ATTACHMENT 7

Final

Refugia Review

Edwards Aquifer Habitat Conservation Program

Edwards Aquifer Authority

Comal and San Marcos Springs, Texas

May

2015

Cover Photo Credits

Top photo: Texas blind salamander. Source: Texas Parks and Wildlife
Bottom photo: Fountain darter. Source: USFWS SMNFH&TC

Abbreviations and Acronyms

cfs	cubic feet per second
cm	centimeter(s)
CWA	Clean Water Act
EAA	Edwards Aquifer Authority
EAHCP	Edwards Aquifer Authority Habitat Conservation Plan
EARIP	Edwards Aquifer Recovery Implementation Program
ESA	Endangered Species Act
ft.	feet
GPM	gallons per minute
IH	Interstate Highway
in	inch
ITP	Incidental Take Permit
km	kilometer
m	meter
mi	mile(s)
NPDES	National Pollutant Discharge Elimination System
RAS	recirculating aquaculture systems
SMARC	San Marcos Aquatic Resources Center
SOP	Standard Operating Procedure
TCEQ	Texas Commission on Environmental Quality
U.S.C.	United States Code
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey

Executive Summary

On 18 March 2013, the USFWS approved the EAHCP, which called for the establishment of a comprehensive management plan to protect 11 Covered Species reliant on the Edwards Aquifer. One of the minimization and mitigation measures of the EAHCP is to establish (or support) a series of off-site refugia for these species for the purpose of re-introduction should their habitat be unsuitable due to a catastrophic event, including springflow cessation. This report identifies the infrastructure, space, water, and species expertise necessary to establish the EAA Refugia Program.

Compliance for the EAA Refugia Program will be reviewed by the USFWS Regulatory Division, Austin Ecological Services Office. Requirements for remaining in compliance are not clearly defined, however the framework for compliance should be based on criteria set forth in the EAHCP (and associated ITP) and the Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act (USFWS 2000).

The EAA Refugia Program should be set-up to house three separate stocks for each of the Covered Species. Standing Stock collection, maintenance, and care should begin as soon as a facility has been identified or built that is capable of maintaining these populations. If springflows in the San Marcos and Comal rivers reach Refugia Stock triggers, the EAA Refugia Program and staff should be prepared to collect Refugia Stock to ensure that target numbers for each Covered Species are obtained. If the decline of springflows continues, additional triggers are in place that would result in the initiation of the collection of Salvage Stock.

The habitats and distributions for the surface water and spring habitat associated species are fairly well understood and thus collecting and maintaining target numbers for these species is achievable. Very little information exists for the subterranean aquatic habitat associated species. Achieving target numbers for these species will require significant effort for establishing and monitoring collection traps as well as the frequent “flushing” of these species from the aquifer into the collection traps. Therefore, achieving target numbers for these species will likely require a regular collection effort for the duration of the EAA Refugia Program.

Refugia infrastructure requirements identified within this report should be considered preliminary and the minimum likely to be necessary based on currently available species information. As future studies become available, such as genetics research and genetic management plans, this EAA Refugia Program should be prepared to adjust the total number of specimens needed as well as the number of management units for each Covered Species.

The EAA Refugia Program should also be designed and managed to include redundant effort at a minimum of two locations. Standing Stock, Refugia Stock, and Salvage Stock target numbers and captive populations should be divided between the main facility and redundant facility. The division of these numbers can remain flexible and should be managed in consultation with the USFWS.

There are many risks associated with operating a refugia program for federally listed species that should be considered. Maintaining populations in an artificial environment comes with

inherent risks of human error and mechanical failure. Should such error or failure result in significant mortality of one or more of the Covered Species, compliance with the ITP could be called into question. Additionally, species knowledge that will affect the refugia operations is still considered in development for most of the Covered Species and thus the program should be prepared to adapt facilities, stock numbers, and species focus throughout the duration of the program.

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1. Introduction

Beginning in 2006, the United States Fish and Wildlife Service (USFWS) initiated the assembly of stakeholders throughout the Edwards Aquifer region to participate in a recovery implementation program focused on development of a plan to contribute to the recovery of the federally listed species dependent on the Edwards Aquifer. This process is referred to as the Edwards Aquifer Recovery Implementation Program (EARIP). In May of 2007, the Texas Legislature directed the Edwards Aquifer Authority (EAA) and certain other state and municipal water agencies to participate in the EARIP and to prepare a USFWS-approved Edwards Aquifer Habitat Conservation Plan (EAHCP) by 2012 for managing the Edwards Aquifer to preserve the federally listed species dependent upon the Comal and San Marcos springs and rivers. The EAHCP and an accompanying Incidental Take Permit (ITP) application were submitted to the USFWS on 20 July 2012 and approved by the USFWS on 18 March 2013. The ITP can be renewed, but will expire on 31 March 2028. EAHCP permittees include: EAA, The City of New Braunfels, The City of San Marcos, The City of San Antonio (acting by and through its San Antonio Water System Board of Trustees), and Texas State University.

The goal of the EAHCP is to protect the federally listed species during the most severe drought to the extent required by state law (Edwards Aquifer Authority Act) and Federal law (Endangered Species Act). The EAHCP and ITP identify a variety of covered activities for EAHCP permittees and stakeholders along with conditions and management actions that must be implemented in order to remain compliant with the EAHCP and ITP. As part of the EAHCP minimization and mitigation measures and the adaptive management program, the EAA is required to establish (or support) a refugia program as a minimization and mitigation measure to preserve the capacity for the Covered Species to be re-established in the event of the loss of population due to a catastrophic event such as the unexpected loss of springflow or a chemical spill.

Sections 2.2.3 and 5.1.1 of the EAHCP identify the establishment (or support) of the refugia program as a minimization and mitigation measure to contribute to the recovery of the EAHCP Covered Species. Section 6.4 of the EAHCP identifies Core Adaptive Management Actions and outlines adaptive management process actions to protect habitat and populations of Covered Species in both the Comal and San Marcos spring/river ecosystems in the event of unexpected loss of springflow. One of the adaptive management process options identifies proposed triggers for an off-site refugia for species covered under the EAHCP and ITP. While certain aspects of the EAHCP call for protection of these federally listed species within their associated habitats, the possibility remains that an off-site refugia would be necessary for the continued survival, and eventual re-introduction, of these federally listed species should aquifer levels and springflows decrease to levels that warrant salvage of in-situ populations.

Condition K of the ITP states the following: “The EAA will support and coordinate with the U.S. Fish and Wildlife Service (Service) on the work relating to the San Marcos Aquatic Resources Center’s operation and maintenance of a series of off-site refugia at the Service’s San Marcos, Uvalde, and Inks Dam facilities (Section 6.4 of the EAHCP). The support of the refugia will augment the existing financial and physical resources of these facilities, and provide

supplementary resources for appropriate research activities, as necessary, to house and protect adequate populations of Covered Species and expanded knowledge of their biology, life histories, and effective reintroduction techniques. The use of this support will be limited to the Covered Species in the EARIP (EAHCP)."

1.1 Purpose of Study

Since the approval of the EAHCP and ITP, certain aspects of the EAA entering into a contract with the USFWS for the operation of the refugia have been called into question. In 2014, the EAA submitted a request of opinion to the Texas Attorney General's Office to clarify the legality of three aspects of the EAA contracting with the USFWS for off-site refugia under Condition K of the ITP and Section 6.4 of the EAHCP. In order to be prepared for an alternative plan in December 2014, the EAA requested an amendment to Condition K of the ITP allowing for the permittees to develop a refugia program with contractors other than the USFWS. This amendment was approved by the USFWS on 21 January 2015. With the acceptance of this amendment, Condition K of the ITP currently reads as follows: "The EAA will support, and coordinate with the U.S. Fish and Wildlife Service (Service) on, a series of off-site refugia (Section 6.4 of the EAHCP). The support of the refugia will augment the existing financial and physical resources of the Service and provide supplementary resources for appropriate research activities, as necessary, to house and protect adequate populations of Covered Species and expanded knowledge of their biology, life histories, and effective reintroduction techniques. The use of this support will be limited to the Covered Species in the EARIP EAHCP."

On 9 March 2015 the Texas Attorney General issued an opinion stating that "a court is likely to conclude" in favor of the EAA entering into a contract with USFWS. Although this ruling provided clarity regarding the EAA entering into a contract with the USFWS for the refugia program, the EAA has decided to proceed with issuing a Request For Proposal to allow for a competitive process for the procurement and establishment of an EAA Refugia Program for the Covered Species.

The purpose of this report is to identify refugia requirements for the federally listed and petitioned species covered under the EAHCP and the associated ITP. Refugia requirements discussed in this report are primarily based on requirements identified in the EAHCP, the USFWS San Marcos/Comal/Edwards Aquifer Rare, Threatened, and Endangered Species Contingency Plan (USFWS 1996a), and the Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act (USFWS 2000). Refugia requirements discussed in this report include the following:

- **Section 2** Covered Species: descriptions, known life cycle information necessary for maintaining refugia populations, and identification of data gaps that should be the focus of future research efforts for maintaining refugia populations;
- **Section 3** Stages of Refugia Implementation: management units for each Covered Species; total numbers needed and implementation triggers for each Covered Species needed at each stage of refugia implementation; and quarantine considerations for incoming populations;

- **Section 4** Refugia Requirements: infrastructure; personnel needs to operate refugia, permits, water quality and quantity needs, and other refugia requirements; and
- **Section 5** Summary and discussion.

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2. Covered Species

Covered Species in the EAHCP include seven species that are currently listed as endangered by the USFWS, one species that is currently listed as threatened by the USFWS, and three species that are currently proposed for listing as threatened or endangered. Of the seven federally listed endangered species covered under the EAHCP, one of these species, the San Marcos gambusia *(Gambusia georgei)*, has not been observed since 1983 and is now believed to be extirpated (McKinney and Sharp 1995). Therefore, refugia populations will be maintained for six of the federally endangered species: Comal Springs dryopid beetle *(Stygoparnus comalensis)*, Comal Springs riffle beetle *(Heterelmis comalensis)*, fountain darter *(Etheostoma fonticola)*, Peck's cave amphipod *(Stygobromus pecki)*, Texas blind salamander *(Eurycea rathbuni)*, and Texas wild-rice *(Zizania texana)*. The San Marcos salamander (*Eurycea nana*) is listed as a federally threatened species and thus warrants coverage and refugia populations in accordance with the EAHCP. The three proposed species that warrant coverage and refugia populations are the Edwards Aquifer diving beetle *(Haideoporous texanus)*, Texas troglobitic water slater *(Lirceolus smithii)*, and the Comal Springs salamander (*Eurycea* sp. 8). The listing status, listing dates, and distribution of these species are summarized in **Table 2-1**.

Captive populations of the federally listed endangered and threatened species are currently being maintained at the USFWS San Marcos Aquatic Resources Center (SMARC [formerly the San Marcos National Fish Hatchery and Technology Center]). Research for maintaining captive populations has taken place at this facility for varying time frames, dependent upon the species. The USFWS has documented Standard Operation Procedures (SOPs) concerning culture protocols for Peck's cave amphipod and Comal Springs riffle beetle (USFWS 2014a), fountain darter (USFWS 2012a), Eurycea salamander (USFWS 2011a), and arthropods (USFWS 2011b). These general procedures support experimental research and are periodically reviewed for accuracy and completeness building on the most current, scientifically valid information available. Additionally, captive populations and life history research has occurred at various zoos and academic institutions for some of these species. In order to identify the refugia requirements for the Covered Species, HDR reviewed publications that focused on species needs in a refugia setting along with standard operating procedures (SOPs) for the federally listed species at SMARC. For some of these species, very little is known regarding the life history and reference resources for maintaining captive populations are limited. In these instances surrogate species were identified and used to describe captive population requirements.

Detailed species accounts, distributions, and habitat associations are well documented in the EAHCP. Additionally, on-going studies associated with the EAHCP are further enhancing the knowledge of these species within their respective habitats. Therefore, the purpose of this section is not to re-iterate these species needs within their natural environments, but rather to describe these species requirements in order to maintain populations of these species in a captive refugia setting. Refugia requirements for each species are further detailed in **Appendix A**.

Table 2-1. Regulatory Summary of the Eleven Covered Species Under the Edwards Aquifer Habitat Conservation Plan and the U.S. Fish and Wildlife Incident Take Permit No. TE63663A-02

Common Name	Scientific Name	Taxonomy	ESA Listing Status	Federal Register Notice	Geographic Distribution	Critical Habitat Designation
Fountain darter	*Etheostoma fonticola*	Fish	Endangered	October 13, 1970 (35 FR 16047)	Aquatic ecosystems of both Comal and San Marcos Springs	July 14, 1980 (45 FR 47355)
San Marcos gambusia	*Gambusia georgei*	Fish	Endangered	July 14, 1980 (45 FR 47355)	Upper San Marcos River; not observed since 1983	July 14, 1980 (45 FR 47355)
Texas wild-rice	*Zizania texana*	Plant	Endangered	April 26, 1978 (43 FR 17910)	Aquatic ecosystems associated with San Marcos Springs	July 14, 1980 (45 FR 47355)
San Marcos salamander	*Eurycea nana*	Amphibian	Threatened	July 14, 1980 (45 FR 47355)	Aquatic ecosystems associated with San Marcos Springs	July 14, 1980 (45 FR 47355)
Comal Springs Salamander	*Eurycea sp. 8*	Amphibian	Petitioned[3]	N/A Critically imperiled	Comal Springs	N/A
Comal Springs riffle beetle	*Heterelmis comalensis*	Insect	Endangered	December 18, 1997 (50 FR 66295)	Aquatic ecosystems of both Comal and San Marcos Springs	October 23, 2013 (78 FR 63100)
Texas blind salamander	*Eurycea rathbuni*	Amphibian	Endangered	March 11, 1967 (32 FR 4001)	Edwards Aquifer near San Marcos Springs	No published habitat rules
Peck's cave amphipod	*Stygobromus pecki*	Crustacean	Endangered	December 18, 1997 (50 FR 66295)	Edwards Aquifer near Comal Springs and Hueco Springs	October 23, 2013 (78 FR 63100)
Comal Springs dryopid beetle	*Stygoparnus comalensis*	Insect	Endangered	December 18, 1997 (50 FR 66295)	Edwards Aquifer near Comal Springs and Fern Bank Springs	October 23, 2013 (78 FR 63100)
Texas troglobitic water slater	*Lirceolus smithii*	Crustacean	Petitioned[3]	N/A	San Marcos Springs; artesian well on Texas State University campus	N/A
Edwards Aquifer diving beetle	*Haideoporus texanus*	Insect	Petitioned[3]	N/A Critically imperiled	Comal Springs; artesian well near San Marcos Springs	N/A

[1] Source: Edwards Aquifer Authority at http://www.eahcp.org/
[2] Source: 2012 Final Environmental Impact Statement; 2013 EAHCP Annual Report
[3] Under review for 12-month finding

2.1 Species Descriptions

As is typical of large karst spring systems, the headwaters of the Comal and San Marcos rivers exhibit a degree of physical stability (e.g., low turbidity, water clarity, temperature, current velocity, discharge, and levels of dissolved materials) seldom seen in other Texas streams. As previously mentioned, this section provides a description of the Covered Species residing in the springs, spring-fed streams, caves, subterranean caverns, or other open cavities of the Edwards Aquifer in Hays and Comal Counties (**Table 2-1**). Six of the protected species are associated with surface waters that emanate from the aquifer. The remaining five species reside within the aquifer and have been collected in springs, caves, or artesian wells, likely as a result of being flushed from subterranean habitats. In the event of decreased springflows, species that occupy surface water would be the most vulnerable to extirpation. Therefore, the following section is organized into two categories of species: Surface water and spring aquatic habitat species; and subterranean aquatic habitat species. As further discussed in **Section 3.1**, implementation of the EAA Refugia Program should be prioritized by the species most vulnerable to the loss of natural habitat as well as USFWS listing status.

2.1.1 Spring and Surface Water Aquatic Habitats

The spring-dominated nature of both the San Marcos River/Springs and Comal River/Springs can be greatly affected by severe drought and groundwater pumping from the Edwards Aquifer. Since the 1950s, the natural conditions of extended drought occurrence are often combined with a growing human presence and associated groundwater production, thereby exacerbating drought consequences in terms of spring discharge. The following species have adapted to the clear spring-fed water, relatively uniform flow rates, and constant year-round temperature conditions provided by both ecosystems.

FOUNTAIN DARTER (*ETHEOSTOMA FONTICOLA*)

Photo: USFWS San Marcos NFH&TC

The fountain darter is endemic to the San Marcos and Comal rivers in central Texas. This fish species is listed as endangered under the Federal Endangered Species Act (ESA) (35 FR 16047) and critical habitat was designated on 14 July 1980 (45 FR 47355). Critical habitat includes all reaches of the river from Spring Lake and its outflow downstream to a point approximately 0.5 mile (mi) (0.8 kilometer [km]) below the Interstate Highway (IH) 35 bridge (**Table 2-1**). No critical habitat has been designated in the Comal River system. Historically, the fountain darter occurred in the San Marcos River from Spring Lake downstream to a point approximately 0.5 mi (0.8 km) below its confluence with the Blanco River and from the headwaters of the Comal River to its confluence with the Guadalupe River (Schenck and Whiteside 1976).

Fountain darters are diminutive, but robust, fish usually reaching a length of 1.5 inch (in) (35.5 millimeters [mm]) and generally exhibit a relatively simple 1-2-year life cycle. Mostly olive-green

or reddish brown in color, up to 16 rectangular mid-lateral blotches may be present with three distinct small basicaudal spots and dark orbital bars. Small wedge-shaped dots are abundant on the dorsum and sides, but absent on the belly. During breeding season, males have a red submarginal band in the spiny dorsal, but are not brightly colored (Kuehne and Barbour 1983).

Presently, fountain darters reside in the upper Comal River, including Landa Lake, and the San Marcos River between Spring Lake and the City of San Marcos wastewater treatment plant outfall (McKinney and Sharp 1995; Schenck and Whiteside 1976; Saunders et al. 2001; BIO-WEST 2002 – 2013a, b). They prefer vegetated stream-floor habitats with a constant water temperature (Schenck and Whiteside 1976). BIO-WEST (2011) noted the influence of the different patterns and spatial distribution of aquatic vegetation types on fish densities in the Comal Spring/River ecosystem. Fountain darters are more prevalent in the more heavily vegetated areas comprised of bryophytes *(Riccia fluitans)* and filamentous algae (*Rhizoclonium* sp.) where amphipods, their primary food source, are also abundant. They are also observed in lesser numbers surrounding patches of *Ludwigia* sp. and *Cabomba* sp. while occasionally venturing into areas of *Hygrophila polysperma*, *Ceratopteris thalictroides*, *Vallisneria americana*, and *Sagittaria platyphylla*. They are seldom seen in open areas lacking submergent vegetation (BIO-WEST 2011). Juveniles prefer heavily vegetated backwater habitat with low to negligible velocities.

The fountain darter primarily feeds on copepods, aquatic insect larvae, and amphipods (McKinney and Sharp 1995; Schenck and Whiteside 1977a). The nutritional requirements and quantity of food required change with fish size and age, season, and food source availability. Available data on the reproductive cycle of wild fountain darters show evidence of year-round spawning (Strawn 1955, Hubbs 1985), while Schenck and Whiteside (1977b) suggest that some seasonality in reproductive activity exists. The natural mortality rates for each life stage (egg, larval, juvenile, and adult) are provided by laboratory and field studies (Brandt et al. 1993; Bonner et al. 1998). Bonner et al. (1998) describes the effects of temperature between 20 and 25 degrees Celsius on egg production and early stages of the fountain darter life cycle.

The SMARC and collaborators have learned much about the life history and environmental requirements of this species through the development of culture techniques (Brandt et al. 1993; Labay and Brandt 1994; Simon et al. 1995; Schaefer 2000). Since 2000, an abundance of habitat use information for this species has been collected during EAA's ongoing Variable Flow Study Program (BIO-WEST 2002 – 2013a,b) and the recently approved EAHCP Biological Monitoring Program initiated in early 2013 (BIO-WEST 2014 – 2015a,b).

The 1956 drought was thought to extirpate the population in the Comal River (Schenck and Whiteside1976). The Comal population was re-established in 1975 and 1976 with 500 individuals from the San Marcos River, and fountain darters are now found in the river from Landa Lake downstream to its confluence with the Guadalupe River. Linam et al. (1993) conducted a population survey in 1991, resulting in an estimated population of about 168,078 individuals. Population estimate studies have also been conducted on the San Marcos River below Spring Lake (Schenck and Whiteside 1976, Linam 1993).

The fountain darter is vulnerable to the gill trematode *(Centrocestus formosanus)* in the Comal and San Marcos river ecosystems. The invasive red-rimmed melania *(Melanoides tuberculatus)*

is reported to be a well-adapted immediate host since this exotic snail is common in both rivers. The Green Heron *(Butorides virescens)* and the great egret *(Ardea alba)* have been identified as definitive hosts (Mitchell 2005). The presence of the red-rimmed melania in both localities is important to correlate the trematode parasite, but represents more of a threat in the Comal River where infestations in the darter are found at a higher level.

There are a total of eight established management units for the fountain darter; four each on both river systems. The segments of the San Marcos River encompassed by the four units starting upstream at Spring Lake include: 1) Spring Lake to Aquarena Springs Drive; 2) City Park from Aquarena Springs Drive to Rio Vista Dam; 3) Rio Vista Dam to Cape's Dam, and 4) the lower river reach between Cape's Dam and the Blanco River confluence. The Comal River is also subdivided into four units: 1) Upper Spring Run; 2) Landa Lake; 3) Old River Channel; and 4) New River Channel. The USFWS developed SOPs concerning experimental culture protocols for this fish (USFWS 2012a).

