Edwards Aquifer Authority
2021 Work Plan

Amendment #1. Approved TBD

2021 Cost Estimate for Edwards Aquifer Authority Work Plan

EAHCP Section	Conservation Measure	Table 7.1	Estimated 2021 Costs[a]
5.1.1	Refugia	$1,678,597	$1,177,340
5.1.2	VISPO [b]	$4,172,000[c]	$2,509,975[d]
5.1.3	RWCP	$1,973,000	$0
5.1.4	Stage V	NA	NA
5.5.1	ASR Leasing & Forbearance [b]	$4,759,000	$6,009,530
	ASR O&M	$2,194,000	$0
5.7.2	Water Quality Monitoring	$200,000	$45,000
6.3.1	Biological Monitoring	$400,000	$755,774 [e]
6.3.3	Ecological Model	$25,000	$0
6.3.4	Applied Research	$0	$250,000
FMA §2.2	Program Management	$750,000	$1,068,006
Total		**$16,151,597**	**$11,815,625**

a. Estimated annual work plan cost per Funding and Management Agreement § 4.4.

b. Expected to change as leases transition to forbearance agreements through 2020 and 2021. Estimate presented based on best available data to date.

c. Dollars in Table 7.1 of the EAHCP were calculated from a volume goal of 40,000 acre-feet (ac-ft). The volume goal was amended to 41,795 ac-ft in 2019 and Table 7.1 dollars are no longer applicable.

d. Not triggered October 1, 2020. Standby payments will be made totaling the estimated cost in the table.

e. Includes Critical Period Monitoring if required.

2021 Amendments to Edwards Aquifer Authority (EAA) Work Plan and Funding Application

Amendment #	Date EAHCP Committee Approved	Conservation Measure Amended	Y/N Funding Application Change	Funding Application Change ($)	Date EAA Board Approved	Comments
0	05/21/2020	Original Work Plan	NA	NA	NA	Original Work Plan
1	10/8/2020	Water Quality Monitoring and Program Management	N	N	NA	Removed costs for water quality equipment to be purchased by the EAA and updated Program Management with known activities and 2021 costs.
0	10/8/2020	Original Funding Application	NA	NA	11/10/2020	Original Funding Application

5.1.1 Refugia Program

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 Edwards Aquifer Habitat Conservation Plan (EAHCP). The tasks and subtasks that follow provide the details for the services to be performed in 2021, which provide for the maintenance of a refugia population of the Covered Species (Table 1), including 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, prey, competitors, pathogens, parasites; or on their habitat, including food, water, and shelter.

2021 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 2020 work plan are expected to be reached.
- Staff members remain employed at the two Service facilities throughout the performance period.

Target for 2021 (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 (Jan 2021)	Anticipated SMARC census (Dec 2021)	Anticipated UNFH census (Jan 2021)	Anticipated UNFH census (Dec 2021)
Fountain Darter (Comal)	1000	1000 including specimens within the standing stock	2000	#	#	#	#
Fountain Darter (San Marcos)	1000	1000 including specimens within the standing stock	2500	500	500	500	500
Texas Wild-Rice	430	430 including specimens within the standing stock	1500	215	215	215	215
Texas Blind Salamander	500	500 including specimens within the standing stock	500	250	250	40	60
San Marcos Salamander	500	500 including specimens within the standing stock	500	250	250	250	250
Comal Springs Salamander	500	500 including specimens within the standing stock	500	115	135	80	105
Peck's Cave Amphipod	500	500 including specimens within the standing stock	500	250	250	250	250
Comal Springs Riffle Beetle	500	500 including specimens within the standing stock	500	75	75	75	75
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	*	*	*	*

We will not be collecting Comal fountain darters until we have a better understanding of their mortality rates
*catch rates and hatchery survival are uncertain given the rarity of the species

Collection: In 2021, 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 the EAA. Captured specimens will be distributed 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. The following sections briefly describe planned 2021 collection, maintenance, and propagation efforts for each species.

Fountain Darters:

Collection: In 2021, Fountain darters from the San Marcos River will be collected primarily in coordination with the Spring and Fall Biomonitoring events to create efficiencies and reduce habitat disturbance. After fountain darters are collected via drop nets for biomonitoring, USFWS staff will retain them for refugia purposes. Specimens will be collected along a longitudinal gradient. Fish will be collected proportionally from the three sections of the San Marcos (Upper = Spring Lake, Middle = Spring Lake dam to Rio Vista dam, Lower = below Rio Vista dam to Cape's dam). 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. Collections will target additional fish so that, as individuals perish, the remainder within the captive population should not decrease below the target number.

Due to the detection of largemouth bass virus (LMBV) in Comal fountain darters throughout the Comal River, all fountain darters from Comal will be maintained in quarantine facilities in consideration of other species located on the two stations. Higher mortality rates of incoming Comal fountain darters have increasingly caused concern as the mortality continues and no root cause has been pinpointed despite extensive testing and evaluation with the USFWS Fish Health Unit. Until we have a better understanding of the high mortality rates of incoming Comal fountain darters we will conduct limited collections from the wild, unless salvage is needed.

As part of quarantine procedures, a subset of fish (n = 60 per river) 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, mixed with purchased frozen food sources. Ponds will be utilized to produce zooplankton and amphipods. 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 produce F1 generation fish for research purposes. 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 San Marcos River reaches (Figure 1), with a break during summer months when wild rice does not fare well due to heat stress. In 2021, collections for SMARC and UNFH will target stands that are not already part of the refugia population or require supplementation. The refugia populations will reflect the wild populations in both their respective proportion, based on the most recent Texas wild-rice survey data, and historical genetic diversity (Wilson et al. 2016). During tiller collection, the geographic coordinates, area coverage, and depth of the stand or individual plant will be recorded so the collection location of the clone is known. Tiller collection will be done by wading and SCUBA diving. Georeferenced aerial imagery will be captured with a small drone over the San Marcos river to help identify distinct TWR stands used for tiller collection. Knowing which TWR stands tillers were collected from is important in maintaining accurate husbandry records.

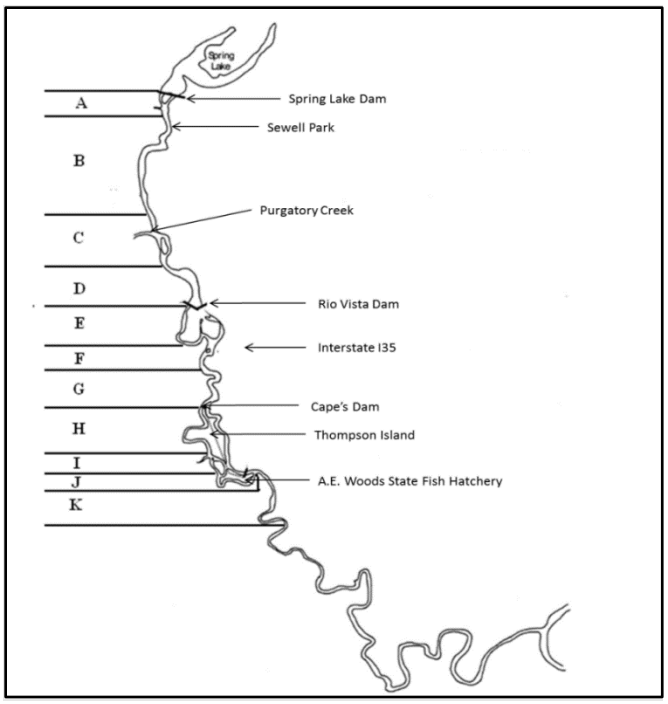


Figure 1. Letters define designated San Marcos River reaches where Texas wild-rice is collected for refugia populations.

