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San Antonio Water System Micron Pipeline and Water Resources Integration Program Habitat Conservation Plan

Prepared for

San Antonio Water System

Prepared by

SWCA Environmental Consultants

SWCA Project Number 26461-AUS

FINAL November 2017

SAN ANTONIO WATER SYSTEM
MICRON PIPELINE AND WATER RESOURCES INTEGRATION PROGRAM
HABITAT CONSERVATION PLAN

Prepared for

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1.0 INTRODUCTION

This San Antonio Water System (SAWS) Micron Pipeline and Water Resources Integration Program Habitat Conservation Plan (HCP) describes SAWS' proposed approach for achieving compliance with the federal Endangered Species Act (ESA) related to the completion of two water integration pipeline projects in Bexar County, Texas (together, the Proposed Projects). The Proposed Projects include portions of the SAWS Water Resources Integration Program (WRIP) and portions of the SAWS Micron to Anderson Tank Phase II Project (Micron Pipeline). The completion of the Proposed Projects has the potential to incidentally take one or more karst invertebrate species that are listed as endangered under the ESA. Any such taking without prior authorization from the U.S. Fish and Wildlife Service (USFWS) would violate section 9 of the ESA. To obtain regulatory certainty, SAWS seeks an Incidental Take Permit (ITP) from the USFWS to authorize a certain amount of take that could occur as a result of the Proposed Projects. This HCP describes the conservation measures proposed by SAWS to benefit listed karst invertebrates in the vicinity of the Proposed Projects and supports an application to the USFWS for an ITP, in accordance with section 10(a)(1)(B) of the ESA.

1.1 Description of the Proposed Projects

1.1.1 *Water Resources Integration Program*

The WRIP is a proposed 45-mile long, 48-inch (may occasionally be up to 60-inch) diameter steel water transmission main that will convey up to 75 million gallons of potable water per day between the Twin Oaks Aquifer Storage and Recovery (ASR) facility in southern Bexar County and SAWS pump stations, both new and existing, in western Bexar County (Figure 1). SAWS determined its preferred route for the WRIP Pipeline in 2008 (Black and Veatch 2004; Chiang, Patel & Yerby Inc. 2005). Once in operation, potable, chlorine-treated water will be moving through the pipeline at all times.

Only a 16.4-mile long segment of the WRIP between the Old Pearsall Road Pump Station and the Anderson Pump Station is addressed in this HCP (the "WRIP Project"; Figure 1), since the remainder of the WRIP is not expected to impact federally threatened or endangered species (Hicks & Company and Civil Engineering Consultants 2012). SAWS completed the acquisition of 78 permanent easements for the WRIP Project in 2014. The permanent easements, which comprise the limits of the WRIP Project Area, are 80-feet wide and collectively include 159.03 acres of land.

The pipeline will be placed underground within the WRIP Project Area. Current construction designs call for approximately 95 percent of the WRIP Project to be installed via surface trenches and the remaining approximately 5 percent of the pipeline to be installed within bored subsurface tunnels to avoid impacts to stream crossings, public roadways, and heritage trees at the surface.

Construction designs for the WRIP Project are currently available at the 90 percent design plan stage. SAWS will finalize the construction plans and standardized specifications prior to project implementation. However, aspects of the proposed WRIP Project relevant to listed species (primarily the location and extent of the proposed subsurface disturbances) are not expected to change with the final design.

Key design elements of the WRIP Project are summarized in Table 1 and described in more detail in Section 3.0.

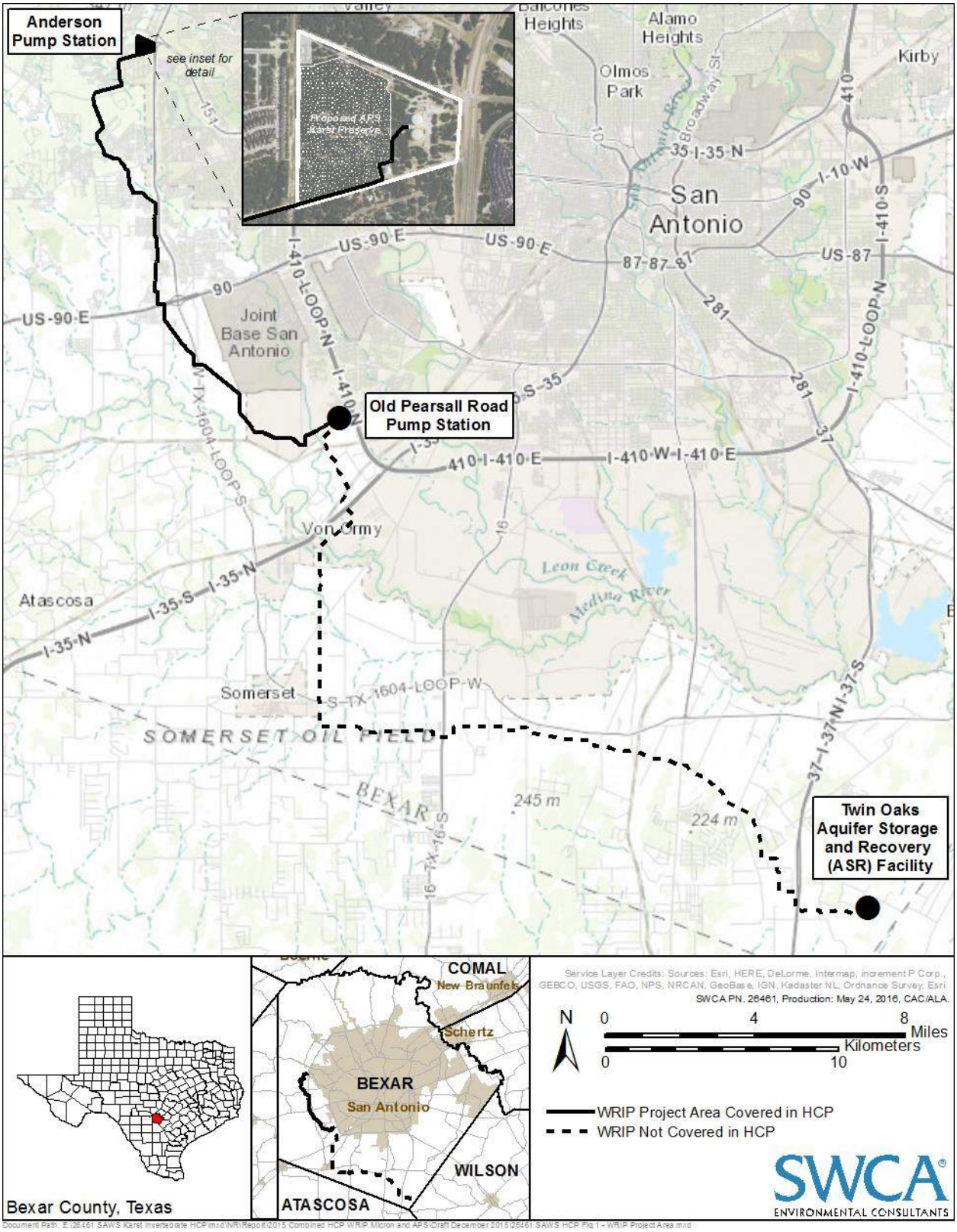

Figure 1. Location of the WRIP Project Area.

Table 1. Approximate Quantities and Dimensions for Key Elements of the WRIP Project.

Project Design Element	Proposed WRIP Project
Pipeline Length	86,592 feet (16.4 mi)
Permanent Easement	80 ft wide (total 159.03 acres)
Temporary Easement	none
Pipe Diameter	48 to 60 inches
Length of Open-Cut Trench	83,793.6 ft (15.87 mi)
Length of Bore, Jack, or Tunnel	2,798.4 ft (0.53 mi)
Typical Trench Dimensions	7 ft wide x 10 to 20 ft deep
Typical Bore/Tunnel Dimensions	66- inch diameter; placed 5 to 35 ft below surface grade
Typical Bore Pit Dimensions	25 ft x 40 ft at surface; 10 to 40 ft deep
Number of Bore Pits	36

1.1.2 *Micron Pipeline*

The Micron Pipeline is a partially constructed, approximately 5.5-mile long, 48-inch diameter steel water transmission main that will connect the existing SAWS Micron Pump Station and the existing SAWS Anderson Pump Station. This pipeline will carry potable, chlorine-treated Edwards Aquifer water between the stations. The Micron Pipeline includes three phases, two of which are already complete. The portion of the Micron Pipeline that is incomplete involves the installation of approximately 2,324 feet of pipeline. This HCP addresses only this incomplete portion of the Micron Pipeline (the "Micron Project", Figure 2).

The finalized route for the Micron Project crosses State Highway (SH) 151, and then travels along the edge of an exit ramp of Loop 1604 within private property, before crossing Loop 1604 onto the Anderson Pump Station that is located at the southwest corner of SH 151 and Loop 1604. The highway rights-of-way (ROWs) crossed by the Micron Project are owned by the Texas Department of Transportation (TxDOT) and construction of the pipeline under these state-owned transportation facilities will be accomplished by boring and tunneling. The other portions of the Micron Project will be installed via surface trenching, generally within an already acquired 45-foot wide easement that includes 20 feet of permanent easement and 25 feet of temporary construction easement. Within the SAWS-owned Anderson Pump Station site, construction will take place within an area approximately 4.5 feet to 8 feet wide. The Micron Project Area includes approximately 1.4 acres.

Construction on the Micron Project began on November 15, 2011, but was halted on September 18, 2012, following the discovery of eyeless spiders of the genus *Cicurina* by TxDOT contractors within the ROW for SH 151 near the project site. Prior to the stop work order, approximately 856 feet of boring and steel casing was completed under SH 151 and under a portion of Loop 1604. However, due to the demobilization, the bore under Loop 1604 has not been completed and approximately 160 feet of boring and steel casing remains to be completed at this location. None of the surface trenching has been completed. To date, the pipeline remains incomplete and work crews and equipment were demobilized. Bore pits were filled in to stabilize the area while construction is on hold.

Key design elements of the Micron Project are summarized in Table 2 and described in more detail in Section 3.0.

Table 2. Approximate Quantities and Dimensions for Key Elements of the Micron Project.

Project Design Element	Proposed Micron Pipeline Phase 2 Project
Pipeline Length	2,324 ft
Private Lands Permanent Easement	20 ft wide
Private Lands Temporary Easement	25 ft wide
Total Area of Disturbance	1.4 acres
Pipe Diameter	48 inches
Length of Open-Cut Trench	1,308 ft
Length of Bore, Jack, or Tunnel	1,016 ft *(856 ft completed; 160 ft remaining)*
Typical Trench Dimensions	7 ft wide x 10 to 20 ft below grade
Typical Bore/Tunnel Dimensions	66-inch diameter; placed 5 to 35 ft below surface grade
Typical Bore Pit Dimensions	25 ft x 40 ft at surface; 10 to 40 ft deep
Number of Bore Pits	4 *(completed, but filled)*

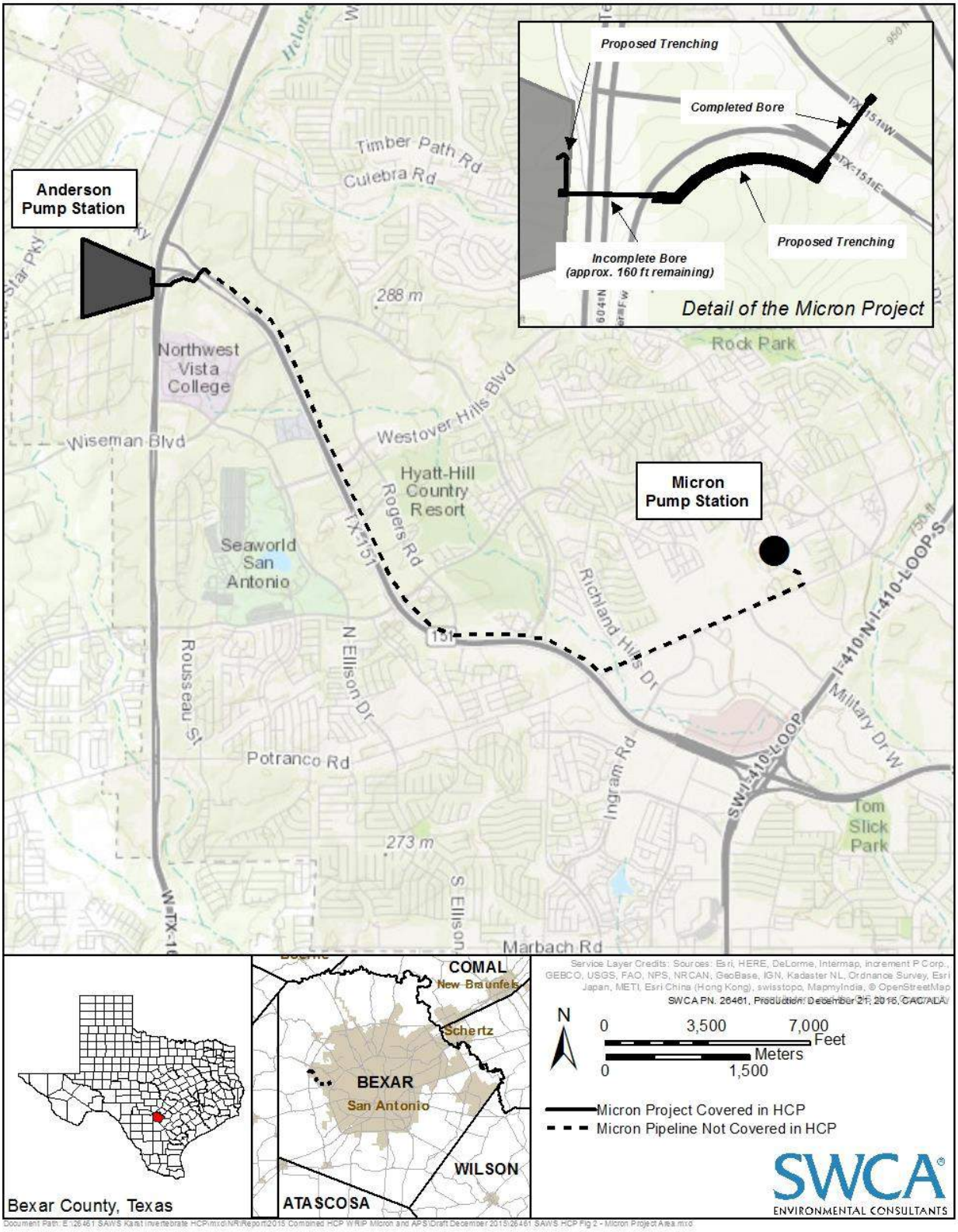

Figure 2. Location of the Micron Project.

1.2 Purpose and Need for the Proposed Projects

SAWS was established in 1992 to create a single public utility responsible for water, wastewater, and reuse water for the City of San Antonio, Texas. SAWS holds one Certificate of Convenience and Necessity (CCN) to provide potable water service issued by the Texas Commission of Environmental Quality (TCEQ). According to section 13.250 of the Texas Water Code, "continuous and adequate service" to a certificated area is required. The Proposed Projects are critical to the continuing ability of SAWS to meet the increasing demand for its services caused by population growth and urban expansion.

The SAWS 2012 Water Management Plan is a tool used by SAWS to effectively plan how current water supplies will be conserved and how future supplies will be supplemented with alternative water sources (SAWS 2012). The Water Management Plan establishes water resource availability and helps establish the rate structure to support future needs. One element considered in the Water Management Plan is population growth. SAWS must anticipate population growth within its certified area and determine how to effectively manage per capita consumption. As population continues to increase in the region, SAWS must anticipate local water needs and ensure that adequate supply and supporting infrastructure are available to accommodate that growth. The Proposed Projects contribute to the larger need for reliable water resources in support of health and human safety that could be jeopardized if sufficient water resources were unavailable.

The Micron Pump Station was added to the SAWS distribution system in 2003. The Micron Pump Station pumps water from three Edwards Aquifer supply wells. The proposed Micron Pipeline will connect the Micron Pump Station to the Anderson Pump Station allowing for efficient and direct movement of water necessary to meet the needs of SAWS customers in the Anderson Pump Station service area. The proposed Micron Pipeline is a critical component of the SAWS distribution system as it provides key infrastructure to water delivery services in the western portion of San Antonio and Bexar County.

The proposed WRIP is identified as a critical component in the Water Management Plan for its ability to help SAWS meet increasing water demands while lessening its dependence upon the Edwards Aquifer (SAWS 2012). The proposed WRIP would allow for the expanded use of four alternative water supplies intended to lessen the pumping demand on the Edwards Aquifer, including the Local Carrizo Project, the Expanded Carrizo Project, the Brackish Desalination Project, and the ASR Program. Together, these four alternative water supplies have the ability to provide up to 34.1 percent of the water needed by SAWS customers during a repeat of the Drought of Record (SAWS 2012).

The proposed WRIP will be used to transport water in two directions. Water transmitted from the Twin Oaks facility would be distributed to water customers in western Bexar County. At the discretion of SAWS water planners, reverse flow from the western pump stations to the ASR facility could return water into the ASR for recovery at a later date. The direction of flow would depend on the availability of various water sources at any given time. The use of the proposed WRIP for this purpose (recharge of the ASR for storage and later use) is Phase II presumptive mitigation for the Edwards Aquifer Recovery Implementation Program (EARIP) Habitat Conservation Plan (EAHCP) approved by the U.S. Fish and Wildlife Service (USFWS) on March 18, 2013.

1.3 Regulatory Context

Construction of the Proposed Projects would occur in a region known to be occupied by several endangered species of karst, or cave-adapted, invertebrates that are protected by the ESA. While, despite full due diligence investigations, the actual presence of listed species or occupied habitats has not been documented within the Project Areas (see Section 2.2.1), the subterranean and cryptic nature of these species leaves open the possibility that take could occur during construction. SAWS, therefore,

desires to obtain the regulatory assurance that take of listed species associated with the Proposed Projects would be authorized by an ITP issued by the USFWS.

The ESA protects listed wildlife species, including invertebrates, by prohibiting "take". "Take "is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 U.S.C. § 1532 [19]). "Harm" is also defined by USFWS regulations as an "act which actually kills or injures wildlife and may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding or sheltering" (50 CFR 17.3). The USFWS may authorize take that occurs incidental to otherwise lawful, non-federal activities by the issuance of an ITP under section 10(a)(1)(B) of the ESA.

Section 10(a)(2)(A) of the ESA provides that the USFWS must issue an ITP provided that the application meets several substantive criteria, including that the applicant submits a conservation plan that: (1) describes the impact that will likely result from the taking; (2) identifies the steps the applicant will take to minimize and mitigate the impacts and the funding available to implement those steps; (3) describes what alternative actions to taking were considered and the reasons the alternatives were not chosen; and (4) includes other measures that the USFWS may require as necessary or appropriate for purposes of the conservation plan (16 USC § 1539(a)(2)(A)). The USFWS Habitat Conservation Planning and Incidental Take Permit Processing Handbook (HCP Handbook) also provides guidance on the elements of an HCP, including the identification of biological goals and objectives, inclusion of biological monitoring and adaptive management measures, and other items (USFWS and National Marine Fisheries Service [NMFS] 1996). ESA implementing regulations also give permittees "no surprises" assurances that provide certainty as to their future obligations under the ESA (50 CFR §§ 17.22, 17.32, 222.2; USFWS 2014a).

This HCP is intended to support an application by SAWS for an ITP with a term of 15 years from the date of issuance and covering federally endangered karst invertebrates that may be taken as a result of the construction or maintenance of the Proposed Projects. SAWS is the sole applicant for the ITP, and will hold the ITP once issued.

Section 7(a)(2) of the ESA requires that each federal agency consult with the USFWS to ensure that agency actions it authorizes, funds, or carries out are not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat (16 USC § 1536(a)(2)). "Jeopardize" is defined by the regulations as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, number, or distribution of that species" (50 CFR § 402.02). As described in the HCP Handbook, issuance of an ITP is considered an action to which section 7(a)(2) applies (USFWS and NMFS 1996). With respect to the issuance of ITPs, the USFWS functions as both the "action" agency and the "resource" agency, so that the USFWS is actually consulting with itself. According to the HCP Handbook, the consultation must include consideration of the direct and indirect effects on the species, as well as the impacts of the proposed project on listed plants and critical habitat, if any (USFWS and NMFS 1996). This HCP considers the impacts of the Proposed Projects with respect to the jeopardy and adverse modification of critical habitat standards provided for in the ESA.

1.4 Karst Invertebrate Discoveries at State Highway 151 and Loop 1604

Between May and October 2012, contractors discovered 25 karst features within TxDOT ROW during construction activities sponsored by that agency at the intersection of SH 151 and Loop 1604 (TxDOT project number CSJ: 2452-01-043), just north of the proposed Micron Project Area (Figure 3). Zara Environmental LLC (Zara) investigated these 25 karst features for potential karst invertebrate habitat and the presence of endangered karst invertebrates (Zara 2013). Zara (2013) reported that four of the 25 features did not contain potential habitat for karst invertebrates and it performed no further investigation of these features. Zara conducted karst invertebrate presence/absence surveys within the remaining 20 features, following USFWS protocols in place at the time. Zara collected a total of 13 individual eyeless *Cicurina* spiders from six of the karst features over a combined 247 survey days of collecting effort with bait trapping. Of the 13 collected eyeless *Cicurina* individuals, three specimens pulled from two of the karst features were adults (two females and one male) that could be identified morphologically (Zara 2013). The remaining 11 collected eyeless *Cicurina* specimens were juveniles that cannot be identified to species without genetic analysis and remain, to-date, unidentified at the species level.

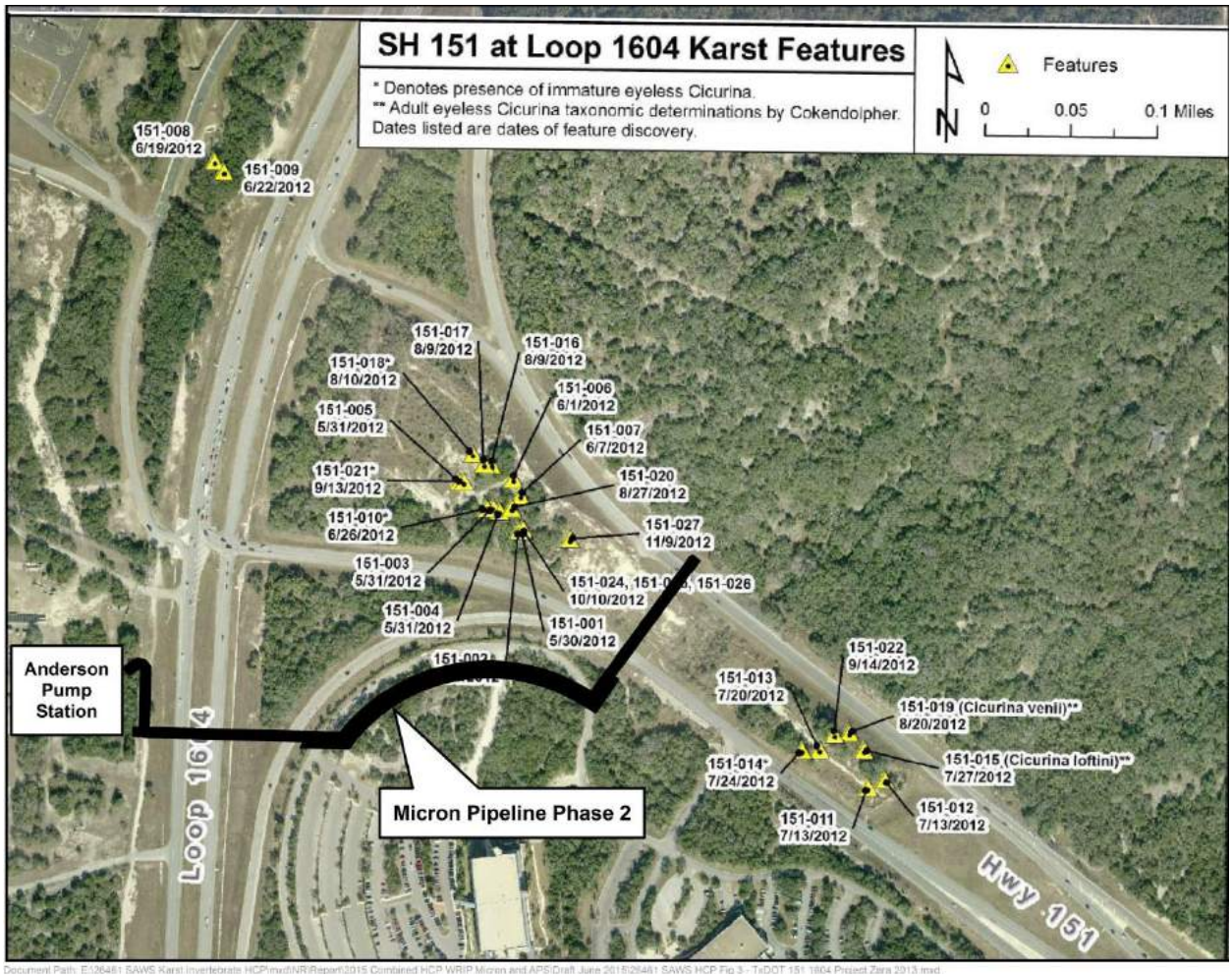

Figure 3. TxDOT SH 151/Loop 1604 project site with construction-phase karst feature discoveries (modified from Zara 2013).

Zara sent the three adult *Cicurina* specimens to two different sets of taxonomists for independent identification. Cokendolpher (2012) concluded that one karst feature contained *C. venii,* while another contained specimens of a non-listed eyeless species, *C. loftini*. A second group of taxonomic experts examined the same three specimens and came to an entirely different conclusion (Paquin and Ledford 2012). In their view, the alleged *C. venii* specimen is actually *C. madla*, and the other three specimens belong to *C. baronia*, both species being listed as federally endangered (Paquin and Ledford 2012) but neither previously known to occur in the karst fauna region of the project site.

Zara (2011) reported the findings of other preconstruction investigations supporting the TxDOT SH 151/Loop 1604 project and documented the discovery of Clandestine Cupola Cave in the TxDOT Loop 1604 ROW (Figure 4). This cave occurs approximately 500 feet south of the Micron Project Area. Zara collected several juvenile eyeless *Cicurina* spiders from this cave in 2010 that were genetically consistent with specimens of *C. loftini*, a non-listed species; although, a definitive taxonomic identification was not provided (Zara 2011). Zara (2011) raised the possibility that, due to the lack of comparative genetic material, the collected *Cicurina* from Clandestine Cupola Cave could be members of the endangered *C. venii*.

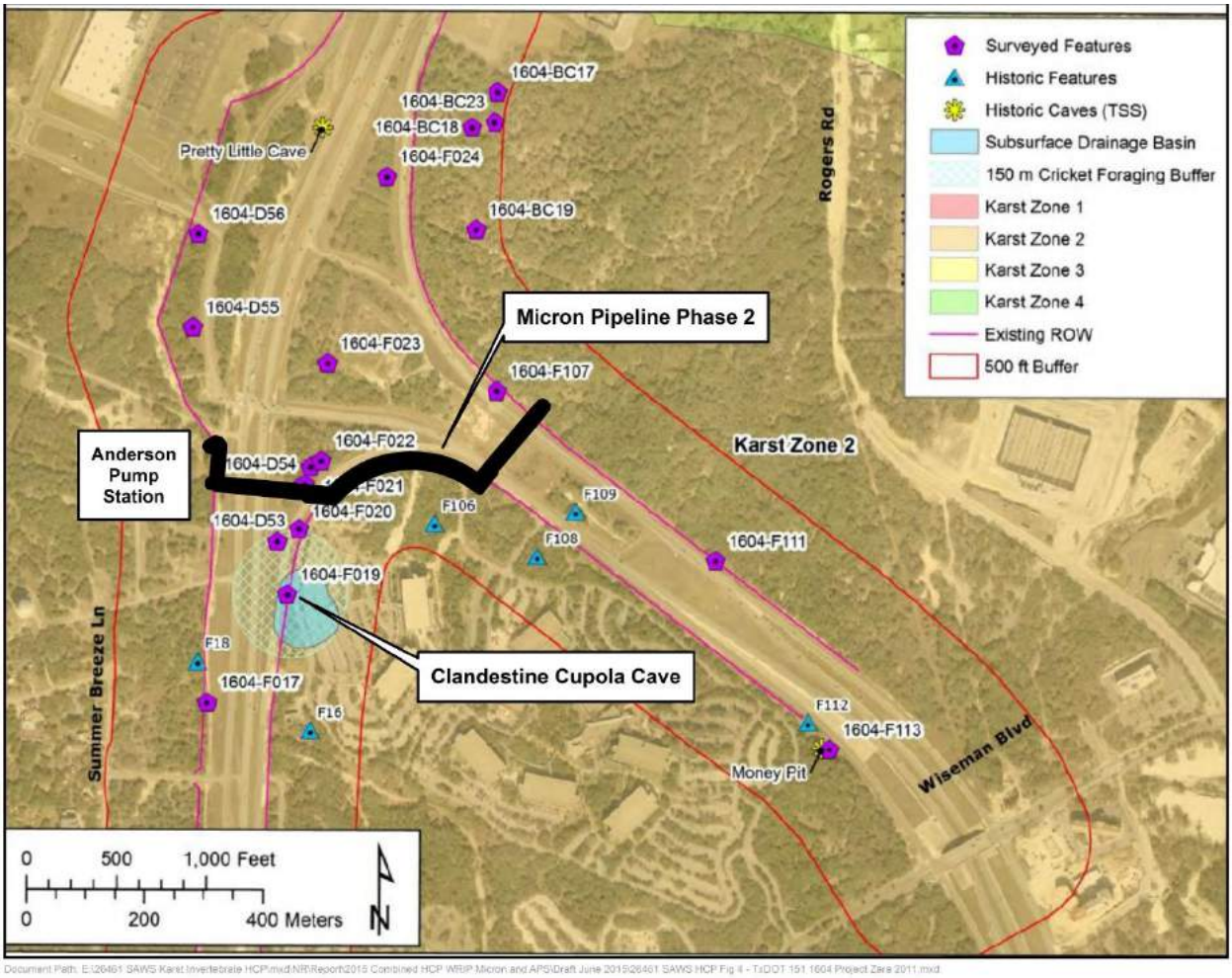

Figure 4. TxDOT SH 151/Loop 1604 project site with pre-construction karst feature discoveries (modified from Zara 2011).

Table 3 lists the collection records and taxonomic identifications for collected *Cicurina* specimens from TxDOT ROW in the vicinity of the Proposed Projects.

Table 3. Taxonomic identify of collected eyeless *Cicurina* spiders from TxDOT ROW in the vicinity of the Proposed Projects.

Specimen ID	Collected Location	Collection Date	Species ID (Cokendolpher 2012)	Species ID (Paquin and Ledford 2012)	Notes
ZARA #7650; P&L No. 188501 (female eyeless *Cicurina*)	Feature 151-019	August 23, 2012	*C. venii*	*C. madla*	Cokendolpher: suggests that preparation of specimen or other damage can result in mis-identification; notes that *C. venii* very similar (same?) to *C. madla* Paquin and Ledford: morphology does not match illustrations of *C. venii* holotype; morphology matches *C. madla* from Lost Pothole Cave and is within range of variation for *C. madla*
ZARA #7308; P&L No. 188520 (female eyeless *Cicurina*)	Feature 151-015	August 6, 2012	*C. loftini*	*C. baronia*	Paquin and Ledford: believe *C. baronia*, *C. loftini*, and *C. vespera* are synonymous; naming priority would place all three species under the name of *C. baronia*
ZARA #7308; P&L No. 188519 (male eyeless *Cicurina*)	Feature 151-015	August 6, 2012	*C. loftini*	*C. baronia*	Cokendolpher: male specimen not studied in detail; assumed to be same species as female from same location Paquin and Ledford: morphology in need of further exploration, but closely matches that of *C. baronia*
ZARA specimens number 8 and 9 (immature eyeless *Cicurina*)	Feature 1604-F019 (Clandestine Cupola Cave)	June 16, 2010	n/a	n/a	Zara (2011): Immature specimens were a genetic match with *C. loftini* specimens according to mitochondrial DNA analysis conducted by F.J.G. de Leon at Centro de Investigaciones Biológicas del Noroeste, S.C. in La Paz, BCS, Mexico Zara (2015): suggests these specimens are either *C. loftini* or *C. venii*

Therefore, the eyeless *Cicurina* recovered from features in the vicinity of the Proposed Projects have been variously identified as three different listed species (*C. venii*, *C. madla*, and *C. baronia*) and one non-listed species (*C. loftini*). The conflicting conclusions arise from the fact that *Cicurina* taxonomy is in the process of being revised. In response to the likely presence of at least one listed karst invertebrate species at the SH 151/Loop 1604 project site, TxDOT halted construction activities in order to consult with the USFWS and address impacts to the previously unknown presence of a listed species. In October 2012, TxDOT also withdrew permission for SAWS to operate within TxDOT ROW during construction of the Micron Project, which was underway at the time.

2.0 PLAN AREA

The Plan Area for this HCP includes three separate areas: the WRIP Project Area (80 feet wide; approximately 16.4 miles long); the Micron Project Area (up to 45 feet wide; 2,324 feet long); and the proposed Anderson Pump Station (APS) Karst Preserve (approximately 57.6 acres of existing SAWS property to be established as a karst invertebrate habitat preserve) (Figure 5; see Figure 2 for a detail of the Micron Project Area). The Plan Area includes all areas where Covered Activities will be conducted (see Section 3.0 for more information about Covered Activities) or where conservation measures will be implemented (see Section 6.0 for information about the conservation measures).

The Plan Area is situated in the far western part of Bexar County, Texas. The WRIP Project Area extends from just south of SH 151 to just north of Interstate Highway 35, west of Loop 1604, and occurs mostly within the City of San Antonio's extra-territorial jurisdiction (ETJ). The Micron Project Area is located at the southeast corner of the Loop 1604 and SH 151 intersection and is within the City of San Antonio. The proposed APS Karst Preserve is undeveloped land within the existing SAWS APS site. The APS is the terminus for both of the Proposed Projects and is located at the southwest corner of the Loop 1604 and SH 151 intersection, within the limits of the City of San Antonio.

In total, the Plan Area encompasses approximately 218.03 acres, with 159.03 acres associated with the WRIP Project, 1.4 acres associated with the Micron Project, and 57.6 acres associated with the proposed APS Karst Preserve.

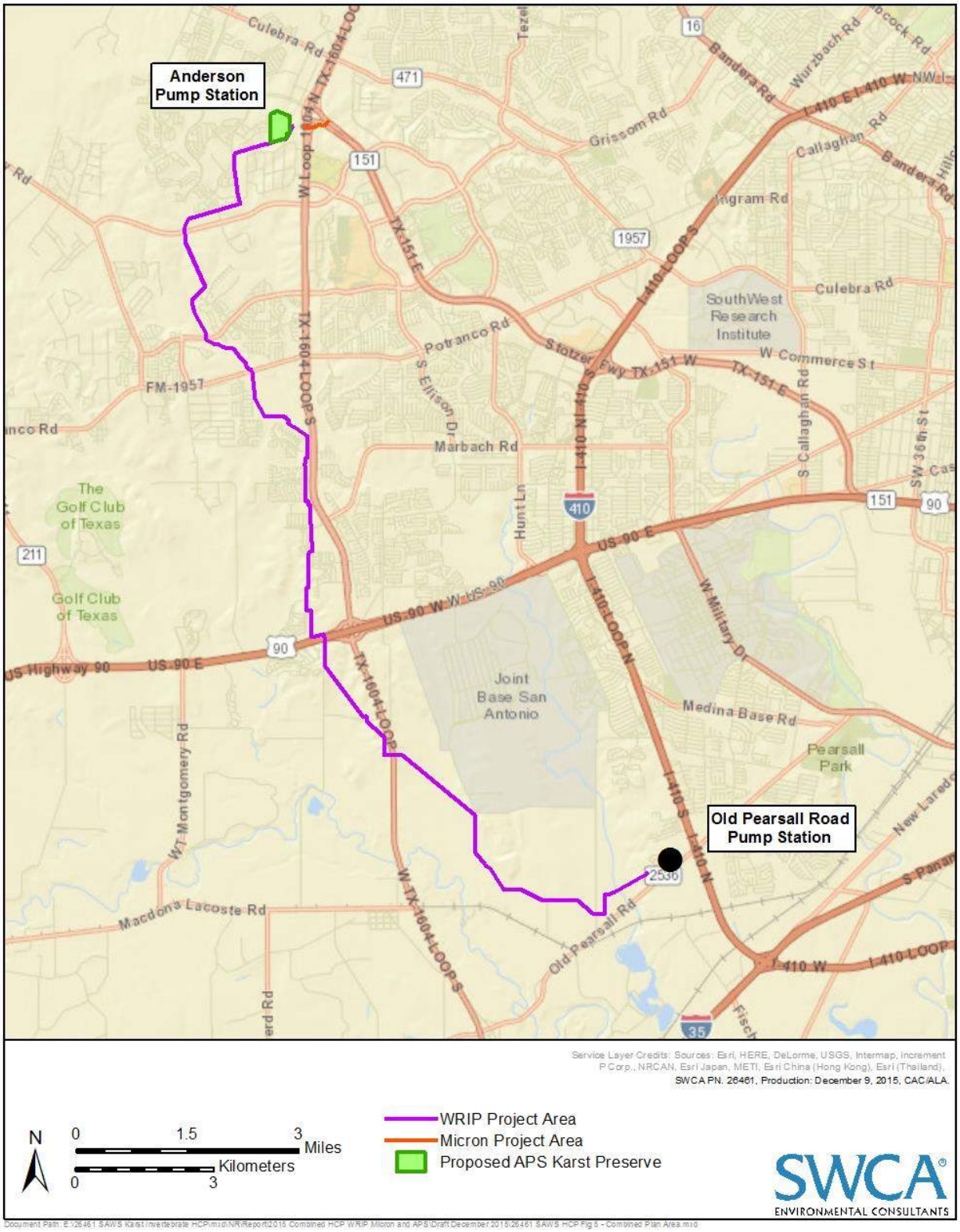

Figure 5. SAWS Karst Invertebrate HCP Plan Area.

Due diligence environmental investigation, and in some cases coordination with USFWS, has been completed for both Project Areas. Relevant reports containing detailed information about the environmental context of the Plan Area include the following:

- WRIP Project Area
    - *Evaluation of Waters of the U.S. and Threatened and Endangered Species Habitat* (SWCA 2005) – A review of the "Segment VI of the Gonzales Water Integration Pipeline" which generally corresponds to the WRIP Project Area for potential impacts to waters of the U.S. and listed species.
    - *San Antonio Water System Gonzales County Carrizo Aquifer Program Water Integration Pipeline Section VI Project* (Chiang, Patel & Yerby 2005) – A routing study for Segment VI of the Gonzales Water Integration Pipeline, which generally corresponds to the WRIP Project Area, that considered environmental impacts to waters of the U.S., threatened and endangered species, and cultural resources.
    - *Draft Environmental Assessment for the SAWS WRIP Segment 3* (Freese and Nichols 2011) – A review of a portion of the WRIP Project Area for consideration of possible effects to the natural, social, and economic environment.
    - *Environmental Assessment SAWS WRIP Segment 2* (Hicks & Company and Civil Engineering Consultants 2012) – A review of a portion of the Project Area for consideration of possible effects to the natural, social, and economic environment.
    - Consultation No. 02ETAU00-2012-TA-0215 with USFWS –
        - July 2012: Review and transmittal of EA for the SAWS WRIP Segment 3 (Freese and Nichols to USFWS Arlington Ecological Services Field Office).
        - August 2012: USFWS Austin Ecological Services Field Office response requesting completion of a karst features survey to accompany the existing Environmental Assessment.
        - September 2012: Review and transmittal of karst feature survey (SWCA 2005) transmitted by Freese and Nichols to USFWS Austin Ecological Services Field Office.
        - November 2012: Response stating there was "No Action" from USFWS Austin Ecological Services Field Office.
    - *Assessment of the Potential for Occurrence of Federally Endangered Karst Invertebrate Species for Phase 2 of the San Antonio Water System Water Resources Integration Pipeline, Bexar County, Texas* (SWCA 2014a) – An updated evaluation of the WRIP Project Area for the presence of habitat suitable for karst invertebrates.
- Micron Project Area
    - *Phase I Environmental Site Assessment* (Baer Engineering 2011) – Review of regulatory and historical records, site assessments, and interviews with individuals familiar with the Micron Project Area.
    - *Environmental Assessment Report* (Baer Engineering 2011) – A desktop review and on-foot habitat assessment for listed species known to occur in Bexar County, Texas, including correspondence related to federal and state agency coordination.
    - Consultation No. 21450-2011-I-0245 with USFWS

        - July 2011: Review and transmittal of the Draft Environmental Assessment and notice of intent to coordinate with the USFWS on the Micron Pipeline transmitted from Baer Engineering to USFWS
        - September 2011: USFWS Austin Ecological Services Field Office response referencing revised karst protocols and requiring any karst features identified during construction to be covered and surveyed by a USFWS-permitted biologist.
    - *Endangered Species Habitat Assessment* (Pape-Dawson Engineers 2012) – A karst feature survey to identify potential habitat for karst invertebrates within and up to 50 feet on either side of the Micron Project Area.
    - *Ground-penetrating Radar (GPR) Survey* (Baer Engineering 2012) – A survey of the Micron Project Area using ground-penetrating radar to detect subsurface voids that may lack surface expression.
- Proposed Anderson Pump Station Karst Preserve
    - Fault Lineation Analysis (Medina Consulting 2013) – Results presented in maps showing the results of satellite and aerial imagery used to identify linear features that may indicate the presence of faults or fractures in the subsurface within the proposed APS Karst Preserve boundary.
    - Karst Invertebrate Habitat Assessment and Presence/Absence Surveys for the SAWS APS in Bexar County, Texas (SWCA 2014) – A karst feature survey to identify potential habitat for karst invertebrates within the proposed APS Karst Preserve boundary. Also reports the findings of karst invertebrate presence/absence surveys.