SAN MARCOS GAMBUSIA (*GAMBUSIA GEORGEI*)

The San Marcos Gambusia is listed as endangered under the Federal ESA and critical habitat was designated on 14 July 1980 (45 FR 47355). The critical habitat includes all reaches of the San Marcos River from the State Highway 12 bridge extending downstream to approximately 0.5 mile (0.8 km) below the IH 35 bridge (**Table 2-1**). Historically, this restricted-range species were found in very low numbers in the river with early collections randomly recorded only as the "San Marcos Springs" (USFWS 1996b).

Photo: Dr. Robert Edwards (UTPA)

Two primary factors leading to the decline of this species can be traced to habitat modification after introduction of non-native elephant ear *(Colocasia asculenta)* (USFWS 1996b) and to hybridization with the western mosquitofish *(Gambusia affinis)* first recognized by Hubbs and Peden (1969). As of 1983, collections showed hybridized individuals becoming more prevalent in the river indicating increased competitive interactions, significant genetic strain, and stress on the remaining native populations (USFWS 1996b). Multiple attempts to locate this species since 1983 have not led to its rediscovery leading many to suspect this species may be extinct (Johnson and Hubbs 1989; McKinney and Sharp 1995). Thus, this species will not be a part of the EAA Refugia Program. Should the San Marcos gambusia be re-discovered, the program should be prepared to incorporate this species into the EAA Refugia Program.

TEXAS WILD-RICE (*ZIZANIA TEXANA*)

Photo: Guadalupe-Blanco River Authority

On 26 April 1978, Texas Wild-rice was listed as a federally threatened species under the ESA (43 FR17910) (**Table 2-1**). The proposed rule to designate critical habitat on 19 March 1980 (45 FR 17888) for this endemic plant species was completed by the USFWS on 14 July 1980 (45 FR 47355). According to USFWS (2012b), the area encompassed by the designated critical habitat amounts to approximately 62 acres (253,000 square meters [m^2]) of the upper San Marcos River.

This aquatic perennial grass is known only from the upper San Marcos River in Hays County. Since 1933, its abundance has been significantly reduced. In 1976, this species was restricted to 1.5 mi (2.4 km of river with an areal coverage of 1,352 square yards (1,131 m^2) (43 FR17910). The "area of vegetative dominance" determined by measurements taken during 1978, 1980, and 1986 showed a decline of areal coverage with measured areas of 1,179 yds^2 (986 m^2), 908 yds^2 (760 m^2), and 542 yd^2 (454 m^2), respectively (45 FR 47355). Texas Parks and Wildlife Department estimated the areal extent of Texas wild-rice coverage from 1,200 yd^2 (1,004 m^2) in 1989 to 5,973 yd^2 (4995 m^2) in 2012 (USFWS 2013). Recent estimates for coverage during surveys conducted by BIO-WEST in 2011, 2012, and 2015 were reported as 4,391.7 yds^2 (3,671.6 m^2), 5,222.9 yds^2 (4,367.1 m^2), and >7,415 yd^2 (6,200 m^2), respectively.

This is a monoecious plant, having male and female flowers appearing on the same panicles or flowering stems. This species has exacting habitat requirements and is restricted to the upper 3 mi (4.9 km) section of river extending downstream of the headwaters (Tolley-Jordan and Power 2007). This plant occupies shoreline habitat areas of quiet waters adjacent to deeper swift stream flow immediately away from the water's edge. Poole and Bowles (1999) found that Texas wild-rice was found in habitats with higher water velocities compared to sites sampled that lacked Texas wild-rice. The plant grows mostly in submerged clear water of constant temperature in depths ranging from 1 ft (0.3 meters [m]) to 6.6 ft (2.0 m), except for the emergent flowering head (rice seed), which ascends 1 ft (0.3 m) to 2 ft (0.6 m) above the water surface. Texas wild-rice is characterized by long linear leaves measuring up to 3.3 ft (1 m) in length and 1 in. (25 mm in width (Terrell et al. 1978, Poole and Bowles 1999). Texas wild-rice produces new plants either sexually by seeds or asexually by stolons (Emery and Guy 1979). Flowers may emerge year round but peak reproductive activity occurs in March through June (USFWS 1996b, Poole and Bowles 1999).

Other native species that occur in Spring Lake and the upper San Marcos River with Texas wild-rice include pondweed *(Potamogeton illinoensis)*, watercelery (*Vallisneria* sp.), arrowhead *(Sagittaria platyphylla)*, hornwort *(Ceratophyllum demersum)*, elodea *(Egeria densa)*, and water primrose *(Ludwigia repens)*. Non-native species that have become more common in this area

include Brazilian waterweed (*Egeria densa*), East Indian hygrophila *(Hygrophila polysperma)*, and hydrilla *(Hydrilla verticillata)*.

Once abundant throughout the river, the presence of Texas wild-rice has diminished primarily to habitat degradation and competition with non-native plants such as the elephant ear and a newly recognized competitor, the water trumpet *(Cryptocoryne beckittii)*. Water recreation has had measurable adverse effects on this species through swimming, tubing, boating, and dog activities (Breslin 1997) and by the intensity of recreational use in the river under different stage of flow (Bradsby 1994). This type of usage has thought to factor in restriction and interference of the plant reproduction process (USFWS 1996b).

The 11 management units designated for the Texas wild-rice extending downstream include: 1) Spring Lake Dam to Aquarena Springs Drive; 2) Aquarena Springs Drive to Hopkins Street; 3) Hopkins street to Playscape; 4) Playscape to Rio Vista Dam; 5) Rio Vista Dam to Ramon Lucio Park; 6) Ramon Lucio Park to IH-35; 7) IH-35 to Cape's Dam; 8) Cape's Dam to upper gauging station; 9) upper gauging station to Cape's Street; 10) Cape's Street to convergence with irrigation channel outflow; and 11) convergence with irrigation outflow to the San Marcos wastewater treatment plant.

SAN MARCOS SALAMANDER (*EURYCEA NANA*)

Photo: Texas Parks and Wildlife Department

The Spring Lake population of the San Marcos salamander was listed as endangered under the Federal ESA and critical habitat was designated on 14 July 1980 (45 FR 47355). Its historic and current habitat is the same as its critical habitat (**Table 2-1**).

The San Marcos salamander is strictly aquatic occurring only in Spring Lake of the San Marcos River and a short section of the river downstream of Spring Lake. It prefers spring areas with a substrate of sand and gravel interspersed with large limestone boulders. In shallow water, the large boulders provide substrate for lush patches of aquatic moss. Typically blue-green algae mats occur between these boulders providing protective cover while foraging on amphipods, aquatic insects, and snails.

The San Marcos salamander has a slender body shape with short legs, four toes on its fore feet and five toes on its hind feet (Campbell 1995), a finned tail, light-colored external gills, small eyes encircled by dark rings, and 16 or 17 costal grooves. Adults reach a size of 1.5 to 2 in. (3 to 5 centimeters [cm]) in total length and are characterized by light brown with small yellow spots arranged in a straight line running down each side of the back and a pale yellow and a translucent ventral surface.

A population collected in the Comal River was previously though conspecific with the San Marcos salamander but is now determined to be a distinct species (Chippindale et al. 1992,

1993, 1994). The USFWS has developed an SOP concerning experimental culture protocols for this salamander (USFWS 2011a).

The six currently recognized San Marcos salamander management units include: 1) Hotel Area to downstream of Johnny Weismuller Spring in Spring Lake;, 2) upstream of Diversion Springs to downstream of Ossified Forest in Spring Lake; 3) upstream of Big Riverbend to the confluence of Slough Arm;4) confluence of Slough Arm to Spring Lake Dam; 5) Spring Lake Dam to the confluence of river channels (old dam spillway); and 6) Spring Lake Dam to the confluence of river channels (Ice House Spillway).

COMAL SPRINGS SALAMANDER (*EURYCEA* SP. OR *EURYCEA* SP. 8)

Photo: BIO-WEST, Inc.

According to USFWS (2015), the current listing status for the Comal Springs salamander is undefined, no conservation plans have been created, and no petition findings or critical habitat rules have been published (**Table 2-1**). No new information on vulnerability and threats is available to reassess the need for listing. This species is covered by the EAHCP which recognizes this species could become listed as threatened or endangered in the future.

Sweet (1978) found this population to exhibit a set of characteristics similar to the San Marcos salamander and presumed they were perhaps conspecific although geographically isolated. However, biochemical, molecular, and morphometric research (Chippindale et al. 1992, 1993, 1994) to more fully address their species status eventually indicated that the salamander found from the Comal Springs is a distinctly separate species.

Observations for presence/absence during 2014 were conducted in April and during the critical period months of July, August, September, and October (BIO-WEST 2014 – 2015a). Ten timed surveys were conducted in Spring Run 1, Spring Run 3, Spring Run 6 (Spring Island), and an upwelling along the east side of Spring Island. A total of 290 salamanders were recorded from the four locations, of which 44 percent of the total numbers were observed at Spring Run 3. There were fewer salamanders to observe as this study noted an apparent decline in total numbers at all localities when compared to similar data collected between 2001 and 2013.

Monthly variation of salamanders detected was most likely reflective of the decrease in the average daily river discharge recorded for each site visit. The temporary cessation springflow affected the surface distribution and dispersal distance away from each of the main orifices as previously available wetted areas evaporated. Limited mechanisms for dispersal may increase the vulnerability of this species due to its inability to freely move when habitat loss or degradation occurs during decreases in spring flow.

Though proven distinct from the San Marcos salamander, identification of this species appears to be problematic requiring more highly specialized knowledge. It has been described in a Federal listing as Eurycea sp. 8 but has yet been officially recognized or named (USFWS 2009).

The USFWS has developed a written SOP document concerning experimental culture protocols for this salamander (USFWS 2011a).

There is little information on the diet, feeding habits, population dynamics, and reproductive capabilities of the Comal Springs salamander. This information may be assumed from the closely related San Marcos salamander. Therefore, additional molecular genetic information is still needed to help determine taxonomic resolution and geographic distribution of this salamander and its relationship to other Eurycea populations.

COMAL SPRINGS RIFFLE BEETLE (*HETERELMIS COMALENSIS*)

Photo: Texas Parks and Wildlife Department

The Comal Springs riffle beetle was listed as endangered under the ESA on 18 December 1997 (50 FR 66295) and critical habitat proposed on 17 July 2007 (72 FR 39248) (**Table 2-1**) went through two revisions on 19 October 2012 (77 FR 64272) and 2 May 2013 (78 FR 25679) before designating areas of revised critical habitat on 23 October 2013 (78 FR 63100). The original designation was a total of 30.3 acres (ac) (12.3 hectares [ha]) of surface critical habitat. The revised designation now consists of 54 ac (22 ha) of surface critical habitat in the Comal River/Springs ecosystem.

Historical accounts show this surface-dwelling species to be present from Comal Springs and San Marcos Springs (Barr 1993; Arsuffi 1993). After documentation from both spring systems, this species was only found in the primary Comal Spring-runs (1, 2, and 3) prior to 2002. BIO-WEST (2002 – 2013a) began documenting and detailing their semi-annual and critical period observations of the local population and confirmed an extended range boundary to the spring upwellings underlying Landa Lake and Spring Island. Collection efforts during 2014 (BIO-WEST 2014 – 2015a) showed species presence in areas previously reported at Spring Run 3, the western shoreline of Landa Lake ("Western Shoreline") and Spring Island (BIO-WEST 2002 – 2013a). Similar to other Covered Species monitored during 2014, the counts and densities for this species were generally lower than past surveys (BIO-WEST 2014 – 2015a).

This aquatic beetle is a member of the Elmidae family. Adults are very small, reddish brown crawling beetle that range in size from 0.06 to 0.08 in. (1.7 to 2.1 mm) in total length and are incapable of flying as a result of short and non-functional hind wings (Bosse et al. 1988). Aquatic beetles usually have numerous instar stages during their larval development; the number produced by this species is unknown (Brown 1987). Since their ability to disperse is poor they rely on plastron respiration. This mechanism involves a mass of tiny, hydrophobic hairs that function as a gill to allow breathing underwater through the diffusion of dissolved oxygen into the plastron. The USFWS has developed an SOP document concerning experimental culture protocols for this species (USFWS 2014a).

Little is known about the diet of larvae and adults but like many other elmid species they are most likely collector-gatherers and scrapers that forage on algae and detritus. The Comal Springs riffle beetle has been assigned to two population management units, the Comal Springs

and the San Marcos Springs. To obtain quantitative description of the life cycle, genetic research will likely be required on the number of larvae in each instar, the timing of oviposition, the number of eggs laid, the timing of pupation, and the number of adults.

2.1.2 Subterranean Aquatic Habitats

The subterranean aquatic habitats associated with the Edwards Aquifer supports a diverse subterranean aquatic ecosystem. Vertebrates and macroinvertebrates have been found in the aquifer at depths ranging from 190 to 2,000 ft (58 to 510 m) in the artesian parts of the aquifer (PPAI 1994). The several springs found in Comal and Hays counties support populations of many species that are restricted to, and dependent on, spring habitats and the surface and subsurface components of karst landscapes. Karst habitats are highly inter-connected and complex ecosytems and contain cave-dwelling terrestrial fauna known as troglobites; the aquatic fauna are referred to as stygobites. Both are organisms that are uniquely adapted to these subterranean environments having reduced pigment and eyesight, and spend their entire lives underground. This type of adaptation is not uncommon in constant temperature spring habitats, and may go even farther, to endemism, wherein a species may be entirely restricted to a particular spring or spring orifice. This section addresses the endangered Texas blind salamander and two unlisted invertebrate species in the EAHCP permit area that are likely to be listed within the foreseeable future or possibly within the life of the Permit. These animals require high humidity and often require stable temperatures that exist in karst caves and other karst features. All three of these endangered karst invertebrates have a limited known range, but are known to inhabit small Edwards limestone caves.

TEXAS BLIND SALAMANDER (*EURYCEA RATHBUNI*)

The Texas blind salamander is listed as endangered under the Federal ESA (32 FR 4001) on 11 March 1967, but critical habitat has not yet been formally designated (**Table 2-1**). The presence of this species has been well documented from the subterranean waters of the San Marcos area in Hays County including Ezells' Cave, San Marcos Spring, Rattlesnake Cave, Primer's Fissure, Texas State University's artesian well, and Frank Johnson's well (Russell 1976; Longley 1978).

Photo: Texas Parks and Wildlife Department

The species is often found in its larval or paedomorphic adult forms (sexually mature adult with juvenile characteristics); both forms have bright red external gills and are restricted to aquatic environments. They are only found above ground when water flow brings them to the surface. This is a slender, long-limbed, sightless salamander with a large flattened head and snout that reaches a maximum total length of 4.7–5.0 in (12–13 cm). Its diet consists of insects and a variety of other small invertebrates such as amphipods, snails, and shrimp. Larvae and adults do not have lungs and breathe through their permeable, translucent skins, which is white or pale pink in color. It has elongated limbs with and four toes on its fore feet and five toes on its hind feet, 12 costal grooves and a finned tail tapering at the tip.

As stated in October 2012 (USFWS 2012b), a review was being conducted regarding the potential revision of the recognized range of this species to include springs and wells associated with the Edward aquifer in Comal County, including Panther Canyon Well and Comal Springs (USFWS 2012b) and to date is incomplete.

The USFWS has developed an SOP document concerning experimental culture protocols for this salamander (USFWS 2011a). The 13 management units selected for the Texas blind salamander are: 1) Texas State University Well; 2) Sessom Creek; 3) lower Sessom Creek;4) Diversion Spring; 5) Spring Lake Well outflow; 6) Johnson's Well; 7) Primer's Fissure;8) Rattlesnake Cave; 9) Rattlesnake Well;10) Ezell's Cave;11) Wonder Cave;12) Mission Valley Bowling Well; and 13) Panther Canyon Well.

PECK'S CAVE AMPHIPOD (*STYGOBROMUS PECKI*)

Photo: Texas Parks and Wildlife Department

The Peck's cave amphipod was designated as endangered by the USFWS on 18 December 1997 (50 FR 66295) and critical habitat proposed on 17 July 2007 (72 FR 39248) (**Table 2-1**) went through two revisions on 19 October 2012 (77 FR 64272) and 2 May 2013 (78 FR 25679) before designating areas of revised critical habitat on 23 October 2013 (78 FR 63100). Originally, the surface critical habitat consisted of 38.5 ac (15.6 ha) without subsurface. The revised designation including habitat in Comal Springs and Hueco Springs now stands at 138.4 ac (5.16 hectares) of surface and 138 ac (56 ha) of subsurface critical habitat.

The amphipod, *Stygobromus pecki*, is mostly associated with deep subterranean environments. This spring-endemic species is limited in range and occurs at Comal Springs, Landa Lake, Hueco Springs and a monitoring well in Panther Canyon (Krejca 2005; Gibson et al. 2008). The shrimp-like crustacean is considered exclusively subterranean due to its morphology due to its lack of eyes and body pigment where it is known from (springheads and a well). The extent this amphipod moves within the gravel interstitial spring habitat is poorly understood as little information is available regarding spatial movement or measuring distance away from the two central spring outlets or utilizing other subterranean components of the aquifer and springs system.

Pennak (1989) suggests their diet is omnivorous consisting of dead vegetation and biofilm attached to submerged surfaces while functioning as a scavenger and a detritovore. Very little is known of its reproductive history and lifespan. Reproduction using captive stock in aquaria at SMARC has resulted in limited and intermittent reproduction (USFWS 2012b).

The Peck's cave amphipod population has been separated into three management units. They are: 1) Comal Springs;2) Hueco Springs; and 3) Panther Canyon Well. Slow progress is being made in the development of culture techniques. The USFWS has developed an SOP concerning experimental culture protocols for this amphipod (USFWS 2014a).

There is little information on the specific dietary, habitat, life history, movement limitations, and reproductive needs of the Peck's cave amphipod. This information may be assumed from other species of similar amphipods with a subterranean life cycle. It is also unclear on the vagility (ability to move) of this species. Studies may need to concentrate in the less than ideal habitats downstream and away from the spring where they normally are encountered

COMAL SPRINGS DRYOPOID BEETLE (*STYGOPARNUS COMALENSIS*)

The Comal Springs dryopid beetle was declared endangered by the USFWS on 18 December 1997 (50 FR 66295) and critical habitat proposed on 17 July 2007 (72 FR 39248) (**Table 2-1**) went through two revisions on 19 October 2012 (77 FR 64272) and 2 May 2013 (78 FR 25679) before designating areas of revised critical habitat on 23 October 2013 (78 FR 63100). Originally, the surface critical habitat consisted of 39.5 ac (16 ha) without subsurface. The revised designation now covers 39.4 ac (15.56 ha) of surface and 139 ac (56 ha) of subsurface critical habitat at the Comal River/Springs ecosystem.

Photo: Joe Fries, USFWS San Marcos NFH&TC

This stygobiontic beetle, a member of the Family Dryopidae (long-toed water beetles), is a small slender and oblong insect having elongate legs with a body length of 0.12 to 0.16 in (3 to 4 millimeters). They are generally aquatic as adults and terrestrial (sometimes semi-aquatic) as larvae. All are poorly pigmented with a translucent thin skin and rudimentary eyes. Adults are usually a reddish-brown color while immature individuals are characterized by a light yellowish-brown tone (Barr and Spangler 1992). The egg, larva, pupa and adult forms have yet been fully described as the mating behavior and life stage history is also unknown. Several adults and larvae of this species have been collected at Comal Springs Run 2, and Fern Bank Springs but specific microhabitat preferences for each are unclear and unknown. Although their feeding habits are not fully understood, this species is probably a scraper feeding on periphyton and biofilm left on rocky and woody surfaces by a combination of algae, detritus, bacteria and other microorganisms. These beetles are active near the water surface, where they trap and form oxygen bubbles to exploit for staying submerged for long periods of time (Arsuffi 1993). This species is presumed to have a rather restricted geographic range occupying areas near spring openings or in the interstitial zones of karstic subterranean waters (Barr and Spangler 1992).

The Comal Springs dryopid beetle has one established management unit: Comal Springs. As previously mentioned, very little is known regarding the natural history of this troglobitic dryopid as described by Barr and Spangler (1992). More research will be needed to understand the complexity of finding this non-swimming species, whose larvae supposedly are believed to be terrestrial, in a subterrranean setting (Barr and Spangler (1992). No Comal Springs dryopid beetles were collected during the EAHCP Biological Monitoring Program in 2014.

There is little information on the on the populations size, mating behavior, genetic variability, reproductive capabilities, and juvenile and adult feeding habits of the Comal Springs dryopid beetle. This information may be assumed from other species of similar stygobiontic beetles with

a subterranean life cycle but will be needed to ensure a viable and sustaining population in Comal Springs. The USFWS has developed a written SOP document concerning experimental culture protocols for this salamander (USFWS 2011).

TEXAS TROGLOBITIC WATER SLATER (*LIRCEOLUS SMITHII*)

This species has no defined status although the Service "determined that substantial information was presented in a petition to indicate that the listing of this species may be warranted due to the present or threatened destruction, modification, or curtailment of its habitat or range resulting from Edwards Aquifer drawdowns and decreasing water quality" (USFWS 2009). This species is covered by the EAHCP which recognizes this species could become listed as threatened or endangered in the future (**Table 2-1**).

The management unit locations set for the Texas troglobitic water slater are San Marcos Springs and Texas State University Well. There is little information on the natural life history of the Texas troglobitic water slater. This information may be assumed from one of six described species in Texas within the genus *Lirceolus* (Krejca 2005). This species is part of monitoring and applied research efforts directed toward federally listed species and those covered by the EAHCP. No Texas troglobitic water slater individuals were collected during the EAHCP Biological Monitoring Program in 2014 (BIO-WEST 2014 – 2015b).

Owing to the paucity of information on the life history and population dynamics, its uncommon presence in the wild and the growing potential need to protect this vulnerable species, further research will be required for adequate management.