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 EAHCP 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.

Texas blind salamanders:

Collection: Texas blind salamanders will be collected through the use of nets and traps. Traps will be deployed quarterly for approximately 14 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. Salamanders will also be collected from a driftnet on Diversion Springs in Spring Lake fished throughout the year during times when we are not actively trapping in caves and wells. Specimens from this site 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. Drift nets on Sessom Creek and Texas State University Artesian Well are generally checked by Texas State University staff, live Texas blind salamanders are transferred

to SMARC according to their permits. USFWS staff may periodically check nets on these sites when they are not being checked by Texas State University staff.

As part of quarantine procedures, all Texas blind salamanders will be non-lethally cotton swabbed, unless they are too small to be swabbed, then we will do a representative batch swab of group housed salamanders when they are large enough to be safely swabbed. These samples will be processed at SMARC 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. Duplicate swabs will be retained in case further testing is warranted. 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 regularly 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.

Maintenance: Salamanders will be individually tagged to retain information on collection location, date, and other life history events. Water quality will be monitored and recorded weekly. Salamanders will be fed live foods reared or purchased, mixed with purchased frozen food sources. Ponds will be utilized to produce amphipods.

Propagation: Standing and refugia stocks will be maintained to encourage reproduction. 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 as space in quarantine and need allows. We will avoid collections close to the HCP Biological Monitoring Program assessment events. All specimens will be transported live and maintained in the SMARC and UNFH refugia.

As part of quarantine procedures, representatives of group housed salamanders in quarantine will be non-lethally cotton swabbed. These samples will be processed at SMARC 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. Duplicate 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.

Maintenance: Salamanders will be tagged to indicate year collected and gender. Water quality will be monitored and recorded weekly. Salamanders will be fed live foods reared or purchased, mixed with purchased frozen food sources. Ponds will be utilized to produce amphipods.

Propagation: Standing and refugia stocks will be maintained to encourage 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 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 EAHCP 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.

As part of quarantine procedures, representatives of group housed salamanders in quarantine will be non-lethally cotton swabbed. These samples will be processed at SMARC 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. Duplicate 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.

Maintenance: Salamanders will be tagged to indicate year collected and gender. Water quality will be monitored and recorded weekly. Salamanders will be fed live foods reared or purchased, mixed with purchased frozen food sources. Ponds will be utilized to produce amphipods.

Propagation: Standing and refugia stocks will be maintained to encourage 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 collections for standing and refugia stocks will occur four times a year from a variety of locations: Spring Run 1, Spring Run 3, Western Shore, and areas surrounding Spring Island (Table 5). Riffle beetles will be collected with cotton lures following EAHCP standard operating procedures (Hall 2016). New protocols established by the CSRB Work Group in 2019, include: 1) the same spring orifice will not be sampled two times in a row, 2) all riffle beetle adults and larvae will be collected from the lures, and 3) standing stock numbers will be reduced to 75 per station until propagation methods are refined and better knowledge of population numbers and meaningful standing stock numbers are derived. Standing stock number will be evaluated yearly by the Comal Springs riffle beetle Work Group. Additional collections for research purposes may be required outside of standing stock collections.

Maintenance: Specimens will be maintained by collection date. 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 for standing stock will occur up to four 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).

Maintenance: Specimens will be maintained by collection date. 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 primarily through the use of wooden lures and hand picking from submerged wood found in the Comal Spring system. If dryopid beetles are found on cotton lures used for Comal Spring riffle beetles they will also be retained (Table 5). We will potentially conduct two events of trapping in Panther Canyon Well during the year as access to the well and staff time allows. These will be bottle traps checked weekly for a month.

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 (Texas State University Artesian Well N = 1; and Diversion Springs N = 1). Drift nets will be deployed and checked by USFWS staff when we are able to sample Texas State University Artesian Well (when not being used by Texas State staff).

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: Texas troglobitic water slater are primarily found in Artesian Well on Texas State Campus. Recent research by Will Coleman shows these are deep aquifer species that are rarely found at the surface. Mr. Coleman was unable to keep any alive for extended periods of time, as all specimens he collected came out of the spring damaged. We will continue to work with invertebrate experts in the field to determine what might be the optimum way to collect this species. Drift nets will be deployed and checked by USFWS staff when we are able to sample Texas State University Artesian Well (when not in use by Texas State staff).

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. The species is also fed fish flake food to supplement their diet.

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 2021. Collections listed here are subject to change with extenuating circumstances such as weather and coordination with external partners. EAA and partners will be notified of sampling dates as they become known or changed.

Edward's Aquifer Species Collection Plan 2021			
Date (month)	**Interval**	**Location**	**Target Species**
January	14 Consecutive day with traps check 2-3 times a week	Rattlesnake Cave & Rattlesnake Well	Texas blind salamander
January	Collect lures	Spring Runs, Landa Lake	CSRB, CSDB, PCA, TTWS
January	1 day sampling event, hand pick from downed wood	Landa Lake	CSDB
February	14 Consecutive day with traps check 2-3 times a week	Primer's Fissure & Johnson's Well	Texas blind salamander
February	1 day sampling event	San Marcos River	Texas wild-rice
March	Check nets T and F every week	Diversion Springs	Texas Blind salamander, San Marcos salamander
March	1-2 day sampling event	Spring Lake and below dam	San Marcos salamander
March	1 day sampling event, hand pick	Landa Lake	Peck's Cave amphipod
March	1 day sampling event	Comal Springs	Comal Springs salamander
March	1 day sampling event, hand pick from downed wood	Landa Lake	CSDB
April	Check 2 consecutive weeks	Rattlesnake Cave & Rattlesnake Well	Texas blind salamander

Edward's Aquifer Species Collection Plan 2021			
Date (month)	**Interval**	**Location**	**Target Species**
April	1-day sampling event	San Marcos River	Texas wild-rice
April	Throughout, coincide with bio-monitoring	San Marcos River	Fountain darters
April	Drift net, donated from bio-monitoring	Comal Springs	PCA
April	Set lures	Spring Runs, Landa Lake	CSRB, CSDB, PCA, TTWS
May	14 Consecutive day with traps check 2-3 times a week	Primer's Fissure & Johnson's Well	Texas blind salamander
May	1-day sampling event	San Marcos River	Texas wild-rice
May	Collect lures	Spring Runs, Landa Lake	CSRB, CSDB, PCA, TTWS
June	Check nets T and F every week	Diversion Springs	Texas Blind salamander, San Marcos salamander
June	1 day sampling event, hand pick	Landa Lake	Peck's Cave amphipod, SMARC
June	1 day sampling event	Comal Springs	Comal Springs salamander
June	Set lures	Western Shore	CSRB, CSDB, PCA, TTWS
July	14 Consecutive day with traps check 2-3 times a week	Rattlesnake Cave & Rattlesnake Well	Texas blind salamander

