# Appendix J

## 2016 Work Plans and Budgets

1 2015 Edwards Aquifer Authority Updated Work Plan and Budget for the Edwards Aquifer Habitat Conservation Plan

2 2015 City of New Braunfels Updated Work Plan and Budget for the Edwards Aquifer Habitat Conservation Plan

3 2015 City of San Marcos and Texas State University Work Plans and Budgets for the Edwards Aquifer Habitat Conservation Plan

4 2016 Edwards Aquifer Authority Work Plan and Budget for the Edwards Aquifer Habitat Conservation Plan

5 2016 City of New Braunfels Work Plan and Budget for the Edwards Aquifer Habitat Conservation Plan

6 2016 City of San Marcos and Texas State University Work Plans and Budgets for the Edwards Aquifer Habitat Conservation Plan

Appendix J1

# 2015 Edwards Aquifer Authority Updated Work Plan and Budget for the Edwards Aquifer Habitat Conservation Plan

June 30, 2014

Roland Ruiz
General Manager
Edwards Aquifer Authority
900 East Quincy
San Antonio, Texas 78215

Re: 2015 Work Plans and Budget for the Edwards Aquifer Habitat Conservation Plan (EAHCP)

Mr. Ruiz,

On behalf of the Implementing Committee for the EAHCP, I am attaching the Work Plans and Budgets for 2015 to support your Board's review and approval of the 2015 EAHCP budget.

In accordance with Article 4 of the Funding and Management Agreement, Work Plans and Budgets must be submitted for each of the conservation measures by their respective Implementing Committee member. Work Plans were initially drafted in mid-March and the Implementing Committee has reviewed and discussed these plans at their last five meetings. Additionally, the Science Committee reviewed all of the Work Plans with scientific components and provided comments that were incorporated into the final versions of the Work Plans. All of the Work Plans were approved by consensus by the Implementing Committee on June 19, 2014.

Please note that a 2015 Refugia Work Plan has yet to be submitted by the Edwards Aquifer Authority (EAA). EAA is continuing to negotiate this contract with USFWS and will bring forward a 2015 Work Plan and budget at that time.

In the upcoming weeks, the Edwards Aquifer Authority and Spring Cities will be following their internal procurement process to identify contractors for the activities listed in these Work Plans in order to assemble a Funding Application that will be submitted to the Edwards Aquifer Board of Directors by October 1, 2014 for approval. The Funding Application budgets will be based on the selected contractors for the work.

Please let me know if you have any questions or require any additional information.

Sincerely,

Nathan Pence
Program Manager
Edwards Aquifer Habitat Conservation Plan

# 2015 EAHCP Work Plans

# Edwards Aquifer Authority

2015 Work Plan

# 2015 EDWARDS AQUIFER AUTHORITY
# & SAN ANTONIO WATER SYSTEM
# AQUIFER STORAGE AND RECOVERY

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:** To acquire 50,000 acre-feet of Edwards Aquifer unrestricted agricultural, municipal, and industrial permits as either leases or options, to be made available to SAWS for the purposes of physical storing or crediting the Regional ASR balance.

**Assumptions:** The ASR contract between EAA and SAWS will continue to be implemented. Successful enrollment of Tier I ASR leases in 2014 of 16,667 acre-feet.

**Target for 2015:** To continue providing SAWS with notices of availability of HCP groundwater and to continue to utilize a leasing agent for acquisition of 50,000 acre-feet of Edwards Aquifer water for the ASR program.

**ASR Program**

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

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

Operations: The significant action of approval of the Edwards Aquifer Habitat Conservation Plan Program Interlocal Contract between the Edwards Aquifer Authority and The San Antonio Water System for the Use of the Twin Oaks Aquifer Storage and Recovery Project for contribution to Springflow Protection "Interlocal Contract" effective August 14, 2013 takes elements of the HCP's ASR flow protection strategy into an operations contract.

*Injection*: Storage of HCP groundwater shall be at the discretion of SAWS and will be dependent on operating conditions. All HCP groundwater made available to SAWS before July 1st 2015 will be physically stored or credited as in storage, with the accompanying forbearance from the Aquifer, should triggers defined in the contract be reached.

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

Leasing:
The EAA will continue to acquire Tier 1 leases for the ASR program in 2015 with the initial target acquisition goal of 16,667 acre-feet. The continuing drought has been a challenge to leasing efforts as the market for available groundwater withdrawal rights tights and prices likely to rise. In response to these market conditions, the ASR program expanded leasing options and will more aggressively target EA permit holders who have been historically identified as having available withdrawal rights. In addition, with the phase-out of EAA aquifer management fee rebates for municipal and industrial users, the ASR program is an attractive opportunity for permit holders who wish to capitalize on their un-used withdrawal rights. Once the Tier 1 goal is reached and current market conditions are assessed, further refinements or strategies will be developed to structure Tier 2 and Tier 3 acquisition for the remaining 33,333 acre-feet required by the HCP. The strategy for Tier 2 and Tier 3 acquisition will be presented to the Implementing Committee when determined.

**ASR Regional Advisory Group:** Per section 5.5.1 of the HCP, a 12-person SAWS ASR Regional Advisory Group will meet quarterly to advise SAWS as it makes 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.

**Monitoring**
The EAA will actively manage the interlocal contract with SAWS. The EAHCP staff will additionally continue to work with SARA in acquisition efforts and monitor progress. Status reports and updates will be provided regularly to the Implementing Committee.

**Budget $6,953,000[1,2]**
Actual expenditures for 2015 will be determined by the terms of the ASR contract depending on the quantity of HCP groundwater physically stored, the amount of active water leases, and the cost of eligible operation and maintenance activities. Budgeted money that is not spent will be placed in the reserve fund.

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[1] $4,759,000 (lease acquisition and payment) + $2,194,000 (ASR O/M) = $6,953,000
[2] Actual costs will be determined for 2015 through methods outlined in the Interlocal Contract, and may be more, or less, than budgeted based on operations.

**Edwards Aquifer Authority**
**2015 Regional Water Conservation Work Plan**

### 5.1.3 Regional Water Conservation Program

Table 7.1 Budgeted Amount: $1,973,000

Proposed Work Plan Amount: $1,973,000

The goal of the Regional Water Conservation Program (RWCP) is to conserve 20,000 ac-ft/yr of permitted or exempt Edwards Aquifer withdrawals. In exchange for technical assistance and incentives for implementing the various measures, one-half of the conserved water (10,000 acft) will be committed to remain in the Aquifer unpumped, but still owned by participating permit holders, for 15 years to benefit springflow levels and contribute to species protection. The other one-half of the conserved water will remain available to the participating entity.

In order to provide an immediate benefit to important habitat (by contributing to spring flows), several entities within the EAA jurisdictional area have agreed to reduce their consumptive use by a combined total of 10,000 acre feet. This initial contribution of water rights will serve as a reserve for up to 10 years which were placed in the Groundwater Trust (see Table below):

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

Loaned water rights will be returned to the loaning entity at the end of 10 years or when an equal amount is identified as conserved and in reserve by the RWCP. Loaned water will be returned to the donor entity annually in a proportion equal to their contribution

Loaned water donors that participate in the Program, conserve additional water, and designate the required 50% for the reserve, at the end of the year receive the same amount as this reserved water in return from their loan. The amount returned to the entity in such a case will be subtracted from the reserve total for the year to be divided by the proportional model. The proportional model will be recalculated every year. (see Initial Commitment Contract excerpt below:)

> (c) If Transferor and/or other Non-Contributing Participants have Conserved Water that has been determined to have been conserved in the previous calendar year, Transferor shall be entitled to a release of the Trust Portion of the Permit calculated as follows:

(Paragraph 4.0(a) initial commitment - previous releases to the Transferor)/(10,000 - previous releases to all Transferors) x 50% of the amount of Conserved Water conserved in the previous calendar year by the Transferor and/or Non-Contributing Participants.

(d) For the calculations in subsections (c), if the Non-Contributing Participant is the owner of an Exempt Well, the 50% factor will be replaced by 100% when making the calculation.

The remaining 10,000 acre feet will be saved through water loss reduction and conservation efforts identified by Texas AgriLife (AgriLife) staff while under contract with the EAA to manage and implement the RWCP.

The RWCP will provide communities in the Edwards Aquifer Region with water system assessments which are designed to identify opportunities for water conservation. After an assessment is completed, the Edwards Aquifer Authority (EAA) will contract with the community to implement conservation opportunities identified. Implementation may include low flow toilet and showerhead distribution to residents, retrofitting large scale water users, and providing education and assistance to exempt well users.

**Long Term Objective:** To conserve and reduce water use by 20,000 acre feet from the Edwards Aquifer by identifying water system infrastructure rehabilitation and replacement needs, installation of residential water saving fixtures, public education, and partnering with high volume water users (schools, hospitals, etc.) to reduce water use by replacing low efficiency fixtures with high-efficiency toilets, shower heads, aerators, and alternatives to kitchen rinsers and other water-using equipment and processes.

**Assumptions:**

The EAA will continue to maintain an Interlocal Cooperation Agreement with AgriLife to manage and implement the RWCP.

AgriLife will represent and act on behalf of the EAA to assist Edwards Aquifer region water users in implementing the incentive programs described in the EAHCP.

**Target Performance Measures for 2015:**

In order to achieve the goal of 10,000 acre feet in the Groundwater Trust by the end of 2015, the EAA (or its contractor) will complete the following measures:

1. AgriLife will continue to contact communities from the matrix developed in 2013 until at least three (3) municipalities willing to allow AgriLife to conduct a water conservation assessment of their water system and participate in the four RWCP elements are identified.

2. AgriLife will schedule and conduct a minimum of three (3) water conservation assessments.

3. EAA will initiate contracts with program participants that will serve as the funding mechanism for EAA to implement the RWCP elements specific to the community and its needs.

4. AgriLife will submit deliverables for 3 communities to the EAA per the Interlocal Cooperation Agreement including:

    - Quarterly RWCP Reports
    - Lost Water and Leak Detection BMPs and Resource Materials
    - Lost Water and Leak Detection Procedures and Forms
    - High-Efficiency Plumbing Distribution Procedures and Forms
    - Commercial/Industrial Retrofit Rebate Procedures and Forms
    - Reclaimed Water Rebate Procedures and Forms
    - Reclaimed Water BMPs and Resource Materials
    - AgriLife Extension Agent EAHCP and RWCP Orientation Materials

5. AgriLife will expand the search for reuse and industrial technology opportunities in the EA Region. When appropriate, AgriLife will provide seminars to industry leaders to inform them of the RWCP and describe opportunities that may exist.

6. AgriLife will expand the "lost water" program and develop the internal capability to assist communities that need a preliminary lost water analysis and do not have the financial resources to pay for the services. If the presence of significant leaks are identified, AgriLife will coordinate with SAWS or other resources as per the HCP to locate and quantify leaking infrastructure. Once complete, AgriLife will provide conceptual level cost estimates to the municipality to repair the leaks. If agreeable to placing 50% of the water conserved by repairing the leaking infrastructure, and the costs are justifiable in terms of program goals, EAA will develop a contract with the municipality to assist in funding all or part of the leak repair.

7. AgriLife will seek appropriate partners and organize a reuse program in a designated geographic area with the Edwards Region to promote the large-scale use of treated effluent, greywater, rainwater catchment, and AC condensate. The effort will be staffed partially or entirely with Texas AgriLife personnel as per the HCP.

8. AgriLife will work with communities and their existing environmental groups (i.e. Parks Board) to develop a water conservation program that includes stakeholder support.

9. AgriLife will contact the Cities of New Braunfels, San Antonio, and San Marcos to discuss opportunities for low-flow, high efficiency plumbing distribution, cost sharing in treated effluent projects, etc.

10. AgriLife will seek opportunities to assist communities in accessing Texas Water Development Board funding such as Proposition 6 for opportunities for EAA to participate in cost sharing in exchange for water savings being placed in the GW Trust.

**Methodology:**

This work plan will be implemented through an Interlocal Cooperation Agreement between the EAA and AgriLife. The Contract was executed on January 1, 2013 will expire December 31, 2017.

**Budget for Implementing 2015 Regional Water Conservation Work Plan:** The requested budget for the Regional Water Conservation work plan is $986,500 (see Table).

| AgriLife 2015 Contract Costs | Funds Allocated for Community Program Implementation | Total Budgeted Funds (Table 7.1) |
|---|---|---|
| $200,000 | $1,773,000 | $1,973,000 |

**Monitoring:**

- Communities that have elected to contract with the EAA for program implementation will be required to provide an accounting of low flow devices (i.e. low flow toilets, and showerheads) that have been distributed to residents.

- Texas AgriLife staff will provide photo documentation of the implementation of the program. EAA staff will periodically accompany Texas AgriLife staff during routine visits of distribution centers, etc.

- Texas AgriLife will report estimated water savings to the EAA.

**Science Committee Review:** Not applicable to this work plan

**Regional Conservation Monitoring Committee Review:** Does require review of the work plan.

## NARRATIVE & BUDGET

**HCP Measure 5.1.2 - Voluntary Irrigation Suspension Program Option**

A Voluntary Irrigation Suspension Program Option (VISPO) has been included as one of the Flow Protection Measures in the approved Edwards Aquifer Habitat Conservation Plan (EAHCP) to reduce aquifer pumping demands during specified critical periods to improve aquifer levels and provide additional springflow for the protected species, and their habitats. The goal of VISPO is to enroll 40,000 acre-feet of permitted irrigation rights (base and/or unrestricted) that will remain unused in years of severe drought. Permit holders will be compensated for the water enrolled in the program. 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 cost of the VISPO is estimated to be $4,172,000 annually for the life of the EAHCP. The annual estimate is based on a combination of factors, including an implementation probability analysis and an enrollment estimate of the percentage of permittees that would enroll in the five-year versus the ten-year program (this estimate is based on a ratio resulting from a 2011 informal survey that showed 65% of permittees would opt for the five-year program and 35% would opt for the ten-year program). It should be noted that enrollment as of October 1, 2013 shows a different trend, with 51% of enrollees favoring the five-year option and 49% of enrollees favoring the ten-year option.

**Long-term Objective:** The enrollment volume goal for the VISPO program is 40,000 acre-feet of groundwater withdrawal rights.

**Assumption:** VISPO will achieve the enrollment goal of 40,000 AF in 2014.

**Activities in 2015:** Activities for 2015 will focus on watching J-17 trigger levels on October 1, of 2014. Should VISPO trigger, there will be a communication effort with VISPO enrollees to ensure all are aware and understand their individual commitments to VISPO. In the unlikely event that VISPO does not reach 40,000 acre-feet in 2014, acquisition of forbearance agreements will continue in to 2015.

**Allocated budget for 2015** **$4,172,000**

Annual funding for VISPO in the EAHCP is estimated by using an approximate ratio of enrollment in the five-year and ten-year options and a probability estimate averaged for a ten-year period. For 2015, expenses will be estimated using the enrollment percentages in the 5-year and 10-year programs for 2013 (51% five-year and 49% ten-year &) and an estimated total enrollment of 40,000 acre-feet.

- **Stand-by payment**

| | |
|---|---|
| 5-Year | |
| 11,385 AF X $50.75/AF (2nd year) | $577,789 |
| 9,015 AF X $50.00/AF (1st year) | $450,750 |
| Subtotal | $1,028,539 |
| | |
| 10-year | |
| 19,600 X $57.50/AF | $1,127,000 |
| | |
| Total Stand-by | $2,155,539 |

- **Implementation payment**

| | |
|---|---|
| 11,385 AF X $152.25/AF (2nd year) | $1,733,366 |
| 9,015 AF X $150.00/AF (1st year) | $1,352,250 |
| Subtotal | $3,085,616 |
| | |
| 10-year | |
| 19,600 X $172.50/AF | $3,381,000 |
| | |
| Total Implementation | $6,466,616 |

- **Total Estimated Expenses**

| | |
|---|---|
| If VISPO is not triggered | $2,155,539 |
| If VISPO is triggered | $8,622,155 |

## HCP § 6.3.1 – 2015 BIOLOGICAL MONITORING WORK PLAN

**Introduction/Overview:** Since 2000, the Edwards Aquifer Authority (EAA) has conducted an extensive biological monitoring program in the Comal and San Marcos spring systems. This program was referred to as the Variable Flow Study[1] (VFS). The elements of this study have now been incorporated into the Edwards Aquifer Habitat Conservation Plan (EAHCP) as the Biological Monitoring Program (BioMP). EAHCP § 6.3.1.

The EAA developed the VFS in collaboration with a Technical Advisory Group consisting of resource specialists/scientists from multiple entities and with input from other natural resource professionals from the Texas Parks and Wildlife Department (TPWD), United States Fish and Wildlife Service's (FWS) Austin Ecological Services and National Fish Hatchery and Technical Center, and scientists from the Edwards Aquifer Research and Data Center, and Texas State University (*see* BIO-WEST, "Variable Flow Study: Seven Years of Monitoring and Applied Research," 2007). The VFS consisted of a comprehensive sampling program conducted in the spring, summer, fall, and winter.[2] *Id.* The VFS also included a Critical Period component for both the Comal and San Marcos systems based on established trigger levels (including high and low flows) for each. *Id.* The Critical Period component essentially mirrors efforts made during Comprehensive Sampling Plan except at a greater frequency triggered by low flows. *Id.*

During the development of the EAHCP, additional components were added to the VFS in 2013, creating the BioMP. The additional components were developed through discussions between scientists involved with the EARIP process including Thom Hardy, Ed Oborny and scientists from Texas State University, Baylor University, TPWD, San Antonio Water System, and the FWS.

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.

**Long-term Objective:** The EAHCP establishes that 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). Although not expressly stated in the EAHCP, another purpose that will be served by the BioMP is to collect data that can be used

[1] EAA, "The Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the Comal and San Marcos Springs Aquatic Ecosystems," 2000.
[2] In 2003, the winter sampling was eliminated from the Comprehensive Plan. In 2005, the Comprehensive Sampling Program was amended. The spring and fall events remained the same. During the summer, the Comprehensive Sampling Program included only Texas wild-rice annual mapping, dip net sampling for fountain darter, and parasite evaluations.

in the applied environmental research studies (EAHCP § 6.3.4) and provide data and information for the ecological model development described in EAHCP § 6.3.3.

**Assumptions:** It is assumed that the 2014 biological monitoring has been completed. In addition, it is assumed that the contractor will coordinate all monitoring activities with the implementation of any Conservation Measures.

**HCP Science Committee:** The BioMP methodologies and scope of work was reviewed and slightly modified by the Science Committee.

**Target for 2015:** Following renewal of the contract, the contractor will implement the BioMP for the San Marcos and Comal spring systems.

**Elements of the 2015 Biological Monitoring Program:** The BioMP consists of a Comprehensive Sampling Program that will be conducted in the fall and spring of 2015. During the summer, the only elements of the Comprehensive Sampling program that will be conducted are Texas wild-rice mapping, dip netting for fountain darters, and parasite evaluations. The 2015 Comprehensive Sampling Program will consist of the following elements:

- **Aquatic Vegetation Mapping, Including Texas Wild-Rice:** Aquatic vegetation mapping, including Texas wild-rice, will be conducted each spring and fall in four representative reaches in the Comal Springs system (Upper Spring reach, Landa Lake reach, Old Channel reach, and New Channel reach) and in three representative reaches in the San Marcos Springs system (Spring Lake Dam reach, City Park reach, and IH-35 reach). Vegetation stands less than 0.5 meters in diameter will not be mapped. The location of the reaches is shown in Attachments 1 and 2. This includes both the physical mapping in the field and map preparation using GIS.

  Full system aquatic vegetation mapping occurred in 2013 and will not occur again until 2018; therefore, it is not included in this Work Plan. Full system mapping included the San Marcos River from Spring Lake to the confluence with the Blanco River and the Comal River from Upper Spring Run reach to the confluence with the Guadalupe River.

- **Annual Texas Wild-Rice Mapping.** Texas wild-rice mapping will be conducted each summer in the San Marcos River from the Spring Lake Dam to the river's confluence with the Blanco River. In addition, surveys will be conducted in the upper stretch of the San Marcos River to identify, map, and record any stands of Texas wild-rice that appear to be in vulnerable areas. Texas wild-rice stands will be considered to be vulnerable if they: 1) occur in shallow water; or 2) possess

extreme root exposure due to scouring of substrate; or 3) appear to be in poor condition. Measurements will be taken at each stand of Texas wild-rice that is considered to be located in a vulnerable area. Measurements will include the maximum length and width of each stand. Water depth and flow measurements will be taken at each stand.

- **Fountain Darter Sampling:** Dip and drop netting and visual aquatic surveys with SCUBA will be conducted in the spring and fall. Additional dip net sampling will be conducted in the summer.
  Drop Net Sampling:
  - Drop nets will be placed in specific aquatic vegetation types that have been selected through stratified random methods. Aquatic vegetation will be mapped in the following reaches prior to drop net activities.

| Reach | Number of Sites | Vegetation |
|---|---|---|
| San Marcos River | | |
| • City Park Reach | 8 | hygrophila, hydrilla, vegetation complexes |
| • IH-35 reach | 8 | hygrophila, hydrilla, cabomba |
| • Spring Lake Dam Reach | 8 | hygrophila, hydrilla, vegetation complexes |
| Comal River | | |
| • Upper Spring Run Reach | 6 | hygrophila, sagittaria, bryophytes |
| • Landa Lake Reach | 10 | hygrophila, ludwigia, vallisneria, cabomba, bryophytes |
| • Old Channel Reach | 6 | algae, ludwigia, hygrophila |

Fountain darters will be identified, enumerated, measured, and returned to the river at the point of collection. All darters collected in the drop net monitoring will be examined visually for evidence of gill parasites.[3] Other fish will be identified and released or preserved and identified in a laboratory. All live ramshorn snails will be counted, measured, and destroyed. Exotic Asian snails (*Melanoides tuberculata* and *Thiara granifera*) and Asian clam (*Corbicula sp.*) will be identified and general abundance recorded. At each location the vegetation type, height, areal coverage, substrate type, mean column velocity, velocity at 15 cm above

[3] In addition, the City of New Braunfels will monitor for gill parasites as part of the requirements in EAHCP § 5.2.6. The monitoring program will evaluate cercarial concentrations in multiple areas along the Comal River on a semiannual basis and more frequently when springflow drops below 150 cfs. *See* EAHCP § 6.3.6.

the bottom, water temperature, conductivity, and dissolved oxygen levels will be recorded.

- Dip Net Sampling: Dip netting involves timed surveys as well as presence/absence surveys in specified reaches throughout the spatial extent of both systems. All darters collected in the dip net monitoring will be examined visually for evidence of gill parasites.
- With respect to the timed sampling, a standard time is set for sampling each reach that will be maintained throughout the study.

| San Marcos River | Survey Time | Comal river | Survey Time |
|---|---|---|---|
| Hotel reach | 0.5 hours | Upper Spring Run reach | 0.5 hours |
| City park reach | 1 hour | Spring Island area | 0.5 hours |
| IH-35 reach | 1 hour | Landa Lake reach | 1 hour |
| Todd Island reach | 1 hour | New Channel reach | 1 hour |
| | | Old Channel reach | 1 hour |
| | | Garden Street reach | 1 hour |

- Fountain darters will be identified, enumerated, measured, and returned to the river at the point of collection.
- Dip net presence/absence surveys will be conducted at 50 sample sites within four representative reaches at Comal Springs (Upper Spring reach, Landa Lake reach, Old Channel reach, and New Channel reach) and three representative reaches in San Marcos Springs (Spring Lake Dam reach, City Park reach, and IH-35 reach). Four "dips" will be conducted at each sample site.
- Visual aquatic surveys will be conducted using SCUBA in fixed locations in Landa Lake and Spring Lake to identify fountain darters at depth deeper than conventional sampling methods allow.

- **Comal Springs Invertebrate Sampling (Comal Springs riffle beetle, Peck's Cave amphipod and Comal Springs dryopid beetle):** Sampling for Comal Springs invertebrates will be conducted in the spring and fall.
  - Drift nets will be placed on the spring orifices of the major Comal Springs, samples will be collected, transferred to an off-site laboratory, and the contexts characterized taxonomically.

- Additional riffle beetle sampling will be conducted in Spring Run 3, western shoreline of Landa Lake, and Spring Island area. At each spring site, 10 springs in potential habitat will be sampled using a cotton lure. Detailed photodocumentation of the wetted perimeter and available habitat will be conducted. Lures will be in place for approximately four weeks, then removed. Beetles will be identified, counted, and returned to their spring of origin. Water depths, current velocity, dissolved oxygen, and temperature also will be measured at each location.

- **Salamander Visual Observations:** Salamander sampling will be conducted in the spring and fall. Salamanders observed within the Comal system will be noted along with time, location, habitat type, and water depth. Salamanders observed in the San Marcos system will be noted along with the substrate composition. The sampling will occur in the following locations:
  - Observation for the San Marcos Salamander will occur at three locations (one below Spring Lake Dam [snorkel] and two within Spring Lake [SCUBA])
  - Observation for the Comal Salamander will occur at three locations (Spring Runs 1 and 3, and Spring Island area).
  - In both systems, the salamanders will be observed and no collection will occur.

- **Comal Springs Discharge Measurements:** To supplement USGS discharge sampling Comal Springs discharge measurements will be conducted spring and fall. The measurements will conducted at Spring Runs 1, 2, and 3, Upper Spring Run reach, and the Old Channel below Elizabeth Street. The measurements 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:** – standard parameters and fixed-station temperature loggers
  - Water quality sampling for standard parameters (temperature, conductivity, pH, and dissolved oxygen) will be conducted in the spring and fall at eighteen stations longitudinally distributed in the San Marcos system and twelve stations longitudinally distributed in the Comal system. The sampling sites are shown in *See* Attachments 1 and 2. All of the standard parameters will be measured at the surface, mid-depth and near bottom, if there is stratification. Additional sampling for nitrates, total nitrogen, ammonium, soluble reactive phosphorous, total phosphorus, alkalinity, and total suspended solids will be conducted as warranted.

- The EAA will conduct additional water quality sampling as required by EAHCP § 6.2.[4]
- Temperature data will be recorded via eleven thermistors longitudinally distributed in the San Marcos system and thirteen thermistors longitudinally distributed twenty continuous data loggers in each system, and will be downloaded at least once every six months.

- **Fixed Station Photography:** Fixed station photography will be conducted in the spring and fall at each established water quality/thermistor site in both the Comal and San Marcos systems. The photographs will typically involve an upstream, across, and downstream photograph of the reach and capture key changes in the habitat in the reach. Any identified changes will be recorded.

- **Flow Partitioning within Landa Lake:** Additional flow partitioning will be monitored within Landa Lake during each Comprehensive Sampling event.[5] The measurements will be made during the spring and fall. This element will provide a better understanding of the spring flow influence within Landa Lake as upwelling flow within Landa Lake plays a role in understanding Comal Springs riffle beetle survival during low-flow events.
  - An Acoustic Doppler profiler or similar device will be used to measure the flow patterns and current velocities from Spring Island through the upper portion of Landa Lake will be measured concurrently with BioMP discharge measurements at Comal Springs.

- **Macroinvertebrate Food Source Monitoring:** Macroinvertebrate food source monitoring will be conducted during the spring and fall to better understand the food source base for fountain darters in each system and how that food base responds to varying flow conditions.
  - The sampling will occur within the City Park, IH-35 and Spring Lake Dam reaches on the San Marcos River, and the Upper Spring Run, Landa Lake, New Channel, and Old Channel reaches on the Comal River
  - Samples will be collected in triplicate from 3 vegetation types (based on majority of species present or adjusted based on fountain darter habitat quality) within each of the seven study reaches for a total of 63 samples per event. Macroinvertebrate samples will be preserved and transferred to a lab for processing.

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[4] For the details of the water quality monitoring program see, EAHCP, "Work Plan: Water Quality Monitoring Program Strategy for Comal Springs and San Marcos Springs for 2014," April 15, 2013.

[5] The Edwards Aquifer Authority plans to conduct flow partition monitoring using an Acoustic Doppler profiler. This task in the Work Plan will be evaluated once the EAA program is developed, to ensure that the two programs are coordinated to operate cost-effectively and to avoid duplication of effort.

- Sample methods will take into account habitat disturbance and will minimize disturbance to maximum extent possible.

- **Edwards Aquifer Diving Beetle and Texas Troglobitic Water Slater** The macroinvertebrate sampling will also gather baseline data on the two non-listed macroinvertebrate species, the Edwards Aquifer diving beetle, and Texas troglobitic water slater that are covered in the EAHCP.

- **Fish Community Sampling For Native Fish:** In coordination with BioMP sampling, fish community sampling for native fish will be conducted in the spring and fall to provide a fishery evaluation of the overall aquatic ecosystem. The information may assist in describing cause and effect relationships with fountain darter abundances over time.
  - Using seines and SCUBA fisheries surveys in both the Comal and San Marcos systems will be conducted as follows:
  - Two locations within Spring Lake associated with San Marcos Salamander surveys (Big riverbed and hotel area) will be sampled for fish via SCUBA transect surveys. Five locations spatially located between Spring Lake Dam and the confluence of the Blanco River will be sampled by seining to evaluate and track native fish populations in the San Marcos River over time.
  - Similarly, one location in Landa Lake associated with fountain darter belt transect surveys will be expanded to include a transect survey for all fish via SCUBA. Additionally, three locations (Upper Spring Run, New Channel, and Old Channel) will be sampled via seines to evaluate and track native fish populations in the Comal River over time.
  - Underwater observation transects will occur from downstream to upstream with 5 meter transects arranged parallel to the shoreline. Underwater observers will work each 5 meter transect from the downstream position moving upstream (*i.e.*, moving into the flow). Fish within each transect will be identified, measured, examined for disease, and returned to the river.
  - In addition to collected data on fish, each seine haul will include data on the velocity, depth, substrate composition, in stream coverage, climatic conditions, and mesohabitat typing of the site at the time of the observation.
  - All non-native fish collected during seine hauls will be removed from the system per scientific permit requirements.
  - Records will be kept as to the non-native species encountered and relative quantity.

- Reporting

  EAA will require its contractor to submit monthly progress reports to EAA describing the contractor's activities conducted during the previous month. The contractor will be required to submit an annual report no later than December 31, 2015, that provides all of the sampling activities conducted for the year period and an evaluation of the results of those activities, and a cumulative evaluation of the data collected since 2000 for the BioMP and its predecessor VFS program. In evaluating the data, the contractor will be required to evaluate the effects of any ongoing Conservation measures on the results of the monitoring program. Sufficient tables, graphs, and exhibits will be provided in the text to clearly indicate what data was collected, the location, and the analytical data. As an appendix to the written report, copies of completed field logbooks and copies of the raw data sheets for all water chemistry and biological sampling will be included.

**Elements of the Critical Period and EAHCP Components of the BioMP**

In the low flow Critical Period monitoring component of the BioMP, the frequency of the Comprehensive Sampling changes when certain flow triggers are reached. In the San Marcos system, the Texas wild-rice physical observations from the Comprehensive Sampling component are triggered when flows at the springs reach 120 cfs. All Comprehensive Sampling elements are implemented when flows reach 100, 85, 60, 25, and 10-0 cfs. Beginning at 100 cfs, habitat evaluations consisting of observing the habitat in the system and documenting those observations photographically will occur each time the flows decrease 5 cfs, but will not occur more frequently than once a week.

In the Comal system, the full Comprehensive Sampling component will be implemented at 200, 150, 100, 50, and 10-0 cfs. In addition, starting at 100 cfs habitat evaluations consisting of observing the habitat in the system and documenting those observations photographically will occur each time the flows decrease 10 cfs, but will not occur more frequently than once a week. The Comal Springs riffle beetle sampling element will be implemented when flows decline to 120 cfs and continued in 10 cfs increments during any continued decline.

In addition, during the Critical Period component, a gill net evaluation will be conducted in Spring Lake and Landa Lake for preliminary examination of exotic fish concentrations and for stomach content analyses with respect to predation of list species. The number of each species (native and non-native) collected in the gill net will be recorded. Finally, the full Comprehensive Sampling elements will be conducted twice as the Comal and San Marcos systems rebound from low-flows.

The elements of the EAHCP component of the BioMP will be conducted when flows reach predefined trigger levels defined by the EAHCP in Section 6.4. This sampling, which is in addition to the Comprehensive and Critical Period components, consists of an increased frequency of sampling for aquatic vegetation and Texas wild-rice mapping and fountain darter, Comal Springs riffle beetle, salamander, and water quality sampling. The increased mapping and sampling are summarized in Attachments 3 and 4.

It is likely that some of the sampling dates of the three components of the BioMP will coincide with each other during low flow periods. Efforts will be made to coordinate sampling events when they are closely-related temporally so as to prevent duplicative sampling events.

**Incidental Take Permit: Permit Conditions, Habitat Baseline, and Take Estimation.**
Section 11.H of the Incidental Take Permit (ITP) sets out the terms and conditions and incidental take protection provided for each covered species over the 15-year term of the permit. The ITP requires the permittees to document compliance with the ITP. To quantify the amount of take per species, the USFWS allows the use of habitat as a surrogate for population number. The BioMP contractor will provide the sampling necessary to establish a baseline of suitable and occupied habitat at the end of each year to be used in documenting compliance with the ITP. The baseline will be used in the subsequent year as the beginning baseline and may be used in the current year to establish a delta if other methods are insufficient.

**Budget for Implementing 2014 BioMP:**

| | |
|---|---|
| *Table 7.1* | *$400,000* |
| *2015 Work Plan* | *$417,029* |

The EAHCP budgeted amount for the BioMP (Comprehensive Sampling component and EAHCP Chapter 6 drought triggered monitoring) is $417,029 for the Comal and San Marcos systems. The cost of any Critical Period component of the BioMP as established by the former EAA Variable Flow Study will continued to be paid by the EAA (Attachment 5).

Attachment 1

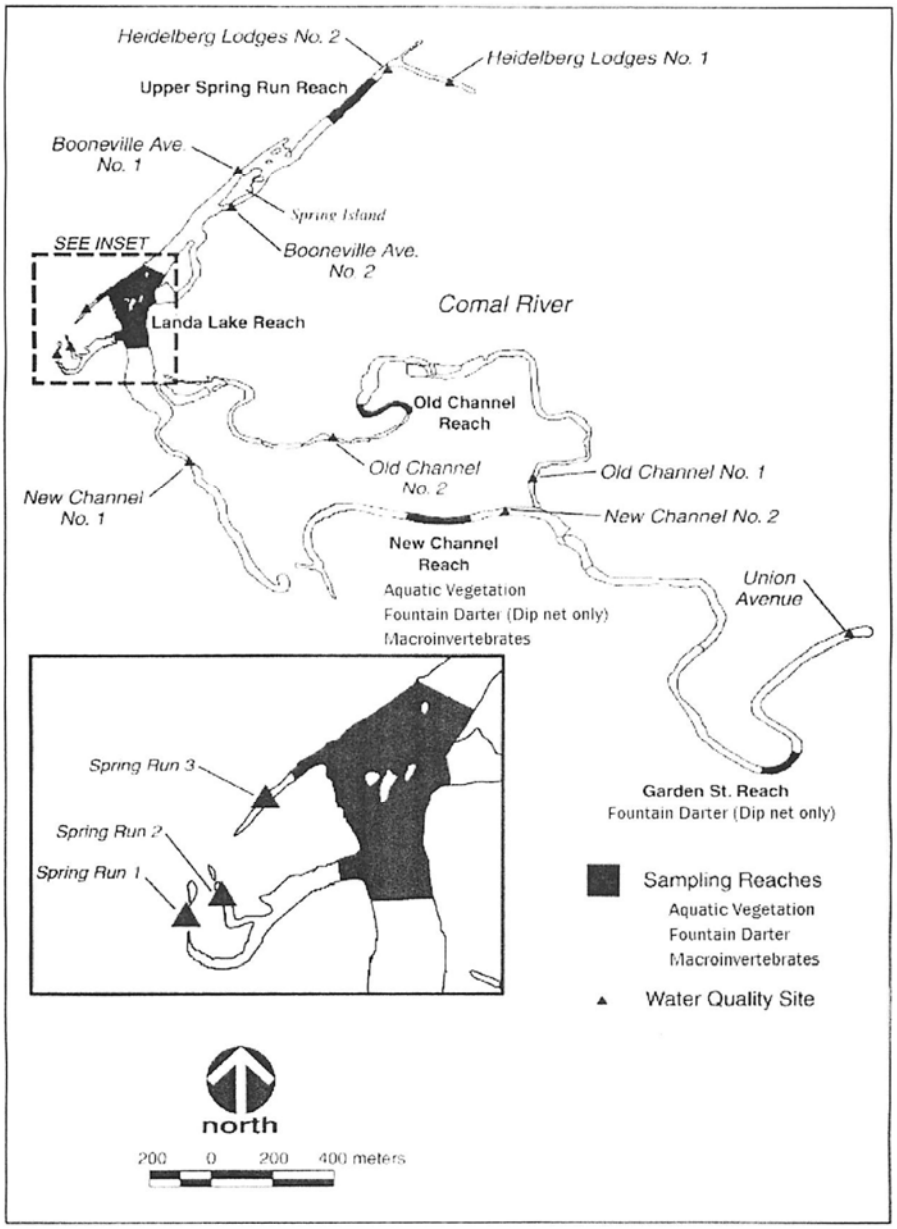
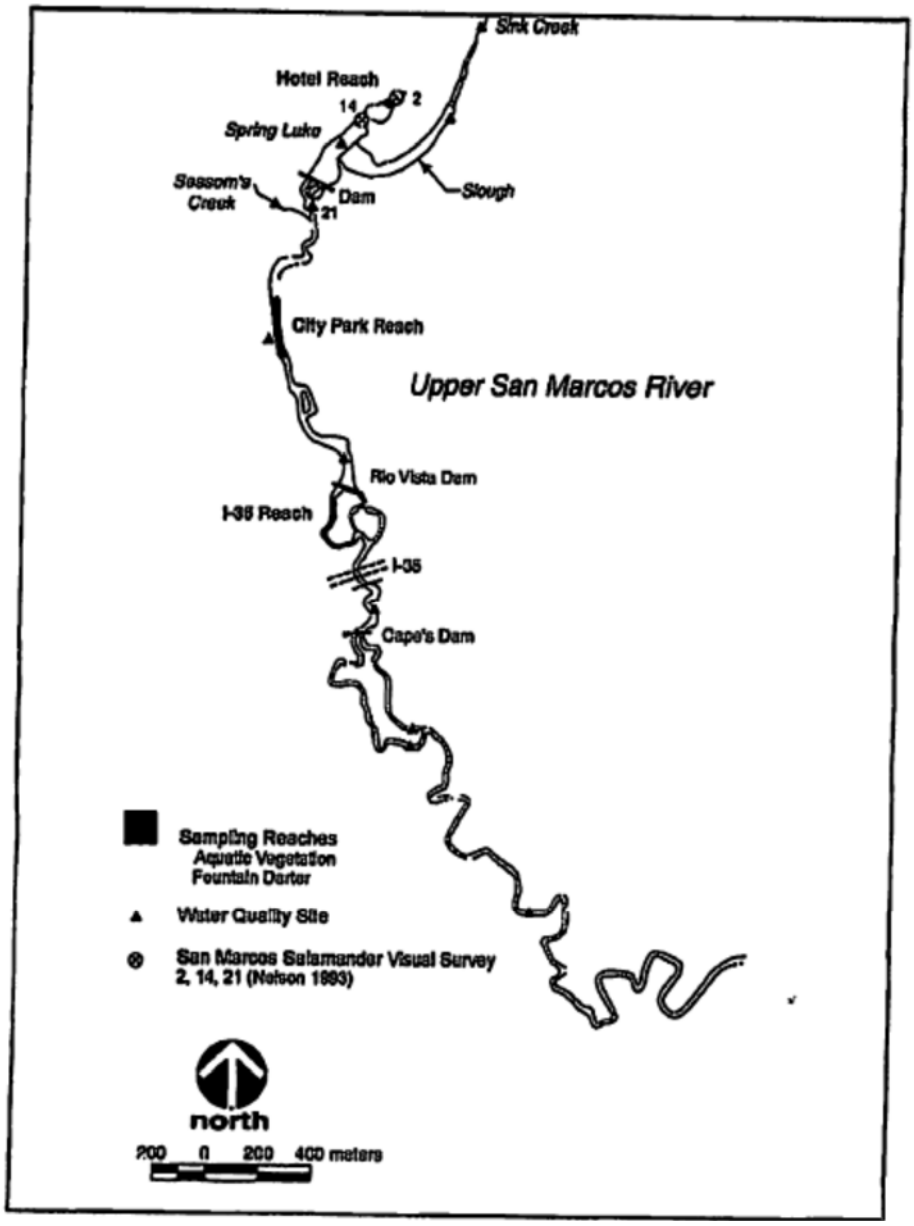



**Figure 1.** Comal River water quality and biological sampling stations.

Attachment 2



Attachment 3
UPPER SAN MARCOS RIVER/SPRINGS
EAHCP MONITORING - LOW FLOW SCHEDULE (Added 2/2013)

| **Flow Rate (+ or - 10 cfs)** | **Species** | **Frequency** | **Parameter** |
|---|---|---|---|
| ≤80 cfs or ≥ 50 cfs continuing until flow rate restores to ≥100 cfs | fountain darter | every other month | Aquatic vegetation mapping at Spring Lake Dam reach, City Park reach, and IH-35 reach. |
| ≤80 cfs or ≥ 50 cfs continuing until flow rate restores to ≥100 cfs | fountain darter | every other month | Conduct dip net sampling/visual parasite evaluations at 50 sites in high quality habitat to include twenty (20) sites in Spring Lake; ten (10) sites in Spring Lake Dam reach; ten (10) sites in City Park reach, and ten (10) sites in IH-35 reach. |
| ≤50 cfs | fountain darter | monthly | Aquatic vegetation mapping at Spring Lake Dam reach, City Park reach, and IH-35 reach. |
| ≤50 cfs | fountain darter | weekly | Conduct Dip net presence/absence sampling/visual parasite evaluations at 50 sites in high quality habitat to include twenty (20) sites in Spring Lake; ten (10) sites in Spring Lake Dam reach; ten (10) sites in City Park reach, and ten (10) sites in IH-35 reach. |
| ≤80 cfs or ≥ 50 cfs | San Marcos salamander | every other week | Salamander surveys (SCUBA and snorkel) will be conducted at the Hotel Area, Riverbed area, and eastern spillway of Spring Lake Dam. |
| <50 cfs | San Marcos salamander | weekly | Salamander surveys (SCUBA and snorkel) will be conducted at the Hotel Area, Riverbed area, and eastern spillway of Spring Lake Dam. |
| 100 cfs | Texas wild-Rice | once | Mapping of Texas wild-rice coverage for the entire San Marcos River will be conducted. |

| | | | |
|---|---|---|---|
| ≤100 cfs or ≥60 cfs | Texas wild-rice | every other week | Physical parameters of Texas wild-rice will be monitored in designated “vulnerable” areas. |
| <80 cfs | Texas wild-rice | monthly | Mapping of Texas wild-rice coverage for the entire San Marcos River will be conducted. |
| <80 cfs | Texas wild-rice | weekly | Physical visual observations of Texas wild-rice will occur. |

Attachment 4
COMAL RIVER/SPRINGS
EAHCP MONITORING FLOW SCHEDULE (Revised 1/2013)

| **Flow Rate (+ or - 5 cfs)** | **Species** | **Frequency** | **Parameter** |
|---|---|---|---|
| ≤150 or ≥80 cfs | fountain darter | every other month | Aquatic vegetation mapping to include Upper Spring Run reach, Landa Lake, Old Channel reach, and New Channel reach. |
| ≤150 or ≥80 cfs | fountain darter | every other month | Conduct Dip net sampling/visual parasite evaluations at five (5) sites in the Upper Spring Reach; twenty (20) sites in Landa Lake; twenty (20) sites in the Old Channel reach and; at five (5) sites in the New Channel reach. |
| ≤60 cfs | fountain darter | weekly | Conduct Dip net sampling/visual parasite evaluations at five (5) sites in the Upper Spring Reach; twenty (20) sites in Landa Lake; twenty (20) sites in the Old Channel reach and; at five (5) sites in the New Channel reach. |
| ≤60 cfs | fountain darter | monthly | Aquatic vegetation mapping at Upper Spring Run reach, Landa Lake, Old Channel reach, and New Channel reach |
| ≤120 cfs | riffle beetle | every 2 weeks | Monitoring via cotton lures at Spring Run 3, western shore of Landa Lake, and Spring Island upwelling |
| ≤120 cfs or ≥80 cfs | salamander | every other week | Salamander snorkel surveys will be conducted at three sites (Spring Runs 1 and 3 and the Spring Island area) |
| ≤80 cfs | salamander | weekly | Salamander snorkel surveys will be conducted at three sites (Spring Runs 1 and 3 and the Spring Island area) |

Attachment 5

BUDGET ESTIMATE FOR A COMPREHENSIVE BIOLOGICAL MONITORING PROGRAM FOR COMAL AND SAN MARCOS SPRINGS ECOSYSTEMS

| TASK | ESTIMATED COST |
|---|---|
| COMPREHENSIVE SAMPLING PROGRAM | |
| Task 1. Literature Review | $ 0 |
| Task 2. Aquatic Vegetation Mapping | $ 56,833. |
| Task 3. Texas wild-rice Mapping | $ 14,513. |
| Task 4. Fountain Darter Sampling | $ 82,837. |
| Task 5. Comal Springs Invertebrate Sampling | $ 47,582. |
| Task 6. Salamander Visual Observations | $ 23,683. |
| Task 7. Comal Springs Discharge Measurements | $ 4,539. |
| Task 8. Water Quality Sampling | $ 4,190. |
| Task 9. Fixed Station Photography | $ 2,154. |
| Task 10. Flow Partitioning in Landa Lake | $ 18,679. |
| Task 11. Macroinvertebrate Food Source Monitoring | $ 68,754. |
| Task 12. Fish Community Sampling | $ 59,613. |
| Task 13. EAHCP Habitat Baseline and Disturbance | $ 14,822. |
| Task 14. Annual "Take" Estimation | $ 18,830. |
| Comprehensive Subtotal | $417,029. |
| CRITICAL PERIOD SAMPLING PROGRAM | |
| Task 15. High/Low Flow Monitoring | $217,384. |
| Task 16. EAHCP Low Flow Sampling Program | $108,693. |
| Critical Period Subtotal | $326,077. |
| **TOTAL PROJECT COST** | **$743,106.** |

# 2015 Water Quality Monitoring Program Strategy for Comal Springs and San Marcos Springs in Support of the Edwards Aquifer Habitat Conservation Plan

**March 25, 2014**

**Prepared by**

**Edwards Aquifer Authority**

## INTRODUCTION

This Work Plan details the sampling strategy and protocols for surface water quality monitoring in 2015 for the Edwards Aquifer Habitat Conservation Plan (EAHCP) document (Section 5.7.2) implemented by the Edwards Aquifer Authority (EAA), utilizing a third party contractor. The goal of the water quality monitoring program, first implemented in 2013, is to detect water quality impairments that may negatively impact the listed species. In the event that certain constituents of concern are detected at levels indicating the potential for adverse effects, the Implementing Committee member with jurisdictional authority will be consulted to identify sources and consider Best Management Practices (BMPs) to reduce and/or eliminate the constituents of concern. If necessary, additional testing could be included in the current or following year to assist in determining the source of contamination and the Science Committee could be consulted to assist with BMP identification and source determination.

## SCOPE OF WORK

The Water Quality Monitoring Program described below includes surface water, storm water, groundwater, and sediment sampling within Comal Springs and San Marcos Springs and associated river systems. Sample collection and analyses performed by EAA staff in 2013, has been performed by a contractor since 2014.

For 2015, the contractor will use the same sampling locations used in 2014 and as shown in the attached figures. However, changes in springflow, surface water runoff, land use, site security and access may dictate minor modification to sample collection locations and schedules as sampling efforts progress. Any minor changes resulting from these factors that are necessary as a result of safety or equipment concerns will be noted in the field sample sheets and dedicated field books. Should logistics or safety issues require any significant changes to this workplan, the sampling contractor shall report those issues to the EAA. Subsequently, the EAA will present those changes to the Science and Implementing committees for review and approval as needed prior to their implementation.

## COMAL SPRINGS

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

Discharge measurements have been collected from Comal Springs since 1933 and the EAA has been collecting water quality samples for more than ten years. In recent years, the EAA has been collecting samples from Spring 1, Spring 3, and Spring 7 on a quarterly basis during normal flow conditions and on a monthly basis when the San Antonio pool critical period triggers have been reached. Spring 1, Spring 3, and Spring 7 discharge into Landa Lake and make up part of the Comal Springs complex. Figure 1 indicates these historical groundwater sampling locations. Water quality samples are collected and analyzed for: dissolved oxygen (DO), pH, conductivity, and temperature, in the field and for alkalinity[1]. Samples are also submitted to the EAA contract laboratory for analysis of cations, anions, nutrients, metals, VOCs, SVOCs, herbicides and pesticides, bacteria, TOC, PCBs, and phosphorous. This list of parameters is defined as the water quality analytical list (WQAL).