A summary of the relevant information from these reports is included in the following sections.

2.1 Topography and Geology

The Plan Area is included on the Culebra Hill and Macdona, Texas, US Geological Survey (USGS) 7.5-minute topographic quadrangle maps (USGS 1993 and 1991). Topography in the area is generally characterized by gentle, rolling hills and drainages, with slopes becoming more gradual towards the south. Elevation across the WRIP Project Area ranges from approximately 1,000 feet above mean sea level (amsl) at the north end of the proposed pipeline to approximately 600 feet amsl at the southern end. Surface flows across the WRIP Project Area generally drain south towards Potranca Creek and Medio Creek, both tributaries of the Medina River. The Micron Project Area is generally situated on a hill slope, dipping to the north-northeast. Elevation across the Micron Project Area ranges from 980 feet amsl to approximately 930 feet amsl. Surface flows across the Micron Project Area generally drains northeast towards Culebra Creek.

Geologic formations exposed on the surface of the Plan Area include generally soft Upper Cretaceous chalk or sandstone formations at the northern end of the Plan Area and a variety of Tertiary and Quaternary period coastal plain gravel deposits to the south (Table 4). Five mapped normal faults downthrown to the south and trending northeast-southwest, in line with the regional faulting patterns of the Balcones Fault Zone, occur across the WRIP Project Area; none occur on or near the Micron Project Area (Bureau of Economic Geology 2007) (Figure 6).

Table 4. Surface geology within the Plan Area (Bureau of Economic Geology 2007).

Map Symbol	Formation Name	Period	Description
Kau	Austin Chalk	Cretaceous	several thin- to thick-bedded chalk, limestone and argillaceous limestone units; formation reaches a thickness of 350 to 580 feet; chalk units are ledge forming and grayish white to white in color; marl units are medium gray in color with bentonitic seams locally recessive and pyrite nodules common; known to be a cave bearing formation within the Culebra Anticline
Kpg	Pecan Gap Chalk	Cretaceous	chalk and chalky marl; weathers to form moderately deep soil; formation reaches a thickness of 400 feet; known to be a cave bearing formation within the Culebra Anticline
Kknm	Navarro Group and Marlbrook Marl undivided	Cretaceous	upper part of this group is composed of marl, clay, sandstone, and siltstone; lower part containing greenish gray to brownish gray clay; group reaches a thickness of up to 980 feet
Emi	Midway Group	Tertiary	clay with silt and sand becoming more abundant at the top of the formation; light gray to dark gray in color; reach a thickness of up to 400 feet
T-Qu	Uvalde Gravel	Tertiary	caliche-cemented gravel with some boulders and well-rounded cobbles of chert, quartz, limestone, and igneous rocks; gravel up to 20 feet thick and occupies topographically higher areas
Qt	Fluviatile Terrace Deposits	Quaternary	terraces along streams; made up of gravel, sand, silt, and clay in various proportions; also contains high gravel deposits; terrace deposits along Medio Creek (tributary to the Medina River) may be as thick as 40 feet
Qal	Alluvium	Quaternary	floodplain deposits, including indistinct low terrace deposits made up of clay, silt, sand, and gravel; silt and clay are calcareous to the surface; dark gray to dark brown; sand is largely quartz; gravel is siliceous and is comprised mostly of chert, quartzite, limestone, and petrified wood

The Plan Area crosses the Culebra Anticline geologic region located along the southern area of the Balcones Fault Zone (Figure 7). The Culebra Anticline is associated with the down-dip end of the San Antonio relay ramp (Collins and Hovorka 1997) and exposes an aerially extensive outcrop of the karstic Austin Chalk formation. The anticline is fault related, but is not a simple horst and may be related to listric faulting (Collins and Hovorka 1997). The northwest fold dips strongly with nearly 700 feet of relief while the southeast flank has a more gentle regional dip complicated by faulting. Due to weak dip closure on the northeast, the feature resembles more of a west-plunging ridge than a symmetrical anticline (Pinkley 1996). The structural high, numerous faults, and high erodability of the Austin Chalk have contributed to its localized and historic development as a cave-bearing formation. Approximately 21 percent of all known caves within Bexar County are formed within the Austin Chalk (Veni 1988).

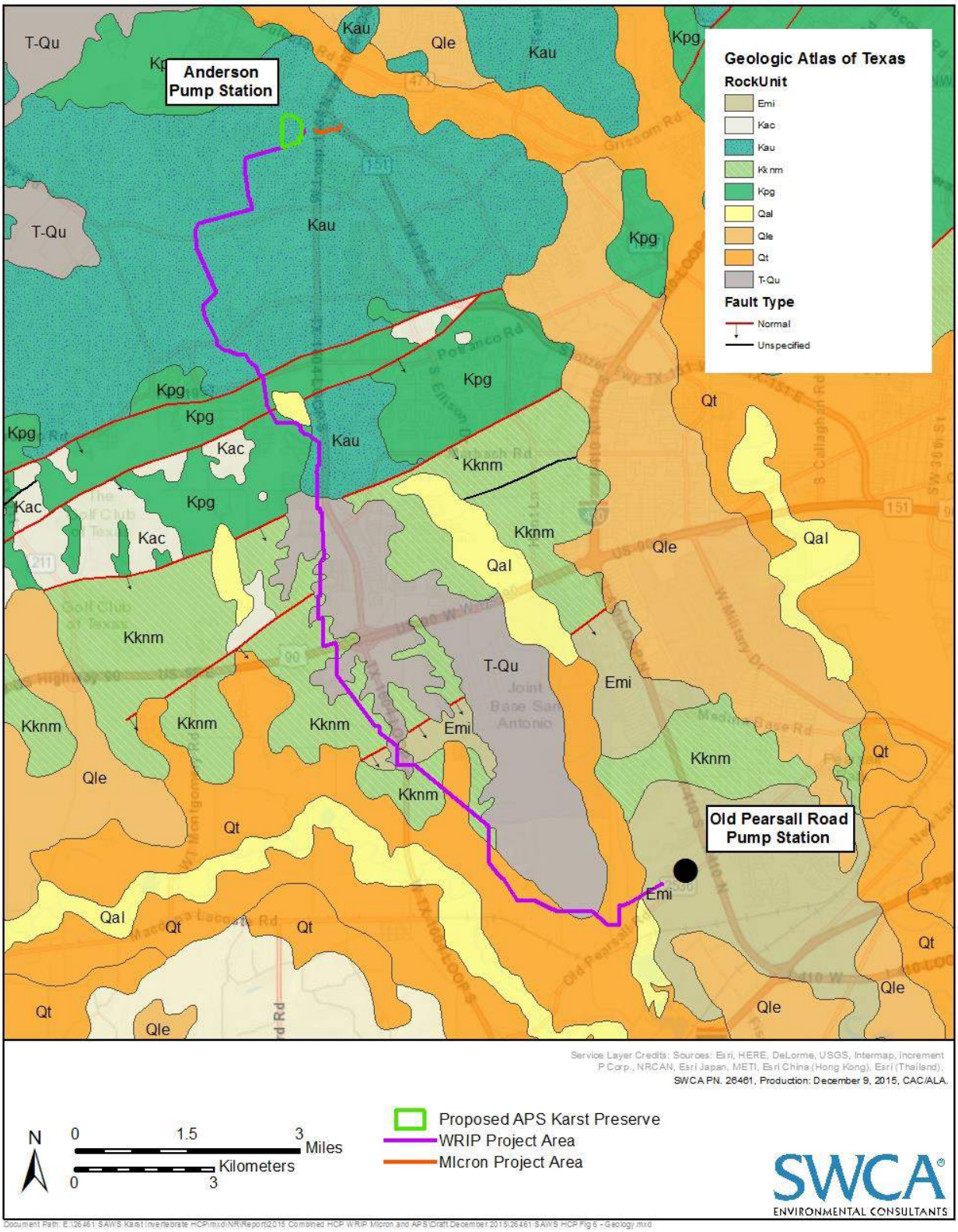

Figure 6. Surface geology of the Plan Area.

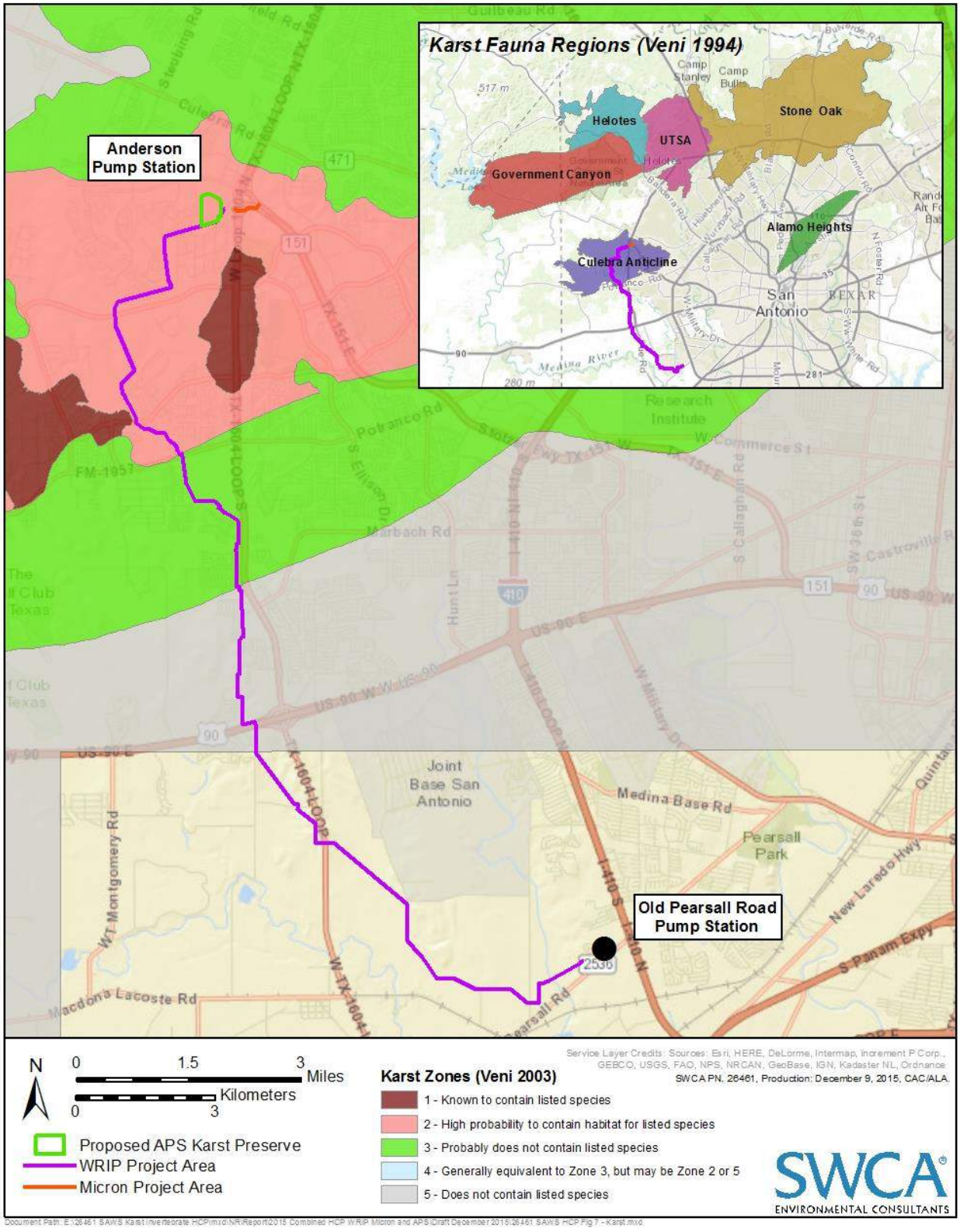

Figure 7. Karst zones and Karst Fauna Regions of the Plan Area.

The WRIP Project Area crosses a significant northeast-southwest fault boundary separating the two cave-bearing chalk formations, with the Pecan Gap Chalk generally comprising the southern, downthrown side of the fault and the Austin Chalk present to the north (Figure 5). Substantially fewer known Bexar County caves are located within the Pecan Gap Chalk (Veni 1988).

2.2 Karst Zones and Karst Fauna Regions

Habitat for karst invertebrates includes subsurface caves and smaller "mesocavernous" spaces in permanent darkness, with moisture input sufficient to maintain high humidity in these spaces and a source of organic material from the surface. Organic material can be washed into subsurface voids by surface water or can be brought into the void by small mammals or trogloxene species such as cave crickets (*Ceuthophilus* spp.) and daddy longlegs (*Leiobunum* spp.).

The USFWS commissioned a study that delineated five geographic zones to facilitate assessment of the probability of the presence of rare or endangered karst invertebrate species (Veni 2003). The zones were delineated through a review of lithology, the distribution of known caves and cave fauna, and geologic controls on cave development. Special attention was given to cavern development in the Edwards Group, Upper Glen Rose, Pecan Gap Chalk, and Austin Chalk geologic formations. The "karst zones" from this study were described as follows and are shown in Figure 7:

- Zone 1: Areas known to contain listed karst invertebrate species;
- Zone 2: Areas having a high probability of containing habitat suitable for listed karst invertebrate species;
- Zone 3: Areas that probably do not contain listed karst invertebrate species;
- Zone 4: Areas that require further research but are generally equivalent to Zone 3, although they may include sections that could be classified as Zone 2 or Zone 5 as more information becomes available; and
- Zone 5: Areas that do not contain listed karst invertebrate species.

Karst zones associated with the Plan Area are summarized in Table 5. However, the USFWS notes that the area of Karst Zone 2 around SH 151 should be considered equivalent to Karst Zone 1, since listed species have been confirmed to occur in that area (Christina Williams, USFWS Austin Ecological Services Field Office, personal communication).

Table 5. Mapped karst invertebrate habitat zones associated with the Plan Area.

Karst Zone (Veni 2003)	WRIP Project Area (acres)	Micron Project Area (acres)	APS Karst Preserve (acres)	Total HCP Plan Area (acres)
Karst Zone 1	0	0	0	0
Karst Zone 2	43.9	1.4	57.6	102.9
Karst Zone 3	22.5	0	0	22.5
Karst Zone 4	0	0	0	0
Karst Zone 5	24.8	0	0	24.8

Veni (1994) hypothesized that certain geologic and geographic features such as stream valleys and faults form barriers to karst invertebrate dispersal and distribution. On the basis of this hypothesis, Veni (1994) delineated six Karst Fauna Regions (KFRs) within Bexar County, including the Stone Oak, UTSA, Helotes, Government Canyon, Culebra Anticline, and Alamo Heights KFRs (Figure 7). Based on the distribution of invertebrate specimens collected from a small percentage of the caves in the county, the boundaries between KFRs were hypothesized to have played significant roles in the species' evolutionary development while defining the ranges of individual karst species or populations (Veni 1994).

Both Proposed Projects occur fully or partially within the Culebra Anticline KFR; no part of either project occurs in any other KFR. The Culebra Anticline is located on the southern edge of the Balcones Fault Zone (BFZ) and is a northeast to southwest trending asymmetrical fold in the bedrock that plunges to the southwest (Collins and Hovorka 1997, Pinkley 1996). The fold extends from Loop 410 in San Antonio west to the Medina River. The Austin Chalk on the Culebra Anticline is up to 200 feet thick and is locally fractured and jointed. Most known caves in this area follow the crest of the Culebra Anticline (SWCA Environmental Consultants unpublished report).

2.2.1 *Known Karst Features*

2.2.1.1 WRIP Project Area

The WRIP Project Area has been evaluated twice for the presence of caves or other karst features that may be exposed at the surface. Professional geologists with SWCA Environmental Consultants (SWCA) completed the first karst feature survey of this area in 2005 and identified three potential karst features that warranted further investigation to determine their potential to provide habitat for listed karst invertebrates. Following excavation, SWCA found that each feature was of non-karst origin and concluded that none of these features provided suitable habitat for listed karst invertebrates (SWCA 2005).

SWCA completed another karst feature survey of the WRIP Project Area in 2014 to update the findings of the 2005 survey. The 2014 karst feature survey reported only one additional potential karst feature (a "closed depression with loose, scattered rocks") within the WRIP Project Area that, upon excavation, did not exhibit potential habitat for listed karst invertebrates (SWCA 2014a). Therefore, after two complete karst feature surveys, performed in accordance with USFWS protocols effective at the time, no features are known to occur within the WRIP Project Area that would indicate the presence of potential habitat for listed karst invertebrates. However, the findings of these investigations are limited to potential karst features that have expression at the surface; void spaces without surface expression would not be detectable by surface surveys.

2.2.1.2 Micron Project Area

Similarly, the Micron Project Area has been investigated multiple times for the presence of karst features that could provide habitat for listed karst invertebrates. Baer Engineering conducted a karst feature survey of the Micron Project Area survey and the adjacent area within 250 feet of the limits of this Project Area in 2011 following the USFWS protocols in place at the time and found no karst features that would indicate the presence of potential habitat for listed karst invertebrates. However, Baer Engineering (2011) reported that karst features containing karst invertebrate fauna are known to occur within 500 feet of the Micron Project Area, including Clandestine Cupola Cave that contains the non-listed, blind spider *C. loftini* or, possibly, the listed *C. venii* (Zara 2011). Baer Engineering (2011) noted that the Micron Project Area does not occur within the likely surface or subsurface drainage basins for Clandestine Cupola Cave, as delineated by Zara Environmental (2011). Following the discovery of the

occupied karst features at the TxDOT SH 151/Loop 1604 project site, Pape-Dawson Engineers conducted another karst feature survey, completed in accordance with the USFWS protocols in place at the time, of the Micron Project Area and similarly reported finding no karst features with expression at the surface (Pape-Dawson Engineers 2012).

Finally, SAWS commissioned a study of the Micron Project Area using ground-penetrating radar (GPR) in an attempt identify any subsurface voids that may lack surface expression. Baer Engineering completed this GPR study in 2012 and did not detect the presence of large voids (i.e., those greater than 1 or 2 feet in diameter) within the Micron Project Area. However, Baer Engineering (2012) also reported finding "reflections likely indicating fractures, fracture-filled weather zones, bedding planes, or other features such as alternating lithologic units" that indicated a higher likelihood of potential void development. While the potential exists for karst voids to be present in the subsurface of the Micron Project Area, no positive confirmation of any such features has been documented.

2.2.1.3 Anderson Pump Station Karst Preserve

SWCA conducted detailed investigations of the APS Karst Preserve in 2013 and 2014 to search for karst features that may provide habitat for the Covered Species. The results of these investigations are described in Section 6.4.

2.3 Surface Conditions and Land Uses

The Plan Area is located within the Northern Blackland Prairie ecoregion of Texas (Griffith et al. 2004). This ecoregion extends along the eastern edge of the Edwards Plateau from San Antonio to Dallas. The Northern Blackland Prairie is characterized by rolling to nearly level, deep and productive soils. The region may be distinguished from surrounding regions by its fine textured clayey soils and ability to support predominantly prairie vegetation, with wooded stream corridors. Currently, the Northern Blackland Prairie ecoregion contains a higher percentage of cropland than adjacent regions, although much of the land has been converted to urban and industrial uses (Griffith et al. 2004).

Land use and land cover within the vicinity of the Plan Area contains a mix of residential neighborhoods and undeveloped lands that are mostly former rangeland or cropland (Figure 8). Most of the undeveloped lands in the vicinity of the Plan Area are vegetated with open herbaceous cover or shrublands, although patches of moderately dense woodland cover occur in the northern part of the Plan Area.

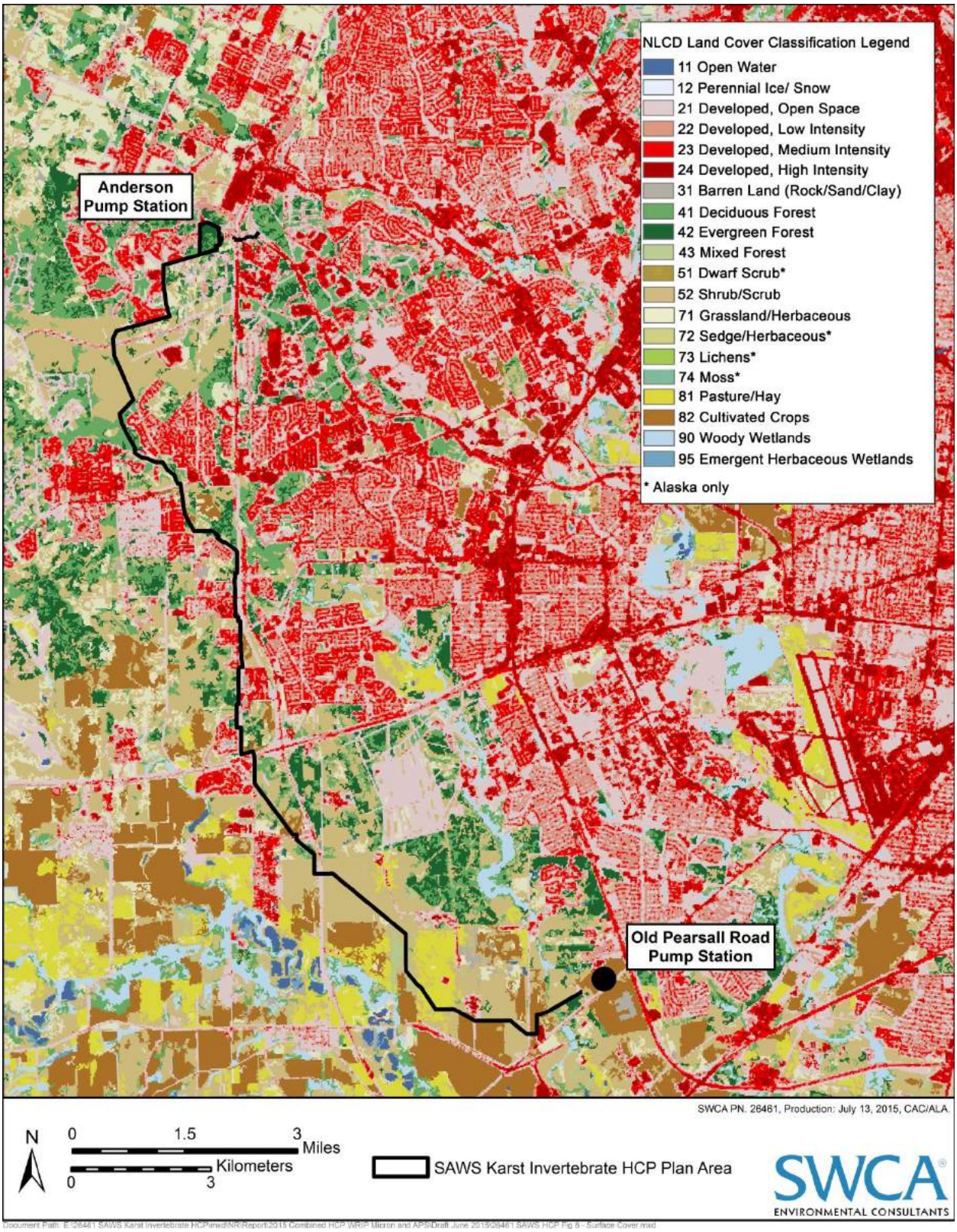

Figure 8. Land use and land cover in the vicinity of the Plan Area (NLCD 2011).

2.4 Climate

The climate of San Antonio, Texas, is subtropical, with average monthly temperatures in Fahrenheit (F) ranging from the 40s in the winter to the 90s in the summer. The area typically sees approximately 12 subfreezing nights each year, and wintry precipitation once every 2 to 3 years; accumulation is very uncommon (NOAA 2013). Summers are long and hot, with July and August typically being the warmest months of the year, with an average summer high of 95°F. Summer conditions extend into September and October (NOAA 2013). The average annual temperature within the San Antonio area is 68.6°F. Studies conducted by federal agencies show that "San Antonio is ranked as the fourth hottest city in the nation with an average of 111 days that temperatures reach 90 degrees or higher" (Hicks & Company and Civil Engineering Consultants 2012).

Precipitation varies substantially in south-central Texas. Based on data collected by the Edwards Aquifer Authority (EAA), during the period from 1934 to 2010, mean annual precipitation for the City of San Antonio was approximately 30.4 inches, "although annual precipitation has ranged from 13.70 to 52.28 inches" during that time (EAA 2013). The NOAA cites an average annual precipitation of 32.27 inches for the years 1981-2010 (NOAA 2011). Generally, precipitation levels are highest in June and October with tropical storms and cold fronts contributing to the amount of precipitation received.

As a result of intense, sporadic rainstorms, run-off from bedrock slopes, and drainage problems due to the urban landscape, the Balcones Escarpment region "is one of the most severely flooded regions of the United States" (Caran and Baker 1986). Additionally, tropical storms and hurricanes "do not often extend far inland but occasional storms penetrate well into the interior of the state and beyond" contributing to some of the heaviest rainfalls to have historically occurred in central Texas (Caran and Baker 1986). Runoff is increased by impervious cover, channel obstruction, channel rectification, and development within the floodplain. All of these factors can exacerbate the impacts of flood conditions during heavy rainfall by as much as 300 percent (Caran and Baker 1986).

In contrast to an inherent susceptibility to flood events, the region surrounding the Plan Area is additionally prone to severe drought events. The drought of record occurred from 1951 to 1956 in the region and "resulted in the only known cessation of artesian flow at Comal Springs in 1956, for 144 days" (EARIP 2012). Based on tree-ring analysis, and utilizing the Palmer Drought Severity Index (PDSI), it was identified that 25.7 percent of the years between 1700 and 1979 qualified as drought years (Mauldin 2003). While there is no dependable scientific technique for determining the likelihood, duration, and severity of future droughts, historical data confirms that the region is likely to experience drought events of varying duration and intensity in the future.

3.0 COVERED ACTIVITIES

The SAWS Karst Invertebrate HCP covers activities associated with the construction of the Proposed Projects. The Covered Activities have the potential to disrupt habitat for endangered karst invertebrates in ways that could result in take. All Covered Activities will occur within the limits of the Plan Area, specifically within the two Project Areas.

Covered Activities generally include: vegetation disturbance; excavation; temporary placement of excavated material; permanent placement of pipe, casings, and stabilizing materials; backfilling of excavated trenches; and restoring surface conditions. Specifically, the Covered Activities associated with the Proposed Projects include:

1. Vegetation removal or disturbance within the limits of the Project Areas for the Proposed Projects only to the extent necessary to allow for construction activities within the Project Area. Vegetation clearing and disturbance will be in accordance with all Tree Protection Plans, as required by the City of San Antonio. [Surface Disturbance Only]
2. Excavation of open-cut trenches to a typical maximum width of seven feet and to depths of between 10 and 20 feet. Exact trench measurements are contingent upon the substrate type at the surface (soil, concrete, or asphalt). [Surface and Subsurface Disturbance]
3. Excavation of bore pits for machinery access to tunneled segments of the proposed pipelines. Each bore pit will generally be 25 by 40 feet at the surface and dug to a depth of 10 to 40 feet. Exact pit measurements are subject to contractor discretion based on site conditions. [Surface and Subsurface Disturbance]
4. Excavation by bore, jack, or tunnel through the subsurface beneath streams, roads, or heritage trees approximately 5 to 35 feet below the surface grade. Such excavation may include the use of water for coolant/lubrication of the pipe or casing materials being tunneled. Excavated material will be removed and disposed of off-site. [Subsurface Disturbance Only]
5. Temporary placement and storage of excavated material or clean fill material within the Project Areas for the Proposed Projects. [Surface Disturbance Only]
6. Permanent placement of sand or gravel pipe bedding and subgrade fill, filter fabrics, flowable fill, mortar, and/or grout, as specified by construction plans to encase and stabilize the pipe. [Subsurface Disturbance Only]
7. Application of water during construction to control dust within active construction areas. [Surface Disturbance Only]
8. Bank stabilization to control erosion and sedimentation prior to boring activities at stream crossings. [Surface Disturbance Only]
9. Restoration of disturbed areas as quickly as possible to their original or better condition. This will include replacement of temporarily stored topsoil and revegetation by seeding with native plant seeds and the utilization of a licensed arborist for any replanting of tree species. [Surface Disturbance Only]
10. Pipeline cleaning and hydrostatic pressure and leakage testing on all pipeline installed. [no additional disturbance is anticipated]
11. Movement of vehicles and heavy construction equipment within the Project Areas. [Surface Disturbance Only]

Table 6 summarizes the anticipated aerial extents of surface and subsurface disturbances for the Covered Activities that would occur over Karst Zones 1, 2 or 3. Additional detail regarding construction standards and specifications for the Proposed Projects is available in:

- *Conformed Set of Specifications and Contract Documents* prepared by SAWS (signed and sealed by a licensed professional engineer on December 21, 2011) for the Micron Pipeline Phase 2 project (SAWS Job No. 10-7002)
- *San Antonio Water System Water Resources Integration Program Project I: Pipeline, Segment II (90 percent submittal)*. Civil Engineering Consultants, Don Durden, Inc. and Maestas & Associates, Inc., October 2011, SAWS Job No. 09-8613-220.
- *San Antonio Water System Water Resources Integration Program Project I: Pipeline, Segment III (90 percent submittal)*. Freese and Nichols (FNI Project No. SWB09391), February 2012, SAWS Job No. 09-8614-220.

Table 6. Approximate aerial extent of surface and subsurface disturbances for the Covered Activities.

Disturbance Type	WRIP Project Area	Micron Project Area	Total for Plan Area	Total Over Karst Zones 1 - 3
Surface Disturbance	Assumed to include the full extent of the 80-ft wide permanent easement for segments proposed for open-cut trenching, which is inclusive of all proposed bore pits 80 ft x 83,793.6 ft (15.87 mi) = 153.89 ac	Assumed to include the full extent of project footprint, defined to include the full extent of all easements on non-SAWS properties and the limits of the project footprint on the SAWS-owned APS (which includes a portion of open-cut trench and four, 25 ft x40 ft bore pits) [969 ft x 45 ft] + [254.9 ft x 4.5 ft] + 25.7 ft x 8 ft] + [(25 ft x 40 ft) x 4] = 1.1 ac	154.99 ac	67.6 ac
Subsurface Disturbance – Open-cut Trench*	7 ft x 83,793.6 ft = 13.47 ac	7 ft x 1,308 ft = 0.21 ac	13.68 ac	5.9 ac
Subsurface Disturbance—Bore Pits*	[25 ft x 40 ft] x 36 pits= 0.8 ac	[25 ft x 40 ft] x 4 = 0.09 ac	0.89 ac	0.6 ac
Subsurface Disturbance – Bore/Tunnel	5.5 ft x 2,798.4 ft = 0.35 ac (without surface expression)	5.5 ft x 1,016 ft = 0.13 ac	0.48 ac	0.2 ac

Subsurface Disturbance	14.62 ac	0.43 ac	15.05 ac	6.7 ac
TOTAL Aerial Extent of Surface or Subsurface Disturbances	153.89 ac + 0.35 ac = 154.24 ac	1.1 ac + 0.13 ac = 1.23 ac	154.99 ac + .48 ac = 155.47 ac	67.6 ac + 0.2 ac = 67.8 ac

*These subsurface disturbances also have surface expression and are also included in the surface disturbance calculation.

4.0 COVERED SPECIES

4.1 Evaluation Species

The Texas Parks and Wildlife Department (TPWD) maintains a list of rare species for each Texas County (TWPD 2014). The TPWD list of rare species for Bexar County currently includes 55 animals and plants, 22 of which are either currently listed as federally threatened or endangered or are identified candidates for future federal listing (Evaluation Species). A brief description of the range and habitat requirements for each Evaluation Species, with an assessment of its potential for occurrence in the Plan Area and the likelihood of being impacted by the Proposed Projects is included in Table 7.

Table 7. Evaluation Species evaluated for possible inclusion as Covered Species.

Common Name (Scientific Name)	Federal Listing Status*	Range or Habitat Requirements	Likely Occurrence Within Plan Area	Potential for Project Impacts	Proposed for Coverage
Interior Least Tern (*Sterna antillarum athalassos*)	Endangered	Nests along sand and gravel bars within braided streams and rivers and on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc. (TPWD 2014)	None	No	No
Sprague's Pipit (*Anthus spragueii*)	Candidate	Migrate to Texas from mid-September to early April where generally found in upland prairies and coastal grasslands (TPWD 2014)	Unlikely	No	No
Whooping crane (*Grus americana*)	Endangered	May occur in Bexar County during the spring and fall migration periods. The traditional migration corridor for the species is to the west of the Plan Area (Lockwood and Freeman 2004)	Unlikely	No	No
Piping Plover (*Charadrius melodus*)	Threatened	Breeds along the northern Atlantic coast, Great Lakes region, and within rivers, lakes and alkali wetlands of the Great Plains and Canada. Wintering habitat includes beaches, tidal sandflats, mudflats, algal mats, washover passes, and small dunes (USFWS 2011)	Unlikely	No	No
Black-capped Vireo (*Vireo atricapilla*)	Endangered	Black-capped vireos typically occur in areas with thin soil and limestone bedrock that support scrubby vegetation dominated by broad-leafed shrubs (USFWS 1991). Shin oak (*Quercus sinuata* var. *breviloba*) or evergreen sumac (*Rhus virens*) is usually common in areas occupied by vireos in Central Texas	Unlikely	No	No

Common Name (Scientific Name)	Federal Listing Status*	Range or Habitat Requirements	Likely Occurrence Within Plan Area	Potential for Project Impacts	Proposed for Coverage
Golden-cheeked warbler (*Setophaga chrysoparia*)	Endangered	The breeding range of the golden-cheeked warbler is restricted to central Texas. Golden-cheeked warblers typically occur in mature woodlands possessing a high percentage of canopy closure and composed of a mixture of Ashe juniper, live oak, and broad-leafed deciduous trees (USFWS 1992).	Unlikely	No	No
Cokendolpher Cave Harvestman (*Texella cokendolpheri*)	Endangered	Subterranean karst spaces with stable temperature and high humidity. This species is not known to occur in the Culebra Anticline KFR (USFWS 2011)	Unlikely	Unlikely	No
Government Canyon Bat Cave Spider (*Neoleptoneta microps*)	Endangered	Subterranean karst spaces with stable temperature and high humidity. This species is not known to occur in the Culebra Anticline KFR (USFWS 2011)	Unlikely	Unlikely	No
Madla's Cave Meshweaver (*Cicurina madla*)	Endangered	Subterranean karst spaces with stable temperature and high humidity. This species has been tentatively identified from the Culebra Anticline KFR (Paquin and Ledford 2012)	Potentially	Yes	Yes
Robber Baron Cave Meshweaver (*Cicurina baronia*)	Endangered	Subterranean karst spaces with stable temperature and high humidity. This species may have been documented from the Culebra Anticline KFR (Paquin and Ledford 2012)	Potentially	Yes	Yes
Government Canyon Bat Cave Meshweaver (*Cicurina vespera*)	Endangered	Subterranean karst spaces with stable temperature and high humidity. This species is not known to occur in the Culebra Anticline KFR (USFWS 2011)	Unlikely	Unlikely	No
Braken Bat Cave Meshweaver (*Cicurina venii*)	Endangered	Subterranean karst spaces with stable temperature and high humidity. This species has been tentatively identified from the Culebra Anticline KFR (Cokendolpher 2012)	Potentially	Yes	Yes
[no common name] Beetle (*Rhadine infernalis*)	Endangered	Subterranean karst spaces with stable temperature and high humidity. This species is known to occur within the Culebra Anticline KFR (USFWS 2011)	Potentially	Yes	Yes
Helotes mold beetle (*Batrisodes venyivi*)	Endangered	Subterranean karst spaces with stable temperature and high humidity. This species is not known	Unlikely	Unlikely	No

Common Name (Scientific Name)	Federal Listing Status*	Range or Habitat Requirements	Likely Occurrence Within Plan Area	Potential for Project Impacts	Proposed for Coverage
		to occur in the Culebra Anticline KFR (USFWS 2011)			
[no common name] Beetle (*Rhadine exilis*)	Endangered	Subterranean karst spaces with stable temperature and high humidity. (USFWS 2011). This species is known to occur within the Culebra Anticline KFR.	Potentially	Yes	Yes
Black Bear (*Ursus americanus*)	Listed (Similar Appearance) / Not Listed	Prefers bottomland hardwoods and large tracts of inaccessible forested areas (TPWD 2014)	None	No	No
Gray Wolf (*Canis lupus*)	Endangered	Extirpated in Central Texas (TPWD 2014)	None	No	No
Red Wolf	Endangered	Extirpated in Central Texas (TPWD 2014)	None	No	No
Golden Orb (*Quadrula aurea*)	Candidate	May be extirpated from Texas; historically found in Rio Grande, Brazos, Colorado, and Guadalupe (historic) river basins (TPWD 2014)	None	No	No
Texas fatmucket (*Lampsilis bracteata*)	Candidate	Found in the Colorado and Guadalupe River basins (TPWD 2014)	None	No	No
Texas pimpleback (*Quadrula petrina*)	Candidate	Found in the Colorado and Guadalupe river basins (TPWD 2014)	None	No	No
Bracted twistflower (*Streptanthus bracteatus*)	Candidate	This species is endemic to the low density oak-juniper woodlands and savannah of the Edwards Plateau (Poole et al. 2007).	Potentially	Unlikely	No

4.2 Covered Species

SAWS reviewed the list of Evaluation Species and determined that only five currently endangered karst invertebrates are likely to be impacted by the Proposed Projects and are appropriate to include in the HCP as Covered Species. SAWS requests incidental take coverage for these five currently endangered karst invertebrates and one currently unlisted karst invertebrate (Covered Species). Each of these six Covered Species has the potential to be incidentally taken by the Covered Activities:

- Bracken Bat Cave meshweaver (*Cicurina venii*) – federally endangered
- Madla Cave meshweaver (*Cicurina madla*) – federally endangered
- Robber Baron Cave Meshweaver (*Cicurina baronia*) – federally endangered
- *Cicurina loftini* (no common name) – not listed
- *Rhadine exilis* (no common name) – federally endangered
- *Rhadine infernalis* (no common name) – federally endangered

SAWS seeks take authorization for the four blind *Cicurina* spiders because each of these species names has been assigned to one or more of the specimens collected from the TxDOT SH 151/Loop 1604 project area (Cokendolpher 2012, Paquin and Ledford 2012), which is in close proximity to the northern end of the Plan Area. While not currently a listed species, *C. loftini* is included as a Covered Species due to the potential for this species to be synonymized with another federally listed species, the Robber Baron Cave meshweaver (*Cicurina baronia*), in a future revision of the taxonomy of the genus that has been suggested by some taxonomists (Paquin and Ledford 2012). It is uncertain when, or even if, such a revision would be published in the scientific literature. In any case, based on the best scientific information, SAWS does not expect that all four of the spiders actually occur within the Plan Area or even within the Culebra Anticline KFR generally. Paquin & Dupérré (2009:63), for instance, states that "the cases where more than one species per cave have been reported or described are suspicious and deserve attention…particularly because of the previously unrecognized intraspecific variability" within *Cicurina*. Rather, this list of names is inclusive of the range of names assigned by taxonomists to the two types of morphologically distinct *Cicurina* specimens collected at the TxDOT SH 151/Loop 1604 project area. Therefore, all four are included as Covered Species to provide regulatory assurances for possible incidental takings.