Edward's Aquifer Species Collection Plan 2021			
Date (month)	**Interval**	**Location**	**Target Species**
July	Collect lures	Western Shore	CSRB, CSDB, PCA, TTWS
August	14 Consecutive day with traps check 2-3 times a week	Primer's Fissure & Johnson's Well	Texas blind salamander
August	1-2 day sampling event	Spring Lake and below dam	San Marcos salamander
September	Check nets T and F every week	Diversion Springs	Texas Blind salamander, San Marcos salamander
September	1 day sampling event, hand pick	Landa Lake	Peck's Cave amphipod, SMARC
September	1 day sampling event	Comal Springs	Comal Springs salamander
October	14 Consecutive day with traps check 2-3 times a week	Rattlesnake Cave & Rattlesnake Well	Texas blind salamander
October	Throughout, coincide with bio-monitoring	San Marcos River	Fountain darters
October	Drift net, donated from bio-monitoring	Comal Springs	PCA
October	1 day sampling event	San Marcos River	Texas wild-rice
October	Set lures	Spring Runs, Landa Lake	CSRB, CSDB, PCA, TTWS
October	1 day sampling event, hand pick from downed wood	Spring Runs, Landa Lake	CSDB

Edward's Aquifer Species Collection Plan 2021			
Date (month)	**Interval**	**Location**	**Target Species**
November	14 Consecutive day with traps check 2-3 times a week	Primer's Fissure & Johnson's Well	Texas blind salamander
November	1 day sampling event, hand pick	Landa Lake	PCA
November	1 day sampling event	Comal Springs	Comal Springs salamander
November	Collect lures	Spring Runs, Landa Lake	CSRB, CSDB, PCA, TTWS
December	Check nets T and F every week	Diversion Springs	Texas Blind salamander, San Marcos salamander
December	1 day sampling event	San Marcos River	Texas wild-rice
December	Set lures	Spring Runs, Landa Lake	CSRB, CSDB, PCA, TTWS

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: Propagation for stocking is not anticipated during 2021.

Salvage Stocks:

Collection: If species-specific salvage triggers defined in the EAHCP are reached, the Refugia Program, 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:

Any maintenance to the program buildings beyond routine will be reported to the EAA as they occur.

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 will practice biosecurity procedures in Refugia and Quarantine areas, plus conduct proper biosecurity procedures on field equipment.

Task 2. Research

The Research Plan for 2021 will involve a series of activities ranging from increasing survival rates of various invertebrate species, salamander reproduction, and Texas wild-rice genetics. The following section describes the basic components of each of these proposed 2021 activities.

Project 1:

Title: Texas wild-rice genetic evaluation of both wild and refugia plants

Species: *Zizania texana*

Principal/Co-PI: FWS staff, sub-contractors (TBD) for genetic analysis

Overview: Staff with collect Texas wild-rice tissue samples from all Refugia Standing Stock and along the range of Texas wild-rice habitat within the San Marcos River. Samples will be analyzed for genetics to (1) characterize the genetic diversity of plants in the river, (2) see if the Refugia Standing Stock plants represent wild populations, (3) compare current wild genetic diversity to historical genetic diversity.

Budget: $ 124,865.50

Benefit to the Refugia: Inform collection strategies from river populations. Determine if refugia populations represent wild populations.

Expected Results: The results of the study will be presented as a report to the EAA and potentially a peer reviewed journal article. Development of a genetic management plan for Texas wild-rice or the building block for the genetic management plan.

Project 2:

Title: Continuation of San Marcos salamander reproduction

Species: *Eurycea nana*

Principal: FWS staff and/or sub-contractor(s) TBD

Overview: Based on results from pilot testing of various methods to predictably induce

San Marcos salamander reproduction in 2020, we will design a larger scale study to statistically test the most promising methods.

Budget: $ 35,975.25

Benefit to the Refugia: Continued refinement of salamander reproduction and propagation. Information gained will inform reintroduction strategy.

Expected Results: The results of the study will be presented as a report to the EAA, an update to the reintroduction strategy, and update to the Eurycea sp. Propagation Manual.

Project 3:

Title: Comal Springs riffle beetle propagation, captive culture, and nutrition

Species: *Heterelmis comalensis*

Principal: FWS staff and/or sub-contractor(s) TBD

Overview: Test the effects of supplementing an invertebrate experimental system with beneficial cultured bacteria. Scale-up best designs for CSRB pupation to larger numbers of refugia larvae.

Budget: $ 72,559.50

Benefit to the Refugia: Increased survival rates of Comal Springs riffle beetles and increased F_1 production.

Expected Results: Interim reports to USFWS and EAA on the successes and failures of various techniques tried and knowledge gained.

Project 4:

Title: Comal Springs dryopid beetle captive culture and propagation

Species: *Stygoparnus comalensis*

Principal/Co-PI: FWS staff and/or sub-contractor(s) TBD

Overview: Scale up of CSDB holding containers based on 2020 results.

Budget: $ 45,717.00

Benefit to the Refugia: Increases survival rates of wild stock Comal Springs dryopid beetles in captivity and increased efficiency in F1 production.

Expected Results: The results of the study will be presented as a report to the EAA and if warranted an update to the Comal Springs dryopid beetle standard protocols.

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 2021: None

Any anticipated triggers being prepared for: Given current weather predictions, spring flows, and the Edwards Aquafer water level, none are anticipated during the 2021 performance period.

Task 5. Reporting

5.1 Species specific Propagation plans (SOPs): Refine throughout year as needed
5.2 Species specific Genetic Management plans: Texas wild-rice, contingent on when genetic study results are finished
5.3 Species specific Reintroduction plans: Refine as needed
5.4 2021 EAHCP Annual Program reporting– A year-end report of 2021 activities will be provided to the EAA no later than 1/31/2022.
5.5 Program reporting as required by ITP and TPWD. TPWD Scientific Research Permit Report will be filed July 31, 2021.
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.

Cost estimate:
See table to follow.

Edwards Aquifer Refugia Program 2021 Budget

	TASK	Sub-Costs	Amounts by Category	Total Task Amount
TASK 1	**[1] Refugia Operations**			
	SMARC Refugia & Quarantine Bldgs.			
	Equipment & Building Maintenance		$ 10,000.00	
	Utilities		$ 50,000.00	
	UNFH Refugia & Quarantine Bldgs.			
	Equipment & Building Maintenance		$ 10,000.00	
	Utilities		$ 50,000.00	
	SMARC Species Husbandry and Collection		$ 118,356.89	
	Fish Biologist (GS-12, 290 hrs)	$ 15,022.88		
	Biological Technician (GS-07, 1100 hrs)	$ 34,444.67		
	Biological Technician (GS-07, 1100 hrs)	$ 34,444.67		
	Biological Technician (GS-07, 1100 hrs)	$ 34,444.67		
	Weekend Walk Through		$ 5,000.00	
	Other Overtime		$ 1,500.00	
	UNFH Species Husbandry and Collection		$ 191,049.95	
	Fish Biologist (GS-11, 1121 hrs)	$ 55,828.72		
	Biological Technician (GS-07, 1428 hrs)	$ 45,503.22		
	Biological Technician (GS-07, 1428 hrs)	$ 45,503.22		
	Biological Technician (GS-07, 1453 hrs)	$ 44,214.79		
	Weekend Walk Through		$ 5,000.00	
	Other Overtime		$ 4,500.00	
	Divers		$ 2,500.00	
	Fish Health		$ 8,000.00	
	SMARC Reimbursibles		$ 40,000.00	
	UNFH Reimbursibles		$ 40,000.00	
	Subtotal		*$ 535,906.84*	
	Admin Cost Subtotal		*$ 91,104.16*	
				$ 627,011.00