EDWARDS AQUIFER DIVING BEETLE (*HAIDEOPORUS TEXANUS*)

The Edwards Aquifer diving beetle has no defined status although the USFWS "determined that substantial information was presented in a petition to indicate that the listing of this species may be warranted due to the present or threatened destruction, modification, or curtailment of its habitat or range resulting from Edwards Aquifer drawdowns and decreasing water quality" (USFWS 2009). It is a petitioned species that is actively being considered for listing as endangered or threatened and carries no procedural or substantive protections under the ESA. This species known to occur in Comal Springs and an artesian well in the San Marcos River located on the Texas State University campus is covered by the EAHCP which recognizes this species could become listed as threatened or endangered in the future (**Table 2-1**).

This diving beetle has a suite of adaptations to permanent subterranean life, as it lacks functional eyes and wings with reduced body pigment and body toughness. It is elongate, oval, with a maximum length of less than 0.5 in. (1.3 cm). The two management units selected for the Edwards Aquifer diving beetle are Comal Springs and Texas State University Well. This species is part of monitoring and applied research efforts directed toward federally listed species and those covered by the EAHCP. No Edwards Aquifer diving beetle individuals were collected during the EAHCP Biological Monitoring Program in 2014 (BIO-WEST 2014 – 2015b).

Information gaps include the distribution of the species, reliance on subterranean habitats, life history, habitat associations, threats to the species, and efficacy of alternative spring buffer widths in maintaining animals and habitat conditions.

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3. Stages of Refugia Implementation

The establishment of a refugia program at the USFWS SMARC was initiated by the San Marcos/Comal/Edwards Aquifer Rare, Threatened, and Endangered Species Contingency Plan of 1996 (USFWS 1996a), hereinafter referred to as the Contingency Plan. The Contingency Plan addressed the initial set-up of captive populations and set criteria for various phases of specimen collection for the following Covered Species: fountain darter; Texas wild-rice; Texas blind salamander; San Marcos salamander; Comal Springs salamander; and the Comal Springs riffle beetle (USFWS 1996a). Collection target numbers and the number of contingency phases, along with the habitat triggers for each phase, vary depending on the species or group of species.

For instance, the Contingency Plan identifies three phases for the fountain darter (**Table 3-1**): Phase I calls for the immediate establishment of standing stock to serve as protection against unexpected catastrophic events that could lead to extirpation in the wild; Phase II calls for the establishment of refugium stock to serve as protection when springflow declines threaten the continued existence of populations in their natural habitats; and Phase III calls for the collection and maintenance of salvage stocks when habitat conditions have degraded to the point that large die-offs of fountain darters in the wild are likely. Conversely, the Contingency Plan identifies four phases for the covered salamander species (**Table 3-2**): Phase I calls for the immediate establishment of breeding stocks in order to establish captive breeding techniques; Phase II calls for the establishment of back-up stocks once phase I target numbers have been achieved; Phase III calls for supplemental collections at low flows if Phase I and II target numbers have not been achieved; and Phase IV calls for the collection of jeopardy or salvage individuals (USFWS 1996a). Additionally, while certain discharge triggers are discussed for the collection and salvage of Texas wild-rice and the Comal Springs riffle beetle, implementation phases and target numbers are not clearly defined.

Table 3-1. Fountain Darter Triggers and Target Numbers for Each Phase Identified in the USFWS Contingency Plan (USFWS 1996a)

Species (River)	Phase I		Phase II		Phase III	
	Trigger	Target #	Trigger	Target #	Trigger	Target #
Fountain darter (Comal)	ASAP	500 (300 at SMARC and 200 at Uvalde)	< 50 cfs for 4 days	500 at SMARC, supplementing Uvalde stock as needed	When die-offs in the wild are likely	≤ 2,000
Fountain darter (San Marcos)	ASAP	650 (450 at SMARC and 200 at Uvalde)	< 75 cfs for 4 days	500 at SMARC, supplementing Uvalde stock as needed		

Source: USFWS 1996a

Table 3-2. Salamander Triggers and Target Numbers for Each Phase Identified in the USFWS Contingency Plan (USFWS 1996a)

Species	Phase I and II		Phase III		Phase IV	
	Trigger	Target #	Trigger	Target #	Trigger	Target #
Texas blind salamander (San Marcos)	ASAP	300-500	< 105 cfs	If Phase I and II target numbers have not been achieved, additional collections should be made to ensure that ≥ 100 individuals are being maintained as breeding stock and back-up populations are in good condition	When die-offs in the wild are likely	≤ 2,000
San Marcos salamander (San Marcos)	ASAP	300-500	< 105 cfs	If Phase I and II target numbers have not been achieved, additional collections should be made to ensure that ≥ 100 individuals are being maintained as breeding stock and back-up populations are in good condition	When die-offs in the wild are likely	≤ 2,000
Comal Springs salamander (Comal)	ASAP	300-500	< 105 cfs	If Phase I and II target numbers have not been achieved, additional collections should be made to ensure that ≥ 100 individuals are being maintained as breeding stock and back-up populations are in good condition	When die-offs in the wild are likely	≤ 2,000

Source: USFWS 1996a

Despite the inconsistencies in terminology, the implementation of the EAA Refugia Program should be considered a three phase approach and should be built, staffed and equipped to handle three stocks of Covered Species populations, hereafter referred to as ”Standing Stock”, “Refugia Stock”, and “Salvage Stock.”

For the purpose of this report the Contingency Plan target numbers and triggers were used along with genetic studies, biological monitoring efforts, the EAHCP and other supporting documents to determine target numbers and triggers for the EAA Refugia Program. As a general rule, target numbers for Standing Stock sufficiently cover both Standing Stock and Refugia Stock, whereas Salvage Stock target numbers are considered separate. Triggers for collecting Refugia Stock will consider an assessment of Standing Stock numbers along with conditions within the Edwards Aquifer and the San Marcos and Comal rivers. Division of Standing Stock and Refugia Stock will depend upon the successful implementation of a genetics management plan.

Criteria that would trigger the collection or increase of the Standing Stock, Refugia Stock and Salvage Stock vary by stock and species. A comprehensive table that displays the triggers and target numbers for each stage of refugia implementation is displayed in **Appendix A, Table A-1**. This section discusses these triggers by their respective stocks along with prioritizing species based on the level of threat and legal protection afforded to each species. Furthermore, this section discusses and provides recommendations for the collection of specimens and the buildup of Standing Stock target numbers.

3.1 Standing Stock and Refugia Stock

Standing Stock is defined as the populations held in the refugia to ensure the continued existence of the Covered Species in the event that wild populations cease to exist due to a catastrophic event. Catastrophic events could be instantaneous, such as a chemical spill into the aquifer or rivers, or predictable and thus allowing time to react, such as spring flow declines. This section provides further guidance for the development of Standing Stock for each species.

The targeted numbers for Standing Stock vary by species and are based on genetic analysis or on the "50:500 rule" when genetic analysis is not available or inconclusive. According to USFWS (2000), the controlled propagation must consider and implement management practices that maintain genetic integrity for endangered species being held in captivity. Genetic analysis is on-going for seven of the 11 Covered Species: fountain darter, Texas wild-rice, Texas blind salamander, San Marcos salamander, Peck's cave amphipod, Comal Springs riffle beetle, and Comal Springs dryopid beetle. Until genetic studies are sufficiently comprehensive to develop a genetics management plan, the target numbers and management units should be based on the best available data. Additionally, the EAA Refugia Program should be prepared to adapt specimen numbers and management units as new genetic analysis becomes available. Current target numbers for Standing Stock are compiled in **Table 3-3**.

Table 3-3. Standing Stock Target Numbers for Each EAHCP Covered Species

Species	Common name (system)	Targeted Number
	Plants	
Zizania texana	Texas wild-rice (San Marcos River)	430[a]
	Fish	
Etheostoma fonticola	Fountain darter (San Marcos River)	1,000[b]
	Fountain darter (Comal River)	1,000[c]
	Salamanders	
Eurycea rathbuni	Texas blind salamander	500[c]
Eurycea nana	San Marcos salamander (San Marcos River)	500[c]
Eurycea sp. 8	Comal Springs salamander (Comal River)	500[c]
	Invertebrates	
Heterelmis comalensis	Comal Springs riffle beetle (Comal River)	500[c]
Stygobromus pecki	Peck's cave amphipod	500[c]
Stygoparnus comalensis	Comal Springs dryopid beetle (Comal River)	500[c]
Lirceolus smithii	Texas troglobitic water slater (Comal River)	500[c]
Haideoporus texanus	Edwards Aquifer diving beetle (Comal River)	500[c]

Sources: [a] Wilson 2013; [b] Phillips et al 2013; [c] USFWS 2014b;

Achieving target numbers will prove to be more difficult for some of the Covered Species. For instance, locations are well known and relatively easy to reach for spring and surface water habitat associated species. Collecting these species is attainable with active capture methods, with the exception of the Comal Springs riffle beetle. Therefore, achieving target numbers for these species could be accomplished with a large initial effort and supplementary collection over time to maintain target numbers. Collecting subterranean aquatic species involves the passive capture at springs, wells, caves and fissures. Therefore, achieving target numbers for these species will likely take a consistent effort over a long period of time. By successfully achieving target numbers for some species prior to the declining springflows the EAA Refugia Program would be able to avoid acting in haste when increased collection triggers are met. This would allow personnel to focus efforts on some species rather than all Covered Species. Additionally achieving and maintaining target numbers for some species will demonstrate the ability to successfully operate the Refugia Program in lieu of not meeting targets for the more elusive species.

Furthermore, in the event that aquifer level declines threaten springflows in the San Marcos and Comal rivers, species associated with spring and surface water habitats would be the most at risk of becoming extirpated in the wild. While information regarding their subsurface distributions is limited, subterranean aquatic species may be able to retreat into the aquifer as springflows drop below the spring outlets of these rivers. Hence, priority should be given to the spring and surface water habitat associated species during Standing Stock development. Therefore, the development of Standing Stocks should begin as soon as a facility is capable of maintaining and caring for the Covered Species.

Collection sites for subterranean aquatic species should be equipped with traps to be regularly checked and specimens transported to the refugia facility to be identified. Collection of surface water and spring habitat associated species should be conducted in a manner that will achieve target numbers as soon as refugia infrastructure (i.e., quarantine procedures) allows.

Collection sites or river segments (hereinafter referred to as management units) in which populations in the refugia should be held in separate rearing systems are also based on genetic analysis, when available. When genetic analysis is not available management units are based on historical collection site distribution.

The intensity of Refugia Stock collection efforts will vary based on three criteria: the species to be collected; Standing Stock numbers for the species; and the looming threat level of a catastrophic event compromising the species existence in the wild. The triggers that will result in increased intensity of the collection of Refugia Stock for all species are compiled in **Table 3-4.** These triggers are not clearly defined in the EAHCP or the Contingency Plan (USFWS 1996a). Therefore, these triggers were deduced as approximate guidelines based on the review of the EAHCP, the Contingency Plan (USFWS 1996a), and Biological Monitoring Program annual reports (Bio-West 2014 – 2015a, b), amongst other literature. These triggers are further discussed below by species or groups of species.

Table 3-4. Refugia Stock Increased Collection Triggers for Each EAHCP Covered Species

Species	Common name (system)	Increased Collection Triggers	Target Numbers
	Plants		
Zizania texana	Texas wild-rice (San Marcos River)	< 120 cfs	430 minus Standing Stock
	Fish		
Etheostoma fonticola	Fountain darter (San Marcos River)	< 80 cfs	1,000 minus Standing Stock
	Fountain darter (Comal River)	< 150 cfs	1,000 minus Standing Stock
	Salamanders		
Eurycea rathbuni	Texas blind salamander (San Marcos River)	< 105 cfs	500 minus Standing Stock
Eurycea nana	San Marcos salamander (San Marcos River)	< 120 cfs	500 minus Standing Stock
Eurycea sp. 8	Comal Springs salamander (Comal River)	< 120 cfs	500 minus Standing Stock
	Invertebrates		
Heterelmis comalensis	Comal Springs riffle beetle (Comal River)	< 120 cfs	500 minus Standing Stock
Stygobromus pecki	Peck's cave amphipod (Comal River)	< 30 cfs	500 minus Standing Stock
Stygoparnus comalensis	Comal Springs dryopid beetle (Comal River)	< 30 cfs	500 minus Standing Stock
Lirceolus smithii	Texas troglobitic water slater (Comal River)	< 50 cfs	500 minus Standing Stock
Haideoporus texanus	Edwards Aquifer diving beetle (Comal River)	< 30 cfs	500 minus Standing Stock

3.1.1 Spring and Surface Water Aquatic Habitats

FOUNTAIN DARTER (*ETHEOSTOMA FONTICOLA*)

Populations of fountain darters in the wild and refugia (SMARC) were analyzed for genetic diversity by Phillips (et al. 2013). The results of this study indicate that the refugia population of fountain darters should be approximately 1,000 individuals. This study also suggests that fountain darters may not need to be separated by management units and that a refugia population of the Comal River fountain darter population may be unnecessary. The report suggests that additional genetic studies are necessary in order to build upon this initial research and implement these findings into the management of refugia populations (Phillips et al. 2013). As such, utilizing the best available information and considering the inconclusiveness of current genetics reports fountain darter populations in the EAA Refugia Program should include approximately 1,000 specimens from the Comal River and approximately 1,000 specimens from the San Marcos River (Phillips et al. 2013, USFWS 2014b, personal communication K. Ostrand). While Phillips (et al. 2013) suggests that fountain darters may not need to be separated based on genetics, for the purpose of biosecurity these fountain darter populations should be kept in separate rearing units. These units should be based upon the river reaches identified in the EAHCP biological monitoring program and are identified in **Table 3-5**.

Table 3-5. Standing Stock Numbers and Management Units for the Fountain Darter

# of Management Units	Management Unit Names and Locations[a]	Specimen #'s
4 (San Marcos River)[a]	Spring Lake : Spring Lake to Aquarena Springs Drive	~ 250
	City Park: Aquarena Springs Drive to Rio Vista Dam	~ 250
	I-35: Rio Vista Dam to Cape's Dam	~ 250
	Lower River (Todd Island/Cypress Tree): Cape's Dam to the Blanco River confluence	~ 250
	Total	**1,000[b]**
4 (Comal River)[b]	Upper Spring Run	~250
	Landa Lake	~250
	Old Channel	~250
	New Channel	~250
	Total	**600[c]**

Sources: [a] Bio-West 2014 – 2015a,b; [b] Phillips et al 2013; [c] USFWS 2014b;

Collection of Standing Stock for fountain darters can occur at any time and achieving Standing Stock numbers would be based on the collection effort levels and success rates of actively capturing specimens in the wild. The level of effort to collect fountain darters could be reduced by combining this effort with the EAHCP biological monitoring program since this program involves the catch and release of fountain darters. If Standing Stock target numbers have not been achieved when Refugia Stock triggers are reached within the San Marcos and Comal rivers collection efforts should increase in order to achieve these numbers. For the San Marcos River population of the fountain darter these increased collection efforts should be considered when the San Marcos River U.S. Geological Survey (USGS) gauge (USGS 08170500) reads <80 cubic feet per second (cfs). For the Comal River population of the fountain darter these increased collection efforts should be considered when the Comal River USGS gauge (USGS 08169000) reads < 150 cfs. These triggers coincide with the EAHCP biological monitoring programs increased inspection efforts of the fountain darter. In order to conduct this effort the Standing Stock should be evaluated in order to identify which segments require additional specimens to achieve targeted Refugia Stock numbers.

TEXAS WILD-RICE (*ZIZANIA TEXANA*)

Populations of Texas wild-rice in the wild and in the refugia (SMARC) were analyzed for genetic diversity in 2012-2013 by Wilson (2013). The findings of this study are still in the draft form, however sufficient information is available within this report to identify initial Standing Stock numbers, management units, and Standing Stock numbers for each management unit. These numbers are outlined in **Table 3-6**. This report was specifically prepared for SMARC and thus took into consideration holding capacity within current SMARC facilities (Wilson 2013). As such, total Standing Stock numbers (430 plants) may be different for the EAA Refugia Program and thus percentages of total Standing Stock numbers may be utilized to develop the appropriate specimen numbers for each management unit. Additionally, as further genetic analysis becomes available the EAA Refugia Program should be prepared to adapt Standing Stock numbers and management units for Texas wild-rice.

Table 3-6. Standing Stock Numbers and Management Units for Texas wild-rice

Management Units	Management Unit Names and Locations*	# of Specimens per Management Unit	% of Refugia Stock
10	A: Spring Lake Dam to Aquarena Springs Drive	50	12%
	B: Aquarena Springs Drive to Hopkins Street	205	48%
	C: Hopkins Street to Playscape	68	16%
	D: Playscape to Rio Vista Dam	10	2%
	E: Rio Vista Dam to Ramon Lucio Park	8	2%
	F: Ramon Lucio Park to I-35	60	14%
	G: I-35 to Cape's Dam	5	1%
	H: Cape's Dam to upper gauging station	5	1%
	I: Upper gauging station to Cape's Street	0	0%
	J: Cape's Street to convergence with irrigation channel outflow	13	3%
	K: Convergence with irrigation outflow to waste water treatment plant	6	1%
Total		**430**	**100**

* Location boundaries are approximate. Exact locations should be confirmed through consultation with USFWS.
Source: Wilson 2013

Collection of Refugia Stock for Texas wild-rice can occur at any time and achieving Standing Stock numbers would be based solely on the input of effort since the locations of this species are well known. If Standing Stock target numbers have not been achieved when Refugia Stock triggers are reached within the San Marcos River collection efforts should increase in order to achieve these numbers. These increased collection efforts should be considered when the San Marcos River USGS gauge (USGS 08170500) reads < 120 cfs. This trigger coincides with the EAHCP biological monitoring programs increased mapping and visual inspection efforts of Texas wild-rice. In order to conduct this effort the Standing Stock should be evaluated in order to identify which segments require additional specimens to achieve targeted Refugia Stock numbers.

SAN MARCOS SALAMANDER (*EURYCEA NANA*)

Populations of San Marcos salamanders in the wild and refugia (SMARC) were analyzed for genetic diversity by Lucas (et al. 2009). The main focus of this study was to provide a baseline of information regarding the level of genetic variation and structure across the species range (Lucas et al. 2009). Thus, this study does not suggest a total number of individual specimens necessary in captivity to ensure a genetically viable population. Therefore, the minimum number of San Marcos salamanders should be 500 specimens, based on the 50:500 rule. This study did indicate that genetic variation amongst sampled individuals across its range is insignificant; and therefore, there is no genetic reason to separate San Marcos salamanders by collection site in a refugia setting (Lucas et al. 2009). Since this was an initial study, further genetic research is recommended and the refugia populations should be separated for the purpose of bio-security the San Marcos salamander refugia population should kept in four to six separate rearing systems. These systems can be based on historical collection sites in **Table 3-7**. Four systems could be utilized by combining management units 1a and 1b into one unit and combining management units 4a and 4b into one management unit.

Table 3-7. Standing Stock Numbers and Management Units for the San Marcos salamander

# of Management Units	Management Unit Names and Locations*	Specimen #'s
6	1a: Hotel Area to downstream of Johnny Weismuller Spring (Spring Lake)	~83
	1b: Upstream of Diversion Springs to downstream of Ossified Forest (Spring Lake)	~83
	2: Upstream of Big Riverbed to confluence of Slough Arm	~83
	3: Confluence of Slough Arm to Spring Lake Dam	~83
	4a: Spring Lake Dam to confluence of river channels (old dam spillway)	~83
	4b: Spring Lake Dam to confluence of river channels (Ice House Spillway)	~83

Sources: [a] USFWS 2013

* Location boundaries are approximate. Exact locations should be confirmed through consultation with USFWS.

Collection of Standing Stock for San Marcos salamanders can occur at any time and achieving Standing Stock numbers would be based on the collection effort levels and success rates of actively capturing specimens in the wild. The level of effort to collect San Marcos salamanders could be reduced by combining this effort with the EAHCP biological monitoring program since this program involves the catch and release of San Marcos salamanders. If Standing Stock target numbers have not been achieved when Refugia Stock triggers are reached within the San Marcos River collection efforts should increase in order to achieve these numbers. These increased collection efforts should be implemented when the San Marcos River USGS gauge (USGS 08170500) reads < 80 cfs. These triggers coincide with the EAHCP biological monitoring programs increased inspection efforts of the San Marcos salamanders. In order to conduct this effort the Standing Stock should be evaluated in order to identify which segments require additional specimens to achieve targeted Refugia Stock numbers.

COMAL SPRINGS SALAMANDER (*EURYCEA* SP. 8)

Genetic studies of the Comal Springs salamander are not currently available. Therefore, the minimum number of Comal Springs salamanders should be 500 specimens, based on the 50:500 rule. Until genetic studies provide conclusive evidence that suggest a lack of genetic diversity within its range all refugia specimens of the Comal Springs salamander should be held in separate rearing units based on their collection/monitoring sites in order to maintain genetic integrity. **Table 3-8** provides a list of all collection/monitoring sites for the Comal Springs salamander.

Table 3-8. Standing Stock Numbers and Management Units for the Comal Springs salamander

# of Management Units	Management Unit Names and Locations	Specimen #'s
4	Spring Run 1 (Comal River)	500
	Spring Run 3 (Comal River)	
	Spring Run 6 (Spring Island [Comal River])	
	Spring Island East Outfall (Comal River)	

Sources: [a] Bio-West 2014 – 2015a

Collection of Standing Stock for Comal Springs salamanders can occur at any time and achieving Standing Stock numbers would be based on the collection effort levels and success rates of actively capturing specimens in the wild. If Standing Stock target numbers have not been achieved when Refugia Stock triggers are reached within the Comal River collection efforts should increase in order to achieve these numbers. These increased collection efforts should be implemented when the Comal River USGS gauge (USGS 08169000) reads < 120 cfs. These triggers coincide with the EAHCP biological monitoring programs increased inspection efforts of the Comal Springs salamanders. In order to conduct this effort the Standing Stock should be evaluated in order to identify which segments require additional specimens to achieve targeted Refugia Stock numbers.