Similarly, SAWS includes the two blind ground beetles (genus *Rhadine*) as Covered Species because each is currently known to occur within the Culebra Anticline KFR (USFWS 2011; James Reddell, University of Texas at Austin, personal communication to Cyndee Watson, USFWS Austin Ecological Services Field Office[1]). *R. infernalis*, a species with a robust body form, is recognized by the USFWS as occurring within the Culebra Anticline KFR. Recently, *Rhadine* specimens were collected from the Culebra Anticline KFR that exhibit an elongate body form, consistent with that of *R. exilis*. The USFWS received taxonomic confirmation that these elongate individuals belong to *R. exilis* (James Reddell, University of Texas at Austin, personal communication to Cyndee Watson, USFWS Austin Ecological Services Field Office). Both listed *Rhadine* beetles have been collected from the same cave elsewhere in Bexar County, Texas, and both species are listed as occurring in various caves designated as critical habitat (USFWS 2011a). Thus, it is possible for both species to be present within the Plan Area (USFWS 2011a). The two listed beetles appear to utilize their habitat differently, as *R. exilis* is often collected deep in the caves away from the entrance, while *R. infernalis* is more commonly collected near the entrance and seldom from dark zones (USFWS 2011a). Therefore, SAWS includes both listed *Rhadine* beetles as Covered Species.

Select information about each of the Covered Species is provided below. A more complete accounting of the biology, life history, habitats, and distribution of each is included in the 2011 Bexar County Karst Invertebrates Recovery Plan (USFWS 2011) and related modules. Figure 9 shows examples of blind *Cicurina* and *Rhadine* specimens from central Texas.

1 Email from James Reddell to Cyndee Watson on May 29, 2015, stating "Rattlesnake Pit is the only locality for R. exilis(?) in the Culebra Anticline."

Figure 9. Blind Cicurina spider (a) and slender-bodied Rhadine exilis (b). (Photos by SWCA Environmental Consultants)

Braken Bat Cave Meshweaver (*Cicurina venii*): The type locality for *C. venii*, which until recently was the only known locality for *C. venii*, is the Braken Bat Cave in the Culebra Anticline KFR (USFWS 2011). A single, damaged specimen of an adult female, later named *C. venii*, was collected from this cave in 1980 (Gertsch 1992). No other specimens of *C. venii* have ever been collected at this site and the current status of *C. venii* at the Braken Bat Cave is unknown because the main entrance of the cave was sealed with concrete (Paquin and Duperre 2009). Recently, Cokendolpher (2012) assigned the name of *C. venii* to an adult female *Cicurina* specimen collected at the TxDOT SH 151/Loop 1604 project site, which if accurate, would be only the second known locality for *C. venii* and the first time since 1980 that the species was observed. As described in Zara (2011) and Zara (2015), researchers were unable to definitively rule out the possibility that an immature specimen found at the Clandestine Cupola Cave may be *C. venii* despite the species being tentatively identified as *C. loftini*.

Madla's Cave Meshweaver (*Cicurina madla*): *Cicurina madla* was first collected in 1963 from a cave in the Helotes KFR (Gertsch 1992). It has now been collected from at least 22 caves in the four Bexar County KFRs associated with the Edwards Limestone formation (e.g., Government Canyon KFR, Stone Oak KRF, Helotes KFR, and the UTSA KFR) (USFWS 2011). However, based on the findings of Paquin and Ledford (2012), *C. madla* could also occur in the Culebra Anticline KFR at the TxDOT SH 151 project. The species may also occupy a cave in Uvalde County at least 60 miles to the west of the Plan Area (USFWS 2011), indicating that *C. madla* may have a much wider range than described for most of the central Texas karst invertebrates.

Robber Baron Cave Meshweaver (*Cicurina baronia*): The first collection of *Cicurina baronia* is from the Robber Baron's Cave in Bexar County in 1969 (Paquin and Dupérré 2009). The species was first described by Gertsch in 1992 (Cokendolpher 2004). Today, only two caves are known to contain *C. baronia* and both are located in the Alamo Heights KFR (USFWS 2011). None of the spiders collected from TxDOT SH 151/Loop 1604 project site was identified as *C. baronia* by Cokendolpher (2012). However, there is suggestion that the species is synonymous to *C. loftini,* which was collected at the TxDOT SH 151/Loop 1604 project site (Paquin and Ledford 2012).

Cicurina loftini (no common name): *Cicurina loftini* was first collected from Caracol Creek Coon Cave located in the Culebra Anticline KFR in 1993 (Paquin and Dupérré 2009) and was first described as a species by James Cokendolpher in 2004. *Cicurina loftini* has also been confirmed from at least one other Bexar County cave (SBC Cave) (Paquin and Dupérré 2009), with tentative confirmation that an immature specimen discovered in Clandestine Cupola Cave may also be *C. loftini* (García de Leon and Krejca 2009). All three of these caves are within the Culebra Anticline KFR. Cokendolpher (2012) also assigned the name of *C. loftini* to two specimens (male and female) collected from the TxDOT SH 151/Loop 1604 project site, but Paquin and Ledford (2012) suggest that *C. loftini* should be considered synonymous with *C. baronia*.

A Ground Beetle (*Rhadine exilis*): *Rhadine exilis* is a ground beetle found in five KFRs (USFWS 2011; James Reddell, University of Texas at Austin, personal communication to Cyndee Watson, USFWS Austin Ecological Services Field Office). *Rhadine exilis* has a very slender body that readily distinguishes it in the field from *R. infernalis* (USFWS 2014a). It was first collected in 1959 from a cave in the Helotes KFR and described as a new species in 1960 (USFWS 2014a). The species first assigned the name *Agonum exile*, but was formally reclassified in 1974 as *Rhadine exilis* (USFWS 2014a). Today, *R. exilis* is known to occupy at least 53 caves across the Government Canyon, Helotes, Stone Oak and UTSA KFRs (USFWS 2011). Recent collections of a slender, eyeless *Rhadine* beetle from the Culebra Anticline KFR have been identified as *R. exilis* (James Reddell, University of Texas at Austin, personal communication to Cyndee Watson, USFWS Austin Ecological Services Field Office). Additional specimens of *R. exilis* have been collected at the proposed APS Karst Preserve.

A Ground Beetle (*Rhadine infernalis*): *Rhadine infernalis* is a ground beetle similar to *R. exilis* but with a more robust body (USFWS 2014a). *Rhadine infernalis* was first collected in 1959 and described as *Agonum infernalis* by Barr and Lawrence in 1960. Barr reassigned the species to *Rhadine* in 1974. *Rhadine infernalis* has been reported from at least 39 caves in the Culebra Anticline, Government Canyon, Helotes, Stone Oak and UTSA KFRs (USFWS 2011).

The USFWS first designated critical habitat for the four listed Covered Species in 2003 and updated the designation in 2012 (USFWS 2012). However, no designated critical habitat for these or any other listed species occurs within the Plan Area.

5.0 INCIDENTAL TAKE AND IMPACTS

5.1 Effects of the Covered Activities

The Covered Activities will involve disturbances of vegetation and soil at the surface within the limits of the Project Areas; the excavation of bedrock within the limits of the trenches, tunnels, and bore pits; and the installation and testing of the pipelines. The combined extent of anticipated surface and subsurface disturbances associated with the Covered Activities is summarized in Table 6. However, not all of this disturbance involves areas that are within potential habitat for one or more of the Covered Species.

Potential habitat for endangered karst invertebrates is generally limited to areas mapped by Veni (2003) as Karst Zone 1 (areas known to contain listed karst invertebrate species), Karst Zone 2 (areas having a high probability of containing habitat suitable for listed karst invertebrate species), or – to a limited degree - Karst Zone 3 (areas that probably do not contain listed karst invertebrate species). The Plan Area does not contain any area mapped as Zone 4, and Zone 5 is not known to provide habitat for listed karst invertebrate species. Therefore, the potential effects of the Covered Activities on one or more of the Covered Species may reasonably be limited to those parts of the Plan Area that are within Karst Zones 1, 2, or 3. The Covered Activities involve approximately 67.8 acres of surface or subsurface disturbance, or both.

5.1.1 *Effects of Surface Activities*

The Covered Activities include a variety of activities to be conducted on or at the surface, including vegetation clearing, soil disturbance, temporary placement of excavated material or fill, dust control, bank stabilization, and soil/vegetation restoration. The USFWS recognizes a variety of potential effects resulting from activities conducted on the surface of karst invertebrate habitat that may threaten listed karst invertebrates, including (USFWS 2011):

- Entrances to caves can be filled-in or collapse during development activities or activities for agricultural purposes. Covering cave entrances can alter the physical cave environment, as well as impede or eliminate nutrient input.
- Chemical contamination from ground water and/or surface drainage, including pesticides, fertilizers, sewage, hazardous material spills, various pipeline leaks, storage tanker leaks, landfills, and urban run-off, could adversely affect karst invertebrates. Trash dumping may also be a source of chemical contamination.
- Altering surface drainage via alterations in topography, impervious cover, etc. could lead to drying of karst features and changes in nutrient inputs.
- Loss or alteration of surface biological communities can potentially adversely affect karst invertebrates by altering nutrient inputs, altering the stable physical environment of the cave, and introducing potentially harmful organisms. When changes in surface community plant composition occur, there is the potential to alter the type and quality of nutrient input into the cave system from the alteration of vegetation. Moreover, changes in surface plant species composition can in turn alter the surface animal species composition. Alterations in animal species composition may lead to less nutrient input into caves via a decrease of troglophiles and trogloxenes.
- Denudation of the surface plant community (replaced with impervious cover, left as bare ground, etc.) could lead to fluctuations in cave temperatures and moisture regimes that are outside the normal range of variability for the system.

- Soil disturbance may lead to an increased density of red imported fire ants (*Solenopsis invicta*) and alter the physical environment of the cave through increased sedimentation.

However, several of these potential surface effects identified by the USFWS may not be relevant to the Covered Activities. For example, the Project Areas contain no surface-exposed cave entrances that could be covered or sealed during conduct of the Covered Activities (see Section 2.2.1), thereby avoiding the possibility of filling in or collapsing the entrance to a cave with surface expression. The design of the Proposed Projects also restores preconstruction contours and the Covered Activities do not add impervious cover to the Project Areas, thereby avoiding the potential for alteration of surface drainage basins for any unknown karst features that may exist outside of the Project Areas.

The surface environment of the Project Areas occurs in a historically agricultural and currently urbanizing landscape, with much of the Project Areas following the undeveloped margins of developed neighborhoods or other linear utility easements. Nevertheless, the Covered Activities are expected to permanently convert approximately 13.3 acres of forested vegetation to open herbaceous vegetation over parts of the Proposed Projects that occur over Karst Zones 1, or 2, or 3; although, this effect would be minimized by the currently patchy nature of the existing woodlands and the implementation of required Tree Protection Plans. The permanent conversion of patchy woodland vegetation to herbaceous cover would not be expected to significantly alter the character of the landscape in which the Plan Area resides, since the clearing is limited to narrow linear corridors (45 to 80 feet wide) that already occur in a woodland-grassland mosaic with extensive areas of existing development (see Figure 8). Therefore, the limited and well-distributed amount of permanent conversion of wooded cover to herbaceous cover is not expected to alter surface biological communities in such a way that would significantly change the overall type or quality of nutrient input to the subsurface.

Denudation of the surface plant community and soil disturbances associated with the Covered Activities would be temporary in nature, since the Project Areas would be restored as quickly as possible to original or better conditions by replacing topsoil and revegetating with native plants. No part of the Plan Area will be converted to bare ground or impervious cover by SAWS. Again, the Project Areas do not include any karst features with surface expression. Therefore, any minor effects associated with temporary vegetation removal and soil disturbance at the surface are not likely to significantly affect the Covered Species.

The USFWS lists infestation by red imported fire ants (*Solenopsis invicta*, RIFA) as a threat to listed karst invertebrates that may be increased by activities that cause soil disturbance (USFWS 2011). RIFA have been found in parts of Bexar and Bell Counties since about 1959, Comal County since about 1975, and Travis, Williamson, and Hays Counties since about 1979 (Texas A&M University 2008). All of these counties continue to contain caves occupied by listed karst invertebrate species. No doubt RIFA, along with other native species occasionally forage on *Ceuthophilus* cave crickets, and on rare occasions, troglobitic karst invertebrates. However, after approximately 45 years of infestation by RIFA in Bexar County, endangered karst invertebrates are still present within Bexar County caves, suggesting that karst invertebrate fauna can coexist with RIFA over time. As an example, SWCA has been actively managing the La Cantera cave preserves in northwest Bexar County since their protection in 2001, including regular monitoring of RIFA and bi-annual biological surveys of cave fauna at each cave on the preserve. SWCA (2013) conducted an evaluation of over ten years of collected scientific data at these caves and did not find any correlation between the rate of occurrence of RIFA and the populations of cave crickets or federally listed *Cicurina* spiders, challenging the assumption that RIFA is a significant threat to listed karst invertebrates.

5.1.2 *Effects of Subsurface Activities*

The USFWS identifies the effects of excavation activities as a threat to listed karst invertebrates (USFWS 2011) whereby material excavation operations have the potential to alter the stable physical environment of the cave ecosystem by increasing the number of cave entrances, which could have a drying effect, increase sedimentation, and change water drainage patterns to the system. Furthermore, USFWS notes that caves can be completely destroyed through this type of activity (USFWS 2011).

The Covered Activities would excavate approximately 6.7 acres of potential karst invertebrate habitat within Karst Zones 1, 2, and 3, reaching depths of approximately 10 to 40 feet below the surface. It is possible that the excavated areas contain habitat suitable for karst invertebrates and, if present, that some of this habitat could be occupied by one or more of the Covered Species. However, it is not known if any members of the Covered Species actually occur in the 3-dimensional volume of rock to be excavated, since all due diligence investigations recommended by USFWS failed to document the presence of caves or voids with the characteristics of potential habitat or the actual presence of a listed species in the Plan Area. Therefore, this measure of impact is likely to be generous with respect to potential impacts on the Covered Species. For example, Zara (2011) surveyed 25 karst features on the TxDOT SH 151/Loop 1604 project site prior to construction finding only one occupied feature with an undescribed species of *Cicurina*. During construction, Zara (2013) identified another 25 karst features, with 20 of those determined to be potential karst invertebrate habitat, and after extensive monitoring only two of these caves were found to be occupied by a listed species. Of the 50 karst features discovered during the investigations for the TxDOT SH 151/Loop 1604 project, less than half provided potential habitat for karst invertebrates and only two (approximately 4 percent) were found to harbor a listed species.

Excavation activities could result in direct effects to an individual of a Covered Species if such individual is present at the same time and in the same location as active excavation and physically encounters equipment, rubble, or materials. Encountered individuals could be killed or wounded as a result. However, the likelihood of actually encountering an individual at the same time and place as active excavation work is very low. For instance, the karst fauna surveys conducted by TxDOT at the SH 151/Loop 1604 project site required 247 survey days with baited traps to collect 13 eyeless *Cicurina* individuals (Zara 2013) – on average, 19 survey days per collected spider. Over most of the survey days, no *Cicurina* individuals were observed or collected; although, it is not known (or even knowable) if there were truly no *Cicurina* present in the void or if they were simply not collected by the baited traps. Even with traditional survey techniques (i.e., visual searches of the interior of caves and karst voids) it is not uncommon repeatedly to observe no individuals in a feature with previously demonstrated occupancy (USFWS 2011). There are no reliable estimates of karst invertebrate population sizes or the density of individuals across a given area of habitat. Therefore, it is not certain, even in "occupied" habitat, that an actual individual of a Covered Species would be directly encountered and affected by excavation activities that occur over a very short duration at any given location.

Excavation activities could also affect individual karst invertebrates that might be present in habitat adjacent to excavated areas. Some void spaces, if present, could be removed by the Covered Activities and made permanently unavailable for use by any remaining individuals of the Covered Species that may be present in habitat adjacent to the excavation. In this way it is possible that the Covered Activities could remove habitable void spaces or fragment previously connected void spaces, or both. It is not known if or to what degree this potential habitat loss or fragmentation would alter the behavior of the Covered Species, since 1) the actual presence of occupied habitat in the excavation areas is not known (see Section 2.2.1); 2) the form or extent of any connectivity among habitable void spaces that may intersect the excavation areas are not known; and 3) how individuals of the Covered Species move

within and among areas of potential habitat, and how much time they spend there, is not known (USFWS 2011).

Areas adjacent to the excavation could also be subjected to surface climate conditions in ways that alter the stable physical environment of typical karst invertebrate habitat by drying, temperature increases and fluctuations, sedimentation, and more direct access by surface fauna. The reach of any such effects into adjacent habitats is unknown and likely dependent on the particular size, shape, preexisting climate, and other characteristics of the feature. These types of "exposure" effects to adjacent voids would be minimized for sections of the pipelines installed by boring or tunneling, since these areas would be less exposed to the surface. The duration of the exposure effect would also be largely temporary since excavated areas will be backfilled following installation of the pipelines with material that would allow stable subsurface climate conditions in any adjacent voids to return by cutting off direct exposure to the surface.

While excavated areas remain unfilled, individual karst invertebrates using adjacent habitats could be displaced into other connected karst voids where stable conditions are still present or they could be killed if they are not able to move away from or adjust to the new conditions. However, how individual karst invertebrates actually respond to these types of abrupt and essentially short-term changes to habitat conditions is unknown. Anecdotally, there is evidence suggesting that temporary openings of karst voids (over days or even weeks) might not significantly disrupt the essential behaviors of karst invertebrates to an extent that results in actual death or injury. For instance, karst fauna surveys conducted according to USFWS protocols commonly return observations of karst invertebrates from features with excavated entrances. For example, collections of *Cicurina* spiders from the karst voids at the TxDOT SH 151/Loop1604 project site occurred after as few as four days after initial discovery of the feature by excavation and as many as 53 days after initial excavation (Zara 2013). Therefore, it is possible but not certain that individuals of the Covered Species using habitat adjacent to the excavated area, if they are present at all, would suffer significant adverse effects over the duration of the construction period.

5.2 Incidental Take

The Proposed Projects occur in an area that contains the geological formations that generally support karst invertebrate habitat and occupied habitat for endangered karst invertebrates has been identified several hundred feet away. However, SAWS has completed all due diligence studies recommended by USFWS and has not documented the occurrence of karst voids occupied by one or more of the Covered Species within or immediately adjacent to the Proposed Projects. Under these circumstances, SAWS cannot preclude the potential for unknowingly encountering habitat occupied by one or more of the Covered Species during construction and desires the regulatory assurances of an ITP to address any unanticipated takings of the Covered Species in connection with the Covered Activities.

5.2.1 *Establishing a Surrogate Measure for Take*

To obtain an ITP, SAWS must determine an appropriate amount of incidental take authorization and assess the impacts of this amount of take on the Covered Species. However, in addition to the uncertainty regarding whether or not any one of these species actually occurs in the Project Areas, making this determination is further complicated by taxonomic uncertainty concerning which of the blind *Cicurina* species may be encountered within the Project Areas. This HCP addresses three species of endangered *Cicurina* spider and one unlisted *Cicurina* species; although, SAWS does not expect that all four species could even occur in the Project Areas together (see discussion in Section 4.2). Rather, only some combination of one or two of these four *Cicurina* species is likely to occupy the Culebra Anticline KFR generally. Definitively resolving the identity of the *Cicurina* spiders that may be present

in the vicinity of the Proposed Projects would be difficult within the desired permitting timeline, since some of the species are perceived to be quite rare (some are "known" from only two karst features), identifiable specimens are difficult to encounter and collect, and, assuming sufficient specimens could be collected, best scientific practices would likely require publication in a peer-reviewed journal to accept a taxonomic confirmation using advanced or novel methods.

SAWS proposes a surrogate approach to specify the authorized level of take of each of the Covered Species that may arise from the conduct of the Covered Activities when, as in the present case, (1) the presence of the Covered Species in the Project Areas (both individually and as a group) is uncertain; (2) the possibility of encountering potential habitat for Covered Species could arise at any time in the construction process; and (3) the taxonomic identification of and differentiation between some of the various species believed to have some possibility of appearing in the Plan Area, only some of which are protected under the ESA, is extremely difficult to accomplish, if possible at all, in time frames consistent with the successful completion of the Covered Activities.

The USFWS recently released guidance for the use of surrogate measures for determining the amount and extent of take that affirms the validity of this approach for ESA compliance if certain conditions are met (80 FR 26832). These conditions include a demonstration that (1) it is impractical to establish the numerical number of individual animals to be taken, (2) the proposed ecological surrogate is rationally linked to actual take of the listed species by the proposed action, and (3) the surrogate provides measurable guidelines to determine when authorized incidental take would be exceeded.

Below, SAWS establishes a surrogate measure for determining take of the Covered Species caused by the Covered Activities that is based on the aerial extent of surface or subsurface disturbances within mapped Karst Zones 1, 2, and 3. Additional discussion of the appropriateness of the proposed surrogate measure of take and mitigation is provided in Appendix A.

The proposed take authorization and mitigation approach for this HCP rests on three central propositions: (1) reliable taxonomic identification of some karst invertebrates that might be present in karst formations encountered during construction would be exceedingly difficult and time consuming to achieve, and probably not possible in most cases; (2) it is likely that species assemblies in karst formations found in the vicinity of the Plan Area are similar; and (3) surface acres provide a reliable metric for estimating the amount of karst formations either disturbed in construction or preserved through mitigation. These propositions align closely with the conditions for approval of take surrogates.

5.2.1.1 Impractical To Determine "Number of Animals" by Species

With respect to the karst invertebrate fauna that occurs in the vicinity of the Proposed Projects, it is impractical, and perhaps impossible, to establish the number and/or specific identity of the individuals of any particular listed species likely to be taken by the Covered Activities. The difficulties in making these determinations are related to the inaccessible nature of the habitat, the cryptic nature of the individuals themselves, and uncertainties about the basic taxonomic identity of several species of karst fauna. The same issues apply to efforts to measure the numbers or species of listed karst invertebrates that may be conserved by mitigation measures that protect areas of karst invertebrate habitat.

Inaccessible Habitat

Habitat for cave-adapted fauna in the vicinity of the Plan Area is the byproduct of the evolution of the Edwards Aquifer and related groundwater systems along the Balcones Escarpment, a hydrogeological process acting across approximately 20 million years of evolutionary time. The paleoaquifers developed locally- to regionally-extensive void networks along the structural grain imparted by the Balcones Fault Zone and the primary porosity of the Glen Rose Limestone, the Edwards Limestone, and Austin Chalk

that are the host rocks for the great majority of caves in the area. The fauna are referred to as karst invertebrates, not cave invertebrates, precisely because their habitat occurs within the fabric of the paleoaquifer. The voids within that fabric may be large enough to be accessible by a human (i.e., caves), but, by volume, the majority of potential habitat available to karst invertebrates is too small for human entry. The interconnected network of small voids in a karst formation are known as *mesocaverns*. Mesocavern voids that can harbor karst invertebrates may be only one-half inch or less in diameter. It may be possible to detect subterranean habitat when a cave entrance is present or when larger mesocaverns are exposed at the surface in the form of a visible solution cavity or enlarged fracture. Habitat in larger voids may also be indirectly detectable with the use of geophysical technology such as ground-penetrating radar or electrical resistivity imaging, but the reliability of these methods is subject to false positive, false negatives, interference from utilities, and the like. Most potential habitat for the species is difficult to detect from the surface and small mesocavernous voids may not be possible to detect (too small) or are so common in the karst formation that they are essentially "background noise."

Where voids are large enough to enter, either directly by a human or by the insertion of equipment like temperature/humidity probes, cameras, or bait traps there is an opportunity to observe habitat conditions and potentially detect karst fauna. However, much of the void space that may comprise habitat for karst invertebrates is not accessible by humans or remote equipment. Therefore, the full extent of potential habitat for listed karst invertebrate species cannot be practicably observed for the purpose of determining the presence or absence of either suitable habitat conditions or the species themselves. Nevertheless, listed karst invertebrates have been collected from voids, including caves and mesocaverns, having no obvious surface connection prior to exposure by excavation.

For the Proposed Projects, karst invertebrate habitat surveys using intensive surface pedestrian surveys have been conducted within the rights-of-way, meeting or exceeding the level of effort recommended by the USFWS. No geologic features suggesting the presence of subsurface voids were encountered within either project site. However, caves and mesocaverns occupied by listed karst invertebrates are known to occur within several hundred feet of the Proposed Projects. In addition, investigation through ground penetrating radar did indicate that there may be underground voids in the vicinity of the projects (Baer Engineering and Environmental Consulting, Inc. 2012). However, it is not practical to determine whether or to what extent any such voids are actually present, habitable, or occupied by one or more of the Covered Species.

Implementation of the Covered Activities, particularly excavation activities, could remove or alter habitat for karst invertebrates, possibly harboring individuals of a listed species, before it would even be possible to determine if such habitat or individuals existed in that space. Even then, only voids exposed by the excavation would be potentially accessible for direct or indirect observation and survey. It is not practical to fully access potential habitat for karst invertebrates at these sites without first destroying or altering the habitat and potentially and unknowingly taking listed species before they are able to be detected, making it impractical to measure take by a count of affected individuals.

Cryptic Species

The listed karst invertebrates of central Texas are small animals, generally ranging between 1 millimeter and 1 centimeter as adults. Individuals can be smaller as immature juveniles. Many karst invertebrates are pale in color, even somewhat translucent. Within caves and voids, some karst invertebrate species are most often found under rocks or other cover items on the cave floor, some utilize small cracks and spaces in cave walls and ceilings, and others rove across open spaces on floors, walls, and ceilings. At best, detecting the small, inconspicuous, and often hidden individuals of most species of karst invertebrate is difficult where voids are large enough to permit entry by humans. However, most of the void space capable of providing shelter for individual karst invertebrates within caves occurs within the

irregular talus pile habitat in breakdown areas where ancient cave ceilings have collapsed onto the cave floor. Needless to say these areas are difficult to fully survey in the dark, cramped conditions. By and large, mesocaverns are not accessible to humans at all. As such, making direct counts of karst invertebrates in the bulk of the potentially suitable habitat area is impractical. Detectability issues are present even under favorable survey conditions in easily accessible caves since our current understanding of species' activity cycles is poor. Various cave-adapted species occurring within the same caves seem to share the habitat by staggering their activity cycles or by specializing in different microhabitats. For example, *Cicurina* sp., especially adult specimens, are apparently more available for collection during the coldest months of the year while *Rhadine* sp. seem to peak in abundance during the late spring or early summer. Any one survey event is likely to miss the best temporal window for encountering a portion of the troglobitic community.

The Bexar County Karst Invertebrates Recovery Plan prepared by the USFWS acknowledges (USFWS 2011):

> Population estimates are unavailable for any of these species due to lack of adequate techniques, their cryptic behavior, inaccessibility of mesocaverns, and difficulty accessing cave and karst habitat. In known locations, one or two individuals are typically observed per survey event, and it is not uncommon to observe none at all (Krejca and Weckerley 2007). Results of point counts are available for some species at some localities in unpublished literature (for example, scientific permittee annual reports). Techniques that may be useful for population estimates of invertebrates include mark-recapture, such as have been used for cave crickets and troglobitic crustaceans (Knapp and Fong 1999, Taylor et al. 2005) but not for any of the listed species or their relatives.

Wildlife survey techniques involving mark-release-recapture or mark-capture methods are sometimes used to estimate population sizes of animals where complete census surveys are impractical. These types of survey methods have not been applied to the listed karst invertebrates of central Texas and safe, reliable marking techniques have not been developed for these species. Even if such methods were available for conducting studies, it is not possible to access most of the habitat in which these animals occur, and the large open caves that humans are able to survey likely differ from the habitat available in small, tight mesocaverns. With the differences in habitat conditions between caves and mesocaverns, extrapolating data collected from cave environments to the more extensive mesocavern environments may not be valid. Furthermore, most species of listed karst invertebrates are very uncommon and it may be difficult to mark enough individuals to conduct an informative study.

For the Proposed Projects, the number of individuals of each of the Covered Species that may be present within the Project Areas cannot be known, nor are there reliable estimates of population sizes or density of individuals occurring in a given area of habitat. At best, the presence of at least one individual of a particular species in an accessible void may be known, but it is not practical to know how many such individuals may be affected or taken by a particular activity.

Taxonomic Uncertainty

When individuals of a karst invertebrate species are detected, most are not identifiable to species in the field. For many species, taxonomic identity is only discernible with a detailed investigation of the minute differences in the shape or position of various body parts under a high-powered microscope. The sex and age of a particular specimen may also affect its ability to be identified. For example, the morphological characteristics used to determine the different species of *Cicurina* spiders is based on adult genitalia, particularly adult female genitalia. It is not possible to use current morphological keys to identify most male *Cicurina* specimens to species. No immature specimens of any *Cicurina* spider may be identified to species using morphological features, even though they are more commonly

encountered during surveys than adults. For most karst invertebrate taxa, only a few scientists are qualified and experienced enough to identify collected specimens to the species level using morphology. For some species, genetic studies can help determine taxonomic identity; but again, there are only a few qualified scientists available who are capable of conducting this work (presuming that such individuals are even interested and available to review specimens). For genetic analysis to yield a species-level identification much context must be made available to them in the form of other specimens from other sites that are rooted in a known taxonomic foundation. These investigations take years to complete and, as such, they are not practical as decision-making tools for individual projects operating on a relatively short time frame.

The Proposed Projects lie within the Culebra Anticline KFR. KFRs are geographic areas delineated based on potential discontinuity of karst habitat (such as downcutting of the geology by streams, changes in geologic formation, or faulting) that may reduce or limit interactions between troglobite populations. The listed karst invertebrates formally recognized by the USFWS as occurring in the Culebra Anticline KFR are *R. infernalis*, *R. exilis*, and *C. venii* (USFWS 2011; James Reddell, University of Texas at Austin, personal communication to Cyndee Watson, USFWS Austin Ecological Services Field Office). Although, as described in the paragraphs below, individual spiders of the genus *Cicurina* collected from the vicinity of the Plan Area have also been assigned names of the listed species *C. madla* and *C. baronia*.

The taxonomy that defines species identity and the relationships among related species of the eyeless *Cicurina* spiders of central Texas is considered by leading researchers to be in need of clarification and revision, particularly for the Bexar County *Cicurina* spiders. Gertsch (1992) published the alpha taxonomy of what has long been considered "the genus from hell" among arachnologists (Pierre Paquin, personal communication). Gertsch (1992) included descriptions of 45 new eyeless *Cicurina* species from 18 Texas counties. He described four species from Bexar County, all four of which are now listed as endangered. Heavily weighing the likely, albeit presumed, physical isolation from site to site, Gertsch seemed to generally follow a "new cave, new species" implicit hypothesis. Cokendolpher (2004) described an additional 5 eyeless species from northern and western Bexar County.

Thirty-four of the eyeless *Cicurina* species in Gertsch (1992) were described on the basis of a single diagnostic specimen. Twenty-eight of the species were described from specimens that had been in preservative for more than 20 years and may have experienced morphological deterioration (Paquin and Dupérré 2009). With most eyeless species described based on single specimens, the degree of morphological variation within most of these species was virtually unknown. Wide morphological variation had been reported for the related, 8-eyed surface dwelling species, notably *C. varians*, which was named for this characteristic. This presented a serious problem for other investigators attempting to identify newly discovered *Cicurina* populations. Even if they were fortunate enough to collect an adult female specimen, the type illustrations may not accurately represent their species. This problem leaves investigators without a fully functioning taxonomic key.

Gertsch's "new cave / new species" implicit hypothesis clearly breaks down at the local scale where extensive cave systems are known to share a common hydrological origin. Most recent work on *Cicurina* sp. that incorporates genetic analysis indicates a clear trend toward synonymy where Gertsch or others have described multiple species in a small geographic area.

In relation to a petition to list *C. cueva* in south Austin in 2003 the USFWS funded an investigation into the genetics and morphological taxonomy of *Cicurina* spp. in that area. In their report to the USFWS, Dr. Marshall Hedin of San Diego State University and his student Dr. Pierre Paquin found strong evidence of the synonymy of three species (*C. bandida, C. cueva and C. reddelli*). It resulted in the USFWS's decision not to list *C. cueva* since it was determined not to be a listable taxon.

Building on this experience, Paquin and Hedin (2004) was the first peer-reviewed and published material dealing with the taxonomy of Texas *Cicurina* from a genetic perspective. Their material did not nearly represent a comprehensive sampling of caves in the state, it included only 18 of the 51 hypothesized morphological species, and yet their analysis of mitochondrial DNA overwhelmingly indicates synonymy of at least three species pairs, two of which occur in Bexar County (*C. madla*/*C. vespera* and *C. platypus*/*C. puentecilla*). Their conclusions were based on a much larger collection of adult specimens than were available to either Gertsch (1992) or Cokendolpher (2004). Based on observed morphological variation, verified by genetic analysis to occur within single species, it seemed clear that intraspecific variation has been previously underestimated.

With regard to the apparent *C. madla*/*C. vespera* synonomy, immature specimens from Government Canyon Bat Cave used in the Paquin and Hedin (2004) genetic analysis that were given the name *C. vespera*, presumably on the basis that they were collected from the type locality for *C. vespera*, are likely misidentified. The type specimen for *C. vespera* has a rounded morphology, similar to specimens typically found in karst habitats of the Austin Chalk formation, while *C. madla* has an elongate morphology. It is extremely unlikely for *C. vespera* to be synonymous with *C. madla*, since genetic work indicates that this rounded vs. elongate morphological characteristic conforms to strong split in taxonomy. Similarly, the type specimen for *C. venii* exhibits an elongate morphology that is uncharacteristically attached to a type locality in the Austin Chalk formation and, as described below, the morphology of *C. venii* fits within the range of *C. madla*. A likely explanation for these conflicting observations is that the locality labels for the type specimens of *C. vespera* and *C. venii* may have been inadvertently switched during the course of Gertsch's work describing them. Presumably, *C. vespera* and *C. venii* were given species status by Gertsch partially on the basis that their morphologies were very different from specimens in nearby locations. If these specimens are not actually from the localities where taxonomists currently assume they were, then neither of these species may really exist.

In 2014, an investigation of *Cicurina* spiders in Travis and Williamson counties yielded a similar result. Hedin (2014) found synonymy among three *Cicurina* species of elongate morphology. Hedin states: "Modern species delimitation should be a data-rich process, where large amounts of data from several sources are subject to multiple objective analyses to detect distinct evolutionary lineages. The existing species hypothesis for *Cicurina wartoni*, based on subjective consideration of a single specimen, is clearly tenuous." Indeed, based on this study, the USFWS itself recently determined that the previously identified *C. wartoni* (known from only one location) is not a valid taxon (USFWS 2014a).

Recognizing the widespread pattern of likely synonymy and the desperate need for bringing the *Cicurina* past the alpha taxonomy stage, Paquin and Dupérré (2009) published the first step in the revision of the troglobitic subgenus. This work included re-illustration of all available type specimens using superior techniques, such as scanning electron microscopy, and an assessment of intraspecific morphological variation. Additional scientific work, followed by publication in a peer-reviewed scientific journal, is needed to resolve questions regarding intraspecific variation in morphology and to integrate genetic data into the understanding of the taxonomy of the eyeless *Cicurina* spiders. Therefore, it is impractical at this time to determine the specific identity of specimens of eyeless *Cicurina* that could occur in the Plan Area and that could be taken by the Covered Activities or preserved in the proposed APS Karst Preserve.

5.2.1.2 Ecological Surrogate is Rationally Linked to Actual Take

It is known that caves and mesocaverns within the central Texas karst geologic formations provide habitat for listed karst invertebrate species and that the habitat matrix was formed by hydrogeological processes acting on a regional scale. This geology creates the physical environment in which listed karst invertebrates may be found; although it may not be practical to know exactly where in this 3-

dimensional volume of potential habitat that individuals occur. Conceptually, the matrix of caves and mesocaverns within karst formations form a system of voids within the horizontal and vertical limits of the karstic strata. Karst invertebrates may move freely within this matrix of voids, perhaps using different areas at different times. The continuity and interconnectedness of this potential habitat may, however, be limited by the extent of karst development, secondary mineral growth that fills voids, faulting that displaces formations vertically, or exposure to conditions that render other critical aspects of habitat unsuitable – like water filled voids or surface climate intrusion.

Based on this conceptual model of potential karst invertebrate habitat, Veni (2002) mapped the surface extent of the karst formations that provide potential habitat for listed species and ranked different areas by the likelihood of occupancy by one or more of the listed species. Rankings were based on the distribution of known occurrences at the time and the continuity and similarity of the geology. The USFWS has adopted the concept of these karst zones acting as a measure of the extent of potential karst invertebrate habitat in permitting actions, consultations, and recovery planning.

The surface extent of the underlying karst geology provides a rational ecological surrogate for measuring the actual take of Covered Species resulting from land use activities that occur over or within this geology or the conservation of such species achieved by the protection of karst features that may occur below a protected property. The USFWS has established that alteration of surface drainage patterns by changing topography or the addition of impervious cover; changes to surface plant and animal communities; and pollution from leaks or spills of sewage, petroleum products, or chemicals, are among the most serious threats to listed karst invertebrates. These threats indicate potential pathways for take of listed karst invertebrates from land use activities that are conducted largely at the surface.

Similarly, the USFWS has defined many of the primary constituent elements of critical habitat for listed karst invertebrates in Bexar County in terms of various aspects of the surface environment over karst geology. Such elements include surface drainage basins and surface plant and animal communities where they occur over karst geology. The USFWS also recommends that preserves for karst invertebrates contain 100 acres or more around an occupied site, which could extend at least 1,178 feet from the occupied site.

Therefore, the surface acres either disturbed or protected over the geologic formations that are known to harbor listed karst invertebrate species are an appropriate ecological surrogate that is rationally linked to the take or conservation of individuals of the listed species that occur in those formations. Given the interconnectedness of the subsurface environment by the matrix of caves and mesocaverns that comprise karst geologic formations, it is rational to assume that the assemblage of species at one location is the same as the assemblage at nearby locations, where the extent of this karst habitat has not been broken by downcutting, fracturing, or other barriers. In fact, the USFWS's policy to date regarding these species is based on surrogate metrics. Both the KFR and the karst zone policies are predicated on the assumption of the presence of faunal communities across large areas based on extrapolating from a small number of surveyed caves.

5.2.1.3 Surrogate Metric Can Measure When Take Has Been Exceeded

The acres of land disturbed or protected by an action is a predictable measure of the take and conservation of listed karst invertebrates under this ecological surrogate. Limits of disturbance or protection are easily measured, are predictable, and can be independently verified by site inspections or (in most cases) aerial imagery.

5.2.2 *Requested Amount of Take*

SAWS proposes to use the number of acres of Karst Zone 1, 2, or 3 that would be subject to surface or subsurface disturbance by the Covered Activities as a surrogate measure for the amount of take of each of the Covered Species. SAWS requests 67.8 acres of take authorization from the USFWS for each of the six Covered Species (66.4 acres allocated to the WRIP Phase 2 Pipeline and 1.4 acres allocated to the Micron Pipeline Phase 2).

It is possible that USFWS-approved management activities within the proposed APS Karst Preserve could incidentally take one or more of the Covered Species. However, any such incidental takings would be associated with beneficial conservation activities and SAWS expects that authorization for such beneficial takings would be covered by separate ESA Section 10(a)(1)(A) enhancement of survival permits held by the biologists conducting such work.

5.2.3 *Impacts of the Requested Taking*

For the reasons described above, it is difficult to assess the impacts of the requested taking on each of the Covered Species without reliance on the surrogate take measure of acres of potential karst habitat disturbed vs. the total acreage of potential habitat present on the landscape. SAWS requests 67.8 acres of take authorization for each of the Covered Species. The Culebra Anticline KFR contains approximately 16,866 acres of potential karst invertebrate habitat (i.e., areas mapped as either Karst Zone 1, 2, or 3) and approximately 9,745 acres of this potential karst invertebrate habitat lies under areas mapped as some form of undeveloped land cover by the 2011 NLCD. The requested amount of incidental take represents only 0.4% of the total acreage of potential karst invertebrate habitat in Culebra Anticline KFR, and only 0.8% of the undeveloped potential karst invertebrate habitat in this region. Furthermore, a portion of the requested take authorization occurs over Karst Zone 3 that only has a low probability of providing habitat for listed karst invertebrates.