### Sampling Methods

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

### EAHCP Surface Water Sampling Locations

To comply with sampling requirements outlined in the EAHCP, five additional surface water sampling locations (Figure 2) were identified in the 2013 EAHCP Water Quality Work Plan for intensive monitoring in the Landa Lake and Comal River area as listed below:

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

[1] Alkalinity analysis will be conducted within eight hours of sample collection.

**Surface Water Sampling Frequency**

In 2015, water samples will be collected twice from each of the five surface water locations listed above. The interval between sampling events will be approximately six months. Water samples will be analyzed for the WQAL parameters and caffeine using a National Environmental Laboratory Accreditation Program (NELAP) laboratory. A listing of analytical parameters is provided in Appendix A.

**Sediment Sampling**

One sediment sample will be collected during 2015 from each of the surface water sampling locations (Figure 2). Three samples will be collected from each sample site and composited into a single sample for analysis (to minimize VOC loss, it is recommended the compositing process be performed at the laboratory). Sediment samples will be analyzed for the analytical parameters provided in Appendix B. Results of sediment sampling analysis will be used to formulate future sediment sampling at Landa Lake and the Comal River. Sediment samples will be collected from zero to three inches below the surface for calendar year 2015. Sediment sample intervals will likely vary in subsequent sample years based on the results of each year of sediment analyses.

**Storm Water Sampling Program for Comal Springs**

Two storm water sampling events will be performed in 2015 to evaluate storm water quality from the urban landscape. A storm water sampling event will be triggered when a local rainfall event causes a significant increase in spring flow at the historic Comal Springs gauging station or changes in two water quality parameters at any of the real time water quality monitoring stations. Three water quality samples will be collected and analyzed from each surface water sampling location during the sampling event. Sample times will be spaced to reflect changes in the stream hydrograph (initial rise or first flush, peak flow, and recession limb). Water samples will be analyzed for the WQAL parameters. A listing of analytical parameters for storm water samples is provided in Appendix A.

The following locations will be sampled for storm water as indicated on Figure 3:

Upper Springs (near Blieders Creek);
New Channel – (below confluence with Dry Comal Creek);
Upper Old Channel - (at Elizabeth Street);
Lower Old Channel - (above Hinman Island); and,
Comal River - (above confluence with Guadalupe River).

**Groundwater Sample Collection for Extreme Low Flow Scenarios for Comal Springs**

In the event flow at Comal Springs drops below 30 cfs, the EAHCP (6.4.3.3) calls for weekly monitoring of three wells in the vicinity of the spring complex for DO, conductivity, pH, and temperature. Should springflow drop below 20 cfs, then additional parameters to include nutrients,

TDS, and TOC are to be added to the weekly sample regimen. Analytical parameters for all low flow sampling is included in Appendix A. Based on conditions during the drought of record (circa 1950s), sampling for lower flow scenario could last for up to 21 weeks. The three specific wells to be used will be determined at the time of low flow sample initiation, based on well conditions and aquifer levels.

**Real Time Instrument Water Quality Data Logging Program for Comal Springs**

Continuous water quality monitoring stations will continue in 2015 at the following locations indicated on Figure 4:

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

Monitoring will be performed using a data logging sonde capable of collecting data on 15 minute intervals. The parameters measured will include temperature, dissolved oxygen, pH, turbidity, and conductivity. These data will be evaluated to identify short-term and long-term water quality variations of the spring system as well as changes in water quality related to storm water runoff. **This monitoring effort will continue to be performed by EAA staff in 2015.**

**Collection of Passive Diffusion Samples (Passive Samples) at Comal Springs**

Passive samples are to be collected during the 2015 sampling effort using a passive diffusion type sampling device. Devices will be obtained from Amplified Geochemical Imaging LLC (AGI), or equivalent to the AGI device for functionality and analytical parameters. Sample locations for PDS samples are provided in Figure 5. The passive sampling effort shall be performed in February, April, June, August, October, and December. The devices shall be installed for a two-week interval at the same locations as the base flow surface water samples. Specifically at the sample points below.

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

The general parameter set for PDS samples is listed in Appendix A, under *Analytical Parameters for Passive Diffusion Samplers, Comal and San Marcos Springs.*

**SAN MARCOS SPRINGS**

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

In recent years, the EAA has been collecting samples from Deep Spring and Hotel Spring on a quarterly basis during normal flow conditions and on a monthly basis when the San Antonio pool critical period triggers have been reached. Both Deep and Hotel springs are located in the bed of Spring Lake and make up part of the San Marcos Springs complex. Figure 6 indicates these historical groundwater sample locations at San Marcos Springs. Water quality samples are collected and analyzed for: dissolved oxygen (DO), pH, conductivity, and temperature, in the field and for alkalinity[2]. Samples are also submitted to the EAA contract laboratory for analysis of cations, anions, nutrients, metals, VOCs, SVOCs, herbicides and pesticides, bacteria, TOC, PCBs, and phosphorous. For the purposes of EAHCP related water sampling, the analyte caffeine has been added to the list of analyzed parameters. This list of WQAL parameters is an identical to the list of parameters analyzed for at Comal Springs.

**Sampling Methods**

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

**Surface Water Sampling Locations**

To comply with sampling requirements outlined in the EAHCP document, seven additional surface water sampling locations (Figure 7) were identified in the 2013 HCP work plan for intensive monitoring as listed below:

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

[2] Alkalinity analysis will be conducted within eight hours of sample collection.

**Surface Water Sampling Frequency**

In 2015, water samples will be collected twice from each of the seven surface water locations listed above. The interval between sampling events will be approximately six months. Water samples will be analyzed for the WQAL parameters and caffeine using a National Environmental Laboratory Accreditation Program (NELAP) laboratory. A listing of analytical parameters is provided in Appendix A.

**Sediment Sampling**

One sediment sample will be collected during 2015 from each of the surface water sampling locations (Figure 7). Three samples will be collected from each sample site and composited into a single sample for analysis (it is recommended that compositing of the sample be performed at the laboratory to minimize VOC loss). Sediment samples will be analyzed for the analytical parameters provided in Appendix B. Results of sediment sampling analysis will be used to formulate future sediment sampling at Spring Lake and the San Marcos River. Sediment samples will be collected from zero to three inches below the surface for calendar year 2015. Sediment sample intervals will vary in subsequent sample years based on the results of each year of sediment analyses.

**Storm Water Sampling Program for San Marcos Springs**

Two storm water sampling events will be performed in 2015 to evaluate storm water runoff from the urban landscape. A storm water sampling event will be triggered when a local rainfall event causes a significant increase in spring flow at the San Marcos Springs gauging station or changes in two water quality parameters at any of the real time water quality monitoring stations. Three water quality samples will be collected from each surface water sampling location during the sampling event. Sampling times will be spaced to reflect changes in the stream hydrograph (initial rise or first flush, peak flow, and recession limb). Water samples will be analyzed for the WQAL parameters. A listing of analytical parameters is provided in Appendix A, for storm water samples.

The following locations will be sampled for storm water as indicated on Figure 8:

Sink Creek;
Sessoms Creek;
Dog Beach Outflow;
Hopkins Street Outflow;
Purgatory Creek (above San Marcos River);
I-35 Reach; and
Willow Creek (above San Marcos River).

**Groundwater Sample Collection for Extreme Low Flow Scenarios for San Marcos Springs**
In the event flow at San Marcos Springs drops below 50 cfs, the EAHCP (6.4.4.3) calls for weekly monitoring of three wells in the vicinity of the spring complex for DO, conductivity, pH, and temperature. Should springflow drop below 30 cfs, then additional parameters to include Nutrients, TDS, and TOC are to be added to the sample regimen. Analytical parameters for all low flow sampling is included in Appendix A. Based on conditions during the drought of record (circa 1950s), sampling for lower flow scenario could last for up to 21 weeks. The three specific wells to be used will be determined at the time of sampling abased on well conditions and aquifer levels.

**Real Time Instrument Water Quality Data Logging Program for San Marcos Springs**
Continuous water quality monitoring stations were established in 2013 and will continue in 2015 at the following locations indicated on Figure 9:

USGS gauging station; and,
Rio Vista Dam.

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

In 2015, an additional water quality data logging point is recommended for installation at the lower (south) end of the sample area for San Marcos. The additional station will help with the timing of storm sample collection as well as improved monitoring of the IH-35 and Willow Creek runoff impacts. Costs for this are included in Appendix C of this document. The location of the proposed new monitoring point is coincident with surface water sample point HSM170 (Capes Dam/Willow Creek area).

**Collection of Passive Diffusion Samples (Passive Samples) at San Marcos Springs**
Passive samples are to be collected during the 2015 sampling effort using a passive diffusion type sampling device. Devices will be obtained from AGI, or equivalent to the AGI device for functionality and analytical parameters. Sample locations for PDS samples are provided in Figure 10. The passive sampling effort shall be performed in February, April, June, August, October, and December. The devices shall be installed for a two-week interval at the same locations as the base flow surface water samples. Specifically at the sample points that follow.

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

The general parameter set for PDS samples is listed in Appendix A, under *Analytical Parameters for Passive Diffusion Samplers, Comal and San Marcos Springs.*

**WATER QUALITY MONITORING REPORT**

The contractor will compile and present sampling results in an annual report to the EAA. The report will include an evaluation of analytical data, graphs of results that exceed comparative or regulatory standards, a discussion of water and sediment quality, laboratory reports and field data sheets, photographs, sampling locations and rationale, description of sampling methods, and a description and rationale for any deviations from the Water Quality Sampling Plan due to logistics or safety issues. The report is to be submitted in hard copy and electronically and will be reviewed internally by EAA. The deadline for submittal to the EAA is December 21, 2015.

**DATA COMPILATION, ANALYSES AND REPORTING**

All of the data collected as a result of the 2015 HCP Water Quality Monitoring Plan will be compiled, and analyzed, and the results will be presented to the Implementing Committee by February 15, 2016; prior to inclusion in the annual EAHCP Annual Report that is required by Sections 6.2.4 and 9.3 of the EAHCP and Section 11.1c of the Implementing Agreement. The report will include an evaluation of all analytical data, including graphs, key photographs and general summary of results.

**CHANGES TO WORKPLAN FROM THE 2014 SAMPLING EFFORT**

In summary, the workplan has few changes from 2014. Funding is needed to add a single RTI water quality data logger at the downstream end of the sampling area in San Marcos. Funding is also requested for maintenance and replacement needs for existing RTIs, as well as data transmission and web hosting fees. Detail for the RTIs is listed in Appendix C.

A change to the sample interval for sediment samples is included in this workplan. The former sample interval is 0 – 18-inches below surface. For 2015, the sediment sample interval will be 0-3-inches below the surface.

**SCIENCE COMMITTEE REVIEW**

This 2015 Water Quality Work Plan will reviewed by the EAHCP Science Committee prior to implementation. The Science Committee will be asked to conform the need for the following additions or changes to the Water Quality Work Plan:

- An additional Real Time Instrument for water quality data logging will be added to the downstream end of the San Marcos Springs sampling area in 2015.
- A change to the sample interval for sediment samples from 0 – 18-inches below surface to 0-3-inches below the surface.

**BUDGET**

Table 7.1 Budget: $200,000

Requested workplan Budget: $504,530

2015 EAHCP Sampling as performed by an outside contractor, annual costs $474,430.00

Real Time Instruments (RTI): $30,100 (see Appendix C)

**Justification for Budget Adjustment**

The real time water quality data logging instrumentation is in need of funding for maintenance (warranties will expire in 2015), in addition spare instrumentation is needed to prevent extended down time in the event of catastrophic failure. The instruments also require funding for calibration fluids, batteries, and other incidental costs. Funding is also needed for the addition of a downstream San Marcos instrument. Cost details are provided in Appendix C.

**Figure 1**
**Comal Springs Groundwater Sample Locations**


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

Samples are collected monthly during low flow conditions (critical period), and quarterly during normal conditions.

Explanation

★ Historical Groundwater (Spring) Sample Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Figure 2**
**Comal Springs Surface Water Sample Locations**


**Comal Springs HCP Related Sample Points**

**Analytical Parameter List (HCP)**

Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

**Explanation**

★ Surface Water Sample Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Figure 3**
**Comal Springs Storm Water Sample Locations**


**Comal Springs HCP Related Sample Points**

**Analytical Parameter List (HCP)**

Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

Explanation

Storm Water Sample Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Figure 4**
**Comal Springs Real Time Water Quality Station Locations**


**Comal Springs HCP Related Sample Points**

**Analytical Parameter List (HCP)**

Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

**Explanation**

Continuous (Real Time) Water Quality Station

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Figure 5**
**Comal Springs Passive Diffusion Sampler Locations**


**Comal Springs HCP Related Sample Points**

**Passive Diffusion Samplers (PDS)**

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

PDS devices will be from Amplifed Geochemical Imagaing, LLC, or equivalent and shall provide analyses for: TPH, BTEX, 1,3,5 and 1,2,4-trimethylbenzene, MTBE, phenanthrene, naphthalene 1-methyl naphthalene, octane, cis and trans-1,2,-dichloroethene, 1,1-dichloroethane, chloroform, 1,1,1-trichloroethane, 1,2-dichloroethane, carbon tetrachloride, trichloroethene, tetrachloroethene, chlorobenzene, 1,4-dichlorobenzene, 1,1,2-trichloroethane, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,3-dichlorobenzene, and 1,2-dichlorobenzene.

**Explanation**

Passive Diffusion Sampler Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Figure 6**
**San Marcos Springs Groundwater Sample Locations**


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

Samples are collected monthly during low flow conditions (critical period), and quarterly during normal conditions.

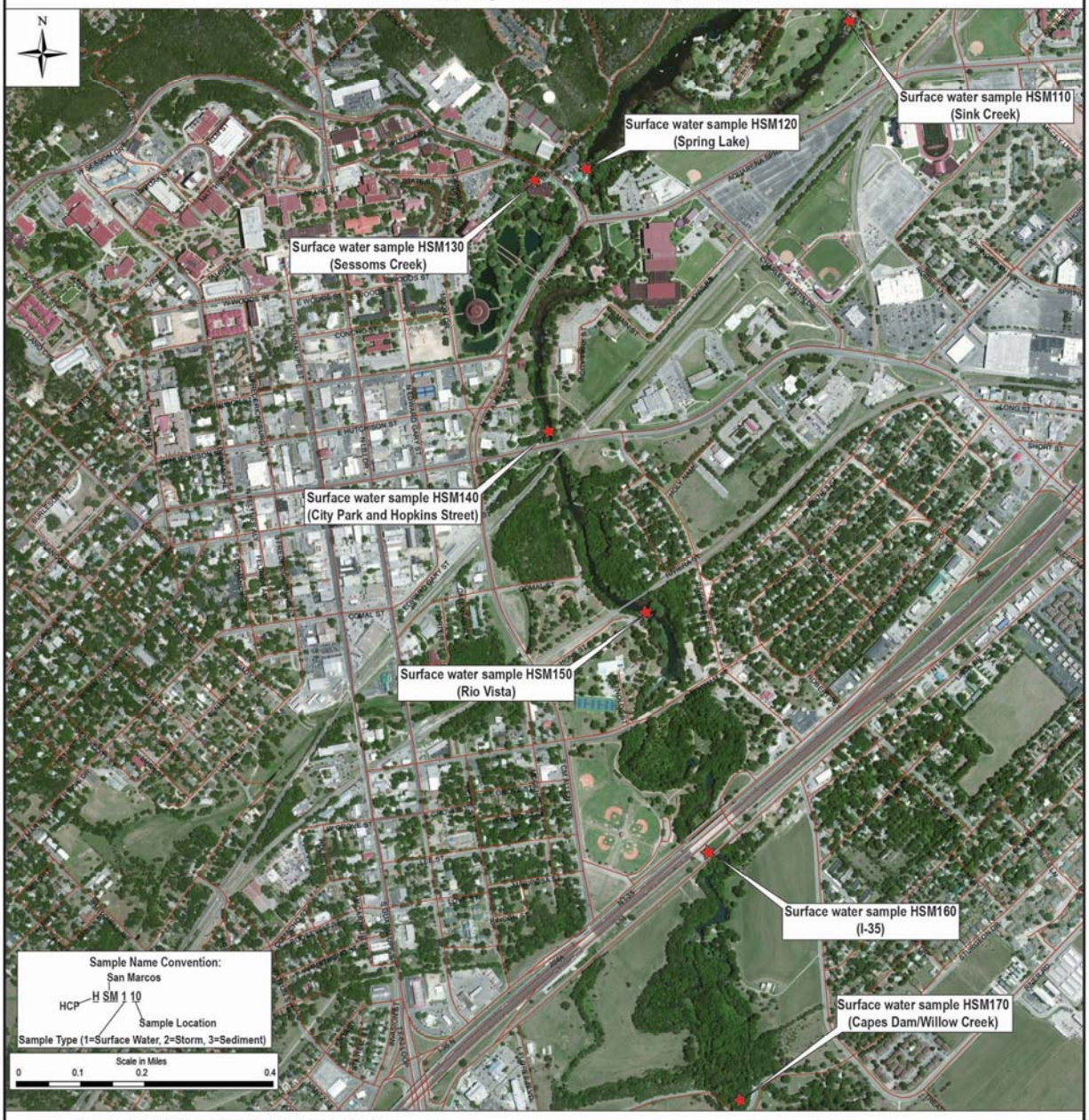
Explanation

★ Historical Groundwater (Spring) Sample Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Figure 7**
**San Marcos Springs Surface Water Sample Locations**




**San Marcos Springs HCP Related Sample Points**

**Analytical Parameter List (HCP)**

| |
|---|
| Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals |
| Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals |
| Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals |

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

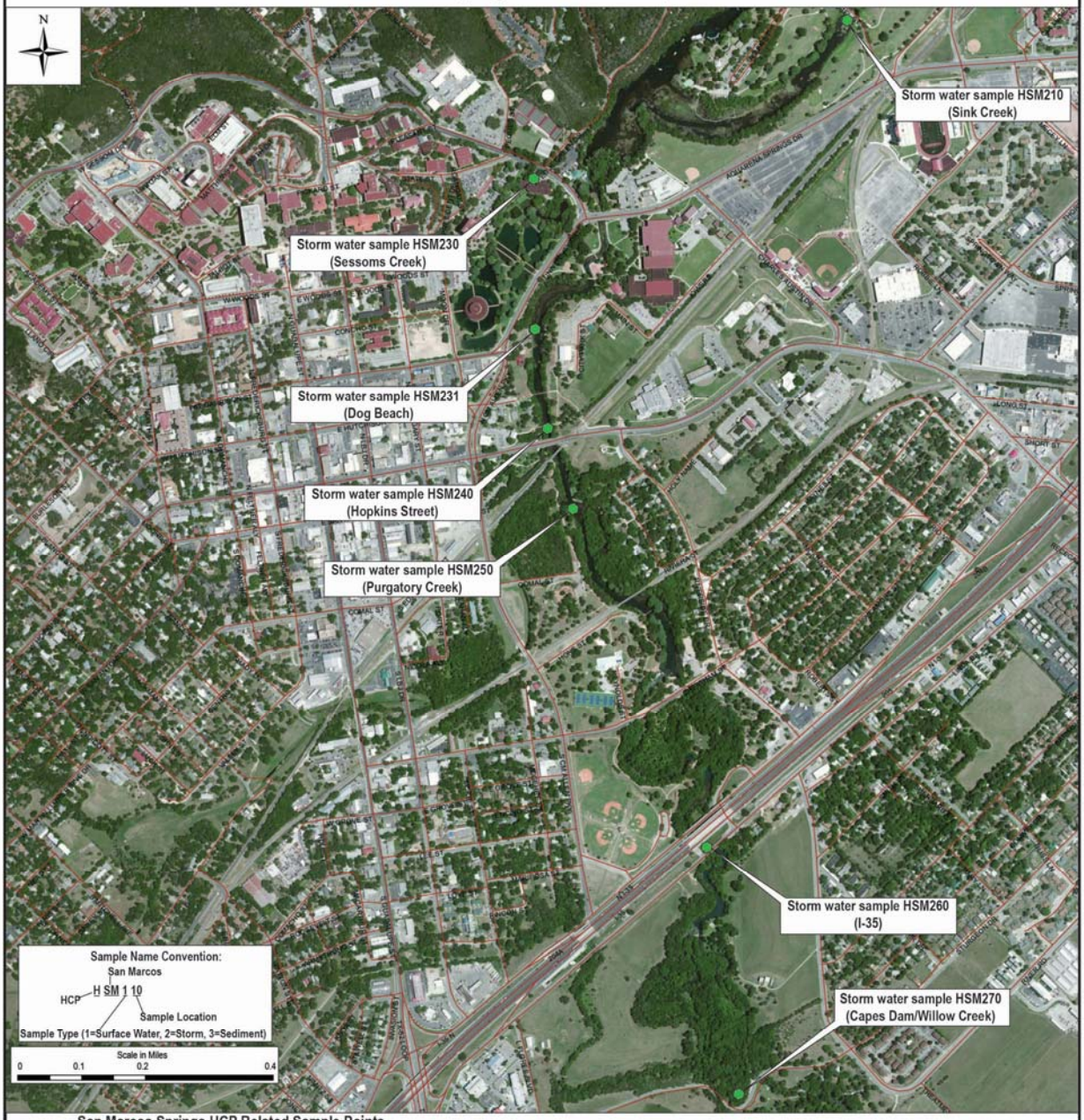
Explanation

★ Surface Water Sample Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Figure 8**
**San Marcos Springs Storm Water Sample Locations**




**San Marcos Springs HCP Related Sample Points**

**Analytical Parameter List (HCP)**

Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

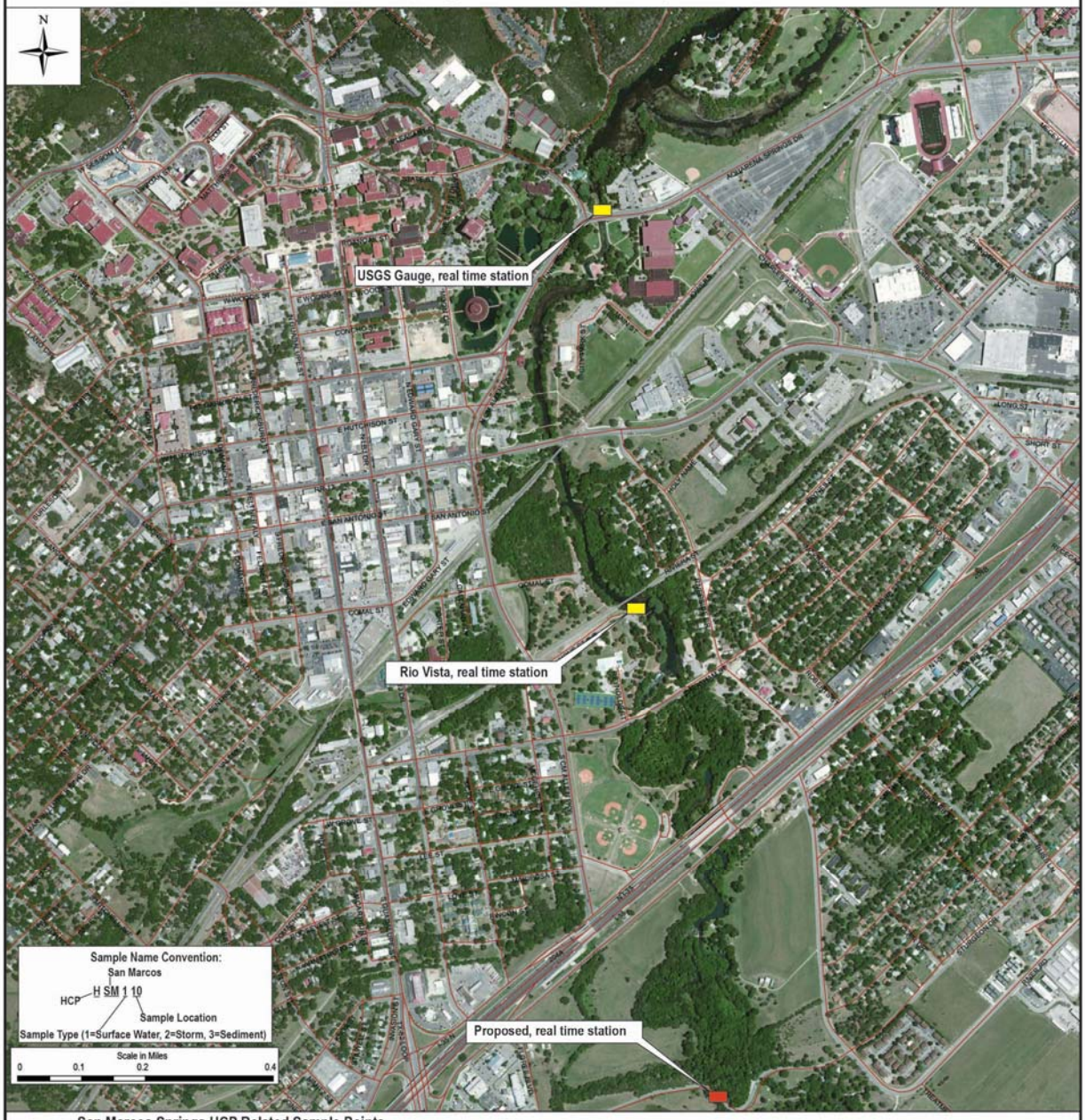
**Explanation**

Storm Water Sample Locations

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Figure 9**
**San Marcos Springs Real Time Water Quality Station Locations**




**San Marcos Springs HCP Related Sample Points**

**Analytical Parameter List (HCP)**

Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

**Explanation**

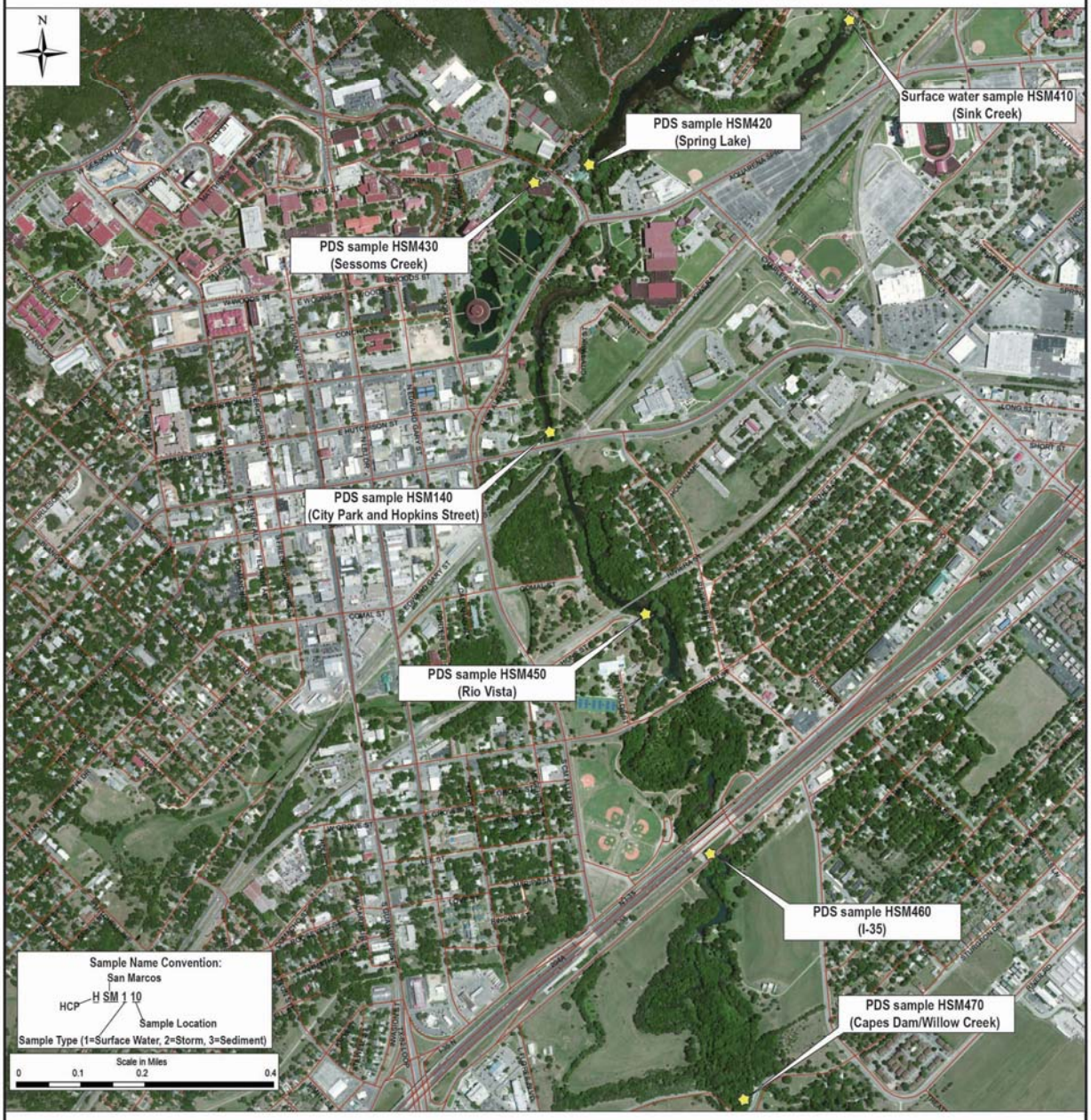
Continuous (Real Time) Water Quality Station Location

Proposed Continuous (Real Time) Water Quality Station Location for Addition in 2015

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Figure 10**
**San Marcos Springs Passive Diffusion Sampler Locations**




**San Marcos Springs HCP Related Sample Points**

**Passive Diffusion Samplers (PDS)**

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

PDS devices will be from Amplifed Geochemical Imagaing, LLC, or equivalent and shall provide analyses for: TPH, BTEX, 1,3,5 and 1,2,4-trimethylbenzene, MTBE, phenanthrene, naphthalene 1-methyl naphthalene, octane, cis and trans-1,2,-dichloroethene, 1,1-dichloroethane, chloroform, 1,1,1-trichloroethane, 1,2-dichloroethane, carbon tetrachloride, trichloroethene, tetrachloroethene, chlorobenzene, 1,4-dichlorobenzene, 1,1,2-trichloroethane, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,3-dichlorobenzene, and 1,2-dichlorobenzene.

**Explanation**

Passive Diffusion Sampler Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Appendix A**

**Analytical Parameters for Assessing Water Quality from Storm Water and Surface Water Locations, Comal and San Marcos Springs**

| **Analyses** |
|---|
| Volatile Organic Compounds (VOCs) |
| Semi-volatile Organic Compounds (SVOCs) |
| Organochlorine Pesticides |
| Polychlorinated Biphenyls (PCBs) |
| Organophosphorous Pesticides |
| Herbicides |
| Metals (Al, Sb, As, Ba, Be, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, 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 Solids (TSS). |
| Phosphorus (total) |
| Total Organic Carbon (TOC), |
| Dissolved Organic Carbon (DOC) |
| Kjeldahl Nitrogen |
| Bacteria Testing (*E coli*) |
| Caffeine |

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

**Protocol References:**

EPA = US Environmental Protection Agency

MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.

SM = "Standard Methods For The Examination Of Water And Wastewater",

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

**Number of required QA/QC Samples for Surface (Base Flow) Sampling, Storm Sampling, and Sediment Sampling**

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

**Analytical Parameters for Critical Period Related (Low Flow) Sampling of Water Wells, Comal and San Marcos Springs**

| **Analyses** |
|---|
| 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, $CO_3$,) |
| Total Organic Carbon (TOC) |
| Total Dissolved Solids (TDS) |
| |

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

| |
|---|
| PDS devices are to be placed at the locations listed Figures 5 and 10, for a two-week time period in the months of February, April, June, August, October, and December. |
| PDS devices will be from Amplifed Geochemical Imagaing, LLC, or equivalent and shall provide analyses for the following: TPH, BTEX, 1,3,5 and 1,2,4-trimethylbenzene, MTBE, phenanthrene, naphthalene1-methyl naphthalene, octane, cis and trans-1,2,-dichloroethene, 1,1-dichloroethane, chloroform, 1,1,1-trichloroethane, 1,2-dichloroethane, carbon tetrachloride, trichloroethene, tetrachloroethene, chlorobenzene, 1,4-dichlorobenzene, 1,1,2-trichloroethane, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,3-dichlorobenzene, and 1,2-dichlorobenzene. |

## Appendix B

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

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

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

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

## Appendix C

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

| | |
|---|---|
| Three new Eueka, Manta 2 Probe, equipped to monitor: DO, pH, Temperature, Conductivity, and Turbidity with Associated Netronix Telemetry System. | $6,000.00 each for a total of $18,000 |
| Annual maintenance costs for equipment, to include batteries (as needed), repairs, and calibration standards (estimated costs are for six total instruments, which includes the proposed new addition in San Marcos)* | $6,000.00 |
| Annual data contract to include cellular data fees, and web hosting at Netronix site (estimated costs are for six total instruments, which includes the proposed new addition in San Marcos) | $5,100.00 |
| Installation costs for proposed new unit to be located on the San Marcos system | $1,000.00 |
| **Total Estimated Costs for Real Time Water Quality Instrumentation calendar year 2015** | **$30,100.00** |

**Instrument warranties expires in 2015, extra funding needs to be earmarked for potential repairs.*

**Edwards Aquifer Authority 2015**
**Ecological Modeling Work Plan**

The development of a mechanistic Ecological Model is assigned to the Edwards Aquifer Authority (EAA) per section 6.3.3 of the Edwards Aquifer Habitat Conservation Plan (EAHCP). The purpose of the ecological model 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. ”

***Long Term Objective:*** Development of a comprehensive mechanistic ecological.
The objective of the predictive ecological model for the Comal and San Marcos ecosystem project is to adapt existing models for aquatic vegetation and fountain darters and begin the development of models for Texas wild-rice and gill parasites impact.

**YEAR 1** (June 1, 2013 – May 31, 2014)

Task 1. Literature Review

The Consultant shall gather and review pertinent scientific literature with respect to two issues: (1) identifying a modeling approach for predicting aquatic macroinvertebrate responses to changing physical, chemical, and biotic (*i.e.*, aquatic vegetation dynamics). This review will focus on potential modeling approaches and life history parameters that may have potential for adaptation to specific applications, including general life histories of communities or individual macroinvertebrate species; and (2) existing modeling approaches that may have potential for modification to address the EAHCP specific applications regarding the Comal Springs riffle beetle response/dynamic, even if the literature does not specifically address the Comal Springs riffle beetle.

Task 2. Data Acquisition

The EAA will provide any pertinent data to the Consultant, as available. However, the Consultant shall be responsible for the acquisition of, and for obtaining permission to use any additional data necessary to complete the requirements of this Contract.

Task 3. Modeling

The Consultant shall undertake four separate modeling efforts, identified as subtasks, each designed to address a specific area of concern. All models developed or modified during this task should have the capacity to be linked to the other models developed in this task, using a larger modeling platform.

Subtask 3.1 U.S. Army Corps of Engineers Model Modification

The Consultant shall modify and/or adapt specific models developed by U.S. Army Corps of Engineers’ Aquatic Plant Control Research Program for application to the Comal and

San Marcos springs ecosystem. The Consultant shall take the four existing monotypic and one competition model and refine them to be specific to the aquatic vegetation of Comal and San Marcos springs. In particular, monotypic models for *Ludwigia*, *Hygrophila*, *Cabomba*, *Vallesneria*, and bryophytes will be explored. Additionally, model parameters including physical/mechanical impacts, carbon dioxide, and substrate will be evaluated for inclusion. Parameters such as water temperature and flow velocity which are already incorporated in the existing models will be evaluated to determine if modifications are needed to apply directly to the Comal and San Marcos system. From these preliminary evaluations it will be determined which system-specific monotypic models are most appropriate for initial development. For 2013, up to 3 monotypic models will be developed that incorporate the response/dynamics of vegetation specific to the Comal and San Marcos system. Calibration techniques for these models will be vetted with the Science Committee and presented at an open meeting of the Implementing Committee early in the process. No data from areas affected by recreation or flooding will be used in model calibration. Upon completion of the monotypic models, the Consultant will make recommendations on linking these models to the spatial and temporal components for both the Comal and San Marcos ecosystems, specifically considering existing aquatic vegetation data that has been shaped by flows, recreation, and flood events. In particular, specific recommendations will be provided on how such physical impacts should be incorporated in future assessments via linked models.

Subtask 3.2 Fountain Darter Response/Dynamics Model

The Consultant shall review and assess available fountain darter, aquatic vegetation, and water quality data for the potential of "data mining" to see if any of the model parameters can be updated. This task shall include but not be limited to the "data mining" efforts of Dr. Mac McKee, Director, Utah Water Research Laboratory at Utah State University, who conducted a preliminary data mining effort in 2012 and early 2013 of the datasets developed during the Edwards Aquifer Recovery Implementation Program. The Consultant shall obtain the results of and review the data mining conducted by Dr. McKee, and based of the assessment, the Consultant shall refine/modify the population dynamics equations to the degree practicable. A final determination on exact modeling framework will be made at the conclusion of the data mining activities and presented to the EAHCP Implementing Committee or their designee. Updates and linkages to the fountain darter model will be explored in 2013 relative to spatial and temporal constraints, aquatic vegetation mapping data and models, and existing water temperature model outputs.

Subtask 3.3 Texas Wild Rice Parameters

Utilizing the modified models identified during subtask 3.1, the Consultant shall simulate the characteristics of Texas wild-rice and identify potential research necessary to parameterize Texas wild-rice dynamics.

Subtask 3.4 Gill Parasite and Non-Native Snails Response/Dynamics Model

The Consultant shall develop the model structure and associated model parameters that will allow an evaluation of the response/dynamics of gill parasites and non-native host snails to projected flow conditions anticipated under the EAHCP.

Task 4. Recommendations and Future Work

The Consultant shall provide recommendations developed during the course of this project regarding the development of the modules and completed ecological model. Specifically, the Consultant shall also provide recommendations for work that should be completed by the EAA or its Consultants in 2014 to continue or enhance the modeling efforts completed during this project. These recommendations should include a timeline that results in the completion of a functional Ecological Model by the end of 2015.

Task 5. Draft and Final Reports

The Consultant shall submit to the EAA two (2) copies of the Literature Review no later than 120 days of the execution of the Contract.

The Consultant shall submit to the EAA two (2) copies of the draft project report no later than 300 days from the execution of the Contract. The report shall discuss any changes to existing models, all modeling results, all data used in calibrating and validating the models, and all assumptions used in the development or adaptation of the models including report describing the modification to the United States Army Corps of Engineers (USACE) model(s) necessary to simulate the characteristics of Texas wild-rice and identify potential research necessary to parameterize Texas wild-rice dynamics.

After receipt and incorporation of EAA's review comments, the Consultant will submit the final report to the EAA on or before 365 days from the execution of this Contract.

Task 6. Meetings and Presentations

The Consultant shall attend a minimum of two (2) meetings to provide information to the Science Committee, Implementing Committee, and Stakeholder group when requested by the EAHCP Director.

Task 7. Deliverables

To the extent possible, the Consultant shall identify a preliminary listing of any needed additional applied research projects as soon as possible, so that the projects may be included in the 2015 Applied Research work plan or executed sooner through some other process. The needed

additional Applied Research related to Texas wild-rice and Task 3.3 shall be identified in writing to EAA staff no later than December 31, 2013.

The Consultant shall deliver preliminary models (as described in the tasks above) that can assess:

a) the response/dynamics of native and key nonnative aquatic vegetation during extended periods of low flow;
b) the response/dynamics of fountain darter populations relating to growth and survival during projected flow conditions;
c) identify potential research necessary to parameterize Texas wild-rice dynamics; and
d) identify the model structure and associated model parameters to assess gill parasites and non-native host snails relative to projected flow conditions anticipated under the EAHCP.

(1) All computer models and spreadsheets developed as a part of this project, shall be submitted to the EAA. *User manuals shall be submitted by the Consultant to EAA providing complete documentation of computer models developed under this project. The user manuals shall also contain the source code language and the type of computer equipment necessary to operate the model(s).*

(2) All data collected and/or generated during this study shall be submitted to the EAA in electronic format compatible with its associated software. (*i.e.*, spreadsheets will be in MS Excel format, etc.). Data shall be delivered via pre-approved digital media and shall be labeled to provide sufficient detail to access the information.

(3) All computer models, databases, and spreadsheets developed herein (written and digital formats) are due on the same date as the final report.

(4) To facilitate the EAA's accurate evaluation of the Consultant's work product, computations, conclusions and recommendations, the Consultant shall:

- Include in the final report a section describing the assumptions and methodology used by the Consultant in generating the data and conclusions contained in that chapter.
- Prepare a project notebook containing a description of the assumptions and methodologies used in the study analysis. The notebook shall be organized in such a way as to allow replication of the steps, calculations, and procedures used by the Consultant to reach conclusions, described in the draft final report. The project notebook shall be submitted with the draft final report.

All models developed and/or modified under the tasks described herein, must be provided to the EAA as executable "turn-key" files with all associated datasets fully populated.

No later than June 15th and each month thereafter, the Consultant shall submit a monthly "invoice packet" to the EAA for each previous month's activities. Each invoice packet shall contain, at a minimum:

(1) A progress report containing:
- a description of the work completed in each Task during the billing cycle;
- a monthly update of the work schedule as it relates to achievement of the deliverables;
- an estimate of the percent completion of each Task; and
- a discussion of any issues or problems that may result in a change in the deliverable due date;

(2) Documentation of all costs and expenses incurred during the billing cycle, including supporting documentation; and

(3) A certified invoice summary sheet

The monthly invoice packet will be submitted electronically in Adobe Acrobat (pdf) format via email to the EAA Senior EAHCP Coordinator.

**YEAR 2** (June 1, 2014 – May 31, 2015)

Task 1: Project Management and Meetings

The Contractor will provide project management and administration for this project. The Contractor will conduct monthly internal team meetings or conference calls and up to four (4) meetings directly with the EAA, should they be needed. When necessary, meetings with the EAA will be combined into the internal team monthly meetings. The Contractor will attend and provide project information to the EAHCP Science Committee, EAHCP Implementing Committee, and National Research Council (NRC) Committee as requested by the EAHCP Program Manager.

Task 2: Literature Review

The Contractor will conduct a literature review focusing on two key areas: (1) available fountain darter food (macroinvertebrates) and (2) aquatic vegetation scour. Regarding food source assessment, the Contractor will use existing information/literature to evaluate the amount of available food present for the fountain darter in both the Comal and San Marcos systems. If the information is available, the Contractor will also evaluate the feeding rate of fountain darters to assess if the amount of food necessary to support fountain darters during periods of low-flow is predicted to be available in the Comal and San Marcos systems. A qualitative assessment of additional fish species present in the Comal and San Marcos systems and their respective food source utilization will also be conducted. The objective of this literature search and analysis is to determine if a food source component should be formally incorporated into the EAHCP ecological model in 2015.

The second literature review component will investigate the mechanisms necessary to create aquatic vegetation scour in the Comal and San Marcos systems. The diversity of sediments and aquatic vegetation species (or species assemblages) occurring in these systems makes it necessary to evaluate the critical bed stress of rooted plants and therefore the threshold of flow velocities at which the vegetation is scoured. As such, the aquatic vegetation data collected during normal periods and following high flow events over the course of biological monitoring will be reviewed in detail. These empirical data will be evaluated for type of aquatic vegetation, quantity, spatial location, and what type of discharge caused the removal of aquatic vegetation in the wild following known pulse events. Once determined, the Contractor will evaluate hydraulic model results to determine types of velocities and critical stress that were likely involved during those events. Following this literature review and existing data analysis, the Contractor will incorporate the results into the aquatic vegetation model as appropriate and subsequently provide applicable results to the contractor selected to perform the 2015 Applied Research study on aquatic vegetation shear stress.

Task 3: Fountain Darter Modeling

In order to better address the specific needs of the EAHCP, the Contractor will replace current preliminary representations of the relationships among physical and biological habitat characteristics and fountain darter vital rates with more appropriate functional relationships, to extend the underlying mathematical formulation to include spatial and temporal dynamics.

Within the spatially-explicit individual-based modeling format developed in year one, additional model development will concentrate on: (1) improving specification of habitat characteristics, (2) delineating dependency of fountain darter vital processes upon habitat variables, and (3) depicting effects of additional external forcing variables. The Contractor will modify or replace the preliminary representations of the spatial-temporal dynamics of fountain darter habitat characteristics (water depth, water velocity, water temperature, and aquatic vegetation) with more refined representations, including functional relationships among these characteristics. The Contractor will establish appropriate functional relationships between habitat characteristics and the life processes of the fountain darter, including recruitment, mortality, and movement rates. For this activity, the Contractor will explore mathematical representations of the effects of additional external variables on the spatial-temporal dynamics of aquatic vegetation for incorporation into the darter model, more specifically the effects of recreational use and scouring processes of high flows on aquatic vegetation, and the associated darter responses.

Once the foundational components and functional relationships are established, the Contractor will apply the model to both the Old Channel study reach of the Comal River and the City Park study reach of the San Marcos River. The Contractor will use existing model framework established in 2013 for the Old Channel study reach and will complete the necessary application for the City Park study reach to interpolate hydraulic grids for use in the existing NetLogo modeling framework. Interpolation of modeled flows will follow the same procedure used to generate the flows in the Old Channel at the Comal River. In addition, this will include the spatial overlay of existing vegetation mapping results for the simulation period to the interpolated grid coordinate system using the same protocols as used in the Old Channel of the Comal River. The associated daily flow rates for the San Marcos River for the simulation period will be extracted for existing USGS

gage records in the San Marcos River. Finally, the hourly water temperature data for the City Park study reach will be extracted from existing data and incorporated into the model grid format.

The Contractor will integrate the existing hourly water temperature models for the Old Channel and City Park study reaches within the NetLogo framework. The appropriate calibrated QUAL2E model input data file(s) for each segment will be utilized. The QUAL2E model will be modified to run given an input flow rate for the day and associated meteorological data. The program will be modified to allow it to be called from NetLogo and return the hourly temperature data for the day for use in the fountain darter model.
Near completion of 2014 activities, the Contractor will calibrate the Year 2 processes that will have been developed for the fountain darter using existing size-class distribution and abundance data for the Old Channel and City Park study reaches. The Contractor will perform a series of sensitivity and robustness analyses on the working version of the fountain darter model(s), including preliminary quantification of sources and magnitudes of uncertainty. As part of that assessment, the sensitivities and elasticities of the various fountain darter demographic parameters will be calculated (i.e., their relative contributions to population growth).

Task 4: Aquatic Vegetation Modeling

In order to assess the dynamics of vegetation across the landscape, as well as to determine the interactions among vegetative communities and fountain darters, the Contractor will model aquatic vegetation in a computationally-tractable, and spatially explicit manner. Aquatic vegetation modeling will proceed in 2014 by utilizing a hybrid modeling approach, which will incorporate functions from the ERDC models as well as vegetative dispersal modeling in order to be able to capture a wider breadth of vegetative dynamics and vegetation-organism interactions. The Contractor will divide aquatic vegetation into structural categories and growth/dispersal will be simulated for each category. The new, hybrid vegetation model will be a grid-based spatially explicit simulation with two main functions per structural grouping: growth (intracell) and dispersal (intercell). The Contractor will use the fountain darter model, the Old Channel study reach of the Comal River and City Park study reach of the San Marcos River to serve as the spatial extent of modeling activities in 2014.

To expand on the modeling activities conducted in Year 1, further model development the Contractor will concentrate on: (1) defining structural groupings of aquatic vegetation, (2) developing spatial interpolations of critical environmental and physical variables required to parameterize growth and dispersal of aquatic vegetation, (3) developing growth function for each structural group, (4) developing dispersal functions for each structural group, and (5) developing re-colonization functions for each structural group. To accomplish these objectives, the Contractor will first describe and define which species are structurally similar with regards to how fountain darters and other species interact with vegetation and then re-categorize existing vegetation coverage in the model into structural groupings. Year 1 model activities and literature reviews indicated that critical environmental parameters included temperature, carbon dioxide, light (for which turbidity might be used as a proxy), depth, velocity, and substrate.

To develop growth functions, dispersal rates, and re-colonization functions for aquatic vegetation, the Contractor will define the appropriate time step for incorporation into the model. The time

step will be selected to be compatible with the fountain darter model. The Contractor will also quantify average and extreme conditions to identify thresholds for aquatic vegetation responses. Based on the literature review and data analysis described in Task 2, the Contractor will subsequently quantify and spatially represent vegetative re-colonization from stochastic events, like floods (or other scour events).