COMAL SPRINGS RIFFLE BEETLE (*HETERELMIS COMALENSIS*)

Genetic studies of the Comal Springs riffle beetle are not currently available. Therefore, the minimum number of Comal Springs riffle beetle should be 500 specimens, based on the 50:500 rule. Until genetic studies provide conclusive evidence that suggest a lack of genetic diversity within its range all refugia specimens of the Comal Springs riffle beetle should be held in separate rearing units based on their collection/monitoring sites in order to maintain genetic integrity. **Table 3-9** provides a list of all collection/monitoring sites for the Comal Springs riffle beetle.

Table 3-9. Standing Stock Numbers and Management Units for the Comal Springs riffle beetle

# of Management Units	Management Unit Names and Locations[a]	Specimen #'s
2	Comal Springs San Marcos Springs	500

Sources: [a] Gibson et al. 2008

Collection of Standing Stock for the Comal Springs riffle beetle will involve trapping beetles using cotton lures at known collection sites. If Standing Stock target numbers have not been achieved when Refugia Stock triggers are reached within the Comal River collection efforts should increase in order to achieve these numbers. These increased collection efforts should be implemented when the Comal River USGS gauge (USGS 08169000) reads < 120 cfs. These triggers coincide with the EAHCP biological monitoring programs increased inspection efforts of the Comal Springs riffle beetle. In order to conduct this effort the Standing Stock should be evaluated in order to identify which segments require additional specimens to achieve targeted Refugia Stock numbers.

3.1.2 Subterranean Aquatic Habitats

TEXAS BLIND SALAMANDER (*EURYCEA RATHBUNI*)

Genetic studies of the Texas blind salamander are not currently available. Therefore, the minimum number of Texas blind salamanders should be 500 specimens, based on the 50:500 rule. Until genetic studies provide conclusive evidence that suggest a lack of genetic diversity within its range all refugia specimens of the Texas blind salamander should be held in separate rearing units based on their known collection sites in order to maintain genetic integrity. **Table 3-10** provides a list of all collection sites and some potential collection sites for the Texas blind salamander. Some of these sites are historical and are no longer considered suitable for the collection.

Table 3-10. Standing Stock Numbers and Management Units for the Texas blind salamander

# of Management Units	Management Unit Names and Locations	Specimen #'s
13	Texas State University Well[a]	500
	Sessom Creek[a]	
	Lower Sessom Creek[a]	
	Diversion Spring[a]	
	Spring Lake Well outflow[a]	
	Johnson's Well[a]	
	Primer's Fissure[a]	
	Rattlesnake Cave[a]	
	Rattlesnake Well[a]	
	Ezell's Cave[b]	
	Wonder Cave[b]*	
	Mission Valley Bowling Well[c]**	
	Panther Canyon Well[c]**	

Sources: [a] USFWS 2014c; [b] USFWS 1996a; [c] USFWS 2013;
* Historical site, no longer considered suitable (Longley 1978)
**Potential Site, no known records

Collection of Standing Stock for Texas blind salamanders will involve trapping salamanders at current and historic collection locations. The USFWS has agreements in place with Texas State University and other land owners that allows for the setting and checking of traps and collection of Texas blind salamanders at these wells, springs and caves. Agreements between these well, spring, cave and landowners along with USFWS will have to be in place in order to begin the collection of Texas blind salamanders at these locations. Specimens collected at springs, creeks, and wells are considered "salvage organisms" because they are lost from the aquifer population whether they are collected or not (USFWS 1996a). The collection from caves and fissures would remove these salamanders from the aquifer population. Collections at these locations should be done in consultation with Texas Parks and Wildlife and USFWS, along with other species technical experts (USFWS 1996a).

If Standing Stock target numbers have not been achieved when Refugia Stock triggers are reached within the San Marcos River collection efforts should increase in order to achieve these numbers. These increased collection efforts should be implemented when the San Marcos River USGS gauge (USGS 08170500) reads < 105 cfs (USFWS 1996a). In order to conduct this effort the Standing Stock should be evaluated in order to identify which segments require additional specimens to achieve targeted Refugia Stock numbers.

PECK'S CAVE AMPHIPOD (*STYGOBROMUS PECKI*), COMAL SPRINGS DRYOPID BEETLE (*STYGOPARNUS COMALENSIS*), TEXAS TROGLOBITIC WATER SLATER (*LIRCEOLUS SMITHII*), AND EDWARDS AQUIFER DIVING BEETLE (*HAIDEOPORUS TEXANUS*)

Genetic studies are currently not available for the Peck's cave amphipod, Comal Springs dryopid beetle, Texas troglobitic water slater, and the Edwards Aquifer diving beetle. Therefore, the minimum number of for these invertebrates should be 500 specimens for each species, based on the 50:500 rule. Until genetic studies provide conclusive evidence that suggest a lack

of genetic diversity within their ranges all refugia specimens of these invertebrates should be held in separate rearing units based on their collection/monitoring sites in order to maintain genetic integrity. **Table 3-11** provides a list of all collection/monitoring sites for these invertebrates.

Table 3-11. Standing Stock Numbers and Management Units for the Peck's cave amphipod, Comal Springs dryopid beetle, Texas troglobitic water slater, and Edward's Aquifer diving beetle

Species		# of Management Units[a]	Management Unit Locations[b]	Specimen #'s
Peck's cave amphipod	*Stygobromus pecki*	3	Comal Springs	500
			Hueco Springs	
			Panther Canyon Well	
Comal Springs dryopid beetle	*Stygoparnus comalensis*	1	Comal Springs	500
Texas troglobitic water slater	*Lirceolus smithii*	2	San Marcos Springs	500
			Texas State University Well	
Edwards Aquifer diving beetle	*Haideoporus texanus*	2	Comal Springs	500
			Texas State University Well	

Sources: [a] USFWS 2014b; [b] Gibson et al. 2008

Collection of Standing Stock for the Peck's cave amphipod, Comal Springs dryopid beetle, and Edwards Aquifer diving beetle will involve trapping invertebrates using cotton lures at known collection sites. If Standing Stock target numbers have not been achieved when Refugia Stock triggers are reached within the Comal River collection efforts should increase in order to achieve these numbers. These increased collection efforts should be implemented when the Comal River USGS gauge (USGS 08169000) reads < 30 cfs. These triggers coincide with the EAHCP biological monitoring programs increased inspection efforts of these invertebrates. In order to conduct this effort the Standing Stock should be evaluated in order to identify which collection sites require additional specimens to achieve targeted Refugia Stock numbers.

Collection of Standing Stock for the Texas troglobitic water slater will involve trapping invertebrates using cotton lures at known collection sites. If Standing Stock target numbers have not been achieved when Refugia Stock triggers are reached within the San Marcos River collection efforts should increase in order to achieve these numbers. These increased collection efforts should be implemented when the Comal River USGS gauge (USGS 08170500) reads < 50 cfs. These triggers coincide with the EAHCP biological monitoring programs increased monitoring of standard water quality parameters for these invertebrates. In order to conduct this effort the Standing Stock should be evaluated in order to identify which collection sites require additional specimens to achieve targeted Refugia Stock numbers.

3.2 Salvage Stocks

Salvage Stock is the captive populations of Covered Species taken from the wild to a refugia setting when it is determined by the EAA and USFWS that significant Covered Species kills in the wild are imminent or on-going. For all surface water and spring aquatic habitat associated species Sections 6.4.3 and 6.4.4 of the EAHCP states "The habitat triggers for off-site refugia

are not solely dependent upon discharge:" These sections go on to say that cubic feet per second (cfs) readings should be considered in addition to habitat and population abundances, or aerial coverage for Texas wild-rice. For subterranean aquatic habitat associated species Sections 6.4.3 and 6.4.4 of the EAHCP states "Off-site refugia will be initiated below 30 cfs when water quality sampling reveals a substantial decline in one or more of the parameters measured." The substantial decline in parameter declines is further clarified as "Any standard or conventional water quality parameters exceed the historical range of the water quality parameters for the Edwards Aquifer by 10 percent or more."

Triggers for the collection of Salvage Stock are based on triggers identified in the EAHCP and EAA (2015), and are outlined in **Table 3-12**. As conditions within the San Marcos and Comal rivers approach salvage triggers the decision to initiate the collection of Salvage Stock should be done in coordination with USFWS to ensure that large salvage efforts are not undertaken when unnecessary. Salvage Stock should be separated by species but efforts to maintain these stocks in separate management units are not necessary. Instead the Salvage Stock will be held in higher densities in a variety of rearing systems. Salvage Stock target numbers are based on USFWS (2014a) and are also outlined in **Table 3-12**.

3.3 Reintroduction

At present time, there is not enough available information to develop a restoration plan for any of the Covered Species. Section 5 of The Contingency Plan (USFWS 1996a) cautions that additional information is needed prior to restoration or restocking of captive species into the wild. Regarding a reintroduction plan, the Contingency Plan states, "It is impossible at the present time to realistically outline a course of action."

While genetics studies have begun to attempt to answer the questions that could assist in developing a reintroduction plan for some of the Covered Species, publications are considered initial and require further assessments and the development of genetics management plans. Additionally, for some of these species initial genetics studies are currently underway or have not been initiated. Until sufficient studies have occurred that could lead to the development of a genetics management plan of populations held in the EAA Refugia Program, reintroduction efforts could result in genetic swamping and the success of reintroduction efforts would be purely speculative.

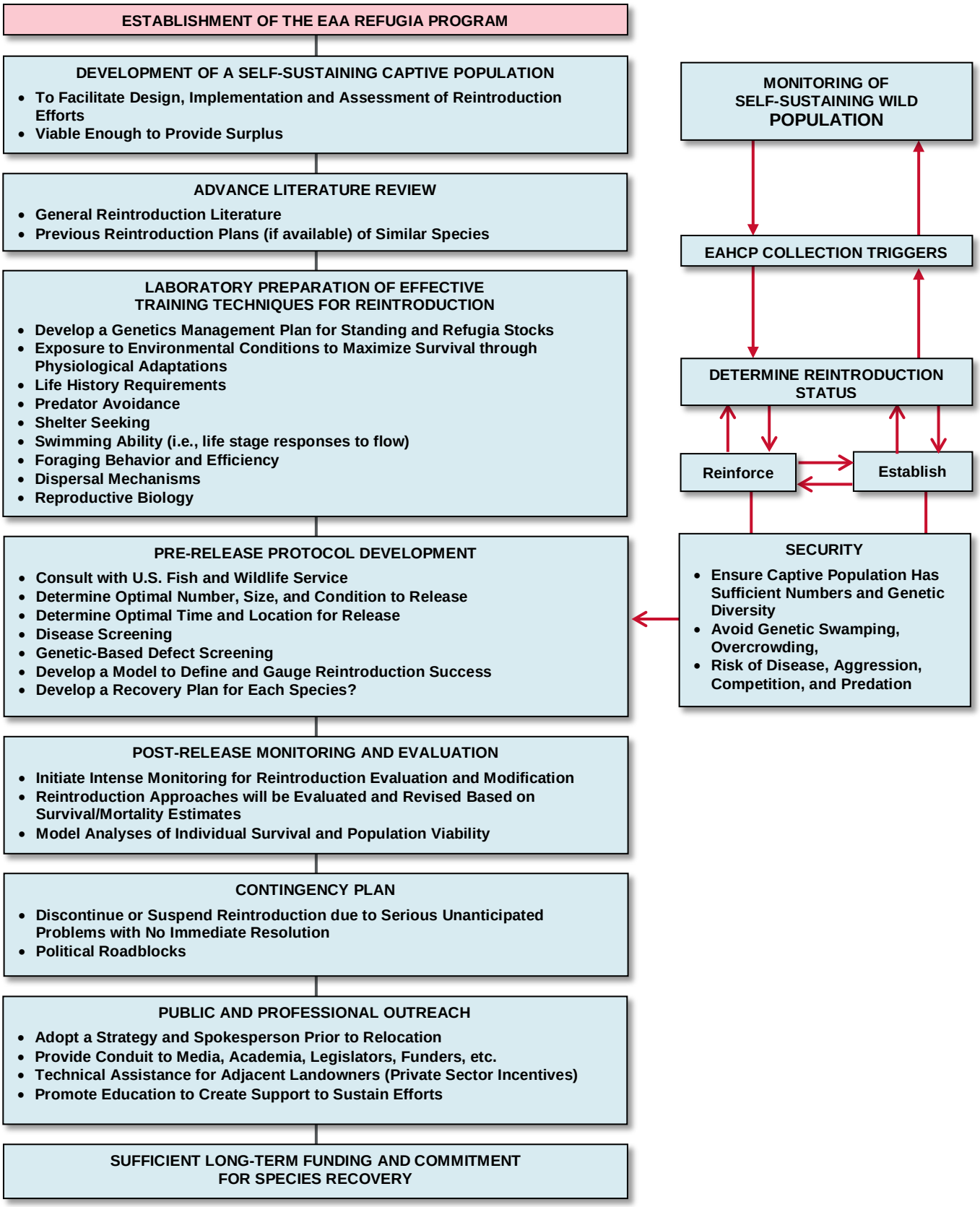
Certain reintroduction steps should be on-going prior to the looming potential of reintroduction efforts being implemented. The first step is the establishment of a refugia program, which this report addresses. The second step is the development and establishment of a genetics management plan for the Standing Stock and Refugia Stock. Once these goals have been achieved a reintroduction plan should be developed that is specific for the Covered Species. The reintroduction plan should include an advanced literature review of reintroduction efforts for similar species and other federally listed species. While further studies are necessary to implement a reintroduction plan for the Covered Species, **Table 3-13** identifies steps that can be considered general guidelines and considerations when the implementation of a reintroduction plan is imperative.

Table 3-12. Salvage Stock Triggers and Numbers

Species	Common name (system)	EAHCP Triggers [a, b, c]	Targeted Number [b, c]
		Plants	
Zizania texana	Texas wild-rice (San Marcos River)	< 3,500 m^2 total coverage in the San Marcos River; or Texas wild-rice exists at < three (3) of the seven (7) distinct sections (Biological Monitoring sections)	1,500
		Fish	
Etheostoma fonticola	Fountain darter (San Marcos River)	≤ 75 cfs for four (4) consecutive days	2,500
	Fountain darter (Comal River)	< 50% mean aquatic vegetation (Landa lake and Old Channel) and darter presence system wide; or <20% mean aquatic vegetation (Landa Lake and Old Channel) and <30% darter presence system wide	2,000
		Salamanders	
Eurycea rathbuni	Texas blind salamander	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
Eurycea nana	San Marcos salamander (San Marcos River)	< 50% suitable habitat (Biological Monitoring locations) and < 20% salamander density; or < 25 % suitable habitat (Biological Monitoring locations) and < 30% salamander density	500
Eurycea sp. 8	Comal Springs salamander (Comal River)	< 50% suitable habitat (Biological Monitoring locations) and < 20% salamander density; or < 25 % suitable habitat (Biological Monitoring locations) and < 30% salamander density	500
		Invertebrates	
Heterelmis comalensis	Comal Springs riffle beetle (Comal River)	< 30 cfs when only one (1) of three (3) monitored sites continues to have six (6) or more adult Comal Springs riffle beetles collected in a 24 hr sample period using cotton lures	500
Stygobromus pecki	Peck's cave amphipod	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
Stygoparnus comalensis	Comal Springs dryopid beetle (Comal River)	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
Lirceolus smithii	Texas troglobitic water slater (Comal River)	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
Haideoporus texanus	Edwards Aquifer diving beetle (Comal River)	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500

Sources: [a] USFWS 1996a; [b] USFWS 2014c; [c] EAA 2015

Table 3-13. Reintroduction Effort Process



4. Refugia Requirements

The EAA Refugia Program requirements developed for this report consider the infrastructure and equipment needs for one facility. A redundant effort, discussed in **Section 4.4**, will likely be required as part of the EAA Refugia Program. It is important to note that a redundant effort should not be considered a duplicate effort of target numbers for Standing Stock, Refugia Stock, and Salvage Stock (**Sections 3.1 and 3.2**), but rather the redundant facility would maintain a percentage of the total target numbers. Therefore, the refugia requirements discussed in this section should be considered sufficient for maintaining the current target numbers of Covered Species, however some refugia requirements would require a duplication of infrastructure (i.e., water source, power supply, geographic location, etc.) while others would require the division of infrastructure (i.e., rearing tanks). There are many scenarios for the division of stock numbers and they should be considered on a case by case basis considering costs and risks described in **Section 4.4**.

4.1 Infrastructure

4.1.1 Site Condition

This document is being developed without a selected site identified. Once a site is identified, physical conditions of that site will affect layout and development costs for that site. It is possible that the configuration of what is discussed below may be altered due to site topography, ingress and egress, property shape, use of existing infrastructure including buildings and other properties of the site. However, the intent of what is needed for this facility still needs to be accommodated from a functional standpoint.

It is estimated that upwards of two acres of land would accommodate the 0.5 ac (0.2 ha) building area, support components, parking, utilities, a liquid oxygen system, loading areas and security fencing. Some components, such as location of wells with associated supply piping, may require additional land due to location and easement needs. Other factors such as environmental impacts to/from adjacent landowners, building code requirements, county setbacks, zoning ordinances, etc., will have to be evaluated on a site by site basis.

4.1.2 Water Supply

WATER SOURCE

The water supply for the EAA Refugia Program (exclusive of potable water) should emulate the water quality conditions of the Edwards Aquifer supply where these species reside. Some water quality parameters can be and may need to be adjusted mechanically or chemically. Other parameters are more difficult to adjust, can be prohibitively expensive, and increase the risk to the animals if there is a failure to the system. Animal health can also be affected by pathogens that may reside in water supply whether it is a surface or groundwater source.

Due to these concerns it is strongly recommended that the source of water for this facility be the Edwards Aquifer. Other sources may be considered if their tested water quality characteristics are acceptable to EAA. The use of a water source other than the Edwards Aquifer may require review and approval by the USFWS regulatory division.

It is recommended that the water supply come from a well system. Samples of this supply will need to be taken and certified by EAA prior to further development of the project. If a surface supply is available, it will also be required to be certified by the EAA for quality, security of water rights and risk of contamination from above intake sources.

The make-up flow requirements of 89.2 gallons per minute (GPM, as identified in **Appendix B: Table B-1**) are continuous flow requirements which need to be available the entire year without interruption. With short periods of flow through requirements in the quarantine systems it is recommended that an additional 10 GPM be added to the total flow needs for a 100GPM water supply need. Salvage stock operations are unpredictable and may or may not occur. If salvage occurs, it is expected to be for intermittent periods of time and not with all species at the same time. While calculations in **Appendix B: Table B-1** indicate a Salvage make-up flow requirement of an additional 60.7 GPM, it is suggested that make-up flows in the standing stock portion of the facility be reduced to accommodate salvage stock needs. This approach is suggested to minimize the acquisition of water from the Edwards Aquifer Authority for the facility which could be especially important during periods requiring salvage operations.

Short duration interruptions can be accommodated, but should not extend beyond 48 hours of shutdown. It is preferred that the well system be designed to have two wells with more than half of the total flow requirement per well. Each well should have variable flow rate controls to minimize excess use of water and associated power requirements. The well system will be connected to the emergency power supply back up system located on site.

The water supply will enter an aeration tower for gas stabilization and drop into a head tank below with suitable water surface elevation for creating enough driving head for gravity flow to all systems with storage for providing additional water when an emergency status (100% reuse and new water required to replace loss due to leakage and evaporation).

RECIRCULATING AQUACULTURE SYSTEM

It is intended to use recirculating aquaculture systems (RAS) on all rearing units. These systems are composed of a return sump, motor sand filter with backwash, and an ultraviolet LED sterilization unit. These systems will allow for up to 95 percent of the flow to be returned to the unit and reduce new water to up to 5 percent of total flow with a reduced corresponding amount as effluent.

The design flow is set at 90 percent reuse with 10 percent makeup flow. Therefore, approximately 10 percent of the total flow is released as effluent out of the facility. One exception to the 10% makeup flow is the Texas wild-rice system which is calculated at 1% of total flow. All rearing systems will have the ability to go less than 90 percent to 0 percent reuse (except Texas wild-rice) for short durations and not all systems can be at low percentages at the same time due to limitations of the water supply system.

EFFLUENT TREATMENT

The effluent from the facility will have a mechanical drum filter sized to take all discharge from the facility for solids removal. The effluent from this system will then be discharged to a receiving body of water with adequate aeration and sediment and nutrient removal to meet local discharge regulations. The waste from the mechanical drum filter, backwash from the facility

filters and rearing room floor drains will enter a two cell evaporative effluent pond. Periodic removal of sediment from these ponds will be required. The operator of the facility may be responsible to acquire a Texas Pollutant Discharge Elimination System (TPDES) permit from the TCEQ for wastewater effluent discharges.

4.1.3 Rearing Facility

STANDING STOCK AND REFUGIA STOCK

The Standing Stock and Refugia Stock for each species identified earlier in **Section 3.1**, have separate management units. These management units are treated as separate stocks for the fountain darter and Texas wild-rice. For the salamanders and invertebrates, the management units are considered one population although separation can be achieved for most if not all species based upon the number of rearing units provided.

Each species category is broken down by appropriate life stage (see **Appendix B: Table B-1**).

Review of published literature and personal conversations with USFWS provided best available culture practices for each of the Covered Species considered for these refugia. The approach for each species is described below.

Fountain darter

Facilities for both the Comal River and San Marcos River fountain darter stocks will include separate facilities for darters from each river and maintain separation for each management unit. The egg and larval stage will have its own rearing system on a recirculating system with filtration and UV sterilization. These systems are quantified in **Appendix B: Table B-1**. The adult stage will also maintain the species and management units separately in fiberglass troughs quantified in **Section 3.1, Table 3-4**. These troughs will be connected to an RAS located in the RAS room (See **Appendix B: Figure B-1**).

Texas wild-rice

The Texas wild-rice system will include two tiers of five fiberglass raceways. The water at the end of the second tier will drain into a sump and be pumped back to the head end of the first tier. New water will be added at the head end of the first tier. Excess water will be released from an overflow standpipe at the sump end.

Each management unit will have its own raceway. Seedlings from the mature plants will be captured via netting placed over the plants and transferred into the main room for propagation in a controlled environment until starter plants are of suitable size to be transferred into the raceways.