Therefore, the requested taking only affects a very small proportion of the regional habitat for the Covered Species, much of which is still undeveloped. However, listed karst invertebrates are known to persist under developed land uses as well. For example, 8-meter Void cave (a cave formed within the Austin Chalk geologic formation within the Alamo Heights KFR) was found to contain the endangered *C. baronia*, despite having been located beneath an athletic field house in a built-out area of San Antonio near Trinity University for several decades prior to discovery (SWCA unpublished information). Therefore, surface disturbance and even the addition of impervious cover on the surface does not always result in the loss of habitat for these species, even after many decades of development.

In the case of the Proposed Projects, the Covered Activities largely restore the surface and subsurface environments in ways that continue to allow for water and nutrients to infiltrate from the surface and limit direct exposure and access from the surface. It is not likely that the Covered Activities substantially alter the climate of the subsurface matrix of mesocavernous spaces that may be used by the Covered Species. Therefore, the overall impact of the requested taking may be considered minor with respect to the regional and range wide populations of the Covered Species.

6.0 CONSERVATION PROGRAM

Applicants for an incidental take permit must demonstrate to the USFWS that they will "minimize and mitigate the impacts of the taking to the maximum extent practicable" (16 USC 1539). When the USFWS is determining whether or not an applicant has met this statutory issuance criteria, it utilizes two criteria, "this finding typically requires consideration of two factors: adequacy of the minimization and mitigation program, and whether it is the maximum that can be practically implemented by the applicant" (USFWS and NMFS 1996).

6.1 Biological Goals and Objectives

The biological goals and objectives of this HCP are: (1) to avoid reasonably certain takings of Covered Species by routing the Proposed Projects through areas with no demonstrated occupancy by the Covered Species and employing construction methods (where practicable) that reduce the amount of excavation needed to install the pipelines; (2) to minimize potential impacts on Covered Species by using best practices to reduce construction phase effects; and (3) to mitigate for the potential impacts of the requested take by permanently protecting and managing approximately 57.6 acres of karst habitat at the APS for the benefit of the Covered Species.

To achieve these goals and objectives, SAWS proposes to implement the conservation measures described in the following sections.

6.2 Avoidance Measures

The Plan Area avoids critical habitat for listed karst invertebrates and investigations to-date have not documented the presence of void spaces with the characteristics of habitat for karst invertebrates or the actual presence of any listed species within either of the Project Areas. Therefore, the routing of the Proposed Projects already avoids all known occurrences of the Covered Species.

6.3 Minimization Measures

The Covered Activities include the application of industry standard erosion and sedimentation controls, spill prevention plans, and site restoration measures designed to minimize impacts to the surface and subsurface environments during and after construction. For example, plans for the Micron Pipeline Phase 2 Erosion and Sedimentation Controls specify the following (SAWS 2011:Drawing No. EC1):

- the application of hydromulching and permanent plantings, sodding, or seeding for soil stabilization within 14 days of permanently or temporarily ceasing construction activities;
- the installation of silt fences, gravel filtration bags, rock berms, and rock bedding as structural erosion and sedimentation control practices prior to ground disturbance;
- bi-weekly inspections of erosion and sedimentation controls and additional inspections after precipitation events, with the replacement or maintenance of controls as needed to ensure they are in good working order;
- the collection of all waste materials in securely lidded dumpsters to be disposed of at a local dump as necessary, with no construction materials to be buried on site; and
- hazardous materials spills responses as specified in the Storm Water Pollution Prevention Plan, with notification to the National Response Center and local authorities for any reportable or life threatening spills of hazardous materials.

SAWS must also comply with Tree Protection Plans required by the City of San Antonio. Design drawings for Micron Pipeline Phase 2 indicate that tree canopy removal for this project is limited to 0.69 acres, preserving 30.27% of the total tree canopy within this Project Area (SAWS 2011:Drawing No. TP1).

Final construction drawings are not yet available for the WRIP Phase 2 project, but similar minimization measures will be employed.

6.4 Mitigation Measures – Anderson Pump Station Karst Preserve

SAWS owns and operates a largely undeveloped parcel of land associated with the Anderson Pump Station located at the southwest corner of Loop 1604 and SH 151 (Figure 5). Both the proposed WRIP and Micron Projects terminate at the Anderson Pump Station. Preservation of the undeveloped land at the Anderson Pump Station provides an opportunity for mitigating the impacts of the requested incidental take of the Covered Species. SAWS consulted USFWS-permitted biologists working for SWCA to conduct a thorough karst invertebrate habitat evaluation for the Anderson Pump Station. As described in more detail below, this evaluation determined that the undeveloped portion of the APS contains habitat for karst invertebrates and is occupied by at least one federally endangered species. SAWS proposes to dedicate approximately 57.6 acres of this undeveloped land as a permanently protected and managed karst habitat preserve (APS Karst Preserve) (Figure 10).

Figure 10. SAWS Anderson Pump Station and the proposed APS Karst Preserve.

6.4.1 *Context and Setting*

The proposed APS Karst Preserve is located over Karst Zone 2 within the Culebra Anticline KFR (Figure 7). The site appears on the Culebra Hill, Texas, U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle map (USGS 1993). Topography within the proposed APS Karst Preserve slopes gently away from a hilltop positioned near the center of the site, with elevations ranging from about 910 to 1,000 feet above mean sea level (MSL) (Figure 11). The Austin Chalk formation outcrops at the surface within the proposed APS Karst Preserve (Figure 6). The karstic Austin Chalk formation has a thickness of approximately 125 feet at this location, based on SAWS well drilling records.

There are no streams, ponds, wetlands, or other sources of surface water within the proposed APS Karst Preserve. The proposed APS Karst Preserve is located entirely within the artesian zone (confined zone) of the Edwards Aquifer, and subcrops of the Edwards and Trinity Aquifers. There are no known spring outlets within the APS.

The Texas Parks and Wildlife Department's (TPWD) Ecological Systems Classification of Texas (ESCT) indicates that the proposed APS Karst Preserve contains "Edwards Plateau Limestone Savanna and Woodland" and the "Edwards Plateau Limestone Shrubland" systems, including areas of Ashe juniper mottes and woodlands, live oak mottes and woodlands, oak/hardwood mottes and woodlands, deciduous oak/evergreen mottes and woodlands, and shin oak shrublands (Elliott 2010).

As observed in the field, vegetation on a vast majority of the proposed APS Karst Preserve consisted of moderately dense Ashe juniper (*Juniperus ashei*) / plateau live oak (*Quercus fusiformis*) woodland. Other tree species occur in small groups or as isolated individuals scattered across the property including cedar elm (*Ulmus crassifolia*), hackberry (*Celtis reticulata*), huisache (*Acacia farnesiana*), and bumelia (*Sideroxylon lanuginosum*). Greenbrier (*Smilax bona-nox*) is the most common vine species found within the property. Tree canopy cover on the property is approximately 70 percent.

Within woodland areas, shrub layer species occur in low to moderate densities primarily along woodland margins. Shrub layer species include Texas persimmon (*Diospyros texana*), Ashe juniper saplings, Texas mountain laurel (*Sephora segundiflora*), elbowbush (*Forestiera pubescens*), Texas hogplum (*Colubrina texensis*), catclaw (*Acacia roemeriana*), condalia (*Condalia hookeri*), yucca (*Yucca constricta*), beargrass (*Nolina texana*), Texas prickly pear (*Opuntia engelmannii*), *and* tasajillo (*Cylindropuntia leptocaulis*). Small scrubby areas occur within central portions of the property. These areas are dominated by Texas persimmon, Ashe juniper, evergreen sumac (*Rhus virens*), beebrush (*Aloysia gratissima*), Texas kidneywood (*Eysenhardtia texana*), and Texas mountain laurel. Ground cover species are relatively sparse throughout the property but are dominated by King Ranch bluestem (*Bothriochloa ischium*) in open areas and cedar sedge (*Carex planostachys*) within wooded areas.

Except for the presence of King Ranch bluestem, which is an extremely common and naturalized ground cover across Texas, non-native plant species are rare within the proposed APS Karst Preserve.

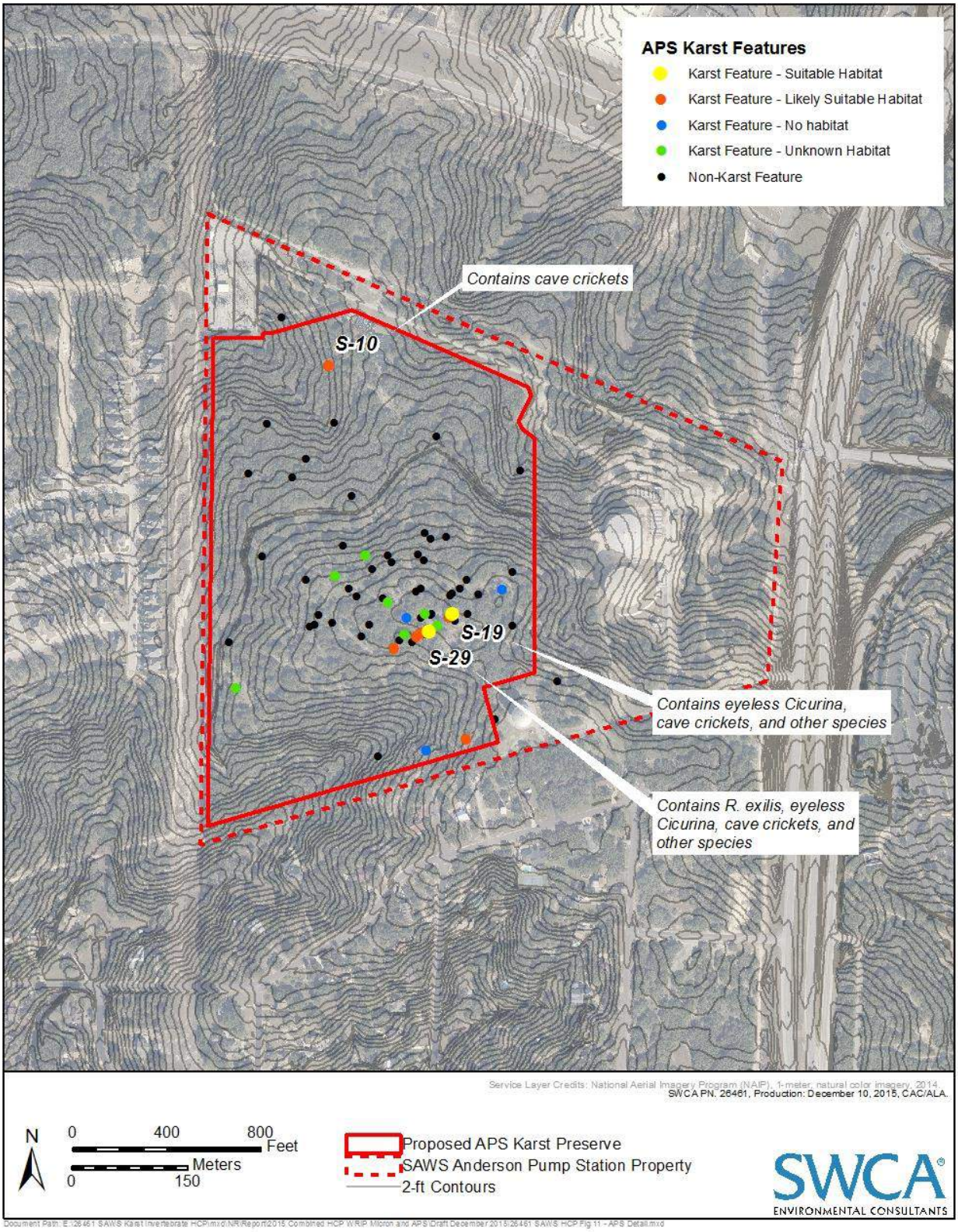

Figure 11. Karst features observed on the proposed APS Karst Preserve.

6.4.2 *Karst Habitat Assessment*

To evaluate whether or not the proposed APS Karst Preserve contains karst invertebrate habitat, SWCA performed a karst feature survey over seven field days between November 21, 2013, and April 5, 2014. A team of geologists and karst technicians supervised by SWCA biologist Chris Collins (USFWS Permit No. TE800611) visually inspected 70 acres of the APS for geologic features exhibiting surface expression. SWCA covered this area twice, with transects walked in both the north-south direction and then in an east-west direction. Additional visual investigations were conducted in greater detail near features found during the karst feature survey. SWCA identified 68 potential karst features within the surveyed area (Figure 11).

SWCA then investigated each of the potential karst features with hand-tools and, as appropriate, mechanized excavation equipment. Of the 68 potential karst features, 18 appeared to be formed by karst processes (i.e., were true karst features) and the remaining 50 features appeared to be anthropogenic in origin or were formed by non-karst processes such as animal burrowing or tree roots. USFWS-permitted biologists, Chris Collins and Kemble White (USFWS Permit No. TE800611) continuously evaluated the features during the excavation process for signs of airflow, subsurface void space, and signs of trogloxenes and karst invertebrates. Features found to contain potential karst invertebrate habitat were covered with a plastic tarp to protect the features against surface temperature and sun exposure.

Of the 18 true karst features identified within the APS, two features were determined to contain suitable habitat for karst invertebrates, six features likely contain suitable habitat, four features do not contain habitat, and the presence of suitable karst invertebrate habitat within the six remaining features remains unknown. The two features confirmed to contain suitable habitat for karst invertebrates are features S-19 and S-29; both possess significant void space, small conduits, organic matter, and cave crickets. Additionally, features S-10, S-17, S-21, S-58, S-61, and S-62 likely contain suitable karst invertebrate habitat (Figure 11). These features possess small conduits and voids and in some cases, cave crickets, but are humanly inaccessible and further excavation (which would have unnecessarily damaged the features) was deemed not warranted.

The complete results of the SWCA (2014) karst and biological investigations within the APS, including cave maps and climate data, are described in a report entitled "*Karst Invertebrate Habitat Assessment and Presence/Absence Surveys for the San Antonio Water System Anderson Pump Station in Bexar County, Texas*." This report (SWCA 2014) is attached as Appendix B.

6.4.3 *Karst Fauna Surveys*

USFWS-permitted biologists, Chris Collins and Kemble White, conducted karst invertebrate biota surveys in the humanly accessible features (S-19 and S-29) between March and May 2014. Four surveys were conducted in feature S-19 for a total of 2.8 person hours of survey time, and six surveys were conducted in feature S-29 for a total of 8.25 person hours.

To supplement the biota surveys, SWCA performed bait trapping in features S-10, S-19, and S-29. None of the other features "likely to contain suitable karst invertebrate habitat" were large enough to insert bait traps. While bait traps were deployed, the area around the entrances of the features was monitored for the presence of RIFA in accordance with USFWS presence/absence survey protocols. No RIFA or their mounds were observed on the surface around the features. However, RIFA were observed within the interior of these features during the trapping efforts. In all cases, biologists ceased bait trapping efforts after the discovery of RIFA within the features to protect the native fauna community.

These surveys documented the presence of eyeless *Cicurina* spiders, harvestman, *Brakenridgia* isopods, *Cambala* millipedes, springtails, *Texoreddellia* silverfish, and *Rhadine* beetles within S-19 and/or S-29, proving that the APS site contains suitable habitat for troglobitic karst invertebrates. The number and distribution of other karst features within the APS having the characteristics of suitable habitat, suggests that suitable habitat also occurs elsewhere on the APS site between and in the vicinity of these features.

SWCA collected 6 juvenile blind *Cicurina* specimens and two elongate blind *Rhadine* specimens from Feature S-29, and 1 juvenile blind Cicurina specimen from Feature S-19. SWCA placed the specimens in 100 percent non-denatured ethanol, as specified by USFWS protocols in place at the time, and stored them in a deep freezer until shipment to Mr. James Reddell, the recommended taxonomist for *Rhadine* species, in June 2015 for further identification. Reddell's preliminary findings (transmitted via personal email communication to Chris Collins, SWCA, on June 18, 2015) suggest the blind *Rhadine* specimens collected from Feature S-29 are "similar to exilis and at this point I would have to call them exilis (?)." Although, Reddell notes that additional taxonomic investigation could reveal that both the elongate and robust forms of *Rhadine* found within the Culebra Anticline KFR are new species. Taxonomic confirmation of the juvenile blind *Cicurina* specimens is not possible based on morphology; genetic studies to confirm their identity are not practicably achievable at this time, but the specimens are now available for future genetic studies.

See Appendix B for a complete reporting on the findings of the APS presence/absence surveys.

In any case, as described in Section 5.2.1.2, the geologic matrix within the portions of the Project Areas that overlay potential habitat for the Covered Species is continuous with the geology that underlies the proposed APS Karst Preserve. Since karst invertebrates may move throughout the interconnected void spaces within this geologic matrix, it may be assumed that the karst fauna assemblage found within and adjacent to the Project Areas is the same as the karst fauna assemblage found underlying the proposed APS Karst Preserve, which is immediately adjacent to both Proposed Projects. As such, the proposed APS Karst Preserve – with its confirmed occupancy by at least one of the Covered Species (*R. exilis*) and the collection of blind *Cicurina* spiders from the site that should match at least one of the four covered spider species – provides suitable mitigation for take that may occur as a result of the Covered Activities. Furthermore, as described below, the proposed size, configuration, protections, and management of the APS Karst preserve is, to the extent practicable, consistent with USFWS recommendations for recovery quality karst preserves. The certainty of the conservation benefit provided by the protection and management of the APS Karst Preserve more than balances the uncertain occurrence of actual incidental take of one or more of the Covered Species.

6.4.4 *APS Karst Preserve Design*

6.4.4.1 Size and Configuration

Size

At approximately 57.6 acres, the proposed APS Karst Preserve is consistent with USFWS acreage recommendations for a medium-quality Karst Fauna Area (2011, 2014). The proposed preserve boundary has a relatively simple, compact shape that minimizes preserve edges. The karst features with demonstrated karst invertebrate habitat and occupancy by troglobites are located more than 300 feet from the perimeter boundary of the proposed APS Karst Preserve. Additional configuration specifications are described in subsequent sections.

Cave Cricket Foraging Zones

A 2005 study on the foraging range of *Ceuthophilus secretus*, a common species of cave cricket in central Texas caves, concluded that most (51%) of these cave crickets were found within 40 meters of a cave entrance. Larger cave crickets were found to routinely forage out up to 80 meters from the cave opening in a relatively uniform density (Taylor et. al. 2005). The maximum distance that cave crickets were observed foraging in this study was 105 meters away from the cave opening. The USFWS recommends that the full 105-meter foraging zone for cave crickets be protected within karst preserves (USFWS 2011).

The proposed APS Karst Preserve contains the full extents of both the 40-meter zone where most cave crickets forage and the 80-meter zone where cave cricket populations maintain uniform densities around each of the three karst habitat features with documented occurrences of cave crickets (S-10, S-19, and S-29). A small portion (approximately 1.5 acres) of the maximum 105-meter cave cricket foraging zones for these three features extends outside of the proposed APS Karst Preserve and into other portions of the SAWS APS site or within easements held by CPS Energy (Figure 12).

Drainage Basins

SWCA Professional Geologist Philip Pearce (Texas Board of Professional Geoscientists License Number 691, Firm Registration Number 50159) evaluated the surface and subsurface drainage areas for features S-10, S-19, and S-29, which each contained cave crickets. To determine these drainage areas, a map of each feature was prepared where possible. Information evaluated during mapping of the caves included strata, fractures, flow features, sediments, speleothems, bone distribution, water flow, air flow, air quality, and the dissolution of speleothems, as applicable. The internal characteristics of the feature were then considered along with aerial photography, regional geologic mapping (including the identification of faults, geologic units, formation contacts, and manmade features), topographic data, and visual site observations. Collectively, these resources were used to determine surface drainage patterns, identify possible hydrogeologic conduits or barriers, and geological/geomorphological features. The feature footprints and associated surface and subsurface drainages delineated in consideration of these factors are show in Figure 12.

The surface drainage basin of each feature was delineated by starting from the edge of the depression immediately surrounding each feature and then drawing a line on the 2-foot interval topographic map in the upslope direction perpendicular to elevation contour lines. Lines from the lateral extents on both sides of the features were drawn up slope until the lines intersected. The surface topography was visually observed in proximity to the features to ascertain if subtle flow paths or rivulets were present to provide additional resolution to the surface drainage basin boundaries drawn on the maps.

The geomorphology of each mapped karst feature and cave was evaluated to determine the hydrogeologic processes that created the karst features and caves. Maps of the caves were then evaluated spatially with respect to the other caves and other mapped karst features. A cross section was drawn depicting the surface topography, feature locations, feature and cave depths, stratigraphy, and cave morphology. A hydrogeologic conceptual model was then developed assimilating all the data. The extents of subsurface drainage basins were inferred based on the conceptual model, the spatial distribution, fracture trends, lengths of passages, and other hydrogeologic data collected and presented on the cave maps and cross sections. The proposed APS Karst Preserve boundary will protect the entire surface and subsurface drainage areas for features S-10, S-19, and S-29 (Figure 12).

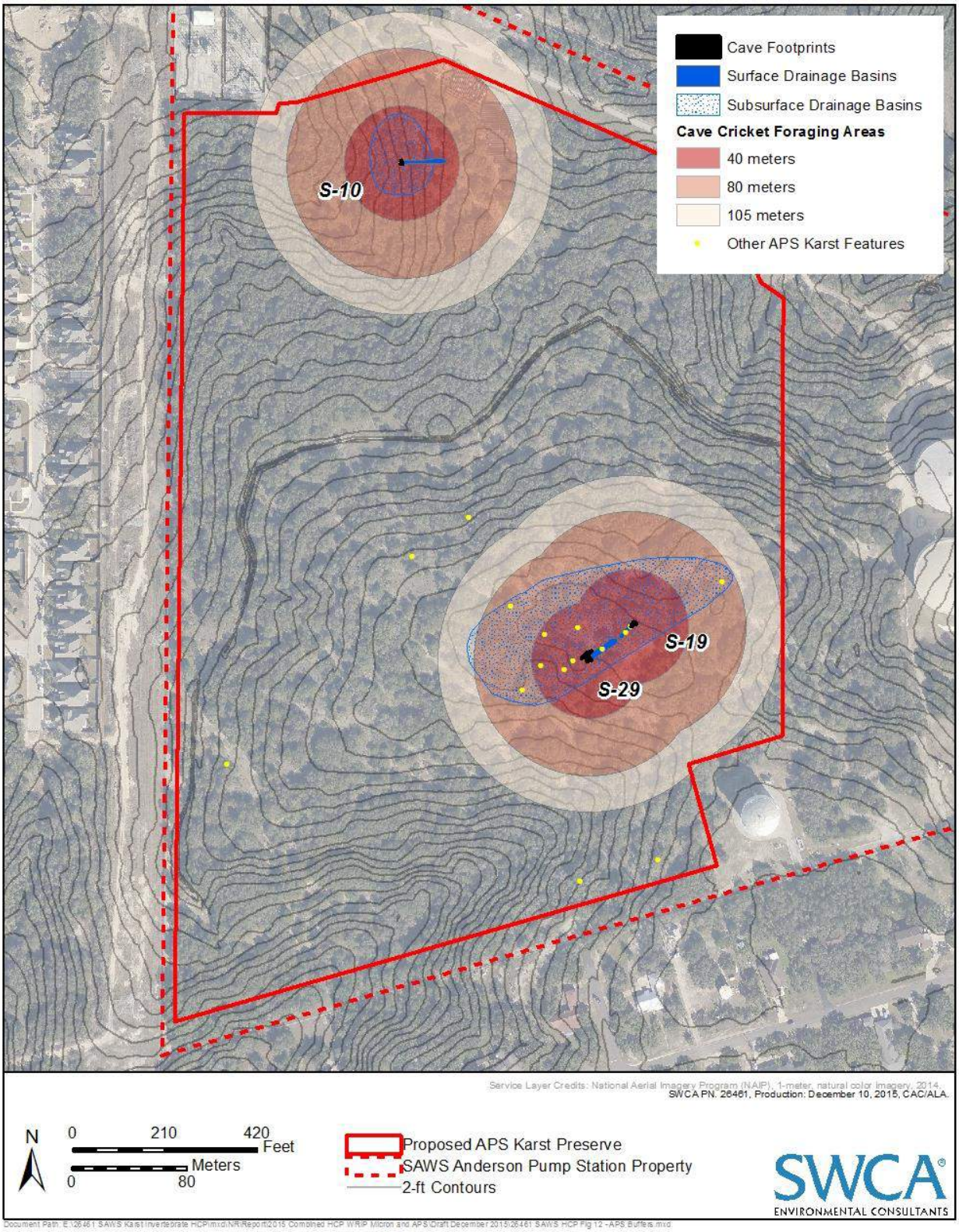

Figure 12. Drainage basins and cricket foraging areas around important karst features.

FEATURE S-10: Feature S-10 appears to have formed as a result of downward movement of vadose waters as water moved vertically until encountering a less soluble bedding plane. Dissolution then occurred laterally within a more soluble bed overlying the less soluble bed. Sheet flow from an area possibly as large as approximately 15 feet wide by 100 feet is potentially captured by the entrance of the feature. Due to the shallow nature and limited extent of Feature S-10, the subsurface drainage area is not anticipated to extend further than approximately 20 meters (65 feet) from the limits of S-10. It is possible the subsurface drainage area extends a more conservative 30 meters (100 feet) along the trend of the lateral void. These distances are consistent with studies conducted of other Austin Chalk caves with limited extent or even greater extent than Feature S-10 (Veni 2003). Other karst features on the subject site have passage lengths less than 10 meters (32 feet).

FEATURE S-19: Feature S-19 appears to have formed originally as a result of phreatic groundwater flow. Domes are present in the ceiling of the lower portion of the feature. Lateral groundwater flow along a fracture set trending approximately N63°E appears likely to have dissolved fractures to varying degrees in the geologic past resulting in development of S-19 and the other 11 karst features identified in proximity to Feature S-19. Vadose modifications of the upper portion of the feature have occurred as a result of more recent infiltration of surface water; however, the current surface catchment area of Feature S-19 is very limited due to its location near the top of a hill.

Sheet flow from an area no larger than 8 feet by 50 feet is potentially captured by the entrance of the feature. Feature S-19 is a relatively shallow feature with limited lateral extent. However, the presence of the 11 other features in a zone measuring approximately 600 feet by 250 feet oriented along a trend measuring approximately N63°E suggests the features within the cluster are hydrogeologically connected to some degree. The features within this cluster appear to have been formed by lateral groundwater flow along a fracture set trending approximately N63°E. The features are now all within the vadose zone.

The observable portions of S-19 are likely to be hydrologically separate from other features in the cluster, due to the relatively shallow depth of this feature. However, surface water infiltrating karst features in the cluster is likely to drain to common conduits deeper in the subsurface that may also serve as karst invertebrate habitat. Therefore, the limits of the cluster of 12 karst features, including enterable caves (features S-19 and S-29), should be included within the subsurface drainage basin of Feature S-19. The subsurface basin appears to extend further to the northwest than to the southeast of the trend line between features S-19 and S-29, because karst features are located north of the trend line and because the fracture that S-29 developed along dips toward the northwest.

FEATURE S-29: Feature S-29 appears to have formed originally as a result of phreatic groundwater flow. The conduit feeding the main lower passage appears to be a phreatic tube. The feature appears to have been formed by lateral groundwater flow along a fracture set trending approximately N63°E that appears likely to have dissolved fractures to varying degrees in the geologic past resulting in development of S-29 and the other 11 karst features identified in proximity to Feature S-29. Vadose modifications of the upper portion of the feature have occurred as a result of more recent infiltration of surface water; however, the current surface catchment area of Feature S-29 is very limited due to its location near the top of a hill. Sheet flow from an area no larger than 10 feet by 50 feet is potentially captured by the entrance of the feature.

Feature S-29 is a relatively shallow feature with limited lateral extent. However, the presence of the 11 other features in a zone measuring approximately 600 feet by 250 feet oriented along a trend measuring approximately N63°E suggests this feature is hydrogeologically connected with other features in the cluster – at least at some depth. The features within this cluster appear to have been formed by lateral

groundwater flow along a fracture set trending approximately N63°E. The features are now all within the vadose zone.

As described for Feature S-19, it is likely that surface water infiltrating the observable portions of Feature S-29 is separate from the waters entering the other features in the cluster. However, infiltrated water is likely to drain to common flow paths deeper in the subsurface. Therefore, the limits of the cluster of 12 features, including enterable caves (Features S-19 and S-29) should be included within the subsurface drainage basin of Feature S-29.

6.4.5 *Protection Mechanism*

SAWS will permanently protect and manage the proposed APS Karst Preserve in perpetuity for the benefit of the karst invertebrate fauna that occupies the geology of the Culebra Anticline. At this time, SAWS prefers to protect the APS Karst Preserve by recording in the real property records of Bexar County deed restrictions that dedicate the property for the perpetual protection and management of karst invertebrate fauna. SAWS will provide USFWS with an opportunity to review and approve the proposed language of the deed restrictions prior to recording and a form of the anticipated restrictions are attached in Appendix C. The deed restrictions would be recorded prior to the conduct of Covered Activities and a copy provided to the USFWS. No other uses for the proposed APS Karst Preserve will be permitted and ongoing use of existing on-site access trails will be limited to preserve management and monitoring purposes.

SAWS acknowledges that USFWS prefers that conservation lands for listed species be protected by conservation easements and SAWS will consider granting a conservation easement on the proposed APS Karst Preserve to a USFWS approved conservation entity or land trust. However, the USFWS has not required other public entities to place easements on public conservation lands. For example, the City of Austin was not required to place an easement on public lands included in the Balcones Canyonlands Preserve, nor were Hays or Williamson Counties required to provide this additional assurance for properties owned in fee simple as part of their HCPs. SAWS, as an agency of the City of San Antonio, is requesting similar consideration as a preserve owner/manager with a public duty to uphold its commitments. If SAWS elects to grant a conservation easement on the proposed APS Karst Preserve, SAWS will coordinate with USFWS to obtain approval for the conservation entity chosen to hold the easement and the specific language of the easement terms and conditions.

6.4.6 *Adaptive Management and Monitoring*

SAWS proposes to implement or otherwise provide for an adaptive management and monitoring program for the APS Karst Preserve that incorporates, to the extent practicable, the USFWS's "*Karst Preserve Management and Monitoring Recommendations*" dated April 8, 2014. The USFWS published the final "five-point policy guidance" on June 1, 2000, as an addendum to the HCP Handbook (USFWS 2000). This policy established the USFWS's intent, where appropriate, to include adaptive management principles in the operating conservation program for an HCP to address uncertainty regarding natural resource management. The USFWS encourages the use of a robust adaptive management program to address the inherent uncertainties associated with HCP development. The USFWS defines adaptive management as "…a method for examining alternative strategies for meeting measureable biological goals and objectives, and then, if necessary, adjusting future conservation management actions according to what is learned." The USFWS is committed to allowing flexibility within the management structure of an approved HCP as long as the Applicant continues to contribute to the fulfillment of the biological goals and objectives and maintain an ongoing commitment to the success of the HCP.

SAWS proposes an initial management and monitoring program for the APS Karst Preserve that will guide such efforts for the first five years of stewardship (Appendix D). It is expected that the routine measures implemented on the ground to achieve the goal of conserving karst invertebrate habitat on the site will change over time through the adaptive management process. However, this initial management and monitoring program establishes a practicable budget for these activities that SAWS commits to providing in support of the perpetual conservation of the APS Karst Preserve. The annual budget will also include a contingency fund of 10% of that year's budget. Unused portions of the contingency fund will be rolled forward for use in later years.

As the proposed APS Karst Preserve will be protected in perpetuity (see Section 6.4.5), it is likely that scientific advances and natural ecological processes will warrant the use of adaptive management measures over time. SAWS will regularly monitor environmental conditions within the proposed APS Karst Preserve, as proposed above, and will adjust the monitoring program as necessary to protect the species and their habitats. SAWS will review management and monitoring data every 5 years and propose revisions as needed to help ensure that available funding is spent effectively towards achieving the biological goals and objectives of this HCP. SAWS will submit any proposed changes to the management and monitoring activities described below to the USFWS for review and approval prior to implementation.

7.0 FUNDING PLAN

SAWS has already allocated funding for construction of both Proposed Projects, including implementation of the proposed best practices to minimize impacts to the Covered Species. SAWS also already owns the 57.6 acres proposed for the APS Karst Preserve and will provide all funds necessary for the continued management and monitoring of the proposed preserve, at a level consistent with the budget shown in Table 8, in perpetuity.

Table 8 identifies the currently expected costs associated with the routine management and monitoring of the APS Karst Preserve during the first 10 years of SAWS stewardship. Estimated costs are based on the management and monitoring activities specified in Appendix D. At this time, the estimated budget for preserve management and monitoring is approximately $21,275 to $28,980 per year. SAWS may adjust these cost estimates as necessary to account for currency inflation or deflation, as well as adjustments to the management and monitoring activities applied to the APS Karst Preserve as a result of adaptive management.

SAWS will also fund the design and installation of permanent caps over Features S-10, S-19, and S-29 under a separate ESA Section 10(a)(1)(A) enhancement of survival permit with an associated USFWS-approved Recovery Project Plan. This expenditure will be a one-time cost and is not be part of the annual budget for the on-going routine management and monitoring activities. The estimated cost for installing the caps on these three features is between $20,000 and $30,000. This includes preparing and implementing a plan to close the features, as well as seeking assistance from gating specialists and coordinating with the USFWS.

SAWS will provide "… the funding that will be available to implement such steps" (16 USC §1539(a)(2)(A)(ii)) as are specified in this HCP pursuant to the requirements of state law. SAWS is an agency of the City of San Antonio, a Texas home rule municipality. SAWS is required by state law to impose and collect charges for services sufficient to pay for all of its operating expenses, such as the costs associated with the management and monitoring of the APS Karst Preserve. State law imposes upon SAWS the obligation to provide "…the funding that will be available to implement such steps" as are required by this HCP and the associated ITP.

As an additional assurance that funding will be available to cover the expenses of the APS Karst Preserve Management and Monitoring Plan, SAWS meets the following financial tests used by USFWS in approving other HCPs (such as the USFWS's Industry Conservation Plan for the American burying beetle). SAWS will provide the USFWS documentation prior to the initiation of Covered Activities that demonstrate: (1) the current rating for its most recent bond issuance is AAA, AA, A or BBB as issued by Standard and Poor's or AAA, AA, A or BAA as issued by Moody's; (2) tangible net worth at least six times the sum of current habitat conservation implementation cost estimates; (3) tangible net worth of at least $10 million; and (4) assets in the United States amounting to at least 90 percent of total assets or at least six times the sum of the current HCP implementation costs.

Table 8. Funding estimate for ongoing management and monitoring of the APS Karst Preserve.

Management Activity	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6*	Year 7	Year 8	Year 9	Year 10
Annual Report	$5,000	$5,000	$5,000	$5,000	$5,000	$5,250	$5,250	$5,250	$5,250	$5,250
RIFA Survey and Eradication	$7,500	$6,750	$6,750	$6,750	$6,750	$7,875	$7,088	$7,088	$7,088	$7,088
Cave Cricket Exit Counts	$2,500	$2,500	$2,500	$2,500	$2,500	$2,625	$2,625	$2,625	$2,625	$2,625
Vegetation Monitoring	$2,750									
In-Cave Biota Surveys/Data Loggers	$6,050	$5,500	$6,050	$5,500	$6,050	$5,775	$6,355	$5,775	$6,355	$5,775
Management Plan Revision						$5,250				
Contingency (10%)	$1,930	$1,525	$1,580	$1,525	$1,580	$2,205	$1,659	$1,601	$1,659	$1,601
ANNUAL COST	**$25,730**	**$21,275**	**$21,880**	**$21,275**	**$21,880**	**$28,980**	**$22,977**	**$22,339**	**$22,977**	**$22,339**

*Estimated costs in Years 6-10 include a 5% increase from the initial five-year management period to adjust for inflation.

8.0 REPORTING AND ADMINISTRATION

8.1 Notification to the USFWS

For each of the Proposed Projects, SAWS will notify the USFWS of the initiation of Covered Activities in writing at least 10 business days prior to the start of work and within 10 days of completion of the Covered Activities. SAWS will also notify the USFWS in writing when deed restrictions or a conservation easement has been recorded on the APS Karst Preserve. SAWS will provide a copy of the recorded restrictions or easement to the USFWS with the notification.

8.2 Annual Reporting

SAWS will submit an annual report to the USFWS by March 31 each year documenting the results of management and monitoring activities that were conducted on the APS Karst Preserve during the prior calendar year. Annual reports will document the dates and times of monitoring and management activities, the nature of the activity, and any relevant results or findings. Reporting for karst fauna surveys will follow the format and content recommended by USFWS in the current protocols for conducting karst invertebrate presence/absence surveys.

SAWS may also propose any modifications to the management and monitoring program or adjustments to the funding allocations based on inflation/deflation in the annual report for USFWS consideration and approval.

8.3 Permit Amendments and Renewals

8.3.1 *Minor Amendment*

Pursuant with the Habitat Conservation Planning and Incidental Take Processing Handbook (HCP Handbook), minor amendments are recommended only when, "(1) the amendment has the unanimous consent of the Permittee and FWS; (2) the original HCP established specific procedures for incorporating minor amendments so that the public had an opportunity to comment on the process, and such amendments are consistent with those procedures; (3) the HCP defines what types of amendments are considered minor; (4) a written record of any such amendments is prepared; and (5) the net effect on the species involved and level of take resulting from the amendment is not significantly different than analyzed under the original HCP and the Service's decision documents" (USFWS and NMFS 1996).

For the purpose of this HCP, minor amendments are defined as amendments to the HCP that do not result in any change to the biological goals and objectives outlined in the HCP or result in any additional take or impacts to the Covered Species. The process for incorporating minor amendments will include written notification from SAWS to the USFWS describing the proposed amendment with a rationale describing why the amendment is being requested and biologically supported evidence that the amendment will not result in any additional effects to the species. SAWS will make the proposed amendment, rationale, and biological support available to the public through its website for at least 30 days prior to submission to the USFWS. The USFWS will then review the amendment and if it concurs, it will provide written authorization to that effect to the Applicant. On the date the USFWS provides authorization approving the amendment, it will automatically become effective, unless an alternative effective date is expressly identified in the authorization.

8.3.2 *Major Amendment*

Section 10(a)(1)(B) permits can be amended. An amendment is required when "the Permittee wishes to significantly modify the project, activity, or conservation program as described in the original HCP" (USFWS and NMFS 1996). Amendments may be required to accommodate "significant boundary revisions, alterations in funding or schedule, addition of a species to the permit that was not addressed in the original HCP, or adjustments to the HCP necessitated by unforeseen circumstances" (USFWS and NMFS 1996). A substantive permit amendment requires an addendum amendment to the HCP, a Federal Register notice, a public comment period (of at least 30 days), compliance with NEPA including environmental review, and intra-agency consultation for Section 7 compliance.

8.4 Permit Renewals

SAWS requests an ITP with a term of 15 years from issuance. In the unlikely event that SAWS is not able to construct the Proposed Projects within that timeframe, SAWS may request ITP renewal to extend the ITP term. To request an ITP renewal, an applicant must:

1. Have complied with the terms and conditions of the original permit, including reporting requirements;
2. File a written request for a permit renewal with the USFWS at least 30 days prior to the permit expiration date that references the permit number;
3. Certify that all statements and information presented in the original permit application are still correct or include a list of changes; and
4. Provide specific information concerning the amount of incidental take that has occurred under the original permit and the amount of incidental take that remains unused.

If SAWS files such a request at least 30 days prior to the permit expiration date, then the ITP will remain valid while the request is being processed. If SAWS fails to file a request at least 30 days prior to permit expiration, then the ITP will become invalid on the original expiration date.

9.0 NO SURPRISES ASSURANCES

An important incentive for implementing an HCP are the assurances provided by the USFWS's "No Surprises" rule (63 FR 8859, codified at 50 CFR §§ 17.22, 17.32, 222.2). Under the No Surprises Rule, the USFWS assures incidental take permittees that, so long as an approved Habitat Conservation Plan is being properly implemented, no additional land use restrictions or financial compensation will be required of the permitee with respect to the covered species, even if unforeseen circumstances arise after the permit is issued indicating that additional mitigation is needed.

The No Surprises Rule recognizes that the permitee and the USFWS can reasonably anticipate and plan for some changes in circumstances affecting a species or geographic area covered by a Habitat Conservation Plan (e.g., the listing of additional species as threatened or endangered or a natural catastrophic event in areas prone to such events). To the extent that changed circumstances are provided for in the Habitat Conservation Plan, the permitee must implement the appropriate measures in response to the changed circumstances if and when they occur.

This section describes the changed circumstances anticipated by SAWS and provided for in the HCP and explains the USFWS's assurances to SAWS with respect to any unforeseen circumstances.