Growth, dispersal, and re-colonization functions will also be assessed based on empirical time-series aquatic vegetation data. The Contractor will implement a study during the summer of 2014 to develop an empirical relationship between vegetation percent cover and biomass. Quantitative above and below ground biomass samples will be collected on an appropriate aerial basis. Samples will be separated by species and then above sediment tissues will be separated from below sediment. All samples will be washed to remove dirt and detritus and dried to constant weight at 60 °C.

Upon completion of the percent cover to biomass study and previously described Year 2 aquatic vegetation modeling activities, the Contractor will calibrate growth, dispersal and re-colonization functions based on data from time-series of aquatic vegetation. Additionally, a series of sensitivity and robustness analyses will be performed on the working version of the aquatic vegetation model(s), in part to quantify sources and magnitudes of uncertainty. As part of that assessment the sensitivities and elasticities of the various aquatic vegetation parameters will be calculated (i.e., their relative contributions to aquatic vegetation growth, dispersal, and re-colonization).

Task 5: Draft and Final Interim Status Reports

Upon completion of data analyses, the Contractor will prepare a Draft and a Final Interim Status Report. Included in the Interim Status Report will be a summary of all meetings/notes from the project year, the literature review and data analysis conducted in Task 2, the methodologies employed and data analysis and results from Tasks 3 and 4, and a section on future recommendations for 2015.

Task 6: Recommendations and Future Work

By March 1, 2015, the Contractor will prepare a detailed Year 3 scope of work outlining activities for the remainder of 2015 and 2016 and will present this scope of work first to the Science Committee and, then to the Implementing Committee for review, comment, and approval. It is anticipated that in 2015, the scope or work will involve 1) the refinement of the fountain darter and aquatic vegetation models with 2014 applied research results, and 2) an expansion of the spatial domain of the models to include additional representative reaches in both systems. It is anticipated that in 2016, the scope of work will involve model refinement based on 2015 applied research results and extensive model calibration, validation and documentation.

Task 7: Deliverables

In Year 2, besides the submittal of monthly progress reports (as described in Task 7, Year 1), the Contractor will submit a Draft and a Final Status Report (as stated above) for Year 2 of model development. The Final Status Report for Year 2 will be submitted by December 31, 2015.

The Contractor will also submit a detailed Year 3 scope of work by March 1, 2015.

**YEAR 3** (June 1, 2015 – December 31, 2016)

Task 1. EAHCP Ecological Model Development, Calibration, and Validation

Following completion of Year 2 activities, the Contractor will carry out its detailed Year 3 scope of work as approved by the Science and Implementing Committees.

Task 2. EAHCP Ecological Model Training and User Guide

Concurrent with the conclusion of model validation, the Contractor will provide on-site training to EAA in the use of the NetLogo software as it pertains to the user interface developed specific to EAHCP Ecological model utilization. In addition to on-site training, the Contractor will develop a "User Guide" to assist EAA staff in becoming familiar with the NetLogo user interface and to serve as a reference in developing model runs. It is anticipated that this training and user guide development would occur in the latter part of 2016.

Task 3: Deliverables

In Year 3, besides the submittal of monthly progress reports (as described in Task 7, Year 1), the Contractor will submit a Draft and a Final Report (as stated above) for Year 3 of model development. The Final Report for Year 3 will be submitted by December 31, 2016.

EXHIBIT B
PROJECT BUDGET

**YEAR 1**

| TASK | | ESTIMATED COST |
|---|---|---|
| Task 1. | Literature Review | $ 12,500. |
| Task 2. | Data Acquisition | $ 3,500. |
| Task 3.1 | U.S. Army Corps of Engineers Model Modification | $ 55,000. |
| Task 3.2 | Fountain Darter Response/Dynamics Model | $ 47,500. |
| Task 3.3 | Wild Rice Parameters | $ 7,500. |
| Task 3.4 | Gill Parasite and Non-Native Snails Response/Dynamics | $ 4,500. |
| Task 4. | Recommendations and Future Work | $ 5,000. |
| Task 5. | Draft and Final Reports | $ 10,500. |
| Task 6. | Meetings and Presentations | $ 11,500. |
| Task 7. | Deliverables | $ 12,500. |
| | YEAR 1 SUBTOTAL | $170,000. |

**YEAR 2**

| TASK | | ESTIMATED COST |
|---|---|---|
| Task 1. | Project Management and Meetings | $ 37,765. |
| Task 2. | Literature Review | $ 16,580. |
| Task 3. | Fountain Darter Modeling | $154,755. |
| Task 4. | Aquatic Vegetation Modeling | $138,520. |
| Task 5. | Draft and Final Interim Status Reports | $ 57,730 |
| Task 6. | Recommendations and Future Work | No Cost |
| Task 7. | Deliverables | No Cost |
| | YEAR 2 SUBTOTAL | $405,350. |

**YEAR 3**

| TASK | | ESTIMATED COST |
|---|---|---|
| Task 1. | EAHCP Ecological Model Development, Calibration, and Validation | $330,000. |
| Task 2. | EAHCP Ecological Model Training and User Guide | $ 25,000. |
| Task 3. | Deliverables | No Cost |
| | YEAR 3 SUBTOTAL | $355,000. |
| | TOTAL PROJECT COSTS | $930,350. |

**Edwards Aquifer Authority 2015**
**Applied Research Work Plan**

Section 6.3.4 of the Edwards Aquifer Habitat Conservation Plan (EAHCP) includes applied research as a "valuable" component of the Phase I package and states that the "Edwards Aquifer Authority (EAA) will contract for the research activities." The main focus of the applied research is to evaluate the effects of low-flows on Covered Species and their habitats. As described in the HCP § 6.3.4.2, applied research for Phase I will focus on the fountain darter relative to Comal Springs (although research should be transferable to the San Marcos system) and the Comal Springs riffle beetle, as these are the two species with the greatest potential for impact relative to the Phase I package.

***Long Term Objective:*** The experimentation done through the applied research program of the EAHCP will evaluate the effects of low-flows on Covered Species and their habitats. The information gathered through this program will be utilized in the ecological model and will subsequently be used to inform the Adaptive Management Process and identify strategies for improved mitigation in the Spring cities model.

To assure that Applied Research projects meet the long term objectives and to meet specific HCP needs, the EAA has initiated a procedure that allows members of the Implementing Committee, Science Committee, or an HCP contractor to submit proposed projects for consideration. The proposed projects are evaluated by EAA Staff, outside experts (if necessary), and the Science Committee. In addition, the Science Committee is asked to provide "key elements to be included in a study's Request for Proposal (RFP). A copy of the 2015 proposed Applied Research project submissions, review and prioritization procedure is attached (Attachment 1).

***Target Performance Measures for 2015:*** After consultation with the Science Committee on April 8, 2014, the following list of eight projects were prioritized for study in 2015.

1. Algae dynamics study.
2. Comal Springs riffle beetle habitat connectivity (spring run, surface and riparian).
3. Effects of sediment shear stress on submerged aquatic vegetation.
4. Food source temperature refinement and response to plant species study.
5. *Ludwigia repens* interference plant competition study.
6. Suspended sediment impacts on TX wild-rice (and other aquatic plant) growth characteristics and aquatic macroinvertebrates
7. What are the behavioral impacts of the fountain darter under different turbidity levels in relation to feeding success?
8. When does fountain darter compensatory reproduction get triggered, and if so, when and what causes it?

At the April 8, 2014 meeting, the Science Committee prioritized the proposed studies so that those with the highest priority could be considered for funding first. Prioritized projects will be funded until the Applied Research budget is expended.

***Assumptions:*** Completion of all 2014 approved Applied Research projects.

***Methodology:***
For each study, the EAA will issue RFPs that include key elements as part of the stated goals to be accomplished. The proposers will submit proposals to include those key elements and reach those stated goals. Contractors that are awarded contracts will have their project's final methodologies approved by the Science Committee.

All Covered Species collected and utilized for Applied Research will be shared with other Applied Research contractors, within United States Fish & Wildlife Service (FWS) and Texas Parks & Wildlife (TPWD) regulations. The FWS and/or TPWD may require that at the conclusion of the research projects, all Covered Species collected and utilized for Applied Research be delivered to the FWS or the TPWD for Refugia operations.

***Monitoring:*** EAHCP staff will receive monthly status reports from selected contractors and will visit with selected contractors on-site to evaluate the progress and methodology compliance of applied research projects.

***Science Committee Review:*** EAA staff followed the procedure approved presented to the Science Committee on April 8, 2014, to determine which proposed Applied Research projects were of higher necessity to the development of the eco-model. All of the information was provided to the Science Committee on March 25, 2014 (by email), to assist with the prioritization of the projects. The Science Committee discussed and prioritized the eight 2015 Applied Research projects at the April 8, 2014 meeting.

In accordance with procedure, after the selection of a contractor for each RFP, the contractors will present final detailed methodologies to the Science Committee for each individual study to solicit input before beginning research.

***Research Facility:***
The EAA has entered into a five-year contract (with five, one-year renewal options available) with Texas State University (TXST) to allow researchers to use the Freeman Aquatic Building (FAB) raceways, two concrete ponds and wet lab (with living streams and aquaria) to conduct EAHCP research, starting in 2014. The TXST facilities meet the needs of providing source water, quarantine capabilities, endangered species handling, and infrastructure/resource needs.

The FAB facilities are available to potential EAHCP contractors, and terms of use will be included in contracts between EAA and researchers. Additionally, EAHCP staff will coordinate the projects for timing and availability of resource needed (tank, living stream, trough, raceway, or pond).

***Budget***

| | |
|---|---|
| *Table 7.1 Applied Research Budgeted Amount:* | *$ 450,000* |
| *Proposed 2015 Applied Research Work Plan Budget* | *$ 525,000* |

The Science Committee reviewed and prioritized eight Applied Research projects for 2015. The approach would be to conduct as much of the highest priority research in 2015 as the allocated budget in Table 7.1 would allow, ensuring the performance of research in the time frame allowed

prior to Phase II decisions. Research contracts will be awarded in the order prioritized by the Science Committee.

The Edwards Aquifer Authority will develop an RFP with expected deliverables and experimental design criteria for each applied study approved by the Implementing Committee. Where possible, all efforts will be made to match similar studies to allow for shared facility and expertise in an effort to promote fiscal stewardship.

These RFPs will each be issued through a competitive procurement process that will include publication in six print regional newspapers and direct distribution to a list of at least sixty potential qualified contractors.

Facility Budget

EAA is required to pay for utilities and minor O/M at FAB; $75,000 has been budget for this purpose.

ATTACHMENT 1

EDWARDS AQUIFER
AUTHORITY

**Name of Proposed Project:**

Algae Dynamics Study

**Project Description:**

Observations in the Upper Spring Run and Landa Lake sections of the Comal River as well as in Spring Lake of the San Marcos system have documented periodic algae blooms that can cover fountain darter (*Etheostoma fonticola*) and/or San Marcos salamander (*Eurycea nana*) habitat. Additionally, excessive algae blooms were observed during laboratory and pond studies conducted during HCP 2013 Applied Research (BIO-WEST 2013). Three types of algae were observed in the HCP 2013 Applied Research treatment tanks. *Spirogyra* sp. was observed to quickly invade the control tank which interestingly was the only treatment with high levels of CO2. In contrast, *Oscillatoria* sp., a blue-green algae, was noted growing in the *Riccia* sp. experimental cups in all tanks except the control. *Pithophora* sp. did not become prevalent until longer durations of exposure occurred. In some instances during the 2013 HCP Applied Research laboratory and pond studies, algae completely covered or replaced most of the *Riccia* sp. biomass.

Therefore, an Algae Dynamics study is proposed and directed at understanding the effect of water quality on algal growth, as well as the effect of algal growth on the survival of aquatic vegetation. There is considerable literature surrounding algae growth and water quality parameters, but limited to no information specific to the Comal and San Marcos Rivers. Growth of algae species is generally highly temperature dependent with community structure linked to temperature gradients (Roberts and Zohary 2010). In general, as temperatures increase, highest growth rates for algal groups change from diatoms, toward green algae to cyanobacteria (Canale and Vogel 1974) although species-specific responses are highly variable (Reynolds1984). O'Neal and Lembi (1995) found that growth of *Pithophora* sp. is inhibited in water temperatures of 15 °C with maximum growth rates occurring at 35 °C. *Spirogyra* sp. growth rates were only moderately inhibited at 15 °C and 35 °C with maximum growth rates at 25 °C.

**Rationale and Benefit to the EAHCP Ecological Model, Groundwater Model or Phase II Strategic Adaptive Management Program:**

The 2013 HCP Applied Research results from the Vegetation Tolerance study (BIO-WEST 2013) demonstrated that the rooted aquatic vegetation types tested were quite resilient to low-flow and resulting reduced water quality conditions (high temperatures, low CO2, etc.). As such these parameters presently serve as direct inputs to the HCP ecological model as tolerance

thresholds for aquatic vegetation. However, based on the algae observed during low-flow conditions in the wild and experienced in the 2013 Applied Research activities, it is prudent to address the concern surrounding potential algae impacts to aquatic vegetation (fountain darter habitat). As shown in the laboratory and pond studies, rooted vegetation in the absence of algae can survive low-flow conditions and reduced water quality, but what happens when that rooted vegetation is covered in algae as has been experienced in the wild?
For example, every summer when ambient temperatures rise, the Upper Spring Run of the Comal River experiences an excessive green algae bloom. Although this condition occurs every summer, it clearly is exasperated during lower than average flow conditions. When an algae bloom occurs, it blankets all aquatic vegetation within the reach. The first aquatic vegetation that is shaded and physically killed off by the algae is the resident bryophytes. This is not surprising, nor really a concern, as bryophytes were shown to be less tolerant to low-flow conditions in the laboratory studies. However, rooted macrophytes are considerably more tolerant than bryophytes to the algae in the wild (during observed conditions) and persist for longer durations. Even such, during the 2013 drought, some rooted macrophytes were detrimentally affected in the Upper Spring Run reach at water quality conditions suitable for growth as predicted by 2013 laboratory and pond studies. When aquatic vegetation dies, fewer fountain darters are typically collected in the Upper Spring Run sample reach.

Aquatic vegetation as habitat continues to be the key variable relative to supporting fountain darters. Understanding the conditions in the San Marcos and Comal river systems that cause excessive algae growth, as well as if and when the rooted macrophytes (habitat) are rendered useless will directly support the refinement of threshold functions in the aquatic vegetation module of the HCP ecological model.

**Respected Supporting Literature:**


1. Anderson, T., and F. Anderson. 2006. Effects of CO2 concentration of growth of filamentous algae and *Littorella uniflora* in a Danish softwater lake. Aquatic Botany 84:267–271.

2. BIO-WEST 2013. Edwards Aquifer Habitat Conservation Plan (HCP) 2013 Applied Research. Prepared for the Edwards Aquifer Authority. October 2013. 109 p.

3. Canale, R. P. and A. H. Vogel. 1974. Effects of temperature on phytoplankton growth. Journal of the Environmental Engineering Division, American Society of Civil Engineers 100: 229–241.

4. O'Neal, S.W. and C.A. Lembi. 1995. Temperature and irradiance effects on growth of *Pithophora oedogonium* (Chlorophyceae) and Spirogyra sp. (Charophyceae). Journal of Phycology 31: 720–726.

5. Ozimek, T., E. Pieczyńska, and A. Hankiewicz. 1991. Effects of filamentous algae on submersed macrophyte growth: a laboratory experiment. Aquatic Botany 41:309–315.

**6.** Roberts, R.D. and Zohary, T. 2010. Temperature effects on photosynthetic capacity, respiration and growth rates of bloom forming cyanobacteria. New Zealand Journal of Freshwater and Marine Research. 21:391–399.

**7.** Sand-Jensen, K. 1977. Effect of epiphytes on eelgrass photosynthesis. Aquatic Botany 3:55–63.

**Submitted by:**

2013 Applied Research team (BIO-WEST, Baylor University, and USFWS Aquatic Resource Center)

ATTACHMENT 2

# Science Committee Key Elements

**Algae Dynamics Study (aquatic ecologist)**

1. Estimates of river algal populations.
2. Studies of algal productivity.
3. Species composition in the rivers studied.

**Algae Dynamics Study (aquatic ecologist)**

1. Study should include a field component, perhaps with study plots or enclosures or frequent detailed mapping, observations, and measurements. This could occur in the Upper Spring Run, Golf Course Slough, or other backwater/slackwater habitat in the Comal or San Marcos systems.
2. Continuous water quality monitoring for some period if not the entire length of the study. Continuous temperature monitoring.

**Algae Dynamics Study (study design & stats)**

1. A replicated, manipulative experiment to determine whether a linear or nonlinear relationship exists between water temperature & algal growth.
2. A replicated, manipulative experiment with different algal concentrations differentially influence bryophytes and macrophytes.

**Algae Dynamics Study (botanist)**

There are ample studies that show the effects of temperature and nutrients on the growth of algae in general and specifically *Spriogyra, Oscillatoria,* and *Pithophora;* therefore, I think this study should examine the effects of *Spirogyra, Oscillatoria* and *Pithorphora* on the growth of at least two of the dominant macrophytes in the Comal and San Marcos Rivers, and *Riccia*.

1. How does the effect change as a function of temperature?
2. How does the effect change as a function of $CO_2$?
3. How does the effect change as a function of nitrogen and phosphate?

**Algae Dynamics Study (aquatic ecologist, botanist)**

1. Effects of algal growth during low-flow conditions on rooted aquatic macrophytes used as habitat by fountain darters in the Comal and San Marcos Rivers
2. Laboratory and pond study designs (with controls and adequate replication) including:
    a. Methodology to measure and control water quality parameters (temperature, flow, $CO_2$) and to mimic low-flow conditions (lower flow, higher temperature, lower $CO_2$)
    b. Selection of the top 3-4 rooted aquatic macrophyte species used as habitat by fountain darters in the Comal and San Marcos Rivers (these may be different between the two rivers)

    c. Selection of the top 3-4 algal species that occur on the top 3-4 rooted aquatic macrophytes in the Comal and San Marcos River (these may be different between the two rivers)
3. Methodology to measure and assess the effects of water quality on algal growth (may be different for different species)
4. Methodology to measure and assess the effects of water quality on rooted aquatic macrophytes (may be different for different species)
5. Methodology to measure and assess the effects of algal growth on the rooted aquatic macrophytes (may be different for different species of both algae and rooted aquatic macrophytes)
6. This could be an extremely complex experiment, with various parameters of water quality and species of both algae and rooted aquatic macrophytes plus all the combinations low-flow conditions vs. algae species vs. macrophytes.

**2015 EDWARDS AQUIFER AUTHORITY**
**PROGRAM MANAGEMENT WORK PLAN AND BUDGET**

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

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

*Project Management*: In 2015, HCP staff will continue to coordinate the work outlined in the Ecological Modeling, Biological Monitoring, Refugia, Applied Research and Regional Water Conservation Program work plans.

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

- Serve on the ASR Advisory Committee,
- Facilitate the Adaptive Management process,
- Serve on the Regional Water Conservation Monitoring Committee, and
- Facilitate and coordinate all meetings of the HCP Implementing, Science and Stakeholder Committees (and possible subcommittees)

*HCP Staff*: The HCP staff will continue the following HCP activities:

- Procure and execute contracts,
- Oversee contract tracking and compliance,
- Process and pay all invoices and mitigation reimbursements,
- Maintain financial records,
- Oversee the City of New Braunfels and San Marcos/Texas State University work plan activities,
- Oversee and coordinate research activities at the Texas State University Freeman Aquatic Building,
- Participate in the 2016 work plan process,
- Seek alternate funding sources,
- Participate in public outreach initiatives,
- Enhance the EAHCP.org website,
- Prepare and compile all of the Parties information for the annual report to USFWS, and
- Track and assist HCP Permittees with maintaining compliance with secondary implementation permits, such as: USACE, TPWD, USFWS and THC permits.

*Routine and Non-routine Adaptive Management Program (AMP)*: HCP staff, under direction of the Program Manager, will continue to manage the routine and non-routine decision making

process as defined in Article 7 of the FMA. The process for this facilitation and adoption is outlined in the EAHCP AMP Memo to the Implementing Committee. HCP staff will also serve as a liaison to USFWS in the AMP process. Additionally, HCP staff will continue to prepare necessary information to support the Phase II Strategic AMP decisions in Year 7 of the permit.

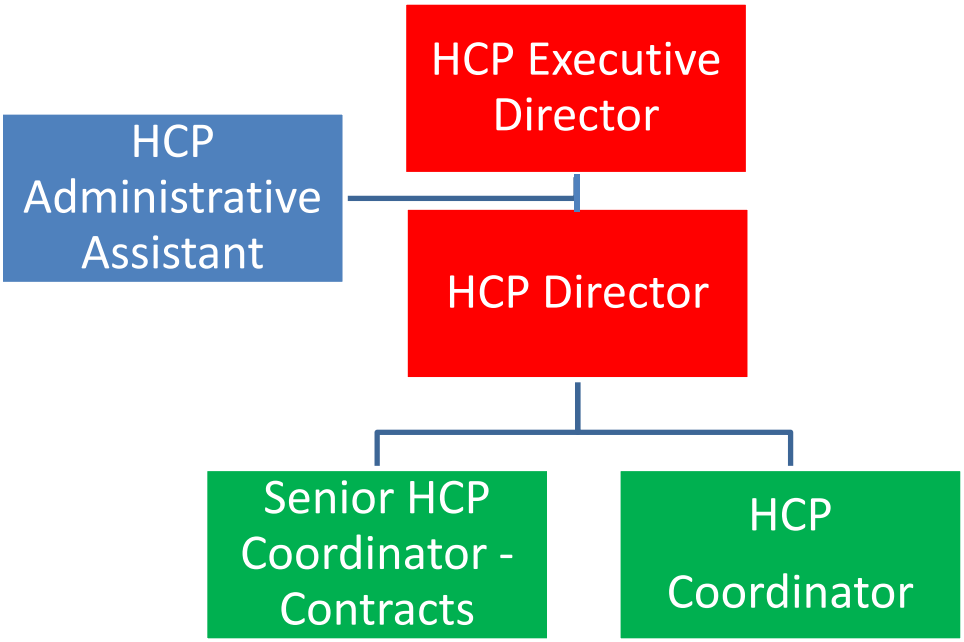
*EAHCP Implementing, Science and Stakeholder Committees:* HCP staff, under the direction of the Program Manager, will continue to manage the meetings and activities of all HCP Committees and any subcommittees or Committee workgroup. Typically, both Implementing and Science Committees meet monthly and the Stakeholder Committee meets bi-annually.

*Science Review Panel:* In 2013, the EAA executed a contract with the National Academy of Sciences National Research Council (NRC) to provide scientific review and evaluation of select programs within the EAHCP. In 2015, HCP staff will continue to provide support for the meetings of the NRC Committee, as needed. By December 31, 2014, the NRC Committee will produce its first report on its review and evaluation of the EAHCP ecological modeling, hydrological modeling, biological and water quality monitoring programs and applied research. In 2015, HCP staff will present NRC Committee recommendations from the first report to the HCP Implementing Committee for consideration.

*Issuing/Managing Contracts for other Applicants per Funding and Management Agreement*: Section 5.6.5 of the FMA requires the Program Manager to issue and manage mitigation contracts of other Applicants, in the event that the responsible Applicant receives the competitive bid to conduct the mitigation.

*Groundwater Modeling:* Section 6.3.2 of the EAHCP requires the EAA to make improvements to its MODFLOW model and to create a new groundwater model as described in the EAHCP. In 2015, EAA staff and its contractor will continue to develop both models to confirm that the EAHCP results for the Aquifer and spring flows are more reliable and defensible.

**Staffing in 2015:** The structure of the existing HCP staff positions is illustrated in the chart below. However, based on workload, the number of public meetings hosted by HCP staff, and future recommendations made by the NRC Committee, it is anticipated that the HCP Program Manager will be requesting an additional full-time employee, and is likely the request may be for two full-time employees.




**Budget**

The following table set out the estimated HCP Project Administration budget for 2015.

| | **Table 7.1** | **2015** |
|---|---|---|
| Program Administration | $750,000 | $750,000 |
| Science Review Panel | $50,000 | $230,000 |
| **Total Budget** | **$800,000** | **$980,000** |

The staffing expenses and operational expenses for 2015 are set out in the tables below.

| | |
|---|---|
| Salaries | $362,609 |
| Fringe/Benefits | $105,635 |
| **Total** | **$468,244** |

| | 2015 |
|---|---|
| Staffing[1] | $468,244 |
| Meeting Expenses[2] | $14,100 |
| Travel | $4,000 |
| Office Supplies | $2,500 |
| Professional Development / Memberships | $2,000 |
| Printing | $8,000 |
| Professional Contracted Services (PCS) | |
| PCS - Miscellaneous | $97,156 |
| PCS – Historic/Archeological Consultation [3] | $10,000 |
| PCS – Annual Report | $40,000 |
| PCS - Science Review Panel | $230,000 |
| PCS - Adaptive Management Program[4] | $75,000 |
| PCS - Permits | $10,000 |
| PCS – SC Compensation | $14,000 |
| PCS – Outreach | $5,000 |
| NAS Recommendations | ?? |
| **Total Expenditure** | **$980,000** |

[1] Staffing expenses subject to change based on EAA HR benefit analysis and the potential addition of staff.
[2] Science Committee travel. Implementing Committee and Stakeholder Committee meetings.
[3] AmaTerra contract for THC or archeological survey or consulting.
[4] The Program Manager has authority up to $50,000 for implementation of modifications resulting from the Adaptive Management process

## Stage V Critical Period Management

**Background**: Stage V Critical Period Management was developed and included in the Edwards Aquifer Habitat Conservation Plan to help decrease withdrawals and maintain adequate spring flows at both Comal and San Marcos Springs during times of drought. On February 14, 2012, the Edwards Aquifer Authority (EAA) Board of Directors voted to amend its Critical Period Management (CPM) Program to include the new emergency Stage V. Implementation of Stage V results in a reduction of 44% to municipal, industrial and irrigation permit holders in both pools of the Edwards Aquifer who are authorized to withdraw more than 3 acre-feet per year. Stage V became effective on March 18, 2013, when the Incidental Take Permit was issued by the U.S. Fish and Wildlife Service.

**2015 Implementation:** EAA staff monitors daily aquifer levels in both the San Antonio and Uvalde Pools of the Edwards Aquifer Region, if at any time, the 10-day average for aquifer or springflow levels in either pool reaches the designated trigger for Stage V, the EAA General Manager will issue a Notice of Commencement for implementation in five newspapers within the EAA jurisdiction. Notice will also be posted at the EAA's office and on the EAA website. All applicable 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 calculate CPM reductions as they apply to each individual permit holder's total authorized withdrawal amount throughout the year.

**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 in Uvalde County falls below 840 msl (see attachment I Critical Period Triggers Chart).

**Reporting:** Permit holders are required to report their annual groundwater use by January 31 for the preceding year. Permit holders who use more Edwards groundwater than authorized annually are subject to enforcement action.

**Attachment 1**

# CRITICAL PERIOD TRIGGERS, STAGES, AND WITHDRAWAL REDUCTIONS

*The following Critical Period triggers and percent reductions apply to all Municipal, Industrial and Irrigation users authorized to withdraw more than 3 acre-feet.*

EDWARDS AQUIFER AUTHORITY

## San Antonio Pool

*Critical Period is declared in the San Antonio Pool when the 10-day average of the rate of springflow at either the Comal or San Marcos springs, or aquifer reading at the J-17 Index Well in Bexar County drops below the Stage I trigger level. Likewise, a more restrictive stage of Critical Period is activated by any one of these triggers. However, the declaration of a less restrictive stage of Critical Period requires the 10-day averages of all three trigger levels to be above the activation thresholds of the particular stage in effect at the time.*

| TRIGGER (based on 10-day average) | CRITICAL PERIOD STAGE I | CRITICAL PERIOD STAGE II | CRITICAL PERIOD STAGE III | CRITICAL PERIOD STAGE IV | CRITICAL PERIOD STAGE V |
|---|---|---|---|---|---|
| Index Well J-17 Level (MSL) | <660 | <650 | <640 | <630 | <625 |
| San Marcos Springs Flow (CFS) | <96 | <80 | N/A | N/A | N/A |
| Comal Springs Flow (CFS) | <225 | <200 | <150 | <100 | <45/40* |
| **Withdrawal Reduction** | 20% | 30% | 35% | 40% | 44% |

## Uvalde Pool

*The Uvalde Pool enters Critical Period at Stage II based on the 10-day average of aquifer level readings at the J-27 Index Well in Uvalde County.*

| TRIGGER (based on 10-day average) | CRITICAL PERIOD STAGE I | CRITICAL PERIOD STAGE II | CRITICAL PERIOD STAGE III | CRITICAL PERIOD STAGE IV | CRITICAL PERIOD STAGE V |
|---|---|---|---|---|---|
| Index Well J-27 Level (MSL) | N/A | <850 | <845 | <842 | <840 |
| San Marcos Springs Flow (CFS) | N/A | N/A | N/A | N/A | N/A |
| Comal Springs Flow (CFS) | N/A | N/A | N/A | N/A | N/A |
| **Withdrawal Reduction** | N/A | 5% | 20% | 35% | 44% |

**San Antonio Pool only: In order to enter into Critical Period Stage V, the applicable springflow trigger is either less than 45 cfs based on a ten-day rolling average or less than 40 cfs based on a three-day rolling average. Expiration of Critical Period Stage V is based on a ten-day rolling average of 45 cfs or greater.*

Definitions: (MSL) Mean Sea Level; (CFS) Cubic Feet Per Second

Appendix J2

2015 City of New Braunfels Updated Work Plan and Budget
for the Edwards Aquifer Habitat Conservation Plan

# The City of New Braunfels

2015 Work Plan

The 2015 City of New Braunfels Work Plan represents a collaboration of ideas, concerns, and methodologies discussed during the current planning year with Implementing Committee members, scientists and stakeholders. As the 2014 projects move forward over the course of the year, the 2015 Work Plans will be adjusted to meet Edwards Aquifer Habitat Conservation Plan (HCP) goals and objectives.

### 5.2.1 Flow split management

Flow-split management is intended to compliment the ecological restoration of native aquatic vegetation in the Old Channel, by reducing long-duration high flows, meeting flow split management targets specified in the HCP –Table 5.3, and by allowing for more seasonal variability in the flow regime that mimics a more natural flow pattern. Presently, the culverts governing flow from Landa Lake into the Old Channel are inoperable, but currently under repair. As a result, a constant level of springflow can proceed through the culverts and into the Old Channel. The main objective for this Work Plan is to provide managed flows in the Old Channel.

**Flow Control Structures**

Long-term Objective: Maintain appropriate flow control structures to manage discharges entering the Old Channel to optimize conditions for fountain darter habitat.

Assumptions: Prior to 2014, the City of New Braunfels observed the smaller culverts (there are two) that connect Landa Lake with the old river channel under tee box two of the golf course were in serious disrepair. The areas around the outside of the pipes eroded away and needed to be reestablished to prevent lowering of Landa Lake levels as a result of dam/culvert failure.
The City of New Braunfels will have restored the original crest elevation of Landa Dam and removed accumulated sedimentation from the Landa Lake emergency spillway by summer of 2014. This will restore functionality of the structure as originally constructed, while reducing the potential for stress and damage to the gates, culverts, and associated infrastructure during high water events. The Landa Lake emergency spillway connects the lake to the Old Channel of the Comal River approximately 100 feet downstream of the gates and culverts. Design and permitting are complete and a construction contract was authorized to start construction in March 2014.

Target 2015/Performance Measure: Continue to exercise gates and perform routine maintenance for the flow control structures.

Methods: To ensure continued gate function, the City of New Braunfels will examine the gates monthly for proper function.

Monitoring: See Flow Split Management below.

**Flow Split Management**

Long-term Objective: Manipulate flows entering the Old Channel as specified in the HCP per Table 5-3, to optimize conditions for fountain darter habitat as controlled by operational flow control structures and real time gauge data. Provide continued maintenance on new flow control structures for long term functionality.

Assumptions: Flow-split management is contingent on fully operational flow control structures and access to real time gauge data.

Target 2015 /Performance Measure: Maintain target flow splits as controlled by proper operation and maintenance of repaired gates. Control gates are currently scheduled for repair in the 2014 work plan. The City of New Braunfels staff will operate the gates and monitor effectiveness and keep flows within the ranges defied by the HCP desired flow-split regime. Gates will be kept free of debris and exercised under a preventive maintenance program.

Methods: The City of New Braunfels staff will monitor real time flow readings from the gauges in the Comal River system and adjust flow control structures to meet the required flow split targets. The City of New Braunfels staff will observe flow control structures for the Old Channel and New Channel of the Comal River monthly, and more often if appropriate, and adjust flows based on measurements from the real-time flow gauges to maintain beneficial hydrologic conditions for habitat in the Old Channel. When total Comal Springs flow drops to 150 cfs and below, flow split structures will be operated as defined in the HCP to protect habitat within the Old Channel year-round, while continuing to allow flow in the New Channel at all times (*see* Table 5-3). Additionally, when total Comal Springs flow drops below 100 cfs, the City of New Braunfels staff will monitor and adjust if necessary the flow control structures more frequently to ensure the flow split ratio defined in Table 5-3.

**TABLE 5-3**
**FLOW-SPLIT MANAGEMENT FOR OLD AND NEW CHANNELS**

| Total Comal Springflow (cfs) | Old Channel (cfs) | | New Channel (cfs) | |
|---|---|---|---|---|
| | Fall, Winter | Spring, Summer | Fall, Winter | Spring, Summer |
| 350+ | 80 | 60 | 270+ | 290+ |
| 300 | 80 | 60 | 220 | 240 |
| 250 | 80 | 60 | 170 | 190 |
| 200 | 70 | 60 | 130 | 140 |
| 150 | 60 | | 90 | |
| 100 | 60 | | 40 | |
| 80 | 50 | | 30 | |
| 70 | 50 | | 20 | |
| 60 | 40 | | 20 | |
| 50 | 40 | | 10 | |
| 40 | 30 | | 10 | |
| 30 | 20 | | 10 | |

Monitoring: Monitoring of daily flow split volumes will be based on information provided by the real time flow gauges in the Comal River. Proper adjustments of the control structures will be accomplished as outlined in the HCP and after major runoff events. Repairs will be immediately undertaken when necessary, but will be dependent upon safe working conditions in the field and availability of any damaged parts to the system. Trash racks at the flow control structures will be monitored on a quarterly basis and cleaned as necessary to prevent operational problems. When required, trash racks will also be cleaned after major runoff events.

Allocated funds for 2015 : $ 0.00

Estimated Budget:$ $5,000

$1,500 Routine cleaning of trash racks and Inspections

$3,500 – Repair and Maintenance (as needed)

### 5.2.2.1 Old Channel Restoration

The City of New Braunfels will continue to assess remaining non-native vegetation and monitor restored native habitat for all 2014 projects that are completed. Additionally, the City of New Braunfels will continue to do limited channel modifications to enhance fountain darter habitat where applicable in the remaining areas of the Old Channel downstream to Hinman Island Drive above the confluence with the New Channel of the Comal River.

**Old Channel Non-native Vegetation Removal and Maintenance**

In addition to continued monitoring and maintenance (gardening) of restored native vegetation from the Sediment Island downstream to Elizabeth street, channel restoration in 2015 will include non-native vegetation removal and subsequent native vegetation

restoration, maintenance and gardening in select areas of the Old Channel between Elizabeth Street downstream approximately 2,400 feet through the Horseshoe of the Old Channel.

Long-term Objective: Control non-native aquatic vegetation and establish favorable native aquatic vegetative species to the maximum extent possible.

Assumptions: Restoration of native aquatic vegetation will be accomplished in select areas of the Old Channel through the Horseshoe bend (approximately 2,400 feet downstream of Elizabeth Street) and will involve the removal of non-native aquatic vegetation, planting of native aquatic vegetation and repeated gardening and supplemental plantings of previous areas upstream. This effort will continue until the proportional native and non-native targets outlined in Table 4-6 of the HCP according to funds appropriated in Table 7.1 of the HCP.

**TABLE 4-6**
**GOALS—FOUNTAIN DARTER HABITAT (AQUATIC VEGETATION) ($m^2$)**

| Study Reach | *Bryophytes* | *Hygrophila* | *Ludwigia* | *Cabomba* | *Fil. Algae* | *Sagittaria* | *Vallisneria* |
|---|---|---|---|---|---|---|---|
| Upper Spring Run Reach | 1,850 | 650 | ***150*** | | | 600 | |
| Landa Lake | 4,000 | ***250*** | ***900*** | ***500*** | | 1,250 | 13,500 |
| Old Channel | 150 | ***200*** | ***1,500*** | | 300 | | |
| New Channel | 150 | 1,350 | | 350 | | | |
| TOTAL | 6,150 | 2,450 | 2,550 | 850 | 300 | 1,850 | 13,500 |

***Bold/italics** indicate a restoration activity that deviates from the Maximum observed.

Target 2015 /Performance Measure: Reestablishment of native aquatic vegetation and reduction of non-native aquatic vegetation in accordance with the areas defined in Table 4-6.

Methods: The target locations for *Hygrophilla* removal will be based on a review of historical vegetation mapping data to identify areas in which high value native vegetation has historically occurred and taking into consideration possible adverse affects from other mitigation actions. Two-dimensional hydraulic model results have been used in the 2013/2014 and will continue to be used in the 2015 to evaluate the potential for success of the native aquatic vegetation restoration. This evaluation will consider the depth, velocity, and substrate conditions present in the proposed areas along with what non-native vegetation is thriving in these areas. In areas bare of vegetation, the reason vegetation is absent (*e.g.*, recent flood scour, or unsuitable depth, velocity or substrate conditions) will be evaluated prior to final selection of target areas.

Selected locations will first be sampled to remove fountain darters. Sampling will employ appropriate methods such as fanning and/or seining depending on local conditions. Non-native vegetation will then be removed and placed adjacent to the stream where qualified personnel will examine the plants for fountain darters (eggs through adults). Fountain darter life stages will be returned to the stream. Native vegetation for

plantings will consist of vegetation grown within the Landa Lake MUPPT nursery or from direct transplants within the Comal system. A variety of native vegetation (e.g., *Ludwigia*, b*ryophytes*, and filamentous algae) will be used to meet targets outlined in Table 4-6 of the HCP.

Monitoring: Each area in which non-native vegetation has been removed will be routinely monitored for the reestablishment of non-native vegetation and effectiveness of the native vegetation planting. Once native aquatic vegetation is established in an area, monitoring will be conducted on a less frequent basis.
As noted in the HCP (Section 5.2.2.3), following natural disturbances such as floods, periods of limited recharge, and/or herbivory, as well as anthropogenic disturbances such as recreation or vandalism, the monitoring/maintenance schedule will be adjusted temporarily in order to provide stability for the native vegetation re-establishment. Monitoring will include estimated aerial coverage of native and non-native vegetation within the treated area. Any reestablished non-native vegetation will be removed during each monitoring visit and if deemed necessary, additional native vegetation will be planted. Removal of non-native vegetation will follow the same protocols as the original removal methodology. Removed vegetation will be transported to an off-site composting facility.

Allocated funds for 2015:$ 175,000

Estimated Budget:$ 175,000

$175,000 Native Aquatic Vegetation Restoration – Old Channel

## 5.2.2.2/5.2.2.3 Comal River Aquatic Vegetation Restoration and Maintenance

The City of New Braunfels will continue their program of native aquatic vegetation restoration within key, sustainable reaches of the Comal River by planting native vegetation in unoccupied areas and in areas where non-native aquatic vegetation is removed. Restoration and maintenance represent two different work plan elements within the HCP as noted below. The amounts and types of vegetation removed and restored in this program will follow the targets provided in Table 4-5 and 4-6 of the HCP.

**Native Aquatic Vegetation Restoration**

Long-term Objective: Control of non-native vegetation and establishment of target native aquatic vegetation preferred by fountain darters. The City of New Braunfels will continue to coordinate with the TPWD on projects located in the Comal River and Landa Lake.

Assumptions: Native vegetation restoration will continue in areas of Landa Lake and the Comal River. Restoration efforts include continued removal of non-native aquatic vegetation throughout Landa Lake, while establishing additional *Cabomba* along the eastern shoreline of Landa Lake and along the New Braunfels' golf course property; establishing additional *Sagittaria* in shallower portions of Landa Lake; andestablishing *Ludwigia* in upper sections of Landa Lake. In addition, in 2015, select locations in the New Channel of the Comal River will be evaluated for potential restoration activities. Restoration of native aquatic vegetation in the Old Channel is covered under the 2015 work plan 5.2.2.1.

Target 2015/Performance Measure: Identification of target non-native aquatic vegetation removal areas and implementation of native aquatic restoration of ~1,250 square meters.

Methods: The target locations for non-native plant removal will be based on a review of historical vegetation mapping data to identify areas in which high value native vegetation has historically occurred. Two-dimensional hydraulic model results will continue to be used to evaluate the potential for success of the native vegetation restoration including areas of existing bare substrate. This evaluation will consider the depth, velocity, and substrate conditions present in the proposed areas along with what non-native vegetation, if any, are thriving in these areas. In areas that are bare of vegetation, the reason vegetation is absent (*e.g.*, recent flood scour, or unsuitable depth, velocity or substrate conditions) will be evaluated prior to final selection of target areas. Target restoration areas will be selected within the various identified locations noted above.
Selected locations will first be sampled to remove fountain darters. Sampling will employ appropriate methods such as fanning and/or seining depending on local conditions. Non-native vegetation will then be removed and placed adjacent to the site where qualified personnel will examine the plants for fountain darters (eggs through adults). Fountain darter life stages will be returned to the Lake/River. Native vegetation for plantings will consist of vegetation grown within the Landa Lake MUPPT nursery or from direct transplants within the Comal system. A variety of native vegetation (e.g., *Ludwigia*, *Sagittaria*, *Cabomba*, and b*ryophytes*) will be used to meet targets outlined in Table 4-6 of the HCP.

Monitoring: Each area in which non-native vegetation has been removed will be routinely monitored for the reestablishment of non-native vegetation and effectiveness of the native vegetation planting. Once native aquatic vegetation is established, monitoring will be conducted on a less frequent basis. However, if monitoring suggests continued gardening and/or supplemental planning is required, this will continue as needed.

However, as noted in the HCP (Section 5.2.2.3), following natural disturbances such as floods, periods of limited recharge, and/or herbivory, as well as anthropogenic disturbances such as recreation or vandalism, the monitoring/maintenance schedule will be adjusted temporarily in order to provide stability for the native vegetation reestablishment. Monitoring will include estimated aerial coverage of native and non-native vegetation within the treated area. Any reestablished non-native vegetation will be removed during each monitoring visit and if deemed necessary, additional native vegetation will be planted. Removal of non-native vegetation will follow the same protocols as the original removal methodology. Removed vegetation will be transported to an off-site composting facility.

Allocated funds for 2015:$ 125,000

Estimated Budget:$ 175,000

$175,000 Native Aquatic Vegetation Restoration – Landa Lake / Comal River involves redistributing **$50,000** from the 2015 Gill Parasite budget to more efficiently use resources to enhance fountain darter habitat in the Comal system.

### 5.2.3 Management of Public Recreation

Public recreational use of the Comal River ecosystems include, but are not limited to swimming, wading, tubing, boating, canoeing, kayaking, golfing, scuba diving, snorkeling and fishing. To minimize the impacts of incidental take resulting from recreation, the City of New Braunfels will continue to expand their existing recreation control measures as specified in Section 5.2.3.(1)of the HCP. The City of New Braunfels will enforce these measures (as covered in various sections of the HCP) to ensure their success.

Long-term Objective: To maintain and continue to expand the voluntary Certificate of Inclusion Program (COI) for all outfitters utilizing the Comal River; while utilizing opportunities to educate the public about the Endangered Species and importance of their protection.

Assumptions: This measure was not specifically funded for FY 2014. The COI is voluntary and is established per the 2013 Work Plan. The 2014 goal is to obtain participation by a majority of the outfitters utilizing the Comal River.

Target 2015/Performance Measure: Continue to inform Outfitters of the benefits to their businesses from participating in the COI program and initiation of the program. Continue

to recruit any Outfitters that are associated with the City of New Braunfels and the Comal River.

Methods: The City will utilize its existing public input process to continue with the COI application, criteria and program administration. The COI will include the minimum requirements as specified in Section 5.2.3 (2) a-h.

Monitoring:The City of New Braunfels staff will collaborate with all COI participants and report on the program annually.

Allocated funds for 2014: $ 0

Estimated Budget: $1000
$1000 – Advertise COI program

### 5.2.4 Decaying Vegetation Removal and Dissolved Oxygen Management

To minimize and mitigate the impact of incidental take from low-flow events, based on real time monitoring of dissolved oxygen (DO) levels in Landa Lake indicating a water quality concern created by decaying vegetation, the City of New Braunfels will continue to manage the DO management program. The program will be focused on ensuring adequate DO levels for the ecosystem regardless of the initiating circumstances.

Long-term Objective: Maintain acceptable levels of DO within Landa Lake and the Old Channel and minimize the impacts associated with decaying vegetation (or other factors).

Assumptions: Section 5.2.4 of the HCP implied the initiation of these actions when total Comal River discharges fall below 80 cfs. However, it is assumed that whenever low DO is evident regardless of the Comal River flows, remedial actions identified below are to be undertaken. Two portable Aerators have been installed in Landa Lake and are utilized when low DO levels are identified.

Target 2015/Performance Measure: Continue to monitor real time water quality monitoring devices in Landa Lake and maintain equipment to assist in DO management.

Methods: In 2013, real time water quality monitoring systems have been installed in Landa Lake and measures dissolved oxygen, temperature, pH, conductivity and turbidity. Since a real time water quality monitoring station has been established in the main body of Landa Lake in the vicinity of the Old Channel flow control structure; real time telemetry data will be connected to a computer system at the City of New Braunfels for monitoring water quality conditions. This is accomplished using wireless technology. The Comal River website will display data being collected in real time within the Comal River.

In 2013, two solar powered aeration systems were installed in Landa Lake. The solar powered aerators are based on a target area of approximately 10 acres (i.e., ~ 70 percent of Landa Lake). Continual testing involves an initial measurement of the diel oxygen profiles for several days during the summer to establish a baseline and then running the units for several days and monitoring the effective changes in the oxygen profiles. Based on these tests, a determination of whether additional units or location changes may be necessary. The units will then be stored for deployment in the event conditions warrant it.

If predicted or observed dissolved oxygen diel patterns are trending toward less than 4 mg/l (or other trigger/criteria as established through the Adaptive Management Process) the solar powered aeration units will be deployed. Vegetation conditions will then be evaluated via visual observations for signs of stress or decay on a weekly basis. If vegetation decay is evident and the aeration system is not able to keep oxygen levels above target thresholds, then mechanical removal of decaying vegetation will be initiated or other comparable management strategies will be developed based on specific conditions. In the event of mechanical vegetation removal, vegetation will systematically be examined for covered species and the species salvaged and returned to the system. Removed vegetation will be disposed offsite at a compost facility.

Monthly Monitoring: Real time dissolved oxygen and temperature will be monitored to evaluate projected trends indicative of problematic temperature or oxygen levels. Vegetation in Landa Lake will be monitored on a monthly basis during the May through September period to assess overall conditions and apparent stress levels (i.e., leaf coloration and condition). In the event projected trends of problematic oxygen levels are observed, then vegetation conditions will be evaluated via visual observations for signs of stress or decay on a weekly basis.

Allocated funds for 2015:$ 15,000

Estimated Budget: $ 15,000
$ 12,750 Monitoring/Maintenance
$ 2,250 15% Contingency

### 5.2.5/5.2.9 Non-native Animal Species Control

The City of New Braunfels will continue to conduct non-native animal species control on an annual basis and include annual maintenance and monitoring. The non-native animal species that will be addressed include the suckermouth catfish, tilapia, nutria, and ramshorn snail. Since this work plan has two components identified within the HCP, each component has been broken out to facilitate the development of the work plan and budgets.

**Control of Harmful Non-Native Animal Species**

Long-term Objective: Eliminate or maintain the density of non-native animal species at suppressed levels to minimize their impact to the Comal River ecosystem.

Assumptions: This will initially focus on the intensive effort to reduce non-native species and the assessment of removal techniques. Updated removal techniques will be utilized based on 2013/2014 results / determinations in the field.

Target 2015/Performance Measure: Continue to evaluate the efficacy of removal techniques and cost benefit of these efforts, focusing primarily on the suckermouth catfish, tilapia; and expanding current Nutria control. Identify Turtle nesting habitat as it relates to consumption of the invasive Giant Rams Horn snails in Landa Lake.