The raceways will be located in a greenhouse structure attached to the refugia building as shown in **Appendix B: Figure B-1**.

Salamanders

The salamander culture system will consist of three systems devoted to the egg, larval and adult stages. Each of the three species will have its own systems. The management units identified in **Section 3.1, Tables 3-6, 3-7, 3-9** will not be kept in separate tanks, however dividers can be inserted into each system. The San Marcos and Comal Springs salamanders could be kept

separate as enough systems are provided, if this was desired. Each system contains a series of tanks and troughs with its own RAS system. The dimensions and numbers are provided in **Appendix B: Table B-1** and illustrated in **Appendix B: Figure B-1**.

Invertebrates

The invertebrate program has individual rearing systems for each of the five species as presented in **Appendix B: Figure B-1**. Management units identified in **Section 3.1, Table 3-8 and 3-10** are not designed to be kept separate; however, that can occur due to the number of units required (see **Appendix B: Table B-1**). Each rearing system has its own RAS at the base of the system.

SALVAGE STOCK APPROACH

Salvage stock accommodations are considered to be for emergency conditions. Space is provided for identified numbers of organisms above that for the Standing Stock and Refugia Stock of organisms in the facility. As salvage stock is an unpredictable and infrequent occurrence. The cost of these facilities can be excessive unless certain relaxation of rearing requirements can be implemented. These relaxations of requirements are as follows:

Fountain Darters

- Assumes adult life stages only collected from wild
- Space for both San Marcos River and Comal River fountain darters calculated as one group covering both species
- Densities increased from six to eight fish/gal. (Vol.)
- Quarantine troughs (two) included for rearing

Texas Wild-Rice

- Reduce pot diameter to 6 inches
- Double number of raceways
- Add 500 pots to existing raceways

Salamanders

- Increase density of animals to 2 specimens per 10 L in existing troughs

Invertebrates

- Double the number of systems

4.1.4 Bio-Security

Quarantine is a safeguard measure to segregate individuals collected in the wild in a separate tank for a predetermined amount of time to be certain it is disease free. Regardless of species, all new arrivals will be allowed to acclimate to captive conditions under strict protocols. Quarantine tanks in separate rooms to help minimize acclimation stress will be restricted to low-traffic areas inside the building with assurances that the facility has a well-operating aeration and bio-filtration system along with source of replacement water in the event therapeutic chemicals or medicated diets are utilized. Heaters may be needed to keep water at infective

temperatures for viral screening, or to increase temperatures for the treatment of some parasites. A net cover for each aquarium will help prevent evaporation and prevent stressed fish from jumping out of the tank.

Feeding quarantined individuals should be performed sparingly and according to established protocols. Throughout the quarantine period, all organisms will be monitored closely, with particular attention to breathing rate, swimming behavior, and overall appearance and behavior. When treating sick organisms, the quarantine facility may also serve as a hospital for treatment of diseases, parasites or injuries, and for rest and recovery areas for individuals recuperating from spawning.

To avoid contamination, all materials used for the quarantine system should be clearly labeled and partitioned from those used for other hatchery activities. Therefore, filter media, heaters, feed containers and feed, nets, buckets, etc. should be kept completely apart. Hatchery staff should always wash their hands and arms, feet, etc. with disinfectant wash, or take a shower between sessions at the other rooms and the quarantine facility(ies).

Facility disinfection guidelines for the prevention and management of diseases in laboratory environments (e.g., cleaning and decontamination) following protection measures described by Torgersen and Hastein (1995) are used when an exotic pathogen is detected.

Isolation and quarantine guidelines have been developed by the USFWS (Fish Health Policy 713 FW 1-5). This guidance is subject to changes as new information becomes available and subsequently revised as appropriate. Additional disinfection information can be found in *Physiology of Fish in Intensive Culture Systems* (Wedemeyer 1996).

The facility is intended to have separate rearing rooms for each of the categories of plant and animals as shown on **Appendix B: Figure B-1**. Each of these rooms has its own quarantine room with an outside entrance to receive organisms from outside the facility and an entrance directly into their own rearing room. Each room has its own separate new water supply and RAS systems. Each rearing room will have its own storage of equipment and supplies to avoid contamination between rooms.

4.1.5 Support Facilities

A non-specific location site plan (**Appendix B: Figure B-1**) has been developed which identifies the above-described facilities as well as those listed in this section. This figure is intended to provide planning level concepts in terms of space requirements and is not intended for construction purposes.

Administrative space will be provided for an open area office complex where up to five desks with associated equipment can be located. Two restroom facilities which meet Americans with Disabilities Act requirements are provided, and one break room with kitchen facilities is provided.

A water quality and animal necropsy lab is also provided. The live feed room will have rearing systems for algae, rotifers and artemia along with holding systems for other live foods such as

brine shrimp and worms. Commercial-sized refrigeration and freezer storage will also be included in this space.

Outdoor facilities include an emergency generator sized to power the entire site, security fencing around the entire compound, the aeration tower/head tank, and the effluent treatment system (enclosed mechanical drum filter and two-cell settling pond).

4.1.6 Cost Estimate

A preliminary opinion of probable construction cost has been developed (**Appendix B: Table B-2**). Site development costs are estimates based upon average site conditions without having an identified site available. The totals for each category are presented for “New Site” and “Existing Site,” where some infrastructure is in place. These numbers are for planning purposes only as actual conditions will vary. A contingency of 40 percent is included for unknowns regarding site conditions, water supply development, changes to design concepts and conformance to local building codes, permit requirements, etc.

4.2 Personnel

4.2.1 Operational Tasks and Personnel

Once the EAA facility is prepared to care for the Covered Species, the EAA Refugia Program facilities will need to be staffed for daily operations and maintenance. Daily operations and maintenance will include the following:

- Visual inspections of tank flows, water temperatures, and tank pH levels
- Visual inspections of specimen health
- Food production and feeding of specimens
- Cleaning (siphoning) of debris from tanks
- Planning for and maintaining equipment for the collection of additional specimens
- Collection of specimens from the natural habitats and transfer to refugia facility (this task will likely be on-going for the duration of the ITP for some of the Covered Species)
- Keying out invertebrates collected from the natural habitats and documenting findings
- Documenting changes in Standing Stock numbers
- Conducting research and documenting results.

Additional duties performed on a regular basis, but not necessarily daily include the following:

- Collection and transfer of eggs/larvae to appropriate tanks
- Transfer of unhealthy specimens to appropriate tanks
- Removal of dead specimens
- Replacement and cleaning of tank plumbing as necessary.

Additional duties that will occur occasionally (annually or semi-annually) throughout the refugia operations include the following:

- Tank to tank transfer of species for tank acid-washing
- Acid-washing of unused tanks
- Sexing and mixing of specimens
- Species counts by management unit
- Preparing annual reports on progress and additional refugia needs
- Meeting with USFWS and other vested parties to discuss operations.

In order to accomplish refugia operations including the tasks mentioned in this section, the EAA Refugia Program should include a full-time staff of the following personnel:

- One supervisory biologist
- Four biologists
    - One fountain darter technical lead
    - One Texas wild-rice technical lead
    - One salamander technical lead
    - One invertebrate technical lead

The initial collection of some specimens may require anywhere from two to four additional temporary staff members that are available to assist in field collection and species identification efforts. The number of staff members needed to fulfill this role depends upon the collection scenarios presented in **Section 3.1.1** and the intensity of collection efforts. Temporary staff may also be needed occasionally throughout the duration of refugia operations to assist with supplementary specimen collections. Additionally, the staff requirements could be increased substantially based on the plan for redundancy in operations depending on the proximity of refugia facilities.

4.2.2 Personnel Qualifications

Refugia personnel should be capable of performing the various duties associated with operating the refugia mentioned in **Section 4.2.2**. As the EAA Refugia Program is in its early stages of inception, all staff members will collaborate and participate in all aspects setting up the EAA Refugia Program. This will include the collection of specimens from their natural habitats, which include swift flowing rivers, with depths ranging from a few feet to approximately 25 feet (7.6 m). In addition to these field requirements and familiarity with the Covered Species, all staff members should also be capable of performing daily maintenance of refugia equipment, which includes identifying and fixing plumbing problems. Therefore capabilities of all staff should include the following:

- Familiarity with the Covered Species of the EAHCP

- Familiarity with and understanding of the San Marcos and Comal river systems and associated karst features
- Familiarity with aquatic sampling techniques (i.e., fish seining, dip netting, invertebrate trapping/collecting, etc.)
- Ability to swim in and conduct field work in swift currents for sustained time periods. SCUBA certification or capable of gaining SCUBA certification preferred
- Ability to perform regular maintenance to plumbing equipment (PVC pipes, sump pumps, etc.)
- Ability to carry up to 50 pounds (22.7 kilograms) for long time periods and long distances
- Proficiency with Microsoft Excel and Word.

Additional personnel qualifications for each position are as follows:

One Supervisory Biologist:

A) Possess a master's degree with a major in a biological science that includes the following course work: 1) aquatic subjects such as limnology, ichthyology, fishery biology, aquatic botany, aquatic fauna, oceanography, fish culture, or related courses in the field of fishery biology; and 2) animal sciences subjects such as general zoology, vertebrate zoology, comparative anatomy, physiology, genetics, ecology, cellular biology, parasitology, entomology, or research courses in such subject.

OR

B) Have a combination of education (bachelor's degree) and experience that is equivalent to a master's degree in a biological science.

AND

C) Interdisciplinary preparation for fisheries management, knowledge of fisheries stock assessment methods, proven writing and speaking skills, communication, coordination and interpersonal skills, and experience with developing policy or position statements should be demonstrated.

AND

D) Specialized experience must include: experience leading or training others; organizing, and conducting administrative functions such as property management, budget and finance, procurement, and safety; and experience conducting laboratory, propagation and culture, and field activities for an applied research program

AND

E) Possess (or capable of possessing) an Incidental Take Permit for all of the Covered Species identified in the EAHCP and this report.

Four Biologists: The following qualifications are general. Each position should be filled with the staff that has experience with appropriate taxa for the position in which they are applying (i.e., botanical experience for Texas wild-rice; fisheries experience for the fountain darter position;

fisheries or amphibian experience for the salamander lead; and invertebrate experience for the invertebrate lead):

A) Possess a bachelor's degree with a major in a biological science that includes the following course work: 1) in aquatic subjects such as limnology, ichthyology, fishery biology, aquatic botany, aquatic fauna, oceanography, fish culture, or related courses in the field of fishery biology; and 2) in the animal sciences subjects such as general zoology, vertebrate zoology, comparative anatomy, physiology, genetics, ecology, cellular biology, parasitology, entomology, or research courses in such subject. Master's degree preferred.

   OR

B) Have a combination of education and experience that is equivalent to a major in a biological science (i.e., at least 30 semester hours) of which a minimum of 6 semester hours were in aquatic subjects and 12 semester hours were in the animal sciences as described in "A" above, plus appropriate experience or additional education.

   AND

C) Interdisciplinary preparation for fisheries management, knowledge of fisheries stock assessment methods, proven writing and speaking skills, communication, coordination and interpersonal skills.

4.3 Additional Requirements

4.3.1 Permits

SCIENTIFIC COLLECTION PERMITS

All necessary federal and state permits must be obtained prior to operation of the EAA Refugia Program. The following permits are required for any person or entity engaged in collection of listed aquatic or terrestrial wildlife for scientific purposes including research, educational, and rescue/salvage projects:

- Incidental Take Permit – This type of permit is issued for activities that may result in "take" of a state or a federally listed species. Applications are contingent upon the EAHCP which defines the full impact on the species, describes methods proposed to minimize take, and outlines mitigation which may be rendered to offset the take. Permit applicants include all federally listed wildlife species likely to be incidentally taken during the life of the Permit.
- State of Texas Scientific Collection Permit – This type of permit is issued by the Texas Parks and Wildlife Department as specified under the authority of Chapter 43, Subchapter C of the Texas Parks and Wildlife Code. A valid and current permit authorizes qualified biologists the scientific collection of fish or other aquatic organisms from the State's waters. All issued permits expire and cease to be valid on December 31, every third year, by the date specified in the permit conditions.

WATER QUALITY

The Facility will be required to have a Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) Permit overseen by the U.S. Environmental Protection Agency (EPA) authorizing the discharge of wastewater. In Texas, the Texas Commission on Environmental Quality (TCEQ) administers the NPDES program referred to as the Texas Pollutant Discharge Elimination System (TPDES) in accordance with Section 402 of the Clean Water Act.

- TPDES Permit Issuance - Disposal of generated wastewater will require a permit or other authorization. Hatchery wastewater is primarily generated through animal wastes during the cleaning of equipment and facilities. Wastewater handling involves collection, possible treatment, then disposal and/or reuse. In order to ensure protection of water quality and human health, an TPDES permit will be required to establish conditions and limitations for the discharge of pollutants from the Facility to a receiving water of the United States, pursuant to the provisions of the CWA, 33 U.S.C. § 1251 *et seq.*

WATER QUANTITY

The ability to obtain an adequate water supply will be one critical factor in the initial decision of where to locate a new facility, and may impact its ultimate success.

- Edwards Aquifer - The contractor will either possess existing water rights in the Edwards Aquifer or secure such water rights through an application process with the EAA authorizing withdrawals. If federal exempt status can be obtained under EAA rules, then the contractor might only need to secure rights in the amount of the required make-up supply for the refugia. **A determination from EAA legal counsel will be necessary to confirm whether a private contractor can obtain such an exemption.** Alternatively, if a private contractor cannot obtain federal exempt status, then sufficient rights will need to be secured so that the required make-up supply for the refugia can still be withdrawn subject to Stage V Emergency Critical Period Withdrawal Reductions.
- Other Groundwater Sources – The contractor must be able to demonstrate legal and physical access to groundwater sufficient in quantity to meet the required make-up supply for the refugia subject to any and all applicable drought withdrawal restrictions. Furthermore, the contractor must demonstrate to EAA and USFWS satisfaction that such non-Edwards groundwater is of suitable quality for use in the refugia.
- Surface Water Sources – Surface water available for diversion and use is governed by the complex interactions of natural, anthropogenic, and legal factors including rainfall, runoff, springflow, evaporation, aquifer recharge, diversions by other water right owners, environmental flow standards, reservoir operations, off-channel storage, treated effluent from municipal and industrial water users, terms and conditions of the water rights, and the prior appropriation doctrine as enforced by the TCEQ South Texas TCEQ Watermaster. The contractor must be able to demonstrate legal and physical access to surface water sufficient in quantity to meet the required make-up supply for the refugia in a repeat of the drought of record subject to any and all applicable restrictions. Furthermore, the contractor must demonstrate to EAA and USFWS satisfaction that such surface water is of suitable quality for use in the refugia.

OTHER

Depending on site or facility conditions, the operator of the refugia operations may be responsible to acquire other federal, state, and / or local permits and approvals. Examples of potential permits include Clean Water Act, Section 404 permits; Section 401 Water Quality Certification; TXDOT driveway Permits, building inspections, etc.

4.4 Backup and System Redundancy

The USFWS uses the biological criteria of redundancy, representation, and resiliency (the "3R framework") as the guiding conservation principles to determine a species' probability of persistence and how best to conserve them (Shaffer and Stein 2000). This provides a margin of safety for a species or certain representation (variation) within a species to withstand catastrophic events such as disease outbreaks and water quality impairment (79 FR 10238) by decreasing the chance of any one event affecting the entire specie. Glick and Stein (2011) states "redundancy addresses the need for multiple protected populations as a backup against loss of any single population."

Redundant efforts will take place within the main facility by separating species populations amongst multiple rearing systems. Back-up pumps will also be in place along with a minimum of two water sources for each tank holding Covered Species. Back-up generators and water sources will also be in place at this facility along with other redundant measures.

The Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act (USFWS 2000) states the following regarding controlled propagation of threatened and endangered species, "Conducted, when feasible, at more than one location in order to reduce the potential for catastrophic loss at a single facility when a substantial fraction of a species or important population segment is brought into captivity."

The EAA has committed to implementing the EAA Refugia Program at multiple facilities, including a main facility and one back-up facility. Flexibility exists for how the EAA determines to proceed with the operation of a back-up facility. There is little guidance from the USFWS regarding particular criteria such as the percentages of refugia populations to be held at a redundant refugia facility. The Contingency Plan (USFWS 1996) suggests maintenance of 300 salamanders at the central facility (SMARC) and 200 salamanders at their back-up facility. Other species covered in the Contingency Plan are also presented in a similar manner (i.e., 750 fountain darters at SMARC and 400 at Uvalde). Dividing Standing Stock and Refugia Stock in this manner could be an option; however, the EAA Refugia Program should consult with the USFWS to determine the flexibility in dividing stock numbers amongst the main and redundant facility. Adding redundant program components can be phased over time as the EAHCP further evolves, and as budget and priorities allow.

The redundant facility should follow all of the guidelines described in this report regarding housing species in separate management units, water quality parameters, on-site redundancy, bio-security, etc. The redundant facility could function as a satellite of the main facility utilizing the quarantine infrastructure of the main facility and transporting to the redundant facility as appropriate. The redundant facility could also be developed to be a standalone facility equipped

to handle in coming specimens from the wild. The logistics of these options should be considered when evaluating the proposed redundant facility capacity, location, water source, etc.

The number of personnel required to operate a redundant facility would depend upon the division of Standing Stock and Refugia Stock numbers between the two facilities. If the facility is located within a reasonable distance of the main facility, it is possible that the personnel needs described in **Section 4.2** would be sufficient to oversee operations at both facilities.

Risk versus cost or logistical efficiencies of measures to consider when evaluating a redundant facility:

- Geographical distance from main facility (in case of severe weather event [i.e., tornado, flashflood, etc.])
- Separate aquifer region from the main facility (in case of catastrophic groundwater pollution).

5. Project Assumptions

The following assumptions are anticipated events or circumstances that may be expected to happen during the life cycle of this project. These assumptions will be used to assist EAA in developing a sound risk management plan.

- The project will most likely require the use of Edwards Aquifer groundwater;
- Facility layout should remain flexible to accommodate culture activities ranging from spawning and incubation through adult rearing;
- Future capacity to facilitate expansion should accommodate future requests and needs of the Covered Species (i.e., current and future genetics studies);
- Risk control measures should be in place to address other potential hazards including genetic and ecological interactions with ESA-listed species, disease transmission, and facility effects;
- Research will continue to collect important information on the population genetics endangered vertebrates and invertebrates which can be used to inform species recovery;
- The primary and redundant facilities are operated in compliance with all applicable guidelines and facility operation standards and protocols specified in the EAHCP, ITP, and the "Policy Regarding Controlled Propagation of Species Listed under the Endangered Species Act."
    - The biological goals and objectives are appropriate for the conservation planning context of the EAHCP;
    - One permitted biologist with the appropriate scientific knowledge and expertise (e.g., familiarity with the species or their habitats, biological needs, and threats) will be assigned to each Covered Species[1];
    - Express a clear statement of the information and value not open to interpretation provided by the EAA Refugia Program;
    - An annual report covering all significant EAHCP-related activities indicating levels of compliance with applicable standards and criteria;
    - Annual meetings, or more frequent meetings, with USFWS will be required to review the compliance of the Refugia Program; and
    - EAA will conduct periodic audits indicating level of compliance with applicable standards and criteria.
- Effluent from hatchery facility will not adversely affect natural populations.
    - Discharge water quality will be tested and compared to applicable water quality standards by TPDES permit (TXR 050000).

[1] One such permitted biologist may be assigned to multiple Covered Species.

- Development and certification of a Best Management Practice Plan that should contain the standard operating procedures use for the control of solids control, material storage, maintenance, record keeping, employee and contractor training, feed management, waste collection and disposal, any discharge associated with transport and harvesting of aquatic animals, carcass removal,
- Periodic updates of existing captive genetic management plans to create and maintain a genetically and demographically robust captive population.

6. References

Arsuffi 1993 — Arsuffi, T. L. 1993. Status of the Comal Springs riffle beetle (Heterelmis comalensis), Peck's cave amphipod (Stygobromus pecki), and the Comal Springs dryopid beetle (Stygoparnus comalensis) from central Texas. Prepared for the U.S. Fish and Wildlife Service.

Barr and Spangler 1992 — Barr, C.B., and P.J. Spangler. 1992. A new genus and species of stygobiontic dryopid beetle, Stygoparnus comalensis (Coleoptera: Dryopidae), from Comal Springs, Texas. Proc. Biol. Soc. Wash. 105(1): 40-54.

BIO-WEST 2002 — BIO-WEST, Inc. 2002. Comal Springs Riffle Beetle Habitat and Population Evaluation. Final Report. Edwards Aquifer Authority. 24 pp.

BIO-WEST 2002-2013a — BIO-WEST, Inc., 2002-2010, Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the Comal Springs/River aquatic ecosystem: Final Annual Reports (2002 through 2013) submitted to the Edwards Aquifer Authority, San Antonio, Texas, variously paginated.

BIO-WEST 2002-2013b — BIO-WEST, Inc., 2002-2010, Comprehensive and critical period monitoring program to evaluate the effects of variable flow on biological resources in the San Marcos Springs/River aquatic ecosystem: Final Annual Reports (2002 through 2013) submitted to the Edwards Aquifer Authority, San Antonio, Texas, variously paginated

BIO-WEST 2011 — BIO-WEST, Inc. 2011. Environmental restoration and protection areas feasibility study: Comal Springs. Prepared for the Edwards Aquifer Recovery Implementation Program.

BIO-WEST 2014-2015a — BIO-WEST 2015. Habitat Conservation Plan Biological Monitoring Program, Comal Springs/River Aquatic Ecosystem. 2014 Annual Report. Prepared for the Edwards Aquifer Authority. 98 p. plus Appendices.

BIO-WEST 2014-2015b — BIO-WEST 2015. Habitat Conservation Plan Biological Monitoring Program, San Marcos River Aquatic Ecosystem. 2014 Annual Report. Prepared for the Edwards Aquifer Authority. 98 p. plus Appendices.