9.1 Changed Circumstances

The No Surprises Rule (USFWS 1998) defines "changed circumstances" as "circumstances affecting a species or geographic area covered by a conservation plan that can reasonably be anticipated by plan developers and the Service and that can be planned for (e.g., the listing of new species, or a fire or other natural catastrophic event in areas prone to such events)."

A Habitat Conservation Plan must identify provisions to compensate for negative impacts to covered species from changed circumstances in order to qualify for No Surprises assurances. If circumstances change, the permittee must implement any provisions included in the Habitat Conservation Plan and/or ITP that address such circumstances.

Changed circumstances that can reasonably be anticipated by SAWS and the USFWS and that can be planned for are described below. The responses provided for each changed circumstance represent an opportunity for SAWS and the USFWS to reevaluate the effectiveness of the conservation program and adjust priorities, reallocate resources, or otherwise modify how the HCP is implemented. The "sideboards" noted in each response indicate the extent to which the USFWS may require modifications of this HCP. The responses to changed circumstances protect SAWS's assurances that additional resources will not be required if the conservation program is being properly implemented.

9.1.1 *Taxonomic Revisions*

The taxonomy of the central Texas karst invertebrates, including the genera *Cicurina* and *Rhadine*, is currently unsettled. It is possible that new science will emerge that indicates one or more of the Covered Species is not a valid taxon or that it belongs to a different taxon, which may or may not be protected by the ESA. A changed circumstance will have occurred if new science involving the karst invertebrate fauna of the Culebra Anticline KFR is published in a peer-reviewed, scientific journal that changes the taxonomic classification of one or more of these species and the taxonomic change is formally accepted by the USFWS in writing published in the Federal Register.

As described in Section 6.4 and in Appendix A, this HCP provides conservation benefits to the full set of karst invertebrates that occupy the geology in and around the proposed APS Karst Preserve, regardless of their taxonomic classification or listing status. If this changed circumstance occurs, SAWS will

coordinate with USFWS to amend the ITP to update the names of the Covered Species. As described in Section 5.2.1, by using karst habitat as a surrogate for individuals, this HCP accounts for take and provides mitigation for the full set of species – by whatever name they are given – that occur in the impacted and protected habitats. Therefore, the estimate of take described in Section 5.2.2 will apply to any newly named species in the updated list of Covered Species and the conservation benefits provided by the dedication, management, and monitoring of the APS Karst Preserve, as described in Section 6.4, will fully mitigate for the authorized take of the newly included Covered Species.

9.1.2 *Discovery of a Significant Void*

SAWS has completed all due diligence investigations recommended by USFWS for determining the presence of listed karst invertebrates within the Project Areas. These studies did not document the presence of any karst features that provide habitat for listed species. However, it is possible that subsurface excavations will uncover previously unknown caves or void spaces that may provide habitat for listed karst invertebrates and SAWS has requested take authorization to address this circumstance. Excavation for the TxDOT SH 151/Loop 1604 project encountered several previously unknown voids in the subsurface. Each of these discovered voids was small and not humanly enterable. SAWS anticipates that any voids that may be encountered during construction of the Proposed Projects would be of similar condition and that current specifications for construction adequately minimize impacts to listed karst species.

A changed circumstance will have occurred if SAWS encounters a significant subsurface void during construction that is humanly enterable without additional excavation. SAWS will require its construction equipment operators to notify the construction foreman immediately if such a feature is encountered during sub-grade activities. The foreman will then notify SAWS of the presence of the feature. SAWS will engage a USFWS permitted karst biologist to investigate the feature and document the approximate size, condition, and climate of the feature; however, a detailed cave map or karst fauna survey will not be required. SAWS will instruct the permitted karst biologist to collect a specimen of any troglobitic species of a listed genus that may be incidentally observed during this investigation and to follow USFWS protocols for the identification of any such collections. SAWS will require its contractors to close the feature as soon as practicable following discovery to minimize exposure from outside elements. To the extent possible, closure will be achieved using natural materials (i.e., rocks and pebbles) from the immediate vicinity that are grouted together with a brick-mortar substance or comparable substance. The closure "wall" will be designed to resemble as closely as possible the existing conditions within the feature prior to discovery and will be sturdy enough to prevent any backfill from entering the feature. If structural integrity is in question, SAWS may consult geotechnical or structural engineers to design an appropriate closure wall that may use alternate materials.

SAWS will notify USFWS of the presence of the significant void within 48 hours of discovery. Within 5 days of completing the closure activities, SAWS will provide a report to USFWS documenting the characteristics of the feature and the closure methods and materials.

9.1.3 *Catastrophic Natural Events*

Catastrophic natural events such as wild fires, tornadoes, floods, outbreaks of tree diseases (e.g., oak wilt), prolonged periods of severe drought, and similar events could temporarily reduce or degrade potential habitat for the Covered Species within the proposed APS Karst Preserve. Many of these acute and catastrophic events are a normal or at least occasional occurrence, particularly at wildland-urban interfaces, and/or may be reasonably foreseen.

SAWS and the USFWS agree that a changed circumstance will have occurred if a natural catastrophic event, of a magnitude that has not exceeded an event of record, alters the surface or subsurface environment of the APS Karst Preserve. Upon recognition of such an event, SAWS will evaluate the situation and stabilize or minimize further damage to the APS Karst Preserve. SAWS will notify the USFWS within 30 days after such an event and will coordinate with the USFWS to implement measures to restore affected habitats within the APS Karst Preserve to the maximum extent practicable using natural processes.

If such an event occurs, the USFWS may require SAWS to temporarily reallocate funding for the management and monitoring of the APS Karst Preserve to restoration efforts. However, any changes to the adaptive management program for addressing the impacts of catastrophic natural events will not require the acquisition or management of additional preserve lands or the provision or additional funds or other resources.

10.0 ALTERNATIVES CONSIDERED

One of the elements of an HCP required by the ESA is a description of the "alternative actions to such taking the applicant considered and the reasons why such alternatives are not being utilized" (16 USC 1539(a)(2)(A)). During development of the Proposed Projects, SAWS considered numerous route alternatives. Since then, however, SAWS finalized the routes for the Proposed Projects and acquired all easements and rights-of-way from landowners. Therefore, alternative routes for the Proposed Projects are no longer valid alternatives for consideration for this HCP. Alternative construction methods, such as laying the pipelines for the Proposed Projects above ground for the portion of the lines that occur over potential karst invertebrate habitats, is also not a feasible alternative due to severe concerns about constructability and security.

SAWS also considered, and coordinated with the USFWS regarding, an alternative of not seeking an ITP (a "No Permit" alternative). SAWS has completed all due diligence investigations recommended by USFWS for determining the presence of listed karst invertebrates within the Project Areas. These studies did not document the presence of any karst features that provide habitat for listed species. Even if SAWS discovered a void during construction that was found to be occupied by a listed species, it would not be possible to detect if actual death or injury to adjacent individuals occurred or is likely to occur as a result of the construction of the Proposed Projects. The best available science provides no evidence that temporary openings of voids (over days or weeks) significantly disrupt essential behaviors of karst invertebrates to an extent that results in actual death or injury of individuals that may be present adjacent to such openings. However, given that SAWS cannot eliminate the possibility of encountering listed species habitat and the severe disruption that a work stoppage might cause (as evidenced by TxDOT's recent experience), SAWS rejected the No Permit alternative in favor of seeking regulatory assurance.

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APPENDIX A

Authorizing Take and Analyzing Jeopardy for Species Covered By Endangered Species Act Section 10(A) Permits or Section 7 Consultations: Use of Numeric Surrogates When Taxonomic Identification and Differentiation of a Species Are Impracticable

Authorizing Take and Analyzing Jeopardy for Species Covered by Endangered Species Act Section 10(a) Permits or Section 7 Consultations: Use of Numeric Surrogates When Taxonomic Identification and Differentiation of a Species are Impracticable

Summary of Issues and Proposed Solutions

Completion of the San Antonio Water System ("SAWS") Micron and Water Resources Integration Pipeline Phase 2 ("WRIP") projects presents two unusual issues under the Endangered Species Act ("ESA"). First, SAWS has completed all recommended endangered species due diligence studies and has not located occupied habitat for endangered karst invertebrates within or adjacent to the project sites. However, occupied habitat for endangered karst invertebrates has been identified at the TxDOT SH 151 project site located approximately 500 feet from the limits of the Micron project area. SAWS cannot preclude the potential for encountering occupied karst habitat during construction of the projects, similar to the circumstances faced by TxDOT at the SH 151 project site. Thus, although SAWS could reasonably elect to not seek an ESA incidental take permit ("ITP") for the projects, SAWS may elect to do so given the potential adverse consequences of encountering previously undetected habitat once construction has begun.

Assuming that SAWS does seek an ESA permit, the second unusual issue presented by the SAWS Micron and WRIP projects is the taxonomic uncertainty concerning which blind *Cicurina* species may be encountered and which species may be occupying proposed mitigation lands. Several blind *Cicurina* individuals were collected from karst voids at the TxDOT SH 151 project site in 2012; three of these were at an adult stage and theoretically able to be identified by morphological characteristics. Two different sets of taxonomists, using different methods and equipment, independently evaluated the three collected *Cicurina* specimens and came to a different result on the identity of each specimen. Together, four different names were provisionally assigned to the set of three collected spiders: *C. venii*, *C. madla*, *C. baronia*, and *C. loftini*. Regardless of which taxonomic specification is the more accurate, this episode makes it clear that definitively resolving the identity of the *Cicurina* spiders that may be present in the vicinity of the SAWS project sites would be difficult within the desired permitting timeline, since some of the species are perceived to be quite rare (some are "known" from only two karst features), identifiable specimens are difficult to encounter and collect, and, assuming sufficient specimens could be collected, best scientific practices would likely require publication in a peer-reviewed journal to accept a taxonomic revision.

This white paper first examines the issue of how to specify the authorized level of take in an ESA permit when (1) the presence of potentially protected species in the project area is uncertain; (2) the possibility of encountering potential habitat for such species could arise at any time in the project construction process; and (3) the taxonomic identification of and differentiation between various related species believed to present

some possibility of appearing in the project area, only some of which are protected under the ESA, is extremely difficult to accomplish, if at all, in time frames consistent with the successful completion of the project.

It is proposed that the administrative policies and judicial treatment of the so-called "take surrogate" issue provides the appropriate framework for approaching the SAWS "taxonomic ambiguity" context. The take surrogate approach is most often used when it is not practicable to quantify the impacts to a protected species in "number of animals" terms. In such cases, agencies and courts have endorsed the use of surrogates in place of counting animals, such as habitat acres and other ecological metrics, when (1) it is impractical to establish a numerical number of animals limit on take, (2) the ecological surrogate used is rationally linked to actual take of the listed species by the proposed action, and (3) the surrogate provides measurable guidelines to determine when authorized incidental take would be exceeded. The rationales and conditions the agencies and courts have used to articulate this approach map exceptionally well onto the taxonomic ambiguity problem presented in the SAWS context and provide guidelines for developing an appropriate permitting strategy.

Under this approach, the ITP would assume that in the event voids or other subterranean karst features are encountered during the construction process for SAWS' two projects, the probability is that although such a feature might contain habitat for or specimens of one or more particular karst invertebrate species, this could not be confirmed within a reasonable time frame for the SAWS projects. SAWS would provide advance mitigation within the immediate vicinity of project area in the form of permanently protected karst formations known to provide suitable habitat for karst invertebrates of at least the same genera as those that may be encountered, measured by the surface area associated with the subterranean formations. In the event SAWS' projects encounter karst formations believed suitable for the listed species during construction, it would be assumed that the species assemblies in those formations are the same as the species assemblies in the nearby protected mitigation formations. No karst invertebrate fauna surveys or collections, nor any related taxonomic identifications, would be conducted for the encountered formations or any species they may contain. Surface acres would be used as the metric for authorizing take, defining mitigation values, and ensuring that take does not exceed authorized levels.

I. Overview of Projects

The San Antonio Water System (SAWS) Micron to Anderson Integration pipeline is a 48-inch steel water transmission main that will connect the Micron Pump Station and the Anderson Pump Station. This pipeline will carry up to 28,224 million gallons per day (mgd) of chlorine-treated potable water between the stations. The Micron to Anderson pipeline project includes three phases. Construction of Phase 1 and Phase 3 is complete. Phase 2 of the Micron will

connect the existing infrastructure installed during Phases 1 and 3 with approximately 2,350 feet of new water transmission main. The route for Phase 2 crosses TxDOT-owned right-of-way for SH 151 onto private property along the edge of a Loop 1604 exit ramp, and across TxDOT-owned right-of-way associated with Loop 1604 to the Anderson Pump Station. Construction of Phase 2 will occur within a 45-foot wide easement, consisting of 20 feet of permanent easement and 25 feet of temporary construction easement. The total extent of the easements acquired for this phase of the project cover approximately 2.42 acres. Within the Micron Phase 2 project area, SAWS plans to install a completely buried 48-inch, 200-250 psi steel pipeline. Approximately 1,320 feet of the pipeline will be installed through open trenches and 1,030 feet (of which 160 feet remains to be constructed) will be installed using bore, jack, or tunnel methods. Where boring or tunneling is required, 66-inch concrete or steel casings, or linear plates will be used for encasement. Pipeline segments installed in trenches will be supported with appropriate bedding and backfill. The surface of construction sites will be stabilized with a combination of best management practices, including the use of silt control fencing, rock berms, and stabilized construction entrances. To date, the pipeline has not been completed. Approximately 810 feet of boring and steel casing has been installed, but due to construction demobilization the bore has not been completed. Approximately 160 feet of boring and installation of steel casing in the bore remains to be completed.

The San Antonio Water System (SAWS) Water Resources Integration Pipeline (WRIP) is a proposed water transmission main that will convey potable water between the Twin Oaks Aquifer Storage and Recovery (ASR) facility in southern Bexar County and SAWS pump stations, both new and existing, in western Bexar County. The WRIP is proposed for construction in two phases, with Phase 1 involving the construction of most components of two new pump stations at the Twin Oaks ASR facility and the Old Pearsall Road site and segments of the pipeline between these new pump stations. Phase 2 of the WRIP project includes construction of the pipeline between the Old Pearsall Road Pump Station and the existing Anderson Pump Station in western Bexar County, as well as the remaining components of the Old Pearsall Pump Station and the Twin Oaks West Pump Station. For planning and design purposes, the pipeline linking these pump stations was divided into three segments, with Phase 1 of the WRIP involving Segment 1 and most of Segment 2 of the pipeline, and Phase 2 involving the remainder of pipeline Segment 2 and all of Segment 3. WRIP Phase 2 includes approximately 17 miles (88,280 feet) of 48-inch diameter, 200 to 300 psi steel piping. It is possible that future designs may include 60-inch diameter piping, but that will not be determined until finalized design plans are developed in 2018. The WRIP pipeline will be placed underground within the limits of the permanent easements throughout the entire route. Current construction designs call for 84,139 feet of the pipeline to be installed via surface trenches and 28,120 feet to be installed within bored subsurface tunnels to avoid impacts at the surface associated with stream crossings, public roadways and heritage trees. The WRIP is an indispensible component of the Aquifer Storage and Recovery facility, which serves as a key mitigation action under the Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan approved by the Service.

Estimates performed by SWCA indicate that the Micron project will result in excavation of approximately .1 surface acre of karst geology and the WRIP will result in approximately 6.2 acres of excavation of karst geology. Preservation of SAWS Anderson Pump station site will result in permanent conservation of approximately 60 acres of karst geology demonstrated to be occupied by blind spiders of the Cicurina genus.

II. Specifying Authorized Level of Take

Legal Background

The Endangered Species Act ("ESA") and its implementing regulations prohibit "take" of listed endangered species. "Take" is defined in the statute as to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct."[1] The U.S. Fish and Wildlife Service (the "Service"), which implements the ESA for terrestrial species, has further defined "harm" by regulation to include significant habitat modification or degradation where such modification actually kills or injures a member of the listed species. The Service has also by regulation extended the prohibition of take to most species listed as "threatened" under the ESA.

Pursuant to sections 7 and 10 of the ESA, the Service may authorize incidental take of listed species, so long as certain conditions are met. Section 7 of the ESA requires federal agencies to ensure that any activity they fund, authorize, or carry out is not likely to jeopardize listed species or destroy or adversely modify designated critical habitat. When a federal agency determines that its activity "may affect" a listed species, it is required to consult with the Service as to the likelihood of jeopardy or adverse modification. If the Service determines that take of one or more listed species may occur, but that those impacts will not jeopardize the species, the Service will issue a biological opinion that contains an "incidental take statement" ("ITS"), which authorizes the federal agency to take listed species, so long as certain measures are taken to minimize the impacts to those species. Section 10(a) of the ESA provides two mechanisms for non-federal entities to receive authorization from the Service to take listed species. For most purposes the relevant provision requires the entity pursuing the activity to prepare a "habitat conservation plan" ("HCP") outlining measures the entity will take to minimize and mitigate impacts to the species. The Service reviews the HCP and, upon finding that the measures are adequate, issues an "incidental take permit" ("ITP") authorizing incidental take of the covered species.

Under the permitting mechanisms in sections 7 and 10, the Service is required to determine the amount of take that will be *caused* by a given activity.[2] The ITS and ITP procedures present two related issues regarding the Service's expression of the *authorized* take: (1) must a quantitative maximum level of take

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[1] 16 U.S.C. § 1532(19).

[2] See, e.g., 50 C.F.R. 17.22(b)(1)(ii) and 50 C.F.R. 402.14(i)(i).

be specified, and (2) what metric of take must be specified. The ESA's legislative history indicates Congress intended that "[w]here possible, the impact should be specified in terms of a numerical limitation."[3] Although neither the ESA itself nor the Service's implementing regulations require the Service to establish a specific numeric cap on authorized take in an ITS or ITP, the Service and the courts have implied such a requirement. The Service and the courts have also endorsed the use of habitat units and other ecological metrics as surrogate numeric specifications of take when counting actual numbers of taken individuals of the species is not practicable. Hence, while a quantitative cap is required, under certain conditions the measure for take may be a metric other than the number of animals.

For example, the Service's *Habitat Conservation Planning and Incidental Take Permit Processing Handbook* ("HCP Handbook") suggests that a cap on take must be established, but that surrogates can be used when using number of animals is not practicable. Specifically, the *Handbook* states that take authorized by the Service may be expressed in one of two ways:

> [I]n terms of the number of animals to be killed, harmed, or harassed, if those numbers are known or can be determined; or (2) in terms of habitat acres or other appropriate habitat units (e.g., acre-feet of water) to be affected generally or because of a specified activity, in cases where the specific number of individuals is unknown or indeterminable.[4]

Similarly, the Service's *ESA Section 7 Consultation Handbook* ("Consultation Handbook") provides the following with respect to establishing the level of authorized take:

> Generally, incidental take is expressed as the number of individuals reasonably likely to be taken or the extent of habitat likely to be destroyed or disturbed…When preparing an incidental take statement, a specific number…or level of disturbance to habitat must be described. Take can be expressed also as a change in habitat characteristics affecting the species…where data or information exists which links such changes to the take of listed species. In some situations, the species itself or the effect on the species may be difficult to detect. However, some detectable measure of effect should be provided.[5]

Going further, the Service recently issued a proposed rule "to address the use of surrogates to express the amount or extent of anticipated incidental take" in section 7 consultations.[6] The rule would essentially codify the principles that have been developed through case law on the topic, discussed in detail below, allowing use of surrogates if the

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[3] H.R. Rep. No. 97-567, at 27 (1982).

[4] HCP Handbook at 3-14.

[5] Consultation Handbook at 4-47.

[6] Interagency Cooperation—Endangered Species Act of 1973, as Amended; Incidental Take Statements, 78 Fed. Reg. 54,437 (Sept. 4, 2013) (to be codified at 50 C.F.R. pt. 402)

biological opinion or incidental take statement describes (1) the causal link between the surrogate and take of the species, (2) why a quantitative take approach is not practical; and (3) clear standards for when the authorized level of species take has been exceeded.

In many ITS and ITP permitting decisions around the country, the Service has utilized habitat or other ecological metrics as a surrogate for actual individuals of a given species. Various groups have challenged the Service's use of these ecological surrogates, and the resulting case law is instructive for the Service and regulated community in how best to describe potential impacts to listed species. The Ninth Circuit recently provided a condensed summary of how the courts have come out on the issue:

> We have recognized that the permissible level of take in an ITS ideally should be expressed as a specific number. However, while Congress indicated its preference for a numerical value, it anticipated situations in which the amount of take could not be contemplated in terms of a precise number. As a result, we have held that the Service need not specify numerical take in an ITS if it establishes that no such numerical value could be practically obtained. In such circumstances, an ITS may utilize a surrogate instead of a numerical cap on take, so long as it explains why it was impracticable to express a numerical measure of take. The chosen surrogate must be able to perform the functions of a numerical limitation by setting forth a "trigger" that, when reached, results in an unacceptable level of incidental take and requires the parties to re-initiate consultation. The ITS also must articulate a rational connection between the surrogate and the taking of the species….A surrogate measure of take in an ITS must be able to perform the functions of a numerical limitation by setting forth a clear standard for determining when the authorized level of take has been exceeded.[7]

In short, while use of actual numbers of individuals of a species to be taken is preferred by the courts as a reflection of congressional intent, courts have frequently approved use of an ecological surrogate where the Service demonstrates that (1) it is impractical to establish a numerical limit on take of listed species, (2) the ecological surrogate used is rationally linked to actual take of the listed species by the proposed action, and (3) the surrogate provides measurable guidelines to determine when incidental take would be exceeded. As explained below, this three-part test is fact intensive, with context varying species to species, and the courts have demanded a robust record of evidence and explanation in support of the decision to use a surrogate.

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[7] *Center for Biological Diversity v. Salazar*, 695 F.3d 893, 911-13 (9th Cir. 2012) (approving use of surrogate for ITS involving the polar bear) (citations, brackets, and quotation marks removed).

Moreover, in its HCP Handbook, the Service expressly recognizes that it is sometimes appropriate to focus and HCP on broader habitat types instead of specific species:

> Most of the HCPs that are being developed address the requirements of section 10(a)(2) on a species-by-species basis. A smaller number of HCPs, however, have focused on specific types of habitat rather than on a particular listed species. The rationale for a habitat-based approach is that if certain habitat-types are scientifically selected and assessed, and adequately protected under the terms of the HCP, the HCP could protect a broader range of species than the few "target" species that might otherwise be addressed by a conventional HCP. This approach may address all species within habitat-types within the plan area, or habitat-types in conjunction with a specific list of species that will be covered by the permit.

Applying the Take Surrogate Approach to the Taxonomic Ambiguity Context

The judicial approach regarding the cap and surrogate issues provides an appropriate framework for resolving the taxonomic ambiguity issue presented in the SAWS permit specifically and for the San Antonio and Austin areas generally. Using the principles and contexts developed in the case law, mapping the take surrogate approach onto the taxonomic ambiguity context is a straightforward analysis.

Take Surrogates in the Courts

Several courts have addressed the issue of whether and under what circumstances the Service may authorize take without using a specific number of individuals, or numerical cap, and may, instead authorize take of listed species by utilizing an ecological surrogate, such as habitat loss. Several years ago the Ninth Circuit Court of Appeals noted, for example, that

> Congress preferred take be specified in terms of a numerical limitation. H.R. Rep. No. 97-567, at 27 (1982). A surrogate is permissible if no number may be practically obtained. The chosen surrogate, however, must be able to perform the functions of a numerical limitation…[8]

The congressional preference to which the Ninth Circuit referred is found in a 1982 House Report on the Committee on Merchant Marine and Fisheries. At the time, that Committee was considering certain amendments to the ESA, including the addition of an incidental take permitting process (this amendment later became section 10(a)(1)(B) of the ESA). With respect to incidental taking under ESA section 7, the Committee Report stated:

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[8] *Oregon Natural Resources Council v. Allen*, 476 F.3d 1031, 1038 (9th Cir. 2007) (internal quotations omitted).

> Where possible, the impact should be specified in terms of a numerical limitation on the Federal agency or permittee or licensee…The Committee recognizes that it may not be possible to determine the number of eggs of an endangered or threatened fish which will be sucked into a power plant when water is used as a cooling mechanism. The Committee intends only that such numbers be established where possible.[9]

Where a surrogate is utilized in lieu of a numerical cap, "the burden is on the Service to establish that no such numerical value could be practically obtained."[10] In other words, if the Service utilizes an ecological surrogate, rather than a species numerical limit, to establish a cap on take, the Service must be able to demonstrate that there is a "reasonable nexus" between the surrogate used and the take.[11]

Where the Service utilizes an ecological surrogate, such as acres of habitat lost, to describe take instead of setting a numerical cap on take, the Service must: "establish that (1) no such numerical value could be practically obtained, and (2) that the use of ecological conditions as a surrogate for defining incidental take…is linked to the take of the protected species."[12] One court has set forth three factors relevant to determining whether establishing a numerical trigger for take is practical:

> (1) the availability and quality of actual or estimated population figures; (2) the ability to measure incidental take; and (3) the ability to determine the extent to which incidental take is attributable to the action prompting the biological opinion and incidental take statement, as opposed to other environmental factors. [13]

With respect to the availability and quality of population figures, several courts have held that the Service's use of an ecological surrogate is improper where "no attempt has been made to obtain population data."[14] Indeed, where population data are available, there is an increased likelihood that a court will find

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[9] H.R. Rep. No. 97-567, at 27 (1982), *reprinted in* 1982 U.S.C.C.A.N. 2807, 2827.

[10] *Center for Biological Diversity v. Bureau of Land Management*, 422 F.Supp. 2d 1115, 1137 (N.D.Cal. 2006). *See also*, *Miccosukee v. United States*, 566 F.3d 1257, 1275 (11th Cir. 2009); *Arizona Cattle Growers' Ass'n v. U.S. Fish and Wildlife*, 273 F.3d 1229, 1249, 1250 (9th Cir.2001); *Miccosukee Tribe of Indians of Florida v. U.S. Fish and Wildlife Service*, 2010 WL 1037962 (S.D. Fla. 2010).

[11] *Arizona Cattle Growers' Ass'n,* 273 F.3d at 1249.

[12] *Miccosukee Tribe of Indians of Florida v. U.S. Fish and Wildlife Service*, 2010 WL 1037962 at *4 (S.D. Fla. 2010)(citing *Ariz. Cattle Growers' Ass'n v. U.S. Fish and Wildlife*, 273 F.3d 1229, 1250 (9th Cir. 2001)).

[13] *Id*.

[14] *See*, *Natural Resources Council v. Allen*, 476 F.3d 1031, 1038 (9th Cir. 2007); *Center for Biological Diversity v. Bureau of Land Management*, 422 F.Supp.2d 1115, 1137-38 (N.D. Cal. 2006); *Natural Resources Defense Council v. Evans*, 279 F.Supp.2d 1129, 1185-86 (N.D. Cal. 2003).

that providing a numerical trigger was, in fact, practical.[15] Courts do, however, take into consideration the quality of available population data.[16] Where population data is either unavailable or unreliable, there is an increased likelihood that use of a surrogate will be permissible.[17] The quality of the available population data is important because "a population estimate that is less accurate will be less useful in identifying changes in actual population numbers than a population estimate that is more accurate."[18] Thus, as the error rate of a population estimate increases, the practicality of using a numerical value decreases.[19]

For example, in City of Santa Clarita v. U.S. Department of Interior, a federal federal district court in California held that use of habitat as a proxy for individual unarmored threespine stickleback was proper, as population data was impractical to to obtain given the fish's small size, the difficulty in detection, and its fluctuating habitat habitat occupancy.[20] In that case, plaintiffs challenged, among other things, a biological biological opinion issued by the Service in connection with a Bureau of Land Management ("BLM") decision to award a mining company a contract to mine 56 million tons of sand and gravel from a federally-owned mineral estate located adjacent to the Santa Clara River in Los Angeles County, California. In connection with its awarding of the mining contract, the BLM entered into ESA section 7 consultation with the Service on several listed species. Among these species was the threespike stickleback, a small, endangered fish. The Service concluded in its biological opinion that the proposed action would not jeopardize the continued existence of the stickleback. Plaintiffs challenged the record of decision the BLM issued in connection with its decision to award the mining contract, as well as the Service's biological opinion regarding the same. Plaintiffs alleged, among other things, that the incidental take statement contained in the Service's biological opinion was invalid because the incidental take statement did not specify numerically the level of take authorized. However, the Service, in its biological opinion, explained why quantifying take as a specific number of sticklebacks was impractical:

> The actual number of unarmored threespine sticklebacks that would be taken cannot be predicted because the species' small size makes detection difficult and the number of individuals inhabiting the area varies. Additionally, determining if a particular fish was incidentally taken as a

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[15] *See, e.g.*, *Miccosukee Tribe of Indians of Florida v. U.S. Fish and Wildlife Service*, 2010 WL 1037962 at *5; *Ramsey v. Kantor*, 96 F.3d 434, 441 n. 12 (9th Cir. 1996); *Swan View Coalition v. Barbouletos*, 2008 WL 5682094, at *23 (D. Mont. 2008).

[16] *Miccosukee Tribe of Indians of Florida*, 2010 WL at *6.

[17] *Id*. *See also*, *Northwest Environmental Defense Center v. U.S. Army Corps of Engineers*, No. 10-1129, 2011 WL 4369129 at *9-11 (D. Ore. Sept. 19, 2011); *Northwest Environmental Defense Center v. National Marine Fisheries Service*, 647 F.Supp.2d 1221, 1237-8 (D.Or. 2009); *Pacific Shores Subdivision Cal. Water Dist. v. U.S. Army Corps of Engineers*, 538 F.Supp.2d 242, 257 (D.D.C. 2008); *Heartwood v. Kempthorne*, 2007 WL 1795296, at *20 (S.D. Ohio 2007); *City of Santa Clarita v. U.S. Dep't of Interior*, 2006 WL 4743970, at *13 (C.D.Cal. 2006).

[18] *Id*.

[19] *Id*.

[20] 2006 WL 4743970, at *13 (C.D.Cal. 2006).

> result of drying of the stream attributed to TMC's activities or if it dies as a result of natural seasonal drying would not be possible.[21]

The court held as adequate the Service's explanation as to why it could not quantify take numerically and how the surrogate used related to actual take of the species at issue:

> The [incidental take statement] thus incorporates as a term and condition [to the taking] the requirement that pumping cease if the regular monitoring of water temperature, oxygen level, stream depth, and stream flow indicates that the water quality and quantity parameters reach particular action levels, which are designed to ensure that the [s]tickleback and its habitat downstream of monitoring station P3 are protected…Once monitoring indicates that the water quality and quantity standards defined by the action level are once again achieved, pumping is limited to a rate and amount that will not result in fluctuations of the water level, water temperature, or oxygen level until the onset of rains during the next wet season…These triggers are unambiguous and rationally linked to parameters that were determined to be within the [s]ticklebacks' observed habitat requirements.[22]

As noted above, Courts have also held incidental take statements invalid where the Service does not articulate adequately why a numerical value cannot be obtained. For example, in *Center for Biological Diversity v. Bureau of Land Management*, plaintiffs alleged that an incidental take statement was invalid because, among other things, the Service failed to "quantify […] or provide an estimate of the amount or extent of take of desert tortoise."[23] With respect to the desert tortoise, the Service's incidental take statement stated:

> The Service anticipates incidental take of desert tortoise…will be difficult to detect for the following reasons: (1) we cannot anticipate the precise numbers of desert tortoises that may be killed or injured because the number of desert tortoises…has not been estimated; (2) the [relevant study area] is large, desert tortoises are patchily distributed in this part of the species' range; and (3) we cannot predict where and when the unmonitored recreational activities described herein will kill or injure tortoises. Incidental take may occur due to vehicle collisions, collection associated with increasing levels of visitor use, changes in raven or other predator abundance associated with presence of people or trash, loss of cover from vehicle use, and approximately 50 acres of construction activities and road maintenance. However, the following level of take of this species will be quantified by the 65,382 acres of potential desert

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[21] *Id*. at *3.

[22] *Id*. at *4. *See also Center for Biological Diversity v. Provencio*, No. CV 10-331 TUC AWT, 2012 WL 966031 (D. Ariz. Jan 23, 2012) (rejecting a surrogate on similar grounds).

[23] 422 F.Supp.2d 1115, 1137 (N.D. Cal. 2006).

> tortoise habitat within the [relevant study area] in microphyll woodland and creosote scrub to the east of the Algodones Dunes, and outside of the North Algodones Dunes Wilderness Management Area. We anticipate that there will be relatively few fatalities or injuries to desert tortoises.[24]

The court agreed with plaintiffs that "the Service acted arbitrarily and capriciously by failing to specify the amount or extent of authorized take with the required degree of exactness."[25] Specifically, the court held that the incidental take statement failed because it "did not provide any meaningful standard by which incidental take of desert tortoise can be measured."[26] In its ruling, the court pointed out that the Service's rationale for its inability to estimate a desert tortoise population was circular: the Service cannot estimate a specific number of desert tortoises that might be taken because the Service does not know how many desert tortoises are in the relevant area. Moreover, the Service was unable to point to any evidence in the record that estimating take numerically was impractical.

The court went on to hold that even if the Service had met its burden to show impracticality, the incidental take statement still failed because it "did not contain a meaningful surrogate for defining the amount or extent of incidental take."[27] In that finding, the court noted that neither the Service's statement that it would allow impacts to more than 65,000 acres of potential tortoise habitat nor any other information in the record provided a meaningful standard by which incidental take could be measured.

In summary, the case law has developed over time to settle on a three-part test for habitat proxies as recently summarized by the Ninth Circuit: (1) has the Service demonstrated that it is impractical to establish a numerical limit on take, (2) is the ecological surrogate used rationally linked to actual take of the listed species by the proposed action, and (3) does the surrogate provide measurable guidelines to determine when incidental take would be exceeded. As the case law also shows, these factors vary widely from species to species and will, therefore, be a fact-intensive determination made by the Service and the entity seeking take authorization. The courts have demanded a rigorous showing by the Service that all three factors have been met, consistently rejecting mere unsupported statements and probing the Service's evidence and rationale closely. Accordingly, those wishing to receive take authorization should ensure that the rationale for using whatever method is chosen to define take is clearly and adequately explained in the administrative record, as reviewing courts are constrained to that record in rendering opinions as to the appropriateness of the take ultimately authorized. The following section develops that approach for the SAWS permit.

Rationale for the SAWS Permit

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[24] *Id*.

[25] *Id*. at 1138.

[26] *Id*.

[27] *Id*.

As summarized above, the proposed take authorization and mitigation approach for the SAWS permit rests on three central propositions: (1) reliable taxonomic specification of karst species that might be present in karst formations encountered during construction would be exceedingly difficult and time consuming, and probably not possible in most cases; (2) it is likely that species assemblies in karst formations in the project area are similar; and (3) surface acres provide a reliable metric for estimating karst formations disturbed in construction and preserved through mitigation. These propositions align closely with the conditions for approval of take surrogates.

1a. <u>It is impractical to establish a numerical "number of animals" limit on take</u>

With respect to the karst invertebrate fauna that occur in the vicinity of the SAWS projects, it is impractical, if not impossible, to establish the number or specific identity of the individuals of any particular listed species likely to be taken by the SAWS projects. The difficulties in making these determinations are related to the inaccessible nature of the habitat, the cryptic nature of the individuals themselves, and uncertainties about the basic taxonomic identity of several species of karst fauna. The same issues apply to efforts to measure the numbers or species of listed karst invertebrates that may be conserved by mitigation measures that protect areas of karst invertebrate habitat.

<u>Inaccessible Habitat</u>

Habitat for cave-adapted fauna in the project area is the byproduct of the evolution of the Edwards Aquifer and related groundwater systems along the Balcones Escarpment, a hydrogeological process acting across approximately 20 million years of evolutionary time. The paleoaquifers developed locally- to regionally-extensive void networks along the structural grain imparted by the Balcones Fault Zone and the primary porosity of the Glen Rose Limestone, the Edwards limestone Limestone, and Austin Chalk that are the host rocks for the great majority of caves in the area. The fauna are referred to as karst invertebrates, not cave invertebrates, precisely because their habitat occurs within the fabric of the paleoaquifer. The voids within that fabric may be large enough to be accessible by a human (i.e., caves), but, by volume, the majority of potential habitat available to karst invertebrates is too small for human entry. The interconnected network of small voids in a karst formation are known as *mesocaverns*. Mesocavern voids that can harbor karst invertebrates may be only one-half inch or less in diameter. It may be possible to detect subterranean habitat when a cave entrance is present or when larger mesocaverns are exposed at the surface in the form of a visible solution cavity or enlarged fracture. Habitat in larger voids may also be indirectly detectable with the use of geophysical technology such as ground-penetrating radar or electrical resistivity imaging, but the reliability of these methods is subject to false positive, false negatives, interference from utilities, and the like. Most potential habitat for the species is difficult to detect from the surface and small mesocavernous voids may not be

possible to detect (too small) or are so common in the karst formation that they are essentially "background noise."

Where voids are large enough to enter, either directly by a human or by the insertion of equipment like temperature/humidity probes, cameras, or bait traps there is an opportunity to observe habitat conditions and potentially detect karst fauna. However, much of the void space that may comprise habitat for karst invertebrates is not accessible by humans or remote equipment. Therefore, the full extent of potential habitat for listed karst invertebrate species cannot be practicably observed for the purpose of determining the presence or absence of either suitable habitat conditions or the species themselves. Nevertheless, listed karst invertebrates have been collected from voids, including caves and mesocaverns, having no obvious surface connection prior to exposure by excavation.

For the SAWS project sites, karst invertebrate habitat surveys using intensive surface pedestrian surveys have been conducted within the rights-of-way, meeting or exceeding the level of effort recommended by the Service. No geologic features suggesting the presence of subsurface voids were encountered within either project site. However, caves and mesocaverns occupied by listed karst invertebrates are known to occur within several hundred feet of the SAWS project sites. In addition, investigation through magnetic resistivity did indicate that there may be underground voids in the vicinity of the projects. Given the nature of the karst geology it is possible that similar voids may be present in the subsurface below the SAWS project sites, but it is not practical to determine whether or to what extent any such voids are actually present, habitable, or occupied .

Such excavation could remove or alter habitat for listed species, possibly harboring individuals of a listed species, before it would even be possible to determine if such habitat or individuals existed in that space. Even then, only voids exposed by the excavation would be potentially accessible for direct or indirect observation and survey. It is not practical to fully access potential habitat for karst invertebrates at these sites without first destroying or altering the habitat and potentially and unknowingly taking listed species before they are able to be detected, making it impractical to measure take by a count of affected individuals.

Cryptic Species

The listed karst invertebrates of central Texas are small animals, generally ranging between 1 millimeter and 1 centimeter as adults. Individuals can be smaller as immature juveniles. Many karst invertebrates are pale in color, even somewhat translucent. Within caves and voids, some karst invertebrate species are most often found under rocks or other cover items on the cave floor, some utilize small cracks and spaces in cave walls and ceilings, and others rove across open spaces on floors, walls, and ceilings. At best, detecting the small, inconspicuous, and often hidden individuals of most species of karst invertebrate is difficult where voids are large enough to permit entry by humans. However, most of the void space capable of providing shelter for individual karst invertebrates within caves occurs within the irregular talus pile habitat in breakdown areas where ancient cave ceilings have collapsed onto the cave floor.

Needless to say these areas are difficult to fully survey in the dark, cramped conditions. By and large, mesocaverns are not accessible to humans at all. As such, making direct counts of karst invertebrates in the bulk of the potentially suitable habitat area is impractical. Detectability issues are present even under favorable survey conditions in easily accessible caves since our current understanding of species' activity cycles is poor. Various caveadapted species occurring within the same caves seem to share the habitat by staggering their activity cycles or by specializing in different microhabitats. For example, *Cicurina* sp., especially adult specimens, are clearly more available for collection during the coldest months of the year while *Rhadine* sp. seem to peak in abundance during the late spring or early summer. Any one survey event is likely to miss the best temporal window for encountering a portion of the troglobitic community.

The Bexar County Karst Invertebrates Recovery Plan prepared by the Service acknowledges:

> Population estimates are unavailable for any of these species due to lack of adequate techniques, their cryptic behavior, inaccessibility of mesocaverns, and difficulty accessing cave and karst habitat. In known locations, one or two individuals are typically observed per survey event, and it is not uncommon to observe none at all (Krejca and Weckerley 2007). Results of point counts are available for some species at some localities in unpublished literature (for example, scientific permittee annual reports). Techniques that may be useful for population estimates of invertebrates include mark-recapture, such as have been used for cave crickets and troglobitic crustaceans (Knapp and Fong 1999, Taylor et al. 2005) but not for any of the listed species or their relatives.