Methods: Seasonal concentration of tilapia and other non-native fish into localized areas will be exploited for removal through seining techniques utilizing mesh sizes that are selective against impacting fountain darters and other Covered Species. Each seining effort will involve salvage of native species, which will be returned to the system. The City of New Braunfels will increase its nutria poisoning program, while considering possible additional physical removal methods and other methods such as relocation. A major focus of non-native removal will target suckermouth catfish given their overall destructive impacts on habitats within the system. Given the anticipated difficulties in control of suckermouth catfish, several different removal techniques will be attempted that include trapping with hoop nets and gigging with divers. These efforts initially focused on Landa Lake in 2013 to evaluate effectiveness and the cost benefit of the efforts and will continue into 2014 on Landa Lake. During these combined efforts, any ramshorn snails encountered in 2014 will continue to be removed. All non-native species removed will be disposed of offsite following City of New Braunfels policies.

Monitoring: It is expected that the planned EAA biomonitoring program will accomplish monitoring requirements.

**Reduction of Non-Native Species Introduction and Live Bait Prohibition**

The City of New Braunfels has undertaken measures to stop or substantially reduce the introduction of non-native species from aquarium dumps and establish the range of prohibition of live bait species.

The City of New Braunfels will continue to educate and promote awareness, targeting specifically the practice of releasing aquarium trade species into the Comal system.

The City of New Braunfels will continue to promote banning the use of certain non-native species as live bait for fishing. The City of New Braunfels will continue to consult with relevant resources such as TPWD and USFWS to determine which native species may be used as bait for fishing locally, that do not present a threat to the Endangered Species. This

information will be used to provide a continual updated list of native bait species to be used.

These preferences and prohibitions will be communicated to the public through signage at key entrance points to parks on Landa Lake and the Comal River. Educational materials for outreach purposes will be developed for distribution.

Long-term Objective: Reduce the introduction of non-native species to the Comal River ecosystem.

Assumptions: This effort is primarily a public outreach and education effort.

Target 2015/Performance Measure: Expand education and enforcement based on the existing State regulation prohibiting the introduction of exotics; priority signage locations would include entrance points to Landa Lake, the fishing pier, and popular fishing locations on the Comal River. TPWD has education programs that will continue to be utilized.

2014 involved the process for NB City Council that will consider adoption of a City ordinance that would prohibit the introduction of domestic and non-native aquatic organisms, prohibiting specific bait species and aquarium trade dumps.

Methods: Expand on educational materials and outreach materials that are designed and produced for distribution to the public. TPWD has education programs that will continue to be assessed and potentially utilized. Continual improvements of existing signage will be managed according to existing City criteria.

Continue to solicit updated information, relevant studies, and opinions from Science expertise regarding potential threats or lack thereof to the Endangered Species by use of native species as live bait; compile into a useable format to assist in identifying native species to be used as bait.

In 2014, the City followed its normal process for creation and adoption of additional ordinances. This will involve public meetings, stakeholder input, drafting of the ordinance and possible adoption by the City.

Monitoring: It is anticipated that the biomonitoring program will detect the presence of newly introduced species. Signage will be inspected annually for repair or replacement as necessary as well as identification of other locations that may need signage.

Total Allocated funds for 2014: $ 75,000

Total Estimated Budget: $ 75,000

$2,000 Signage and Educational Materials
$65,500 Species Control
$7,500 - 10% Contingency

**5.2.6/6.3.6 Monitoring and Reduction of Gill Parasites**

The City of New Braunfels will retain and oversee the work of a contractor to conduct gill parasite (Asian trematode –*Centrocestus formosanus*) and *Melanoides* long-term monitoring .

Long-term Objective: Effective monitoring of gill parasite concentrations and host snail counts to minimize their threat to the fountain darters and other Covered Species within the Comal system.

Assumptions: The focus in 2015 will be on continued monitoring of water column cercaria along established transects and conducting an annual system-wide inventory of *Melanoides* distribution and density. Cercarial concentrations will continue to be monitored in established transects along the Comal River annually, and more frequently when spring flow drops below 100 cfs or other springflow triggers that are developed.

Target 2015/Performance Measure: Continue system-wide snail distribution and density estimates and continuation of the existing gill parasite monitoring program.

Methods:
It is anticipated that methods used in 2014 to conduct the annual *Melanoides* distribution and density survey will be used for 2015 monitoring. Two fisheries biologist using dip nets will traverse the entire Comal System recording the location of dip net sweeps and number of snails collected within each sweep. Water column cercarial concentration sampling will be conducted annually across the channel at the established 2014 transects. A total of 10 samples will be targeted at each cross section unless complex hydraulics suggests a higher spatial sampling. Sampling will proceed from downstream to upstream reaches. Samples will be collected between 9 and 11 am on sunny days to minimize temporal variance in the sampling. Each water sample will be filtered using an apparatus described in Cantu (2003). The cercariae will then be stained on the filters with a 10% Rose Bengal solution. Filters will then be transported to the contractors laboratory where the number of cercariae on each filter will be counted with the aid of a dissecting microscope. Cercarial concentrations will be monitored more frequently when spring flow declines below 100 cfs or other springflow triggers that are developed.

Allocated funds for 2015: $ 75,000

Estimated Budget: $ 25,000

**It is recommended that $50,000 be transferred from 2015 Gill Parasite activities to Landa Lake / Comal River native aquatic vegetation restoration activities to most efficiently use the HCP allocated funds.**

### 5.2.7 Prohibition of Hazardous Materials Transport Across the Comal River and Its Tributaries

The City of New Braunfels will continue coordination with the Texas Department of Transportation (TXDOT) to promote prohibited transportation of hazardous materials on routes that cross the Comal River and its tributaries. This effort may include refinement of City of New Braunfels ordinances, additional signage, and TXDOT approval.

Long-term Objective: Continue to identify and eliminate hazardous materials transport across the Comal River and its tributaries.

Assumptions: This effort will involve continual stakeholder engagement, public meetings, and coordination with TXDOT to follow the TXDOT guidelines. This work plan element is contingent on TXDOT continuous participation and support.

Target 2015 Performance Measure: Expanding the existing process of identification of smaller roadways and alternate routes that cross the Comal River and its tributaries. These routes pose an eventual threat to the endangered species and the need for refinement to the existing Hazardous Material prohibition transport plan, will provide safer transport across the Comal River and its tributaries.

Methods: Continue to expand and identify alternate transport routes that cross the Comal River and its primary tributaries that require protection and therefore prohibition. This information will be used to initiate public meetings, drafting and approval of City ordinances, and continuing coordination with TXDOT.

Monitoring: Annual monitoring of all installed signage will be undertaken and repair or replacement as necessary.

Allocated funds for 2015 :$ 0.00

Estimated Budget:$ 3,000
$ 3,000 - Signage and Education

### 5.2.8 Native Riparian Habitat Restoration (Comal Springs Riffle Beetle)

The City of New Braunfels will continue restoration of native riparian zones, where appropriate, to benefit the Comal Springs riffle beetle by increasing the amount of usable habitat and food sources (i.e., root structures and associated biofilms). The method of riparian zone establishment will include the removal of non-natives and replanting of native vegetation representative of a healthy, functioning riparian zone. Trees and plants with extensive root systems will be given preference to create the maximum beetle habitat. Fine sediment covering exposed roots and springs will also be removed. The riparian zone will be monitored (at least annually) for continued success and removal of reestablished non-natives. Riparian zones will be protected until the preferred riparian zone is established. Riparian habitat zones will be created along Spring Run 3 and along the portion of the western shoreline that is owned by City of New Braunfels. In addition, riparian restoration also benefits the system through bank stabilization and nutrient and sediment processes. The City of New Braunfels will continue their program to incentivize private landowners on the Comal River and its tributaries to establish riparian zones along the western shoreline. This program will be accomplished through work plan element 5.7.1.

Long-term Objective: Continual removal of perimeter areas that have non-native vegetation and fine sediments from the target area of Landa Lake and hillside adjacent to Spring Run 3. Establishment of beneficial native riparian species for Comal Springs riffle beetles.

Assumptions: It is assumed that this effort will continue to focus on the identification of target native riparian species most beneficial for Comal Springs riffle beetles that also meet erosion control requirements and the subsequent removal and establishment of native vegetation in the upstream 100 meters of target areas of Landa Lake and Spring Run 3 and proceeding north into private property lots (along the waters edge). It is assumed that the effort will be split between the bluff and Spring Run 3 given the different characteristics in these locations and therefore differences in approaches are anticipated. Restoration of the remaining area will be accomplished in segments during future years and incorporate revisions based on monitoring of the first year (2013) efforts. The continuous long term objective will be to continually evaluate the effectiveness of the proposed methods.

Target 2015/Performance Measure: Continue identification of target native vegetation, monitoring newly restored areas in 2014 for stability and effectiveness; as well as potential restoration of additional areas of the western shoreline upstream of the original 2013/2014 work area in Landa Lake and Spring Run 3 onto private property lots. Collaboration with landowners other than the City to gain access and cooperation will be undertaken in late 2014/early 2015.

Methods: Continual technical workshops will be undertaken with riparian ecologists and aquatic biologist to identify target native vegetation for use in the restoration. A technical

assessment of the removal of non-native vegetation and bank stabilization will be used to produce a specific work plan to accomplish this effort. This will include establishment of sediment control structures to eliminate sediment input to Landa Lake and Spring Run 3 during restoration activities. Given the sensitive nature of beetle habitats, additional implementation of BMPs in Panther Canyon will be considered for future consideration.

Monitoring: The effectiveness of establishing native riparian vegetation will be assessed near the end of 2015 with sufficient lead time to influence work plan development for 2015. Accumulation of fine sediments will be assessed in the restoration area at the same time based on visual inspection. In the event of heavy rainfall, the accumulation of fine sediments will be assessed in the following week.

Allocated funds for 2014:$ 50,000

Estimated Budget: $ 50,000
$ 45,000 Riparian Restoration
$ 5,000 10% Contingency

### 5.2.10 Litter and Floating Vegetation Control

The City of New Braunfels will perform activities to manage floating vegetation and litter removal to enhance habitats for Covered Species. Management activities will include dislodging of vegetation mats, to allow continued movement downstream, that form on top of the water surface, particularly during low flows, and removal of litter for the littoral zone and stream bottom. The City of New Braunfels will manage aquatic vegetation in Landa Lake by removing floating vegetation that is entrained on the flow control structures, fishing piers, Spring Island, Landa Park Drive Bridge and other areas where mats collect. Litter removal in Landa Lake and the Comal River will continue under the existing City of New Braunfels program.

Long-term Objective: Minimize impacts of floating vegetation and litter on the overall aquatic community within the Comal River.

Assumptions: Litter and floating vegetation mat removal will follow the existing protocol and schedules currently employed by the City of New Braunfels as described below.

Methods: Currently the City of New Braunfels contracts with a private contractor for removal of litter and dislodging of floating weedmats from Landa Lake, the Comal River and the Guadalupe River. Those contracts are renewed annually and in 2012 were set at a cost not to exceed $160,000 and include numerous mechanisms to reduce cost and scope mid season. SCUBA collections on the Comal River were added in 2007 as a pilot program and in 2008 as part of the contracts. SCUBA was added to protect the underwater habitat in the Comal River. Also in 2008, litter collection in Landa Lake was added to specifically

protect species habitat. The City of New Braunfels cooperated with the USFWS to implement litter collections in Landa Lake. These additional expenditures have been voluntary on the part of the City of New Braunfels in past years, but now are mandatory based on requirements in the HCP Section 5.2.10. It is possible that without funding from the HCP, this mitigation action would be continued to be unfunded in 2015. Funds previously committed for litter collection by the City of New Braunfels will be allocated for flow control work in 2014.

All litter removal and weedmat dislodging in Landa Lake is associated with protection of resource (species habitat), as there is no tubing recreation in Landa Lake. Underwater collection (SCUBA) in the Comal River is associated with resource protection (species habitat), however above water collection on the Comal River is a direct result of tubing activities. Collections on the Guadalupe River have no relevance to the HCP or species protection. Therefore only costs associated with Landa Lake and underwater Comal River collections will be included in HCP activities and budgets.

Target 2015/Performance Measure: Continued implementation of the established protocols.

Methods:

*Landa Lake* - (May 1st to September 30th). Vegetation maintenance and liter pickup during the non-recreation season is on an as needed basis. Floating vegetation mats will be dislodged from flow control structures and other locations.

*Comal River* – (May 1st to September 30th). Vegetation maintenance and liter pickup during the non-recreation season is on an as needed basis. Floating vegetation will be pushed downstream and inorganic litter will be picked up from the substrate, surface and littoral zone of the Comal River in the Old Channel and from the New Channel downstream to below the last tuber takeout point during the recreational season.

Monitoring: City of New Braunfels staff will monitor the contractor for compliance and initiate additional action when deemed necessary.

Allocated funds for 2015: $ 0

Estimated Budget:$40,000

$37,500 Underwater Litter Collection (22 weeks, Comal River and Landa Lake)
$2,500 Weed Mat Clearing (34 weeks)

### 5.2.11 Golf Course Management and Planning

The City of New Braunfels will implement their existing Integrated Pest Management Plan (IPMP) for Landa Park Golf Course. This process will incorporate public input and the Golf Course Advisory Board. The golf course IPMP will incorporate environmentally sensitive techniques to minimize chemical application, continue to improve water quality, and reduce negative effects to the ecosystem. Expanded water quality sampling targeted at Golf Course operations will be conducted as described in Section of 5.7.2 of the HCP.

Long-term Objective: Management of the golf course and grounds to minimize and reduce negative effects to aquatic ecosystem in Landa Lake and the Comal River.

Assumptions: The Landa Park Golf Course will continue to implement their existing IPMP and make adjustments to the plan as needed.

Target 2015/Performance Measure: Implement the existing IPMP using continual Public Input process.

Methods: The golf course and grounds will be maintained in an aesthetically pleasing, yet environmentally sensitive manner. It is the responsibility of the Golf Course Manager to maintain the course and grounds in accordance with the new IPMP. The IPMP will describe the activities and materials to be used to control pests (i.e. insects, weeds, and other living organisms requiring control) on the golf course in a way that minimally impacts the environment.

Monitoring: Each year the City of New Braunfels Watershed Manger in cooperation with the Golf Course Manager will report to the HCP detailed information on all pertinent activities during the year.

Allocated funds for 2015: $ 0

Estimated Budget: $1000

$ 1000 - Educational Materials and Signage (along Riparian areas)

### 5.7.1 Native Riparian Habitat Restoration

The City of New Braunfels will initiate a riparian restoration program to enhance the riparian zone along the Old Channel, the golf course, and in the vicinity of Clemens Dam. As long term plans continue to take shape for the reestablishment of the riparian zone, private and public landowners will be asked to participate in the plan. Reimbursement for the price of native plants will be provided to private and public landowners. Criteria to

qualify for reimbursement will be established along with a list of preferred natives to replant developed in consultation with the New Braunfels City Forester.

Long-term Objective: Restore the native riparian vegetation and encourage private landowners to utilize native plants when landscaping.
Restoration of native riparian vegetation in the previous location of the sediment island is needed to support the bank stabilization effort currently underway.

Assumptions: Sequencing will start with the completion of the bank stabilization project and continue with riparian vegetation restoration along the north bluff of the Old Channel. Native riparian vegetation restoration should be conducted to maximize the interactions of shading/light with the extensive native aquatic vegetation efforts being conducted in this reach to create direct habitat for fountain darters.

EAHCP Science Committee – As part of the bank stabilization effort, after initial design for riparian restoration is completed and prior to actual construction, the HCP Science Committee and Native Aquatic Vegetation Restoration Contractor will be consulted to ensure proposed concepts maximize the benefit to the species and for final approval of the design.

Target 2015/Performance Measure: The first step is the final implementation of bank stabilization and riparian restoration in the Old Channel adjacent to where the Sediment Island was removed. The remaining riparian restoration to be conducted along the Old Channel in conjunction with the native aquatic vegetation restoration work to maximize benefit to the fountain darter.

Methods: Utilizing the 2013 engineering assessment of the northern bluff of the Old Channel, will be the best approach to identify further stabilization measures. This assessment will give preference to methodologies that are least disruptive to habitat and are supportive of archeological preservation. The assessment will also include preparation of the existing engineering designs; identify methods to minimize environmental impacts within the Old Channel; and supporting documentation necessary to obtain any additional permits. Riparian Restoration at a minimum will include the removal of non-native riparian vegetation species and planting of appropriate native species. Bank stabilization and riparian restoration will be initiated upon receipt of the required permits.

Monitoring: The effectiveness of establishing native vegetation will be assessed near the end of 2015 with sufficient lead time to influence work plan development for 2015.

Allocated funds for 2015: $ 100,000

Estimated Budget: $100,000

$25,000 Riparian Restoration
$55,000 Vegetation Planting
$5,000 Monitoring and Maintenance from 1st Phase of construction (2014)
$15,000 15% Contingency

### 5.7.5 Management of Household Hazardous Wastes

The City of New Braunfels will continue the hazardous household waste (HHW) program that includes accepting prescription drugs and Freon, through the TCEQ and/or the waste disposal division of the City of New Braunfels. The City of New Braunfels will establish a four-times-a-year program that could be recognized in the City's MS4 compliance and storm water permit as a contributing activity.

Long-term Objective: Reduction in the improper disposal of hazardous wastes and incorporation of prescription drug and Freon drop off.

Assumptions: This effort will employ the existing program in place by the City of New Braunfels but include an expansion of public outreach, frequency and add additional scheduled efforts.

Target 2015/Performance Measure: Implementation of increased public outreach and education and addition of additional drop off event or events.

Methods: Public outreach and education will be increased in association with the increased scheduled drop off effort.

Monitoring: The amount and number of pickups will be noted and compared against historical efforts.

Allocated funds for 2015: $ 30,000

Estimated Budget: $ 30,000

$2,000 Outreach
$25,000 Additional Collection Events
$3,000 10% Contingency

### 5.7.6 Impervious Cover/Water Quality Protection/LID

The City of New Braunfels will expand criteria related to desired impervious cover, provide incentives to reduce existing impervious cover on public and private property in New Braunfels, and implement BMP’s associated with stormwater runoff in the area of Landa Lake and the Springruns. The City of New Braunfels will implement program based upon the low impact development (LID)/Water Quality Work Group Final Report recommendations for Implementation Strategies and best management practices (BMPs).

This Work Plan element includes development of the rebate and criteria program as well as an incentive/rebate program for implementation.

Long-term Objective: Reduction and control of non-point source runoff in the Comal River system.

Assumptions: The primary focus of this program is implementation of criteria, identification of specific BMPs, program guidance, and implementation strategy based on the LID/WQ Work Group Report from 2013. The efforts will focus on the identification of implementing the incentive program and identification of target program elements such as public education and outreach, rainwater harvesting, reduction of impervious areas, and other BMPs that would qualify for incentives. This initial effort has involved a stakeholder process followed by public outreach and education that outlines the incentive program and mechanisms for its implementation. It should be noted that the existing HCP budgets assume no BMP dollars in Year One. Given the public driven process, actual BMP design and implementation will not begin until Year Two and Three.

Target 2015/Performance Measure: Implementation of the program and strategy is to work in conjunction with current MS4 processes that are currently underway in the City of New Braunfels. The need to incorporate a funded LID and impervious rebate/incentive and education program is important, as the BMP's developed as part of this program will include practices that directly benefit the lake and springs systems and are well above and beyond the features of the City's standard MS4 program.

The first potential Pilot Project to implement LID/BMP features will be focused on the New Braunfels High School to reduce potential contaminant runoff to Landa Lake and the Spring runs.

Methods: The LID/WQ Work Group Report will continue to serve in improving the specifics of the existing program and implementation strategy. A public process will be continuous to provide for further stakeholder input, implementation of the program elements and implementation strategy. As a public entity, the City of New Braunfels will utilize its own program to administer rebates for implementing BMP's associated with stormwater runoff in the area of Landa Lake and the Spring runs. The LID program focuses on existing impervious cover areas (established older homes, business and schools), while the MS4 program focuses on new or redeveloped areas of impervious cover.

Monitoring: It is assumed that the WQ monitoring program of the HCP covered under other work elements will provide data for assessing the overall effectiveness of this measure. Review of the WQ data will track the overall benefits of any installed BMP's and/or education outreach that are utilized in the areas above the Comal springs / Landa Lake. Additional monitoring and yearly maintenance regarding BMP placement will be

considered to show continued functionality and potential reduction in specific WQ contaminants.

Allocated funds for 2015: $ 100,000

Estimated Budget: $ 100,000
$ 5,000 Develop rebate structure and criteria for BMP's
$ 90,000 Offer rebates and conduct LID education campaign
$ 5,000 5% Contingency

**City of New Braunfels - HCP Budget**

| HCP Section | Mitigation Action | HCP Budget | Estimated FY2015 |
|---|---|---|---|
| 5.2.2.1 | Old Channel Restoration | 175,000 | 175,000 |
| 5.2.1 | Flow split management | 0 | 5,000 |
| 5.2.2/5.2.3 | Aquatic vegetation restoration | 125,000 | 175,000 |
| 5.2.5/5.2.9 | Non-native animal species control | 75,000 | 75,000 |
| 5.2.4 | Decaying vegetation removal | 15,000 | 15,000 |
| 5.2.8 | Native Riparian / Riparian improvement - riffle beetle | 50,000 | 50,000 |
| 5.2.6/6.3.6 | Gill parasite control | 75,000 | 25,000 |
| 5.7.1 | Restoration of riparian zones | 100,000 | 100,000 |
| 5.2.7 | Prohibition of hazardous material routes | 0 | 3,000 |
| 5.7.6 | Incentive program for LID/BMP stormwater management | 100,000 | 100,000 |
| 5.7.5 | Household hazardous waste program | 30,000 | 30,000 |
| 5.2.3 | Management of public recreation use | 0 | 1,000 |
| 5.2.10 | Litter control and floating vegetation management | 0 | 40,000 |
| 5.2.11 | Golf Course Management Plan | 0 | 1,000 |
| | | | |
| | **Totals** | **745,000** | **795,000** |

Appendix J3

# 2015 City of San Marcos and Texas State University Work Plans and Budgets for the Edwards Aquifer Habitat Conservation Plan

# The City of San Marcos / Texas State University

2015 Work Plan

# San Marcos/Texas State University 2015 Work Plan

## 5.3.1/5.4.1 Texas Wild-Rice Enhancement and Restoration

Texas State University and the City of San Marcos are partnering to undertake a program of Texas wild-rice (TWR) enhancement and restoration in Spring Lake and the San Marcos River.

Long-term Objective (Phase I): To restore 8000 $m^2$ of TWR (in addition to the 2013 baseline of 4000 $m^2$) and successfully implement the State Scientific Area (SSA) protection program for existing and restored areas of TWR during flows of 120 cfs and below (see HCP Section 5.6).

Assumptions: The average long term biological goal for TWR is 12,000 $m^2$ (see Table 4-10; pg 4-16 EAHCP). To achieve this goal, an 8000 $m^2$ increase over the first phase of the HCP period (2013-19) would be required with an annual goal of approximately 1100 $m^2$ of TWR restoration each year. It is also assumed that production of Texas wild-rice will occur at the Freeman Aquatic Building at Texas State University and the U.S. Fish and Wildlife Service San Marcos Aquatic Research Center. Production of plants at the FAB is incorporated into this work plan budget.

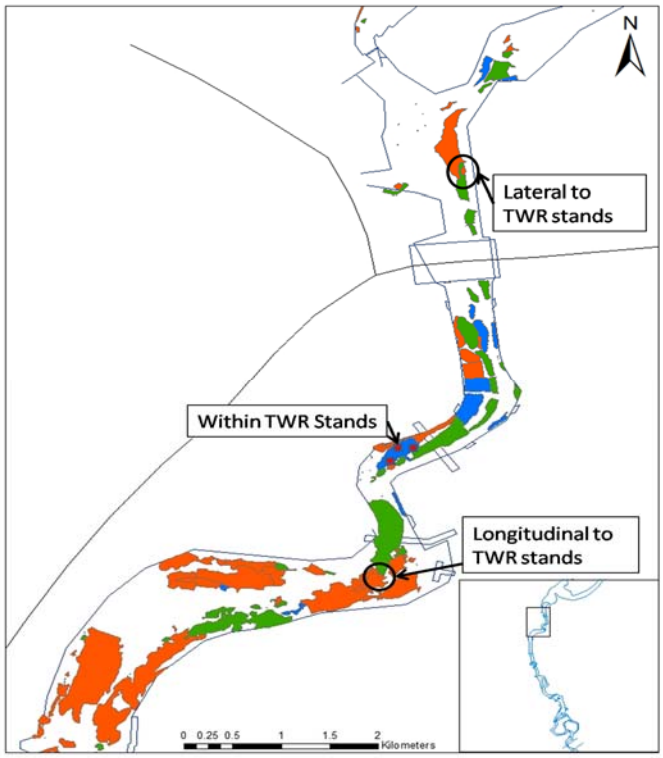
Enhancement and restoration of TWR focuses on the removal of non-native vegetation within mixed stands of TWR and removal of non-native vegetation in areas adjacent to existing TWR stands. The work plan also includes selective TWR planting in up to 20% of the areas where non-native vegetation and sediment is removed as discussed in HCP measures 5.3.6/5.4.4 (Sediment removal) and 5.3.8/5.4.3/5.4.12 (Control of non-native plant species).

Hardy et al. (2011a) estimated that the removal of non-native plants within TWR stands and in a 2-meter buffer around those stands could potentially provide over 1,000 $m^2$ of additional TWR stands within the San Marcos River downstream of Spring Lake. In addition, TWR areal coverage within Spring Lake is targeted for 1500 $m^2$.

Target 2015/Performance Measure: Successful expansion of TWR stands through selective gardening within and around existing stands and plantings where non-native vegetation and silt is removed. These strategies will target a goal of 1100 $m^2$. The 2015 target goal may be adjusted depending on "lessons learned" from 2014 work.

Methods: Model results from Hardy et al. (2011a) were used to identify restoration/enhancement areas for TWR that would have sustainable depth and velocity during low flows below 90 cfs (optimal habitat). *Hydrilla* and *Hygrophila* were selected as target species for removal due to their high relative abundance in the San Marcos River. In mixed stand areas, the non-natives will be removed and the original TWR stand monitored for expansion. Similarly, for TWR stands occupying optimal areas with adjacent non-native vegetation, the non-native plants will be removed and the TWR monitored for expansion. Finally, in optimal areas for TWR that are unoccupied by TWR, any non-native vegetation that is present will be removed and TWR planted and monitored to assess the success of transplants.

The specific areas chosen for planting prioritizes optimal habitat areas that remain suitable over the full range of discharges between the long-term average and lower flows as show in model results from Hardy et al (2011a). TWR stands will primarily be selected upstream of IH-35. TWR stands will be selected based on predicted TWR optimal conditions and a practical working environment (i.e. manageable current velocity). SMARC will be planting TWR downstream of IH-35.




When removing non-native vegetation, the non-native vegetation will be fanned to displace fountain darters prior to uprooting the vegetation. The non-native aquatic plants will be shaken, fountain darters (or other native species) salvaged and returned to the river, and the non-native vegetation bagged for disposal at the city's or university's composting facility.

Monitoring: Replanted areas will be monitored weekly for the first three months, then monthly to evaluate success. The treatment areas will be weeded as needed. Turbidity will be monitored during and after all removal efforts. Success will be determined by the amount of areal coverage as well as the success rate for newly planted TWR. Success will be based on the rate of success achieved by Dr. Robert Doyle and his student Rachel Bormann in 2012. They achieved a 78% (tillers) to 92% (whole plant) success rate with TWR. In 2014, we achieved a 95% success rate.

Allocated funds for 2014 from Table 7.1: $ 175,000

Two percent increase: $3,500

Estimated Budget: $178,500

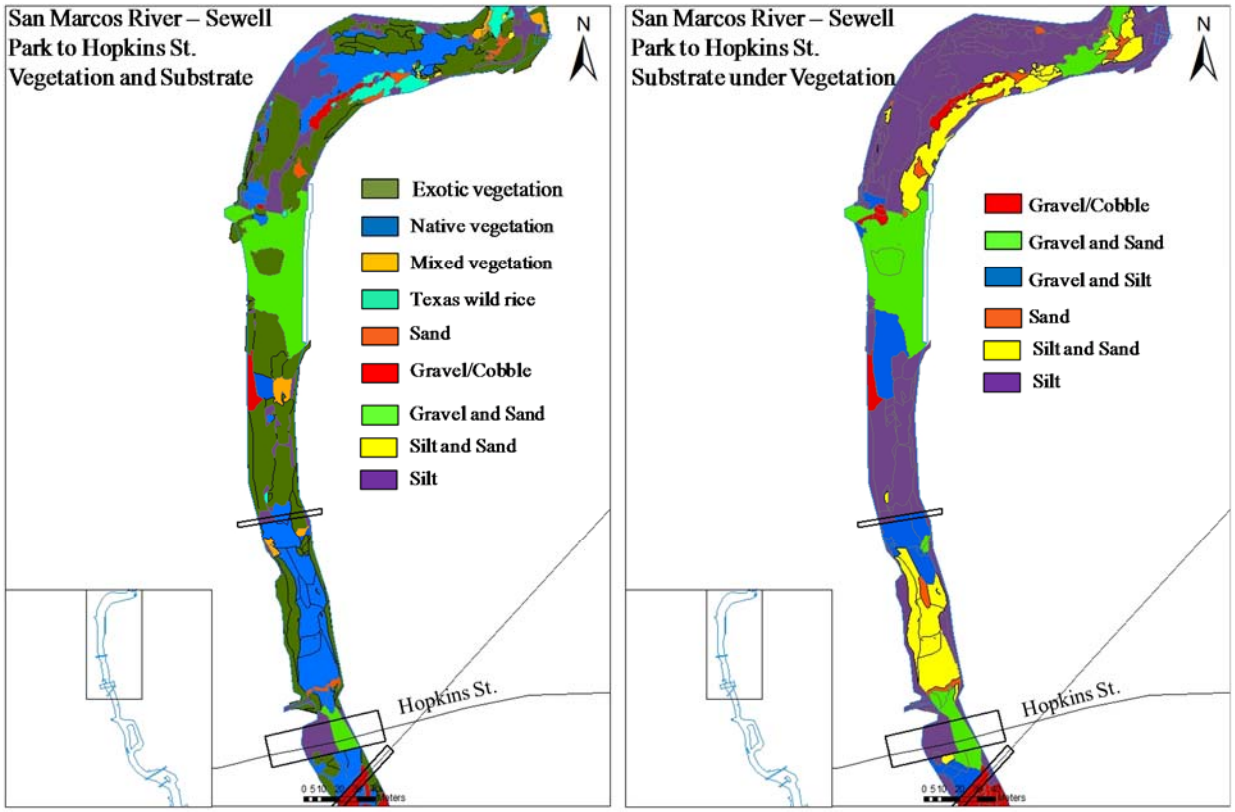
### 5.3.6/5.4.4 Sediment Removal

The City of San Marcos and Texas State University are partnering to implement an ongoing program of sediment removal from the river bottom at various locations from Spring Lake to IH-35.

Long-term Objective: Initial removal of targeted fine sediments and then maintenance removal of accumulations of sediment for the purpose of optimizing quality of riverine habitat.

Assumptions: FY 2015 sediment removal efforts and budget target a practical restoration effort that is integrated with other Work Plan efforts and minimizes potential negative impacts on the aquatic ecosystem and Covered Species habitats.

Hardy et al. (2011b) estimated 21,645 $m^2$ (12,749 $m^3$) of fine sediment in the San Marcos River between City Park and Rio Vista Falls. As illustrated in figure below, a high correlation can be observed between the distribution of silt and non-native vegetation. The reasons for this correlation are unknown. This correlation will be used to target areas with fine sediment accumulation and associated non-native vegetation for simultaneous removal. Native replanting is addressed in Measure 5.7.1.




Target 2015/Performance Measure: Successful removal of 1000 $m^2$ (and associate volumes) of fine silt and associated non-native vegetation. The 2015 target goal was adjusted based the amount of time required to accomplish this measure.

Methods: Removal of non-native vegetation prior to sediment removal is covered under Work Plan elements 5.3.8, 5.4.3, and 5.4.12. As specified in the HCP, hydrosuction will be used to remove accumulations of sediment. Divers will be trained on equipment operations, diving safety protocols, and recognition of all stages of listed species from larval to adult as part of the 2014 work plan.

Divers will fin the area proposed for sediment removal, remove all vegetation and then scan the area for the presence of listed species and other biota. In addition, placement of stakes around the area prior to vegetation removal will keep divers within designated area. One diver floats on surface to relay information to the dredge operator, one worker will be stationed by the discharge point to monitor operations and answer public questions. Disposal of removed sediment will be at the Texas State University Composting Center or Animal Shelter compost site.

Permits: Prior to work beginning in 2015, the COSM and TxState will submit the completed turbidity study to TPWD to obtain the required sand & gravel permit covering the entire upper reach from Spring Lake to IH-35.

Monitoring: Turbidity will be monitored during and after all removal efforts. In addition, colonization of vegetation, macroinvertebrates, and fish will be monitored in all treatment areas and compared to the reference site for each reach. After targeted depth of fine sediment removal has been achieved, the bed elevation will be measured from existing benchmarks and the sediment composition delineated (i.e., sand, gravel, etc). Bed elevation and substrate composition will then be monitored at each location before and after the recreation season. Measure success will be determined by the volume of sediment removed.

Allocated funds for 2014 from Table 7.1: $ 25,000

Remainder of initial funding:
$500,000 (initial) - $151,800 (2013) & $150,000 (2014) = $198,200 remaining

Estimated Budget: $223,200

This project was awarded $500,000 in 2013. Due to permit restrictions and the physical and temporal limitations of this project, it was not possible to expend the entire $500,000 in 2013/14. Therefore, only $151,800 from $500,000 budget was requested for 2013 and $150,000 in 2014, leaving $198,200 for 2015.

### 5.3.8/5.4.3/5.4.12 Control of Non-Native Plant Species

The City of San Marcos and Texas State University are partnering to implement an on-going non-native plant replacement program for the San Marcos River from Spring Lake to city limits. Non-native species of aquatic, littoral, and riparian plants will be replaced with native species to enhance Covered Species habitat.

Long-term Objective: To keep the density of invasive aquatic and littoral plants as low as possible through monitored removal along the San Marcos River.

Assumptions: Non-native aquatic plants will be removed in association with fine sediment removal and TWR enhancement as described in conservation measures 5.3.6/5.4.4 and 5.3.1/5.4.1. It is also assumed that production of native aquatic plants will continue at the Freeman Aquatic Building at Texas State University and the U.S. Fish and Wildlife Service San Marcos Aquatic Research Center. Funding for the production of plants at the FAB and SMARC is incorporated into this work plan budget.

Target 2015/Performance Measure: *Non-native Aquatic* - Non-native aquatic plant removal will occur in conjunction with sediment removal along with removal within and around TWR stands. Therefore, the 2014 goal is 1500 $m^2$ of plant removal.

*Littoral* – The area from Spring Lake to IH-35 has undergone initial removal of elephant ears, so in 2015 all areas will be monitored for regrowth and littoral areas will be planted with natives.

Methods

*Non-native Aquatic Plants* - Divers conducting sediment control will first remove non-native aquatic plant species from the area to be worked that day. Prior to plant removal, the area will be fanned to help remove fountain darters and other native species. The non-native aquatic plants will be removed, shaken and bagged for disposal at the composting facility. Denuded areas will either be targeted for TWR and/or selected native species planting. TWR and native species will be obtained from the SMARC, Tx State FAB, the San Marcos River, or approved vendors. Initial efforts for restoration of TWR or native vegetation will target planting of approximately 20 percent of the surface area restored.

*Littoral* - On the banks, elephant ear (*Colocasia esculentes*) is the focus of removal efforts. *C. esculenta* primarily reproduces by producing additional tubers beneath the soil or by sending off long runners called stolons which attempt to root in the soil or in any nearby body of water. The species also produces an inflorescence with a spathe tube that is green but the blade is orange on both sides.

Hand removal will be used wherever possible. Chemical removal consists of the use of glyphosate-based aquatic herbicide and surfactant that is drip-sprayed onto the surface of the leaves to remove more “entrenched” elephant ear plants.

Monitoring: *Aquatic vegetation* – Newly planted areas will be monitored monthly to evaluate success rate. The planted areas will be weeded (non-native species removed) and replanted as needed to meet target areal coverage. An annual river inventory will be conducted to identify the presence and location of new non-native vegetation establishment. Turbidity will be monitored during and after all removal efforts. Success will be measured by the surface area cleared of non-native plants and the success rate of replanted TWR or native plants (based on Dr. Doyle’s field work –input success rates).

Allocated funds for 2015 from Table 7.1: $ 125,000

Additional amount required to accomplish 2015 objectives: $113,928

Estimated Budget: $238,928

The budget reflects the time and effort necessary to meet the target biological goals as specified in the HCP. The budget reflects the level of effort based on applied work conducted in 2013 and 2014.

### 5.3.3/5.4.3 Management of Floating Vegetation Mats and Litter

The City of San Marcos and Texas State University are partnering to implement an ongoing program to manage floating vegetation and litter removal for the enhancement of listed species habitat. Management activities will include removal of vegetation mats that form on top of Texas wild-rice plants, particularly during low flows, and removal of litter for the littoral zone, stream bottom and tributaries. Texas State University will manage aquatic vegetation in Spring Lake through use of its harvester boat and through hand cutting of vegetation by divers authorized to dive in Spring Lake.

Long-term Objective: Minimize impacts of floating vegetation and litter on TWR stands and overall aquatic community within the San Marcos River, as well as keep springs clear to enhance San Marcos salamander habitat.

Assumptions: Existing vegetation management activities in Spring Lake will continue to follow the Spring Lake Management Plan (approved by the President's Cabinet) and the EAHCP, as described under Methods. Litter and floating vegetation mat removal will follow the existing protocol and schedules currently employed by the City of San Marcos and the EAHCP, as described below under Methods.

Target 2015/Performance Measure: Continued implementation of the established protocols.

Methods: *Spring Lake* - Each week about five springs are cut, with divers returning to cut the same springs every two to three weeks. During summer algal blooms, the springs will be managed more frequently (up to four springs per day), but mostly to remove algae. Texas State employees and supervised volunteers will fin the area around the springs to remove accumulated sediment, and then clear a 1.5 meter radius around each spring opening in Spring Lake with a scythe. Over the next 1.5 meter radius around the spring opening, they will shear vegetation to a height of 30 cm, and then to one meter over the following three meter radius. Plant material will not be collected, but carried away by the current. Cumulatively, about six meters of vegetation around each spring opening will be modified. Mosses will not be cut. The volume of plant material to be removed will vary by the amount of time between cuttings, and season. The harvester boat will remove a range of 15 to 20 boatloads of plant material a month from Spring Lake. The harvester will clear the top meter of the water column, cutting vegetation from sections one, two, and three once a week (See HCP Figure 5.2). The harvested vegetation will be visually checked by driver for fauna caught in the vegetation. If the driver observes fauna, he/she will stop work and put the animal(s) back into Spring Lake if appropriate. Texas State employees and supervised volunteers are trained to recognize the Covered Species through the Diving for Science program (Section 5.4.7.1), and avoid contact with them. Vegetation mats will be removed from zones four and five on an as-needed basis (See HCP Figure 5-2). The total area cut will equal about nine surface acres. The Spring Lake Area Supervisor also schedules cleanup of nuisance floating species such as water hyacinth and water lettuce from Spring Lake. The floating plants will be collected by hand and shaken prior to removal from the river to dislodge any aquatic species caught in the plant. The plants will be deposited into dump trucks and taken to the Meadows Center compost area. The activities described in this section are not funded by the EAHCP. They are fully supported by Texas State University.

*San Marcos River* – Floating vegetation in Texas wild-rice stands will be pushed off the stand and removed. Inorganic litter will be picked up weekly from the substrate, surface and littoral zones of the San Marcos River from upper Sewell Park to City Park and from IH-35 to Stokes Island during the recreational season (May 1st to September 30th) and monthly during offseason. Litter will also be picked up from public lands within the four tributaries. Monitoring of downstream Texas wild-rice stands to keep the stands clear of drifting vegetation will also be undertaken. On Texas wild-rice stands, contractor will lift (not push) the floating material from the top of the Texas wild-rice stands and remove it from the system.

Monitoring: Floating vegetation and litter are targeted for weekly removal during the recreation season and then monthly during the remainder of the year. In the event of low flows, this activity will be monitored for potential impacts on listed species and will be suspended if impacts are observed. Volume of litter will be tracked.

Allocated funds for 2015 from Table 7.1: $ 80,000

Contract Amount: $48,798.10

Public Outreach Funds: $2,500.00

Transfer to Measure 5.7.1/Native Riparian Habitat Restoration: $28,701.90

**5.3.5/5.3.9/5.4.11/5.4.13 Non-Native Species Control**

The City of San Marcos, in partnership with Texas State University, will implement a program of invasive faunal control in the San Marcos River on a periodic basis with expanded efforts of control, if needed, at low flows. The species include suckermouth catfish, tilapia, nutria and *Melanoides* and *Marisa cornuarietis.* Educational materials will be provided to local pet shops and commercial outlets who sell aquarium species. Alternatives, such as a university and nature center release pond, will be offered to fish and snail owners.

Long-term Objective: Reduction of non-native, invasive species in the San Marcos River to levels that minimize their direct and indirect impacts on Covered Species and the aquatic ecosystem.

Assumption: The Edward Aquifer Authority's Biomonitoring Program will perform population counts of targeted species to monitor changes in population numbers.

Target 2015/Performance Measure: Contractor will use methods that have proven to be successful in efficient capture of invasive species from Spring Lake to IH-35. Contractor will count and trend captured individuals for all targeted species. Contractor will also develop an acceptable method of nutria removal.

Methods: In Spring Lake, tilapia removal will be targeted during the winter to early spring period. Methods will be undertaken in a manner that avoids impacts to resident turtles and other native species. Catfish control is accomplished by bow and spearfishing within Spring Lake and the San Marcos River. Studies and monitoring need to accomplished outside this budget.

Effective removal of *Melanoides* and *Marisa cornuarietus* will continue to be accomplished by determining the locations of highest snail density and using dip nets to remove the snails weekly. The species will be controlled by diving several hours after sunset to hand-pick the snails from the submergent vegetation as well as setting baited traps.

Monitoring: It is assumed that the integrated biological monitoring program will assess the status of non-native animal species. Established population counts will be used as baseline to track success of efforts along with the biomonitoring program.

Allocated funds for 2014 from Table 7.1: $ 35,000

Contract Amount: $24,960.00

Two Percent Increase: $499.20

Public Outreach Funds: $2,500

Transfer to Measure 5.7.1/Native Riparian Habitat Restoration: $7,040.80

### 5.3.7 Designation of Permanent Access Points/Bank Stabilization

The City of San Marcos has completed the construction of bank stabilization/access points at six locations along the San Marcos River.

Long-term Objective: Maintain integrity of structures and control erosion in the recreation traffic areas at each structure.

Target 2015 Performance Measure: Establish hard surface, fence or plants as needed to control erosion around bank stabilization/access structures and conduct an annual inspection of each structure above and below the water line.

Methods/Monitoring. See above.

Allocated funds from Table 7.1 for 2015: $20,000

Estimated budget: $20,000

### 5.7.1 Native Riparian Habitat Restoration

The City of San Marcos and Texas State University will undertake a program to increase the area and density of the riparian zone on public and private lands from the Spring Lake Dam to IH-35 using native vegetation. Upon completion of the riparian zone on public land, private landowners will be asked to voluntarily participate in the plan.

Long-term Objective: Establish a robust native riparian community that benefits Covered Species and the habitat quality adjacent to and within the San Marcos River down to IH-35 (heaviest recreation zone) as well as prevents public access in undesirable locations which will decrease bank erosion. A zone of prohibitive vegetation along the uppermost edge of the riparian community will be established to encourage river users to access the river via hardened access points.

Assumptions: Removal of non-native riparian vegetation (Measure 5.3.8) will occur prior to or simultaneous with Measure 5.7.1 and is funded from the Measure 5.7.1.

Target 2015/Performance Measure: Treat the remaining riparian areas as shown in maps of Sites A & B below.

Site A – 840 linear feet/4,050 square feet

Site B. 3330 linear feet/16,400 square feet

Table 1. Cost breakdown of native riparian establishment at Sites A & B.

| | Rio Vista | Ramon Lucio | Total |
|---|---|---|---|
| Square Feet: | 4050 | 16400 | 20450 |
| 5 gal Woody Plants: | 81 | 328 | 409 |
| 1 gallon shrubs/herbs: | 162 | 656 | 818 |
| 4" Grasses, Herbs, Vines: | 405 | 1640 | 2045 |
| CY Mulch @ 3" Deep | 38 | 152 | 189 |
| | Site A | Site B | |
| Plant Installation Cost: | $15,187.50 | $61,500.00 | $ 76,687.50 |
| Irrigation Cost: | $ 1,620.00 | $ 6,560.00 | $ 8,180.00 |
| Maintenance: | $9,590.00 | $ 60,000.00 | $ 27,418.99 |
| Erosion Control: | $1,120.00 | $14,644.00 | $15,764.00 |
| Invasive Removal: | $1,980.00 | $47,850.00 | $ 49,830.00 |
| Total | **$29,497.50** | **$190,554.00** | **$220,051.50** |

**Existing Invasive Plant Composition:**
Ligustrum: extreme majority
Paper Mulberry: scattered stands of paper mulberry
Chinaberry: scattered large specimen, large crop of seedlings
Chinese Tallow: scattered large specimen, crop of seedlings

Without invasive control, these invasive plants will propagate rapidly over the next decade as shown by the rapidly establishing invasive seed bank. This further decreases the diverse and native understory vegetation which increases erosion. Wildlife would also lose a significant source of food and habitat.

The majority of plants to be used are listed below. Whenever possible, a 30 ft riparian buffer will be established, edged by a restrictive access plants. Restrictive access plantings will use thick woody and, or, thorny plantings to discourage pedestrian traffic. Some areas will not need the plantings while others will need more than specified.

Methods:
1. Remove invasive plants cutting and treating stumps using glyphosate or triclopyr based herbicides with the low impact paint method.
2. Install erosion control as needed to prevent loose soil, using mulch logs, logs, and plain mulch. Erosion control to be set up "on contour" as much as possible to preserve the natural patterns.
3. Plant during spring to accommodate a 30 ft buffer in all areas not identified as formal access point.
4. Establish plantings through the rest of the year. Some woody plants may need extra care a second year, depending on their exposure and size.

| **Common Name** | **Plant / Pot Size** |
|---|---|
| Bald Cypress | 5 Gal. |
| Sycamore | 5 Gal. |
| Eastern Persimmon | 5 Gal. |
| Texas Ash | 5 Gal. |
| Arizona Walnut | 5 Gal. |
| Mexican Plum | 5 Gal. |
| Fragrant Sumac | 5 Gal. |
| Cedar Elm | 5 Gal. |
| Red Mulberry | 1 Gal. |
| Palmetto "Brazoria" | 5 Gal. |
| Emory Sedge | 4", 1gal |
| Coral Bean | 1 Gal. |
| Mexican Olive | 1 Gal. |
| Chinquapin | 5 Gal. |
| Carolina Buckthorn | 5 Gal. |
| Nimblewill | 1 Gal. |
| Buttonbush | 1 Gal. |
| Red Buckeye | 3 Gal. |
| Bur Oak | 5 Gal. |
| Bald Cypress | 3 Gal. Sapling |
| Shummard red Oak | 3 Gal. Sapling |
| Chinquapin Oak | 3 Gal. Sapling |
| American Plum | 3 Gal. Sapling |
| Honey Locust | 3 Gal. Sapling |
| Fragrant Mimosa | 1 Gal. |
| False Indigo | 1 Gal. |
| Switch Grass | 4", 1 gallon |
| Inland Sea Oats | 4" |

Monitoring: Monitoring will occur weekly in newly planted areas to ensure success and revise methods as needed. Success will be measured in two ways: first, (once the fence has been removed) undesirable public access will be surveyed throughout the recreation season; second, riparian coverage will be measured prior to enhancement efforts and post-completion to determine amount of increased coverage and continued annually to track changes.

Allocated funds for 2015 from Table 7.1: $ 20,000

Transfer funds from Litter Removal (Measure 5.3.3) and Non-native Species Control (Measure 5.3.5): $35,742.70

Estimated Total Budget: $220,000 or $55,000/year

Budget plan: Fund the project over four years to cover expenses through the transfer of funds from other measures and the yearly allocation.