Bonner et al. 1998 — Bonner, T.H., T.M. Brandt, J.N. Fries, and B.G. Whiteside. 1998. Effects of temperature on egg production and early life stages of the fountain darter. Transactions of the American Fisheries Society 127:971-978.

Bosse et al. 1998 — Bosse, L.S., D.W. Tuff, and H.P. Brown. 1988. A new species of Heterelmis from Texas (Coleoptera: Elmidae). Southwestern Naturalist 33:199-203.

Bradsby 1994 — Bradsby, D.D. 1994. A recreational use survey of the San Marcos River. M.S. thesis, Southwest Texas State University. San Marcos, Texas.

Breslin 1997 — Breslin, S. 1997. The impact of recreation on Texas wild-rice. Master of Applied Geography thesis, Southwest Texas State University. San Marcos, Texas.

Brandt 1993 — Brandt, T. M., K. G. Graves, C. S. Berkhouse, T. P. Simon, and B. G. Whiteside. 1993. Laboratory spawning and rearing of the endangered fountain darter. Progressive Fish-Culturist 55:149–156.

Campbell 1995 — Campbell, L. 1995. Endangered and threatened animals of Texas. Resource Protection Division, Endangered Resources Branch. Texas Parks and Wildlife Department, Austin, Texas.

Chippindale 1992 — Chippindale, P.T., D.M. Hillis, and A.H. Price. 1992. Central Texas neotenic salamanders (Eurycea and Typhlomolge): Taxonomic status, relationships, and genetic differentiation. Section 6 Interim Report. U.S. Fish and Wildlife Service, Austin, Texas.

Chippindale 1993 — Chippindale, P.T., D.M. Hillis, and A.H. Price. 1993. Central Texas salamander studies. Draft Section 6 Report submitted to U.S. Fish and Wildlife Service, Austin, Texas.

Chippindale 1994 — Chippindale, P.T., D.M. Hillis, and A.H. Price. 1994. Relationships, status, and distribution of central Texas hemidactyline plethodontid salamanders (*Eurycea* and *Typhlomolge*). Final Section 6 Report, July 1994.

EAA 2015 — Edwards Aquifer Authority. 2015. Request For Proposal for Salvage Refugia Operations Proposal for the Edwards Aquifer Authority Proposal No. 142-15-HCP. Edwards Aquifer Authority. San Antonio, Texas.

Emery and Guy 1979 — Emery, W.H.P., and M.N. Guy. 1979. Reproduction and embryo development in Texas wild-rice (*Zizania texana* Hitchc.). Bulletin of the Torrey Botanical Club 106(1):29-31.

Gibson et al. 2008 — Gibson, James R., Harden, Scott J., Fries, Joe N. 2008. Survey and Distribution of Invertebrates From Selected Springs of the Edwards Aquifer in Comal and Hays Counties, Texas. The Southwestern Naturalist 53(1): 74-84.

Glick and Stein 2011 — Glick, P. H. Chmura, and B.A. Stein. 2011. Moving the conservation goalposts: a review of climate change adaptation literature. National Wildlife Federation, 901 E Street NW, Washington, DC 20004.

Hubbs 1985 — Hubbs, C. 1985. Darter reproductive seasons. Copeia 1985(1):56-68.

Hubbs and Peden 1969 — Hubbs, C., and A.E. Peden. 1969. *Gambusia georgei* sp. nov. San Marcos, Texas. Copeia (2):357-364.

Johnson and Hubbs 1989 — Johnson, J.E. and C. Hubbs. 1989. Status and conservation of poeciliid fishes. Pages 301-317 In: G. Meffe and F. Snels, eds. Ecology and evolution of livebearing fishes (Poecillidae). Prentis Hall, New York.

Kuehne and Barbour 1983 — Kuehne, R.A. and R.W. Barbour. 1983. The American darters. The University Press of Kentucky.

Krejca 2005 — Krejca, J.K. 2005. Stygobite phylogenetics as a tool for determining aquifer evolution. Dissertation, University of Texas at Austin. 115 pp.

Labay and Brandt 1994 — Labay, A. A., and T. M. Brandt. 1994. Predation by Cyclops vernalis on Florida largemouth bass and fountain darter larvae. Progressive Fish-Culturist 56:37–39.

Linam et al. 1993 — Linam, G.W., K.B. Mayes, and K.S. Saunders. 1993. Habitat utilization and population size estimate of fountain darters, Etheostoma fonticola, in the Comal River, Texas. Texas Journal of Science 45(4):341-348.

Linam 1993 — Linam, L.A. 1993. A reassessment of the distribution, habitat preference, and population size estimate of the fountain darter (Etheostoma fonticola) in the San Marcos River, Texas. Section 6 report, Texas Parks and Wildlife Department, Job 2.5. March 12, 1993.

Lucas et al. 2009 — Locas, Lauren K., Fries, Joe N., Gabor, Caitlin R., Nice, Chris C. 2009. Genetic Variation and Structure in *Eurycea nana*, a Federally Threatened Salamander Endemic to the San Marcos Springs. Journal of Herpetology, Vol. 43, No. 2, pp. 220-227, 2009

Longley 1978 — Longley, Glenn. 1978. Status of *Typhlomolge (=Eurycea) rathbuni,* the Texas Blind Salamander. U.S. Fish and Wildlife Service Endangered Species Report 2.

Menard 1995 — Menard, J.A. 1995. Bibliography of Edwards aquifer, Texas, through 1993. U.S. Geological Survey, Open-file Report 95-336, Austin, Texas. 74 p.

McKinney and Sharp 1995 — McKinney, D. C., and J. M. Sharp. 1995. Springflow augmentation of Comal Springs and San Marcos Springs, Texas: phase I - feasibility study. Center for Research in Water Resources Technical Report CRWR 247, Bureau of Engineering Research, University of Texas at Austin, TX.

Mitchell et al. 2005 — Mitchell, A.J., R.M. Overstreet, A.E. Goodwin, E. Andrew, and T.M. Brandt. 2005. Spread of an exotic fish-gill trematode: a far-reaching and complex problem" (2005). Faculty Publications from the Harold W. Manter Laboratory of Parasitology. Paper 441. http://digitalcommons.unl.edu/parasitologyfacpubs/441

PPAI 1994 — Paul Price Associates, Inc. 1994. Phase I environmental studies: water supply alternatives for the City of San Marcos, Texas. Prepared for the City of San Marcos.

Pennak 1989 — Pennak, R.W. 1989. Fresh-water invertebrates of the United States, Protozoa to Mollusca, 3rdEdition. John Wiley and Sons, Inc. New York.

Phillips et al. 2013 — Phillips, C.T. J.K. Wenburg, C. Lewis, J. Olsen, and K.G. Ostrand. 2013. An analysis of genetic diversity in the fountain darter *Etheostoma fonticola*. Report presented to the Edwards Aquifer Recovery Implementation Program Steering Committee.

Poole and Bowles 1999 — Poole, J.M. and D. Bowles. 1999. Habitat characterization of Texas wild-rice *(Zizania texana*), an endangered aquatic macrophyte from the San Marcos River, Texas, USA. Marine and Freshwater Ecosystems 9: 291-302.

Russell 1976 — Russell, W.H. 1976. Distribution of troglobitic salamanders in the San Marcos area, Hays County, Texas. Biological Investigations of Troglobitic *Eurycea* Report, 7601. 35 pp.

Saunders et al. 2001 — Saunders, K.E., K.B. Mayes, T.A. Jurgensen, J.F. Trungale, L.J. Kleinsasser, K. Aziz, J.R. Fields, and R.E. Moss. 2001. An evaluation of spring flows to support the Upper San Marcos River Spring Ecosystem, Hays County, Texas. River Studies Report No. 16. Resource Protection Division, Texas Parks and Wildlife Department, Austin, TX.

Schaefer 2000 — Schaefer, P. 2000. The effects of supersaturated nitrogen on the endangered fountain darter and the San Marcos salamander. Thesis; presented to the Graduate Council of Southwest Texas State University in partial fulfillment of the requirement for the Degree of Master of Science. San Marcos, Texas.

Schenck and Whiteside 1976 — Schenck, J.R., and B.G. Whiteside. 1976. Distribution, habitat preference and population size estimate of *Etheostoma fonticola*. Copeia 1976(4):697-703.

Schenck and Whiteside 1977a — Schenck, J.R. and B.G. Whiteside. 1977. Food habits and feeding behavior of the fountain darter, *Etheostoma fonticola* (Osteichthyes: Percidae). Southwest. Naturalist 21:487-492.

Schenck and Whiteside 1977b — Schenck, J.R. and B.G. Whiteside. 1977. Reproduction fecundity, sexual dimorphism, and sex ratio of *Etheostoma fonticola* (Osteichthyes, Percidae). American Midland Naturalist 98(2):365-375.

Shaffer and Stein 2000 — Shaffer, M.L. and B.A. Stein. 2000. Safeguarding Our Precious Heritage. Pages 301-321 in B.A. Stein, L.S. Kutner and J.S. Adams (eds.), Precious Heritage: The Status of Biodiversity in the United States. Oxford University Press, New York.

Simon et al. 1995 — Simon, T. P., T. M. Brandt, K. G. Graves, and B. G. Whiteside. 1995. Ontogeny and description of eggs, larvae, and early juveniles of the fountain darter, Etheostoma fonticola. Southwestern Naturalist 40: 208–215.

Strawn 1955 — Strawn, K. 1955. A method of breeding and raising three Texas darters, Part I. Aquarium J. 26:408-412.

Sweet 1978 — Sweet, S.S. 1978. The evolutionary development of the Texas Eurycea (*Amphibia: Plethodontidae*). Ph.D. Dissertation. Univ. Calif., Berkeley, California.

Terrell et al. 1978 — Terrell, E.E., W.H.P. Emery, and H.E. Beatty. 1978. Observations on Zizania texana (Texas wild-rice), an endangered species. Bull. Torrey Bot. Club 105:50-57.

Tolley-Jordan and Power 2007 — Tolley-Jordan L.R. and P. Power, 2007. Effects of water temperature on growth of the federally endangered Texas wild rice (Zizania texana). The Southwestern Naturalist 52(2):201-208.

Torgersen and Hastein 1995 — Torgersen T. and Hastein T. 1995. Disinfection in aquaculture. In: Scientific and Technical Review. Disinfectants: actions and applications. Office International des Epizooties 14(2):419-434.

USFWS 1996a — United States Fish and Wildlife Service. 1996. San Marcos/Comal/Edwards Aquifer Rare, Threatened, and Endangered Species Contingency Plan. USFWS Ecological Services Office. Austin, Texas.

USFWS 1996b — U.S. Fish and Wildlife Service. 1996a. San Marcos & Comal Springs & Associated Aquatic Ecosystems (Revised) Recovery Plan. Albuquerque, New Mexico. 121 p.

USFWS 2000 — U.S. Fish and Wildlife Service. 2000. Policy Regarding Controlled Propagation of Species Listed Under the Endangered Species Act. Federal Register Vol. 65, No. 183. September 20, 2000.

USFWS 2009 — U.S. Fish and Wildlife Service. 2009. Part III: Endangered and threatened wildlife and plants; partial 90-day finding on a petition to list 475 species in the southwestern United States as threatened or endangered with critical habitat; proposed rule. Federal Register Vol. 74, No. 240. December 16, 2009.

USFWS 2011a — Salamander culture protocol (still considered experimental). Updated October 14, 2011.

USFWS 2011b — Arthropod culture protocol (still considered experimental). Updated October 17, 2011.

USFWS 2012a — Standard operation procedures: *Etheostoma fonticola*, Fountain darter (Comal and San Marcos) (still considered experimental). Updated October 17, 2012.

USFWS 2012b — U.S. Fish and Wildlife Service. 2012. Final environmental impact statement, Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan. U.S. Department of the Interior, U.S. Fish and Wildlife Service, December 2012. http://www.fws.gov/southwest/es/Documents/R2ES/EARIP_HCP_FEIS.pdf

USFWS 2013 — United States Fish and Wildlife Service. 2013. San Marcos Aquatic Resources Center San Marcos, Texas 78666 Annual Report. Fiscal Year 2013. San Marcos, Texas.

USFWS 2014a — Standard operation procedures: culture protocols for the Peck's cave amphipod *Stygobromus pecki* and the Comal Springs riffle beetle *Heterelmis comalensis*. (still considered experimental). Updated October 31, 2014.

USFWS 2014b — United States Fish and Wildlife Service. 2014. Refugia Work Plan Summary 2014-2027.

USFWS 2014c — United States Fish and Wildlife Service. 2014. San Marcos Aquatic Resources Center San Marcos, Texas 78666 Annual Report. Fiscal Year 2014. San Marcos, Texas.

USFWS 2015 — U.S. Fish and Wildlife Service. 2015. Species profile for Comal Springs salamander (*Eurycea species*). Accessed on April 8, 2015. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=D03Z

Wedemeyer 1996 — Wedemeyer, G. 1996. Physiology of fish in intensive culture systems. (Chapter 6, pp. 202-226, ISBN 0-412-07801-5). Chapman and Hall, New York.

Wilson 2013 — Wilson, Wade. 2013. Genetic Diversity Assessment of Wild and Refugia Texas Wild Rice (*Zizania texana*) Populations 2012. Prepared for the USFWS SMARC, San Marcos, Texas.

A

Triggers and Target Numbers for Stages of Refugia Implementation

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Table A-1. Triggers and Target Numbers for Stages of Refugia Implementation

Species	Standing Stock (~ 5 full-time staff)		Refugia Stock (~ 5 full-time staff & 4 part-time staff)		Salvage Stock (~ 5 full-time staff & 4 part-time staff. Additional staff may be needed)	
	Trigger	Target #	Trigger	Target #	Trigger	Target #
Fountain Darter (Comal)	ASAP	1,000	< 150 cfs	1,000 minus standing stock	< 50% mean aquatic vegetation (Landa lake and Old Channel) and darter presence system wide; or <20% mean aquatic vegetation (Landa Lake and Old Channel) and <30% darter presence system wide	2000
Fountain Darter (San Marcos)	ASAP	1,000	< 80 cfs	1,000 minus standing stock	≤ 75 cfs for four (4) consecutive days	2500
Texas Wild-Rice	ASAP	430	< 120 cfs	430 minus standing stock	< 3,500 m^2 total coverage in the San Marcos River; or Texas wild-rice exists at < three (3) of the seven (7) distinct sections (Biological Monitoring sections)	1500
Texas Blind Salamander	ASAP	500	< 105 cfs	500 minus standing stock	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
San Marcos Salamander	ASAP	500	< 120 cfs	500 minus standing stock	< 50% suitable habitat (Biological Monitoring locations) and < 20% salamander density; or < 25 % suitable habitat (Biological Monitoring locations) and < 30% salamander density	500
Comal Springs Salamander	ASAP	500	< 120 cfs	500 minus standing stock	< 50% suitable habitat (Biological Monitoring locations) and < 20% salamander density; or < 25 % suitable habitat (Biological Monitoring locations) and < 30% salamander density	500
Peck's Cave Amphipod	ASAP	500	< 30 cfs	500 minus standing stock	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
Comal Springs Riffle Beetle	ASAP	500	< 120 cfs	500 minus standing stock	< 30 cfs when only one (1) of three (3) monitored sites continues to have six (6) or more adult Comal Springs riffle beetles collected in a 24 hr sample period using cotton lures	500

Species	Standing Stock (~ 5 full-time staff)		Refugia Stock (~ 5 full-time staff & 4 part-time staff)		Salvage Stock (~ 5 full-time staff & 4 part-time staff. Additional staff may be needed)	
	Trigger	Target #	Trigger	Target #	Trigger	Target #
Comal Springs Dryopid Beetle	ASAP	500	< 30 cfs	500 minus standing stock	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
Edward's Aquifer Diving Beetle	ASAP	500	< 30 cfs	500 minus standing stock	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
Texas Troglobitic Water Slater	ASAP	500	< 50 cfs	500 minus standing stock	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500

B

Theoretical Facility Layout, Specifications, and Cost Estimate

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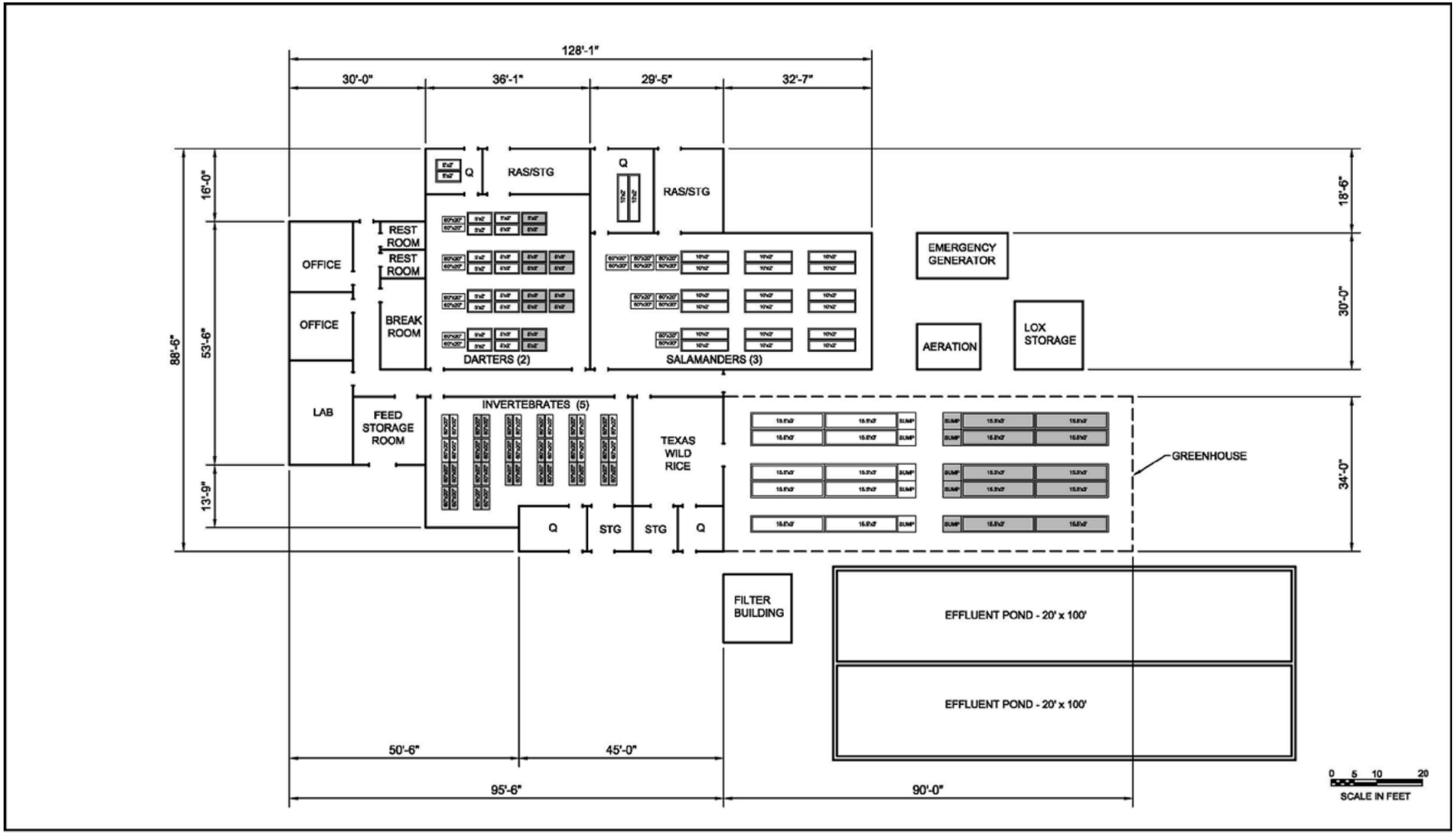

CONCEPT DRAWINGS FOR PLANNING PURPOSES ONLY
NOT FOR CONSTRUCTION

NOT DEVELOPED FOR A DESIGNATED FACILITY OR SPECIFIC LOCATION

LEGEND:

RAS - RECIRCULATING AQUICULTURE SYSTEM
Q - QUARANTINE
STG - STORAGE
LOX - LIQUID OXYGEN
▭ - SALVAGE STOCK

Edwards Aquifer Authority

Refugia Layout

DATE
April 17, 2015

FIGURE
Figure B-1

Table B-1. EAA Refugium Rearing Specifications - Standing Stock/Refugia

Species	Mgmt Units (MUs)	Species per MU	Survival	Species/ MUplus Mortality	Lifestage	Rearing Vessel	Density	Vessels per MU	Vessels per System	System Dimensions	Total No. of Systems	Salvage Number	Salvage Addt'l Space	New Water Flow (gpm) Note f	Reuse Flow(gpm) Note g	Salvage New Water Flow(gpm) Note f	Salvage Reuse Flow (gpm) Note g
Fountain Darter (Comal)	4	250	76%	310	Egg & Larval	21 L tank (5.5 gal)	1.58 fish/l L (6 fish/gal)	9.39 = 10	10	60"W x 20"D x 58"T	41 per MU			2.4	24		
					Adult	140 L trough (37 gal)	1.58 fish/L (6 fish/gal)	1.39 = 2	1	2'W x 5'L x 0.5' H	82 per MU	2000	12 troughs Note c and d	4.8	48	7.2	72
Fountain Darter (San Marcos)	4	250	76%	310	Egg & Larval	21 L tank (5.5 gal)	1.58 fish/l L (6 fish/gal)	9.39 = 10	10	60"W x 20"D x 58"T	41 per MU			2.4	24		
					Adult	140 L trough (37 gal)	1.58 fish/L (6 fish/gal)	1.39 = 2	1	2'W x 5'L x 0.5' H	82 per MU	2500	Included in Fountain Darter (Comal)	4.8	48		
Texas Wild-Rice	10	Varies, total plants = 430	80%	538	Seedling												
			90%	478	Adult	Fiberglass raceway (870 gal)	1 plant / 8" dia. pot	MUs separated by grating	48	3'W x 15.5'L x 2.5'D	10	1500	10 rcwys Note a and b Flow: see Note h	29.5	2950	29.5	2950
Texas Blind Salamander	13	500 for all MUs	77%	650 for all MUs	Egg	10 gal env. chamber	6 adults/tank (4 F, 2 M)	2	8	60"W x 20"D x 58"T	3.25 = 4			1.2	12		
					Larval	114 L tank	1 / L	1	6	60"W x 20"Dx 58"T (4 units / system)	2.16 = 2			0.6	6		
					Adult	Fiberglass trough (1,136 L)	1 per 10 L	2	6	2'W x 10'L x 2'D	6	500	Note e	6	60		
San Marcos Salamander	6	500 for all MUs	77%	650 for all MUs	Egg	10 gal env. chamber	6 adults/tank (4 F, 2 M)	2	8	60"W x 20"D x 58"T	2			0.6	6		
					Larval	114 L tank	1 / L	1	6	60"W x 20"Dx 58"T (4 units / system)	1			0.3	3		
					Adult	Fiberglass trough (1,136 L)	1 per 10 L	1	6	2'W x 10'L x 2'D	6	500	Note e	6	60		
Comal Springs Salamander	4	500 for all MUs	77%	650 for all MUs	Egg	10 gal env. chamber	6 adults/tank (4 F, 2 M)	2	8	60"W x 20"D x 58"T	1			0.3	3		
					Larval	114 L tank	1 / L	1	6	60"W x 20"Dx 58"T (4 units / system)	1			0.3	3		
					Adult	Fiberglass trough (1,136 L)	1 per 10 L	1	6	2'W x 10'L x 2'D	6	500	Note e	6	60		
Peck's CaveAmphipod	3	500 for allMUs	80% (assumed)	625 for allMUs	All life stages	50 L tank	9 per 50 L	69	9	60"W x 20"D x 82"T	8	500	Add 8 systems	9.6	96	9.6	96
Comal SpringsRiffle Beetle	2	500 for allMUs	80% (assumed)	625 for allMUs	All life stages	50 L tank	22 per 50 L	28	9	60"W x 20"D x 82"T	3	500	Add 3 systems	3.6	36	3.6	36
Comal SpringsDryopid Beetle	1	500 for allMUs	80% (assumed)	625 for allMUs	All life stages	50 L tank	22 per 50 L	28	9	60"W x 20"D x 82"T	3	500	Add 3 systems	3.6	36	3.6	36
Edward's AquiferDiving Beetle	2	500 for allMUs	80% (assumed)	625 for allMUs	All life stages	50 L tank	22 per 50 L	28	9	60"W x 20"D x 82"T	3	500	Add 3 systems	3.6	36	3.6	36
Texas TroglobiticWater Slater	1	500 for allMUs	80% (assumed)	625 for allMUs	All life stages	50 L tank	22 per 50 L	28	9	60"W x 20"D x 82"T	3	500	Add 3 systems	3.6	36	3.6	36
Total														89.2	3547	60.7	3262

Notes:

a. Use 6" pots = 100 pots/rcwy
b. Existing 10 rcwys will handle addit'l 500 pots
c. Increase density to 8 fish/gal
d. Use quarantine troughs
e. Increase density to 2 animals/10 L in existing troughs
f. New flow set at 10% of total flow (reuse flow)
g. Reuse flow tentative until verified later
h. New water calculated at 1% of total flow

Table B-2. EAA Refugia Summary

PRELINIMARY OPINION OF PROBABLE CONSTRUCTION COST (FY 2015) - PLANNING PURPOSES ONLY

ITEM	NEW SITE TOTAL	EXTG SITE TOTAL
MOBILIZATION	$304,488	$0
GENERAL CONDITIONS (SUBMITTALS AND REQUEST FOR INFORMATION)	$304,488	$304,488
SITEWORK	$100,050	$0
REFUGIA BUILDING	$2,793,205	$2,793,205
PROCESS WATER	$110,000	$110,000
LOX SYSTEM	$50,000	$50,000
UTILITIES	$60,000	$0
EMERGENCY GENERATOR	$41,000	$41,000
AERATION / HEADTANK	$50,000	$50,000
EFFLUENT SYSTEM	$690,000	$690,000
INSTRUMENTATION AND ALARMS (3%)	$74,684	$74,684
A/E Design Services (10%)	$380,889	$380,889
TOTAL CONSTRUCTION COST	$4,958,804	$4,494,266
CONTINGENCY (40%)	$1,983,522	$1,797,706
TOTAL WITH CONTINGENCY	$6,942,326	$6,291,972

Table B-3. EAA Refugia Detail

PRELINIMARY OPINION OF PROBABLE CONSTRUCTION COST (FY 2015) - PLANNING PURPOSES ONLY

ITEM	QUANTITY	UNIT	COST	AMOUNT	NEW SITE TOTAL	EXTG SITE TOTAL
MOBILIZATION (7%, NEW SITE ONLY)	1	LS	304,487.96	304,488	304,488	0
GENERAL CONDITIONS ((SUBMITTALS AND REQUEST FOR INFORMATION, 7%)	1	LS	304,487.96	304,488	304,488	304,488
SITEWORK (NEW SITE ONLY)					100,050	0
EROSION CONTROL	1	LS	10,000	10,000		
EXCAVATION	150	CY	25	3,750		
BACKFILL	100	CY	25	2,500		
OFF-SITE DISPOSAL OF EXCESS SPOILS	50	CY	30	1,500		
FINE GRADING	2,000	SY	1	2,000		
GRAVEL SURFACING	2,000	SY	15	30,000		
SECURITY FENCE	1,180	LF	35	41,300		
SECURITY ENTRANCE GATE	1	LS	5,000	5,000		
SITE CLEANUP	1	LS	4,000	4,000		
REFUGIA BUILDING (8154 SF)					2,793,205	2,793,205
OFFICE, BREAK RM,REST RM AREA	1,155	SF	150	173,250		
LAB	240	SF	225	54,000		
PRODUCTION AREA (WET AREAS)	6,759	SF	175	1,182,825		
GREENHOUSE, 34'X90', GROWERS SUPPLY BRAND						
GREENHOUSE	2,700	SF	8	21,600		
SHIPPING	1	LS	5,000	5,000		
ASSEMBLY	1	LS	7,500	7,500		
CONCRETE FOUNDATION, PERIMETER	40	CY	750	30,000		
GRAVEL BASE	500	SY	15	7,500		
POWER, LIGHTING AND VENTILATION	2,700	SF	20	54,000		
DARTER REARING COMPONENTS						
FG TROUGH, 5'X2'	28	EA	700	19,600		
AQUATIC HOUSING SYSTEM. 60"X20"	8	EA	15,500	124,000		
COMMERCIAL FILTRATION SYSTEM, 100 GPM	2	EA	7,000	14,000		
STORAGE	1	LS	1,000	1,000		
QUARANTINE COMPONENTS						
FG TROUGH, 5'X2'	2	EA	700	1,400		
AQUATIC HOUSING SYSTEM. 60"X20"	1	EA	15,500	15,500		
SALAMANDER REARING COMPONENTS						
FG TROUGH, 10'X2'	18	EA	2,400	43,200		
AQUATIC HOUSING SYSTEM. 60"X20"	12	EA	15,500	186,000		
COMMERCIAL FILTRATION SYSTEM, 100 GPM	2	EA	7,000	14,000		
STORAGE	1	LS	4,000	4,000		
QUARANTINE COMPONENTS						
FG TROUGH, 10'X2'	2	EA	2,400	4,800		
AQUATIC HOUSING SYSTEM. 60"X20"	1	EA	15,500	15,500		

ITEM	QUANTITY	UNIT	COST	AMOUNT	NEW SITE TOTAL	EXTG SITE TOTAL
BEETLE REARING COMPONENTS						
AQUATIC HOUSING SYSTEM. 60"X20"	40	EA	15,500	620,000		
STORAGE	1	LS	4,000	4,000		
TW RICE REARING COMPONENTS						
FG TROUGH, 15.5'X3'	20	EA	6,500	130,000		
SUMP AND RECIRC PUMP	10	EA	4,000	40,000		
FG TROUGH, 5'X2'	2	EA	2,400	4,800		
STORAGE	1	LS	4,000	4,000		
ROTIFER TANK, 2' DIA	6	EA	575	3,450		
ROTIFER TANK, 1' DIA	4	EA	320	1,280		
COMMERCIAL FREEZER	1	EA	3,500	3,500		
COMMERCIAL REFRIGERATOR	1	EA	3,500	3,500		
PROCESS WATER					110,000	110,000
WATER SUPPLY (WELL, PUMP, VFD AND MAIN PIPING)	1	LS	90,000	90,000		
DRAINS	1	LS	20,000	20,000		
LOX SYSTEM (LEASED EQPT)					50,000	50,000
FOUNDATION, FENCING, GATES, MISC	1	LS	35,000	35,000		
DISTRIBUTION SYSTEM	1	LS	15,000	15,000		
UTILITIES					60,000	0
SEWAGE	1	LS	20,000	20,000		
WATER	1	LS	20,000	20,000		
ELECTRICAL	1	LS	10,000	10,000		
COMMUNICATIONS	1	LS	10,000	10,000		
EMERGENCY GENERATOR, 100 kw, 277/460v	1	LS	41,000	41,000	41,000	41,000
AERATION / HEADTANK	1	LS	50,000	50,000	50,000	50,000
EFFLUENT SYSTEM					690,000	690,000
EFFLUENT POND (DUAL CELL)	1	LS	570,000	570,000		
DRUM FILTER AND BUILDING	1	LS	120,000	120,000		
INSTRUMENTATION AND ALARMS (2%)	1	LS	74,684	74,684	74,684	74,684
A/E Design Services (10%)	1	LS	380,889	380,889	380,889	380,889
TOTAL CONSTRUCTION COST						
CONTINGENCY (40%)					$4,958,804	$4,494,266
TOTAL WITH CONTINGENCY					1,983,522	1,797,706
					$6,942,326	$6,291,972

Table B-4. First Year O&M

PRELINIMARY OPINION OF PROBABLE ANNUAL O&M COSTS (FY 2016)- PLANNING PURPOSES ONLY

ITEM	QUANTITY	UNIT	COST	AMOUNT	TOTAL
WATER					21,600
Water Supply	144	ac/ft	150	21,600	
UTILITIES					41,020
Electrical	1	LS	40,000	40,000	
internet/phone service	12	month	85	1,020	
Equipment					77,000
Equipment and Building Maintenance	1	LS	15,000	15,000	
Work Trucks (Purchase)	2	LS	20,000	40,000	
feed	1	LS	15,000	15,000	
computers/IT equipment	1	LS	5,000	5,000	
Field Supplies	1	LS	2,000	2,000	
Other operational costs					53,000
travel	1	LS	5,000	5,000	
Insurance	1	LS	8,000	8,000	
laboratory and research budget (gut analysis, fish pathology, peer reviews, genetics, engineering design revisions, biological consultation, etc.)	1	LS	40,000	40,000	
Staff					560,000
Supervisory Biologist (85k/yr with 2.0 multiplier [OH costs])	1	salary	170,000	170,000	
Biologist (42k/yr with 2.0 multiplier [OH costs])	4	salary	84,000	336,000	
Temporary Staff (3k/month, 3 staff, 3 months with 2.0 multiplier)	9	monthly rate	6,000	54,000	
TOTAL ANNUAL O&M COST					$752,620
PROFIT (20%, If Private)					150,524
Contingency (20%)					150,524
TOTAL					$1,053,668

Table B-5. Remaining Years O&M with 3% Annual Increase

PRELINIMARY OPINION OF PROBABLE ANNUAL O&M COSTS (FY 2017- 2028) - PLANNING PURPOSES ONLY

ITEM	QUANTITY	UNIT	COST	AMOUNT	TOTAL (Government Agency)
WATER					22,320
Water Supply	144	ac/ft	155	22,320	
UTILITIES					42,256
Electrical	1	LS	41,200	41,200	
internet/phone service	12	month	88	1,056	
Equipment					42,565
Equipment and Building Maintenance	1	LS	25,000	25,000	
feed	1	LS	15,500	15,500	
computers/IT equipment	1	LS	1,550	1,550	
Field Supplies	1	LS	515	515	
Other operational costs					23,250
travel	1	LS	5,150	5,000	
Insurance	1	LS	8,250	8,250	
laboratory and research budget (gut analysis, fish pathology, peer reviews, genetics, engineering design revisions, biological consultation, etc.)	1	LS	41,200	10,000	
Staff					576,800
Supervisory Biologist (87,550/yr with 2.0 multiplier [OH costs])	1	salary	175,100	175,100	
Biologist (42k/yr with 2.0 multiplier [OH costs])	4	salary	86,520	346,080	
Temporary Staff (3k/month, 3 staff, 3 months with 2.0 multiplier)	9	monthly rate	6,180	55,620	
TOTAL 2nd Year O&M COST (3% annual increase)					$707,191
PROFIT (20%, If Private)					141,438
Contingency (20%)					141,438
TOTAL					$990,067
TOTAL 3rd Year O&M COST (3% annual increase)					$1,019,769
TOTAL 4th Year O&M COST (3% annual increase)					$1,050,363
TOTAL 5th Year O&M COST (3% annual increase					$1,081,873
TOTAL 6th Year O&M COST (3% annual increase					$1,114,330
TOTAL 7th Year O&M COST (3% annual increase)					$1,147,759
TOTAL 8th Year O&M COST (3% annual increase)					$1,182,192
TOTAL 9th Year O&M COST (3% annual increase)					$1,217,658
TOTAL 10th Year O&M COST (3% annual increase)					$1,254,188
TOTAL 11th Year O&M COST (3% annual increase)					$1,291,813
TOTAL 12th Year O&M COST (3% annual increase)					$1,330,568
TOTAL 13th Year O&M COST (3% annual increase)					$1,370,485

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Draft Request for Proposal

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July XXXX, 2015

Dear Interested Offeror:

The Edwards Aquifer Authority (the "EAA") is requesting proposals from qualified vendors for the purpose of providing planning, design, construction, operation and maintenance activities of refugia facilities necessary for practicing husbandry for the care and propagation of the eleven (I I) covered species as required by the Edwards Aquifer Habitat Conservation Plan (proposal # XXX-15-HCP).

Attached is the proposal package. Please complete the attached sheets with one (1) unbound original, three (3) copies and one (1) electronic copy Proposal Summary (Attachment A1), Cost Proposal Summary (Attachment A2), and Client Reference forms (Attachments B1-BJ) and submit to:

Mr. Cyndi Holman
Procurement Specialist
Edwards Aquifer Authority
900 E. Quincy Street
San Antonio, TX 78215

Proposals must be submitted only on the attached proposal summary forms and are to be sealed with "CONSERVATION REFUGIA OPERATIONS PROPOSAL" indicated on the top of the envelope. Proposals are due in the EAA offices no later than 10:00 a.m., XXX, XX, 2015, at which time the proposals will be opened. PROPOSALS RECEIVED AFTER THE DEADLINE WILL NOT BE ACCEPTED AND WILL BE RETURNED IMMEDIATELY UNOPENED.

Proposals offering less than 90 calendar days for acceptance by the EAA from the date set for opening will be considered nonresponsive and will be rejected.

The EAA reserves the right to reject any and all proposals.

A pre-proposal meeting is scheduled for XXXX, XXX, 2015 at 10:00 a.m., at the EAA office.

REQUEST FOR PROPOSAL
FOR
EDWARDS AQUIFER AUTHORITY
EDWARDS AQUIFER HABITAT CONSERVATION PLAN
COVERED SPECIES REFUGIA PROGRAM

PROPOSAL NO. XXX-15-HCP

Issued by:
Edwards Aquifer Authority
900 E. Quincy Street
San Antonio, TX 78215
(210) 222-2204

Issue Date:	TBD
Proposals Close:	TBD
Time:	10:00 a.m., Central Time

SECTION 1. PROJECT INTRODUCTION AND BACKGROUND

1.1 PURPOSE OF REQUEST FOR PROPOSALS (RFP)

The EDWARDS AQUIFER AUTHORITY (EAA) is requesting a statement of team qualifications and technical proposals from qualified vendors to provide a fully integrated team of professionals for Refugia Operations for the covered species under the Edwards Aquifer Habitat Conservation Plan Program (EAHCP). The primary purpose of the EAHCP Refugia Operations is to provide for the development and operations of artificial habitat facilities where viable source populations of covered species can be protected and survive during episodes of drought, disease outbreaks, and water quality impairment in the Comal and San Marcos Springs and River systems with the intent to reintroduce and repopulate following a disturbance back into the wild (i.e., non-refugia springs and river ecosystems).

1.2 DESCRIPTION OF PROPOSED PROJECT

The selected refugia operations team shall develop a Refugia Master Plan intended to serve as the guidance document for future refugia operations for the design, construction, maintenance, and operation of a refugia facility(ies) for 11 threatened and endangered species as part of the **Edwards Aquifer Habitat Conservation Plan Covered Species Refugia Program.** The refugia operations, in coordination with EAA, shall manage all aspects of Refugia Operations for a period of equal to the duration of the Incidental Take Permit (valid through 2028).

Refugia operations is defined herein to include the following:

- Refugia facility planning, programming, design, and construction management,
- Refugia program staffing with qualified and permitted individuals for all EAHCP Covered Species,
- Collection, establishment, and maintenance of refugium populations of EAHCP or similarly sensitive species including standing stocks and salvage stocks,
- Development and refinement of animal rearing methods and captive propagation techniques,
- Conduct of research to further refine refugia operations, and
- Reintroduction and monitoring of EAHCP Covered Species if triggered.

Qualified teams shall demonstrate expertise in fisheries science; fisheries facility engineering; hatchery/refugia program development and operations planning; and environmental compliance.

A record of developing programs in a manner that demonstrates the ability to meet the requirements of the Edwards Aquifer Authority Act, will be a required criteria for vendor qualification. Prospective vendor teams shall describe their approach to developing a Refugia

Master Plan in coordination with EAA and USFWS to meet the requirements of the Edwards Aquifer Habitat Conservation Plan Program (EAHCP).

1.3 PROJECT SCHEDULE

Description:

RFP Advertisement	TBD
Pre-Proposal Meeting	TBD
Last Date for Questions	TBD
Proposals Close	TBD

SECTION 2. INSTRUCTIONS TO OFFERORS

2.1 REQUESTS FOR INFORMATION

This RFP is being issued by the EAA, San Antonio, Texas, which is the sole point of contact for purposes of information concerning this RFP. The EAA reserves the right to issue addenda if required. All questions and inquiries regarding this request for proposal may be submitted in writing to Ms. Cyndi Holman, Procurement Specialist, by 12:00 p.m., Central Time, [DAY, DATE], 2015. Requests for information received prior to the above stated deadline are to be responded to in writing by the EAA in the form of an addendum addressed to all proposal specification recipients.

The EAA will conduct a pre-proposal meeting with prospective Offerors on Wednesday, April15, 2015 at 10:00 a.m. in the Artesian Room of the EAA's office located at 900 E. Quincy Street. All questions regarding this request for proposal will be taken and/or answered up to the last day for questions. All technical questions will be addressed and relayed back to all prospective vendor teams who register at the pre-proposal meeting.

Submission of a proposal shall be considered *prima facie* evidence that the Offeror has familiarized himself/herself with, and understands, the solicitation, its terms and general conditions, etc., under which the contract is to be awarded, administered, and performed. The EAA will not be responsible for any interpretations or misinterpretations of any oral instructions.

There are no expressed or implied obligations for the EDWARDS AQUIFER AUTHORITY to reimburse responding firms for any expenses incurred in preparing proposals in response to this request. Your proposal shall remain valid for a period of ninety (90) days from the closing date.

2.2 SUBMISSION REQUIREMENTS

Offerors are required to submit their proposals on the attached Proposal Summary forms (see Attachment AI). Proposal envelopes are to be plainly marked, "EAHCP REFUGIA PROGRAM PROPOSAL".

Offerors are required to submit their proposals no later than 10:00 a.m., Central Time, on [DAY, DATE], 2015, to:

Mr. Cyndi Holman
Procurement Specialist
Edwards Aquifer Authority 900
E. Quincy Street
San Antonio, TX 78215

NO FACSIMILE PROPOSALS WILL BE ACCEPTED.

Upon receipt by the EAA, each proposal will be stamped with the date and time received and stored unopened in a secure place until the proposal opening. All proposals become the property of the EAA, which will hold the contents of all proposals confidential until an award is made.

PROPOSALS RECEIVED AFTER THE TIME SET FOR THE OPENING WILL BE DECLARED LATE AND NOT ELIGIBLE FOR OPENING AND CONSIDERATION. THE EAA IS NOT RESPONSIBLE FOR MAIL, COURIER OR OTHER DELIVERY METHODS, IN-TRANSIT TIME OR NON-DELIVERY. LATE DELIVERIES WILL BE HELD UNOPENED. OFFEROR WILL BE ADVISED BY MAIL THAT HIS/HER PROPOSAL WAS LATE AND NOT ACCEPTED AND WILL BE ALLOWED TO PICK UP HIS/HER PROPOSAL PACKAGE OR FURNISH A "CALL TAG" AND HAVE THE PACKAGE PICKED UP BY A COURIER.

2.3 PROPOSAL FORMAT

The EAA requires that submitted proposals adhere to the following general format to simplify the review process. Failure to follow the required format or to respond to each specification may result in rejection of the proposal. All proposals must be submitted on the enclosed forms in duplicate, or photocopies of the forms and electronically on CD or flash drive format. Failure to do so may result in rejection of the proposal.

2.3.1 General Requirements

To be considered responsive, responsible, reliable, qualified, and possessing the ability to design, manage and operate the entire project for a period of up to the year 2028 (ITP authorization period). More specifically to be considered qualified, vendor teams, must provide their approach and demonstrate their technical ability to fulfill the criteria for development and management of refugia facilities as described in Attachment A1.