Wildlife survey techniques involving mark-release-recapture or mark-capture methods are sometimes used to estimate population sizes of animals where complete census surveys are impractical. These types of survey methods have not been applied to the listed karst invertebrates of central Texas and safe, reliable marking techniques have not been developed for these species. Even if such methods were available for conducting studies, it is not possible to access most of the habitat in which these animals occur, and the large open caves that humans are able to survey likely differs from the habitat available in small, tight mesocaverns. With the differences in habitat conditions between caves and mesocaverns, extrapolating data collected from cave environments to the more extensive mesocavern environments may not be valid. Furthermore, most species of listed karst invertebrates are very uncommon and it may be difficult to mark enough individuals to conduct an informative study.

For the SAWS project sites, the number of listed karst invertebrates in the project rights-of-way cannot be known, nor are there reliable estimates of population sizes or density of individuals occurring in a given area of habitat. At best, the presence of at least one individual of a particular species in an accessible

void may be known, but it is not practical to know how many such individuals may be affected or taken by a particular activity.

Taxonomic Uncertainty

When individuals of a karst invertebrate species are detected, most are not identifiable to species in the field. For many species, taxonomic identity is only discernible with a detailed investigation of the minute differences in the shape or position of various body parts under a high-powered microscope. The sex and age of a particular specimen may also affect its ability to be identified. For example, the morphological characteristics used to determine the different species of *Cicurina* spiders is based on adult genitalia, particularly adult female genitalia. It is not possible to use current morphological keys to identify most male *Cicurina* specimens to species. No immature specimens of any *Cicurina* spider may be identified to species using morphological features, even though they are more commonly encountered during surveys than adults. For most karst invertebrate taxa, only a few scientists are qualified and experienced enough to identify collected specimens to the species level using morphology. For some species, genetic studies can help determine taxonomic identity; but again, there are only a few qualified scientists available who are capable of conducting this work (presuming that such individuals are even interested and available to review specimens). For genetic analysis to yield a species-level identification much context must be made available to them in the form of other specimens from other sites that are rooted in a known taxonomic foundation. These investigations take years to complete and, as such, they are not practical as decision-making tools for individual projects operating on a relatively short time frame.

The SAWS project sites lie within the Culebra Anticline Karst Fauna Region. Karst Fauna Regions (KFRs) are geographic areas delineated based on potential discontinuity of karst habitat (such as downcutting of the geology by streams, changes in geologic formation, or faulting) that may reduce or limit interactions between troglobite populations. The listed karst invertebrates currently recognized by the Services as occurring in the Culebra Anticline KFR are *Rhadine infernalis* and *Cicurina venii*. Although, as described in the paragraphs below, individual spiders of the genus *Cicurina* collected from the vicinity of the SAWS project sites have also been assigned names of the listed species *C. madla* and *C. baronia*.

The taxonomy that defines species identity and the relationships among related species of the eyeless *Cicurina* spiders of central Texas is considered by leading researchers to be in need of clarification and revision, particularly for the Bexar County *Cicurina* spiders. In 1992, Gertsch published the alpha taxonomy[28] of what has long been considered "the genus from hell" among arachnologists (Pierre Paquin, personal communication). Gertsch (1992) included descriptions of 45 new eyeless *Cicurina* species from 18 Texas Counties. He described four species from Bexar County, all four

[28] Gertsch, W. J., 1992. Distribution patterns and speciation in North American cave spiders with a list of the troglobites and revision of the cicurinas of the subgenus Cicurella. Studies on the endogean fauna of North America II. Texas Memorial Museum Speleological Monographs, 3: 75–122.

of which are now listed as endangered. Heavily weighing the likely, albeit presumed, physical isolation from site to site, Gertsch seemed to generally follow a "new cave, new species" implicit hypothesis. Cokendolpher (2004)[29] described an additional 5 eyeless species from northern and western Bexar County.

Thirty-four of the eyeless *Cicurina* species in Gertsch (1992) were the basis of a single diagnostic specimen. Twenty-eight of the species were described from specimens that had been in preservative for more than 20 years and may have experienced morphological deterioration (Paquin and Duperre 2009[30]). With most eyeless species described based on single specimens, the degree of morphological variation within most of these species was virtually unknown. Wide morphological variation had been reported for the related, 8-eyed surface dwelling species, notably *C. varians*, which was named for this characteristic. This presented a serious problem for other investigators attempting to identify newly discovered *Cicurina* populations. Even if they were fortunate enough to collect an adult female specimen, the type illustrations may not accurately represent their species. This problem leaves investigators without a fully functioning taxonomic key.

Gertsch's "new cave / new species" implicit hypothesis clearly breaks down at the local scale where extensive cave systems are known to share a common hydrological origin. Most recent work on *Cicurina* sp. that incorporates genetic analysis indicates a clear trend toward synonymy where Gertsch or others have described multiple species in a small geographic area.

In relation to a petition to list *Cicurina cueva* in south Austin in 2003 the Service funded an investigation into the genetics and morphological taxonomy of *Cicurina* spp. in that area. In their report to the Service, Dr. Marshall Hedin of San Diego State University and his student Dr. Pierre Paquin found strong evidence of the synonymy of three species (*C. bandida, C. cueva and C. reddelli*). It resulted in the Service's decision not to list *C. cueva* since it was determined not to be a listable taxon.

Building on this experience, Paquin and Hedin (2004)[31] was the first peer-reviewed and published material dealing with the taxonomy of Texas *Cicurina* from a genetic perspective. Their material did not nearly represent a comprehensive sampling of caves in the state, it included only 18 of the 51 hypothesized morphological species, and yet their analysis of mitochondrial DNA overwhelmingly indicates synonymy of at least three species pairs, two of which occur in Bexar County (*C. madla/C. vespera* and *C. platypus/C. puentecilla*).

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[29] Cokendolpher, J. C., 2004. Cicurina spiders from caves in Bexar County, Texas (Araneae: Dictynidae). Texas Memorial Museum, Speleological Monographs, 6: 13-58.

[30] Paquin, P. & N. Dupérré, 2009. A first step towards the revision of Cicurina: redescription of type specimens of 60 troglobitic species of the subgenus Cicurella (Araneae: Dictynidae), and a first visual assessment of their distribution. Zootaxa, 2002: 1-67.

[31] Paquin, P. & M. Hedin, 2004. The power and perils of 'molecular taxonomy': a case study of eyeless and endangered Cicurina (Araneae: Dictynidae) from Texas caves. Molecular Ecology, 13: 3239–3255.

Their conclusions were based on a much larger collection of adult specimens than were available to either Gertsch (1992) or Cokendolpher (2004). Based on observed morphological variation, verified by genetic analysis to occur within single species, it seemed clear that intraspecific variation has been previously underestimated.

With regard to the apparent *C. madla*/*C. vespera* synonomy, immature specimens from Government Canyon Bat Cave used in the Paquin and Hedin (2004) genetic analysis that were given the name *C. vespera*, presumably on the basis that they were collected from the type locality for *C. vespera*, are likely misidentified. The type specimen for *C. vespera* has a rounded morphology, similar to specimens typically found in karst habitats of the Austin Chalk formation, while *C. madla* has an elongate morphology. It is extremely unlikely for *C. vespera* to be synonymous with *C. madla*, since genetic work indicates that this rounded vs. elongate morphological characteristic conforms to strong split in taxonomy. Similarly, the type specimen for *C. venii* exhibits an elongate morphology that is uncharacteristically attached to a type locality in the Austin Chalk formation and, as described below, the morphology of *C. venii* fits within the range of *C. madla*. A likely explanation for these conflicting observations is that the locality labels for the type specimens of *C. vespera* and *C. venii* may have been inadvertently switched during the course of Gertsch's work describing them. Presumably, *C. vespera* and *C. venii* were given species status by Gertsch partially on the basis that their morphologies were very different from specimens in nearby locations. If these specimens are not actually from the localities where taxonomists currently assume they were, then neither of these species may really exist.

Just this year an investigation of *Cicurina* sp. in Travis and Williamson counties yielded a similar result. Hedin (2014)[32] found synonymy among three *Cicurina* species of elongate morphology. Hedin states: "Modern species delimitation should be a data-rich process, where large amounts of data from several sources are subject to multiple objective analyses to detect distinct evolutionary lineages. The existing species hypothesis for *Cicurina wartoni*, based on subjective consideration of a single specimen, is clearly tenuous." Indeed, based on this study, the Service itself recently determined that the previously identified C. wartoni (known from only one location) is not a valid taxon. 79 FR 47413.

Recognizing the widespread pattern of likely synonymy and the desperate need for bringing the *Cicurina* past the alpha taxonomy stage, Paquin and Duperre (2009) published the first step in the revision of the troglobitic subgenus. This work included re-illustration of all available type specimens using superior techniques, such as scanning electron microscopy, and an assessment of intraspecific morphological variation. The next publication will be the revision of Gertsch (1992) and Cokendolpher (2004) based on an integration of morphological and genetic data.

[32] Hedin, M. 2014. Using novel genetic markers and multigenic species delimitation methods to resolve the species status of the cave-dwelling spider species Cicurina wartoni Gertsch from Travis County, Texas. FINAL REPORT FOR USFWS CONTRACT #F13PX00770. Department of Biology, San Diego State University San Diego, CA 92182.

Several specimens of eyeless *Cicurina* spiders were discovered in solution cavities near the SAWS project sites in 2012 during the construction of an State Highway (SH) 151. These specimens were examined independently by Cokendolpher (2012)[33] and by Paquin and Ledford (2012)[34]. Cokendolpher concluded that one karst feature contained *C. venii*, while another contained three specimens of a non-listed eyeless species, *C. loftini*. His conclusions were heavily by the Karst Fauna Region hypothesis. A second group of taxonomic experts examined the same four specimens and came to an entirely different conclusion (Paquin and Ledford 2012). In their view, the alleged *C. venii* specimen is actually *C. madla*, and the other three belong to *C. baronia*, both species being listed as federally endangered.

Additional scientific work, followed by publication in a peer-reviewed scientific journal, is needed to resolve questions regarding intraspecific variation in morphology and to integrate genetic data into the understanding of the taxonomy of the eyeless *Cicurina* spiders. Therefore, it is impractical at this time to determine the specific identity of specimens of eyeless *Cicurina* that could occur at the SAWS project sites and be taken by the SAWS projects.

2. <u>The ecological surrogate used is rationally linked to actual take of the listed species by the proposed action</u>

It is known that caves and mesocaverns within the central Texas karst geologic formations provide habitat for listed karst invertebrate species and that the habitat matrix was formed by hydrogeological processes acting on a regional scale. This geology creates the physical environment in which listed karst invertebrates may be found; although it may not be practical to know exactly where in this 3-dimensional volume of potential habitat that individuals occur. Conceptually, the matrix of caves and mesocaverns within karst formations form a system of voids within the horizontal and vertical limits of the karstic strata. Karst invertebrates may move freely within this matrix of voids, perhaps using different areas at different times. The continuity and interconnectedness of this potential habitat may, however, be limited by the extent of karst development, secondary mineral growth that fills voids, faulting that displaces formations vertically, or exposure to conditions that render other critical aspects of habitat unsuitable – like water filled voids or surface climate intrusion.

Based on this conceptual model of potential karst invertebrate habitat, Veni (1994) mapped the surface extent of the karst formations that provide potential habitat for listed species and ranked different areas by the likelihood of occupancy by one or more of the listed species. Rankings were based on the distribution of known occurrences at the time and the continuity and similarity of

[33] Cokendolpher, J. 2012 Adult female Cicurina spider identifications Features 151-015 and 151-019 hwy 151 at loop 1604, Bexar County, Texas Submitted by James C. Cokendolpher, 17 August 2012

[34] Paquin, P., and J. Ledford. 2012. Identification of four mature Cicurina specimens from the State Highway 151 Project. Technical Report submitted to ZARA Environmental. 21 September 2012, 13 p.

the geology. The Service has adopted the concept of these karst zones acting as a measure of the extent of potential karst invertebrate habitat in permitting actions, consultations, and recovery planning.

The surface extent of the underlying karst geology provides a rational ecological surrogate for measuring the actual take of listed species resulting from land use activities that occur over or within this geology or the conservation of such species achieved by the protection of karst features that may occur below a protected property. The Service has established that alternation of surface drainage patterns by changing topography or the addition of impervious cover; changes to surface plant and animal communities; and pollution from leaks or spills of sewage, petroleum products, or chemicals, are among the most serious threats to listed karst invertebrates. These threats indicate potential pathways for take of listed karst invertebrates from land use activities that are conducted largely at the surface.

Similarly, the Service has defined many of the primary constituent elements of critical habitat for listed karst invertebrates in Bexar County in terms of various aspects of the surface environment over karst geology. Such elements include surface drainage basins and surface plant an animal communities where they occur over karst geology. The Service also recommends that preserves for karst invertebrates contain 100 acres or more around an occupied site, which could extend at least 1,178 feet from the occupied site.

Therefore, the surface acres either disturbed or protected over the geologic formations that are known to harbor listed karst invertebrate species are an appropriate ecological surrogate that is rationally linked to the take or conservation of individuals of the listed species that occur in those formations. Given the interconnectedness of the subsurface environment by the matrix of caves and mesocaverns that comprise karst geologic formations, it is rational to assume that the assemblage of species at one location is the same as the assemblage at nearby locations, where the extent of this karst habitat has not been broken by downcutting, fracturing, or other barriers. In fact, the Service's policy to date regarding these species is based on surrogate metrics. Both the Karst Fauna Region and the karst zone policies are predicated on the assumption of the presence of faunal communities across large areas based on extrapolating from a small number of surveyed caves.

3. <u>The surrogate contains measurable guidelines to determine when incidental take would be exceeded</u>

The acres of land disturbed or protected by an action is a predictable measure of the take and conservation of listed karst invertebrates under this ecological surrogate. Limits of disturbance or protection are easily measured, are predictable, and can be independently verified by site inspections or (in most cases) aerial imagery.

II. Section 7 Jeopardy Analysis

Given the close fit between the surrogate approach and the taxonomic ambiguity context involved in the SAWS permit, it is appropriate to use surface area over karst habitat as the surrogate for take in lieu of a "number of animals" approach. The conservation area acres can legitimately serve as take mitigation in the event construction encounters a void, thus satisfying the HCP issuance standards. Moreover, as the Service's proposed rule for use of surrogates in incidental take statement establishes, surrogates are appropriate when the Service conducts its intra-Service section 7 consultation on issuance of the HCP permit.

In the case of the SAWS permit, the balancing of conservation area and any potential take through encountering a void produce no negative net impact relative to the baseline for any of the species involved. Any possible take through a void encounter will have already been fully offset by the conservation area, hence the overall status of the species will not trigger jeopardy under section 7.

Legal Background

Section 7(a)(2) of the ESA requires every federal agency, in consultation with the Service, to "insure that any action authorized, funded, or carried out by such agency…is not likely to jeopardize the continued existence of any endangered species or threatened species."[35] Because issuance of an HCP permit is an action subject to this provision, the Service must conduct an intra-agency consultation with itself before issuing the proposed SAWS permit.

Sections 7(b)-(d) outline standards and procedures for conducting the required consultation, but most of the standards relevant to the SAWS permit context are spelled out in the Service's consultation regulations at 40 C.F.R. Part 402. Those regulations require the Service to consider the effects of the proposed action relative to the pre-existing environmental baseline. These relevant terms are defined as followed:

> *Effects of the action* refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process.

[35] 16 U.S.C. § 1536(a)(2). Section 7(a)(2) also addresses effects to critical habitat, but none of the species involved has had critical habitat designated.

> *Jeopardize the continued existence of* means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.[36]

Under these standards, a proposed action cannot jeopardize a species unless it changes the status of the species relative to its baseline status—i.e., through reduction of the species' baseline reproduction, numbers, or distribution—so as to reduce appreciably the likelihood of both its survival and recovery in the wild.

Application to the SAWS HCP Permit

While it is true that at present several of the covered karst species are known from only a few locations, under the proposed approach the SAWS HCP permit will not jeopardize the continued existence of any of the covered karst species. Given the reasonable approach of using the surface area above appropriate karst formations as a surrogate for occupied habitat, the baseline status of the species, while in some cases reflecting few known locations, cannot be reduced under the proposed approach because the HCP will be adding occupied habitat to the baseline and removing at most only an equal quantity of occupied habitat from the baseline. The worst case scenario, in other words, is net neutral to the species, and if no voids are encountered the outcome will be net positive. Under those conditions, the SAWS project cannot be concluded to reduce appreciably the likelihood of both the survival and recovery of the species in the wild.

[36] 50 C.R.F. 402.02.

APPENDIX B

Anderson Pump Station Karst Invertebrate Habitat Assessment and Biota Surveys

SWCA®
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.®

Assessment of the Potential for Occurrence of Federally Endangered Karst Invertebrate Species for the San Antonio Water System Anderson Pump Station, Bexar County, Texas

Prepared for

San Antonio Water System

Prepared by

SWCA Environmental Consultants

July 2014

SWCA Project Number 26461

ASSESSMENT OF THE POTENTIAL FOR OCCURRENCE OF FEDERALLYENDANGERED KARST INVERTEBRATE SPECIES FOR THE SAN ANTONIO WATER SYSTEM ANDERSON PUMP STATION, BEXAR COUNTY, TEXAS

Prepared for

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July 2014

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1.0 INTRODUCTION

SWCA Environmental Consultants (SWCA) was contracted by San Antonio Water System (SAWS) to assess the potential for the presence of habitat suitable for federally endangered karst invertebrate species on the SAWS Anderson Pump Station ("project" or "project area"), western Bexar County, San Antonio, Texas (Figures 1 and 2, Appendix A). The project area consists of approximately 70 acres of woodland bounded to the north by undeveloped land, to the west and south by residential development, and to the east by the SAWS Anderson Pump Station facilities.

2.0 ENDANGERED SPECIES BACKGROUND

The United States Fish and Wildlife Service (USFWS) considers nine listed endangered species of cave-dwelling (karst) invertebrates as having the potential to occur in Bexar County. These species include: Madla's Cave meshweaver (*Cicurina madla*), Robber Baron Cave meshweaver (*Cicurina baronia*), Government Canyon Bat Cave meshweaver (*Cicurina vespera*), Braken Bat Cave meshweaver (*Cicurina venii*), Government Canyon Bat Cave spider (*Tayshaneta microps*), Cokendolpher cave harvestman (*Texella cokendolpheri*), Helotes mold beetle (*Batrisodes venyivi*), and two unnamed species of ground beetle (*Rhadine exilis* and *Rhadine infernalis*).

Species listed as threatened or endangered by USFWS are protected by the federal ESA. Section 9 of the ESA prohibits the "take" of threatened and endangered species; take is defined as "harass, harm, pursue, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." Generally, USFWS considers modification of regularly occupied endangered species habitat to constitute "harm" and, therefore, be a violation of the ESA.

A summary of federally listed karst species, their scientific names, and their listing status is provided in Table 1 below.

Table 1. Federally Listed Karst Invertebrate Species with the Potential to Occur or be Adversely Affected by Activities in Bexar County, Texas

Species		Federal Status[1]
Common Name	Scientific Name	
KARST INVERTEBRATES		
Braken Bat Cave Meshweaver	*Cicurina venii*	E
Cokendolpher Cave Harvestman	*Texella cokendolpheri*	E
Government Canyon Bat Cave Meshweaver	*Cicurina vespera*	E
Government Canyon Bat Cave Spider	*Tayshaneta microps*	E
Ground Beetle	*Rhadine exilis*	E
Ground Beetle	*Rhadine infernalis*	E
Helotes Mold Beetle	*Batrisodes venyivi*	E
Madla's Cave Meshweaver	*Cicurina madla*	E
Robber Baron Cave Meshweaver	*Cicurina baronia*	E

1 E = endangered (USFWS 2014).

2.1 Karst Invertebrates

On 26 December 2000, the USFWS published a Final Rule to list nine species of troglobitic invertebrates known only from caves in Bexar County, Texas as endangered under the ESA (USFWS 2000). Troglobites are obligate cave-dwelling organisms. These species include Robber Baron Cave meshweaver, Madla's Cave meshweaver, Government Canyon Bat Cave meshweaver, Braken Bat Cave meshweaver, Government Canyon Bat Cave spider, Cokendolpher cave harvestman, Helotes mold beetle, and the ground beetles, *Rhadine exilis*, and *R. infernalis* (five spiders, one harvestman, and three beetles, respectively). Threats considered to be potentially endangering these species are listed in the Final Rule as destruction and/or deterioration of habitat by commercial, residential, and road construction; filling of caves; loss of permeable cover; potential contamination from such sources as septic effluent, sewer leaks, runoff, and pesticides; predation by and competition with non-native fire ants (*Solenopsis invicta*); and vandalism.

Habitat requirements for these species include subsurface void spaces in permanent darkness, moisture input sufficient to maintain high humidity, and a source of organic material from the surface. Organic material can be washed into subsurface voids by surface water, or brought into the void by small mammals or trogloxene species such as cave crickets (*Ceuthophilus* spp.) and daddy longlegs (*Leiobunum* spp.). Features that can host these organisms include caves, sinkholes, and smaller karst conduits.

In 1993 (revised in 2002), the USFWS commissioned a study that delineated five geographic zones according to their potential to provide suitable habitat for karst invertebrates (Veni 2002). The zones were based on lithology, distribution of known caves and cave fauna, and geologic controls on cave development. Special attention was paid to cavern development in the Edwards Group, Upper Glen Rose, Pecan Gap Chalk, and Austin Chalk. The zones were delineated as follows:

Zone 1-contains endangered or endemic cave fauna.
Zone 2-high probability of endangered or endemic cave fauna.
Zone 3-low probability of endangered or endemic cave fauna.
Zone 4-requires further study, probably equivalent to zone 3.
Zone 5-does not contain endangered or endemic cave fauna.

Certain geologic and geographic features such as stream valleys and faults were hypothesized (Veni 1994) to form barriers to karst invertebrate dispersal and distribution. Six karst faunal regions (KFRs) were delineated within Bexar County, including Stone Oak, UTSA, Helotes, Government Canyon, Culebra Anticline, and Alamo Heights. Based on the distribution of invertebrate specimens collected from a small percentage of the caves in the county, the boundaries between KFRs were hypothesized to have played significant roles in the species evolutionary development and to define the ranges of individual troglobitic species or populations (Veni 1994).

The entire project area occurs within Karst Zone 2, an area with a high probability to contain listed karst invertebrates. The project area occurs within the Culebra Anticline KFR, which is known to contain *Cicurina venii* and *Rhadine infernalis*.

3.0 METHODS

Prior to conducting field surveys, SWCA reviewed aerial, topographic, karst invertebrate zone maps, and geologic maps of the project area, and other published information from the following:

- Aerial photography: several sources, see credits on Figure 2;
- Geologic Atlas of Texas, San Antonio Sheet, 1:250,000, University of Texas Bureau of Economic Geology (Barnes 1982);
- Vegetation Types of Texas (McMahan et al. 1984);
- United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS) Web Soil Survey (USDA NRCS 2014);
- USFWS county threatened and endangered species lists (USFWS 2014);
- USFWS karst zone maps, Culebra Hill Quadrangle, Texas (Veni 2002); and
- U.S. Geological Survey (USGS) digital 7.5-minute topographic quadrangle map, Culebra Hill Quadrangle, Bexar County, Texas (USGS 1991).

On 21 November, and 3, 5, and 11 December 2013, and 13 March, and 4 and 5 April 2014, a team of SWCA scientists supervised by SWCA biologist (Chris Collins, USFWS Permit # TE800611-4) conducted site visits of the project area and a visual inspection of the surrounding area. The area was inspected for geologic features that may provide habitat for threatened and endangered species. The project area occurs within karst invertebrate Zones 2, an area with high potential to contain endangered karst invertebrates; therefore, a karst terrain feature survey was conducted (USFWS 2011). The karst terrain features survey was conducted by walking parallel transects spaced no more than 50 feet apart along the project alignment. Closer spacing was used in areas of dense vegetation cover. Transects were walked across the entire property in north-south direction and then in an east-west direction. Additional surveys were conducted in greater detail near features found during the karst terrain features survey. The methodology used for this survey cannot preclude the presence of sub-grade karst features that lack surface expression. Potential karst features identified during the karst terrain features survey were further investigated with the use of hand-tools and, when required, mechanized excavation equipment. Karst invertebrate biota surveys and/or bait trapping was performed in features found to contain potentially suitable karst invertebrate habitat. Biota surveys and bait trapping followed USFWS protocols (USFWS 2011). Results of the karst terrain features survey and karst invertebrate investigations are listed in section 5.0 of this report.

4.0 EXISTING ENVIRONMENT

4.1 Topography, Surface Drainage, and Land Use

The project area appears on the Culebra Hill, Texas USGS 7.5-minute topographic quadrangle map (USGS 1991). Topography of the project consist of a gently sloping hilltop with elevations ranging from about 910 to 990 feet above mean sea level (msl). Surface water runoff generally drains radially from the hilltop toward unnamed tributaries of Culebra and Caracol creeks which

occur off property. Adjacent land use consists of light industrial and residential areas and undeveloped land (Figure 2, Appendix A).

4.2 Geology and Karst Development

The project area is located within the Culebra Anticline located along the southern area of the Balcones Fault Zone. The western tip of the Culebra Anticline is a N65°E trending, structurally up-thrown, asymmetrical fold that plunges to the southwest (Barnes 1982). The Culebra Anticline is associated with the down-dip end of the San Antonio relay ramp (Collins 2000; Collins and Hovorka 1997) and exposes an aerially extensive outcrop of the karstic Austin Chalk Formation up to 200 feet thick. The structure is fault related, but is not a simple horst and may be related to listric faulting (Collins and Hovorka 1997). The structural high, numerous faults and high erodability of the Austin Chalk have contributed to its localized and historic development as a cave-bearing formation. The greatest diversity of cave types in Bexar County is in the Austin Chalk, the number of caves being only second to the Edwards formations. More than 50 percent of all Austin Chalk caves are classified as vadose insurgences, referring to karst development characterized by generally vertical dissolution of limestone through insurgence of surface waters via sinkholes into the vadose groundwater zone (Veni 1988). Approximately 20.7 percent of all caves within Bexar County are formed within the Austin Chalk. Rocks outcropping on the property are mapped as Austin Chalk (Barnes 1982). No evidence of faulting was observed on the project area.

4.3 Soils

There is one soil type within the project area as mapped by the USDA NRCS (USDA NRCS 2014). This soil type is summarized below.

Eckrant cobbly clay (formerly Tarrant association), 1 to 5 percent slopes (TaB): Eckrant cobbly clay typically occurs on ridges and plateaus. The parent material consists of residuum weathered from limestone. In a typical profile, the soil layer is 10 inches of slightly alkaline cobbly clay, 10 to 18- inch subsurface layer of slightly alkaline extremely stony clay loam, and 18 to 25-inch subsurface layer of bedrock. Depth to a root restrictive layer, bedrock, lithic, is 8 to 20 inches. The soil is well drained with moderate shrink-swell potential. The minimum depth to a water table is greater than 6 feet. This soil does not meet hydric criteria.

4.4 Vegetation

The project lies within the Edwards Plateau ecoregion of Texas and is mapped by the TPWD as occurring in the **Mesquite-Live Oak-Bluewood Parks** vegetation type (McMahan et al. 1984).

Common species of the **Mesquite-Live Oak-Bluewood Parks** include: mesquite (*Prosopis glandulosa*), bluewood or condalia (*Condalia hookeri*), huisache (*Acacia farnesiana*), whitebrush (*Aloysia gratissima*), spiny hackberry (*Celtis pallida*), lotebush (*Ziziphus obtusifolia*), Berlander wolfberry (*Lycium berlandieri*), Texas prickly pear (*Opuntia engelmannii*), bumelia (*Sideroxylon lanuginosum*), tasajillo (*Cylindropuntia leptocaulis*), agarita (*Mahonia trifoliolata*), and Texas persimmon (*Diospyros texana*).

The TPWD vegetation mapping is at a plant association level; i.e., community type described typically by one, two or three dominant species. The map was based on previous vegetation

maps, geologic mapping, ground-truthing, and Landsat data flown between 1972 and 1981. The purpose of the mapping was to provide a general picture of vegetation community types throughout the state. In addition, since the TPWD maps are based on information from the 1970s and 1980s, it provides information on historical vegetation types for much of the state. The vegetation descriptions created by the TPWD were, by necessity, defined on a broad scale and may not accurately reflect micro scale vegetation types or recent changes in vegetation and land use within the area.

Vegetation on the property does not match that as mapped by the TPWD; however, some species listed as occurring in the Mesquite-Live Oak-Bluewood Parks vegetation type do occur in the project area. Vegetation on a vast majority of the property consists of moderately dense Ashe juniper (*Juniperus ashei*) /live oak (*Quercus fusiformis*) woodland. Other tree species occur in small groups or as isolated individuals scattered across the property including cedar elm (*Ulmus crassifolia*), hackberry (*Celtis reticulata*), huisache, and bumelia. Greenbrier (*Smilax bona-nox*) is the most common vine species found within the property. Tree canopy cover on the property is approximately 70 percent.

Within woodland areas, shrub layer species occur in low to moderate densities primarily along woodland margins. Shrub layer species include Texas persimmon, Ashe juniper saplings, Texas mountain laurel (*Sephora segundiflora*), elbowbush (*Forestiera pubescens*), Texas hogplum (*Colubrina texensis*), catclaw (*Acacia roemeriana*), condalia, yucca (*Yucca constricta*), evergreen sumac (*Rhus virens*), beargrass (*Nolina texana*), Texas prickly pear, and pencil cactus. Small scrubby areas occur within central portions of the property. These areas are dominated by Texas persimmon, Ashe juniper, evergreen sumac, beebrush (*Aloysia gratissima*), Texas kidneywood (*Eysenhardtia texana*), and Texas mountain laurel. Ground cover species are relatively sparse throughout the property but are dominated by King Ranch bluestem (*Bothriochloa ischium*) in open areas and cedar sedge (*Carex planostachys*) within wooded areas.

5.0 ASSESSMENT OF THE POTENTIAL FOR OCCURRENCE OF ENDANGERED KARST INVERTEBRATE SPECIES

The project area occurs within the Culebra Anticline Karst Faunal Region, underlain by the Austin Chalk Formation (Barnes 1982), and lies within an area delineated as Zone 2 on USFWS karst invertebrate zone maps. Zone 2 delineates an area with a high potential to contain endangered karst invertebrates (Veni 2002).

A total of 68 features were identified during the karst terrain features survey on the 70-acre project area located within the SAWS Anderson Pump Station property (Figure 3a-3i, Appendix A). All of these features were excavated with the use of hand tools, and some with the use of a jackhammer and a mechanical excavator.

Of the 68 features, only three features, S-10, S-19, and S-29 (Appendix C), were large enough to allow human accessibility. S-10, S-19, and S-29 were all bait trapped; however, only S-19 and S-29 were large enough to allow for biota surveys. On several occasions, rodent glue traps were baited with blue cheese and placed within each of these features. The entrances to these three features were covered with a plastic tarp to allow a buffer against surface temperate and sun exposure. The biological surveys were conducted between March through May 2014, and consisted of four surveys in S-19 and five surveys in S-29 (Appendix D). Surveys were conducted by a Supervisory Biologist permitted under Threatened and Endangered Species Permit (TE800611-

4). Prior to each survey, surface air temperature and relative humidity at least 5 meters from the feature entrance were recorded and general climatic conditions were recorded. Visual inspection for listed karst invertebrates was performed by examining rock walls and crevices, and lifting rocks and organic debris.

Below is a description of all potential karst features identified on the SAWS Anderson Pump Station Property. Additionally, the results of excavation activities and the likelihood of potential suitable karst invertebrate habitat are also described.

S-1 **Non-karst Closed Depression**

The feature consists of a closed depression, approximately 5 feet in diameter by 1 foot deep, located on a hillside. On 14 February 2014, SWCA personnel excavated the feature to 1.5 feet deep, with the use of hand tools to remove vegetation and tree roots to allow further investigation. At approximately 1.5 feet deep solid bedrock was encountered. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-2 **Hillside stress fracture**

The feature consisted of a void space possibly caused by hillside stress, located on a hillside. The feature measures 15 feet long by 1 foot tall by at least two feet lateral depth. Infill consisted of loose rocks, soil, and organic material. On 14 February 2014, SWCA personnel excavated the feature with the use of hand tools and a jackhammer to remove vegetation and bedrock to allow further investigation. During the excavation process numerous cave crickets were observed. It is believed that this feature may have been caused by hillside stress fracturing. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-3 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 6 feet in diameter by 0.5 foot deep. On 14 February 2014, SWCA personnel excavated the feature to 1.5 feet deep, with the use of hand tools to remove vegetation and tree roots to allow further investigation. At approximately 1.5 feet deep solid bedrock was encountered. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-4 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 2 feet in diameter by 1 foot deep, located on a hillside. SWCA personnel excavated the feature to 1.25 feet deep, with the use of hand tools to remove vegetation and tree roots to allow further investigation. At approximately 1.25 feet deep solid bedrock was encountered. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-5 **Solution Cavity**

The feature consisted of a solution cavity, approximately 1.5 feet by 1 foot by greater than 1 foot deep, located on a hillside. SWCA personnel excavated the feature to 2 feet long by 1.5 feet deep, with the use of hand tools and a jackhammer to remove vegetation

and bedrock to allow further investigation. The feature appears to have a lateral component extending horizontally; however, it extends beyond what can be humanly accessed. Due to the limited size of the solution cavity and time constraints, SWCA could not fully evaluate the potential for suitable endangered karst invertebrate habitat.

S-6 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 1 foot by 0.75 foot by greater than 1 foot deep, located adjacent to a live oak tree. SWCA personnel excavated the feature to 3 feet by 1.5 feet deep, with the use of hand tools to remove vegetation and cobbles to allow further investigation. At approximately 1.5 feet deep solid bedrock was encountered. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-7 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 3 feet in diameter by 1 foot deep, located on a hillside. SWCA personnel excavated the feature to 4.5 feet by 1.75 feet deep, with the use of hand tools to remove vegetation and tree roots to allow further investigation. At approximately 1.75 feet deep solid bedrock was encountered. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-8 **Solution Cavity**

The feature consisted of a solution cavity, approximately 1.5 feet in diameter by greater than 1 foot deep, located adjacent to a cedar elm tree. SWCA personnel excavated the feature to 3 feet by 1.5 feet deep, with the use of hand tools to remove vegetation and cobbles to allow further investigation. At approximately 1.5 feet deep compact soil was still present. Due to the limited size of the solution cavities and time constraints, SWCA could not fully evaluate the potential for suitable endangered karst invertebrate habitat. Therefore, the presence of suitable habitat is unknown.

S-9 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 0.5 foot in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and cobbles to allow further investigation. At approximately 1 foot deep, a solid bedrock floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-10 **Solution Cavity**

The feature consisted of a solution cavity, approximately 1.25 feet in diameter by greater than 1 foot deep, with a persimmon tree growing into the soil plug within the feature. SWCA personnel excavated the feature to 5 feet in diameter by 8 feet deep, with the use of hand tools and a jackhammer to remove soil and solutionally modified cobbles to allow further investigation. Numerous shallow bedding plane void spaces extending laterally were identified. At the base of the feature, a small continuation of the void space continues beyond what is humanly accessible. Due to the limited size of the solution cav-

ity and time constraints, SWCA could not fully evaluate the potential for suitable endangered karst invertebrate habitat; however, based on the shallow bedding plane void spaces extending laterally, SWCA believes the potential for suitable habitat is likely.

S-11 **Non-karst Closed Depression**

The feature consisted of a depression approximately 6 feet in diameter by 1 foot deep. SWCA personnel excavated the feature to 2 feet deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 2 feet deep, a clay packed floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-12 **Non-karst Closed Depression**

The feature consisted of a depression approximately 2.5 feet in diameter by 1 foot deep. SWCA personnel excavated the feature to 1.5 feet deep, with the use of hand tools to remove vegetation and cobbles to allow further investigation. At approximately 1.5 feet deep, a solid bedrock floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-13 **Non-karst Closed Depression**

The feature consisted of a depression, approximately 2.5 feet in diameter by 1 foot deep, located adjacent to a hackberry tree. SWCA personnel excavated the feature to 1.5 foot deep, with the use of hand tools to remove vegetation, soil, and cobbles to allow further investigation. At approximately 1.5 feet deep, compact soil was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-14 **Non-karst Closed Depression**

The feature consisted of a depression, approximately 1 foot in diameter by 1 foot deep, with a partial rock rim exposed. SWCA personnel excavated the feature to 2 feet deep, with the use of hand tools to remove vegetation and cobbles to allow further investigation. At approximately 2 feet deep, a compact soil floor was encountered. Additional void space continues underneath the rock rim; however, it appears to become pinch out. Compact soil was encountered along this portion of the feature as well. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-15 **Non-karst Closed Depression**

The feature consisted of three depressions, approximately 2 feet in diameter by 1 foot deep, all exhibiting partial rock rims. SWCA personnel excavated the features to 2.5 feet deep, with the use of hand tools and a jackhammer to remove vegetation and cobbles to allow further investigation. At approximately 2.5 to 3 feet deep, a compact soil floor was encountered. No additional void space was identified. These features appear to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-16 **Solution Cavity**

The feature consisted of three small solution cavities, the largest of which is approximately 1 foot in diameter by 2 feet deep. SWCA personnel excavated the feature by removing the overlying bedrock connecting each of the void spaces and using a jackhammer to reach a depth of 2.5 feet. At approximately 2.5 feet deep, a solid bedrock floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does provide suitable endangered karst invertebrate habitat.

S-17 **Solution Cavity**

The feature originally consisted of a closed depression with a partial rock rim, approximately 1.5 feet in diameter by 1.5 feet deep. SWCA personnel excavated the feature to 6 feet long by 1 to 2 feet wide by 2.5 feet deep. Hand tools and a jackhammer were used to remove vegetation and cobbles to allow further investigation. At approximately 2.5 feet deep, a solid bedrock floor was encountered; however, at the southern wall of the feature, a small conduit continues beyond what is humanly accessible. This void space appears to be less than 1 foot in diameter. Due to the limited size of the solution cavity and time constraints, SWCA could not fully evaluate the potential for suitable endangered karst invertebrate habitat; however, based on the void space extending vertically into the subsurface, SWCA believes the potential for suitable habitat is likely.

S-18 **Solution Cavity**

The feature consisted of a closed depression with a partial rock rim, approximately 2.5 feet long by 1 foot wide by at least 1 foot deep. SWCA personnel excavated the feature to 6 feet long by 5 feet wide by 3.5 feet deep, with the use of a large mechanical excavator to remove soil and cobbles to allow further investigation. At approximately 3.5 feet deep, a compact clay floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-19 **Sinkhole**

The feature consisted of a depression with a partial rock rim, approximately 2.5 feet in diameter by at least 2 feet deep. SWCA personnel excavated the feature to 12 feet long by 3 feet wide by 12 feet deep, with the use of hand tools and a jackhammer to remove vegetation, soil, and cobbles to allow further investigation. At approximately 12 feet deep, an additional small passage, measuring 2.75 feet tall by 2 feet wide, continues to the northeast for an undetermined distance.

The humanly accessible portions of S-19 only included twilight zone. Preferred karst invertebrate habitat, dark zone, was not accessible but appeared to be extensive. Biota surveys were conducted within the twilight zone. Cave crickets were numerous along the ceilings and walls; however, no trogolobites were observed. As a result, one attempt at bait trapping the feature was performed. One of the bait traps was attached to an 8-foot pole and inserted into the dark zone. This bait trap produced the troglophilic beetle *Rhadine howdeni* (troglophilic species prefer cave habitats). While not considered a tro-

globite (species that require cave habitats). This species is most often found within central Texas caves.

S-20 **Solution Cavity**

The feature consisted of a solution cavity approximately 3 feet long by 0.5 foot wide by at least 1 foot deep. The feature appears to be plugged by loose soil. SWCA personnel excavated the feature to 2.5 feet wide by 2.5 feet deep, with the use of hand tools and a large mechanical excavator to remove soil and solid rock to allow further investigation. At approximately 2.5 feet deep, a solid bedrock floor was encountered. A small 6 inch void space continues northwest; however, it appears to pinch out. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-21 **Sinkhole**

The feature consisted of a group of three depressions, each approximately 1.5 feet in diameter by 1 foot deep, near a persimmon tree. SWCA personnel excavated the feature to 10 feet long by 3 feet wide by 1 foot deep, with the use of hand tools and a jackhammer to remove vegetation, soil, and cobbles to allow further investigation. On 16 April 2014, a SAWS mechanized excavator was used to excavate the feature further. The feature was widened to 4 feet in diameter. At approximately 3.5 feet deep, a solid bedrock floor sloping to the north was encountered. Along the sloping bedrock is a 1 foot tall void space that appears to narrow beyond the rock rim. The feature likely connects to feature S-29; however, the connection is not large enough for human passage. The feature likely contains habitat suitable for endangered karst invertebrates; however, the habitat is located beyond what is humanly accessible.