Justification for increased costs. The cost of riparian restoration was originally based on vegetative transects performed in 2011. Surveys by the contractor have shown a higher percentage of invasive trees, shrubs and vines than was estimated by the vegetative transects. Increased tree removal and required plantings have increased the overall cost of this critical effort. This is a critical measure in that riparian restoration not only increases riverine integrity, but it provides the barrier to prevent undesired access and subsequent bank erosion and river sedimentation.

After the completion of the 2013 riparian restoration, the remaining cost was projected to be $437,500. Riparian work was funded $203,000 in 2014.

The City has provided and will continue to provide all fences to protect the sites as well as game cameras and other security measures as needed to prevent theft, vandalism and unauthorized access. Theft, vandalism and unauthorized access occurred within the two days of the first plantings. Additionally, the City has submitted a FY15 budget request for ongoing maintenance of completed riparian areas.

### 5.3.2/5.4.2 Management of Recreation in Key Areas

Public recreational use of the San Marcos Springs and River ecosystems include, but are not limited to swimming, wading, tubing, boating, canoeing, kayaking, golfing, scuba diving, snorkeling and fishing. To minimize the impacts of incidental take resulting from recreation, the City of San Marcos will implement the Recreation Mitigation Measures adopted by the San Marcos City Council on February 1, 2011 (Resolution 2011-21). The City of San Marcos and Texas State University will enforce these measures (as covered in HCP Section 5.3.2.1) to ensure their success. Section 5.3.2.1 includes multiple educational and public outreach suggestions for implementation:

*Education of the river user and the community. Suggestions include*:

a. Signage. Post signage at the City Park tube rental facility, Rio Vista Falls and at proposed hard access points along the river. Signs will have the same template and coloration so they are recognized up and down the river. Signs will cover the rules of the river and educate the public on the importance of the resource. All signs will be bilingual.

b. Video Loop at City Park offering information about the river and safety rules while people are waiting for shuttle or tubes. Possibly also at Rio Vista Falls.

c. Posted maps showing trail, access points, fishing access and other amenities. Include a map at Stokes Park to help inform about the San Marcos River/Blanco confluence.

d. Work with the Tourist Information Bureau to include information on the endangered species and ongoing HCP projects at hotels/restaurants, bed and breakfast facilities, Chamber of Commerce, Visitor's Center, City of San Marcos internet site, etc. along with the recreational information.

e. Park Rangers. Include a section on river biology in the training of the park rangers so they can help disseminate the information.

f. School Outreach. Implement an outreach program for San Marcos Consolidated Independent School District (SMCISD) so this information can be relayed to youth in San Marcos and indirectly to the parents.

g. Overall Interpretation Plan. This would pull all the informational ideas together for conformity, continuity, and implementation.

<u>Long-term Objective:</u> To establish a trained seasonal conservation resource that will monitor recreational activities and ongoing HCP measures in and along the San Marcos River while educating the public about the Covered Species and importance of their protection as part of our enforcement obligations under the SSA and HCP measures. To establish an ongoing stream of information to increase public awareness and support.

<u>Target 2015/Performance Measure:</u> Educate the public engaged in water-based recreation on sustainable river use that protects listed species and their habitats. Collect data on recreational activities to determine impacts on listed species and success of HCP measures. The seasonal workers will also conduct miscellaneous cleanup and HCP project maintenance while walking/kayaking.

Establish signage at each new access point to educate the public on HCP projects and goals.

Methods: The contracted conservation resource will monitor river user activities from Memorial Day weekend to Labor Day weekend on a Wednesday through Sunday schedule. They will also actively engage in public education and outreach about target species and their habitats. In addition, they will collect data on specific recreational activities to provide insights for the HCP programs.

Monitoring: The public will be surveyed annually during the recreation season to assess the level of understanding of Covered Species, ongoing HCP Measures, effectiveness of the public outreach and education program, and the impacts of recreational activities on species and habitat.

Allocated funds for 2015 from Table 7.1: $ 56,000

Estimated Budget: $56,000

### 5.7.6 Impervious Cover/Water Quality Protection

The City of San Marcos and Texas State University will implement a program to protect water quality and reduce the impacts of urbanization based upon the LID/BMP practices. Urban land development tends to increase the intensity of storm water flows and the amount of nonpoint source (NPS) pollution reaching local water resources. Buildings, roads, and other impervious surfaces shed rain more rapidly than areas covered by vegetation, and most typical urban land uses require rapid drainage of storm water. The very rapid, direct connection of developed land across paved surfaces and through drainage conveyances to waterways tends to carry more pollutants more quickly from the land surface to water resources. A number of water quality problems and impairments in Texas are attributed in full or in part to such urban storm water runoff carried through storm sewers and channelized streams. The science committee stated this measure was one of great importance to the success of the EAHCP for listed species protection (May 9, 2013).

Long-term Objective: Implement a program that minimizes the impacts associated with urbanization and changes in land use/cover in the Upper San Marcos watershed, manages stormwater as close to its source as possible, treats stormwater as a resource rather than a waste product, emphasizes conservation and the use of on-site features to protect water quality, and increases infiltration to groundwater and aquifer recharge for the protection of riverine integrity.

Target 2015/Performance Measure: Continue the implementation of the Water Quality Protection Plan by Texas State University and City of San Marcos incorporating all jurisdictional watershed areas that directly or indirectly impact Covered Species' critical habitat for the purpose of meeting the goals stated in the long-term objective. Include public education, staff integration, four conceptual designs for retrofit water quality projects, grant proposals, and coordination with ongoing stormwater management plans for city and university. Upon completion, the WQPP should be provided to the Science Committee. The Science Committee has also requested an opportunity to review the Watershed Protection Plan (WPP) under development by the Meadows Center with funding from the Texas Commission on Environmental Quality.

Methods: City of San Marcos and Texas State University have a contract for the implementation of the developed plan.

Monitoring: N/A

Allocated funds for 2015 from Table 7.1: $ 200,000

Estimated budget: $200,000

### 5.7.5 Management of Household Hazardous Waste

The City of San Marcos will maintain a HHW program that involves the periodic collection of Household Hazardous Waste Collection (HHWC) and its disposal.

Long-term Objective: Continue to provide a place for citizens of San Marcos and Hays County to safely dispose of HHW.

Assumptions: City of San Marcos will continue its existing program.

Target 2015/Performance Measure: Continue outreach to 1400 participants; contract with two additional part-time personnel to conduct public outreach events and then convert or dispose of the HHW between events. Fund outreach to surrounding communities within the San Marcos River watershed that cannot afford to partner in a HHWC program.

Methods: Open drop-off opportunities two days a week (Tuesday and Friday) from 12:00 noon to 3:30 p.m. to the public. Conduct HHWC events 1 to 2 times per year on a Saturday in north central Hays County. Cover disposal costs for these events.

Monitoring: Track the amount of HHW received and number of participants from San Marcos, Hays County, and surrounding communities. All necessary documentation will be turned in to TCEQ. Identify the HHW that comes from communities with the San Marcos River watershed and the cost of collecting, processing and disposing of HHW from these communities.

Allocated funds for 2014 from Table 7.1: $30,000

Estimated Budget: $30,000

### 5.3.4 Prohibition of Hazardous Materials Transport Across the San Marcos River and Its Tributaries

The City of San Marcos will coordinate with the Texas Department of Transportation to designate hazardous materials routes which minimize the potential for spills into the San Marcos River. This effort will include legislation, if necessary, and additional signage.

Long-term Objective: Reduce the potential of spill of hazardous materials in the San Marcos River and its tributaries.

Assumptions: The primary effort will involve stakeholder engagement, public meetings, and coordination with TXDOT.

Target 2015/Performance Measure: Coordination with TxDOT for the implementation of hazardous materials restrictions and establishment of signage.

Methods: Complete checklist provided by TxDOT to establish a hazmat route that all transport routes that cross the San Marcos River and its primary tributaries.

Monitoring: Bi-annual monitoring of hazmat traps on designated roadways to determine functionality and annual monitoring of all installed signage will be accomplished. Substandard conditions will be repaired or replaced as necessary.

Allocated funds for 2015: $ 0

Estimated Budget: $ 0

### 5.7.3 Septic System Registration and Permitting Program

The City of San Marcos will undertake an aerobic and anaerobic septic system registration, evaluation, and permitting program to prevent subsurface pollutant loadings from potentially being introduced to the San Marcos Springs ecosystem within city limits.

Long Term Objective: To continue the registration, permitting and inspection of all new or existing septic systems installed or modified in the City of San Marcos jurisdiction. This has and will continue to be done to ensure compliance of all Texas Commission on Environmental Quality (TCEQ) regulations governing septic systems.

Assumptions: The existing program is adequate to meet the intent of this Measure.

Target 2015/Performance Measure: To have an accurate record of new and existing septic systems installed and modified in city jurisdiction. Also, by ordinance, to have all owners of septic systems connect to municipal sewer lines as they become available.

Methods: It is required by law that all septic systems are permitted by the local Designated Representative (DR), which is the City of San Marcos Environmental Health Department. Plans are submitted with the application and reviewed by the DR for TCEQ compliance. Once these are met, the permit to construct is issued. The design, site evaluation, installation and inspections can only be performed by individual that are licensed by TCEQ. Before the installation or modification is approved, inspections are made by the DR to ensure that the system installed corresponds with the design. Once completed, a license to operate is issued to the property owner by the DR. All DRs are subject to TCEQ Compliance Reviews.

Monitoring: The City of San Marcos Environmental Health Department reviews all applications and inspects the installations of all new and modified septic systems within the City's jurisdiction. The Department also monitors maintenance and responds to all complaints reported or observed.

Allocated funds for 2015: None

Estimated Budget: N/A

### 5.7.4 Minimizing Impacts of Contaminated Runoff

The City of San Marcos will construct two sedimentation ponds along the river to help reduce the amount of contaminated material that enters the river as a result of rain events. The first pond will be located in Veramendi Park beside Hopkins Street Bridge. The second pond will be created by widening the drainage ditches that run alongside Hopkins Street and cut directly to the San Marcos River.

Long-term Objective: Reduce the input of sediment and roadway pollutants into the San Marcos River.

Assumptions: Construction of the proposed sediment retention ponds are funded under Measure 5.7.6.

Target 2015/Performance Measure: Research funding sources for the design and construction of the Best Management Practices (BMPs) to be constructed at Veramendi Park and along Hopkins Street that will reduce total suspended solids (TSS) by 85%. Baseline water quality measurements should be taken prior to BMP installation. Storm water discharge should be re-sampled after BMP installation to measure success.

Methods: A contractor will be retained to research applicable BMP designs and recommend the most economic and efficient methods to control contaminants.

Monitoring: N/A

Allocated funds for 2015: $0

Estimated Budget: See Measure 5.7.6

### 5.4.5 Diversion of Surface Water

Texas State University will curtail its permitted surface water diversions as a function of total San Marcos spring flow to protect the aquatic resources as specified under the HCP flow management strategy. Under TCEQ Certificates 18-3865 and 18-3866, Texas State University's total diversion rate from the headwaters of the San Marcos River for consumptive use is limited to 8.1 cfs (See HCP Section 2.5.5). The total diversion rate from Spring Lake is limited to 4.88 cfs; the total diversion rate from the San Marcos River at Sewell Park is limited to 3.22 cfs (See HCP Section 2.5.5.1 and 2.5.5.2 respectively).

Long-term Objective: Meet diversion restrictions specified under the HCP.

Assumptions: None

Target 2015/Performance Measure: Restriction of surface pumping as specified under the HCP.

Methods: To minimize the impacts of these diversions, when flow at the USGS gauge at the University Bridge reaches 80 cfs, Texas State University will reduce the total rate of surface water diversion by 2 cfs, *i.e.*, to a total of approximately 6.1 cfs. This reduction in pumping will occur at the pump just below Spring Lake Dam in order to maximize the benefits to salamanders, Texas wild-rice, and other aquatic resources in the San Marcos River below Spring Lake Dam. The University will reduce the total rate of surface water diversion by an additional 2 cfs when the USGS gauge reaches 60 cfs. The additional 2 cfs reduction will be made from the pumps located in the slough arm of Spring Lake, and, therefore, maximize the benefits to the aquatic resources within the main stem San Marcos River below Spring Lake Dam. When the USGS gauge reaches 49 cfs, Texas State University will reduce the total diversion rate to 1 cfs. This further reduction will be made by restricting the pumps located in the Sewell Park reach. The diversion of water will be suspended when the springflow reaches 45 cfs.

Monitoring: Pumping rates will be reported on a daily basis when any of the pumping restrictions are in force.

Allocated funds for 2015: $ 0

Estimated Budget: $ 0

### 5.4.7 Diving Classes in Spring Lake

Access to Spring Lake is strictly controlled and regulated in accordance to federal, state and local laws. City ordinance and state law designate the public waters of Spring Lake as restricted to activities authorized by the University. All diving activities in Spring Lake are governed by the Spring Lake Management Plan.

Long-term Objective: Maintain the integrity of the ecology and cultural resources within Spring Lake.

Assumptions: All diving activities in Spring Lake are governed by the Spring Lake Management Plan.

Target 2015/Performance Measure: Implement the diving protocols as outlined in the Spring Lake Management Plan and the Edwards Aquifer HCP Incidental Take Plan.

Methods: The Diving Safety Officer will monitor all diving activities in Spring Lake, assuring all guidelines contained in the Diving Safety Manual for Spring Lake and the EAHCP ITP are observed.

Monitoring: The Lake Manager, with assistance from the Diving Safety Officer, will compile an annual summary of diving activities conducted in Spring Lake and provide to the Diving Control Board for its review.

Allocated funds for 2015: $ 0

Estimated Budget: $ 0

### 5.4.8 Research Programs in Spring Lake

Access to Spring Lake is strictly controlled and regulated in accordance to federal, state and local laws. City ordinance and state law designate the public waters of Spring Lake as restricted to activities authorized by the University. Proposals for research projects in Spring Lake must be submitted to the Environmental Review Committee, through the Lake Manager, for review and approval.

Long-term Objective: Maintain the integrity of the ecology and cultural resources within Spring Lake.

Assumptions: All research activities in Spring Lake are governed by the Spring Lake Management Plan.

Target 2015/Performance Measure: Implement the protocols for research as specified in the Spring Lake Management Plan and the EAHCP ITP.

Methods: 1. Proposals for research projects in Spring Lake must be submitted to the Environmental Review Committee, through the Lake Manager, for review and approval.

Proposals for research projects must be submitted in writing and include:

- Name and contact information of the responsible party conducting the research,
- Purpose and expected outcomes of the activities, including a description of how the project contributes to science,
- Description of activities, including, if appropriate, measures to be taken to minimize any impact on endangered species or their habitat, or any cultural resources found in the lake,
- Methodology, including literature review,
- Type of equipment used, how much; where it will be placed, and for how long it will remain in lake (see Equipment in Lake Section E of the Spring Lake Management Plan)
- Expected impact, and
- Timeline of Project

A copy of the final report and any publications on a research project will be provided to the Lake Manager.

Monitoring: The Lake Manager will compile an annual summary of the research conducted in the lake, including statements on the impact of these activities on the health of the lake.

Allocated funds for 2015: $ 0

Estimated Budget: $ 0

### 5.4.10 Boating in Spring Lake and Sewell Park

Access to Spring Lake is strictly controlled and regulated in accordance to federal, state and local laws. City ordinance and state law designate the public waters of Spring Lake as restricted to activities authorized by the University. All activities involving access to the lake, including glass bottom boat operations, will abide by the rules and intentions of the Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan.

Long-term Objective: Maintain the integrity of the ecology and cultural resources within Spring Lake and San Marcos River.

Assumptions: All boating activities in Spring Lake are governed by the Spring Lake Management Plan and the EAHCP ITP.

Target 2015/Performance Measure: Implement the protocols for boating as specified in the Spring Lake Management Plan in support of the EAHCP ITP.

Methods: Boats (canoe, kayak) used for educational activities, excluding glass bottom boats:

- All boats must be properly washed/disinfected before being placed in lake and once they are removed (see Equipment in Lake in the Spring Lake Management Plan).
- Participants must receive an orientation prior to boating including: instruction on safety, basic boat handling, and on-site rules and regulations. The orientation will cover information specific to Spring Lake's sensitivity and endangered species.
- All boating events must be designed to keep participants away from glass bottom boat operations.

To minimize the impacts of boating on the Covered Species' habitat in Sewell Park, canoeing/kayaking classes in Sewell Park will be confined to the region between Sewell Park and Rio Vista dam. Students will enter/exit canoes/kayaks at specified access points to avoid impacting the flora and fauna along the bank. Classes will be no longer than two hours and up to three classes will be held per day. Classes will have a maximum of 20 students in 10 canoes. All classes will be supervised.

Monitoring: The Lake Manager will compile an annual summary of boating activities conducted on the lake, including statements on the impact of these activities on the health of the lake.

Allocated funds for 2015: $ 0

Estimated Budget: $ 0

### 5.4.9 Management of Golf Course and Grounds

Texas State University will complete a golf course management plan that will document current practices and include an Integrated Pest Management Plan (IPMP). The golf course management plan and IPMP will incorporate environmentally sensitive techniques to minimize chemical application, improve water quality, and reduce negative effects to the ecosystem. Expanded water quality sampling targeted at Golf Course operations will be conducted as described in Section of 5.7.2. of the HCP.

Long-term Objective: Management of the golf course and grounds to minimize and reduce negative effects to aquatic ecosystem in Spring Lake and the San Marcos River.

Assumptions: None

Target 2015/Performance Measure: Continued implementation of the Golf Course Management Plan and Integrated Pest Management Plan.

Methods: The golf course and grounds will be maintained in an aesthetically pleasing, yet environmentally sensitive manner. It is the responsibility of the Golf Course Manager to maintain the course and grounds in accordance with the Integrative Pest Management Plan (IPM). This plan will describe the activities and materials to be used to control pests (i.e. insects, weeds, and other living organisms requiring control) on the golf course in a way that minimally impacts the environment. The IPM will be developed and updated by the Golf Course Manager, in consultation with the Lake Manager and the Environmental Review Committee. The Golf Course Manager will consult with the Lake Manager on any unique situation that may arise outside of routine maintenance that could impact Spring Lake.

Monitoring: Each year the Golf Course Manager will report to the Lake Manager detailed information on maintenance activities and materials used during the year. The water quality monitoring program performed by the Edwards Aquifer Authority will sample for runoff from the golf course.

Allocated funds for 2015: $ 0

Estimated Budget: $ 0

**Protocol for Implementation of HCP Measures Requiring Diving and/or Boating**

All activities in Spring Lake must be submitted to the Spring Lake Environmental Review Committee and/or the Spring Lake Diving Control Board for approval as outlined in the Spring Lake Management Plan. This includes required training and orientation for any diving based activities in Spring Lake by the RSI Diving Safety Officer, using guidelines set out in the RSI Diving Safety Manual for Spring Lake and the San Marcos River. This includes an orientation that covers: instruction on safety, basic boat handling, and on-site rules and regulations. The orientation will cover information specific to Spring Lake's sensitivity, endangered species as well as cultural resources.

All personnel implementing any portion of the HCP for the City of San Marcos and Texas State University will undergo an orientation at the SMARC to ensure awareness of the listed species and safe procedures while working in and along the San Marcos River.

Appendix J4

# 2016 Edwards Aquifer Authority Work Plan and Budget for the Edwards Aquifer Habitat Conservation Plan

June 25, 2015

Roland Ruiz
General Manager
Edwards Aquifer Authority
900 East Quincy
San Antonio, Texas 78215

Re: 2016 Work Plans and Budget for the Edwards Aquifer Habitat Conservation Plan (EAHCP)

Mr. Ruiz,

On behalf of the Implementing Committee for the EAHCP, I am attaching the Work Plans and Budgets for 2016 to support your Board's review and approval of the 2016 EAHCP budget.

In accordance with Article 4 of the Funding and Management Agreement, Work Plans and Budgets must be submitted for each of the conservation measures by their respective Implementing Committee member. Work Plans were initially drafted in mid-March and the Implementing Committee has reviewed and discussed these plans at their May and June meetings. Additionally, the Science Committee reviewed all Work Plans with scientific components and provided comments that were incorporated into the final versions of the Work Plans. All of the Work Plans were approved by consensus by the Implementing Committee on June 18, 2015.

In the coming weeks, the Permittees will use their internal procurement process to identify contractors for the activities listed in these Work Plans in order to assemble a Funding Application that will be submitted to the Edwards Aquifer Authority Board of Directors by October 1, 2015 for approval. The Funding Application budgets will be based on the selected contractors for the work.

Please let me know if you have any questions or require any additional information.

Sincerely,

Nathan Pence
Program Manager
Edwards Aquifer Habitat Conservation Plan

# 2016 Edwards Aquifer Authority Work Plan
# For
# Edwards Aquifer Habitat Conservation Plan

**2016 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:** To acquire 50,000 acre-feet of Edwards Aquifer unrestricted agricultural, municipal, and industrial permits as either leases or options, to be made available to SAWS for the purposes of physical storing or crediting the Regional ASR balance.

**Target for 2016:** The ASR contract between EAA and SAWS will continue to be implemented. EAA will become the primary leasing agent for ASR leases and will continue providing SAWS with notices of availability of HCP groundwater for acquisition of 50,000 acre-feet of Edwards Aquifer water for the ASR program. To encourage greater participation, EAA staff will pursue two initiatives. First, secure a rate adjustment and then work aggressively to inform permit holders of the new prices and determine interest; even scheduling targeted small group meetings. Second, EAA staff will closely review 2014 authorization and annual groundwater use reporting to identify additional leasing opportunities, and will roll out a program to enlist permit holders to pool together un-pumped authorization to make additional ASR regional contributions. Additionally, Tier 2 will trigger for 2016; therefore, EAA will develop and pursue Tier 2 participation in 2015 and 2016.

**ASR Program**

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

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

Operations: The significant action of approval of the Edwards Aquifer Habitat Conservation Plan Program Interlocal Contract between the Edwards Aquifer Authority and The San Antonio Water System for the Use of the Twin Oaks Aquifer Storage and Recovery Project for contribution to Springflow Protection "Interlocal Contract" effective August 14, 2013 takes elements of the HCP's ASR flow protection strategy into an operations contract.

*Injection*: Storage of HCP groundwater shall be at the discretion of SAWS and will be dependent on operating conditions. All HCP groundwater made available to SAWS before June 30, 2015 will be physically stored or credited as in storage, with the accompanying forbearance from the Aquifer, should triggers defined in the contract be reached.

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

Leasing:
The EAA will continue to acquire Tier 1 leases for the ASR program in 2016 with the initial target acquisition goal of 16,667 acre-feet. The continuing drought has been a challenge to leasing efforts as the market for available groundwater withdrawal rights tights and prices likely to rise. In response to these market conditions, the EAHCP staff has secured more competitive rates for the ASR program and will more aggressively target EA permit holders who have been historically identified as having available withdrawal rights. In addition, with the phase-out of EAA aquifer management fee rebates for municipal and industrial users, the ASR program is an attractive opportunity for permit holders who wish to capitalize on their un-used withdrawal rights. As the Tier 1 goal nears fulfillment, and current market conditions are assessed, strategies will be developed and discussed with the Implementing Committee for Tier 2 and Tier 3 acquisition for the remaining 33,333 acre-feet required by the HCP.

**ASR Regional Advisory Group:** Per section 5.5.1 of the HCP, a 12-person SAWS ASR Regional Advisory Group will meet quarterly to advise SAWS as it makes 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.

**Monitoring**
The EAA will actively manage the interlocal contract with SAWS. Status reports and updates will be provided regularly to the Implementing Committee.

**Budget**
Table 7.1

$4,759,000 – lease options
$2,194,000 – O&M
$6,953,000 – total

Estimated budget for 2016

$5,200,100 – lease options

$2,194,000 – O&M (this amount may vary)
$7,394,100 – total (with Tiers I & II filling and O&M at Table 7.1 rate)

Actual expenditures for 2016 will be determined by the terms of the ASR contract depending on the quantity of HCP groundwater physically stored, the amount of active water leases, and the cost of eligible operation and maintenance activities. Budgeted money that is not spent will be placed in the reserve fund.

# 2016 Edwards Aquifer Authority
# Regional Water Conservation Program Work Plan

### 5.1.3 Regional Water Conservation Program

Table 7.1 Budgeted Amount: $1,973,000

Proposed Work Plan Amount: $1,813,000

**Long Term Objective:**

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

**Discussion:**

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

- An initial donation of 10,000 acre-feet is solicited from Edwards Aquifer Authority (EAA) permit holders to remain in the EAA Groundwater Trust for a period of ten years.
- The donated water is returned to the original donors through the implementation of conservation initiatives and technical assistance provided by the EAHCP. As conservation savings accrue, one-half of the savings are realized by the party participating in the RWCP and the other half is placed in the Groundwater Trust for a period of 15 years (the term of the EAHCP); allowing the original donors to have their donated water returned on a pro-rata basis. Consequently, 20,000 acre-feet of conservation savings are necessary for full return of the original donations.

In order to provide an immediate benefit to the aquifer and springflow, several entities within the EAA jurisdictional area have agreed to reduce their authorized withdrawals. As of January 2015, the initial donations are 8,400 acre-feet. This initial contribution of water rights were placed in the Groundwater Trust for a period of ten years (see Table below):

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

Loaned water rights will be returned to the loaning entity at the end of 10 years or when an equal amount is identified as conserved and in reserve by the RWCP. Loaned water will be returned to the donor entity in a proportion equal to their contribution

.

At the September 18, 2014 Implementing Committee, a RWCP work group was appointed to review the progress of conservation initiatives and make recommendations to achieve the goal of reducing aquifer withdrawals by 10,000 acre-feet. The work group had an initial meeting on October 15 and met five times, concluding on December 11. A final report was presented to the January 15, 2015 Implementing Committee with nine recommendations:

1 Implement an outreach program to ensure all permit holders are aware of the RWCP.
2 Look for opportunities to pay permit holders for permanent conservation of historically unused permitted water.
3 Expand the search for reuse and industrial technology opportunities in the EA Region and offer incentives for their excess capacity.
4 Look for opportunities to create flexible agreements with program participants (i.e. varying terms).
5 Provide settlement opportunities for permit holders who over-pump their permit.
6 Offer incentives and assistance to encourage municipalities to promote landscape conservation, especially during peak demand.
7 Create a conservation incentive program for exempt well owners.
8 Explore partnerships with land trusts.
9 Target conservation measures to producers that use flood irrigation.

In 2013 and 2014, twenty communities and utilities within the EAA jurisdiction were ranked, based on Gallons per Capita per Day, and thirteen were contacted to determine interest. Only two have agreed to participate with the EAHCP and their total savings, and commitment to the Groundwater Trust has been less than 200 acre-feet. The drought that has persisted since the EAHCP was approved and the requirement to place one-half of the estimated conserved water in the Groundwater Trust for 15 years severely deterred participation in the RWCP. Unfortunately, after two years, only two percent of conserved water has been realized. The EAA has determined that it will be more beneficial to utilize a portion of the RWCP funds to add staff to the EAHCP team to pursue initiatives for reduced aquifer withdrawals. This concept was presented and approved at the January 15, 2015, Implementing Committee meeting.

Five Performance Measures were identified for 2015:

1. Obtain additional staff and resources to pursue measures that will reduce aquifer withdrawals:
2. Consider the recommendations presented by the RWCP work group;
3. Find a more efficient means of coordinating with the Department of Defense;
4. Pursue direct communications parties that have been specifically targeted, such as the Texas Aggregate and Concrete Association and the San Antonio Zoo;

5. Continue to develop innovative ways to reduce withdrawals from the aquifer by 10,000 acre-feet; and
6. Convene a meeting of the Regional Conservation Monitoring Committee.

**Target Performance Measures for 2016:**

In order to achieve the goal of 10,000 acre feet in the Groundwater Trust by the end of 2016, the EAA will continue, and hopefully expand, the initiatives began in 2015

**Methodology:**

This work plan will be implemented by EAA staff with limited assistance from other contractors as needed.

**Budget for Implementing 2016 Regional Water Conservation Work Plan:** The requested budget for the Regional Water Conservation work plan is $1,813,000 (see Table).

| Outside Contract Costs | Funds Allocated for Community Program Implementation | Revised Budget | Total Budgeted Funds (Table 7.1) |
|---|---|---|---|
| $ 40,000 | $1,773,000 | $ 1,813,000 | $1,973,000 |

**Monitoring:**

- Parties that have elected to contract with the EAA for program implementation will be required to provide an accounting of low flow devices (i.e. low flow toilets, and showerheads) or other means that have been used to reduce demands. EAA staff will provide photo documentation of the implementation of the program through routine visits of parties and distribution centers, etc.
- Move conserved water in Uvalde to the Groundwater Trust.

**Science Committee Review:** Not applicable to this work plan

**Regional Conservation Monitoring Committee Review:** Does require review of the work plan.

# 2016 Edwards Aquifer Authority
# Voluntary Irrigation Suspension Program Option (VISPO) Work Plan

**HCP Measure 5.1.2 - Voluntary Irrigation Suspension Program Option**

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

Table 1 – VISPO Enrollment Options

| Option | Fee | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5-Yr* | Stand-by | 50.00 | 50.75 | 51.51 | 52.28 | 53.06 | N/A | N/A | N/A | N/A | N/A |
| | Suspension[1] | 150.00 | 152.25 | 154.53 | 156.84 | 159.18 | N/A | N/A | N/A | N/A | N/A |
| 10-Yr | Stand-by | 57.50 | 57.50 | 57.50 | 57.50 | 57.50 | 70.20 | 70.20 | 70.20 | 70.20 | 70.20 |
| | Suspension[1] | 172.50 | 172.50 | 172.50 | 172.50 | 172.50 | 210.60 | 210.60 | 210.60 | 210.60 | 210.60 |

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

**Enrollment Goal Reached in 2014:**

Enrollment concluded on October 6, 2014, with a total enrollment of 40,921 acre-feet (AF) as shown below.

| Program | Atascosa (AF) | Bexar (AF) | Comal (AF) | Hays (AF) | Medina (AF) | Uvalde (AF) | Total (AF) |
|---|---|---|---|---|---|---|---|
| 5-year | 354 | 884 | 0 | 123 | 3,693 | 20,417 | 25,471 |
| 10-year | 0 | 1,573 | 0 | 0 | 7,803 | 6,074 | 15,450 |
| Total | 354 | 2,457 | 0 | 123 | 11,496 | 26,491 | 40,921 |

**Activities for 2016:** As enrollment is full and VISPO has triggered, the following activities will occur: get payments out in a timely fashion, monitor pumping to confirm compliance, and observe J-17 as October 1 approaches.

**Target for 2016:** Enrollment is complete and will not need to be addressed until the end of 2018 when the term will expire for 2013 enrollees that selected the five-year option.

**Allocated budget for 2016 (Table 7.1)** **$4,172,000**

Estimated 2016 Expenses

Since VISPO enrollment is full and fixed, expenses for 2016 will be determined by whether or not a trigger condition exists on October 1, 2015.

If VISPO does not trigger, the 2016 expenses will be:

| Enrollment Year | 5 – year | 10 – year | Total |
|---|---|---|---|
| 2013 | $496,516 | $632,142 | $1,128,658 |
| 2014 | $803,480 | $256,237 | $1,059,717 |
| | | Grand Total | $2,188,375 |

If VISPO does trigger, the 2016 expenses will be:

| Enrollment Year | 5 – year | 10 – year | Total |
|---|---|---|---|
| 2013 | $1,986,064 | $2,528,568 | $4,514,632 |
| 2014 | $3,213,920 | $1,024,948 | $4,238,868 |
| | | Grand Total | $8,753,500 |

# 2016 Edwards Aquifer Authority
# Biological Monitoring Work Plan

**Introduction/Overview:** Since 2000, the Edwards Aquifer Authority (EAA) has conducted an extensive biological monitoring program in the Comal and San Marcos spring systems. This program was referred to as the Variable Flow Study[1] (VFS). The elements of this study have now been incorporated into the Edwards Aquifer Habitat Conservation Plan (EAHCP) as the Biological Monitoring Program (BioMP) (EAHCP § 6.3.1).

The EAA developed the VFS in collaboration with a Technical Advisory Group consisting of resource specialists/scientists from multiple entities and with input from other natural resource professionals from the Texas Parks and Wildlife Department (TPWD), United States Fish and Wildlife Service's (FWS) Austin Ecological Services and National Fish Hatchery and Technical Center, and scientists from the Edwards Aquifer Research and Data Center, and Texas State University (*see* BIO-WEST, "Variable Flow Study: Seven Years of Monitoring and Applied Research," 2007). The VFS consisted of a comprehensive sampling program conducted in the spring, summer, fall, and winter.[2] *Id.* The VFS also included a Critical Period component for both the Comal and San Marcos systems based on established trigger levels (including high and low flows) for each. *Id.* The Critical Period component essentially mirrors efforts made during Comprehensive Sampling Plan except at a greater frequency triggered by low flows. *Id.*

During the development of the EAHCP, additional components were added to the VFS in 2013, creating the BioMP. The additional components were developed through discussions between scientists involved with the EARIP process including Thom Hardy, Ed Oborny and scientists from Texas State University, Baylor University, TPWD, San Antonio Water System, and the FWS.

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.

**Long-term Objective:** The EAHCP establishes that 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). Another benefit of the BioMP is to collect

[1] EAA, "The Comprehensive and Critical Period Monitoring Program to Evaluate the Effects of Variable Flow on Biological Resources in the Comal and San Marcos Springs Aquatic Ecosystems," 2000.

[2] In 2003, the winter sampling was eliminated from the Comprehensive Plan. In 2005, the Comprehensive Sampling Program was amended. The spring and fall events remained the same. During the summer, the Comprehensive Sampling Program included only Texas wild-rice annual mapping, dip net sampling for fountain darter, and parasite evaluations.

data that can be used in the applied environmental research studies (EAHCP § 6.3.4) and provide data and information for the ecological model development described in EAHCP § 6.3.3.

The BioMP will be conducted according to established, standard operating procedures to assure consistent data collection and quality:

- Comal Springs: http://www.eahcp.org/files/admin-records/NEPA-and-HCP/DRAFT_FINAL_SOP_COMAL_20150317.pdf.
- San Marcos Springs: http://www.eahcp.org/files/admin-records/NEPA-and-HCP/DRAFT_FINAL_SOP_SAN_MARCOS_20150317.pdf

**Assumptions:** It is assumed that the 2015 biological monitoring has been completed. In addition, it is assumed that the contractor will coordinate all monitoring activities with the implementation of any Conservation Measures.

**HCP Science Committee:** The BioMP methodologies and scope of work was previously reviewed and slightly modified by the Science Committee.

**Target for 2016:** Following renewal of the contract, the contractor will implement the BioMP for the San Marcos and Comal spring systems.

**Elements of the 2016 Biological Monitoring Program:** The BioMP consists of a Comprehensive Sampling Program that will be conducted in the fall and spring of 2016. During the summer, the only elements of the Comprehensive Sampling program that will be conducted are Texas wild-rice mapping, dip netting for fountain darters, and parasite evaluations. The 2016 Comprehensive Sampling Program will consist of the following elements:

- **Aquatic Vegetation Mapping, Including Texas Wild-Rice**
  - Full system aquatic vegetation mapping occurred in 2013 and will not occur again until 2018; therefore, it is not included in this Work Plan.
- **Annual Texas Wild-Rice Mapping**
- **Fountain Darter Sampling:**
  - In addition, the City of New Braunfels will monitor for gill parasites as part of the requirements in EAHCP § 5.2.6. The monitoring program will evaluate cercarial concentrations in multiple areas along the Comal River on a semiannual basis and more frequently when springflow drops below 150 cfs (EAHCP § 6.3.6).
- **Comal Springs Invertebrate Sampling (Comal Springs riffle beetle, Peck's Cave amphipod and Comal Springs dryopid beetle**
- **Salamander Visual Observations**
- **Comal Springs Discharge Measurements**
  - To supplement USGS discharge sampling Comal Springs discharge measurements will be conducted spring and fall at Spring Runs 1, 2, and 3, Upper Spring Run

reach, and the Old Channel below Elizabeth Street. The measurements will be used to establish the contributions of each major spring run to total discharge in the Comal River and to establish the relative proportion of water flowing in the Old and New Channels.

- **Water Quality Sampling**
  - For the details of the water quality monitoring program see, EAHCP, "Work Plan: Water Quality Monitoring Program Strategy for Comal Springs and San Marcos Springs for 2016" (http://www.eahcp.org/files/admin-records/NEPA-and-HCP/2016_Water_Quality_Monitoring_Work_Plan.pdf)
- **Fixed Station Photography**
- **Flow Partitioning within Landa Lake:**
  - Flow partitioning will be monitored within Landa Lake during each Comprehensive Sampling event.
  - An Acoustic Doppler profiler or similar device will be used to measure the flow patterns and current velocities from Spring Island through the upper portion of Landa Lake will be measured concurrently with BioMP discharge measurements at Comal Springs.
- **Macroinvertebrate Food Source Monitoring**
- **Edwards Aquifer Diving Beetle and Texas Troglobitic Water Slater**
- **Fish Community Sampling For Native Fish**
- **Reporting**
  - EAA will require its contractor to submit monthly progress reports to EAA describing the contractor's activities conducted during the previous month.
  - The contractor will be required to submit a draft annual report no later than December 31, 2016, that provides all of the sampling activities conducted for the year period and an evaluation of the results of those activities, and a cumulative evaluation of the data collected since 2000 for the BioMP and its predecessor VFS program.
  - The contractor will be required to evaluate the effects of any ongoing Conservation measures on the results of the monitoring program.
  - Sufficient tables, graphs, and exhibits will be provided in the text to clearly indicate what data was collected, the location, and the analytical data.
  - As an appendix to the written report, copies of completed field logbooks and copies of the raw data sheets for all water chemistry and biological sampling will be included.

**Elements of the Critical Period and EAHCP Components of the BioMP:** Critical Period and EAHCP Components of the BioMP will be conducted according to the established, standard operating procedures. It is likely that some of the sampling dates of the three components of the BioMP will coincide with each other during low flow

periods. Efforts will be made to coordinate sampling events when they are closely-related temporally to prevent duplicative sampling events.

**Incidental Take Permit: Permit Conditions, Habitat Baseline, and Take Estimation**

- Section 11.H of the Incidental Take Permit (ITP) sets out the terms and conditions and incidental take protection provided for each covered species over the 15-year term of the permit.
- The ITP requires the permittees to document compliance with the ITP. To quantify the amount of take per species, the USFWS allows the use of habitat as a surrogate for population number.
- The Incidental Take Permit: Permit Conditions, Habitat Baseline, and Take Estimation methodology and results for will be conducted according to the standard method agreed upon with USFWS in 2014 and presented to the Science Committee and the Implementing committees (http://www.eahcp.org/files/admin-records/NEPA-and-HCP/BW_2014_ItemM_Incidental_Take_memo_1.pdf).

**Budget for Implementing 2016 BioMP:**

| | |
|---|---|
| *Table 7.1* | *$400,000* |
| ***2016 Work Plan*** | ***$417,029*** |

The breakdown of the budget estimate for the comprehensive biological monitoring program for Comal and San Marcos Springs ecosystems is found in Attachment 1. The BioMP budgeted amount for Comprehensive Sampling and EAHCP Ch. 6 drought triggered monitoring for the Comal and San Marcos systems is $417,029. The cost of any Critical Period component of the BioMP, as established by the former EAA Variable Flow Study will continue to be paid by the EAA.

Attachment 1

BUDGET ESTIMATE FOR A COMPREHENSIVE BIOLOGICAL MONITORING PROGRAM FOR COMAL AND SAN MARCOS SPRINGS ECOSYSTEMS

| TASK | ESTIMATED COST |
|---|---|
| COMPREHENSIVE SAMPLING PROGRAM | |
| Task 1. Literature Review | $ 0 |
| Task 2. Aquatic Vegetation Mapping | $ 56,833. |
| Task 3. Texas wild-rice Mapping | $ 14,513. |
| Task 4. Fountain Darter Sampling | $ 82,837. |
| Task 5. Comal Springs Invertebrate Sampling | $ 47,582. |
| Task 6. Salamander Visual Observations | $ 23,683. |
| Task 7. Comal Springs Discharge Measurements | $ 4,539. |
| Task 8. Water Quality Sampling | $ 4,190. |
| Task 9. Fixed Station Photography | $ 2,154. |
| Task 10. Flow Partitioning in Landa Lake | $ 18,679. |
| Task 11. Macroinvertebrate Food Source Monitoring | $ 68,754. |
| Task 12. Fish Community Sampling | $ 59,613. |
| Task 13. EAHCP Habitat Baseline and Disturbance | $ 14,822. |
| Task 14. Annual "Take" Estimation | $ 18,830. |
| Comprehensive Subtotal | $417,029. |
| | |
| CRITICAL PERIOD SAMPLING PROGRAM (EAA expenditure only) | |
| Task 15. High/Low Flow Monitoring | $217,384. |
| Task 16. EAHCP Low Flow Sampling Program | $108,693. |
| Critical Period Subtotal | $326,077. |
| **2016 TOTAL** | **$743,106.** |

# 2016 Edwards Aquifer Authority
# Water Quality Monitoring Program Work Plan
# for Comal Springs and San Marcos Springs

## INTRODUCTION

This Work Plan details the sampling strategy and protocols for surface water quality monitoring in 2016 for the Edwards Aquifer Habitat Conservation Plan (EAHCP) document (Section 5.7.2) implemented by the Edwards Aquifer Authority (EAA), utilizing a third party contractor. The goal of the water quality monitoring program, first implemented in 2013, is to detect water quality impairments that may negatively impact the listed species. In the event that certain constituents of concern are detected at levels indicating the potential for adverse effects, the Implementing Committee member with jurisdictional authority will be consulted to identify sources and consider Best Management Practices (BMPs) to reduce and/or eliminate the constituents of concern. If necessary, additional testing could be included in the current or following year to assist in determining the source of contamination and the Science Committee could be consulted to assist with BMP identification and source determination.

## SCOPE OF WORK

The Water Quality Monitoring Program described below includes surface water, storm water, groundwater, and sediment sampling within Comal Springs and San Marcos Springs and associated river systems. Sample collection and analyses performed by EAA staff in 2013, has been performed by a contractor since 2014.

For 2016, the contractor will use the same sampling locations used in 2014 and as shown in the attached figures. However, changes in springflow, surface water runoff, land use, site security and access may dictate minor modification to sample collection locations and schedules as sampling efforts progress. Any minor changes resulting from these factors that are necessary as a result of safety or equipment concerns will be noted in the field sample sheets and dedicated field books. Should logistics or safety issues require any significant changes to this work plan, the sampling contractor shall report those issues to the EAA. Subsequently, the EAA will present those changes to the Science and Implementing committees for review and approval as needed prior to their implementation.

## COMAL SPRINGS

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

Discharge measurements have been collected from Comal Springs since 1933 and the EAA has been collecting water quality samples for more than ten years. In recent years, the EAA has been collecting samples from Spring 1, Spring 3, and Spring 7 on a quarterly basis during normal flow conditions and on a monthly basis when the San Antonio pool critical period triggers have been reached. Spring 1, Spring 3, and Spring 7 discharge into Landa Lake and make up part of the Comal Springs complex. Figure 1 indicates these historical groundwater sampling locations. Water quality samples are collected and analyzed for: dissolved oxygen (DO), pH, conductivity, and temperature, in the field and for alkalinity[1]. Samples are also submitted to the EAA contract laboratory for analysis of cations, anions, nutrients, metals, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), herbicides, pesticides, bacteria, total organic carbons (TOC), dissolved organic carbons (DOC), polychlorinated biphenyls (PCBs), and phosphorous. For the purposes of EAHCP related water sampling, the analyte caffeine has been added to the list of analyzed parameters. This list of parameters is defined as the water quality analytical list (WQAL).

**Sampling Methods**

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

**EAHCP Surface Water Sampling Locations**

To comply with sampling requirements outlined in the EAHCP, five additional surface water sampling locations (Figure 2) were identified in the 2013 EAHCP Water Quality Work Plan for intensive monitoring in the Landa Lake and Comal River area as listed below:

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

[1] Alkalinity analysis will be conducted within eight hours of sample collection.

**Surface Water Sampling Frequency**

In 2016, water samples will be collected twice from each of the five surface water locations listed above. The interval between sampling events will be approximately six months. Samples will be collected in March and September. Water samples will be analyzed for the WQAL parameters and caffeine using a NELAP laboratory. A listing of analytical parameters is provided in Appendix A.

**Sediment Sampling**

One sediment sample will be collected during June 2016 from each of the surface water sampling locations (Figure 2). Three samples will be collected from each sample site and composited into a single sample for analysis (to minimize VOC loss, it is recommended the compositing process be performed at the laboratory). Sediment samples will be analyzed for the analytical parameters provided in Appendix B. Results of sediment sampling analysis will be used to formulate future sediment sampling at Landa Lake and the Comal River. Sediment samples will be collected from zero to three inches below the surface for calendar year 2016. Sediment sample intervals will likely vary in subsequent sample years based on the results of each year of sediment analyses.

**Storm Water Sampling Program for Comal Springs**

Two storm water sampling events will be performed in 2016 to evaluate storm water quality from the urban landscape. A storm water sampling event will be triggered when the flow rate at the United States Geological Survey (USGS) Comal Springs gauging station (#08169000) increases by five percent or there is a twenty percent change in three of the five water quality parameters measured in the downstream real time water quality monitoring probe. Three water quality samples will be collected and analyzed from each surface water sampling location during the sampling event. Sample times will be spaced to reflect changes in the stream hydrograph (initial rise, peak flow, and recession limb). Water samples will be analyzed for the WQAL parameters and caffeine using a NELAP laboratory. A listing of analytical parameters for storm water samples is provided in Appendix A.

The following locations will be sampled for storm water as indicated on Figure 3:

Upper Springs (near Blieders Creek);
New Channel – (below confluence with Dry Comal Creek);
Upper Old Channel - (at Elizabeth Street);
Lower Old Channel - (above Hinman Island); and,
Comal River - (above confluence with Guadalupe River).

**Groundwater Sample Collection for Extreme Low Flow Scenarios for Comal Springs**

In the event total springflow at Comal Springs (as measured by USGS Comal Springs gauging station #08169000) drops below 30 cfs, the EAHCP (6.4.3.3) calls for weekly monitoring of three wells in the vicinity of the spring complex for DO, conductivity, pH, and temperature. Should springflow be at 20 cfs, then additional parameters to include nutrients, total dissolved solids (TDS), and TOC are to be added to the weekly sample regimen. Analytical parameters for all low flow sampling is included in Appendix A. Based on conditions during the drought of record (circa 1950s), sampling for lower flow scenario could last for up to 21 weeks. The three specific wells

to be used will be determined at the time of low flow sample initiation, based on well conditions and aquifer levels.

**Real Time Instrument Water Quality Data Logging Program for Comal Springs**

Continuous water quality monitoring stations will continue in 2016 at the following locations indicated on Figure 4:

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

Monitoring will be performed using a data logging sonde capable of collecting data on 15 minute intervals. The parameters measured will include temperature, dissolved oxygen, pH, turbidity, and conductivity. These data will be evaluated to identify short-term and long-term water quality variations of the spring system as well as changes in water quality related to storm water runoff. **This monitoring effort will continue to be performed by EAA staff in 2016.**

**Collection of Passive Diffusion Samples (Passive Samples) at Comal Springs**

Passive samples are to be collected during the 2016 sampling effort using a passive diffusion type sampling device. Devices will be obtained from Amplified Geochemical Imaging LLC (AGI), or equivalent to the AGI device for functionality and analytical parameters. Sample locations for PDS samples are provided in Figure 5. The passive sampling effort shall be performed in February, April, June, August, October, and December. The devices shall be installed for a two-week interval at the same locations as the base flow surface water samples. Specifically at the sample points below.

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

The general parameter set for PDS samples is listed in Appendix A, under *Analytical Parameters for Passive Diffusion Samplers, Comal and San Marcos Springs.*

**SAN MARCOS SPRINGS**

Located in San Marcos, Texas on the campus of Texas State University, San Marcos Springs discharges an average of 176 cfs into Spring Lake. The springs issue from the Edwards Group limestone along the northeast-southwest trending escarpment formed by the San Marcos Springs

Fault. Spring Lake forms the headwaters of the San Marcos River. Discharge measurements have been collected from San Marcos Springs since 1957 and the EAA has been collecting water quality samples for more than ten years.