Submit the names of three references (clients or professional recommendations) for whom similar refugia operations and or research has been provided within the past five (5) years on the form contained in Attachments B1-B3, Professional Reference. Do not use the EAA as one of the three references. The description must provide the following minimum information:

- Reference name;
- Reference contact name;
- Reference address and telephone number(s);
- Date contract or conservation activity began; and

- Description of services / conservation activities.

The Offeror agrees EAA staff may contact the references given.

2.3.2 Response to Commercial Questions and Statements

OPTION A – LANGUAGE FOR TECHNICAL AND COST PROPOSAL:

Please answer the questions indicated in Attachment A1, Proposal Summary, directly and specifically. All pricing is to be included in Attachment A2, Cost Proposal Summary. Any exceptions to any of the requirements and specifications contained in this RFP must be noted in the allotted space in Attachment AI. Attachments AI and A2 must be returned with the Offeror's response.

[**NOTE TO EAA**: Need EAA Procurement input on ability to request costs for design portion of work, if required, pursuant to Texas Statutes on procurement of Architectural / Engineering / Survey activities]

OPTION B - LANGUAGE FOR EAA's CONSIDERATION:

Please answer the questions indicated in Attachment A1, Proposal Summary, directly and specifically. Pursuant to the Texas Government Code, Sections 2254.004 (Contract for Professional Services for Architect, Engineer, or Surveyor) and Section 271.119 (Design-Build Contracts for Facilities), this solicitation is intended to identify qualified entities (e.g., state and federal agencies, institutions, and/or private firms) based on team qualifications and overall program approach, with access to property and sustained supply of suitable water from the Edwards Aquifer. EAA intends to develop a shortlist of qualified teams from whom to request full technical and cost proposals for the Refugia Operations program will be solicited.

[**NOTE to EAA:** Need confirmation from EAA related to ability to fund facility on property owned by entity other than State of Texas, subdivision, or the U.S. government**]**

2.3.3 Cost Proposal (NOTE TO EAA: this section only applies to Option A language above)

Provide, under separate sealed envelope, an itemized list of projected costs necessary to complete this project. Use the forms provided in Attachment A2, Cost Proposal Summary, to quote a price for the refugia operations program described in this RFP. The EAA is exempt from sales tax, but could be subject to other types of taxes. If any other type of tax is added, please specify.

[NOTE TO EAA: Need EAA Procurement input on ability to request costs for design portion of work, if required, pursuant to Texas Statutes on procurement of Architectural / Engineering / Survey activities]

2.4 MINORITY-OWNED AND WOMEN-OWNED BUSINESSES

The EAA strongly encourages minority and women-owned businesses to submit proposals. The EAA also encourages applicants, in those instances when joint venturing and/or subcontracting

is appropriate, to form joint ventures and/or provide subcontract opportunities to minority and women-owned firms.

2.5 PROPOSALS BINDING

Proposals must set forth accurate and complete information as required by this RFP (including attachments). Negligence upon the part of the Offeror in preparing the proposal confers no right of withdrawal after the time fixed for the submission of proposals.

2.6 LATE PROPOSALS, MODIFICATIONS, OR WITHDRAWALS

Proposals received after the date and the time indicated will not be considered and will be returned unopened if the Offeror is identified on the envelope.

Proposals may be withdrawn or modified in writing prior to the proposal opening. Responses that are resubmitted or modified shall be sealed and resubmitted to the Procurement Specialist prior to the proposal opening.

2.7 PROPOSAL COSTS

All costs for preparing the proposals are to be borne by the Offeror and may not be included in the cost proposal.

2.8 PROPOSAL SIGNATURE

The EAA will prepare a contract for the successful Offeror using the name exactly as it appears on the proposal. Therefore, it is imperative the Offeror sign the proposal using correct and complete legal names and titles.

2.9 CONTRACT AWARD

The EAA reserves the right to accept or reject any and all proposals. Unless all proposals are rejected or the solicitation is cancelled, the contract is to be awarded to the Offeror whose proposal best meets the requirements and criteria set forth in these specifications. No proposal is to be considered binding upon the EAA until a contract has been awarded. The EAA reserves the right to award the proposal and/or contract to more than one Offeror.

Contract award is to be issued to the successful Offeror by letter. The vendor shall not begin any work on this contract until such time as a Notice to Proceed has been issued by the General Manager.

2.10 CONTRACT

It is expressly understood by the Offerors that written notice of award by the EAA will constitute acceptance of the proposal.

2.11 CONTRACTOR SELECTION

2.11.1 Selection Process

The selection process will include the following steps:

1. Receipt of proposals.
2. Review of proposals submitted.
3. Evaluation of proposals and ranking of Offerors EAA staff shall review all information available from the selection process and rank the Offerors.
4. Contract Award - The EAA will award the contract to the Offeror whose proposal is the most advantageous to the EAA and which will result in the most economical provision of these required services to the EAA.

During the evaluation process the EDWARDS AQUIFER AUTHORITY reserves the right, where it may serve the EDWARDS AQUIFER AUTHORITY best interest, to request additional information or clarifications from proposers or allow corrections of errors or omissions. At the discretion of the EDWARDS AQUIFER AUTHORITY, firms submitting proposals may be requested to make oral presentations as part of the evaluation process.

The EDWARDS AQUIFER AUTHORITY reserves the right to retain all proposals submitted and to use any ideas in the proposal regardless of whether that proposal is selected. Submission of a proposal indicates acceptance by the prospective vendor of the conditions contained in this RFP.

2.11.2 Selection Criteria

Selection will be based on the following criteria which are listed in order of importance:

- Commercial Quality (65 Points)
    - Proven scientific understanding of endangered species issues
    - Experience with similar programs
    - Adequate consideration of scientific constraints
    - Possession of, or plan to obtain, appropriate permits from United States Fish and Wildlife Services (USFWS) and Texas Parks and Wildlife Department (TPWD) as needed for activities including endangered species, or any other requisite permits
    - Description of technical approach for the development of a Refugia Master Plan
    - Ability to start immediately
    - Ability and approach to house (i.e., property, facilities, water, and utilities) standing and salvage stock all the covered species in redundant facilities for a period up to the ITP authorization (i.e., through 2028)
    - Ability to safely collect and transport individuals to and from natural habitats and refugia facilities, including temporary salvage refugia operations
    - Knowledge of the environmental conditions in the project areas and species' habitats

- Demonstration of qualified program management personnel and plan for meeting staffing needs for facility operations, maintenance, culturists, research, salvage operations, etc.
- Customer references and satisfaction of existing customers
- Proposal quality

*If permit(s) are not currently held by firm or proposed team personnel, proposal must include a date by which such permit(s) will be granted and describe the process by which the permit(s) will be obtained.

Cost Factors (30 points) (Note to EAA: Depending on decision regarding procurement of design services, this subsection may require modification)

- Total cost
- Contingency costs (estimated costs for services not included or specified).

Financial Stability (5 points)

- Current financial condition of vendor team members.

2.12 CONFIDENTIAL MATERIAL

Proposals will remain confidential until an award is made, except for the information that is public during a proposal opening. At that time, all information is public unless considered confidential by the Public Information Act, such as trade secrets and financial information. Offeror must indicate if any of the information provided constitutes an exception to the Public Information Act. All information not labeled as confidential will be presumed to be public information.

SECTION 3. SPECIFICATIONS

3.1 BACKGROUND INFORMATION

The EAA is a political subdivision of the State of Texas. Governed by an elected board of directors, the EAA is empowered to manage, preserve, and protect the Edwards Aquifer.

The primary purpose of this project is to develop a refugia operations program for the conservation of eleven (11) covered species listed below and identified in the EAHCP and listed for coverage under the ITP. Additionally, Section K of EAA's ITP requires that the EAA provide for refugia to house and protect the covered species in the event that a drought or other disaster may threaten the species' continued existence without intervention.

3.2 SCOPE OF REQUESTED SERVICES.

The selected refugia operations team shall develop a Refugia Master Plan intended to serve as the guidance document for future refugia operations for the design, construction, maintenance, and operation of a refugia facility(ies) for 11 threatened and endangered species as part of the

Edwards Aquifer Habitat Conservation Plan Covered Species Refugia Program. The refugia program should be developed in accordance with guidelines identified in the EAHCP, Section K of the ITP, and the USFWS "Policy Regarding Controlled Propagation of Species Listed under the Endangered Species Act." The refugia operations, in coordination with EAA, shall manage all aspects of Refugia Operations for a period of equal to the duration of the Incidental Take Permit (valid through 2028).

Refugia operations is defined herein to include the following:

- Refugia facility planning, programming, design, and construction management for one main refugia facility and one redundant refugia facility
- The design of the Refugia facility will be based upon space requirements and specifications presented in the conceptual layout (see Appendix 1). (Note to EAA: this appendix should be the conceptual layout in Appendix A of the main report)
    - This facility, or series of facilities, could be new construction, existing infrastructure with new construction, or existing infrastructure modified to meet the space requirements identified in Appendix 1.
    - Salvage facility components could be constructed at a separate location and/or at a later date.
- Refugia program staffing with qualified and permitted individuals for all EAHCP Covered Species
- Collection, establishment, and maintenance of refugium populations for EAHCP covered species standing stocks, refugia stocks, and salvage stocks,
- Development and refinement of animal rearing methods and captive propagation techniques,
- Conduct of research to further refine refugia operations,
- Reintroduction and monitoring of EAHCP Covered Species if triggered, and
- Refugia program reporting (ITP/USFWS and TPWD Scientific Collection Permits annual reports and USFWS/EAHCP compliance meetings,

In responding to this RFP, the Offeror shall discuss the general approach to tasks, specific methodologies, infrastructure, project management and team organization, strategies to accomplish work in a timely manner, and budget requirements to complete each of the tasks listed below. After the negotiation of a contract and for the following scope of work, the successful Offeror will be a Contractor with the EAA

- **Task 1.** Development of a Refugia Master Plan in coordination with EAA and the USFWS to provide detailed plans intended to serve as the guidance document for design, construction, maintenance, and operation of a refugia facility(ies) with appropriate redundancy for 11 threatened and endangered species as part of the Edwards Aquifer Habitat Conservation Plan Covered Species Refugia Program

- **Task 2.** Construction of new, or identification of existing, facility (ies) capable of satisfying criteria described within this RFP.
- **Task 3.** Collection, establishment, and maintenance of standing stocks, refugia stocks, and salvage stocks of Covered Species (when triggered).
- **Task 4.** Conduct research as necessary to expand knowledge of the EAHCP Covered Species necessary for refugia operations, including by not limited to species' physiology, environmental requirements, health and disease issues, life histories, and effective reintroduction techniques. The Contractor will propose, with confirmation of EAA staff, specific research needed to accomplish Task 1.
- **Task 5.** Develop and refine animal rearing methods and captive propagation techniques for the Covered Species. The Contractor will document the success and failures of each rearing methods and captive techniques.
- **Task 6.** Reintroduction of species and monitoring of recovery in the event of a loss of species in their native environment in coordination with USFWS.
- **Task 7.** Annual reports describing all activities completed under this project including "lessons learned." This task also requires the development (and annual updates) of a "stand alone procedural/operations manual.
- **Task 8**: Attend meetings and give presentations to the USFWS regulatory division, EAHCP Science Committee, EAHCP Implementing Committee, and EAA Board of Directors as requested by the EAHCP Program Manager. Offeror should budget for a minimum of three meetings each year.

The Qualified teams shall demonstrate expertise in fisheries science; fisheries facility engineering; hatchery/refugia program development and operations planning; and environmental compliance.

A record of developing programs in a manner that demonstrates the ability to meet the requirements of the Edwards Aquifer Authority Act, will be a required criteria for vendor qualification. Prospective vendor teams shall describe their approach to developing a Refugia Master Plan in coordination with EAA and USFWS to meet the requirements of the Edwards Aquifer Habitat Conservation Plan Program (EAHCP).

Offerors will be required to demonstrate extensive knowledge of refugia operations, care and propagation, and research of the 11 covered species listed in the EAHCP. Offerors may be required to conduct research to assist in successfully implementing refugia for the covered species and may include: physiology, life histories, effective reintroduction techniques, collection techniques, husbandry, and propagation.

The use of EAA funds will be limited to the operation and maintenance of refugia for the covered species, other operations and research activities will not be funded.

The refugia program will be developed to maintain standing stock, refugia stock, and salvage stock (if necessary). Standing stock and refugia stock will be collected and maintained in a manner that preserves genetic integrity of covered species. The refugia program will also be

developed in a manner that allows for the adaptation of target numbers and management units as new information about the species becomes available. Current standing stock and refugia stock target numbers for each species are as follows:

Species	Common name (system)	Targeted Number
Plants		
Zizania texana	Texas wild-rice (San Marcos River)	430
Fish		
Etheostoma fonticola	Fountain darter (San Marcos River)	1,000
	Fountain darter (Comal River)	600
Salamanders		
Eurycea rathbuni	Texas blind salamander	500
Eurycea nana	San Marcos salamander (San Marcos River)	500
Eurycea sp.	Comal Springs salamander (Comal River)	500
Invertebrates		
Heterelmis comalensis	Comal Springs riffle beetle (Comal River)	500
Stygobromus pecki	Peck's cave amphipod	500
Stygoparnus comalensis	Comal Springs dryopid beetle (Comal River)	500
Lirceolus smithii	Texas troglobitic water slater (Comal River)	500
Haideoporus texanus	Edwards Aquifer diving beetle (Comal River)	500

The contractor will collect, house and care for salvage stock if required based on certain EAHCP triggers. Salvage stock triggers and target numbers for each species are as follows:

Species	Common name (system)	EAHCP Triggers	Targeted Number
Plants			
Zizania texana	Texas wild-rice (San Marcos River)	< 3,500 m^2 total coverage in the San Marcos River; or Texas wild-rice exists at < three (3) of the seven (7) distinct sections (Biological Monitoring sections)	1,500
Fish			
Etheostoma fonticola	Fountain darter (San Marcos River)	≤ 75 cfs for four (4) consecutive days	2,500
	Fountain darter (Comal River)	< 50% mean aquatic vegetation (Landa lake and Old Channel) and darter presence system wide; or <20% mean aquatic vegetation (Landa Lake and Old Channel) and <30% darter presence system wide	2,000
Salamanders			
Eurycea rathbuni	Texas blind salamander	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500

Species	Common name (system)	EAHCP Triggers	Targeted Number
Salamanders (continued)			
Eurycea nana	San Marcos salamander (San Marcos River)	< 50% suitable habitat (Biological Monitoring locations) and < 20% salamander density; or < 25 % suitable habitat (Biological Monitoring locations) and < 30% salamander density	500
Eurycea sp.	Comal Springs salamander (Comal River)	< 50% suitable habitat (Biological Monitoring locations) and < 20% salamander density; or < 25 % suitable habitat (Biological Monitoring locations) and < 30% salamander density	500
Invertebrates			
Heterelmis comalensis	Comal Springs riffle beetle (Comal River)	< 30 cfs when only one (1) of three (3) monitored sites continues to have six (6) or more adult Comal Springs riffle beetles collected in a 24 hr sample period using cotton lures	500
Stygobromus pecki	Peck's cave amphipod	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
Stygoparnus comalensis	Comal Springs dryopid beetle (Comal River)	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
Lirceolus smithii	Texas troglobitic water slater (Comal River)	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500
Haideoporus texanus	Edwards Aquifer diving beetle (Comal River)	When any standard or conventional water quality parameter exceeds the historical range of water quality parameters for the Edwards Aquifer by ≥ 10%	500

ADDITIONAL INFORMATION TO OFFERORS

1. Proposals shall discuss the process and methodology for completing the tasks described in this RFP. It should identify all subcontractors that will be used on the project and the task on which each subcontractor will be used.
2. The Contract will be a time and material contract with a specified "not to exceed" amount.

   The budget will be itemized by tasks. Cost estimates should take personnel, infrastructure, supplies, equipment, and travel into account for each task. Project personnel should be identified by position title and the hourly rate. The budget should clearly indicate the indirect costs or overhead charged for the work.
3. This project requires the use of Edwards Aquifer groundwater. The proposal should include discussion of the water source for the proposed project including purveyor, access point, etc.

4. The proposal should discuss infrastructure and facilities (existing or proposed), and location of refugia.
5. The proposal should discuss health issues including disease control and disinfection of effluent discharge and quarantine of the covered species brought in.
6. The Offeror may propose to provide refugia for all or some of the 11 covered species.

   The proposal should clearly indicate which species the proposal addresses.
7. Scope alterations are encouraged and should contain detailed discussions of task alternatives, alternative task budgets, and alternative timelines. If scope alternatives are provided, the Offeror will provide a separate budget table as described in section 3.2.2 of this RFP.
8. The EAA reserves the right to select any combination of tasks and subtasks for the final scope of work.

3.2.2 Pricing Information

Respondents are required to submit itemized cost proposals for items as described in this RFP in a separate sealed envelope. The form shown in Attachment A2 shall be used for all costs. All charges are to be included in the cost proposal. All price quotations shall be valid for at least 90 days from the proposal opening. (Note to EAA: Depending on decision regarding procurement of design services, this subsection may require modification)

SECTION 4. TERMS AND CONDITIONS

4.1 STANDARD FORM OF CONTRACT

Attached is a copy of the EAA's Standard Form of Contract stating the general terms and conditions which will be contained in any contract resulting from this RFP (see Attachment C). Exhibit A, Scope of Work, of the contract form is attached for informational purposes only. Exhibit A is not to be completed at this time. It will be completed upon award of contract. Offerors, by virtue of submitting a proposal, acknowledge, understand, and agree to these terms and conditions, unless such is indicated on the Proposal Summary.

4.2 LAWS AND REGULATIONS

The EAA requires that all responses to this RFP, and any contracts that may result, be in accordance with the laws and regulations of the State of Texas. Furthermore, the awarded Contractor must adhere to all Occupational Safety and Health Administration standards as applicable to the contracted work.

4.3 PROPOSAL ACCEPTANCE PERIOD

All prices and conditions of the proposal shall remain in effect for 90days after the date set for the proposal opening. Proposals offering less than 90 calendar days for acceptance by the EAA from the date set for opening will be considered nonresponsive and will be rejected.

The EAA's Code of Ethics is attached for your reference only (see Attachment D). No action is necessary.

4.4 TIME OF COMPLETION

The Contractor shall take all necessary and appropriate actions to complete the project in accordance with the ongoing schedule incorporated in the resultant contract.

4.5 INSURANCE REQUIREMENTS

4.5.1 Worker's Compensation Insurance

The Contractor shall procure and shall maintain during the life of the contract, Worker's Compensation and Employer's Liability Insurance as required by applicable State law for all of his/her employees to be engaged in work at the site of the project under the contract and, in case of any such work sublet, the Contractor shall require the subcontractor(s) similarly to provide Worker's Compensation Insurance for all of the latter's employees to be engaged in such work unless such employees are covered by the protection afforded by the Contractor's Workers Compensation and Employer's Liability Insurance. In case any class of employees engaged in hazardous work on the project under the contract is not protected under the worker's compensation statutes, the Contractor shall provide and shall cause each subcontractor to provide adequate Employer's Liability Insurance in the amount of $500,000 for the protection of such of his/her employees as are not otherwise protected.

4.5.2 Contractor's (Commercial General) Public Liability and Property Damage Insurance and Vehicle Liability Insurance

The Contractor shall procure and shall maintain during the life of the contract Commercial General

Liability (Bodily Injury and Property Damage) Insurance and Automobile (Vehicle) Liability Insurance coverage as specified below. The General Liability Policy shall also include products and Completed Operations Insurance in the same limits as the General Liability coverage as well as an endorsement providing Broad Form Contractual Liability coverage:

INSURANCE COVERAGE

1. Worker's Compensation Statutory,

   and

2. Employer's Liability: $100,000/500,000/100,000

Commercial General (Public) Liability insurance including coverage for the following:

a. Premises operations
b. Independent contractors
c. Products/completed operations
d. Personal injury
e. Contractual liability

f. Medical payments
g. Underground hazard
h. Explosion and collapse hazard
i. EAA's property in Contractor's care, custody, or control

1. Each Occurrence: $1,000,000,

   and

2. General Aggregate: $2,000,000

Comprehensive Automobile Liability Insurance, including coverage for loading and unloading hazards, for:

a. Owned/Leased vehicles
b. Non-owned vehicles and;
c. Hired vehicles

Combined single limit for bodily injury and property damage of $500,000 per occurrence or its equivalent.

4.5.3 Subcontractor's Public Liability and Property Damage Insurance and Vehicle Liability Insurance.

The Contractor shall either (1) require each subcontractor to procure and to maintain during the life of his/her subcontract, Subcontractor's Public Liability and Property Damage Insurance, and Vehicle Liability Insurance of the type and in the amounts specified or, (2) insure the activities in his/her policy as specified.

4.5.4 Additional Insureds

The Contractor shall provide in the Liability Policies of Insurance the Edwards Aquifer Authority as additional insured as it relates to this contract.

4.5.5 Scope of Insurance and Special Hazards

Insurance required under the above sections shall provide adequate protection for the Contractor and his/her subcontractors, respectively, against damage claims which may arise from operations under the contract, whether such operations be by the insured or by anyone directly or indirectly employed by him/her, and also against any of the special hazards which may be encountered in the performance of the contract, including explosions, collapse and underground hazards.

4.5.6 Proof of Insurance Coverage

The Contractor shall furnish the EAA with insurance certificates for him/her and his/her subcontractors showing the type, coverage, limits of liability, class of operations covered, effective dates, date of expiration of policies and name of insurance companies prior to beginning any work. The attached Insurance Requirement Affidavit is required to be submitted along with the Proposal. The Contractor must furnish the EAA with 30 days written notice by either certified mail or personal delivery should any of the above described policies change that

materially affect the coverage or be cancelled prior to the expiration date. All notices shall be mailed to:

Ms. Cyndi Holman
Procurement Specialist
Edwards Aquifer Authority
900 E. Quincy Street
San Antonio, TX 78215

Insert the following:

EDWARDS AQUIFER AUTHORITY, INSURANCE REQUIREMENT AFFIDAVIT

EAA RFP Attachments A1, A2, B1-B3, C, D

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