S-22 **Solution Cavity**

The feature consisted of a solution cavity approximately 1.5 feet in diameter by at least 2 feet deep. The feature appears to be plugged by loose soil. SWCA personnel excavated the feature to 5 feet in diameter by 6 feet deep, with the use of hand tools and a large mechanical excavator to remove soil and solid rock to allow further investigation. At approximately 6 feet deep, a solid bedrock floor was encountered with a small void space pack with compact clay. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-23 **Solution Cavity**

The feature consisted of a solution cavity, approximately 1.5 feet in diameter by 1.5 feet deep, with a partial rock rim exposed. The feature appears to be plugged by loose soil. SWCA personnel excavated the feature to 2.5 feet in diameter by 3 feet deep, with the use of hand tools and jackhammer to remove soil and solid rock to allow further investigation. At approximately 3 feet deep, a compact soil floor was encountered. The rock walls continued to slope in creating a smaller, narrower space. Due to the limited size of the solution cavity and time constraints, SWCA could not fully evaluate the potential for suitable endangered karst invertebrate habitat. Therefore, the presence of suitable habitat is unknown.

S-24 **Non-karst closed depression**

The feature was originally classified as a solution cavity, approximately 1 foot in diameter by at least 1 foot deep, with a partial rock rim exposed. The feature appears to be plugged by loose soil. SWCA personnel excavated the feature to 3 feet by 1.5 feet wide by 1.5 feet deep, with the use of hand tools to remove soil and cobbles to allow further investigation. At approximately 1.5 feet deep, a solid bedrock floor was encountered. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-25 **Non-karst closed depression**

The feature was originally classified as a solution cavity, approximately 2 feet in diameter by at least 1 foot deep, with a partial rock rim exposed. The feature appears to be plugged by loose soil. SWCA personnel excavated the feature to 3 feet by 1.75 feet deep, with the use of hand tools to remove soil and cobbles to allow further investigation. At approximately 1.75 feet deep, a compact soil floor was encountered. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-26 **Non-karst closed depression**

The feature was originally classified as a solution cavity, approximately 2.5 feet long by 1 foot wide by at least 1.5 feet deep, located adjacent to a small drainage. The feature appears to be plugged by loose soil and leaf litter. SWCA personnel excavated the feature to 3 feet by 1.75 feet deep, with the use of hand tools to remove soil and cobbles to allow further investigation. At approximately 1.75 feet deep, a compact soil floor was encountered. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-27 **Non-karst closed depression**

The feature was originally classified as a possible sinkhole, approximately 3.5 feet in diameter by at least 1.5 feet deep, with a partial rock rim exposed. The feature appears to be plugged by loose soil. SWCA personnel excavated the feature to 6 feet by 3 feet by 3 feet deep, with the use of hand tools to remove soil and cobbles to allow further investigation. At approximately 3 feet deep, a compact soil floor was encountered. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-28 **Non-karst closed depression**

The feature was identified on the SAWS WRIP project area and is described in that report.

S S-29 **Cave**

The feature was originally classified as a possible sinkhole, approximately 4 feet in diameter by at least 0.5 foot deep. SWCA personnel excavated the feature to 7 feet long by 2.5 feet wide by 3 feet deep, with the use of hand tools and a jackhammer to remove soil and cobbles to allow further investigation. At approximately 3 feet deep, a small void space along the northern wall was encountered. This area was excavated to reveal a gently sloping bedrock floor extending approximately 20 feet to a cobble filled room. The

void space extending down along the bedrock slope is approximately 3.5 feet wide by 1.75 feet tall. At the base of this slope is a fracture controlled room, approximately 8 feet long by 3.5 feet wide. The majority of the cave floor consists of loose cobbles and soil knocked down from the surface plugging during excavation. Based on the results of the excavation, SWCA has determined the feature does provide suitable endangered karst invertebrate habitat.

Biota surveys and bait trapping were conducted within S-29. The results of these surveys are provided in Tables 1 and 2, Appendix D. Of significance, blind, juvenile (young) *Cicurina* spiders and blind *Rhadine* beetles were encountered during biota survey efforts. Species level determination of the *Cicurina* spiders requires adult specimens for positive identification. Thus, the determination of whether these spiders belong to the endangered *Cicurina venii* or a closely related species are unknown. The two *Rhadine* beetles found within S-29 were elongate-shaped. Owing to their elongate morphology, the *Rhadine* beetles found within S-29 do not belong to the endangered *Rhadine infernalis*, a robust form found within the general project region. These beetles, however, compare favorably to the endangered *Rhadine exilis* or possibly a new species of *Rhadine* beetle. It should be noted however, that *R. exilis* is not currently known to occur in the Culebra Anticline Karst Faunal Region, the karstic area encompassing the project region.

S-30 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 2 feet in diameter by 0.5 foot deep, near a cleared two-track road. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-31 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 1.75 feet in diameter by 0.5 foot deep, near a cleared two-track road. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-32 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 2 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 3 feet in diameter by 2.5 feet deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 2.5 feet deep, a compact soil floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-33 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 1.75 feet in diameter by 0.5 foot deep, near a cleared two-track road. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-34 **Solution Cavity**

The feature consisted of a closed depression, approximately 2 feet in diameter by 0.5 foot deep, near a cleared two-track road. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a solid rock rim was encountered. On 25 June 2014, a SAWS mechanized excavator was used to excavate the feature further. The feature was widened to 3.5 feet in diameter by 4 feet deep. Due to the limited size of the solution cavity and time constraints, SWCA could not fully evaluate the potential for suitable endangered karst invertebrate habitat. Therefore, the presence of suitable habitat is unknown.

S-35 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 2 feet in diameter by 0.5 foot deep, near a cleared two-track road. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-36 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 1.5 feet in diameter by 0.5 foot deep, near a cleared two-track road. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-37 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 2.25 feet in diameter by 0.5 foot deep, near a cleared two-track road. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-38 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 2 feet in diameter by 0.5 foot deep, near a cleared two-track road. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-39 **Non-karst Closed Depression**

The feature consisted of a closed depression, approximately 2 feet in diameter by 0.5 foot deep, near a cleared two-track road. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-40 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1.75 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-41 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1.5 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-42 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1.75 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-43 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1.25 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-44 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1.25 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 1.5 feet deep, with the use of hand tools to remove vegetation, soil, and cobbles to allow further investigation. At approximately 1.5 feet deep, a bedrock floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-45 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1.25 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-46 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 0.75 foot in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-47 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1.75 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-48 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 2 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-49 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1.25 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-50 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 2.25 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-51 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 2 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-52 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 2 feet in diameter by 0.25 foot deep. SWCA personnel excavated the feature to 0.5 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. On 25 June 2014, a SAWS mechanized excavator was used to excavate the feature further. The feature was widened to 5feet in diameter by 6 feet deep. At approximately 6 feet deep the bedrock walls sloped in towards the center. A small area of compact soil was also present. Due to the limited size of the solution cavity and time constraints, SWCA could not fully evaluate the potential for suitable endangered karst invertebrate habitat. Therefore, the presence of suitable habitat is unknown.

S-53 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 0.75 foot in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-54 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1.5 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-55 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 3 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 1.25 feet deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1.25 feet deep, a compact soil floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-56 **Solution Cavity**

The feature consisted of a closed depression approximately 1 foot in diameter by 0.5 foot deep, located adjacent to a large cedar elm tree. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. Two solution cavities, measuring approximately 1.5 feet in diameter by 1.5 feet deep, were exposed at this depth. On 25 June 2014, a SAWS mechanized excavator was used to excavate the feature further; however, due to the dense surface layer of limestone, the feature could not be widened significantly enough to allow further excavation at depth. At approximately 2 feet deep, additional soil and cobble were present in the solution cavities. No additional void space was identified. Due to the limited size of the solution cavities and time constraints, SWCA could not fully evaluate the potential for suitable endangered karst invertebrate habitat. Therefore, the presence of suitable habitat is unknown.

S-57 **Solution Cavity**

The feature consisted of a closed depression approximately 1 foot in diameter by 0.25 foot deep, located adjacent to a persimmon tree. SWCA personnel excavated the feature

to 0.5 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. One solution cavity, measuring approximately 2.5 feet long by 0.5 foot wide by at least 1 foot deep, was exposed at this depth. On 25 June 2014, a SAWS mechanized excavator was used to excavate the feature further. At approximately 2 feet deep, a bedrock floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-58 **Solution Cavity**

The feature consisted of a closed depression approximately 1.25 foot in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.5 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. One solution cavity, measuring approximately 3 feet long by 1.25 feet wide by at least 3 foot deep, was exposed at this depth. On April 17 and 25 June 2014, a SAWS mechanized excavator was used to excavate the feature further. The feature was widened to 4 feet in diameter. At approximately 6 feet deep, a bedrock floor was encountered. At the base of the feature, a small continuation of the void space (approximately 0.5 foot in diameter) continues beyond what is humanly accessible. Due to the limited size of the solution cavity and time constraints, SWCA could not fully evaluate the potential for suitable endangered karst invertebrate habitat; however, based on the void space extending vertically into the subsurface, SWCA believes the potential for suitable habitat is likely.

S-59 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 8 feet long by 1 foot wide. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. This feature appears to be the result of tree pulling activities. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-60 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 2 feet in diameter. SWCA personnel excavated the feature to 0.5 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.5 foot deep, a bedrock floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-61 **Solution Cavity**

The feature originally consisted of a closed depression approximately 1 foot in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 1.5 feet deep, with the use of hand tools to remove vegetation and soil to allow further investigation. No additional void space was identified; however, the feature appears to be connected to the large sinkhole, S-19, based on its proximity and similar fracture orientation. Based on the results of the excavation, SWCA has determined the feature likely provides suitable endangered

karst invertebrate habitat; however, due to the narrow size of the feature, the full extent of the feature could not be evaluated.

S-62 **Solution Cavity**

The feature originally consisted of a closed depression approximately 1 foot in diameter by 0.5 feet deep. SWCA personnel excavated the feature to 3 feet long by 1.5 feet wide by 2 feet deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 2 feet deep, additional void space extending towards feature S-29 was identified. Additional excavation of the feature would likely expose the habitat zone of feature S-29, and as a result excavation was discontinued. Based on the results of the excavation, SWCA has determined the feature is likely an extension of S-29 and does provide suitable endangered karst invertebrate habitat.

S-63 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1 foot in diameter by 0.25 foot deep. SWCA personnel excavated the feature to 3 feet in diameter by 1.5 feet deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1.5 feet deep, a compact clay floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-64 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 3 feet in diameter by 2 feet deep. SWCA personnel excavated the feature to 2.75 feet deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 2.75 feet deep, a compact soil floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-65 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 2 feet in diameter by 1 foot deep. SWCA personnel excavated the feature to 3 feet in diameter by 2 feet deep, with the use of hand tools to remove vegetation and soil to allow further investigation. On 24 and 25 June 2014, a SAWS mechanized excavator was used to excavate the feature further. At approximately 4 feet deep, a clay filled floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-66 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 2.5 feet long by 0.5 foot wide by 0.5 foot deep. SWCA personnel excavated the feature to 2 feet deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 2 feet deep, a compact soil floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-67 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1 foot in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-68 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1 foot in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 0.75 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 0.75 foot deep, a bedrock floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

S-69 **Non-karst Closed Depression**

The feature consisted of a closed depression approximately 1.5 feet in diameter by 0.5 foot deep. SWCA personnel excavated the feature to 1 foot deep, with the use of hand tools to remove vegetation and soil to allow further investigation. At approximately 1 foot deep, a bedrock floor was encountered. No additional void space was identified. Based on the results of the excavation, SWCA has determined the feature does not provide suitable endangered karst invertebrate habitat.

6.0 CONCLUSIONS

SWCA performed a karst terrain features survey and federally endangered karst invertebrate habitat assessment on an approximately 70-acre wooded tract within the SAWS Anderson Pump Station Property. A total of 68 features were identified during the karst terrain features survey. All of these features were excavated with the use of hand tools, and some with the use of a jackhammer and a mechanical excavator. Of the 68 features, only two features, S-19 and S-29, were humanly accessible. These two features possessed suitable habitat for karst invertebrates.

Of significance, S-29 contained blind, juvenile *Cicurina* spiders and blind *Rhadine* beetles. Species level determination of the *Cicurina* spiders requires adult specimens for positive identification. Thus, the determination as to whether these spiders belong to the endangered *Cicurina venii* or a closely related species are unknown. Owing to their elongate morphology, the *Rhadine* beetles found within S-29 do not belong to the endangered *Rhadine infernalis*, a robust form. However, the beetles found within S-29 compare favorably to the endangered *Rhadine exilis* or possibly a new species of *Rhadine* beetle. Nevertheless, species level identification for both the spider and beetle are undetermined at this time.

The humanly accessible portion of S-19 only included the twilight zone, with preferred karst invertebrate habitat, dark zone, just out of reach for survey. The full extent of the dark zone is undetermined but appears to be significant. Bait trapping produced the troglophilic beetle *Rhadine*

howdeni, a non-listed species. While not considered a troglobite, *R. howdeni* is often found within central Texas caves.

Features S-10, S-17, S-21, S-58, S-61, and S-62 are considered to likely contain suitable karst invertebrate habitat. These features contained small conduits and voids that were inaccessible for survey or bait trapping but appear to possess suitable habitat for karst invertebrates. Owing to time constraints and excavation logistics, suitable habitat within features, S-5, S-8, S-20, S-23, S-34, S-52, and S-56 could not be determined. The remaining features appear to be of a non-karst origin or surficial (shallow) karst features and do not possess suitable karst invertebrate habitat. As shown in Figures 3a-3i (Appendix A), a majority of the features with suitable karst invertebrate habitat or likely suitable karst invertebrate habitat occur within central portions of the 70-acre tract of the SAWS Anderson Pump Station Property.

7.0 REFERENCES

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APPENDIX A

FIGURES

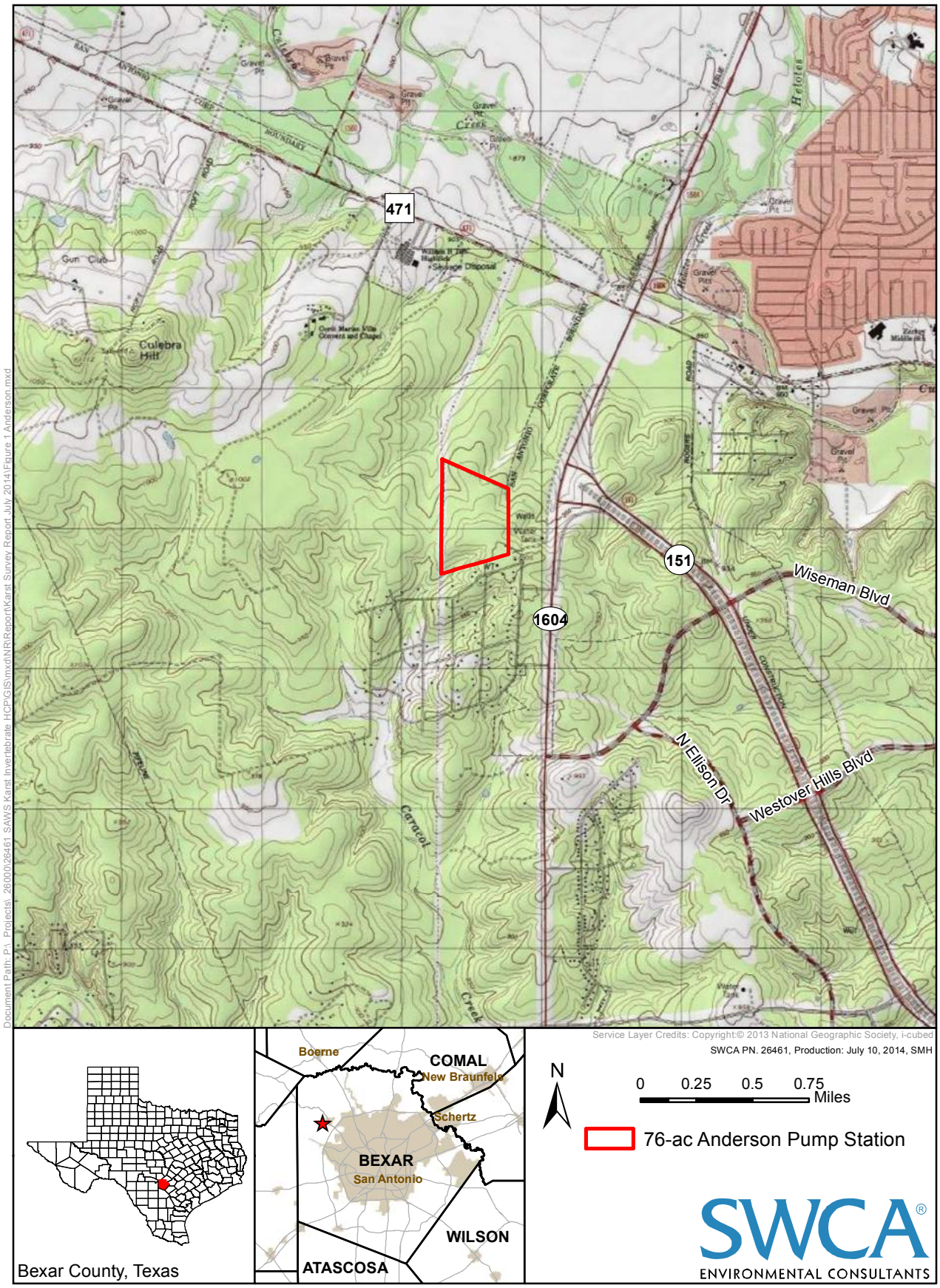


Figure 1. Project location map for the SAWS 76-ac Anderson Pump Station, Bexar County, Texas.

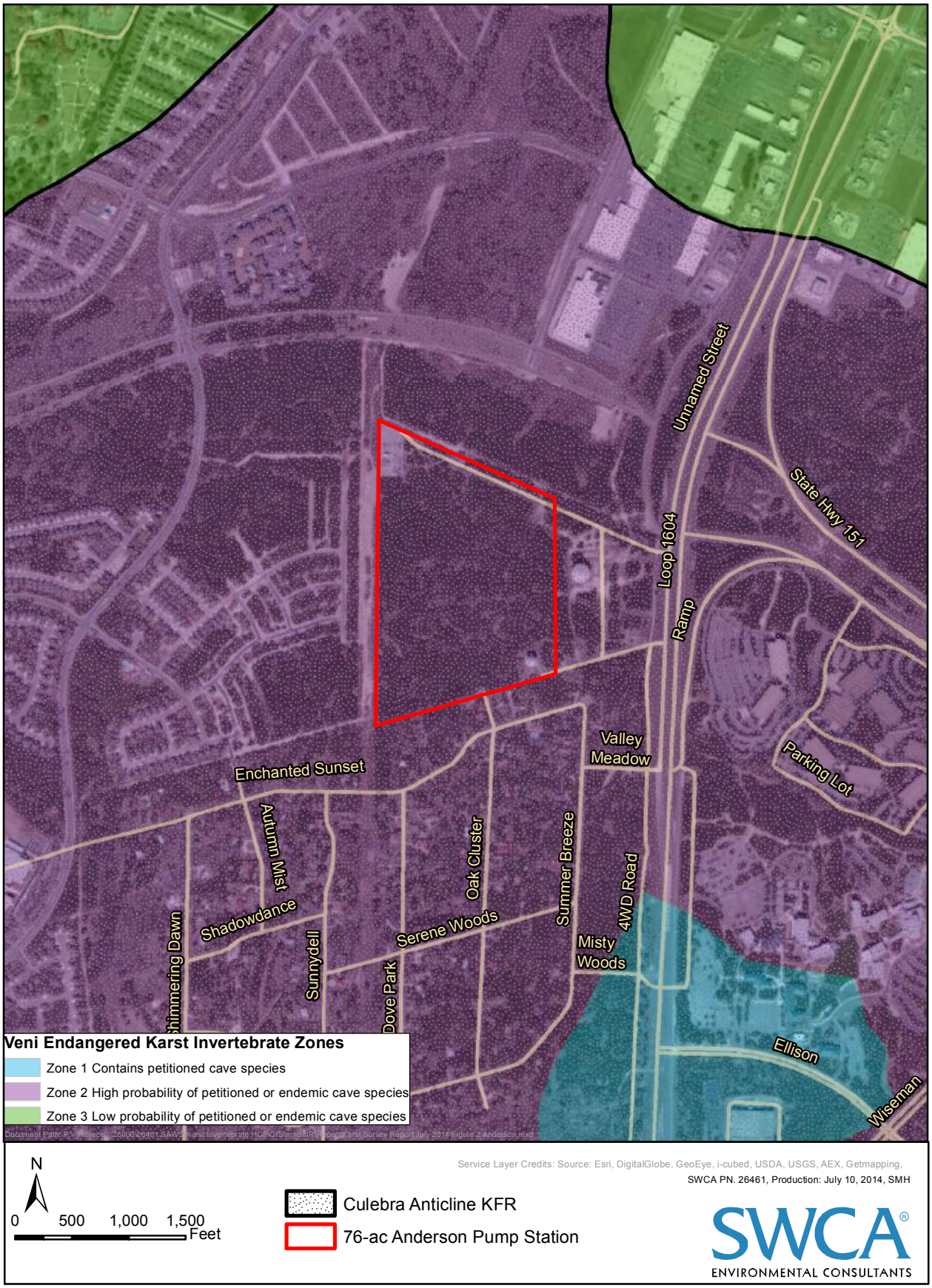


Figure 2. Aerial photo of the Anderson Pump Station project area indicating the locations of Bexar County Karst Zones and KFRs.

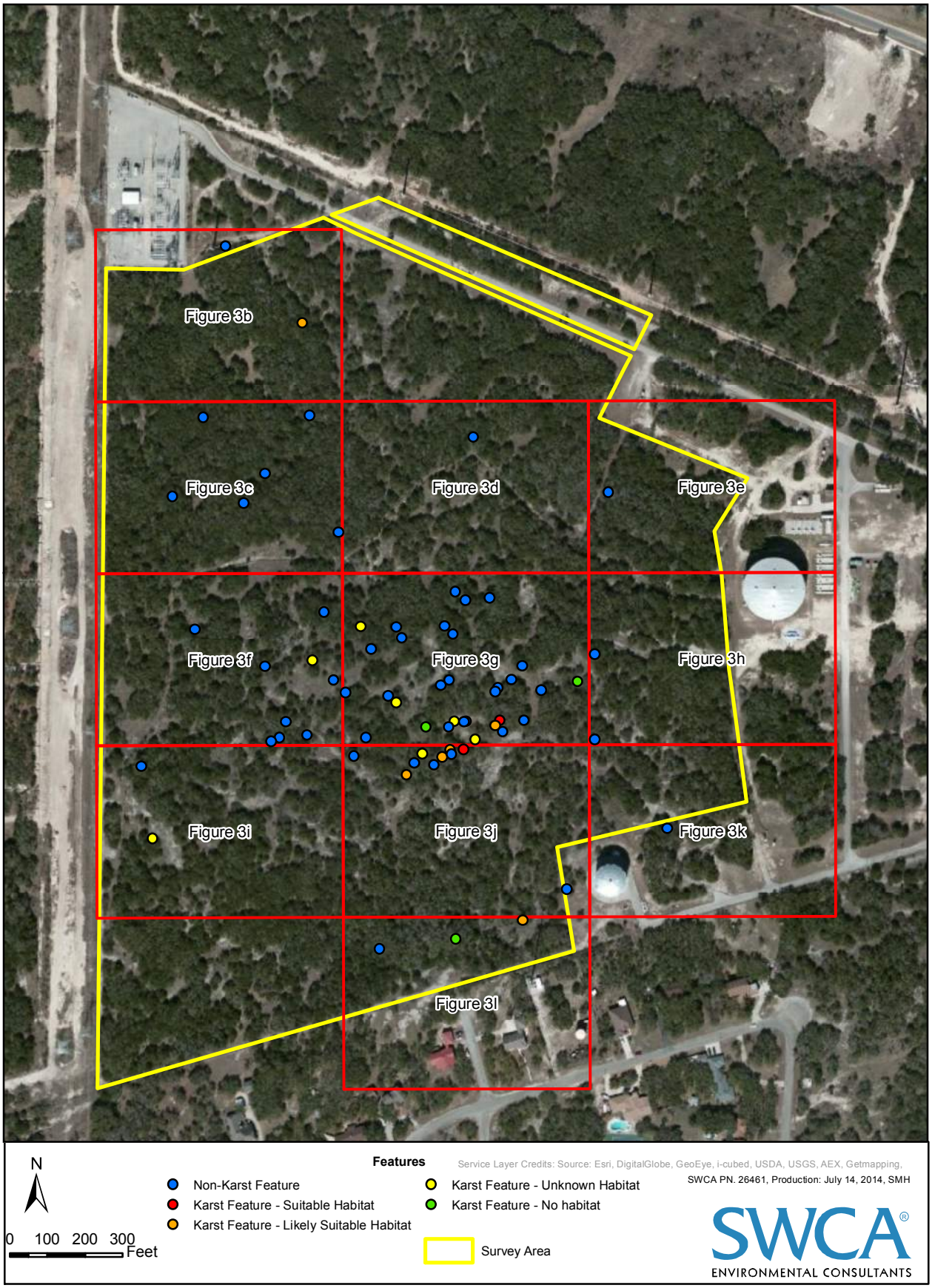


Figure 3a. Overview of the results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

Figure 3b Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

Figure 3c Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

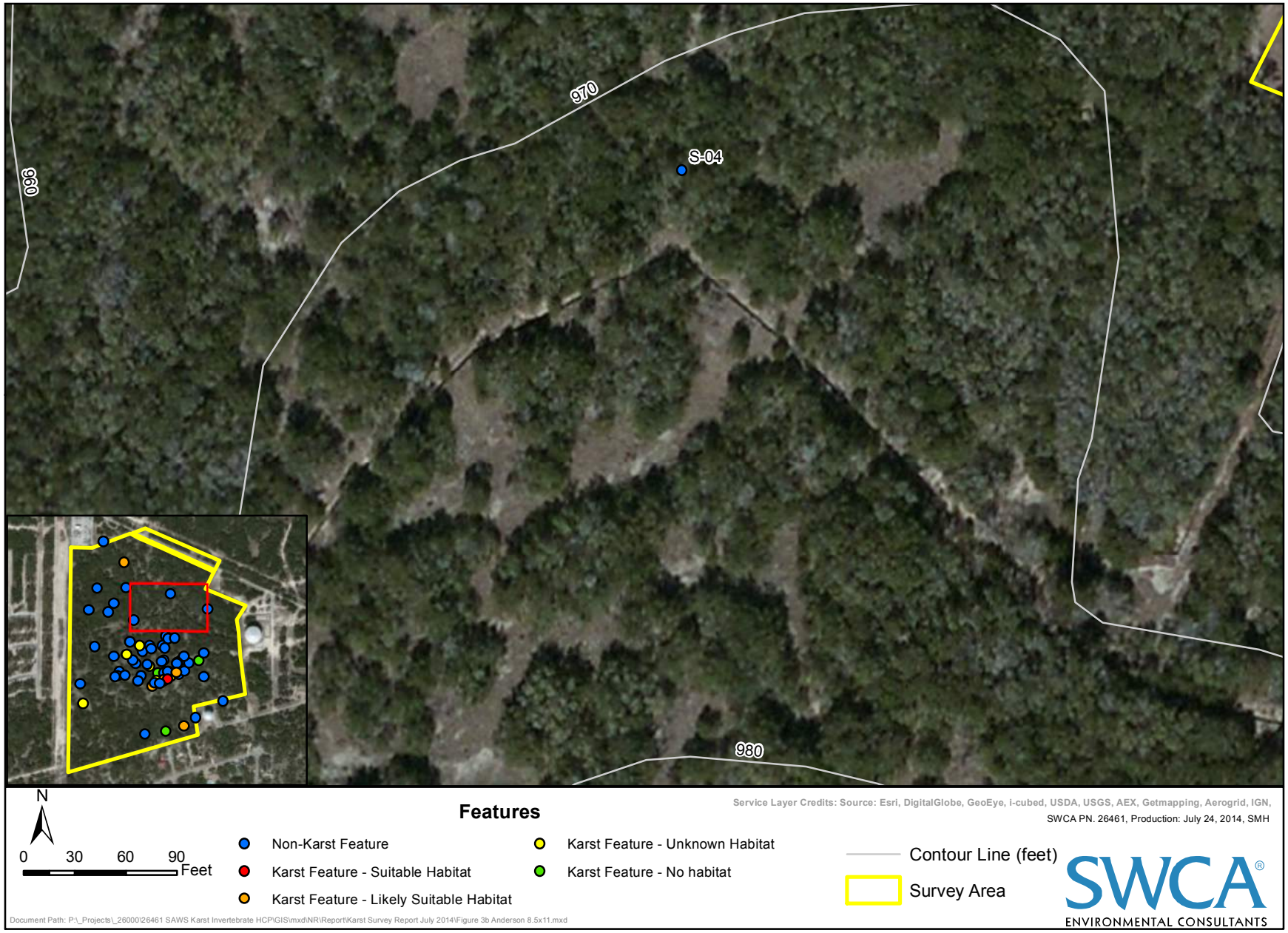


Figure 3d Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

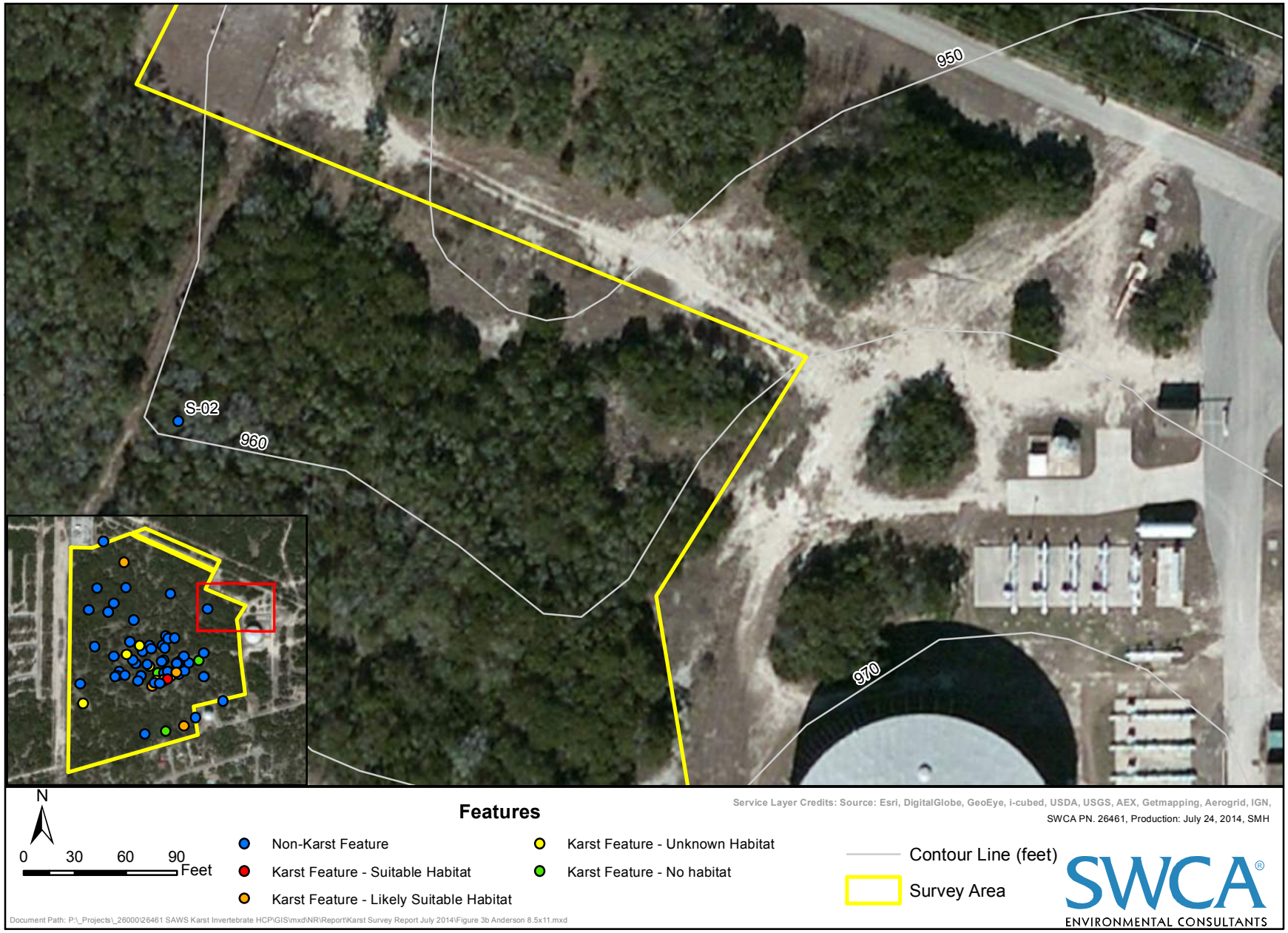


Figure 3e Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

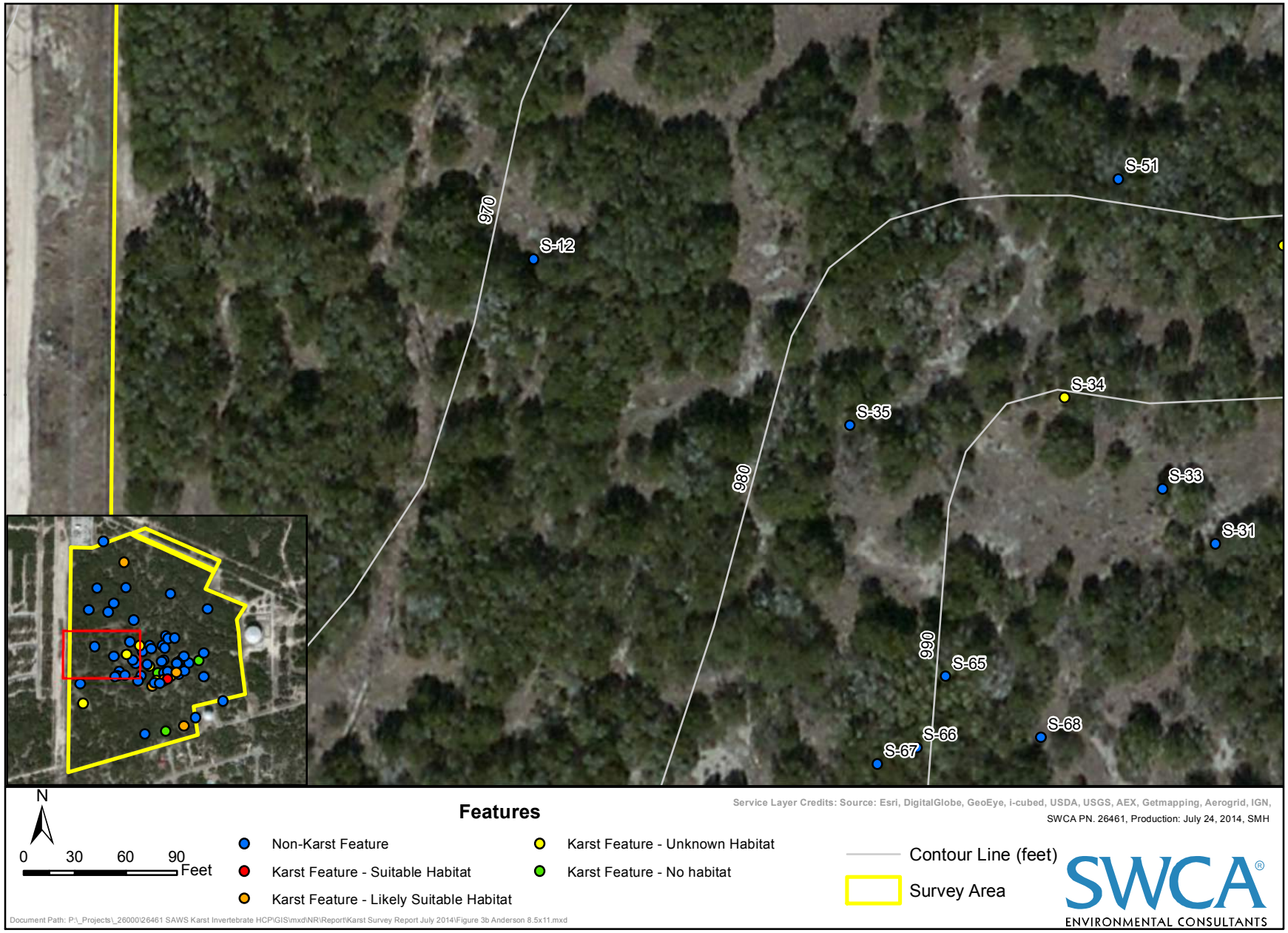


Figure 3f Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

Figure 3g Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

Figure 3h Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

Figure 3i Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

Figure 3j Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

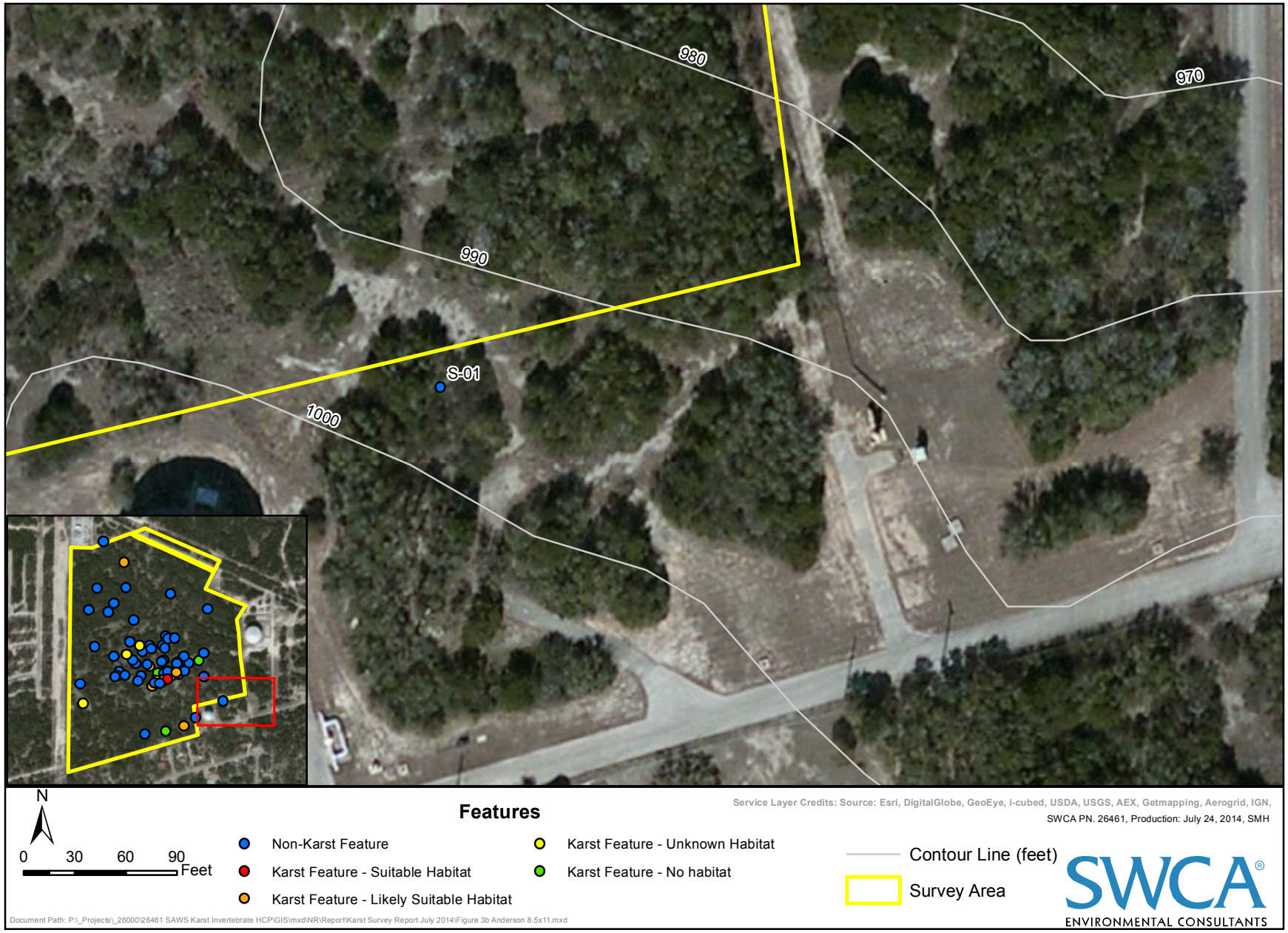


Figure 3k Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

Figure 3l Results of the karst survey for the SAWS Anderson Pump Station, Bexar County, Texas.