In recent years, the EAA has been collecting samples from Deep Spring and Hotel Spring on a quarterly basis during normal flow conditions and on a monthly basis when the San Antonio pool critical period triggers have been reached. Both Deep and Hotel springs are located in the bed of Spring Lake and make up part of the San Marcos Springs complex. Figure 6 indicates these historical groundwater sample locations at San Marcos Springs. Water quality samples are collected and analyzed for: dissolved oxygen (DO), pH, conductivity, and temperature, in the field and for alkalinity[2]. Samples are also submitted to the EAA contract laboratory for analysis of cations, anions, nutrients, metals, VOCs, SVOCs, herbicides, pesticides, bacteria, TOC, PCBs, and phosphorous. For the purposes of EAHCP related water sampling, the analyte caffeine has been added to the list of analyzed parameters. This list of WQAL parameters is an identical to the list of parameters analyzed for at Comal Springs.

**Sampling Methods**

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

**Surface Water Sampling Locations**

To comply with sampling requirements outlined in the EAHCP document, seven additional surface water sampling locations (Figure 7) were identified in the 2013 HCP work plan for intensive monitoring as listed below:

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

---

[2] Alkalinity analysis will be conducted within eight hours of sample collection.

**Surface Water Sampling Frequency**

In 2016, water samples will be collected twice from each of the seven surface water locations listed above. The interval between sampling events will be approximately six months. Samples will be collected in March and September. Water samples will be analyzed for the WQAL parameters and caffeine using a NELAP laboratory. A listing of analytical parameters is provided in Appendix A.

**Sediment Sampling**

One sediment sample will be collected during June 2016 from each of the surface water sampling locations (Figure 7). Three samples will be collected from each sample site and composited into a single sample for analysis (it is recommended that compositing of the sample be performed at the laboratory to minimize VOC loss). Sediment samples will be analyzed for the analytical parameters provided in Appendix B. Results of sediment sampling analysis will be used to formulate future sediment sampling at Spring Lake and the San Marcos River. Sediment samples will be collected from zero to three inches below the surface for calendar year 2016. Sediment sample intervals will vary in subsequent sample years based on the results of each year of sediment analyses.

**Storm Water Sampling Program for San Marcos Springs**

Two storm water sampling events will be performed in 2016 to evaluate storm water runoff from the urban landscape. A storm water sampling event will be triggered when the flow rate at the USGS San Marcos Springs gauging station (#08170500) increases by five percent or there is a twenty percent change in three of the five water quality parameters measured in the downstream real time water quality monitoring probe. Three water quality samples will be collected from each surface water sampling location during the sampling event. Sampling times will be spaced to reflect changes in the stream hydrograph (initial rise, peak flow, and recession limb). Water samples will be analyzed for the WQAL parameters and caffeine using a NELAP laboratory. A listing of analytical parameters is provided in Appendix A, for storm water samples.

The following locations will be sampled for storm water as indicated on Figure 8:

Sink Creek;
Sessoms Creek;
Dog Beach Outflow;
Hopkins Street Outflow;
Purgatory Creek (above San Marcos River);
I-35 Reach; and
Willow Creek (above San Marcos River).

**Groundwater Sample Collection for Extreme Low Flow Scenarios for San Marcos Springs**
In the event total springflow at San Marcos Springs (as measured by USGS San Marcos Springs gauging station (#08170500)) drops below 50 cfs, the EAHCP (6.4.4.3) calls for weekly monitoring of three wells in the vicinity of the spring complex for DO, conductivity, pH, and temperature. Should springflow drop below 30 cfs, then additional parameters to include Nutrients, TDS, and TOC are to be added to the sample regimen. Analytical parameters for all low flow sampling is included in Appendix A. Based on conditions during the drought of record (circa 1950s), sampling for lower flow scenario could last for up to 21 weeks. The three specific wells to be used will be determined at the time of sampling abased on well conditions and aquifer levels.

**Real Time Instrument Water Quality Data Logging Program for San Marcos Springs**
Continuous water quality monitoring stations were established in 2013 and will continue in 2016 at the following locations indicated on Figure 9:

USGS gauging station;
Rio Vista Dam; and
Capes Dam/Willow Creek.

Monitoring will be performed using a data logging sonde capable of collecting data on 15 minute intervals. The parameters measured will include temperature, dissolved oxygen, pH, turbidity, and specific conductance. These data will be evaluated to identify short-term and long-term water quality variations of the spring system as well as changes in water quality related to storm water runoff. **This monitoring effort will continue to be performed by EAA staff in 2016.**

In 2015, an additional water quality data logging point was installed at Capes Dam/Willow Creek area that coincident with surface water sample point HSM 170 (Capes Dam/Willow Creek area). The additional station will help with the timing of storm sample collection as well as improved monitoring of the IH-35 and Willow Creek runoff impacts.

**Collection of Passive Diffusion Samples (Passive Samples) at San Marcos Springs**
Passive samples are to be collected during the 2016 sampling effort using a passive diffusion type sampling device. Devices will be obtained from AGI, or equivalent to the AGI device for functionality and analytical parameters. Sample locations for PDS samples are provided in Figure 10. The passive sampling effort shall be performed in February, April, June, August, October, and December. The devices shall be installed for a two-week interval at the same locations as the base flow surface water samples. Specifically at the sample points that follow.

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

The general parameter set for PDS samples is listed in Appendix A, under *Analytical Parameters for Passive Diffusion Samplers, Comal and San Marcos Springs.*

**WATER QUALITY MONITORING REPORT**

The contractor will compile and present sampling results in an annual report to the EAA. The report will include an evaluation of analytical data, graphs of results that exceed comparative or regulatory standards, a discussion of water and sediment quality, laboratory reports and field data sheets, photographs, sampling locations and rationale, description of sampling methods, and a description and rationale for any deviations from the Water Quality Sampling Plan due to logistics or safety issues. The report is to be submitted in hard copy and electronically and will be reviewed internally by EAA. The deadline for submittal to the EAA is December 21, 2016.

**DATA COMPILATION, ANALYSES AND REPORTING**

All of the data collected as a result of the 2016 HCP Water Quality Monitoring Plan will be compiled, and analyzed, and the results will be presented to the Implementing Committee by February 15, 2017; prior to inclusion in the annual EAHCP Annual Report that is required by Sections 6.2.4 and 9.3 of the EAHCP and Section 11.1c of the Implementing Agreement. The report will include an evaluation of all analytical data, including graphs, key photographs and general summary of results.

**CHANGES TO WORKPLAN FROM THE 2014 SAMPLING EFFORT**

In summary, the work plan has few changes from 2015. Funding is requested for maintenance and replacement needs for existing RTIs, as well as data transmission and web hosting fees. Detail for the RTIs is listed in Appendix C.

**SCIENCE COMMITTEE REVIEW**

This 2016 Water Quality Work Plan was reviewed by the EAHCP Science Committee at their April 2015 meeting. They recommended no additions or changes for 2016.

**BUDGET**

Table 7.1 Budget: $200,000

Requested work plan Budget: $497,530.00

2016 EAHCP Sampling as performed by an outside contractor, annual costs $474,430.00

Real Time Instruments (RTI): $23,100.00 (see Appendix C)

**Justification for Budget Adjustment**

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

## Figure 1
## Comal Springs Groundwater Sample Locations


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

Samples are collected monthly during low flow conditions (critical period), and quarterly during normal conditions.

**Explanation**

★ Historical Groundwater (Spring) Sample Location

***Prepared by:***

EDWARDS AQUIFER AUTHORITY

# Figure 2
## Comal Springs Surface Water Sample Locations


### Comal Springs HCP Related Sample Points

**Analytical Parameter List (HCP)**

| |
|---|
| Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals |
| Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals |
| Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals |

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

**Explanation**

★ Surface Water Sample Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

## Figure 3
## Comal Springs Storm Water Sample Locations


### Comal Springs HCP Related Sample Points

**Analytical Parameter List (HCP)**

Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

**Explanation**

Storm Water Sample Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

## Figure 4
## Comal Springs Real Time Water Quality Station Locations


### Comal Springs HCP Related Sample Points

**Analytical Parameter List (HCP)**

Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

**Explanation**

Continuous (Real Time) Water Quality Station

***Prepared by:***

EDWARDS AQUIFER AUTHORITY

# Figure 5
## Comal Springs Passive Diffusion Sampler Locations


### Comal Springs HCP Related Sample Points

**Passive Diffusion Samplers (PDS)**

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

PDS devices will be from Amplifed Geochemical Imagaing, LLC, or equivalent and shall provide analyses for: TPH, BTEX, 1,3,5 and 1,2,4-trimethylbenzene, MTBE, phenanthrene, naphthalene 1-methyl naphthalene, octane, cis and trans-1,2,-dichloroethene, 1,1-dichloroethane, chloroform, 1,1,1-trichloroethane, 1,2-dichloroethane, carbon tetrachloride, trichloroethene, tetrachloroethene, chlorobenzene, 1,4-dichlorobenzene, 1,1,2-trichloroethane, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,3-dichlorobenzene, and 1,2-dichlorobenzene.

**Explanation**

Passive Diffusion Sampler Location

***Prepared by:***

EDWARDS AQUIFER AUTHORITY

## Figure 6
## San Marcos Springs Groundwater Sample Locations


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

Samples are collected monthly during low flow conditions (critical period), and quarterly during normal conditions.

**Explanation**

★ Historical Groundwater (Spring) Sample Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

# Figure 7
## San Marcos Springs Surface Water Sample Locations


### San Marcos Springs HCP Related Sample Points

**Analytical Parameter List (HCP)**

| |
|---|
| Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals |
| Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals |
| Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals |

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

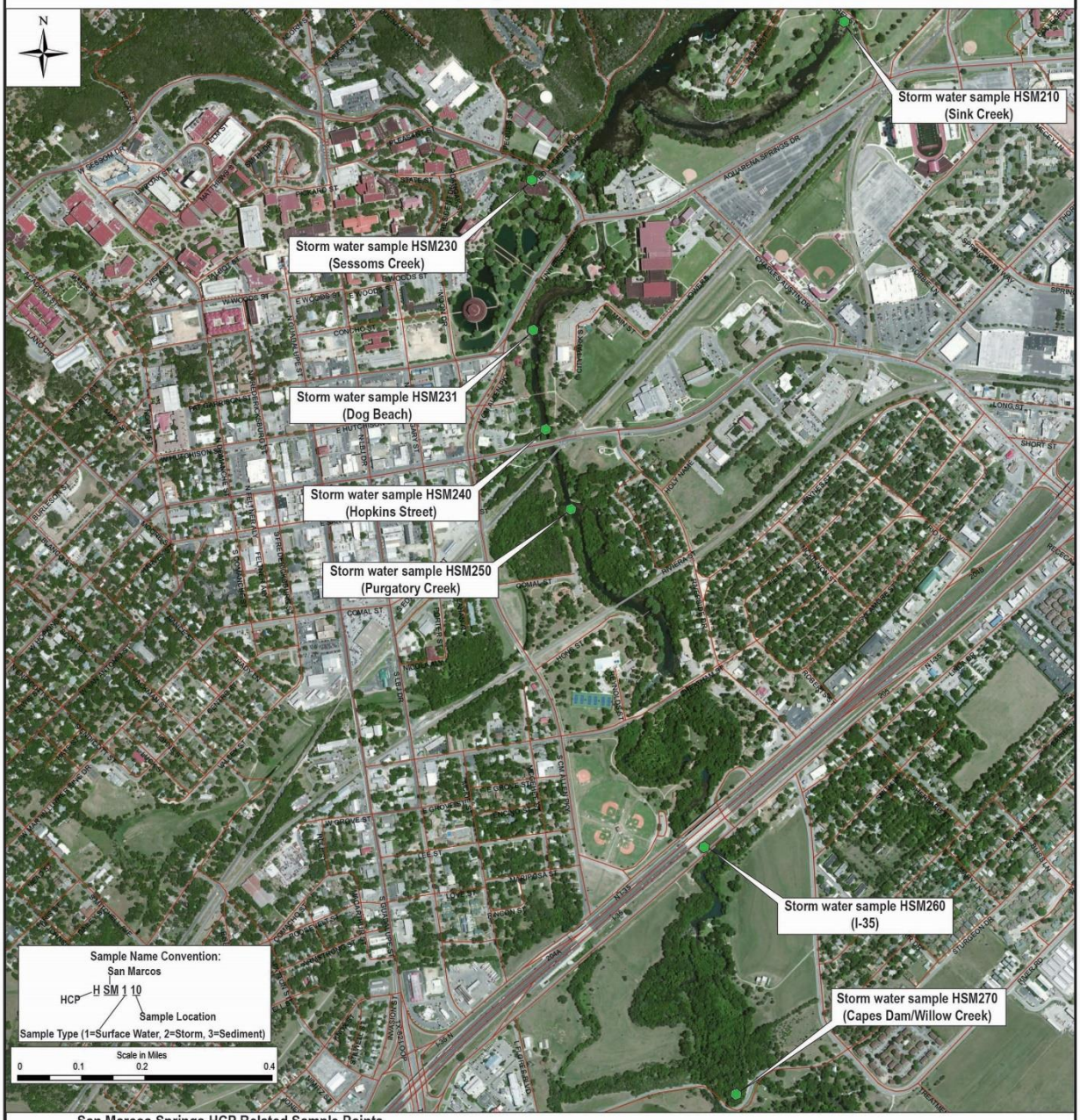
**Explanation**

Surface Water Sample Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

## Figure 8
## San Marcos Springs Storm Water Sample Locations




### San Marcos Springs HCP Related Sample Points

**Analytical Parameter List (HCP)**

| |
|---|
| Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals |
| Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals |
| Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals |

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

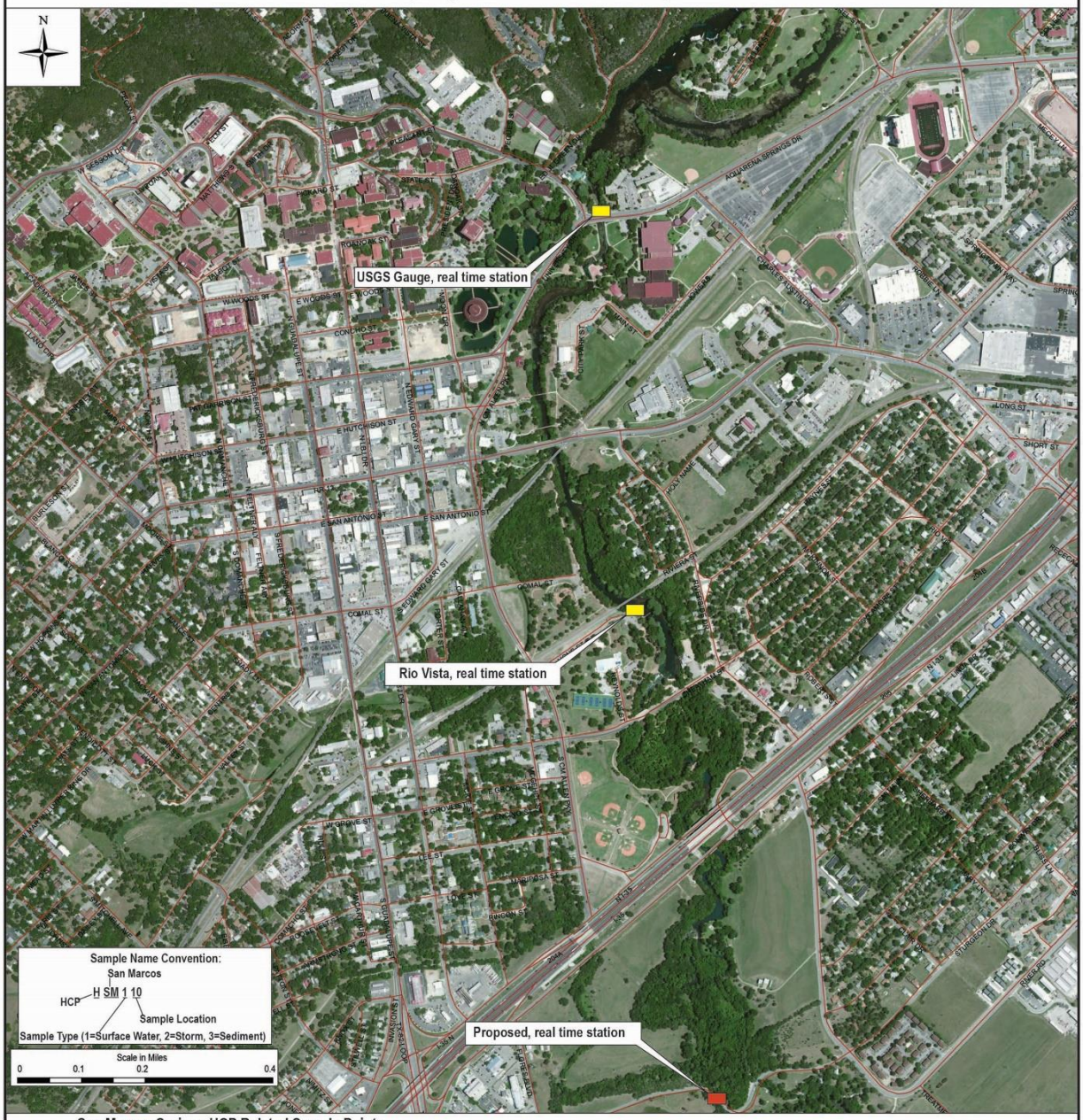
**Explanation**

Storm Water Sample Locations

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

# Figure 9
## San Marcos Springs Real Time Water Quality Station Locations




### San Marcos Springs HCP Related Sample Points

**Analytical Parameter List (HCP)**

| |
|---|
| Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals |
| Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals |
| Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals |

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.

**Explanation**

- Continuous (Real Time) Water Quality Station Location
- Proposed Continuous (Real Time) Water Quality Station Location for Addition in 2015

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

# Figure 10
## San Marcos Springs Passive Diffusion Sampler Locations


### San Marcos Springs HCP Related Sample Points

**Passive Diffusion Samplers (PDS)**

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

PDS devices will be from Amplifed Geochemical Imagaing, LLC, or equivalent and shall provide analyses for: TPH, BTEX, 1,3,5 and 1,2,4-trimethylbenzene, MTBE, phenanthrene, naphthalene 1-methyl naphthalene, octane, cis and trans-1,2,-dichloroethene, 1,1-dichloroethane, chloroform, 1,1,1-trichloroethane, 1,2-dichloroethane, carbon tetrachloride, trichloroethene, tetrachloroethene, chlorobenzene, 1,4-dichlorobenzene, 1,1,2-trichloroethane, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,3-dichlorobenzene, and 1,2-dichlorobenzene.

**Explanation**

Passive Diffusion Sampler Location

*Prepared by:*

EDWARDS AQUIFER AUTHORITY

**Appendix A**

**Analytical Parameters for Assessing Water Quality from Storm Water and Surface Water Locations, Comal and San Marcos Springs**

| **Analyses** |
|---|
| Volatile Organic Compounds (VOCs) |
| Semi-volatile Organic Compounds (SVOCs) |
| Organochlorine Pesticides |
| Polychlorinated Biphenyls (PCBs) |
| Organophosphorous Pesticides |
| Herbicides |
| Metals (Al, Sb, As, Ba, Be, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, 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 Solids (TSS). |
| Phosphorus (total) |
| Total Organic Carbon (TOC), |
| Dissolved Organic Carbon (DOC) |
| Kjeldahl Nitrogen |
| Bacteria Testing (*E coli*) |
| Caffeine |

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

**Protocol References:**

EPA = US Environmental Protection Agency

MCAWW = "Methods for Chemical Analysis of Water and Wastes," EPA-600/4-79-020, March 1983 and Subsequent Revisions.

SM = "Standard Methods for the Examination of Water and Wastewater,"

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

**Number of required QA/QC Samples for Surface (Base Flow) Sampling, Storm Sampling, and Sediment Sampling**

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

**Analytical Parameters for Critical Period Related (Low Flow) Sampling of Water Wells, Comal and San Marcos Springs**

| **Analyses** |
|---|
| 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, $CO_3$,) |
| Total Organic Carbon (TOC) |
| Total Dissolved Solids (TDS) |
| |

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

| |
|---|
| PDS devices are to be placed at the locations listed Figures 5 and 10, for a two-week time period in the months of February, April, June, August, October, and December. |
| PDS devices will be from Amplified Geochemical Imaging, LLC, or equivalent and shall provide analyses for the following: TPH, BTEX, 1,3,5 and 1,2,4-trimethylbenzene, MTBE, phenanthrene, naphthalene1-methyl naphthalene, octane, cis and trans-1,2,-dichloroethene, 1,1-dichloroethane, chloroform, 1,1,1-trichloroethane, 1,2-dichloroethane, carbon tetrachloride, trichloroethene, tetrachloroethene, chlorobenzene, 1,4-dichlorobenzene, 1,1,2-trichloroethane, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, 1,3-dichlorobenzene, and 1,2-dichlorobenzene. |

# Appendix B

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

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

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

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

## Appendix C

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

| | |
|---|---|
| TWO new Eureka, Manta 2 Probe, equipped to monitor: DO, pH, Temperature, Conductivity, and Turbidity with Associated Netronix Telemetry System. | $6,000.00 each for a total of $12,000 |
| Annual maintenance costs for equipment, to include batteries (as needed), repairs, and calibration standards (estimated costs are for six total instruments) | $6,000.00 |
| Annual data contract to include cellular data fees, and web hosting at Netronix site (estimated costs are for six total instruments, which includes the proposed new addition in San Marcos) | $5,100.00 |
| **Total Estimated Costs for Real Time Water Quality Instrumentation calendar year 2015** | **$23,100.00** |

# 2016 Edwards Aquifer Authority
# Ecological Modeling Work Plan

The development of a mechanistic ecological model is assigned to the Edwards Aquifer Authority (EAA) per section 6.3.3 of the Edwards Aquifer Habitat Conservation Plan (EAHCP). The purpose of the Ecological Model 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.

**Long Term Objective:**

The objective is the development of a comprehensive, mechanistic Ecological Model for the Comal and San Marcos ecosystems. The model requires adapting modules for aquatic vegetation and fountain darters, developing a module for Texas wild-rice, and a module for the impact of gill parasites on fountain darters. The model is a predictive tool for management.

**Year 1 and Year 2 Overview:**

The Ecological Model is a complex combination of studies that input data into the development of specific modules for individual components. Supporting studies and modules for input into the Ecological Model Year 1 through Year 2 (May 2015) include:

- Hydraulic Modeling
  - Complete for both the Comal and San Marcos systems
- Water Quality Modeling
  - Complete for water temperature in both systems
- Aquatic Vegetation Modeling
  - Complete in Old Channel study reach
  - Calibrated models in the Old Chanel study reach (Comal) and City Park study reach (San Marcos)
- Fountain Darter Modeling
- Fountain Darter to Aquatic Vegetation linkage complete
- Fountain Darter to Water Temperature linkage complete
- Percent Cover to Biomass Study
- Biological Monitoring (2000-2014)
- 2013 Applied Research
  - Aquatic vegetation tolerance
  - Food source tolerances
  - Bicarbonate utilization
- 2014 Applied Research
  - Fountain darter movement
  - Fecundity
  - Predation
- 2015 Applied Research
  - Algae dynamics
  - Effect of turbidity on submerged aquatic plants
  - Native –vs– non-native plant competition

**Target for 2016:**
The Year 3 (June 1, 2015 – December 31, 2016) Ecological Model scope as approved is available at
http://www.eahcp.org/files/admin-records/NEPA-and-HCP/BW_Year3_Ecomodel_Scope_and_Costs_20140302_EAA.pdf

The Year 3 scope provides for:

- Water quality modeling
    - Dissolved oxygen incorporated system wide
- Aquatic vegetation and fountain darter modeling
    - Comal System – expanded study reaches in the Upper Spring Run reach and Landa Lake reach
    - San Marcos System – expanded study reaches in the I35 study reach
- Incorporate 2015 Applied Research where applicable
- Model calibration, sensitivity analysis and validation
- HCP flow regime scenario run
- User's manual and training sessions

The schedule for Year 3 includes:

- March 2015
    - Year 3 scope of work submitted for approval
- May 2015
    - Complete integration/linkage of water temperature, aquatic vegetation and fountain darter models
    - Complete – calibrated models for the Old Channel (Comal River) and the City Park (San Marcos River) reaches
- December 2015
    - Submit annual model status report
- Summer 2016
    - Complete spatial expansion modeling in both systems.
    - Model validation
- December 2016
    - Complete users' manual and submit final working models

In Year 3, besides the submittal of monthly progress reports, the Contractor will submit a Draft and a Final Report for Year 3 of model development by December 31, 2016.

TOTAL PROJECT BUDGET

**YEAR 1 (June 1, 2013 – May 31, 2014)**

| TASK | | ESTIMATED COST |
|---|---|---|
| Task 1. | Literature Review | $ 12,500. |
| Task 2. | Data Acquisition | $ 3,500. |
| Task 3.1 | U.S. Army Corps of Engineers Model Modification | $ 55,000. |
| Task 3.2 | Fountain Darter Response/Dynamics Model | $ 47,500. |
| Task 3.3 | Wild Rice Parameters | $ 7,500. |
| Task 3.4 | Gill Parasite and Non-Native Snails Response/Dynamics | $ 4,500. |
| Task 4. | Recommendations and Future Work | $ 5,000. |
| Task 5. | Draft and Final Reports | $ 10,500. |
| Task 6. | Meetings and Presentations | $ 11,500. |
| Task 7. | Deliverables | $ 12,500. |
| | YEAR 1 SUBTOTAL | $170,000. |

**YEAR 2 (June 1, 2014 – May 31, 2015)**

| TASK | | ESTIMATED COST |
|---|---|---|
| Task 1. | Project Management and Meetings | $ 37,765. |
| Task 2. | Literature Review | $ 16,580. |
| Task 3. | Fountain Darter Modeling | $154,755. |
| Task 4. | Aquatic Vegetation Modeling | $138,520. |
| Task 5. | Draft and Final Interim Status Reports | $ 57,730 |
| Task 6. | Recommendations and Future Work | No Cost |
| Task 7. | Deliverables | No Cost |
| | YEAR 2 SUBTOTAL | $405,350. |

**YEAR 3 (June 1, 2015 – December 31, 2016)**

| TASK | | ESTIMATED COST |
|---|---|---|
| Task 1. | EAHCP Ecological Model Development, Calibration, and Validation | $330,000. |
| Task 2. | EAHCP Ecological Model Training and User Guide | $ 25,000. |
| Task 3. | Deliverables | No Cost |
| | YEAR 3 SUBTOTAL | $355,000. |
| | *(January 1, 2016 – December 31, 2016)* | *$180,000* |
| | TOTAL PROJECT COSTS | $930,350. |

# Edwards Aquifer Authority 2016
# Applied Research Work Plan

Section 6.3.4 of the Edwards Aquifer Habitat Conservation Plan (EAHCP) includes Applied Research as a "valuable" component of the Phase I package and states that the "Edwards Aquifer Authority (EAA) will contract for the research activities." The main focus of the Applied Research is to evaluate the effects of low-flows on Covered Species and their habitats. As described in the HCP § 6.3.4.2, Applied Research for Phase I will focus on the fountain darter relative to Comal Springs (although research should be transferable to the San Marcos system) and the Comal Springs riffle beetle, as these are the two species with the greatest potential for impact relative to the Phase I package.

***Long Term Objective:*** The experimentation done through the Applied Research program of the EAHCP will evaluate the effects of low-flows on Covered Species and their habitats. The information gathered through this program will be utilized in the ecological model and will subsequently be used to inform the Adaptive Management Process and identify strategies for improved mitigation in the spring cities' model.

***Assumptions:*** Completion of all 2015 approved Applied Research projects.

***Methodology***

***Selection Process:*** In order to assure that Applied Research projects meet the long term objectives and to meet specific EAHCP needs, the EAA has initiated a process that allows members of the Implementing Committee, Stakeholder Committee, Science Committee, and EAHCP Staff to submit proposed studies for consideration.
The following link is to the Applied Research Selection Process:
http://www.eahcp.org/files/admin-records/NEPA-and-HCP/AR_Selection_pACKET.pdf

As a part of the process, at their April 7 and May 6, 2015 meetings, the Science Committee reviewed, prioritized, and approved the following research questions for the 2016 Applied Research program:

1. What is the seasonal variation in the abundance and distribution of the Comal Springs Salamander in the Comal Springs aquatic ecosystem?

2. What is the trophic level status and functional feeding group categorization of Comal Springs riffle beetle larvae and adults in their natural habitat?

3. What are the long-term, elevated temperature and low Dissolved oxygen tolerances of Comal Springs riffle beetle Larvae and adults?

4. What is the life history of the Comal Springs riffle beetle, from egg to adult in the Comal Springs aquatic ecosystem?

The Edwards Aquifer Authority will develop an RFP based on the key elements with expected deliverables and experimental design criteria for each study approved by the Implementing

Committee. Where possible, all efforts will be made to match similar studies to allow for shared facility and expertise in an effort to promote fiscal stewardship.

These RFPs will each be issued through a competitive procurement process that will include publication in six print regional newspapers and direct distribution to a list of at least sixty potential qualified contractors.

***Study Implementation:*** All Covered Species collected and utilized for Applied Research may be shared with other Applied Research contractors, within United States Fish & Wildlife Service (FWS) and Texas Parks & Wildlife (TPWD) regulations. The FWS and/or TPWD may require that at the conclusion of the research projects, all Covered Species collected and utilized for Applied Research be delivered to the FWS or the TPWD for Refugia operations.

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

***Research Facility/Freeman Aquatic Building:*** In 2015, the Edwards Aquifer Authority entered the second year of a five-year contract (three, one-year extensions remaining) with Texas State University (TEXAS STATE) to allow researchers to use the Freeman Aquatic Building (FAB) raceways, two concrete ponds and wet lab (with living streams and aquaria) to conduct EAHCP research. The TEXAS STATE facilities meet the needs of providing source water, quarantine capabilities, endangered species handling, and infrastructure/resource needs. The EAA pays the utility costs for use of the facilities.

In 2016, the FAB facilities will be available to potential EAHCP contractors, and terms of use will be included in contracts between EAA and researchers. Additionally, EAHCP staff will coordinate the projects for timing and availability of resource needed (tank, living stream, trough, raceway, or pond).

***Budget:***

| | |
|---|---|
| *Table 7.1 Applied Research Budget:* | *$450,000* |
| | |
| *Research Projects* | |
| *Prioritized Applied Research Budget:* | *$425,000* |
| Research contracts will be awarded until funds are utilized. | |
| | |
| *Research Facility Budget* | |
| The EAA pays the utility costs for use of the FAB. | $25,000 |

# 2016 Edwards Aquifer Habitat Conservation Plan
# Refugia Work Plan

Section 5.1.1 of the Edwards Aquifer Habitat Conservation Plan (EAHCP) provides for Edwards Aquifer Authority (EAA) to support and coordinate with three U.S. Fish & Wildlife Service (USFWS) facilities (San Marcos, Uvalde, and Inks Dam) 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 such as a severe reduction or loss of spring flow, or a chemical spill. On December 4, 2014, the Implementing Committee submitted to the USFWS a minor amendment to the EAHCP and Incidental Take Permit (ITP) to allow the EAA to establish a Refugia with someone else other than the USFWS. The USFWS approved that amendment on January 21, 2015.

The concept of a Refugia is to house and protect adequate populations of the Covered Species (see Table 1) and to conduct research activities to expand knowledge of their habitat requirements, biology, life histories, and effective reintroduction techniques. The use of this support will be limited to the Covered Species listed in the Edwards Aquifer Habitat Conservation Plan (EAHCP) and those associated species that have significant impact on the covered species such as predators, competitors, pathogens, parasites, food, cover, and shelter.

*Table 1.-Covered eleven species identified in the Edwards Aquifer Habitat Conservation Plan 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:*** A series of refugia, with back-up populations at other facilities, will preserve the capacity for these species to be re-established in the event of the loss of population due to a catastrophic event such as the loss of spring flow or a chemical spill.

***Assumptions:*** In 2015, the EAA established a Salvage Stock Refugia, conducted research related to the propagation of the invertebrates, prepared information as to the resource and infrastructure requirements of a Refugia facility and conducted a public bid process for a full Refugia Program.

***Methodology:***

- The Salvage Stock contractor will continue to implement the Salvage Stock Refugia Program of the EAHCP until a long-term Refuia Program is established.
- Research will continue to establish a successful captive propagation program for the invertebrate species covered under the EAHCP, including captive rearing, life history, and environmental requirement needs. Research will be conducted on five aquatic invertebrates species covered under the EAHCP:
  1. Comal Springs riffle beetle (*Heterelmis comalensis*); and
  2. Comal Springs dryopid beetle (*Stygoparnus comalensis*); and
  3. Peck's cave amphipod (*Stygoparnus pecki*); and
  4. Edwards Aquifer diving beetle (*Haideoporus texanus*); and
  5. Texas troglobitic water slater (*Lirceoilus smithii*).
- EAA will negotiate and establish a contract for a full Refugia Program for the term of the ITP.

***Budget:***

*Table 7.1 Refugia Budget:* *$ 1,678,597*

*2016 Budget* *$ 8,342,324*

*2016 Breakdown*

| | |
|---|---|
| *Salvage Refugia* | *$1,400,000* |
| *Refugia Construction* | *$4,958,804* |
| *40% Construction Contingency* | *$1,983,520* |
| ***Total*** | ***$8,342,324*** |

**2016 Edwards Aquifer Authority**
**Program Management Work Plan and Budget**

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

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

*Program Management*: In 2016, EAHCP staff will continue to coordinate and monitor the work outlined in the Ecological Modeling, Biological Monitoring, Applied Research, Refugia, ASR, and Regional Water Conservation Program work plans. EAHCP staff will continue to oversee the federal and state permit requirements for the conservation measures and will continue to coordinate activities associated with the National Academy of Sciences first report.

Finally, EAHCP staff will also continue to monitor the activities in the City of New Braunfels and City of San Marcos/Texas State University work plans.

Specifically, in 2016, EAHCP staff will continue the following activities:

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

- Serve on the ASR Advisory Committee,
- Facilitate the Adaptive Management process,
- Serve on the Regional Water Conservation Monitoring Committee, and
- Facilitate and coordinate all meetings of the EAHCP Implementing, Science and Stakeholder Committees (and possible Subcommittees and Work Groups as created by the Implementing and Stakeholder Committees).

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

- Procure and execute contracts,
- Oversee contract tracking and compliance,
- Process and pay all invoices and mitigation reimbursements,
- Oversee the City of New Braunfels and San Marcos/Texas State University work plan activities,
- Oversee and coordinate research activities at the Texas State University Freeman Aquatic Building,
- Coordinate 2016 work plan amendments and 2017 work plan development process,
- Draft and submit amendments, informational memorandums, and clarifications to the Incidental Take Permit and EAHCP,

- Participate in public outreach initiatives,
- Publish the EAHCP Steward newsletter,
- Enhance the EAHCP.org website,
- Prepare and compile all of the 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.

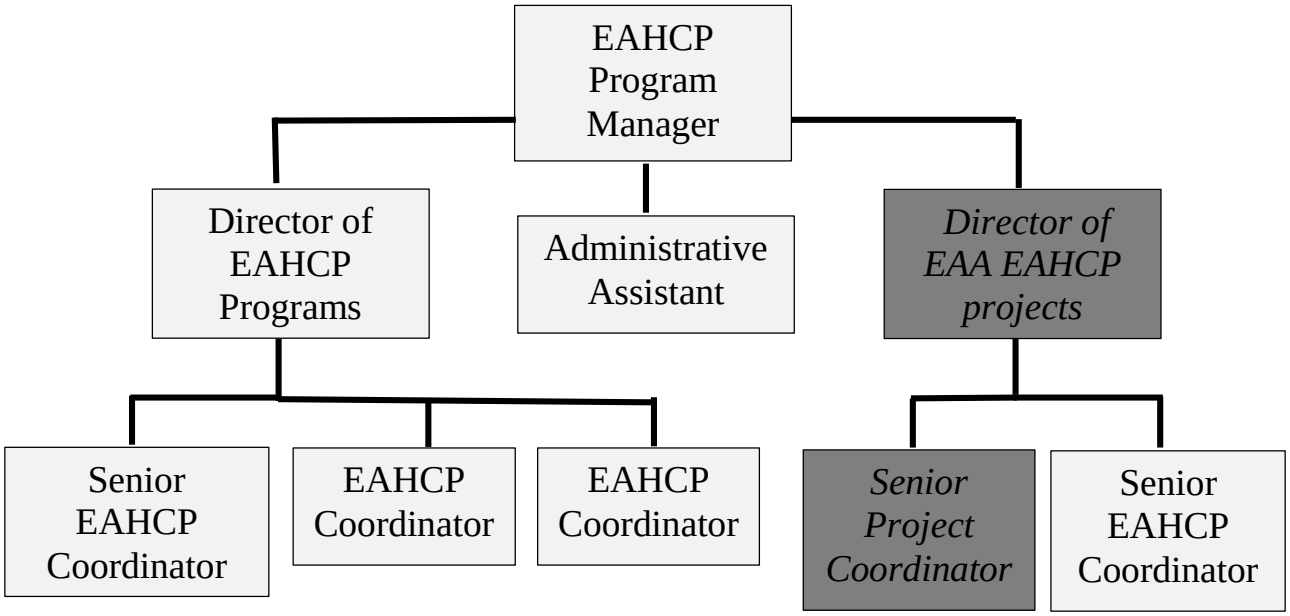
*Routine and Non-routine Adaptive Management Program (AMP)*: EAHCP staff, under direction of the Program Manager, will continue to manage the routine and non-routine decision making process as defined in Article 7 of the FMA. The process for this facilitation and adoption is outlined in the EAHCP AMP Memorandum to the Implementing Committee. EAHCP staff will also serve as a liaison to USFWS in the AMP process.

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

*Science Review Panel:* In 2016, EAHCP staff will continue to provide support for the meetings of the National Research Committee/National Academy of Sciences (NRC/NAS) and will assist the Panel in the development of its second report. In March 2015, the NRC/NAS committee produced its first report on its review and evaluation of the EAHCP ecological modeling, hydrological modeling, biological monitoring, water quality monitoring, and applied research programs. In 2016, EAHCP staff will coordinate the plan developed to implement the recommendations from this first report.

*Issuing/Managing Contracts for other Applicants per Funding and Management Agreement*: Section 5.6.5 of the FMA requires the Program Manager to issue and manage mitigation contracts of other Applicants, in the event that the responsible Applicant receives the competitive bid to conduct the mitigation.

**Staffing in 2016:** The structure of the existing EAHCP staff positions is illustrated in the chart on the next page. In summary, the EAHCP staff consists of the Program Manager, Director of EAHCP programs, Senior EAHCP Coordinator, two EAHCP Coordinators, and the Administrative Assistant.




- New Positions

- Positions Paid form EAA General Budget

**Budget**

The following table set out the estimated HCP Project Administration budget for 2016.

| | **Table 7.1** | **2016** |
|---|---|---|
| Program Administration | $750,000 | $910,000 |
| Science Review Panel | $50,000 | $230,000 |
| **Total Budget** | **$800,000** | **$1,140,000** |

The staffing expenses and operational expenses for 2016 are set out in the tables below.

| | |
|---|---|
| Salaries | $469,230 |
| Fringe/Benefits | $140,387 |
| **Total** | **$609,617** |

| | 2016 |
|---|---|
| Staffing | $609,617 |
| Meeting Expenses[1] | $20,000 |
| Travel | $5,000 |
| Office Supplies | $3,000 |
| Professional Development / Memberships | $2,500 |
| Printing | $5,000 |
| Professional Contracted Services (PCS) | |
| PCS - Miscellaneous | $ 85,883 |
| PCS – Adaptive Mgmt | $75,000 |
| PCS – Historical/Archeological Consultation [2] | $10,000 |
| PCS – Annual Report | $40,000 |
| PCS - Science Review Panel | $230,000 |
| PCS – Permit Oversight[3] | $19,500 |
| PCS – Science Committee Compensation | $18,000 |
| PCS – Outreach/Newsletter[4] | $16,500 |
| NAS Recommendations Implementation[5] | ?? |
| **Total Expenditure** | **$1,140,000** |

[1] Meeting expenses for Implementing, Stakeholder and Science Committees and reimbursement expenses for Science Committee members travel costs.
[2] Contract for costs to obtain Texas Historical Commission permits for conservation and mitigation measures activities.
[3] Contract for costs to obtain U.S. Army Corps of Engineers, Texas Parks and Wildlife Department, and Texas Commission on Environmental Quality permits for conservation and mitigation measures activities.
[4] Contract to produce the EAHCP bi-monthly newsletter.
[5] Since the implementation plan for the first report of the National Academy of Sciences is currently being developed, its impact to the budget is unknown.

**Edwards Aquifer Authority- 2016 HCP Budget**

| HCP Section | Mitigation Action | 2016 HCP Budget (From Table 7.1) | 2015 HCP Budget | Estimated FY2016 |
|---|---|---|---|---|
| 5.5.1 | Aquifer Storage and Recovery | $6,953,000 | $6,060740 | $7,394,100 |
| 5.1.3 | Regional Water Conservation | $1,973,000 | $1,813,000 | $1,813,000 |
| 5.1.2 | VISPO | $4,172,000 | $8,753,500 | $4,172,000 |
| 6.3.1 | Biological Monitoring | $400,000 | $417,029 | $417,029 |
| 5.7.2 | Water Quality Monitoring | $200,000 | $504,530 | $497,530 |
| 6.3.3 | Ecological Monitoring | $175,000 | $380,350 | $180,000 |
| 6.3.4 | Applied Research | $450,000 | $450,000 | $450,000 |
| 5.1.1 | Refugia | $1,678,597 | $1,678,597 | $8,342,324 |
| | Program Management | $750,000 | $910,000 | $910,000 |
| | Science Review Panel | $50,000 | $230,000 | $230,000 |
| | **Totals** | **$16,801,597** | **$21,197,746** | **$24,405,983** |

Appendix J5

# 2016 City of New Braunfels Work Plan and Budget for the Edwards Aquifer Habitat Conservation Plan

# 2016 City of New Braunfels Work Plan
# For
# Edwards Aquifer Habitat Conservation Plan

The City of New Braunfels' 2016 HCP work plan represents a collaboration of ideas, concerns, and methodologies discussed during the current planning year with Implementing Committee members, Science Committee members and stakeholders. The 2016 work plan builds upon work completed in 2013, 2014 and early 2015 to meet Edwards Aquifer Habitat Conservation Plan (EAHCP) goals and objectives.

### 5.2.1 Flow Split Management

The City of New Braunfels will continue to maintain flow-control structures and manage flow-partitioning between the Old and New Channels of the Comal River per Table 5-3 of the HCP.

**Flow Control Structures**

Long-term Objective: Maintain flow-control structures to allow for continued management of diversions from Landa Lake into the Old Channel of the Comal River to provide optimal habitat conditions for fountain darters.

Assumptions: None

Target 2016/Performance Measure: Ensure continued operability of the flow-control structures to allow for an effective flow-split management program. Install additional flow-control gates at the two 14" culverts, currently closed with threaded caps, to be utilized as a back-up to the existing primary 48" culvert and gate. The gates will allow for controlled flow into the Old Channel during maintenance activities required for long-term functionality. The 14" culverts and gates will also serve as a back-up to divert flow into the Old Channel during emergency situations in which the primary 48" culvert is unable to provide adequate flow rates.

Methods: The City of New Braunfels will exercise the flow-control gate on a regular basis to ensure continued operability. Visual inspection of the flow-control gate will occur on a regular basis to evaluate functionality and to assess for potential issues. Identified issues will be addressed to ensure continued operation of the flow-control structures and the continued ability to manipulate flows. Any necessary repairs to the flow-control structures will be immediately undertaken but will be dependent upon safe working conditions and availability of damaged parts.

Installation of flow-control gates at the 14" culverts will occur following the completion of design specifications, engineering analysis, and acquisition of required permits. The 14" culverts are located approximately 100 feet north of the primary 48" culvert and gate. The

two 14” culverts exist where the former 24” culverts were capped and fitted with 14” pipe sleeves.

Monitoring: See Flow Split Management below.

**Flow Split Management**

Long-term Objective: To sustain flow rates in the Old Channel of the Comal River to compliment Old Channel aquatic vegetation restoration efforts, prevent channel scouring during high-flow events, and maximize the quality of fountain darter habitat.

Assumptions: Flow-split management is contingent upon continued access to USGS real-time streamflow data and operability of the flow-control gate.

Target 2016 /Performance Measure: Maintain flow rates in the Old and New Channels of the Comal River to meet objectives specified in Table 5-3 of the HCP. Priority will be given to achieving target flow rates in the Old Channel and, secondly, to flow rates in the New Channel. City of New Braunfels staff will monitor streamflow conditions via USGS streamflow gages and operate the flow-control gate to achieve target flows. Gates will be kept free of debris, to the extent practicable, and will be exercised routinely to maintain functionality of the gate.

Methods: The City of New Braunfels will manage the flow-split program according to flow rates specified in Table 5-3. A standard operating procedure has been developed by the City of New Braunfels to guide control gate manipulation and streamflow monitoring efforts to achieve flow-split targets. The City of New Braunfels staff will monitor real-time streamflow conditions at USGS gages in the Comal River system and adjust the flow-control gate, as needed, to meet flow-split targets. Additionally, when total Comal Spring flow drops below 150 cfs, City of New Braunfels staff will monitor and adjust the flow control structures more frequently, and as needed, to meet the flow-split guidelines defined in Table 5-3.

**TABLE 5-3**
**FLOW-SPLIT MANAGEMENT FOR OLD AND NEW CHANNELS**

| Total Comal Springflow (cfs) | Old Channel (cfs) | | New Channel (cfs) | |
|---|---|---|---|---|
| | Fall, Winter | Spring, Summer | Fall, Winter | Spring, Summer |
| 350+ | 80 | 60 | 270+ | 290+ |
| 300 | 80 | 60 | 220 | 240 |
| 250 | 80 | 60 | 170 | 190 |
| 200 | 70 | 60 | 130 | 140 |
| 150 | 60 | | 90 | |
| 100 | 60 | | 40 | |
| 80 | 50 | | 30 | |
| 70 | 50 | | 20 | |
| 60 | 40 | | 20 | |
| 50 | 40 | | 10 | |
| 40 | 30 | | 10 | |
| 30 | 20 | | 10 | |

Monitoring: Monitoring of streamflow in the Old Channel, New Channel, and Comal River will be based on information provided by the USGS real-time streamflow gages in the Comal River. Necessary adjustments of the flow-control gate will be made on an on-going basis, and after major runoff events, to meet flow-spilt management objectives in Table 5-3. When required, trash racks will be cleaned to prevent build-up of vegetation and debris which may present operational problems and may inhibit sufficient flow to the culvert.

Allocated funds for 2016 (from Table 7.1): $ 30,000

Estimated Budget: $43,500

$ 3,500 – Repair and Maintenance (as needed)

$40,000– Design and installation of flow-control devices at 14" culverts

**5.2.2.1 Old Channel Restoration**

The City of New Braunfels will continue to remove non-native aquatic vegetation, expand coverage of native aquatic vegetation and monitor previously restored native habitat. Additionally, the City of New Braunfels will continue to perform limited channel modifications to enhance fountain darter habitat, where applicable, in portions of the Old Channel from outlets at Landa Lake downstream to Hinman Island Drive above the confluence with the New Channel of the Comal River.

**Old Channel Non-Native Vegetation Removal and Maintenance**

In addition to continued monitoring and maintenance (gardening) of previously restored native vegetation from the former Sediment Island downstream to the horseshoe bend of the Old Channel, aquatic vegetation restoration efforts in 2016 will consist of non-native vegetation removal and subsequent native vegetation restoration in select areas of the Old Channel between the culverts at Landa Lake downstream to approximately 2,400 feet past the Horseshoe bend. The City of New Braunfels' spring-fed pool will be monitored for reestablishment of non-native vegetation that was removed in 2015. Gardening of this area will be accomplished on an as-needed basis.

Long-term Objective: To decrease the density of invasive, non-native aquatic vegetation and establish preferred native aquatic vegetation, to the maximum extent practicable, to enhance Covered Species habitat.

Assumptions: Aquatic restoration in certain locations of the Old Channel will be contingent upon the removal of non-native riparian vegetation which currently prohibits solar exposure to segments of the channel, especially along the banks. Removal of non-native riparian vegetation in targeted locations will allow additional sunlight to penetrate to portions of the channel that currently do not favor native aquatic species due to

limited solar exposure associated with shading effects. Riparian restoration along the Old Channel will be conducted as part of task 5.7.1 (Native Riparian Habitat Restoration). Riparian restoration work will be carefully coordinated with Old Channel aquatic restoration efforts. Old Channel aquatic restoration will continue until the proportional native and non-native targets outlined in Table 4-6 of the HCP are achieved with anticipated funding defined in Table 7.1 of the HCP.

