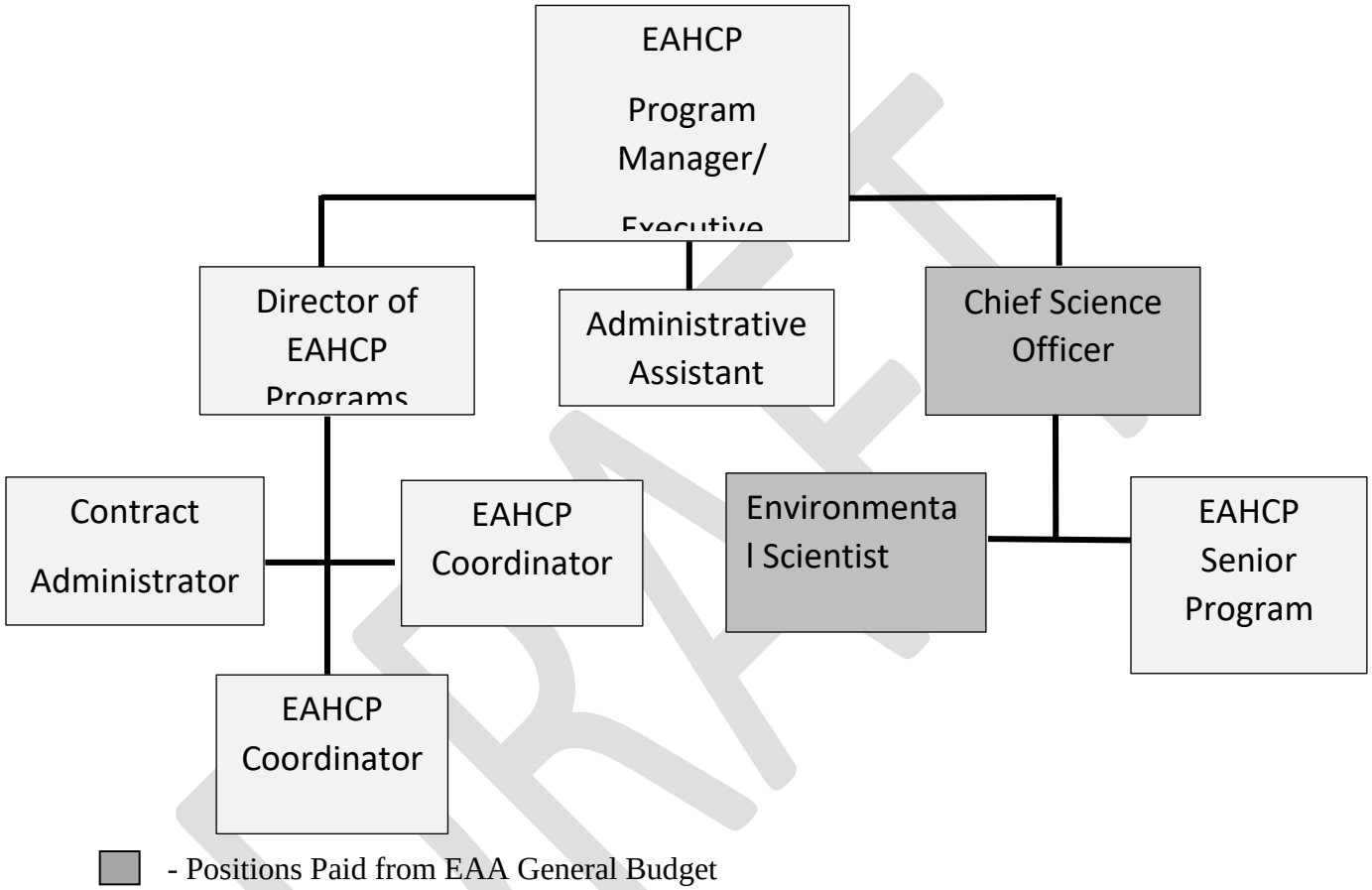
EAHCP Implementing, Science and Stakeholder Committees and Work Groups and subcommittees: EAHCP staff, under the direction of the Program Manager, will continue to manage the meetings and activities of all EAHCP Committees and any subcommittees or Work Groups. The Implementing and Science Committees will meet according to approved schedules and the Stakeholder Committee will meet quarterly.

Science Review Panel/National Academy of Sciences Report #3: In December 2018, the NAS committee produces its third and final report on its evaluation of the Phase I conservation measures and its identification of the biological and hydrological questions that the ecological and hydrologic models should be used to answer. In 2019, EAHCP staff will evaluate the recommendations from this third report.

Staffing in 2019: In summary, the EAHCP staff consists of the Program Manager, Director of EAHCP programs, Contract Administrator, Senior Program Coordinator, two EAHCP Coordinators, and the Administrative Assistant. EAA funds the Chief Science Officer and the Environmental Scientist staff positions.[2] The structure of the existing EAHCP staff positions and EAA-funded positions – **the Threatened and Endangered Species Team** - are illustrated in the chart on the next page.

[2] The Contract Administrator and Environmental Scientist positions were previously named Senior Contract Coordinator and Senior Project Coordinator, respectively.

Threatened and Endangered Species Team



Budget

The following table summarizes the estimated EAHCP Program Management budget for 2019.

Staffing and Operational Expenses	
Salaries and Fringe Benefits	$750,000
Meeting Expenses[3]	$20,000
Travel	$3,000
Office Supplies	$3,000
Professional Development	$2,500
Printing	$2,000
Professional Contracted Services (PCS)	
PCS – Other	$33,400
PCS – Historical/Archeological Consultation [4]	$2,500
PCS – Annual Report	$44,000
PCS – Permit Oversight[5]	$10,000
PCS – Science Committee Compensation	$21,600
PCS – Outreach/Newsletter[6]	$18,000
Total Expenditure	**$910,000**

[3] Meeting expenses for Implementing, Stakeholder and Science Committees as well as ad-hoc work groups. Also, includes reimbursement expenses for Science Committee members travel costs.
[4] Contract for costs to obtain Texas Historical Commission permits for conservation and mitigation measures activities.
[5] Contract for costs to obtain U.S. Army Corps of Engineers, Texas Parks and Wildlife Department, and Texas Commission on Environmental Quality permits for conservation and mitigation measures activities.
[6] Contract to produce the EAHCP bi-monthly newsletter.