	[2] Research			
	Texas wild rice genetics		$ 124,865.50	
	Biological Technician (GS-07, 600 hrs)	$ 18,672.00		
	Biological Technician (GS-07, 450 hrs)	$ 13,693.50		
	Genetic Analysis sub-contractor TBD	$ 90,000.00		
	Materials	$ 2,500.00		
	San Marcos salamander reproduction		$ 35,975.25	
	Biological Technician (GS-07, 600 hrs)	$ 18,774.00		
	Biological Technician (GS-07, 475 hrs)	$ 14,701.25		
	Materials	$ 2,500.00		
	CSRB propagation, culture, & nutrition		$ 72,559.50	
TASK 2	Biological Technician (GS-07, 500 hrs)	$ 15,765.00		
	Biological Technician (GS-07, 475 hrs)	$ 15,570.50		
	Biological Technician (GS-07, 200 hrs)	$ 6,224.00		
	Subcontractor(s) if needed	$ 30,000.00		
	Materials	$ 5,000.00		
	CSDB culture & propagation		$ 45,717.00	
	Biological Technician (GS-07, 300 hrs)	$ 9,459.00		
	Biological Technician (GS-07, 200 hrs)	$ 6,258.00		
	Subcontractor(s) if needed	$ 27,500.00		
	Materials	$ 2,500.00		
	Oversight and Research Development		$ 108,303.26	
	FWS Administrator (99 hrs)	$ 7,532.66		
	Fish Biologist (GS-12, 1390 hrs)	$ 70,111.60		
	Fish Biologist (GS-11, 620 hrs)	$ 30,659.00		
	Subtotal		*$ 387,420.51*	
	Admin costs for Task 2		*$ 65,861.49*	
				$ 453,282.00

	[3] Species Propagation and Husbandry			*$*	-	**$** -
	[4] Species Reintroduction			*$*	-	**$** -
TASK 5	**[5] Reporting**					
	SMARC Staff			$	38,470.77	
	FWS Administrator (24 hrs)	$	1,759.28			
	Admin Staff (160 hrs)	$	6,445.00			
	Fish Biologist (GS-12, 330 hrs)	$	16,645.20			
	Biological Technician (GS-07, 145 hrs)	$	4,540.43			
	Biological Technician (GS-07, 145 hrs)	$	4,540.43			
	Biological Technician (GS-07, 145 hrs)	$	4,540.43			
	UNFH Staff			$	30,724.96	
	Admin Staff (GS-07, 80 hrs)	$	2,484.00			
	Fish Biologist (GS-11, 295 hrs)	$	14,587.75			
	Biological Technician (GS-07, 145 hrs)	$	4,551.07			
	Biological Technician (GS-07, 145 hrs)	$	4,551.07			
	Biological Technician (GS-07, 145 hrs)	$	4,551.07			
	Subtotal			*$*	*69,195.73*	
	Admin costs for Task 5			*$*	*11,763.27*	
						$ 80,959.00
TASK 6	**[6] Meetings and Presentations**					
	SMARC staff			$	9,430.75	
	FWS Administrator (34 hrs)	$	2,612.04			
	Fish Biologist (GS-12, 70 hrs)	$	3,530.80			
	Biological Technician (GS-07, 35 hrs)	$	1,095.97			
	Biological Technician (GS-07, 35 hrs)	$	1,095.97			
	Biological Technician (GS-07, 35 hrs)	$	1,095.97			
	UNFH Staff			$	4,319.31	
	Fish Biologist (GS-11, 44 hrs)	$	1,306.20			
	Biological Technician (GS-07, 32 hrs)	$	1,004.37			
	Biological Technician (GS-07, 32 hrs)	$	1,004.37			
	Biological Technician (GS-07, 32 hrs)	$	1,004.37			
	Subtotal			*$*	*13,750.06*	
	Admin costs for Task 6			*$*	*2,337.51*	
						$ 16,087.57
TOTAL $1,177,339.57						

Projected (2021) Budget Summarized by Task:

Task 1: $ 627,011
Task 2: $ 453,282 (this does not include any funds not spent by contractors in 2020 that will also asked to rollover into 2021)
Task 3: $0
Task 4: $0
Task 5: $ 80,959
Task 6: $ 16,087.57

Projected (2021) Subcontractor Expenses Summarized by Task

Task 1: Southwest Regional Fish Health Unit, Dexter NM $8,000 (Health Diagnostics)
Task 2: Sub-contractors TBD $147,500
Task 3: $0
Task 4: $0
Task 5: $0
Task 6: $0

Timeline of 2021 Milestones

(List major deliverables)

January	Continue with species collection
	Subcontract research awards executed
	2022 Specific Research Study Plans finalized
July	Submit and renew TPWD permit
September to December	Draft Research Reports
	Draft Annual report

Literature Cited

AFS-FHS (American Fisheries Society-Fish Health Section). 2005. Model Quality Assurance/Quality Control Program For Fish Health Laboratories, 2016 edition. Accessible at: http://afs-fhs.org/bluebook/bluebook-index.php.

Cantu, V., J. N. Fries, and T. A. Ryan. 2009. An apparatus for separating live amphipods from debris. North American Journal of Aquaculture 71:6-9.

Crawford, D. M., and D. C. Tarter (1979) Observations on the life history of the freshwater amphipod, *Crangonyx forbesi* (Hubricht and Mackin), in a spring-fed cistern in West Virginia. American Midland Naturalist 2: 320-325.

Culver DC, T Pipan (2009) The biology of caves and other subterranean habitats. Oxford University Press, New York.

Hall, R (Edwards Aquifer Authority). 2016. 2016 Comal Springs Riffle Beetle SOP Work Group: Attachment 2: Existing CSRB Cotton Lure SOP. Available at:

http://www.eahcp.org/index.php/administration/work_groups/2016_comal_springs_riffle_beetle_sop_work_group

Wilson, W. D., J. T. Hutchinson, K. G. Ostrand. 2016. Genetic diversity assessment of in situ and ex situ Texas wild-rice (*Zizania texana*) populations, an endangered plant. Aquatic Botany 136:212-219.

Ulrich, G. W (1986) The larvae and pupae of *Helichus suturalis* Leconte and *Helichus productus* Leconte (Coleoptera: Dryopidae). The Coleopterist Bulletin 40: 325-334.

USFWS and AFS-FHS (U.S. Fish and Wildlife Service and American Fisheries Society-Fish Health Section). 2016. Standard procedures for aquatic animal health inspections. *In* AFS-FHS. FHS blue book: suggested procedures for the detection and identification of certain finfish and shellfish pathogens, 2016 edition. Accessible at: http://afs-fhs.org/bluebook/bluebook-index.php.