**TABLE 4-6**
**GOALS—FOUNTAIN DARTER HABITAT (AQUATIC VEGETATION) ($m^2$)**

| Study Reach | *Bryophytes* | *Hygrophila* | *Ludwigia* | *Cabomba* | *Fil. Algae* | *Sagittaria* | *Vallisneria* |
|---|---|---|---|---|---|---|---|
| Upper Spring Run Reach | 1,850 | 650 | ***150*** | | | 600 | |
| Landa Lake | 4,000 | ***250*** | ***900*** | ***500*** | | 1,250 | 13,500 |
| Old Channel | 150 | ***200*** | ***1,500*** | | 300 | | |
| New Channel | 150 | 1,350 | | 350 | | | |
| TOTAL | 6,150 | 2,450 | 2,550 | 850 | 300 | 1,850 | 13,500 |

***Bold/italics** indicate a restoration activity that deviates from the Maximum observed.

Target 2016 /Performance Measure: Re-establishment of native aquatic vegetation and reduction of non-native aquatic vegetation in accordance with goals set forth in Table 4-6. Restoration efforts in 2016 will be focused in select portions of the Old Channel from the culverts at Landa Lake downstream through the horseshoe bend.

Methods: The target locations for non-native plant removal will be based on observations and historical vegetation mapping data identifying areas in which high value native vegetation has historically occurred. Assessments of potential restoration areas will consider the depth, velocity, and substrate conditions present in the areas along with existing non-native vegetation identified. In areas lacking vegetation, the reason vegetation is absent (*e.g.*, recent flood scour, unsuitable depth, solar exposure, velocities or substrate conditions) will be evaluated prior to final selection of target areas.

Selected locations will first be sampled to remove fountain darters. Sampling will employ appropriate methods such as fanning and/or seining depending on local conditions. Non-native vegetation will then be removed and placed adjacent to the stream where qualified personnel will examine the plants for fountain darters (eggs through adults). Fountain darter life stages will be returned to the stream. Native aquatic vegetation will be planted, as soon as possible, following the removal of non-native vegetation. Native vegetation for plantings will consist of vegetation grown within the Landa Lake MUPPT nursery or from direct transplants within the Comal system. A variety of native vegetation (e.g., *Ludwigia, Cabomba, bryophytes*, and filamentous algae) will be used to meet targets outlined in Table 4-6 of the HCP.

Monitoring: Areas where non-native vegetation removal has occurred will be routinely monitored for the reestablishment of non-native vegetation and effectiveness of the native

aquatic vegetation planting. Once native aquatic vegetation is established in an area, monitoring will be conducted on a less frequent basis.

As noted in the HCP (Section 5.2.2.3), following natural disturbances such as floods, periods of limited recharge, and/or herbivory, as well as anthropogenic disturbances such as recreation or vandalism, the monitoring/maintenance schedule will be adjusted temporarily in order to provide stability for the re-establishment of native vegetation. Monitoring will include aerial coverage mapping of native and non-native vegetation within previously restored areas. Any reestablished non-native vegetation will be removed during each monitoring visit, and if deemed necessary, additional native vegetation will be planted. Removal of non-native vegetation will follow the same protocols as the original removal methodology. Removed vegetation will be disposed of properly according to TPWD Invasive Species Removal permit requirements.

Allocated funds for 2016 (from Table 7.1): $125,000

Estimated Budget: $125,000

**5.2.2/5.2.3 Comal River Aquatic Vegetation Restoration and Maintenance**

The City of New Braunfels will continue native aquatic vegetation restoration in Landa Lake and within targeted, sustainable reaches of the Comal River by replacing non-native aquatic vegetation with native aquatic species to enhance Covered Species habitat. Proposed work for 2016 includes removal of non-native aquatic plant species and planting of native aquatic vegetation in the Upper Spring Run area, assessment of potential restoration areas in the New Channel of the Comal River, and continued maintenance/ gardening of previously restored areas. Native vegetation planting and non-native removal will be based on coverage targets identified in Table 4-5 and 4-6 of the HCP.

**Native Aquatic Vegetation Restoration**

Long-term Objective: To decrease density of invasive, non-native aquatic vegetation and establish favorable native aquatic vegetation, to the maximum extent practicable, within Landa Lake and select portions of the Comal River to enhance Covered Species habitat.

Assumptions: Native vegetation restoration will continue in areas of Landa Lake and the Comal River. Restoration efforts include continued removal of non-native aquatic vegetation throughout Landa Lake, while establishing additional *Cabomba* along the eastern shoreline of Landa Lake and along the New Braunfels' golf course property; establishing additional *Sagittaria* in shallower portions of Landa Lake; and establishing *Ludwigia* in upper sections of Landa Lake. In addition, in 2016, select

locations in the New Channel of the Comal River will be evaluated for potential restoration activities.

Target 2016/Performance Measure: Re-establishment of native aquatic vegetation and reduction of non-native aquatic vegetation within Landa Lake in accordance with goals set forth in Table 4-6 of the HCP. In addition to ongoing gardening and maintenance of previously restored areas in Landa Lake, restoration efforts in 2016 will be focused on the removal of non-native aquatic vegetation and establishment of native vegetation in the Upper Spring Run area. The New Channel of the Comal River will be further assessed in order to identify potential areas for sustainable restoration that will benefit the Covered Species.

Methods: The target locations for non-native plant removal will be based on observations and historical vegetation mapping data identifying areas in which high value native vegetation has historically occurred. Assessments of potential restoration areas will consider depth, velocity, and substrate conditions along with existing non-native vegetation identified. In areas lacking vegetation, the reason vegetation is absent (*e.g.*, recent flood scour, unsuitable depth, solar exposure, velocities or substrate conditions) will be evaluated prior to final selection of target areas.

Selected locations will first be sampled to remove fountain darters. Sampling will employ appropriate methods such as fanning and/or seining depending on local conditions. Non-native vegetation will then be removed and placed adjacent to the stream where qualified personnel will examine the plants for fountain darters (eggs through adults). Fountain darter life stages will be returned to the stream. Native aquatic vegetation will be planted, as soon as possible, following the removal of non-native vegetation. Native vegetation for plantings will consist of vegetation grown within the Landa Lake MUPPT nursery or from direct transplants within the Comal system. A variety of native vegetation (e.g., *Ludwigia*, *Cabomba*, b*ryophytes*, and filamentous algae) will be used to meet targets outlined in Table 4-6 of the HCP. In applicable locations, “mother” plant colonies will be established to allow for natural growth and expansion. If Hygrophila (non-native) coverage in specific areas decreases below the coverage area specified in Table 4-6, native plant species will be introduced to fill the coverage gap.

Monitoring: Each area in which non-native vegetation has been removed will be routinely monitored for the reestablishment of non-native vegetation and effectiveness of the native vegetation planting. Once native aquatic vegetation is established, monitoring will be conducted on a less frequent basis. However, if monitoring suggests continued gardening and/or supplemental planning is required, this will continue as needed.

However, as noted in the HCP (Section 5.2.2.3), following natural disturbances such as floods, periods of limited recharge, and/or herbivory, as well as anthropogenic disturbances such as recreation or vandalism, the monitoring/maintenance schedule will be adjusted temporarily in order to provide stability for the native vegetation reestablishment. Where possible, landowners immediately adjacent to Landa Lake and the Upper Spring Run area will be informed of aquatic restoration efforts in order to promote awareness and minimize negative impacts associated with recreation and/ or maintenance. Monitoring will include estimated aerial coverage of native and non-native vegetation within the treated area. Any reestablished non-native vegetation will be removed during each monitoring visit and if deemed necessary, additional native vegetation will be planted. Removal of non-native vegetation will follow the same protocols as the original removal methodology. Removed vegetation will be transported to an off-site composting facility.

Allocated funds for 2016 (from Table 7.1): $100,000

Estimated Budget: $100,000

### 5.2.3 Management of Public Recreation

Public recreational use of the Comal River ecosystems include, but are not limited to swimming, wading, tubing, boating, canoeing, kayaking, golfing, scuba diving, snorkeling and fishing. To minimize the impacts of incidental take resulting from recreation, the City of New Braunfels will continue to expand their existing recreation control measures as specified in Section 5.2.3.(1) of the HCP. The City of New Braunfels will enforce these measures (as covered in various sections of the HCP) to ensure their success.

Long-term Objective: To maintain and continue to expand the voluntary Certificate of Inclusion Program (COI) to outfitters utilizing the Comal River; educate the public about the Endangered Species and importance of their protection.

Assumptions: The success of this program will be contingent on the cooperation of river outfitters and their willingness to participate in the COI program.

Target 2016/Performance Measure: Continue to inform Outfitters of the benefits for participation in the COI program. Recruit Outfitters who conduct their operations in the Comal River system.

Methods: The City will utilize its existing public input process to continue with the COI application, criteria and program administration. The COI will include the minimum requirements as specified in Section 5.2.3 (2) a-h.

Monitoring: The City of New Braunfels staff will collaborate with all COI participants and report on the program annually.

Allocated funds for 2016: $ 0

Estimated Budget: $0

**5.2.4 Decaying Vegetation Removal and Dissolved Oxygen Management**

The City of New Braunfels will implement a dissolved oxygen (DO) management program within Landa Lake. The program will focus on monitoring of dissolved oxygen (and related parameters) and ensuring adequate DO levels for the ecosystem regardless of the initiating circumstances.

Long-term Objective: Maintain acceptable levels of DO within Landa Lake and minimize the impacts associated with decaying vegetation (or other factors). Long-term biological goals for the fountain darter include a management objective for maintaining dissolved oxygen concentrations > 4.0 mg/L throughout fountain darter habitat.

Assumptions: Section 5.2.4 of the HCP implies the initiation of DO mitigation activities when total Comal River discharge falls below 80 cfs. However, it is assumed that whenever low DO is evident, regardless of the Comal River flows, the remedial actions identified below are to be undertaken.

In 2015, additional DO monitoring will be conducted in order to better understand the spatial and temporal distribution of DO levels in Landa Lake and to evaluate the effectiveness of the aerators installed in Landa Lake in 2013. Dissolved oxygen management efforts in 2016 will be based on results of 2015 monitoring.

Target 2016/Performance Measure: Continue to monitor water quality parameters, including DO concentrations, within Landa Lake. Operate and maintain aerators and associated equipment to mitigate low DO levels. Continue to evaluate the effectiveness of the program and the need for additional DO management strategies to meet DO objectives.

Methods: In 2013, real-time water quality monitoring equipment was installed in Landa Lake to monitor and record dissolved oxygen, temperature, pH, conductivity and turbidity. Real-time water quality data from the monitoring device is currently being transmitted via telemetry to provide access to the monitoring data via the internet. Water quality data will be assessed on a regular basis to identify problematic dissolved oxygen levels.

In 2013, two solar-powered aeration systems were installed in Landa Lake. The solar powered aerators were initially based on a target area of approximately 10 acres (i.e., ~ 70 percent of Landa Lake). If predicted or observed dissolved oxygen diel patterns are trending toward less than 4 mg/l (or other trigger/criteria as established through the Adaptive Management Process) the solar-powered aeration units will be deployed. Vegetation conditions will then be evaluated via visual observations for signs of stress or decay on a weekly basis. If vegetation decay is evident and the aeration system is not able to keep oxygen levels above target thresholds, then removal of decaying vegetation will be initiated or other comparable management strategies will be developed based on specific conditions. In the event of vegetation removal, vegetation will systematically be examined for covered species and the species salvaged and returned to the system. Removed vegetation will be disposed offsite at a compost facility.

In 2015, additional research will be conducted to evaluate DO levels and trends throughout fountain darter habitat in Landa Lake. The 2015 research will be applied in order to define a more suitable DO management program which may include the installation of additional aerator units. Research findings will be incorporated into the 2016 management program. Additional DO monitoring will be conducted specifically to evaluate the effectiveness of aerators tentatively scheduled for installation in late 2015.

Monthly Monitoring: Real-time dissolved oxygen and temperature data will be monitored to evaluate projected trends indicative of problematic temperature or oxygen levels. Vegetation in Landa Lake will be monitored on a monthly basis during the May through September period to assess overall conditions and apparent stress levels (i.e., leaf coloration and condition). In the event projected trends of problematic oxygen levels are observed, then vegetation conditions will be evaluated via visual observations for signs of stress or decay on a weekly basis.

Allocated funds for 2016 (from Table 7.1): $15,000

Estimated Budget: $ 20,000

- $ 15,000 Operation and Maintenance of WQ Instrumentation & Aerators
- $ 5,000 Additional DO Monitoring to Evaluate Effectiveness of Aerators

### 5.2.5/5.2.9 Non-native Animal Species Control

The City of New Braunfels will continue to implement a program to reduce non-native animal species in the Comal River system. The non-native animal species that will be targeted include the suckermouth catfish, tilapia, nutria, and ramshorn snail. Since this work plan has two components identified within the HCP, each component has been broken out to facilitate the development of the work plan and budgets.

**Control of Harmful Non-Native Animal Species**

Long-term Objective: Reduce populations of non-native animal species to minimize their direct and indirect impacts to the Comal River ecosystem and Covered Species.

Assumptions: The Edwards Aquifer Authority's HCP bio-monitoring Program will continue to track populations of targeted invasive, non-native species to monitor populations. Data collected as part of this program will be utilized to guide and refine invasive species removal efforts.

Target 2016/Performance Measure: Continue existing program to remove non-native invasive species from the Comal River system utilizing removal methods proven successful in previous years. Continue to record counts and biomass of removed species.

Methods: Seasonal concentration of tilapia and other non-native fish into localized areas will be exploited for removal through seining techniques utilizing mesh sizes that are selective against impacting fountain darters and other Covered Species. Each seining effort will involve salvage of native species, which will be returned to the system. The City of New Braunfels will continue its nutria trapping program. A major focus of non-native removal will target suckermouth catfish given their overall destructive impacts on habitats within the system. Given the anticipated difficulties in control of suckermouth catfish, several different removal techniques will be attempted that include trapping with hoop nets and gigging with divers. During these combined efforts, any ramshorn snails encountered in 2016 will continue to be removed. All removed non-native species will be disposed of offsite following City of New Braunfels policies.

Monitoring: The planned EAA bio-monitoring program will assess the status of non-native species populations.

**Reduction of Non-Native Species Introduction and Live Bait Prohibition**

The City of New Braunfels will continue efforts to minimize the introduction of non-native species from aquarium dumps and implement prohibitions regarding the use of specific live bait species. The City of New Braunfels will continue to educate and promote public awareness related to aquarium dumping and the use of specific bait fish in the Comal River system.

Long-term Objective: Reduce the introduction of non-native species to the Comal River ecosystem.

Assumptions: This effort is primarily a public outreach and education effort.

Target 2016/ Performance Measure: Expand education efforts associated with the dumping of aquarium species into local waterways. This will be achieved by distributing

educational information and installing signage at key locations at Landa Lake and the Comal River. TPWD education materials and programs will be consulted and utilized.

The City of New Braunfels will continue to take action to develop an ordinance aimed at prohibiting aquarium trade dumps and the use of specific bait species.

Methods: Distribute education and outreach materials designed to inform the public of the impacts of invasive species on the Comal River ecosystem. TPWD programs regarding the introduction of non-native, invasive species will be assessed and potentially utilized. Installation of and improvements to existing signage will be managed according to existing City criteria.

Continue to solicit updated information, relevant studies, and opinions from Science expertise regarding potential threats or lack thereof to the Endangered Species by use of native species as live bait; compile into a useable format to assist in identifying native species to be used as bait.

The City will continue to promote the establishment of a live bait and aquarium dumping prohibition ordinance through public meetings, stakeholder input and the drafting of the ordinance. Input from the public and stakeholders will be presented to City Council for consideration.

Monitoring: It is anticipated that the bio-monitoring program will detect the presence of newly introduced species. Signage will be inspected annually for repair or replacement as necessary as well as identification of other locations that may need signage.

Total Allocated funds for 2016 (from Table 7.1): $75,000

Total Estimated Budget: $ 75,000
$2,000 Signage and Educational Materials
$73,000 Non-native Species Control

**5.2.6/6.3.6 Monitoring and Reduction of Gill Parasites**

The City of New Braunfels will continue to implement a monitoring program associated with the gill parasite (*Centrocestus formosanus*) and its intermediate host snail *Melanoides tuberculatus*.

Long-term Objective: To conduct monitoring and acquire data regarding gill parasite water columns concentrations, fountain darter infection rates, host snail density and distribution, and other potential gill parasite hosts to determine potential threats to fountain darters and

other Covered Species within the Comal system. Propose management measures, as needed, to minimize negative impacts on fountain darter populations by gill parasites.

Assumptions: The focus in 2016 will be on continued monitoring of water column cercariae along established transects and conducting an annual system-wide inventory of *Melanoides* distribution and density. Cercarial concentrations will continue to be monitored in established transects along the Comal River annually and more frequently when spring flow drops below 100 cfs or other springflow triggers that are developed. Cercariae water column concentration monitoring and snail abundance survey activities are expected to continue into subsequent years. Additional gill parasite research, including infection prevalence and density monitoring, will be completed in 2016 and are not anticipated to continue into subsequent years.

Target 2016/ Performance Measure: Continue existing monitoring program which includes snail distribution and density monitoring, cercariae water column concentration monitoring, snail infection prevalence, snail characteristic analysis, and fountain darter infection prevalence.

Methods:
It is anticipated that methods used in 2014 to conduct the annual *Melanoides* distribution and density survey will be used for 2015 monitoring. Two fisheries biologist using dip nets will traverse the entire Comal System recording the location of dip net sweeps and number of snails collected within each sweep. Water column cercarial concentration sampling will be conducted annually across the channel at the established transects. A total of 10 samples will be targeted at each cross section unless complex hydraulics suggests a higher spatial sampling. Sampling will proceed from downstream to upstream reaches. Samples will be collected between 9 and 11 am on sunny days to minimize temporal variance in the sampling. Each water sample will be filtered using an apparatus described in Cantu (2003). The cercariae will then be stained on the filters with a 10% Rose Bengal solution. Filters will then be transported to the contractor's laboratory where the number of cercariae on each filter will be counted with the aid of a dissecting microscope. Cercarial concentrations will be monitored more frequently when spring flow declines below 100 cfs or other springflow triggers that are developed.

Allocated funds for 2016 (from Table 7.1): $ 75,000

Estimated Budget: $ 75,000

### 5.2.7 Prohibition of Hazardous Materials Transport Across the Comal River and Its Tributaries

The City of New Braunfels will continue coordination with the Texas Department of Transportation (TXDOT) to promote prohibited transport of hazardous materials on routes crossing the Comal River and its tributaries. This effort may include development of local ordinances, installation of additional signage, and TXDOT approval.

Long-term Objective: Continue to identify and eliminate hazardous materials transport across the Comal River and its tributaries.

Assumptions: This effort will involve continual stakeholder engagement, public meetings, City Council consideration and coordination with TXDOT. This work plan element is contingent on TXDOT continuous participation and support.

Target 2016/ Performance Measure: Further identify roadways and alternate routes crossing the Comal River and its tributaries where the transport of hazardous materials poses a threat to the endangered species. Prepare maps and other information needed to inform City Council of the proposed route restrictions. Install signage at designated locations to inform hazardous material cargo carriers of the route prohibitions.

Methods: In 2015, the City of New Braunfels identified potential transport routes crossing the Comal River and its primary tributaries requiring protection and therefore prohibition. In 2016, this information will be used to initiate public meetings and draft ordinances to be considered by City Council. Efforts will be coordinated with TXDOT.

Monitoring: N/A

Allocated funds for 2016: $0

Estimated Budget: $3,000

$ 3,000 – Hazardous Material Transport Route Prohibition Signage and Education

### 5.2.8 Native Riparian Habitat Restoration (Comal Springs Riffle Beetle)

The City of New Braunfels will continue to implement a program to restore native riparian zones along Spring Run 3 and the western shoreline of Landa Lake to benefit the Comal Springs Riffle Beetle. Upon establishment of riparian zones on City of New Braunfels property, the City will develop a program to incentivize landowners to establish native riparian vegetation along privately owned lots located on the Western shoreline of Landa Lake.

Long-term Objective: Establish a healthy, functioning riparian area along Spring Run 3 and the western shoreline of Landa Lake to benefit the Comal Springs Riffle Beetle. Establish native riparian vegetation species that will increase the amount of usable habitat and food sources. Riparian vegetation will also be established to promote bank stabilization and minimize slope erosion and sedimentation in Riffle Beetle habitat areas.

Assumptions: It is assumed this effort will continue to focus on the identification of target native riparian species most beneficial for the Comal Springs Riffle Beetle that also meet erosion control requirements. The target area for subsequent removal and establishment of native vegetation is the upstream 100 meters of Landa Lake and Spring Run 3 and proceeding north into private property lots (along the waters edge). It is assumed the effort will be split between the bluff and Spring Run 3 given the different characteristics in these locations and therefore differences in approaches are anticipated. Restoration of the remaining area will be accomplished in segments during future years and incorporate revisions based on monitoring of work that was undertaken in 2013, 2014, and 2015.

Target 2016/Performance Measure: Continue riparian restoration efforts based on monitoring and success of previous work. Continue to monitor recently restored areas for stability and established vegetative growth. Establish native riparian vegetation within the riparian zone of private lots located along the western shoreline of Landa Lake.

Methods: Continue the removal of non-native, invasive plant species within the riparian zone. Plant deer-resistant, native plant species in Spring and Fall in areas where vegetation is sparse or not present. Plantings will be focused immediately along the waters' edge and in areas immediately up gradient of the shoreline. Utilize native plant species which have been observed in the immediate area and have proven successful in previous planting efforts. Install erosion/ sediment control devices, as needed in areas lacking sufficient vegetation and stability, to control hillside erosion and resulting sedimentation to riffle beetle habitat areas. Install fencing around young plants, as needed, to control foraging and damage by wildlife. Irrigation lines were installed in previous years and will be utilized and maintained, as necessary, to increase the survivability of plantings. Private landowners will be approached to determine interest in expanding restoration efforts on to private lots located along the western shoreline of Landa Lake.

Monitoring: Monitoring will occur on a regular basis to assess the survivability of plantings and the presence of non-native vegetation. Planting plots have been mapped and are utilized to track the success of plantings in specific locations. Methods will be revised, as needed, based on results of monitoring. In the event of heavy rainfall, the erosion and sedimentation will be assessed in the following week. Sediment control devices will be monitored to assess effectiveness and stability. Sediment captured behind the control devices will continue to be measured and total volume quantified. The HCP Bio-monitoring program will track riffle beetle populations within Spring Run 3 and along

the western shoreline of Landa Lake. Data collected as part of the bio-monitoring program will be utilized to determine locations for focusing riparian zone restoration activities.

Allocated funds for 2016 (from Table 7.1): $25,000

Estimated Budget: $25,000

### 5.2.10 Litter and Floating Vegetation Control

The City of New Braunfels will continue ongoing activities to manage floating vegetation and litter removal to enhance Covered Species and to prevent accumulations above and within aquatic vegetation restoration areas. Management activities will include dislodging of vegetation mats, to allow continued movement downstream, that form on top of the water surface and removal of litter for the littoral zone and stream bottom. The City of New Braunfels will manage aquatic vegetation in Landa Lake by dislodging floating vegetation entrained on the flow control structures, fishing piers, Landa Park Drive Bridge and other locations within Landa Lake where vegetation mats and litter accumulate.

Long-term Objective: Minimize impacts of floating vegetation and litter on the overall aquatic community within the Comal River system.

Assumptions: Litter removal and dislodging floating vegetation will follow existing protocols and schedules currently employed by the City of New Braunfels as described below.

Methods: Currently the City of New Braunfels contracts with a private contractor for removal of litter and dislodging of floating vegetation from Landa Lake, the Comal River and the Guadalupe River. Those contracts are renewed annually and in 2012 were set at a cost not to exceed $160,000 and include numerous mechanisms to reduce cost and scope mid season. SCUBA collections on the Comal River were added in 2007 as a pilot program and in 2008 as part of the contracts. SCUBA was added to protect the underwater habitat in the Comal River. Also in 2008, litter collection in Landa Lake was added to specifically protect species habitat. The City of New Braunfels cooperated with the USFWS to implement litter collections in Landa Lake. These additional expenditures have been voluntary on the part of the City of New Braunfels in past years, but now are mandatory based on requirements in the HCP Section 5.2.10. It is possible that without funding from the HCP, this mitigation action would be unfunded in 2016.

All litter removal and vegetation dislodging in Landa Lake is associated with protection of Covered Species habitat, as there is no tubing recreation in Landa Lake. Underwater collection (SCUBA) in the Comal River is associated with resource protection (species habitat), however above water collection on the Comal River is a direct result of tubing activities. Collections on the Guadalupe River have no relevance to the HCP or species

protection. Therefore only costs associated with Landa Lake and underwater Comal River collections will be included in HCP activities and budgets.

Target 2016/Performance Measure: Continue efforts to remove litter and dislodge floating vegetation mats from applicable portions of the Comal River system to prevent negative impacts to flow control structures, aquatic restoration areas, and Covered Species habitat.

Methods:
*Landa Lake* - (Jan 1st to December 31st). Routine vegetation maintenance and litter removal will occur from Jan 1st to December 31st. Vegetation maintenance and litter removal will occur on a scheduled basis between March and September and on an as-needed basis during the remainder of the year. Floating vegetation mats will be dislodged from flow control structures, the Three Islands area, fishing pier and other locations where vegetation mats accumulate.

*Comal River* – (April 1st to October 30th). Vegetation maintenance and litter pickup from May 1st to September 30th is on a scheduled basis. Floating vegetation will be dislodged and inorganic litter will be picked up from the substrate, surface and littoral zone of the Old Channel. Underwater litter in the New Channel from the NBU Hydroelectric dam downstream to below the last tubers exit will be removed utilizing SCUBA.

Monitoring: City of New Braunfels staff will monitor litter and floating vegetation mats in applicable areas. City staff will monitor contractor efforts and coordinate additional efforts when deemed necessary.

Allocated funds for 2016 (from Table 7.1): $ 0

Estimated Budget: $30,000

- $20,000 Floating Vegetation Clearing (52 weeks)
- $5,000 Underwater Litter Collection (32 weeks, Comal River and Landa Lake)
- $5,000 Litter Removal within Old Channel of Comal River (16 weeks, Landa Lake to Elizabeth Street and from confluence of New and Old Channels to 100 ft up-stream of Hinmann Island Dr)

### 5.2.11 Golf Course Management and Planning

The City of New Braunfels will implement their existing Integrated Pest Management Plan (IPMP) for Landa Park Golf Course. This process will incorporate public input and the Golf Course Advisory Board. The golf course IPMP will incorporate environmentally sensitive techniques to minimize chemical application, continue to improve water quality, and reduce negative effects to the ecosystem. Expanded water quality sampling targeted at Golf Course operations will be conducted as described in Section of 5.7.2 of the HCP.

Long-term Objective: Management of the golf course and grounds to minimize and reduce negative effects to aquatic ecosystem in Landa Lake and the Comal River.

Assumptions: The Landa Park Golf Course will continue to implement their existing IPMP and make adjustments to the plan as needed.

Target 2016/Performance Measure: Continue to implement and update the existing IPMP.

Methods: The golf course and grounds will be maintained in an aesthetically pleasing, yet environmentally sensitive manner. It is the responsibility of the Golf Course Manager to maintain the course and grounds in accordance with the new IPMP. The IPMP describes activities and materials to be used to control pests (i.e. insects, weeds, and other living organisms requiring control) on the golf course in a way that minimally impacts the environment.

Monitoring: Each year the City of New Braunfels Watershed Manger, in cooperation with the Golf Course Manager, will report to the HCP information on annual activities.

Allocated funds for 2016 (from Table 7.1): $0

Estimated Budget: $0

### 5.7.1 Native Riparian Habitat Restoration

The City of New Braunfels will continue efforts to provide further stabilization of the large eroding bluff along the Old Channel in the vicinity of the former sediment island. In addition to the completion of the bank stabilization project, native riparian vegetation will be established along select areas of the Old Channel to provide further bank stabilization and to compliment in-stream aquatic vegetation restoration efforts. The City of New Braunfels will also implement a program to increase the coverage area and density of the riparian zone along the Old Channel, golf course, and in the vicinity of Clemens Dam. As long term plans continue to take shape for the reestablishment of the riparian zone, private and public landowners will be asked to participate in the plan. Reimbursement for the price of native plants will be provided to private and public landowners. Criteria to qualify for reimbursement will be established along with a list of preferred natives to replant will developed in consultation with the City of New Braunfels forester.

Long-term Objective: Increase native riparian vegetation, reduce non-native invasive riparian vegetation, and prevent streambank erosion in areas along the Old Channel of the Comal River that will compliment aquatic vegetation restoration efforts.

Assumptions: Sequencing will start with the completion of the bank stabilization project and continue with riparian vegetation restoration along the north bluff of the Old Channel. Construction of the bank stabilization project will be contingent upon adequate springflow rates (>130 cfs) for a 6-8 month period to allow for continuous work efforts. Native riparian vegetation restoration will be conducted to maximize the interactions of shading and light with native aquatic vegetation efforts being conducted in this reach to create direct habitat for fountain darters.

Target 2016/Performance Measure: The first step is the completion of bank stabilization and riparian restoration in the Old Channel adjacent to where the sediment island was removed. Subsequent riparian restoration along the Comal River and Landa Lake will occur in targeted areas following the completion of the bank stabilization project. Further riparian restoration will be conducted in areas of the Old Channel to increase the density of native riparian species, compliment in-stream aquatic vegetation restoration efforts (by increasing solar exposure in the channel) and further enhance fountain darter habitat.

Methods: Complete construction of the Old Channel bank stabilization project according to specifications provided in the "Comal River Bank Reclamation and Riparian Zone Restoration Construction Plans" prepared by Freese and Nichols. Riparian restoration efforts associated with the project will be implemented per construction plan specifications. Riparian restoration efforts along the Old Channel in areas not associated with the Bank Stabilization project will include removal of invasive species, installation of erosion control devices (as needed), and establishment of native riparian plantings. Temporary erosion and sediment control BMPs will be installed following the removal of non-native vegetation and will remain in place until native vegetation becomes established and/ or the riparian zone is stabilized. Coordination with the Old Channel aquatic vegetation restoration project will occur to maximize solar exposure to select portions of the channel where aquatic restoration is feasible.

Monitoring: The effectiveness of establishing native vegetation will be assessed near the end of 2016 with sufficient lead time to influence work plan development for 2017.

Allocated funds for 2016 (from Table 7.1): $100,000

Estimated Budget: $100,000

### 5.7.5 Management of Household Hazardous Wastes

The City of New Braunfels will continue the hazardous household waste (HHW) program that includes accepting prescription drugs and Freon, through the TCEQ and/or the waste disposal division of the City of New Braunfels. The City of New Braunfels anticipates establishment of a three-times-a-year program.

Long-term Objective: Reduction in the improper disposal of hazardous wastes and incorporation of prescription drug and Freon drop off.

Assumptions: None

Target 2016/Performance Measure: Continue the existing hazardous household waste program and increase associated public outreach and education efforts.

Methods: Conduct three HHW collection events which incorporate an education and outreach component.

Monitoring: The volume of hazardous waste material collected during the HHW collection events will be noted and compared to previous efforts.

Allocated funds for 2016 (from Table 7.1): $ 30,000

Estimated Budget: $ 30,000
$2,000 Outreach
$28,000 Additional Collection Events

### 5.7.6 Impervious Cover/Water Quality Protection/LID

The City of New Braunfels will expand criteria related to desired impervious cover, provide incentives to reduce existing impervious cover on public and private property in New Braunfels, and implement stormwater BMP's in the area of Landa Lake and the Springruns. The City of New Braunfels will implement a program based upon the low impact development (LID)/Water Quality Work Group Final Report recommendations for Implementation Strategies and best management practices (BMPs). The 2016 Work Plan includes implementation of an incentive program and directly supports the reduction of impervious cover at the Comal Springs Conservation Center.

Long-term Objective: Reduction and control of non-point source pollutant discharges to Landa Lake and the Comal River system. To increase public awareness of LID concepts and stormwater BMPs utilized to control pollutant discharges.

Assumptions: Efforts will focus on the implementation of a rebate program designed to offer incentives for residents and businesses to install LID BMPs. It is assumed residents

and businesses in the Comal River watershed will take advantage of the rebates for the installation of LID BMPs on their property.

Planning discussions with New Braunfels Utilities (NBU) staff occurred in 2015 regarding the proposed Comal Springs Conservation Center and potential collaboration with the City of New Braunfels and the EAHCP. NBU anticipates beginning Phase I construction of the Comal Springs Conservation Center project in 2016.

Target 2016/Performance Measure: Implement a LID and impervious cover reduction rebate/incentive program targeted at residential and commercial properties contributing stormwater runoff to endangered species habitat within the Comal River system. BMP's developed as part of this program will include measures directly benefiting the Comal River system that are well above and beyond the features of the City's standard MS4 program. Efforts in 2016 will include collaboration with NBU to fund the removal of impervious cover immediately adjacent to Landa Lake at the proposed Comal Springs Conservation Center. The removal of impervious cover and subsequent native plant restoration will increase infiltration, minimize stormwater runoff and decrease the volume of sediment and pollutants entering Landa Lake.

Methods: The City of New Braunfels will implement a program to issue rebates to residents and businesses for installation of LID projects on their properties. Rebates will be provided for the LID BMPs such as removal of impervious cover, rainwater harvesting barrels, rain gardens, pervious pavement, and native landscaping within areas contributing stormwater runoff to Landa Lake.

The City will collaborate with NBU to decrease the amount of impervious cover at the Comal Springs Conservation Center. Native plant restoration will occur in areas where impervious cover was removed. Phase I of the Comal Springs Conservation Center project is scheduled to begin in 2016. The Comal Springs Conservation Center includes educational components to inform residents, developers, and construction contractors of LID treatment concepts, stormwater pollution mitigation and information on the endangered species.

Summary of the Comal Springs Conservation Center Project: The property designated for the Comal Springs Conservation Center consists of approximately 16 acres located at the headwaters of Landa Lake at the mouth of Blieders Creek. The existing site is owned by NBU and consists of asphalt parking areas and aging warehouse structures formerly utilized for NBU operations. Phase I of the project is expected to begin in 2016 and involves removal of 85% of the existing impervious cover, native plant restoration, restoration of Spring Run #4, and construction of LID features, such as bioswales and rain gardens, designed to treat stormwater runoff prior to entering Landa Lake. The project will provide direct water quality benefits to Landa Lake and the Comal River system by

increasing infiltration and treating stormwater runoff. Phase I of the project also includes trails, an observation area, and an outdoor classroom intended to educate residents, students, and developers about LID concepts. Design plans for the project have been completed by NBU and are available for review. The estimated total cost for Phase 1 is $6 million with $95,000 being proposed for EAHCP funding through the 2016 City of New Braunfels Work Plan. In 2016 it is anticipated the EAHCP program can fund the removal of impervious cover and native plant restoration. In subsequent years EAHCP funding could help support the restoration of Blieders Creek along the project site and construction of a spring trail for observation of riparian habitat and facilitating water quality sampling.

Monitoring: None

Allocated funds for 2016 (from Table 7.1): $100,000 (for LID program development and implementation) + $50,000 (for stormwater BMPs)

Estimated Budget: $150,000

$55,000 LID Rebate/ Incentive Program Implementation & Community Outreach
$95,000 Removal of impervious cover at Comal Springs Conservation Center

## City of New Braunfels – 2016 HCP Budget

| HCP Section | Mitigation Action | 2016 HCP Budget (From Table 7.1) | 2015 HCP Budget | Estimated FY2016 |
|---|---|---|---|---|
| 5.2.1 | Flow Split Management | 30,000 | 5,000 | 43,500 |
| 5.2.2.1 | Old Channel Restoration | 125,000 | 225,000 | 125,000 |
| 5.2.2/5.2.3 | Comal River Aquatic Vegetation Restoration | 100,000 | 275,000 | 100,000 |
| 5.2.3 | Management of Public Recreation | 0 | 0 | 0 |
| 5.2.4 | Decaying Vegetation Removal and Dissolved Oxygen Management | 15,000 | 105,000 | 20,000 |
| 5.2.5/5.2.9 | Non-native Animal Species Control | 75,000 | 75,000 | 75,000 |
| 5.2.6/6.3.6 | Monitoring and Reduction of Gill Parasites | 75,000 | 75,000 | 75,000 |
| 5.2.7 | Prohibition of Hazardous Material Transport Routes | 0 | 3,000 | 3,000 |
| 5.2.8 | Native Riparian Habitat Restoration (Riffle Beetle) | 25,000 | 50,000 | 25,000 |
| 5.2.10 | Litter and Floating Vegetation Management | 0 | 40,000 | 30,000 |
| 5.2.11 | Golf Course Management | 0 | 1000 | 0 |
| 5.7.1 | Native Riparian Habitat Restoration | 100,000 | 430,000 | 100,000 |
| 5.7.5 | Management of Household Hazardous Waste | 30,000 | 30,000 | 30,000 |
| 5.7.6 | Impervious Cover/ Water Quality/ LID Program | 150,000 | 100,000 | 150,000 |
| | **Totals** | **$725,000** | **$1,414,000** | **$776,500** |

Appendix J6

# 2016 City of San Marcos and Texas State University Work Plans and Budgets for the Edwards Aquifer Habitat Conservation Plan

# 2016 City of San Marcos/Texas State University

# Work Plan

# For

# Edwards Aquifer Habitat Conservation Plan

# San Marcos/Texas State University 2016 Work Plan

## 5.3.1/5.4.1 Texas Wild-Rice Enhancement and Restoration

Texas State University and the City of San Marcos are partnering to undertake a program of Texas wild-rice (TWR) enhancement and restoration in Spring Lake and the San Marcos River to the San Marcos wastewater treatment plant.

Long-term Objective (Phase I): To restore 8000 $m^2$ of TWR (in addition to the 2013 baseline of 4000 $m^2$) and successfully implement the State Scientific Area (SSA) protection program for existing and restored areas of TWR during flows of 120 cfs and below (see EAHCP Section 5.6).

Assumptions: The average long term biological goal for TWR is 12,000 $m^2$ (see Table 4-10; pg 4-16 EAHCP). To achieve this goal, an 8000 $m^2$ increase over the first phase of the EAHCP period (2013-19) would be required with an annual goal of approximately 1100 $m^2$ of TWR restoration each year. It is also assumed that production of Texas wild-rice will occur at the Freeman Aquatic Building (FAB) at Texas State University and the U.S. Fish and Wildlife Service San Marcos Aquatic Research Center. Production of plants at the FAB is incorporated into this work plan budget.

Enhancement and restoration of TWR focuses on the removal of non-native vegetation within mixed stands of TWR and removal of non-native vegetation in areas adjacent to existing TWR stands. The work plan also includes selective TWR planting in up to 20% of the areas where non-native vegetation and sediment is removed as discussed in EAHCP measures 5.3.6/5.4.4 (Sediment removal) and 5.3.8/5.4.3/5.4.12 (Control of non-native plant species). In addition, TWR areal coverage within Spring Lake is targeted for 1500 $m^2$.

Target 2016/Performance Measure: Successful expansion of TWR stands through plantings where non-native vegetation and silt is removed for expansion purposes as well as selective gardening within and around existing stands for maintenance. These strategies will target a goal of 1100 $m^2$**.** As shown in Table 1 below, in 2013 and 2014, the focus for TWR has been in the Spring Lake dam to just above the Rio Vista segment of the San Marcos River. By the fall of 2014, Texas State/San Marcos met the minimum target set for this reach in the EAHCP. Therefore, in 2015, work shifted focus to maintenance of this segment with a concentration of new plantings in the segment downstream - from Rio Vista to IH-35. In 2016, Texas State/San Marcos will continue to maintain the TWR in the Spring Lake to Rio Vista segment, and will continue with new plantings downstream to meet the minimum targets. Also, in 2016, Dr. Hardy will set up test plots in Spring Lake to determine potential success of TWR plantings.

| River Segment | Spring 2013 Area (sq m)* | Fall 2014 Area (sq m)# | Target (sq m) | Min Target (sq m) | Median Target (sq m) | Max Target (sq m) |
|---|---|---|---|---|---|---|
| Spring Lake | 30.34 | 30.34 | 1,000 - 1,500 | 1,000 | 1,250 | 1,500 |
| Spring Lake to Rio Vista | 3985.26 | 5714.43 | 5,810 - 9,245 | 5,810 | 7,528 | 9,245 |
| Rio Vista to IH-35 | 424.26 | 337.64 | 910 - 1,650 | 910 | 1,280 | 1,650 |
| Below IH-35 | * | 118.99 | 280 -3,055 | 280 | 1,668 | 3,055 |
| Total | 4439.86* | 6201.4 | 8,000-15,450 | 8,000 | 11,725 | 15,450 |

** Spring 2013 MCWE vegetation survey from Spring Lake spillway to IH-35*

*# 2014 Annual Texas Wild-Rice by Biowest from Spring Lake to Blanco River confluence*

Table 1. Targets for TWR by segment

Methods: Model results from Hardy et al. (2011a) were used to identify restoration/enhancement areas for TWR that would have sustainable depth and velocity during low flows below 90 cfs (optimal habitat). *Hydrilla* and *Hygrophila* were selected as target species for removal due to their high relative abundance in the San Marcos River. In mixed stand areas, the non-natives will be removed and the original TWR stand monitored for expansion. Similarly, for TWR stands occupying optimal areas with adjacent non-native vegetation, the non-native plants will be removed and the TWR monitored for expansion. Finally, in optimal areas for TWR that are unoccupied by TWR, any non-native vegetation that is present will be removed and TWR planted and monitored to assess the success of transplants. Monitoring thus far has shown that invasive plants move into cleared areas more quickly than TWR, so cleared areas are now planted with either TWR or a native plant.

Seeds and tillers will be collected as discussed in the guidance being developed by the San Marcos Aquatic Resource Center.

TWR stands were selected based on predicted TWR optimal conditions and a practical working environment (i.e. manageable current velocity) with the consideration of attaining EAHCP biological goals. SMARC has been experimenting with plantings of TWR downstream of IH-35 and approximately five $m^2$ has been established (as of April 2015).

When removing non-native vegetation, the non-native vegetation is fanned to displace fountain darters prior to uprooting the vegetation. The non-native aquatic plants are shaken, fountain darters (or other native species) salvaged and returned to the river, and the non-native vegetation bagged for disposal at the city's or university's composting facility.

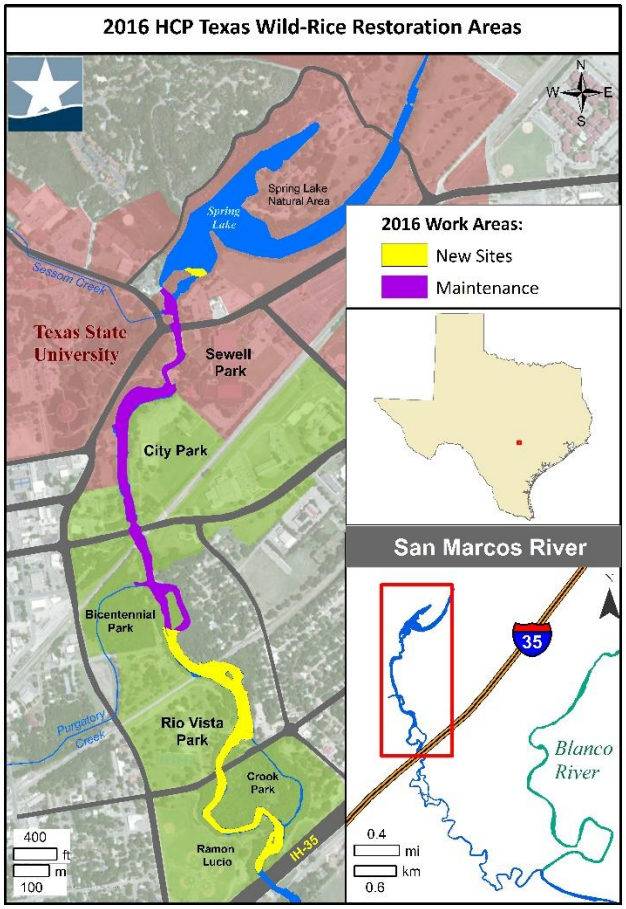



Fig 1. Target area for TWR and native plantings in 2016.

Native plants such as *Ludwigia* and *Potomageton* are planted while divers are planting TWR. This is the most efficient approach.

<u>Texas Wild-rice/Non-native Removal and Planting Budget Rationale</u>. As areas of non-native plant removal (with associated targets of 20 to 50 percent planting over the exposed area) expand, we are finding that aggressive gardening to keep the non-natives from reestablishing results in better success of the planting to expand. As more areas are planted, more effort is required for repeated gardening for several months until the stands are well established. Additionally, the fact that we are approaching the apparent minimum biological targets in the City Park segment of the San Marcos River does not mean that work in complete in that segment. First, there needs to be a demonstrated persistence of the areal gains over time that has not yet been demonstrated and secondly we are targeting the maximum threshold to ensure continuance of TWR plantings over time. The proposed budgets for the TWR and Non-native Removal measures also reflect a more difficult effort. Physical and biological conditions in the remaining segments are not as conducive to success as demonstrated in the upper reaches. A higher planting per unit area of restoration will likely be required and more trial and error on specific locations where establishment success can be achieved in order to meet the projected biological targets for these lower

reaches. Additionally, these segments will be worked while still maintaining remedial gardening of existing restoration in the reaches below Spring Lake Dam.

The budget reflects the time and effort necessary to meet the target biological goals as specified in the EAHCP and is the annual funding projection through Phase I.

### 5.3.6/5.4.4 Sediment Removal

The City of San Marcos and Texas State University are partnering to implement an ongoing program of sediment removal from the river bottom at various locations from Spring Lake to IH-35.

Long-term Objective: Initial removal of targeted fine sediments and then maintenance removal of accumulations of sediment for the purpose of optimizing quality of riverine habitat.

Target 2016/Performance Measure: Successful removal of 1000 $m^2$ (approx. 500$m^3$) of fine silt and associated non-native vegetation. In 2014, 77$m^2$ was removed. Equipment (pump and pit) could not provide the rate of labor needed to achieve 1000 $m^2$ and for the last half the year Provision M shut down this measure. In 2015, sediment removal started in May. The first part of the year was dedicated to removal of the invasive regrowth that occurred as a result of Provision M in 2014. The new pump has a removal rate of 25cy/hr and the geobag takes 250cy. Areas will be chosen based on historical presence of TWR, high recreation, and possible impact on downstream listed species habitat from sediment. The target area for 2016 is from Spring Lake Dam to IH-35 upon receipt of sand & gravel permit from the TPWD.

Methods: Removal of non-native vegetation prior to sediment removal is covered under Work Plan elements 5.3.8, 5.4.3, and 5.4.12. As specified in the HCP, hydrosuction will be used to remove accumulations of sediment. Divers will be trained on equipment operations, diving safety protocols, and recognition of all stages of listed species from larval to adult.

Divers fin the area proposed for sediment removal, remove all vegetation and then scan the area for the presence of listed species and other biota. One diver floats on surface to relay information to the dredge operator, one worker will be stationed by the discharge point to monitor operations and answer public questions. Disposal of removed sediment will be at the Texas State University Composting Center or Animal Shelter compost site.

Monitoring: Turbidity is monitored during and after all removal efforts. After targeted depth of fine sediment removal has been achieved, the bed elevation will be measured from existing benchmarks and the sediment composition delineated (i.e., sand, gravel, etc). Bed elevation and substrate composition will then be monitored at each location before and after the recreation season. Success will be determined by the volume of sediment removed, reduction of stream turbidity during recreation season and reduction of sediment deposition on listed species habitat.

Sediment Removal Budget Rationale. The 2011 GPR study estimated 21,500 m2 (12,750 m3) of fine sediment in the San Marcos River between City Park and Rio Vista Falls. Sediment sampling upstream of Capes Dam estimate that approximately 6700 m3 of fine sediments are

trapped in this reach between Rio Vista and Capes Dam. Approximately 150 m2 of fine sediment has been identified for removal in Spring Lake, as well as the entire slough arm.

During 2013, sediment removal was constrained by the 0.25 inch mesh covering on the suction dredge required under the initial provisions of the HCP. Efficiency was also hampered by the relatively low sediment to water ratio of the initial pump system deployed. However, MCWE was able to remove approximately 44 cubic meters of fine sediment from the two permitted areas within the San Marcos River.

The 2014 work plan targeted removal of approximately 3000 $m^2$ and associated volumes. In 2014, as efficiency increased with an improved sediment to water pumping system and no 0.25 inch mesh covering, 77 cubic meters was removed prior to shutdown of the measure due to flows as outlined under provision M. In the remainder of 2014, during flows below the Provision M restriction, MCWE focused on the assessment of the distribution of fine sediments in areas not evaluated in GPR study (see Figure 2). That study collected substrate data at eight discrete sampling areas within the upper reach of the San Marcos River (Fig. 2).