5.1.2 Voluntary Irrigation Suspension Program Option

Long-term Objective:
The goal of VISPO is to enroll 41,795 acre-feet (AF) of permitted irrigation rights (base and/or unrestricted) that will remain unused in years of severe drought based on the USFWS approved 2019 minor amendment. Permit holders are enrolled in five-year and ten-year VISPO agreements and will be compensated based on the amount of water enrolled and the program selected; a standby fee of $54/ac-ft per year will be paid to the enrollee every year of the term, regardless of aquifer conditions and a fee of $160/ac-ft per year will be paid for each year when temporary pumping suspensions are required. Beginning January 1, 2020, 22,940.58 ac-ft of 5-year and 15,620 ac-ft of 10-year VISPO forbearance agreements were in place totaling 38,561 ac-ft. The remaining 3,234 ac-ft are anticipated to be under contract effective January 1, 2021, which will complete the enrollment goal of 41,795 ac-ft until a portion of the 5-year VISPO agreements begin to expire on January 1, 2024.

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. The determination for a VISPO trigger will be made on October 1, 2020; if it does not trigger, all enrolled water can be used by the permit holders in 2021. If it triggers, all enrolled water will be forborne. Annual VISPO payouts are through 2020 are reflected in Table 5.1.2-1.

Table 5.1.2-1: VISPO Total Payout by Year

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
2019	Stand-by	39,646	$2,320,309
2020	Stand-by	39,803	$2,333,415
		Grand Total	$21,158,724

Target for 2021:
The effort to enroll participants into the VISPO forbearance program began in 2018 and will continue throughout 2020 to achieve the EAHCP volume goal of 41,795 ac-ft. It is expected the enrollment goal will be achieved by January 1, 2021. VISPO payments in 2021 were determined by the October 1, 2020 J-17 index well water level.

Cost Estimate:
Table 7.1:
$4,172,000

Estimated 2021 cost:
Standby: $2,509,975

5.1.3 Regional Water Conservation Program

Long-term Objective:
Conservation measures will be implemented to conserve 20,000 acre-feet of water to reduce withdrawals from the Edwards Aquifer by 10,000 acre-feet. The concept is to reduce aquifer withdrawals by 10,000 acre-feet using a Regional Water Conservation Program (RWCP).

Several entities within the Edwards Aquifer Authority (EAA) jurisdictional area agreed to make Initial Commitments to the EAA Groundwater Trust to provide an immediate benefit to the aquifer and springflow. The EAA maintains contracts with three communities to conserve water under the RWCP through 2028. The City of Uvalde began implementing its toilet replacement program in 2013 to conserve 57.450 ac-ft of water. In 2014, the City of Universal City began implementing its leak detection program to conserve 163.684 ac-ft of water and in 2016, SAWS began implementing a five-year Leak Detection and Repair Program. The SAWS Leak Detection and Repair Program satisfies the total remaining RWCP goal for water committed into the EAA Groundwater Trust for the remainder of Incidental Take Permit (TE-63663A-1).

The estimated total savings of 20,053 ac-ft of conserved water was achieved from all three communities in 2020. One-half of the conserved water (10,027.13 ac-ft) has been placed in the EAHCP Groundwater Trust through the RWCP to remain unpumped through 2028.

Target for 2021:
None. This conservation measure was achieved in 2020 and 10,027.13 ac-ft has been placed in the EAHCP Groundwater Trust.

Cost estimate:
Estimated 2021 cost:
$0

5.1.4 Edwards Aquifer Authority Stage V Critical Period Management

Stage V Critical Period Management was developed to help decrease withdrawals and maintain adequate springflows 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 ac-ft 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.

2021 Implementation:

EAA staff monitors daily aquifer levels in both the San Antonio and Uvalde Pools of the Edwards Aquifer Region, and 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.

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.

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 2021:
The ASR contract between EAA and SAWS will continue to be implemented. EAA is the leasing agent for ASR leases and in year 2020 issued its final notice of availability of EAHCP groundwater to SAWS for injection. In year 2020, a total of 9,957.439 acre-feet was stored, bringing the total stored to 126,000 acre-feet and meeting the goal of the EAHCP. Future water acquired by the EAA through contractual agreements due to expiring leases will be utilized for forbearance purposes during a repeat of a drought of record as outlined in the EAHCP. During a drought of record, the ASR may be used by SAWS to offset forbearance. In addition to forbearance by SAWS, the EAA Will forbear the 50,000 acre-feet of groundwater under their control.

ASR Program:

Description of the SAWS ASR: The SAWS H_2Oaks ASR is an underground storage reserve in the Carrizo Aquifer in southern Bexar County. As a SAWS water management project, it is designed to store Edwards Aquifer 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 protecting the Covered Species at Comal and San Marcos Springs.

Operations: The EAHCP Program Interlocal Contract between the EAA and SAWS 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 EAHCP's ASR flow protection strategy and places them into an operations contract.

Injection: Storage of EAHCP groundwater shall be at the discretion of SAWS and will be dependent on operating conditions. All EAHCP groundwater made available to SAWS before June 30th, 2020, was 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 2021.

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. The ten-year rolling recharge average reported April 1, 2020 was 618,730 acre-feet and the ten-day average of aquifer levels measured at the J-17 index well as of April 1, 2020 was 671.5.

Leasing: In 2018, EAA staff began marketing long-term (ten-year) forbearance agreements with regional permit holders and continued throughout 2020. In 2020 the total amount of water available under long-term leases was 15,924 acre-feet and 33,745.923 acre-feet in forbearance agreements for a total of 49,670 acre-feet. On December 31, 2020 a total of 1,232 acre-feet in ASR leases will expire and will be re-enrolled as forbearance agreements. It is expected that a total 50,000 acre-feet of groundwater withdrawal rights will be under EAA control and will remain unused during drought of record conditions.

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 EAHCP, 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.

Cost estimate:
Table 7.1:
$4,759,000 – Lease Options
$2,194,000 – O&M
$6,953,000 – Total

Estimated 2021 cost:*
$6,009,530 – Lease & Forbearance Options
$0 – O&M
$6,009,530 – Total

*Actual expenditures for 2021 will be determined by the terms of the Interlocal Contract depending on the quantity of EAHCP 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.

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

This work plan details the sampling strategy and protocols for water quality monitoring in 2021 for the Edwards Aquifer Habitat Conservation Plan (EAHCP) (Section 5.7.2) implemented by the Edwards Aquifer Authority (EAA). Water quality monitoring of the Comal and San Marcos springs complexes and their associated surface waters has occurred since 2013 under implementation of the EAHCP. During this time period, the program has employed a variety of sampling strategies: stormwater, surface water, sediments, fish tissue, and passive samplers aimed at a range of environmental contaminants.

The Water Quality monitoring program underwent a formal review as part of 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. Subsequently, a work group was formed in 2016 to assess recommendations presented in the NAS report. The result was a scope of work that was executed from 2017 – 2020.

Beginning in 2021, additional refinements to the program are being implemented. The primary changes from the previous implementation include discontinuing stormwater and passive sampling, adding surface water sampling, and modifying the analyte list. Table 1 presents an overview of the core activities comprising the EAHCP Water Quality monitoring program. Additionally, as needs arise, other water quality sampling activities may occur as developed through the EAHCP committees and included in the Annual Work Plan.

Target for 2021:
Water quality monitoring activities for 2021 include sampling activities for surface water, groundwater, and fish tissue in addition to operation of the real-time network. Specific actions for each sample type are discussed below. Analyte lists and maps can be found in Appendix A. All samples will be collected following the EAA's *Field Sampling Plan* and analyzed by a NELAP accredited contract laboratory.

Groundwater sampling:

Groundwater samples will be collected from Spring 1, Spring 3, Spring 7 (Comal), Deep and Hotel (San Marcos) springs during the Spring and Fall under normal flow conditions (Figures A1 and A2). Groundwater samples will be collected by directly filling a bottle or using a previously decontaminated peristaltic pump with the intake portion of the pump placed in the spring orifice to minimize surface water contamination. Samples will be submitted to a contract laboratory for analysis of cations, anions, nutrients, metals, VOCs, SVOCs, herbicides and pesticides, bacteria, TOC, PCBs, and PPCPs. The analyte list for laboratory analyses along with the methods are shown in Table A1. During the collection event, field parameters will be collected that include dissolved oxygen, pH, conductivity, temperature and alkalinity.

In addition to the biannual groundwater sampling, sucralose will be measured on a monthly basis at Spring 3 and Hotel. These samples will be collected by directly filling bottles at the source of spring flow. During the collection event, field parameters will be collected that include dissolved oxygen, pH, conductivity, and temperature.

Table 1. EAHCP Water Quality monitoring program core activities.

Sample Type	Activity
Surface water	Twice annual sampling in conjunction with Biological Monitoring activities
	Laboratory analyses are focused on bacteria and nutrients
	Locations include upper and lower stations at each spring system
Groundwater	Twice annual sampling in conjunction with EAA springs sampling activities
	Laboratory analyses are focused on geochemical analytes and industrial, commercial, and emerging contaminants. The analytes include cations, anions, nutrients, metals, VOCs, SVOCs, herbicides, pesticides, bacteria, TOC, PCBs, and PPCPs
	Locations include Spring 1, Spring 3, Spring 7 (Comal), Hotel, and Deep (San Marcos)
Sediment	Every other year sampling in even numbered years
	Laboratory analyses are focused on PAHs
	Locations include 6 San Marcos and 5 Comal stations
Fish Tissue	Every other year sampling in odd numbered years
	Laboratory analyses are focused on metals and PPCPs in two fish species
	Locations include upper and lower stations at each spring system
Real-time network	Continuous, telemetered measurements
	Analytes include temperature, dissolved oxygen, and conductivity
	Locations include 3 San Marcos and 3 Comal stations

Surface water sampling:

Surface water samples will be collected from upper and lower river stations at both systems. For Comal Springs, Landa Lake near Spring Island will serve as the upper location, and the lower station is downstream of the Old and New Channel confluence. In San Marcos, Spring Lake near Hotel spring will serve as the upper location, and the downstream location is located at the most downstream real-time water quality monitoring station. Samples at each location will be collected on a biannual basis during normal flow conditions in conjunction with the Biological Monitoring program (Spring and Fall). Water samples will be taken from flowing parts of the stream on the upstream side of the sample collector. A previously decontaminated Kemmerer or similar device will be used to collect samples at approximately mid-depth in the water column. Samples will be submitted to a contract laboratory for analysis of nutrients, chlorophyll a, and bacteria (Table A2). During the collection event, field parameters will be collected that include dissolved oxygen, pH, conductivity, and temperature.

Fish tissue sampling:

Fish collections from the Comal and San Marcos rivers will be conducted during the spring Biological Monitoring survey. For both systems, fish will be collected at locations near the surface water sampling locations described above.

At each site, gambusia and largemouth bass will be collected. 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 samples will be submitted to a contract laboratory and analyzed for metals and PPCP contaminants listed in Table A3.

Real Time Instrument Water Quality Data Logging:

Continuous water quality monitoring stations will continue in 2021 at three locations in the Comal and three locations in San Marcos. The network consists of Eureka Manta+ 30s (or other continuous measuring sonde) measuring dissolved oxygen, conductivity, temperature, and turbidity (Sessom Creek only). Measurements are collected every fifteen minutes and telemetered in real-time. The Sessom Creek site logs data on five-minute intervals to support turbidity measurements at this location.

Quality control procedures:

Field collection methods and quality control procedures for the discrete sampling types are guided by the EAA's Field Sampling Plan. The anticipated number of samples and field quality control samples sent for analyses in 2021 are shown in Table 2. Brief descriptions of the intent of the quality control tests are described below.

Table 2. Sample amounts for 2021 water quality activities.

Sample type	Samples	Equipment blank	DI blank	Lab duplicate	Field duplicate	Total samples
Groundwater	10	2	2	4		18
Sucralose	24		8	8		40
Surface water	8	2	2	4	4	20
Fish tissue	8			2		10

Both equipment blanks and DI blanks use reagent grade ASTM II deionized water to assess external contamination of environmental samples. Equipment blanks examine the contamination introduced through the sampling procedure. These are conducted by transferring the deionized water through equipment that has been decontaminated for field use. DI blanks consist of deionized water sent directly to the laboratory and are designed to examine sample container and other laboratory contamination.

Lab and field duplicates are intended to assess the precision and repeatability of the analytical procedure and homogeneity of the environmental sample type. Laboratory duplicates consists of

a single well-mixed sample split into two samples for analysis. Field duplicates consists of a second sample collected immediately after an initial sample.

Additionally, all laboratory quality control data including matrix spikes and surrogate blanks will be reported.

Monitoring:
A summary report presenting the 2021-year findings will be prepared by EAA staff and included in the EAHCP annual report. The report will include an evaluation of the analytical data and its quality, discussions of results, and a description and rationale for any deviations from the Work Plan described here. The report will be completed in February 2022.

Data collected as part of the 2021 EAHCP Water Quality monitoring program will be kept electronically with the EAA. Data from quality controlled discrete sample types (surface water, groundwater, and fish tissue) will be housed by EAHCP staff in delimited file types that include all discrete measurements from the program beginning in 2013. Quality controlled time series data associated with the real-time network are housed with existing aquifer time-series data by the EAA.

Cost Estimate:
Costs for laboratory analyses are shown in Table 3 and are based on estimates provided by commercial laboratories in 2019-2020. Field supplies costs in Table 3 cover field collection and analysis equipment including calibration standards and Kemmerer device.

Table 3. 2021 EAHCP Water Quality monitoring program costs.

Sample type	Total samples	Cost per sample	Total Costs
Groundwater	18	1000	$18,000
Sucralose	40	250	$10,000
Surface water	20	225	$4,500
Fish tissue	10	750	$7,500
Field Supplies			$5,000
		Total	**$45,000**

Appendix A. Sample location maps and analyte lists

Figure A1. Groundwater sampling locations for Comal.

Figure A2. Groundwater sampling locations for San Marcos.

Table A1. Analytical parameters for groundwater samples.

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*)
PPCPs

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	PPCPs	LC-MS/MS

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.