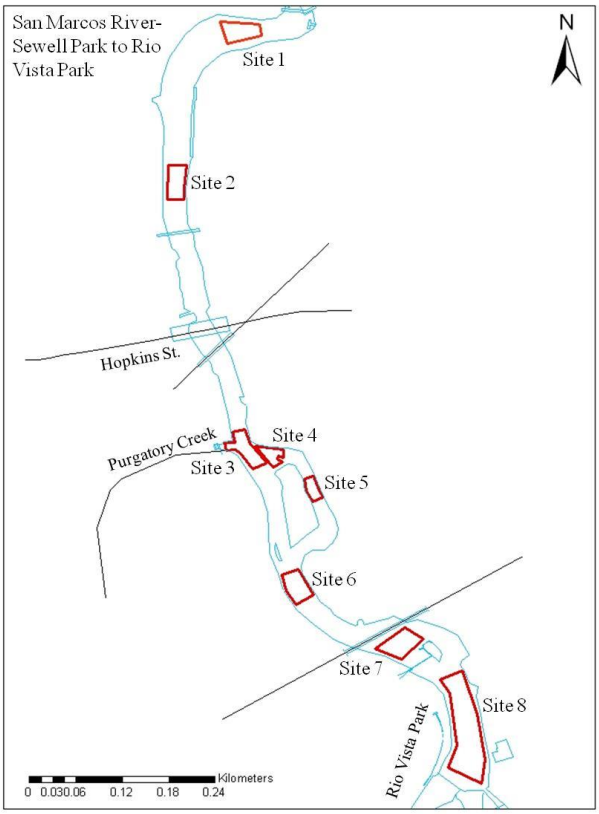



Figure 2. Map of sampling areas using ground penetrating radar in the upper San Marcos River.

The HCP identifies the expansion from ~1 square meter of existing TWR to 1500 square meters as the biological target in Spring Lake. While Provision M restriction of sediment removal was

in force, MCWE conducted a collaborative mapping effort with the University of Texas to profile bottom sediments within Spring Lake (i.e., no disturbance of sediments as prescribed under Provision M). The targeted sediment removal specified in the HCP did not necessarily consider restrictions within Spring Lake associated with sensitive cultural resource areas where removal may not be or require more extensive coordination with the Center for Archeological Studies at Texas State University. These data were analyzed to identify specific target areas in Spring Lake for fine sediment removal in conjunction with TWR expansion that had low potential for conflict with in situ cultural resources. These areas are currently being evaluated by the archeological staff at The Meadows Center for Water and Environment in coordination with the Center for Archeological Studies at Texas State University which has oversight responsibility for cultural resources at Texas State University.

Allocated funds for 2016 from Table 7.1: $ 25,000

Additional amount requested: $168,041.62

Estimated Budget: $193,041.62 (last year - $223,200); labor ($181,041.62) & expenses ($12,000)

The budget reflects the time and effort necessary to meet the target biological goals for TWR as specified in the EAHCP and represents the annual funding projection through Phase I.

### 5.3.8/5.4.3/5.4.12 Control of Non-Native Plant Species

The City of San Marcos and Texas State University are partnering to implement an on-going non-native plant replacement program for the San Marcos River from Spring Lake to city limits. Non-native species of aquatic, littoral, and riparian plants will be replaced with native species to enhance Covered Species habitat.

Long-term Objective: To keep the density of invasive aquatic and littoral plants as low as possible through monitored removal along the San Marcos River.

Assumptions: Non-native aquatic plants will be removed in association with fine sediment removal and TWR enhancement as described in conservation measures 5.3.6/5.4.4 and 5.3.1/5.4.1. It is also assumed that production of native aquatic plants will continue at the Freeman Aquatic Building at Texas State University and the U.S. Fish and Wildlife Service San Marcos Aquatic Research Center. Funding for the production of plants at the FAB and SMARC is incorporated into this work plan budget. Removal of littoral plants and other small caliper invasives is also included in this budget as a separate project.

Target 2016/Performance Measure: *Non-native Aquatic* - Non-native aquatic plant removal will occur in conjunction with sediment removal. Therefore, the 2016 goal is 1500 $m^2$ of plant removal. This target was achieved in 2013 and 2014.

*Littoral* – The area from Spring Lake to IH-35 has undergone initial removal of elephant ears, so in 2016 all areas will continue to be monitored for regrowth and littoral areas will be planted with natives**.** Currently 50% of the labor cost is spent on addressing re-growth of invasive littoral species.

Methods

*Non-native Aquatic Plants* - Divers conducting sediment control first remove non-native aquatic plant species from the area to be worked that day. Prior to plant removal, the area is fanned to help remove fountain darters and other native species. The non-native aquatic plants are removed, shaken and bagged for disposal at the composting facility. Denuded areas will either be targeted for TWR and/or selected native species planting. TWR and native species will be obtained from the SMARC, Tx State FAB, and tillers from the San Marcos River following protocol established in the guidance under development by SMARC. Initial efforts for restoration of TWR or native vegetation will target planting of approximately 50 percent of the surface area restored.

Propagation of *Cabomba* has been unsuccessful to date, so other methods will be considered in 2016 to ensure the targets set in the HCP are met (Table 2 below).

*Littoral* - On the banks, elephant ear (*Colocasia esculentes*) is the focus of removal efforts. *C. esculenta* primarily reproduces by producing additional tubers beneath the soil or by sending off long runners called stolons which attempt to root in the soil or in any nearby body of water. The species also produces an inflorescence with a spathe tube that is green but the blade is orange on both sides.

Hand removal will be used wherever possible. Chemical removal consists of the use of glyphosate-based aquatic herbicide and surfactant that is drip-sprayed onto the surface of the leaves to remove more "entrenched" elephant ear plants. Small caliper invasive plants in the littoral zone are also removed.

Monitoring: *Aquatic vegetation* – Newly planted areas are monitored monthly to evaluate success rate. The planted areas will be weeded (non-native species removed) and replanted as needed to meet target areal coverage. An annual river inventory will be conducted to identify the presence and location of new non-native vegetation establishment. Turbidity will be monitored during and after all removal efforts. Success will be measured by the surface area cleared of non-native plants and the success rate of replanted TWR or native plants as shown in Table 2 below.

Table 2. HCP targets for native and invasive submerged aquatic plants.

| **2014 Areal Coverage (m2)** | ***Hygrophila*** | ***Ludwigia*** | ***Cabomba*** | ***Hydrilla*** | ***Potamogeton*** | ***Sagittaria*** | ***Vallisneria*** |
|---|---|---|---|---|---|---|---|
| Spring Lake Dam | 39 | 0 | 0 | 124 | 92 | 40 | 32 |
| City Park | 593 | 10 | 0 | 997 | 58 | 129 | 3 |
| IH-35 | 406 | 46 | 223 | 160 | 0 | 219 | 0 |
| **TOTAL** | **1037** | **56** | **223** | **1281** | **151** | **388** | **35** |

| HCP Targets from Table 4-21 (m2) | *Hygrophila* | *Ludwigia* | *Cabomba* | *Hydrilla* | *Potamogeton* | *Sagittaria* | *Vallisneria* |
|---|---|---|---|---|---|---|---|
| Spring Lake Dam | 50 | 200 | 25 | 100 | 1000 | 100 | 125 |
| City Park | 200 | 1000 | 50 | 500 | 2000 | 300 | 50 |
| IH-35 | 50 | 200 | 300 | 100 | 300 | 100 | 25 |
| **TOTAL** | **300** | **1400** | **375** | **700** | **3300** | **500** | **200** |

Allocated funds for 2016 from Table 7.1: $ 125,000

Additional amount requested: $119,402.67

Estimated Budget: $244,280.66 (last year was $344,000); labor ($231,280.66) & expenses ($13,000)

The budget reflects the time and effort necessary to meet the target biological goals as specified in the EAHCP and represents the annual funding projection through Phase I.

Justification for increased funds for TWR/native plantings and non-native plant removal:

As the progression of removing non-native aquatic vegetation and subsequent planting of native aquatic species continues in areas of the river, more time (i.e., effort) is necessary to maintain the continual expanded work area. Typically, it takes several efforts to effectively remove non-native aquatic vegetation within an area. Figure 3 illustrates the range of effort MCWE has invested for non-native vegetation removal downstream of Sewell Park in the San Marcos River. Areas in red indicate intensive effort (i.e., up to 8 times) for non-native removal.

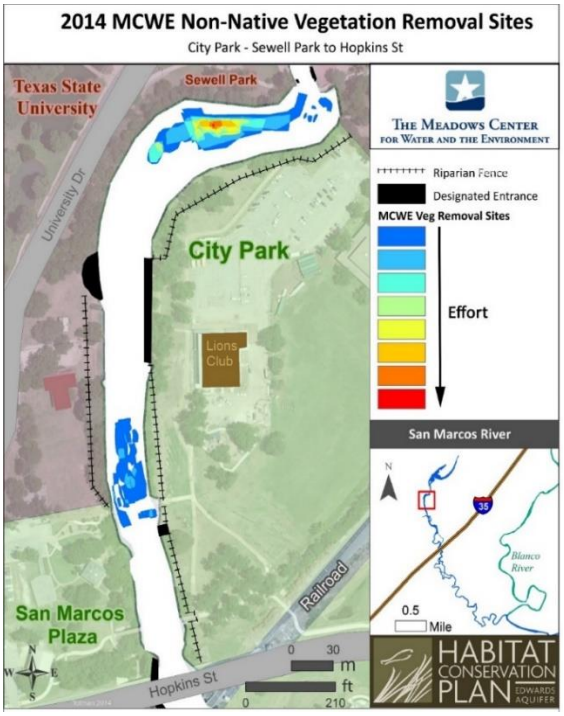



Figure 3. Vegetation removal effort by MCWE staff for removing non-native vegetation in the San Marcos River downstream of Sewell Park. Red spots indicate the areas of highest effort (i.e, hotspots) needed for continued non-native removal. Each color box represents increasing labor hours with blue = one week and red = eight weeks.

A major component to consider when removing non-native vegetation and replanting with native species is manpower. Figure 4 shows the quantity of non-native vegetation we remove on a daily basis. Having a sufficient number of people to remove vegetation is necessary because it requires a great deal of strength and endurance. Consequently, maintaining areas while also denuding new areas requires more people and extra man hours.

Figure 4. A load of non-native vegetation (Hydrilla) removed just downstream of city park during one morning with a crew of eight people.

### 5.3.3/5.4.3 Management of Floating Vegetation Mats and Litter

The City of San Marcos and Texas State University are partnering to implement an ongoing program to manage floating vegetation and litter removal for the enhancement of listed species habitat. Management activities include removal of vegetation mats that form on top of Texas wild-rice plants, particularly during low flows, and removal of litter for the littoral zone, stream bottom and tributaries. Texas State University will manage aquatic vegetation in Spring Lake through use of its harvester boat and hand cutting of vegetation by divers authorized to dive in Spring Lake.

Long-term Objective: Minimize impacts of floating vegetation and litter on TWR stands and overall aquatic community within the San Marcos River, as well as keep springs clear to enhance San Marcos salamander habitat.

Assumptions: Existing vegetation management activities in Spring Lake will continue to follow the Spring Lake Management Plan (approved by the President's Cabinet) and the EAHCP, as described under Methods. Litter and floating vegetation mat removal will follow the existing protocol and schedules currently employed by the City of San Marcos and the EAHCP, as described below under Methods.

Target 2016/Performance Measure: Continued implementation of the established protocols and document the impact of simply pushing (or lifting), rather than push (or lift) and remove, floating plant mats.

Methods: *Spring Lake* - Each week about five springs are cut, with divers returning to cut the same springs every two to three weeks. During summer algal blooms, the springs will be managed more frequently (up to four springs per day), but mostly to remove algae. Texas State employees and supervised volunteers will fin the area around the springs to remove accumulated sediment, and then clear a 1.5 meter radius around each spring opening in Spring Lake with a scythe. Over the next 1.5 meter radius around the spring opening, they will shear vegetation to a height of 30 cm, and then to one meter over the following three meter radius. Plant material will not be collected, but carried away by the current. Cumulatively, about six meters of vegetation around each spring opening will be modified. Mosses will not be cut. The volume of plant material to be removed will vary by the amount of time between cuttings, and season. The harvester boat will remove a range of 15 to 20 boatloads of plant material a month from Spring Lake. The harvester will clear the top meter of the water column, cutting vegetation from sections one, two, and three once a week (See HCP Figure 5.2). The harvested vegetation will be visually checked by driver for fauna caught in the vegetation. If the driver observes fauna, he/she will stop work and put the animal(s) back into Spring Lake if appropriate. Texas State employees and supervised volunteers are trained to recognize the Covered Species through the Diving for Science program (Section 5.4.7.1), and avoid contact with them. Vegetation mats will be removed from zones four and five on an as-needed basis (See HCP Figure 5-2). The total area cut will equal about nine surface acres. The Spring Lake Area Supervisor also schedules cleanup of nuisance floating species such as water hyacinth and water lettuce from Spring Lake. The floating plants will be collected by hand and shaken prior to removal from the river to dislodge any aquatic species caught in the plant. The plants will be deposited into dump trucks and taken

to the Meadows Center compost area. The activities described in this section are not funded by the EAHCP. They are fully supported by Texas State University.

*San Marcos River* – Floating vegetation in Texas wild-rice stands will be pushed (or lifted & removed) off the stands. The impact of sending mats of vegetation downstream, rather than removing them from the river, will be documented. Inorganic litter will be picked up weekly from the substrate, surface and littoral zones of the San Marcos River from upper Sewell Park to City Park and from IH-35 to Stokes Island during the recreational season (May 1st to September 30th) and monthly during offseason. Litter will also be picked up from public lands within the four tributaries. Monitoring of downstream Texas wild-rice stands to keep the stands clear of drifting vegetation will also be undertaken.

Monitoring: Floating vegetation and litter are targeted weekly during the recreation season and then monthly during the remainder of the year. In the event of low flows, this activity will be monitored for potential impacts on listed species and will be suspended if impacts are observed. Volume of litter will be tracked.

Allocated funds for 2015 from Table 7.1: $ 80,000

Contract Amount**:** $48,798.10

Public Outreach Funds: $2,500.00

Transfer to Measure 5.7.1/Native Riparian Habitat Restoration: $28,701.90

**5.3.5/5.3.9/5.4.11/5.4.13 Non-Native Species Control**

The City of San Marcos, in partnership with Texas State University, will implement a program of invasive faunal control in the San Marcos River on a periodic basis with expanded efforts of control, if needed, at low flows. The species include suckermouth catfish, tilapia, nutria and *Melanoides* and *Marisa cornuarietis.* Educational materials will be provided to local pet shops and commercial outlets who sell aquarium species. Alternatives, such as a university and nature center release pond, will be offered to fish and snail owners.

Long-term Objective: Reduction of non-native, invasive species in the San Marcos River to levels that minimize their possible impacts on Covered Species and the aquatic ecosystem.

Target 2016/Performance Measure: Contractor(s) will use methods that have proven to be successful in efficient capture of invasive species from Spring Lake to IH-35. Contractor(s) will count and trend captured individuals for all targeted fish species. Contractor(s) will begin nutria removal.

Methods: Methods will be undertaken in a manner that avoids impacts to resident turtles and other native species. Fyke nets, spear and bow fishing continue to be effective methods.

Effective removal of *Melanoides* and *Marisa cornuarietus* will continue to be accomplished by determining the locations of highest snail density and using dip nets to remove the snails weekly. The species will be controlled by diving several hours after sunset to hand-pick the snails from the submergent vegetation as well as setting baited traps.

Monitoring: It is assumed that the integrated biological monitoring program will assess the status of non-native animal species. Established population counts will be used as baseline to track success of efforts along with the bio-monitoring program.

Allocated funds for 2016 from Table 7.1: $ 35,000

Contract Amount: $25,459.20

Public Outreach Funds: $2,500

Transfer to Measure 5.7.1/Native Riparian Habitat Restoration: $7,040.80

### 5.3.7 Designation of Permanent Access Points/Bank Stabilization

The City of San Marcos has completed the construction of bank stabilization/access points at seven locations along the San Marcos River.

Long-term Objective: Maintain integrity of structures and control erosion in the recreation traffic areas at each structure.

Target 2016 Performance Measure: Stabilize six access points according to the Texas Parks and Wildlife Department recommendations to address safety concerns. Establish hard surface, fence, or plants as needed to control erosion around bank stabilization/access structures and conduct an annual inspection of each structure above and below the water line.

Methods/Monitoring. See above.

Allocated funds from Table 7.1 for 2015: $20,000

Estimated budget: $20,000 (The total estimated costs to stabilize six access points is approximately $50,000. The EAHCP will fund $20,000, while the City of San Marcos will provide the funding for the balance.)

### 5.7.1 Native Riparian Habitat Restoration

The City of San Marcos and Texas State University have undertaken a program to increase the area and density of the riparian and water quality buffer zone on public and private lands from the Spring Lake Dam to IH-35 using native vegetation. Upon completion of the riparian and water quality buffer zone on public land, private landowners will be asked to voluntarily participate in the plan.

Long-term Objective: Establish a robust native riparian and water quality buffer community that benefits Covered Species and the habitat quality adjacent to and within the San Marcos River down to IH-35 (heaviest recreation zone) as well as prevents public access in undesirable locations which will decrease bank erosion. A zone of prohibitive vegetation along the uppermost edge of the riparian and water quality buffer community will be established to encourage river users to access the river via hardened access points.

Assumptions: Removal of non-native riparian and water quality buffer vegetation (Measure 5.3.8) will occur prior to or simultaneous with Measure 5.7.1 and is funded from the Measure 5.7.1.

Target 2016/Performance Measure: The riparian and water quality buffer areas targeted for remaining years are shown in maps below. Site A was completed in 2015 & Site B will be accomplished in 2016. Remaining gaps along the river, including private lands, will be accomplished in 2017 & 2018.

Site A – 840 linear feet/4,050 square feet

Site B. 3330 linear feet/16,400 square feet

Table 3. List of riparian plants being produced and the propagation methods at the U.S. Fish and Wildlife Service's San Marcos Aquatic Resources Center.

| Plant Species | Common Name | Propagation Method |
|---|---|---|
| *Bacopa caroliniana* | Water hyssop | Cuttings, division |
| *Carex crus-corvi* | Crow-foot caric sedge | Seeds, division |
| *Carex emoryi* | Emory's sedge | Seeds, division |
| *Cephalanthus occidentalis* | Buttonbush | Seeds |
| *Cyperus setigerus* | Lean flatsedge | Seeds, division |
| *Eleocharis montevidensis* | Sand spikerush | Division |
| *Equisetum hyemale* | Horsetail | Cuttings, division |
| *Hydrocotyle* spp. | Pennywort | Division |
| *Juncus texanus* | Texas rush | Cuttings, division |
| *Justicia americana* | American water willow | Division |
| *Leersia oryzoides* | Rice cutgrass | Seeds, seedlings |
| *Marsilea macropoda* | Water clover | Division |

| | | |
|---|---|---|
| *Pluchea odorata* | Purple pluchea | Seeds |
| *Salix nigra* | Black willow | Cuttings |
| *Taxodium distichum* | Bald cypress | Seeds, seedlings |

Table 3. List of terrestrial plants being produced and the propagation methods at the U.S. Fish and Wildlife Service's San Marcos Aquatic Resources Center.

| Plant Species | Common Name | Propagation Method |
|---|---|---|
| *Acer negundo* | Box elder | Seedlings, cuttings |
| *Aesculus pavia* | Red buckeye | Seeds |
| *Andropogon glomeratus* | Bushy bluestem | Seeds |
| *Berberis trifoliolata* | Agarita | Seeds, cuttings |
| *Boehmeria cylindrica* | False nettle | Seeds |
| *Bouteloua curtipendula* | Sideoats grama | Seeds, division |
| *Callicarpa americana* | Beautyberry | Seeds |
| *Campsis radicans* | Trumpet creeper | Division |
| *Carya illinoinensis* | Pecan | Seeds |
| *Celtis canadensis* | Sugarberry | Seedlings |
| *Chasmanthium latifolium* | Broadleaf woodoats | Seeds |
| *Colubrina texensis* | Hog plum | Seeds |
| *Condalia hookeri* | Brasil | Seeds |
| *Cornus drummondii* | Rough leaf dogwood | Seeds |
| *Diospyros texana* | Texas persimmon | Seeds |
| *Ehretia anacua* | Anacua | Seeds, cuttings (?) |
| *Eysenhardtia texana* | Texas kidneywood | Seeds |
| *Fraxinus texensis* | Texas ash | Seeds |
| *Juglans microcarpa* | Texas walnut | Seeds |
| *Juniperus ashei* | Ashe juniper | Seeds |

| | | |
|---|---|---|
| *Mimosa biancifera* | Cats claw mimosa | Seeds |
| *Mimosa borealis* | Pink mimosa | Seeds |
| *Muhlenbergia lindheimeri* | Lindheimer muhly | Seeds, division |
| *Opuntia leptocaulis* | Pencil cactus | Fragments |
| *Opuntia macrorhiza* | Prickly pear cactus | Fragments |
| *Panicum virgatum* | Switchgrass | Seeds, division |
| *Parkinsonia aculeata* | Retama | Seeds |
| *Platanus occidentalis* | Sycamore | Seeds, Seedlings |
| *Populus deltoides* | Cottonwood | Seeds |
| *Prosopis glandulosa* | Honey mesquite | Seeds |
| *Prunus mexicana* | Mexican plum | Seeds, cuttings |
| *Ptela trifoliata* | Wafer-ash | Cuttings |
| *Quercus macrocarpa* | Bur oak | Seeds |
| *Quercus virginiana* | Live oak | Seeds |
| *Rhus virens* | Evergreen sumac | Seeds |
| *Sambucus canadensis* | Elderberry | Seeds, cuttings |
| *Sapindus saponaria* | Western soapberry | Seeds |
| *Schizachyrium scoparium* | Little bluestem | Seeds, division |
| *Sophora secundiflora* | Texas mountain laurel | Seeds, seedlings |
| *Tripsacum dactyloides* | Eastern gamagrass | Seeds, division |
| *Ulmus americana* | American elm | Seeds |
| *Ulmus crassifolia* | Cedar elm | Seeds, seedlings |
| *Ungnadia speciosa* | Mexican buckeye | Seeds, seedlings |

Monitoring: Monitoring will occur monthly to check for re-growth and treat as needed. Success will be measured in two ways: first, (once the fence has been removed) undesirable public access will be surveyed throughout the recreation season; second, riparian and water quality buffer coverage will be measured prior to enhancement efforts and post-completion to determine amount of increased coverage and continued annually to track changes.

Allocated funds for 2016 from Table 7.1: $ 20,000

Transfer funds from Litter Removal (Measure 5.3.3) and Non-native Species Control (Measure 5.3.5): $35,742.70

Estimated Total Budget: $220,000 or $55,000/year

Budget plan: Fund the project over four years (2015 -2018) to cover expenses through the transfer of funds from other measures and the yearly allocation.

The City has provided and will continue to provide all fences to protect the sites as well as game cameras and other security measures as needed to prevent theft, vandalism and unauthorized access. Theft, vandalism and unauthorized access occurred within the two days of the first plantings. Additionally, the City has submitted a FY15 budget request for ongoing maintenance of completed riparian and water quality buffer areas*.

*This budget request was not funded by the City in 2015, so all planting and re-growth control from the headwaters to IH-35 is performed by volunteers.

### 5.3.2/5.4.2 Management of Recreation in Key Areas

Public recreational use of the San Marcos Springs and River ecosystems include, but are not limited to swimming, wading, tubing, boating, canoeing, kayaking, golfing, scuba diving, snorkeling and fishing. To minimize the impacts of incidental take resulting from recreation, the City of San Marcos will implement the Recreation Mitigation Measures adopted by the San Marcos City Council on February 1, 2011 (Resolution 2011-21). The City of San Marcos and Texas State University will enforce these measures (as covered in HCP Section 5.3.2.1) to ensure their success. Section 5.3.2.1 includes multiple educational and public outreach suggestions for implementation:

> *Education of the river user and the community. Suggestions include*:
> a. Signage. Post signage at the City Park tube rental facility, Rio Vista Falls and at proposed hard access points along the river. Signs will have the same template and coloration so they are recognized up and down the river. Signs will cover the rules of the river and educate the public on the importance of the resource. All signs will be bilingual.
>
> b. Video Loop at City Park offering information about the river and safety rules while people are waiting for shuttle or tubes. Possibly also at Rio Vista Falls.
>
> c. Posted maps showing trail, access points, fishing access and other amenities. Include a map at Stokes Park to help inform about the San Marcos River/Blanco confluence.

d. Work with the Tourist Information Bureau to include information on the endangered species and ongoing HCP projects at hotels/restaurants, bed and breakfast facilities, Chamber of Commerce, Visitor's Center, City of San Marcos internet site, etc. along with the recreational information.

e. Park Rangers. Include a section on river biology in the training of the park rangers so they can help disseminate the information.

f. School Outreach. Implement an outreach program for San Marcos Consolidated Independent School District (SMCISD) so this information can be relayed to youth in San Marcos and indirectly to the parents.

g. Overall Interpretation Plan. This would pull all the informational ideas together for conformity, continuity, and implementation.

h. The San Marcos Nature will provides a facility dedicated to inclusion of HCP education and public outreach for the aquifer region.

Long-term Objective: To establish and maintain a trained seasonal conservation resource that will monitor recreational activities and monitor/maintain ongoing HCP measures in and along the San Marcos River while educating the public about the Covered Species and importance of their protection as part of our enforcement obligations under the SSA and HCP measures. To establish an ongoing stream of information to increase public awareness and support.

Target 2016/Performance Measure: Educate the public engaged in water-based recreation on sustainable river use that protects listed species and their habitats. Collect data on recreational activities to determine impacts on listed species and success of HCP measures. The seasonal workers will also conduct miscellaneous cleanup and HCP project maintenance while walking/kayaking.

Methods: The contracted conservation resource will monitor river user activities from Memorial Day weekend to Labor Day weekend on a Wednesday through Sunday schedule. They will also actively engage in public education and outreach about target species and their habitats. In addition, they will collect data on specific recreational activities to provide insights for the HCP programs.

Monitoring: The public will be surveyed annually during the recreation season to assess the level of understanding of Covered Species, ongoing HCP Measures, effectiveness of the public outreach and education program, and the impacts of recreational activities on species and habitat.

Allocated funds for 2016 from Table 7.1: $ 56,000

Estimated Budget: $56,000

### 5.7.6 Impervious Cover/Water Quality Protection

The City of San Marcos and Texas State University will implement a program to protect water quality and reduce the impacts of urbanization based upon the LID/BMP practices. Urban land development tends to increase the intensity of storm water flows and the amount of nonpoint source (NPS) pollution reaching local water resources. Buildings, roads, and other impervious surfaces shed rain more rapidly than areas covered by vegetation, and most typical urban land uses require rapid drainage of storm water. The very rapid, direct connection of developed land across paved surfaces and through drainage conveyances to waterways tends to carry more pollutants more quickly from the land surface to water resources. A number of water quality problems and impairments in Texas are attributed in full or in part to such urban storm water runoff carried through storm sewers and channelized streams. The science committee stated this measure was one of great importance to the success of the EAHCP for listed species protection (May 9, 2013). TSS and nutrients are a concern to the San Marcos River as it is situated in the "fastest-growing small city in the nation". Other than the water quality protection regulations over the recharge zone, the city does not have water quality protection at this time. Addressing water quality is critical to protection of the listed species in a rapidly developing environment.

Long-term Objective: Implement a program that minimizes the impacts associated with urbanization and changes in land use/cover in the Upper San Marcos watershed, manages stormwater as close to its source as possible, treats stormwater as a resource rather than a waste product, emphasizes conservation and the use of on-site features to protect water quality, and increases infiltration to groundwater and aquifer recharge for the protection of riverine integrity.

Target 2016/Performance Measure: Continue the implementation of the Water Quality Protection Plan (WQPP) by Texas State University and City of San Marcos incorporating all jurisdictional watershed areas that directly or indirectly impact Covered Species' critical habitat for the purpose of meeting the goals stated in the long-term objective. Includes public education, staff integration, potential changes to the City's Land Development Code and Stormwater Technical Criteria Manual, potential changes to the University's Master Plan and Construction Standards, designs for retrofit water quality projects, grant proposals, and coordination with ongoing stormwater management plans for city and university.

The WQPP has identified many potential water quality retrofits (constructed water quality controls treating existing development) throughout the City of San Marcos and on the Texas State University campus (133 total). The retrofits analysis is a major component of the master plan for water quality control implementation for both the City and University in that it identifies, models, prioritizes, and recommends cost effective retrofits to be implemented for the foreseeable future - and even provides some preliminary engineering for the most promising.

**Water Quality Protection Plan (WQPP): Proposed Project Spending Plan (2015 – 2019)**

**Legend:** WQPP funds are shown in **black**
WQPP fund serving as a match for the WPP 319-Grant are shown in **brown**
EPA 319-Grant funds are shown in **green**

| Program/Project & Benefits | 2015 ($1000) | 2016 ($1000) | 2017 ($1000) | 2018 ($1000) | 2019 ($1000) | Totals |
|---|---|---|---|---|---|---|
| **Sessom Creek Restoration** | Reduce sediment load to river; minimize future sediment removal | | | | | |
| Prelim design | 30 | 20 | | | | 50 |
| Construction plans/inspection | | 50 | 20 | | | **70** |
| Construction (319 Grant funds) | | | **105** | | | **105** |
| **City Park Retrofit Project** | Build a basin to treat parking lot runoff | | | | | |
| Design | 45 | | | | | 45 |
| Construction inspection | 5 | | | | | 5 |
| **Land Conservation** | Acquire conservation easements in RZ | | | | | |
| Planning | 15 | 5 | 5 | 5 | | **30** |
| WQPP funding | | 20 | 20 | 20 | 20 | **80** |
| 319 Grant Funding | | | | **80** | **80** | **160** |
| **Regional and Large Scale Retrofits*** | Build BMP retrofits to reduce pollutant loads | | | | | |
| Site planning | 40 | | | | | 40 |
| BMP design | | 40 | 120 | 125 | 135 | **420** |
| 319 Grant funded construction | | | **240** | **210** | **215** | **665** |
| BMP construction inspection | | | 10 | 15 | 15 | **40** |
| **Small Scale Retrofits** | Build BMP retrofits to reduce pollutant loads | | | | | |
| Site planning | 30 | | | | | 30 |
| BMP design | | 10 | 5 | 5 | 5 | **25** |
| WQPP funding | | 30 | 20 | 30 | 25 | **105** |
| 319 Grant funding | | | **75** | **75** | **75** | **225** |
| **Land Development Code** | Regulations to reduce pollutant loads from new development | | | | | |
| Code & criteria development | 35 | 25 | | | | 60 |
| **Proposed WQPP (HCP) Funds Spent** | **200** | **200** | **200** | **200** | **200** | **1000** |
| **HCP Table 7.1 WQPP Funding** | **200** | **200** | **200** | **200** | **200** | **1000** |

Match funds for WPP 319 Grant: **$770,000**
319-Grant funding from Match**: **$1,155,000**

* Retrofit BMPs will be designed to encourage enhanced recharge to expand water supplies
** 319-Grant funding will be used to construct water quality retrofits to limit sediment and pollutant discharges to critical habitat

Regardless of whether the 319-Grant funds are awarded to the WPP Program in late 2016, the City and Texas State University are committed to constructing the BMPs in the future.

Preliminary cost estimates and concepts were prepared for 18 retrofits identified as high-potential and their location and cost estimates are listed below:

| Project Name | Location | BMP Type | Cost (Millions) |
|---|---|---|---|
| Purgatory Creek Greenspace | COSM | Biofiltration | $ 6.58 |
| The Big Ditch | COSM | Biofiltration and Conveyance | $ 4.06 |
| Veterans Memorial Park 1 | COSM | Biofiltration | $ 3.19 |
| Wastewater Treatment Plant | COSM | Infiltration Basin | $ 1.52 |
| Spring Lake Preserve | COSM | Biofiltration | $ 1.45 |
| City Park 7 | COSM | Biofilter and Raingarden | $ 0.98 |
| Dunbar Park | COSM | Infiltration Basin | $ 0.84 |
| Hummingbird Hollow | COSM | Biofiltration | $ 0.39 |
| Mariposa Street | COSM | Biofiltration | $ 0.34 |
| Hopkins Channel 2 | COSM | Extended Detention | $ 0.07 |
| Hopkins Channel 1 | COSM | Extended Detention | $ 0.04 |
| Sessom Creek Wetpond / Fish Ponds | TXST | Wet Ponds (x 8) | $ 11.57 |
| Peques Street | TXST | Biofiltration | $ 0.56 |
| The Glade 1 | TXST | Biofiltration and Detention | $ 0.39 |
| Jowers Center 3 | TXST | Raingarden | $ 0.36 |
| The Gulch 2 | TXST | Extended Detention | $ 0.26 |
| Jowers Center 1 | TXST | Biofilter | $ 0.18 |
| Jowers Center 2 | TXST | Rainwater Harvesting | $ 0.11 |
| | | Grand Total | $ 32.9 |

The sum of the average capital costs for all unique projects (excluding multiple scenarios) for the City of San Marcos is approximately $19.5 million while the sum for Texas State University – San Marcos is approximately $13.4 million.

In 2015, the WQPP funded the water quality basin design at the Lion's Club parking lot next to the river, it will be constructed during the summer of 2016, and will treat runoff from a large parking facility that used to drain directly to the river.

Below is a matrix of projects that will be submitted for a $2,000,000 EPA 319 grant using HCP

Methods: City of San Marcos and Texas State University have a contract for the implementation of the developed plan.

Monitoring: N/A

Allocated funds for 2016 from Table 7.1: $200,000

Estimated budget: $200,000

### 5.7.5 Management of Household Hazardous Waste

The City of San Marcos will maintain a Household Hazardous Waste (HHW) program that involves the periodic collection of Household Hazardous Waste Collection (HHWC) and its disposal.

Long-term Objective: Continue to provide a place for citizens of San Marcos and Hays County to safely dispose of HHW.

Assumptions: City of San Marcos will continue its existing program.

Target 2016/Performance Measure: Continue outreach to 1400 participants; contract with two additional part-time personnel to conduct public outreach events and then convert or dispose of the HHW between events. Fund outreach to surrounding communities within the San Marcos River watershed that cannot afford to partner in a HHWC program.

Methods: Open drop-off opportunities two days a week (Tuesday and Friday) from 12:00 noon to 3:30 p.m. to the public. Conduct HHWC events 1 to 2 times per year on a Saturday in north central Hays County. Cover disposal costs for these events.

Monitoring: Track the amount of HHW received and number of participants from San Marcos, Hays County, and surrounding communities. All necessary documentation will be turned in to TCEQ. Identify the HHW that comes from communities with the San Marcos River watershed and the cost of collecting, processing and disposing of HHW from these communities.

Allocated funds for 2016 from Table 7.1: $30,000

Estimated Budget: $30,000

### 5.3.4 Prohibition of Hazardous Materials Transport Across the San Marcos River and Its Tributaries

The City of San Marcos will coordinate with the Texas Department of Transportation to designate hazardous materials routes which minimize the potential for spills into the San Marcos River. This effort will include legislation, if necessary, and additional signage.

Long-term Objective: Reduce the potential of spill of hazardous materials in the San Marcos River and its tributaries.

Assumptions: The primary effort will involve stakeholder engagement, public meetings, and coordination with TXDOT.

Target 2016/Performance Measure: Coordination with TxDOT for the implementation of hazardous materials restrictions and establishment of signage. Contact district office for assistance in this measure.

Methods: Complete checklist provided by TxDOT to establish a hazmat route that all transport routes that cross the San Marcos River and its primary tributaries.

Monitoring: Bi-annual monitoring of hazmat traps on designated roadways to determine functionality and annual monitoring of all installed signage will be accomplished. Substandard conditions will be repaired or replaced as necessary.

Allocated funds for 2016: $ 0

Estimated Budget: $ 0

### 5.7.3 Septic System Registration and Permitting Program

The City of San Marcos will undertake an aerobic and anaerobic septic system registration, evaluation, and permitting program to prevent subsurface pollutant loadings from potentially being introduced to the San Marcos Springs ecosystem within city limits.

Long Term Objective: To continue the registration, permitting and inspection of all new or existing septic systems installed or modified in the City of San Marcos jurisdiction. This has and will continue to be done to ensure compliance of all Texas Commission on Environmental Quality (TCEQ) regulations governing septic systems.

Assumptions: The existing program is adequate to meet the intent of this Measure.

Target 2016/Performance Measure: To have an accurate record of new and existing septic systems installed and modified in city jurisdiction. Also, by ordinance, to have all owners of septic systems connect to municipal sewer lines as they become available.

Methods: It is required by law that all septic systems are permitted by the local Designated Representative (DR), which is the City of San Marcos Environmental Health Department. Plans are submitted with the application and reviewed by the DR for TCEQ compliance. Once these are met, the permit to construct is issued. The design, site evaluation, installation and inspections can only be performed by individual that are licensed by TCEQ. Before the installation or modification is approved, inspections are made by the DR to ensure that the system installed corresponds with the design. Once completed, a license to operate is issued to the property owner by the DR. All DRs are subject to TCEQ Compliance Reviews.

Monitoring: The City of San Marcos Environmental Health Department reviews all applications and inspects the installations of all new and modified septic systems within the City's jurisdiction. The Department also monitors maintenance and responds to all complaints reported or observed.

Allocated funds for 2016: None

Estimated Budget: N/A

### 5.7.4 Minimizing Impacts of Contaminated Runoff

The City of San Marcos will construct two sedimentation ponds along the river to help reduce the amount of contaminated material that enters the river as a result of rain events. The first pond will be located in Veramendi Park beside Hopkins Street Bridge. The second pond will be created by widening the drainage ditches that run alongside Hopkins Street and cut directly to the San Marcos River.

Long-term Objective: Reduce the input of sediment and roadway pollutants into the San Marcos River.

Assumptions: Construction of the proposed sediment retention ponds are funded under Measure 5.7.6.

Target 2016/Performance Measure: Research funding sources for the design and construction of the Best Management Practices (BMPs) to be constructed at Veramendi Park and along Hopkins Street that will reduce total suspended solids (TSS) by 85%. Baseline water quality measurements should be taken prior to BMP installation. Storm water discharge should be re-sampled after BMP installation to measure success.

Methods: A contractor will be retained to research applicable BMP designs and recommend the most economic and efficient methods to control contaminants.

Monitoring: N/A

Allocated funds for 2016: $0

Estimated Budget: See Measure 5.7.6

### 5.4.5 Diversion of Surface Water

Texas State University will curtail its permitted surface water diversions as a function of total San Marcos spring flow to protect the aquatic resources as specified under the HCP flow management strategy. Under TCEQ Certificates 18-3865 and 18-3866, Texas State University's total diversion rate from the headwaters of the San Marcos River for consumptive use is limited to 8.1 cfs (See HCP Section 2.5.5). The total diversion rate from Spring Lake is limited to 4.88 cfs; the total diversion rate from the San Marcos River at Sewell Park is limited to 3.22 cfs (See HCP Section 2.5.5.1 and 2.5.5.2 respectively).

Long-term Objective: Meet diversion restrictions specified under the HCP.

Assumptions: None

Target 2016/Performance Measure: Restriction of surface pumping as specified under the HCP.

Methods: To minimize the impacts of these diversions, when flow at the USGS gauge at the University Bridge reaches 80 cfs, Texas State University will reduce the total rate of surface water diversion by 2 cfs, *i.e.*, to a total of approximately 6.1 cfs. This reduction in pumping will occur at the pump just below Spring Lake Dam in order to maximize the benefits to salamanders, Texas wild-rice, and other aquatic resources in the San Marcos River below Spring Lake Dam. The University will reduce the total rate of surface water diversion by an additional 2 cfs when the USGS gauge reaches 60 cfs. The additional 2 cfs reduction will be made from the pumps located in the slough arm of Spring Lake, and, therefore, maximize the benefits to the aquatic resources within the main stem San Marcos River below Spring Lake Dam. When the USGS gauge reaches 49 cfs, Texas State University will reduce the total diversion rate to 1 cfs. This further reduction will be made by restricting the pumps located in the Sewell Park reach. The diversion of water will be suspended when the springflow reaches 45 cfs.

Monitoring: Pumping rates will be reported on a daily basis when any of the pumping restrictions are in force.

Allocated funds for 2016: $ 0

Estimated Budget: $ 0

### 5.4.7 Diving Classes in Spring Lake

Access to Spring Lake is strictly controlled and regulated in accordance to federal, state and local laws. City ordinance and state law designate the public waters of Spring Lake as restricted to activities authorized by the University. All diving activities in Spring Lake are governed by the Spring Lake Management Plan.

Long-term Objective: Maintain the integrity of the ecology and cultural resources within Spring Lake.

Assumptions: All diving activities in Spring Lake are governed by the Spring Lake Management Plan.

Target 2016/Performance Measure: Implement the diving protocols as outlined in the Spring Lake Management Plan and the Edwards Aquifer HCP Incidental Take Plan.

Methods: The Diving Safety Officer will monitor all diving activities in Spring Lake, assuring all guidelines contained in the Diving Safety Manual for Spring Lake and the EAHCP ITP are observed.

Monitoring: The Lake Manager, with assistance from the Diving Safety Officer, will compile an annual summary of diving activities conducted in Spring Lake and provide to the Diving Control Board for its review.

Allocated funds for 2016: $ 0

Estimated Budget: $ 0

### 5.4.8 Research Programs in Spring Lake

Access to Spring Lake is strictly controlled and regulated in accordance to federal, state and local laws. City ordinance and state law designate the public waters of Spring Lake as restricted to activities authorized by the University. Proposals for research projects in Spring Lake must be submitted to the Environmental Review Committee, through the Lake Manager, for review and approval.

Long-term Objective: Maintain the integrity of the ecology and cultural resources within Spring Lake.

Assumptions: All research activities in Spring Lake are governed by the Spring Lake Management Plan.

Target 2016/Performance Measure: Implement the protocols for research as specified in the Spring Lake Management Plan and the EAHCP ITP.

Methods: 1. Proposals for research projects in Spring Lake must be submitted to the Environmental Review Committee, through the Lake Manager, for review and approval.

Proposals for research projects must be submitted in writing and include:

- Name and contact information of the responsible party conducting the research,
- Purpose and expected outcomes of the activities, including a description of how the project contributes to science,
- Description of activities, including, if appropriate, measures to be taken to minimize any impact on endangered species or their habitat, or any cultural resources found in the lake,
- Methodology, including literature review,
- Type of equipment used, how much; where it will be placed, and for how long it will remain in lake (see Equipment in Lake Section E of the Spring Lake Management Plan)
- Expected impact, and
- Timeline of Project

A copy of the final report and any publications on a research project will be provided to the Lake Manager.

Monitoring: The Lake Manager will compile an annual summary of the research conducted in the lake, including statements on the impact of these activities on the health of the lake.

Allocated funds for 2016: $ 0

Estimated Budget: $ 0

### 5.4.10 Boating in Spring Lake and Sewell Park

Access to Spring Lake is strictly controlled and regulated in accordance to federal, state and local laws. City ordinance and state law designate the public waters of Spring Lake as restricted to activities authorized by the University. All activities involving access to the lake, including glass bottom boat operations, will abide by the rules and intentions of the Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan.

Long-term Objective: Maintain the integrity of the ecology and cultural resources within Spring Lake and San Marcos River.

Assumptions: All boating activities in Spring Lake are governed by the Spring Lake Management Plan and the EAHCP ITP.

Target 2016/Performance Measure: Implement the protocols for boating as specified in the Spring Lake Management Plan in support of the EAHCP ITP.

Methods: Boats (canoe, kayak) used for educational activities, excluding glass bottom boats:

- All boats must be properly washed/disinfected before being placed in lake and once they are removed (see Equipment in Lake in the Spring Lake Management Plan).
- Participants must receive an orientation prior to boating including: instruction on safety, basic boat handling, and on-site rules and regulations. The orientation will cover information specific to Spring Lake's sensitivity and endangered species.
- All boating events must be designed to keep participants away from glass bottom boat operations.

To minimize the impacts of boating on the Covered Species' habitat in Sewell Park, canoeing/kayaking classes in Sewell Park will be confined to the region between Sewell Park and Rio Vista dam. Students will enter/exit canoes/kayaks at specified access points to avoid impacting the flora and fauna along the bank. Classes will be no longer than two hours and up to three classes will be held per day. Classes will have a maximum of 20 students in 10 canoes. All classes will be supervised.

Monitoring: The Lake Manager will compile an annual summary of boating activities conducted on the lake, including statements on the impact of these activities on the health of the lake.

Allocated funds for 2016: $ 0

Estimated Budget: $ 0

### 5.4.9 Management of Golf Course and Grounds

Texas State University will complete a golf course management plan that will document current practices and include an Integrated Pest Management Plan (IPMP). The golf course management plan and IPMP will incorporate environmentally sensitive techniques to minimize chemical application, improve water quality, and reduce negative effects to the ecosystem. Expanded water quality sampling targeted at Golf Course operations will be conducted as described in Section of 5.7.2. of the HCP.

Long-term Objective: Management of the golf course and grounds to minimize and reduce negative effects to aquatic ecosystem in Spring Lake and the San Marcos River.

Assumptions: None

Target 2016/Performance Measure: Continued implementation of the Golf Course Management Plan and Integrated Pest Management Plan.

Methods: The golf course and grounds will be maintained in an aesthetically pleasing, yet environmentally sensitive manner. It is the responsibility of the Golf Course Manager to maintain the course and grounds in accordance with the Integrative Pest Management Plan (IPM). This plan will describe the activities and materials to be used to control pests (i.e. insects, weeds, and other living organisms requiring control) on the golf course in a way that minimally impacts the environment. The IPM will be developed and updated by the Golf Course Manager, in consultation with the Lake Manager and the Environmental Review Committee. The Golf Course Manager will consult with the Lake Manager on any unique situation that may arise outside of routine maintenance that could impact Spring Lake.

Monitoring: Each year the Golf Course Manager will report to the Lake Manager detailed information on maintenance activities and materials used during the year. The water quality monitoring program performed by the Edwards Aquifer Authority will sample for runoff from the golf course.

Allocated funds for 2016: $ 0

Estimated Budget: $ 0

**Protocol for Implementation of HCP Measures Requiring Diving and/or Boating**

All activities in Spring Lake must be submitted to the Spring Lake Environmental Review Committee and/or the Spring Lake Diving Control Board for approval as outlined in the Spring Lake Management Plan. This includes required training and orientation for any diving based activities in Spring Lake by the RSI Diving Safety Officer, using guidelines set out in the RSI Diving Safety Manual for Spring Lake and the San Marcos River. This includes an orientation that covers: instruction on safety, basic boat handling, and on-site rules and regulations. The orientation will cover information specific to Spring Lake's sensitivity, endangered species as well as cultural resources.

All personnel implementing any portion of the HCP for the City of San Marcos and Texas State University will undergo an orientation at the SMARC to ensure awareness of the listed species and safe procedures while working in and along the San Marcos River.

## City of San Marcos and Texas State University- 2016 HCP Budget

| HCP Section | Mitigation Action | 2016 HCP Budget (From Table 7.1) | 2015 HCP Budget | Estimated FY2016 |
|---|---|---|---|---|
| 5.3.1/5.4.1 | Texas Wild Rice Enhancement/Restoration | $125,000 | $178,500 | $166,737 |
| 5.3.6/5.4.4 | Sediment Removal | $25,000 | $223,200 | $193,042 |
| 5.3.8/5.4.3/5.4.12 | Non-Native Plant Species Control | $125,000 | $344,402 | $244,281 |
| 5.3.3/5.4.3 | Management - Floating Vegetation Mats & Litter | $80,000 | $51,298 | $51,298 |
| 5.3.5/5.3.9/5.4.11 /5.4.13 | Non-Native Animal Species Control | $35,000 | $27,960 | $27,959 |
| 5.3.7 | Bank Stabilization/Permanent Access Points | $20,000 | $20,000 | $20,000 |
| 5.7.1 | Native Riparian Habitat Restoration | $20,000 | $55,000 | $55,743 |
| 5.3.2/5.4.2 | Management - Key Recreation Areas | $56,000 | $56,000 | $56,000 |
| 5.7.6 | LID/BMP Management | $200,000 | $200,000 | $200,000 |
| 5.7.5 | Household Hazardous Waste Management | $30,000 | $30,000 | $30,000 |
| | Sessom Creek Sand Bar | $0 | $0 | $0 |
| | **Totals** | **$716,000** | **$1,186,360** | **$1,045,060** |