Table A2. Analytical parameters for surface water samples

Analyses
Chlorophyll a
Soluble Reactive Phosphorous
Phosphorus (total)
Total Organic Carbon (TOC),
Dissolved Organic Carbon (DOC)
Kjeldahl Nitrogen
Bacteria Testing (*E coli*)
Nitrates and Ammonium

Method	**Method Description**	**Protocol**
365.4	Phosphorus,	Total EPA
9060	Organic Carbon,	Total (TOC) SW846
351.2	Nitrogen, Total Kjeldahl	MCAWW
445.0	Chlorophyll a	Fluorescence
8141a	Organophosphates	SW846
353.2	Nitrates	
350.3	Ammonia	

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.

Table A3. Analytical parameters for fish tissue samples

Analyses
Metals (Al, Sb, As, Ba, Be, B, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, V, and Zn)
PPCPs

Method	**Method Description**	**Protocol**
6010B	Metals	(ICP) SW846
6020	Metals	(ICP/MS) SW846
7470A	Mercury	(CVAA) SW846
1694	PPCPs	LC-MS/MS

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.

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 (EAHCP).

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 2021:
The 2021 BioMP for the Comal and San Marcos aquatic ecosystems will continue to include Baseline and Critical Period Monitoring along with a Net Disturbance impact assessment and overall Take Determinations. The 2021 BioMP will continue to use the standard operating procedures adopted in 2016 because of the Biological Monitoring Work Group (EAHCP 2016) in addition to what is noted in this document. These standard operating procedures were instituted for the BioMP beginning in 2017.

Monitoring:
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 Texas 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 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 among dominant aquatic vegetation species 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 rams-horn snails will be counted, measured, and destroyed. Exotic Asian snails and Asian clam will be identified, general abundance recorded, then destroyed. The number of crayfish and grass shrimp per drop net will be noted. Furthermore, vegetation species, vegetation height, vegetative areal coverage, substrate type, water depth, mean column velocity, velocity at 15 centimeters (cm) above the bottom, water temperature, conductivity, pH, and dissolved oxygen levels will be recorded for each drop net.

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 gill condition. Additionally, total length of collected individuals will be measured during timed dip net surveys. Timed surveys will be conducted in all habitat types up to a depth of 1.4 m, within each section, moving upstream during the sampling process with prime darter habitat receiving the most effort.

Presence/absence surveys will be conducted by taking 4 dip net sweeps at 50 random 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 random 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 (SMARC) will take place each time to assist with refugia collections when needed.

The Comal Springs riffle beetle (CSRB) 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 three locations (i.e., Spring Run 3, western shoreline of Landa Lake, and Spring Island area). Ten springs within each of the three locations will be identified for sampling by the contractor.

The CSRB cotton lure standard operating procedure, cotton lure quantitative survey method, and recommendations generated during the CSRB workgroup describe the appropriate protocols for CSRB to be identified, counted, and returned to their spring of origin. Other spring invertebrates

collected on the lures will also be noted including the Comal Springs dryopid beetle (*Stygoparnus comalensis*) and Peck's cave amphipod (*Stygobromus pecki*).

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°C, pH, dissolved oxygen [mg/l], 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 Sampling and Critical Period Monitoring events.

Fish Community Sampling:

SAN MARCOS SYSTEM—Fish will be sampled at two locations within Spring Lake associated with San Marcos salamander surveys (Big Riverbed and Hotel Area) and one location just upstream of the eastern spillway. Two different SCUBA techniques will be used to document the fish within the three locations, mesohabitat and microhabitat surveys. Three additional SCUBA survey locations will occur in the San Marcos River (Upper, Mid, and Lower), located in representative deep areas where seining has proven to be inefficient. The exact location of the SCUBA sampling within each section may change slightly based on conditions at the time of the sampling event.

In addition to SCUBA, fish in the San Marcos River will be sampled among five sites within three reaches (Upper: Sewell, Veteran's Park, Middle: Crook's Park, and Lower: San Marcos Wastewater Treatment plant and Smith property) via seines within wadeable habitats. Multiple seine hauls will occur along a river transect perpendicular to the flow. Within each seine haul, fish 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 fish data, habitat data will be collected for each seine haul including current velocity, water depth, substrate composition, in-stream coverage, climatic conditions, and mesohabitat type.

COMAL SYSTEM—Fish will be sampled at three locations within Landa Lake via SCUBA surveys. In particular, one of the SCUBA survey locations in Landa Lake will be in the same as the ongoing fountain darter belt transect survey. In addition, SCUBA surveys will be conducted within the Upper Spring Run, Old Channel, and New Channel sections of the Comal River. Two different SCUBA techniques will be used to document the fish within the three locations, mesohabitat and microhabitat surveys.

In addition to SCUBA surveys, three locations (Upper Spring Run, New Channel, and Old Channel) will be sampled via seines among wadeable habitats to evaluate and track fish populations in the Comal River. Multiple seine hauls will occur along a river transect perpendicular to the flow. Within each seine haul, fish will be identified, measured, examined for disease, and native fish returned to the river. Exotics will be removed from the system per scientific permit requirements. In addition to fish data, each seine haul will include habitat measurements (i.e. current velocity, water depth, substrate composition, in-stream coverage, climatic conditions, and mesohabitat type).

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

DOCUMENT BASELINE HABITAT CONDITIONS—The contractor will use January 1 of the contract year GIS mapping, biomonitoring data and other existing sources to establish occupied habitat for the EAHCP 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 EAHCP 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 EAHCP 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 EAHCP 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 the BioMP, the information and guidance in Chapters 4 and 6 of the EAHCP, 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 Monitoring: 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 10-0 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, 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 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 Sampling and Critical Period Monitoring 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.

Cost estimate:
Table 7.1:
$400,000

Estimated 2021 cost:
$755,774*

*Includes Critical Period Monitoring if required

6.3.3 Ecological Modeling

Long-term Objective:
The development of a mechanistic ecological model (Ecomodel) is assigned to the Edwards Aquifer Authority per section 6.3.3 of the 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 2021:
No Ecological Modeling work is anticipated in 2021.

Cost estimate:
Table 7.1:
$25,000

Estimated 2021 cost: *
$0

*There is no proposed budget for 2021.

6.3.4 Applied Research

Long-term Objective:
Applied research adds a valuable component to the EAHCP to better understand the ecological dynamics for all Covered Species.

Target for 2021:
Savings from past years will be applied to perform research to support a better understanding of existing Conservation Measures, address questions proposed by the Springflow Habitat Protection Work Group and collect data to support efforts to define biological goals for the next Incidental Take Permit.

Cost estimate:
Table 7.1:
$0

Estimated 2021 cost:
$250,000*

* $2,201,007 remains from the Table 7.1 budget.

FMA § 2.2 EAHCP Program Management

Section 2.2 of the Funding and Management Agreement (FMA) assigns "general management and oversight" of the 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 ITP from the USFWS for designated Covered Activities.

Program Activities in 2021:
EAHCP staff will continue to coordinate and monitor habitat protection measures completed by the City of New Braunfels and City of San Marcos/Texas State University in their respective 2021 Work Plans. The springflow and supporting measures are described in this 2021 EAA Work Plan.

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

- Manage EAHCP day-to-day activities;
- Facilitate program correspondence with the USFWS;
- Manage program activities in response to a 2028 ITP include oversight of a contract for facilitated workshops and HCP Handbook training;
- Serve on the ASR Advisory Committee;
- Facilitate the Adaptive Management Process (AMP) for all Routine and Nonroutine decisions;
- Facilitate and coordinate all meetings of the EAHCP Implementing and Stakeholder committees and possible Subcommittees and Work Groups as created by the Implementing, Science and Stakeholder committees; and
- Prepare for all meetings of the Springflow Habitat Protection Work Group.

EAHCP Chief Science Officer and support staff will continue the following activities:

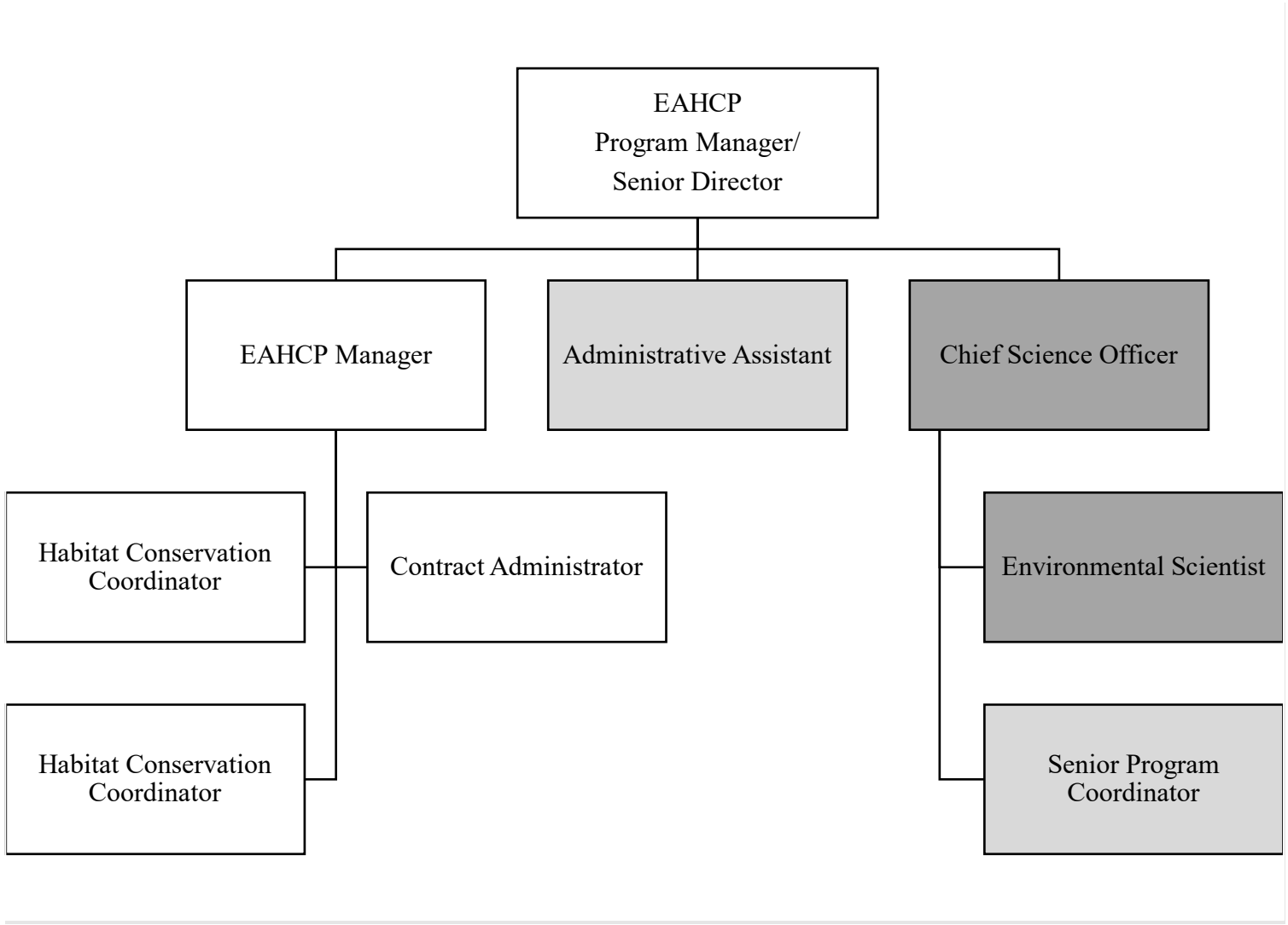
- Manage Refugia Work Plan activities including operations and research;
- Manage applied research;
- Manage biological monitoring;
- Manage and perform water quality monitoring;
- Update and maintain biological and water quality monitoring databases;
- Prepare for all meetings of the EAHCP Science Committee and EAHCP Implementing, and Stakeholder committees at the request of the Program Manager; and
- Prepare for all meetings of the Comal Springs Riffle Beetle Work Group, Research Work Group, and other possible Subcommittees and Work Groups as created by the Implementing, Science and Stakeholder committees at the request of the Program Manager.

EAHCP Administrative Staff will continue the following activities:

- Oversee the City of New Braunfels and San Marcos/Texas State University Work Plan activities;
- Coordinate 2021 Work Plan and funding application amendments for the EAA, City of New Braunfels, and San Marcos/Texas State University;
- Coordinate the development of 2022 Work Plans and funding applications for EAA, City of New Braunfels, and San Marcos/Texas State University;
- Process City of New Braunfels and San Marcos/Texas State University reimbursement's from EAA for habitat protection measures;
- Procure and execute contracts for support measures and program administration;
- Oversee EAA contract tracking and compliance;
- Process EAA contractor's invoices for support measures and program administration;
- Coordinate and 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);
- Coordinate and prepare correspondence with all EAHCP Implementing, Science, and Stakeholder committee members and Work Groups members under the direction of the EAHCP Program Manager;
- Prepare materials for all AMP activities consistent with Article 7 of the FMA and under the direction of the EAHCP Program Manager;
- Support the EAHCP Program Manager in correspondence to the USFWS including informational memorandums, clarifications, and amendments to the ITP and EAHCP;
- Participate in public outreach initiatives;
- Coordinate and publish the monthly EAHCP Steward newsletter and podcast;
- Maintain the content of the EAHCP 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.

Staffing in 2021:
The EAHCP staff consists of the Program Manager, EAHCP Manager, Contract Administrator, and two EAHCP Coordinators. EAA funds the Chief Science Officer and the Environmental Scientist staff positions. Two positions remained vacant during the development of this 2021 EAA Work Plan, but both could be filled in 2021. 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.

Threatened and Endangered Species Team



Positions Paid from EAA General Budget
Vacant Positions

Cost estimate:

EAHCP Program Management Costs for 2021

Description of Expense	Estimated 2021 Costs
Salaries and Fringe Benefits	$ 688,006
Office Supplies	$ 1,500
Non-Capital Assets	$ 6,000
Meeting Expenses	$ 20,000
Conferences, Seminars, and Training	$ 22,500
Memberships	$ 2,000
Printing	$ 8,000
Professional Contracted Services	
Annual Report	$ 50,000
Historical/Archeological Consultation	$ 20,000
Permit Oversight	$ 30,000
Outreach/Newsletter	$ 50,000
Science Committee Compensation	$ 20,000
Other	$ 150,000
Estimated 2021 Total	**$1,068,006**

Table 7.1:
$750,000

Estimated 2021 cost:
$1,068,006