APPENDIX B

PHOTOLOG

S-1. Closed depression before excavation, measuring approximately 5 feet in diameter by 1 foot deep.

S-1. Post-excavation. Feature was excavated to approximately 1.5 feet deep.

S-2. Solution cavity, approximately 15 feet long by 1 foot wide by greater than 2 feet lateral depth.

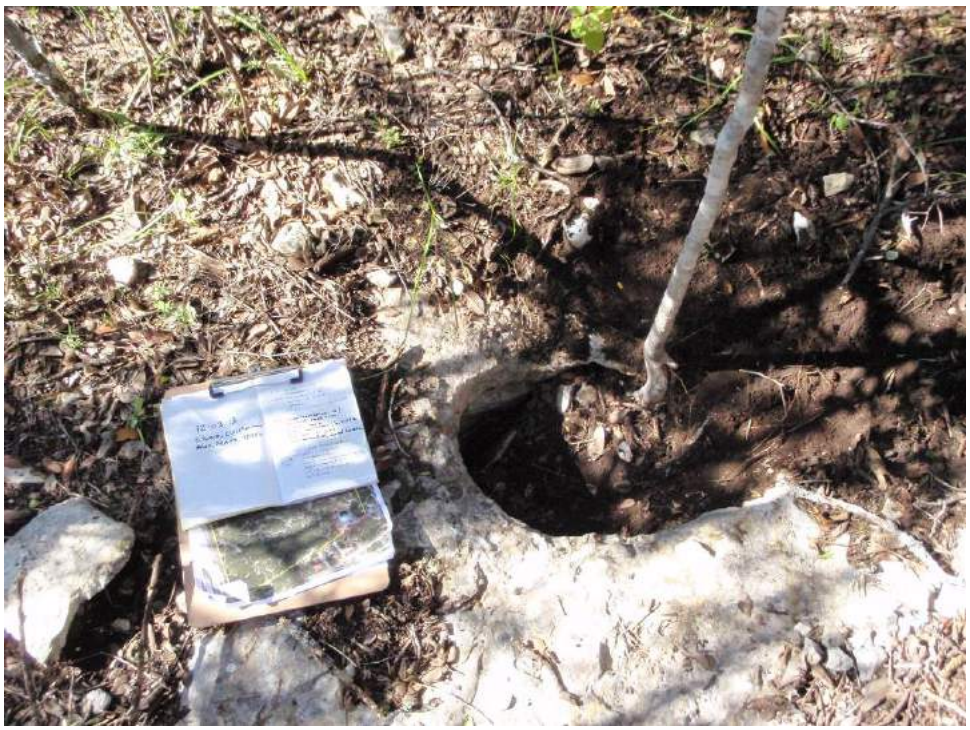
S-2. Post-excavation.

S-3. Non-Karst closed depression approximately 6 feet in diameter by 0.5 feet deep.

S-3. Post-excavation. Feature was excavated to approximately 1.5 feet deep.

S-4. Closed depression approximately 2 feet in diameter by 1 foot deep.

S-4. Post-excavation. Feature was excavated to approximately 1.25 feet deep.



S-5. Solution cavity approximately 1.5 feet by 1 foot by at least 1 foot deep.

S-5. Post-excavation. Feature was excavated to 2 feet long by 1.5 feet deep. The feature appears to have a lateral component extending horizontally; however, it extends beyond what can be humanly accessed.

S-6. Non-karst closed depression approximately 1 foot by 0.75 foot by at least 1 foot deep.

S-6. Post excavation. Feature was excavated to approximately 3 feet in diameter by 1.5 feet deep.

S-7. Closed depression approximately 3 feet in diameter by 1 foot deep.

S-8. Solution cavity approximately 1.5 feet in diameter by greater than 1 foot deep.

S-8. Post-excavation. Feature was excavated to approximately 3 feet in diameter by 1.5 feet deep.

S-9. Closed depression approximately 0.5 foot in diameter by 0.5 foot deep.

S-9. Post-excavation. Feature was excavated to approximately 1 foot deep.

S-10. Solution cavity approximately 1.5 feet in diameter by greater than 1 foot deep.

S-10. Post-excavation. Feature was excavated to approximately 5 feet in diameter by 8 feet deep. At the base of the feature, a small continuation of the void space continues beyond what is humanly accessible.

S-11. Closed depression approximately 6 feet in diameter by greater than 1 foot deep.

S-11. Post-excavation. Feature was excavated to approximately 2 feet deep.

S-12. Closed depression approximately 2.5 feet in diameter by 1 foot deep.

S-12. Feature was excavated to approximately 1.5 feet deep.

S-13. Closed depression approximately 2.5 feet in diameter by 1 foot deep.

S-13. Post excavation. Feature was excavated to approximately 1.5 feet deep.

S-14. Closed depression approximately 1 foot in diameter by greater than 1 foot deep.

S-14. Post excavation. Feature was excavated to approximately 2 feet deep. Additional void space continues underneath the rock rim; however, it appears to become pinch out.

S-15. One of three closed depressions approximately 2 feet in diameter by 1 foot deep.

S-15. Post-excavation. Feature was excavated to approximately 2.5-3 feet deep.

S-16. Solution cavity zone consisting of three solution cavities, the largest of which measures approximately 1 foot in diameter by 2 feet deep.

S-16. Post-excavation. Feature was excavated to approximately 2.5 feet deep.

S-17. Solution cavity approximately 1.5 feet in diameter by 1.5 feet deep.

S-17. Post-excavation. Feature was excavated to approximately 6 feet long by 1-2 feet wide by 2.5 feet deep. At the southern wall of the feature, a small conduit continues beyond what is humanly accessible. This void space appears to be less than 1 foot in diameter.

S-18. Closed depression approximately 2.5 feet by 1 foot by more than 1 foot deep.

S-18. Feature was excavated to approximately 6 feet long by 5 feet wide by 3.5 feet deep.

S-19. Sinkhole approximately 2.5 feet in diameter by more than 2 foot deep.

S-19. Post-excavation. Feature was excavated to approximately 12 feet long by 3 feet wide by 12 feet deep. At approximately 12 feet deep, an additional small passage, measuring 2.75 feet tall by 2 feet wide, continues to the northeast for at least 15 feet.

S-20. Solution cavity approximately 3 feet long by 0.5 foot wide by more than 1 foot deep.

S-20. Post-excavation. Feature was excavated to approximately 2.5 feet wide by 2.5 feet deep. A small 6 inch void space continues northwest; however, it appears to pinch out.

S-21. One of three closed depressions, each approximately 1.5 feet in diameter by 1 foot deep.

S-21. Post-excavation. Feature was excavated to approximately 4 feet in diameter to 3.5 feet deep. At approximately 3.5 feet deep, a solid bedrock floor sloping to the north was encountered. Along the sloping bedrock is a 1 foot tall void space that appears to narrow beyond the rock rim.

S-22. Solution cavity approximately 1.5 feet in diameter by greater than 2 feet deep.

S-22. Post-excavation. Feature was excavated to approximately 5 feet in diameter by 6 feet deep.

S-23. Solution cavity approximately 1.5 feet in diameter by greater than 1.5 feet deep.

S-23. Feature post hand excavation. Approximately 2.5 feet by 3 feet deep.

S-24. Closed depression approximately 1 foot in diameter by greater than 1 foot deep.

S-24. Post-excavation. Feature was excavated to approximately to 3 feet long by 1.5 feet wide by 1.5 feet deep.

S-25. Closed depression approximately 2 feet in diameter by greater than 1 foot deep.

S-25. Post-excavation. Feature was excavated to approximately 3 feet in diameter by 1.75 feet deep.

S-26. Closed depression approximately 2.5 feet long by 1 foot wide by 1.5 feet deep.

S-26. Post-excavation. Feature was excavated to approximately 3 feet in diameter by 1.75 feet deep.

S-27. Closed depression measuring approximately 3.5 feet in diameter by 1.5 feet deep.

S-27. Post-excavation. Feature was excavated to approximately 6 feet long by 3 feet wide by 3 feet deep.

S-29. Cave/Sinkhole measuring approximately 4 feet in diameter by 0.5 foot deep.

S-29. Post-excavation. Feature was excavated to approximately 7 feet long by 2.5 feet wide by 3 feet deep. A small void space along the northern wall was excavated to reveal a gently sloping bedrock floor extending approximately 20 feet to a cobble filled room. The void space extending down is approximately 3.5 feet wide by 1.75 feet tall. At the base of this slope is a fracture controlled room, approximately 8 feet long by 3.5 feet wide.

S-30. Closed depression measuring approximately 2 feet in diameter by 0.5 foot deep.

S-30. Post-excavation. Excavated to approximately 1 foot deep.

S-31. Closed depression measuring approximately 1.75 feet in diameter by 0.5 foot deep.

S-31. Post-excavation. Excavated to approximately 1 foot deep.

S-32. Closed depression measuring approximately 2 feet in diameter by 0.5 foot deep.

S-32. Post-excavation. Excavated to approximately 3 feet in diameter by 2.5 feet deep.

S-33. Closed depression measuring approximately 1.75 feet in diameter by 0.5 foot deep.

S-33. Post-excavation. Feature was excavated to approximately 0.75 foot deep.

S-34. Solution cavity measuring approximately 2 feet in diameter by 0.5 foot deep.

S-34. Post-excavation. Feature was excavated to approximately 3.5 feet in diameter by 4 feet deep.

S-35. Closed depression measuring approximately 2 feet in diameter by 0.5 foot deep.

S-35. Post-excavation. Feature was excavated to approximately 1 foot deep.

S-36. Closed depression measuring approximately 1.5 feet in diameter by 0.5 foot deep.

S-36. Post-excavation. Feature was excavated to approximately 0.75 foot deep.

S-37. Closed depression measuring approximately 2.25 feet in diameter by 0.5 foot deep.

S-37. Post-excavation. Feature was excavated to approximately 1 foot deep.

S-38. Closed depression measuring approximately 2 feet in diameter by 0.5 foot deep.

S-38. Post-excavation. Feature was excavated to approximately 1 foot deep.

S-39. Closed depression measuring approximately 2 feet in diameter by 0.5 foot deep.

S-39. Post-excavation. Feature was excavated to approximately 1 foot deep.

S-40. Closed depression measuring approximately 1.75 feet in diameter by 0.5 foot deep.

S-40. Post-excavation. Feature was excavated to approximately 0.75 foot deep.

S-41. Closed depression measuring approximately 1.5 feet in diameter by 0.5 foot deep.

S-42. Closed depression measuring approximately 1.75 feet in diameter by 0.5 foot deep.

S-42. Post-excavation. Feature was excavated to approximately 0.75 foot deep.

S-43. Closed depression measuring approximately 1.25 feet in diameter by 0.5 foot deep.

S-43. Post-excavation. Feature excavated to approximately 0.75 foot deep.

S-44. Closed depression measuring approximately 1.25 feet in diameter by 0.5 foot deep.

S-44. Post-excavation. Feature was excavated to approximately 1.5 feet deep.

S-45. Closed depression measuring approximately 1.25 feet in diameter by 0.5 foot deep.

S-45. Post-excavation. Feature was excavated to approximately 0.75 foot deep.

S-46. Closed depression measuring approximately 0.75 foot in diameter by 0.5 foot deep.

S-46. Post-excavation. Feature was excavated to approximately 0.75 foot deep.

S-47. Closed depression measuring approximately 1.75 feet in diameter by 0.5 foot deep.

S-47. Post-excavation. Feature was excavated to approximately 1 foot deep.

S-48. Closed depression measuring approximately 2 feet in diameter by 0.5 foot deep.

S-48. Post-excavation. Feature was excavated to approximately 1 foot deep.

S-49. Closed depression measuring approximately 1.25 feet in diameter by 0.5 foot deep.

S-49. Post excavation. Feature was excavated to approximately 0.75 foot deep.

S-50. Closed depression measuring approximately 2.25 feet in diameter by 0.5 foot deep.

S-51. Closed depression measuring approximately 2 feet in diameter by 0.5 foot deep.

S-52. Closed depression measuring approximately 2 feet in diameter by 0.25 foot deep.

S-52. Post-excavation. Feature was excavated to approximately 0.5 foot deep.

S-53. Closed depression measuring approximately 0.75 foot in diameter by 0.5 foot deep.

S-53. Post-excavation. Feature was excavated to approximately 1 foot deep.

S-54. Closed depression measuring approximately 1.5 feet in diameter by 0.5 foot deep.

S-54. Post-excavation. Feature was excavated to approximately 1 foot deep.

S-55. Closed depression measuring approximately 3 feet in diameter by 0.5 foot deep.

S-55. Post-excavation. Feature was excavated to approximately 1.25 feet deep.

S-56. Solution cavity measuring 1 foot in diameter by 0.5 foot deep.

S-56. Post-excavation. Feature was excavated to approximately 2 feet deep. At approximately 1 foot deep, two solution cavities, measuring approximately 1.5 feet in diameter by 1.5 feet deep, were exposed.

S-57. Solution cavity measuring approximately 1 foot in diameter by 0.25 foot deep.

S-57. Post-excavation. Feature was excavated to approximately 2 feet deep. At approximately 1 foot deep, one solution cavity, measuring approximately 2.5 feet long by 0.5 foot wide by at least 1 foot deep, was exposed

S-58. Solution cavity measuring approximately 1.25 foot in diameter by 0.5 foot deep.

S-58. Post-excavation. Feature was excavated to approximately 4 feet in diameter by 6 feet deep. At approximately 0.5 foot deep, one solution cavity, measuring approximately 3 feet long by 1.25 feet wide by at least 3 foot deep, was exposed. A small 0.5 foot diameter opening continued east beyond the newly excavated rock walls.

S-59. Closed depression measuring approximately 8 feet long by 1 foot wide.

S-59. Post-excavation. Feature was excavated to approximately 1 foot deep.

S-60. Closed depression measuring approximately 2 feet in diameter.

S-60. Post-excavation. Feature was excavated to approximately 0.5 foot deep.

S-61. Solution cavity measuring approximately 1 foot in diameter by 0.5 foot deep.

S-61. Post-excavation. Feature was excavated to approximately 1.5 feet deep.

S-62. Solution cavity measuring approximately 1 foot in diameter by 0.5 feet deep.

S-62. Post-excavation. Feature was excavated to approximately 3 feet long by 1.5 feet wide by 2 feet deep. At approximately 2 feet deep, additional void space extending towards feature S-29 was identified.

S-63. Closed depression measuring approximately 1 foot in diameter by 0.25 foot deep.

S-63. Post-excavation. Feature was excavated to approximately 3 feet in diameter by 1.5 feet deep.

S-64. Closed depression measuring approximately 3 feet in diameter by 2 feet deep.

S-64. Post-excavation. Feature was excavated to approximately 2.75 feet deep.

S-65. Closed depression measuring approximately 2 feet in diameter by 1 foot deep.

S-65. Post-excavation. Feature was excavated to approximately 3 feet in diameter by 4 feet deep.

S-66. Closed depression measuring approximately 2.5 feet long by 0.5 foot wide by 0.5 foot deep.

S-66. Post-excavation. Feature was excavated to approximately 2 feet deep.

S-67. Closed depression measuring approximately 1 foot in diameter by 0.5 foot deep.

S-67. Post-excavation. Feature was excavated to approximately 0.75 foot deep.

S-68. Closed depression measuring approximately 1 foot in diameter by 0.5 foot deep.

S-68. Post-excavation. Feature was excavated to approximately 0.75 foot deep.

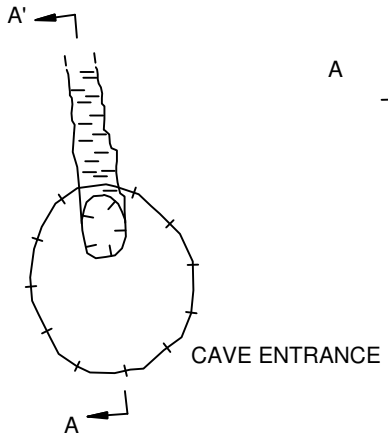
S-69. Closed depression measuring approximately 1.5 feet in diameter by 0.5 foot deep.

S-69. Post-excavation. Feature was excavated to approximately 1 foot deep.

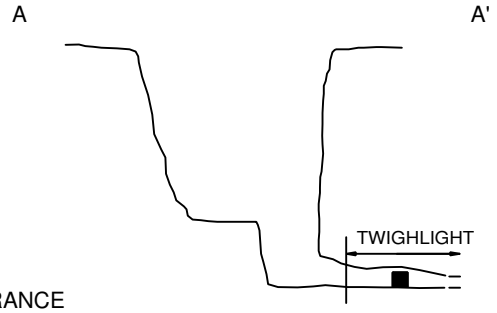
APPENDIX C

CAVE MAPS

SAWS ANDERSON PUMP STATION
FEATURE S-10
7/15/2014
GUY RUBIO
PHIL PEARCE
JEN MORELAND



PLAN VIEW



PROFILE

LEGEND

SOIL FLOOR

BAIT TRAP

N

0' 6'

SCALE IN FEET
1" = 6'

SAWS ANDERSON PUMP STATION
FEATURE S-10

SWCA®
ENVIRONMENTAL CONSULTANTS
Sound Science. Creative Solutions.®

SAWS ANDERSON PUMP STATION
FEATURE S-19

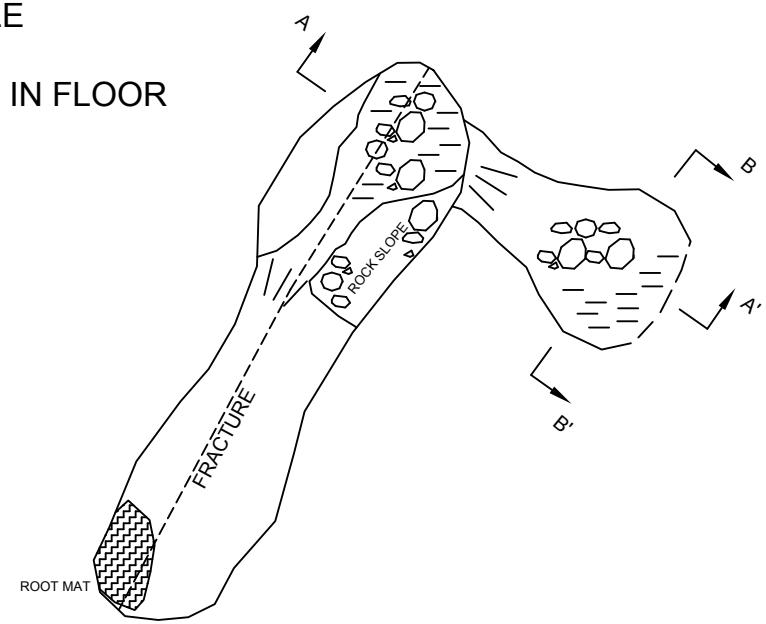
GUY RUBIO

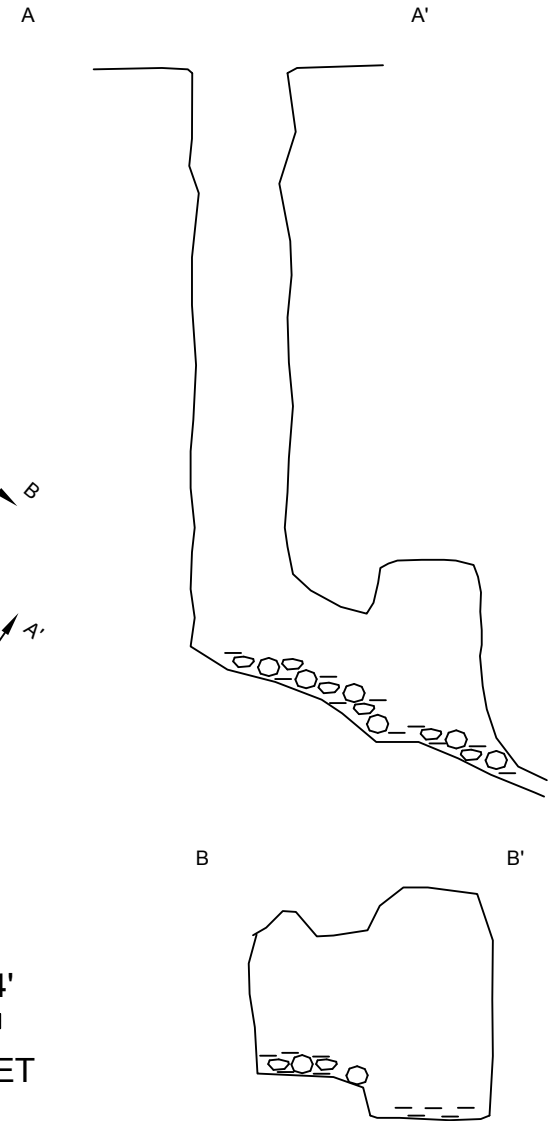
LEGEND

COBBLE

LOW
HIGH
SLOPE IN FLOOR

SOIL



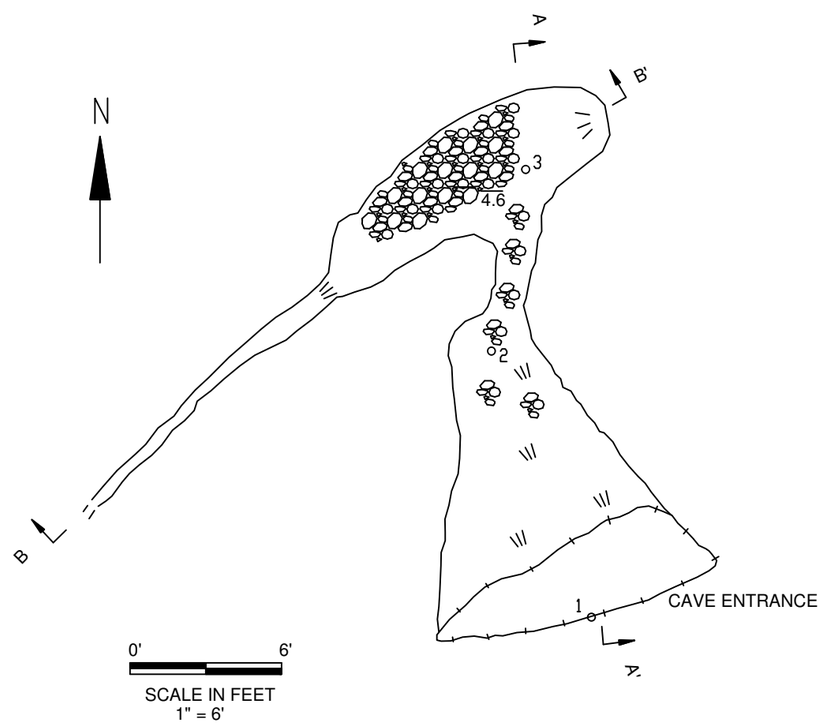


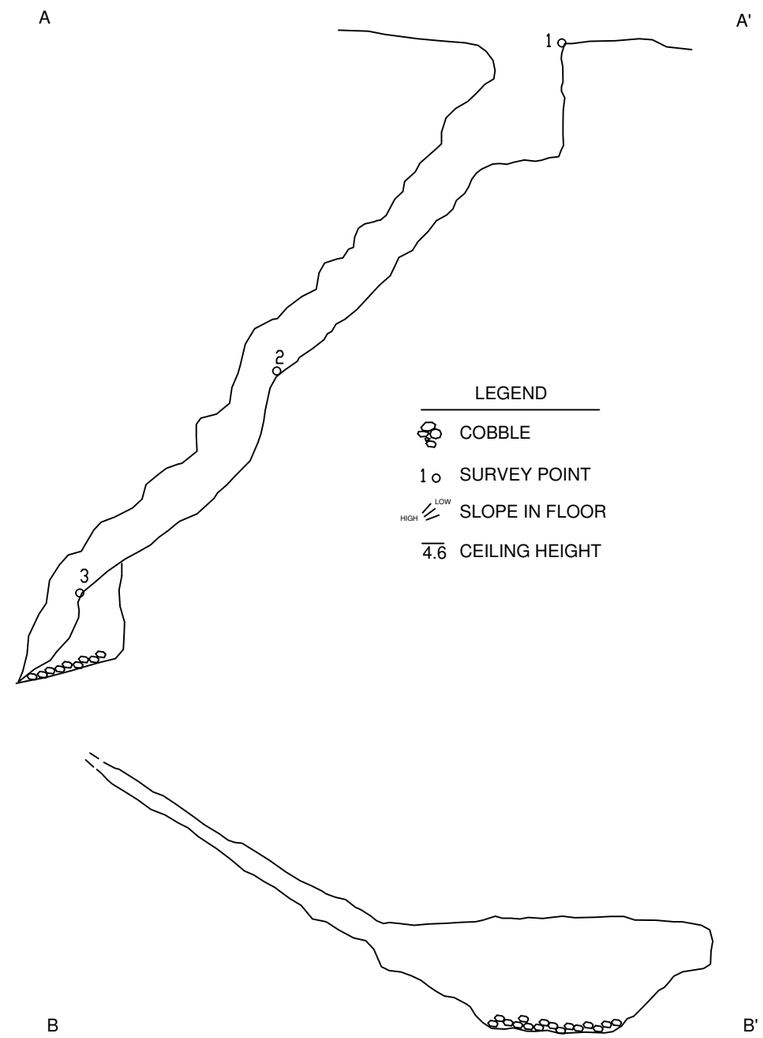
N

0' 4'

SCALE IN FEET
1" = 4'

SAWS ANDERSON PUMP STATION
FEATURE S-29
7/15/2014
PHIL PEARCE
GUY RUBIO
JEN MORELAND





LEGEND

- COBBLE
- 1 SURVEY POINT
- HIGH LOW SLOPE IN FLOOR
- 4.6 CEILING HEIGHT

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APPENDIX D

BIOTA SURVEY RESULTS

Table 1.

Biota Survey Results	**S-19 Survey**				**S-29 Survey**				
Dates	3/25/2014	3/28/2014	4/28/2014	5/15/2014	3/19/2014	3/25/2014	3/28/2014	4/28/2014	5/15/2014
Temperature and Humidity Inside Feature	75.8˚F, 63.9%	66.2˚F, 82.9%	72.2˚F, 64.2%	68.5˚F, 75.0%	73.3˚F, 80.9%	66.9˚F, 91.5%	68.5˚F, 83.6%	69.6˚F, 76.0%	73.9˚F, 65.7%
Total Survey Time (minutes)	20	116	12	20	90	66	158	51	100
Fauna									
Phylum Mollusca **Class Gastropoda**									
Rabdotus sp. (snail)					2		1		
Phylum Arthropoda **Class Arachnida** **Order Araneae**									
Cicurina sp. (eyeless)		1			1	2		1 (collected)	2 (collected)
Cicurina varians				1					
Eidmanella sp.					1			1	
Wolf spider sp.						1	1		
Order Opiliones									
troglobitic harvestman (unidentified)							1 (out of reach)		
Lieobunum townsendii			40	200+			Many	10	
Class Crustacea **Order Isopoda**									
Armadillidium vulgare			7				5		8
Porcellio scaber		1						1	
Brackenridgia sp.					1				2
Class Diplopoda									
Cambala sp.							6	4	6
Scutigera coleoptrata									4
Surface millipede	1	1	1				2		
Class Insecta **Order Collembola**									
Pseudosinella sp.		1			1	32	2	19	100+
Order Zygentoma									
Texoreddellia texensis							1		
Order Orthoptera									
Ceuthophilus secretus	147	190	30	75+	160	160	185	200	200+
Ceuthophilus cunicularis	3				3	11	9	27	200+
Order Coleoptera									
Surface beetle (unidentified)		2	2			1			1
Family Carabidae									
Rhadine sp. (elongate blind)							1 (collected)	1 (collected)	
Order Lepidoptera									
Moth (unidentified)			1				1		
Order Diptera									
fly (unidentified)	5		Many	1					
gnat (unidentified)		10					10		1
Order Hymenoptera **Family Formicidae**									
Camponotus sp.				1					
Solenopsis invicta							10's		
Family Sphecidae									
Wasp (unidentified)									
Phylum Chordata **Class Amphibia** **Order Anura**									
Eleutherodactylus marnockii	2	3		2	3	3	1	1	1

Table 2.

*** Features bait trapped**	**S-10**		**S-19**	**S-29**
Date trap was set	5/28/2014	6/2/2014	3/24/2014	3/24/2014
Date trap was checked	5/29/2014	6/4/2014	3/25/2014	3/25/2014
Number of traps used	2	3	3	3
Ceuthophilus secretus	6	12	4	5
Ceuthophilus cunicularis	-	1	-	-
Parts of cave crickets	Yes	Yes	Yes	Yes
Rhadine howdeni	-	-	1	-
Diptera sp.	-	-	1	-

* Blue cheese was used as bait and set on commercially available rodent sticky traps

APPENDIX C

Form of Deed Restrictions for the Anderson Pump Station Karst Preserve

Restrictions

The City of San Antonio, for the use and benefit of the San Antonio Water System (hereafter the "San Antonio Water System") is the owner of that approximately 57.6 acre tract of land in Bexar County, Texas that is more particularly described by metes and bounds in Exhibit "A", attached hereto and incorporated by reference for all purposes (hereafter the "Real Property"), being 57.6 acres out of the real property that is described in an instrument recorded at book 17333, page 1436 , Real Property Records of Bexar County, Texas.

The San Antonio Water System has been issued Incidental Take-Endangered Species Federal Fish and Wildlife Permit number _____ by the United States Department of the Interior, U.S. Fish and Wildlife Service. A copy of that permit is attached hereto and incorporated by reference for all purposes as Exhibit "B" (hereafter the "Permit")...

To comply with the Permit, the San Antonio Water System hereby declares that the Real Property shall be held subject in perpetuity to the following conditions and restrictions, which shall constitute covenants running with the land and which shall be binding upon all persons, parties and entities having any right, title, or interest in any of the Real Property (hereafter the "Restrictions"):

1. No clearing, excavation, or construction activity on or under the surface of the Real Property shall be conducted or permitted on the Real Property, unless expressly authorized by the Permit or by other authorization granted by the U.S. Fish & Wildlife Service.
2. No entry by any persons on or to the Real Property is permitted, save and except for entry authorized by the Permit.
3. All uses inconsistent with the Permit are prohibited.

The U.S. Fish & Wildlife Service is recognized, identified and is an intended third – party beneficiary of the Restrictions. The U.S. Fish & Wildlife Service shall have the right to seek legal and equitable relief by injunction, specific performance or otherwise to enforce the Restrictions

This document may be amended only by a written instrument signed by the U.S. Fish & Wildlife Service and the San Antonio Water System and recorded in the Real Property Records of Bexar County, Texas

Executed and effective on this __ day of _____, 2015.

City of San Antonio by and through the
San Antonio Water System
By: _____
Robert R. Puente
President and Chief Executive Officer

Acknowledgement

THE STATE OF TEXAS

COUNTY OF BEXAR

BEFORE ME, the undersigned Notary Public, on this day personally appeared Robert R. Puente, known to me to be the person whose name is subscribed to the foregoing instrument and acknowledged to me that he executed the same for the purposes and consideration therein expressed.

GIVEN UNDER MY HAND AND SEAL OF OFFICE THIS _____ DAY OF _____, 2015.

_____

NOTARY PUBLIC, STATE OF TEXAS

Printed Name: _____

My Commission Expires:_____

APPENDIX D

Aps Karst Preserve Initial Management Plan

Management and Monitoring Plan for the Anderson Pump Station Karst Preserve: Year 1 to Year 5

SWCA Project Number 26461

DRAFT July 7, 2016

SUBMITTED TO:

San Antonio Water System
2800 U.S. Hwy 281 North
San Antonio, Texas 78212

SUBMITTED BY:

SWCA Environmental Consultants
4407 Monterey Oaks Boulevard
Building 1, Suite 110
Austin, Texas 78749

MANAGEMENT AND MONITORING PLAN FOR THE ANDERSON PUMP STATION KARST PRESERVE: YEAR 1 TO YEAR 5

Prepared for

SAN ANTONIO WATER SYSTEM
2800 U.S. Hwy 281 North
San Antonio, Texas 78212
Attn: John Reynolds
(210) 233-3299

Prepared by

SWCA ENVIRONMENTAL CONSULTANTS
4407 Monterey Oaks Boulevard
Building 1, Suite 110
Austin, Texas 78749
www.swca.com

SWCA Project Number 26461

DRAFT July 7, 2016

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2.0 GOALS AND OBJECTIVES 1
3.0 MANAGEMENT AND MONITORING ACTIVITIES 3
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3.2 Red Imported Fire Ant Management 3
3.3 Temperature and Humidity Monitoring 4
3.4 Biota Monitoring 4
3.5 Cave Cricket Exit Counts 4
3.6 Vegetation Management 4
4.0 ANNUAL REPORTING 5
5.0 LITERATURE CITED 5

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1.0 INTRODUCTION

The San Antonio Water System (SAWS), in coordination with the U.S. Fish and Wildlife Service (USFWS), created the Anderson Pump Station Karst Preserve (APS Karst Preserve) as mitigation for the impacts of incidental take of federally endangered karst invertebrates consistent with the [FINAL DATE] SAWS Karst Invertebrate Habitat Conservation Plan (HCP) and USFWS Incidental Take Permit (ITP) No. XXX-XXX. The APS Karst Preserve contains 57.6 acres of undeveloped land and is located within the Culebra Anticline Karst Fauna Region (KFR) near the intersection of Loop 1604 and State Highway (SH) 151 in northwest Bexar County, Texas (Figure 1). As described in the HCP, the APS Karst Preserve contains several karst features with the characteristics of suitable karst invertebrate habitat and one such feature (Feature S-29) is known to contain the endangered beetle *Rhadine exilis*.

This Management and Monitoring Plan describes the measures that SAWS will implement on the APS Karst Preserve to help fulfil its obligations under the HCP and ITP. The Management and Monitoring Plan is a "living document" and is intended to be periodically updated to adjust to scientific advances and changing ecological conditions on the APS Karst Preserve The HCP and ITP contemplate an adaptive management cycle for the APS Karst Preserve of 5 years. Therefore, this iteration of the Management and Monitoring Plan addresses Years 1 through 5 of preserve stewardship.

At the end of each 5-year adaptive management period, SAWS will review monitoring data and propose revisions to the Management and Monitoring Plan, if warranted to protect listed karst invertebrates and their habitats. Any such changes to the Management and Monitoring Plan will be subject to review and approval by the USFWS.

2.0 GOALS AND OBJECTIVES

Consistent with USFWS guidance for the management and monitoring of karst preserves (USFWS 2014), the goals and objectives for the Management and Monitoring Plan are as follows:

GOALS – To ensure the continued survival of listed karst invertebrates at the APS Karst Preserve and, to the extent practicable, to contribute to their recovery.

OBJECTIVES –

1. Control red-imported fire ants (RIFA) to a level that does not directly or indirectly threaten the continued presence of listed karst invertebrates within the APS Karst Preserve;

2. Prevent damage to habitat for listed karst invertebrates from vandalism, over-visitation, and contamination;

3. Maintain the essential elements of listed karst invertebrate habitat, including stable and mild subsurface temperature, high relative humidity, and appropriate water input;

4. Maintain or improve the condition of the surface plant community that provides nutrients to subsurface habitat for listed karst invertebrates; and

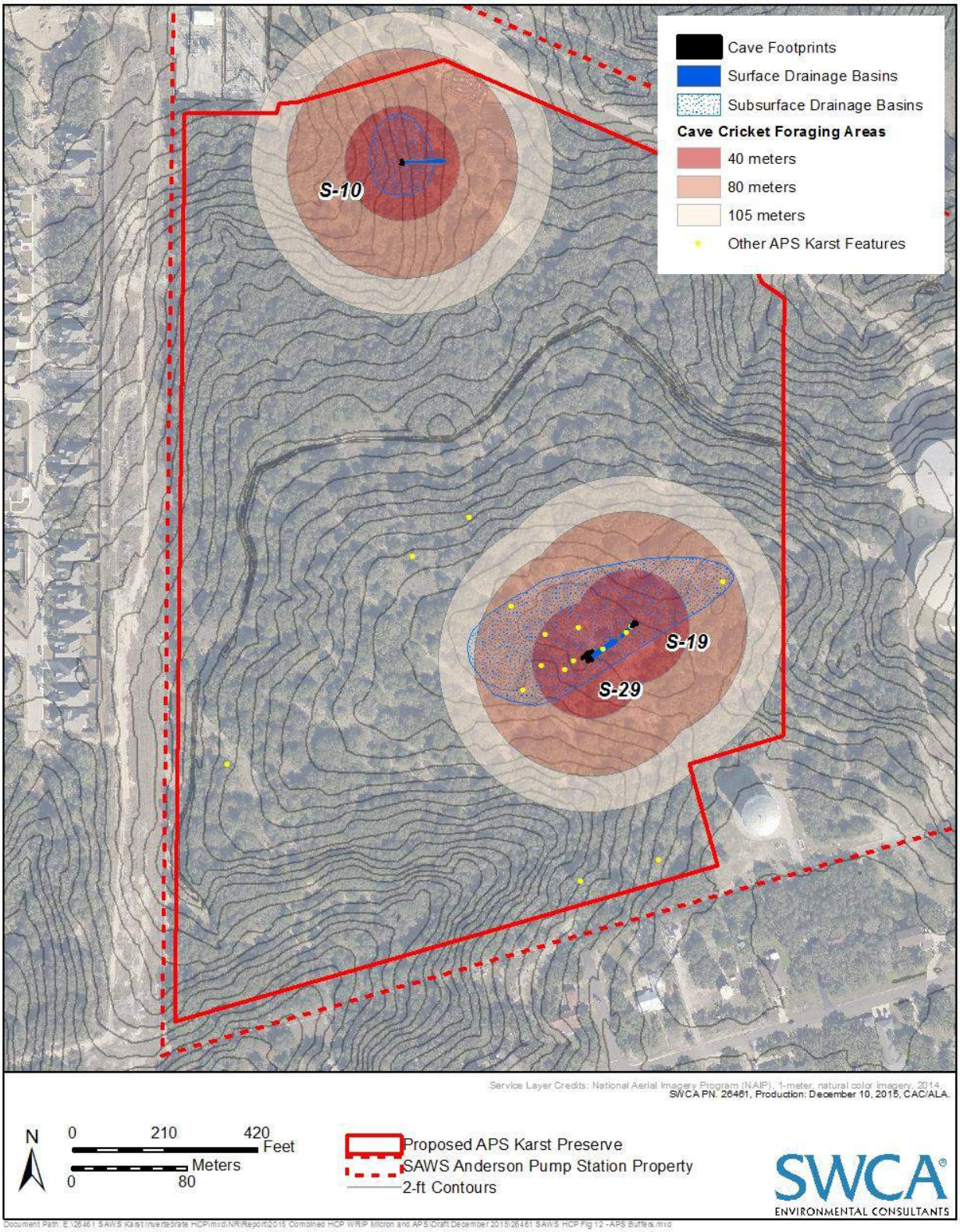

Figure 1. APS Karst Preserve boundary with drainage basins and cricket foraging areas around important karst features.

5. Collect data needed to evaluate the condition of habitat for listed karst invertebrates and the status of the local populations within the APS Karst Preserve in order to support future management decisions.

3.0 MANAGEMENT AND MONITORING ACTIVITIES

SAWS will implement the following activities that contribute to achieving the goals and objectives of the Management and Monitoring Plan.

3.1 On-Site Security

The APS Karst Preserve is within the fully-gated SAWS APS facility with several security features already in place to prevent unauthorized access consistent with achieving Objective 2. The entire APS perimeter is marked by a regularly maintained six-foot high fence with three strands of barbed wire on top. Access to the APS is restricted by two gates with electronic card access and the entrances are monitored with cameras. Access to the APS is restricted to SAWS personnel and a limited number of approved CPS Energy personnel. The APS is patrolled weekly by the SAWS security team, with the entire perimeter inspected regularly. SAWS Production Operations inspectors go to the station every day and inspect the facility operation area and do a cursory inspection of the front part of the station (the portion of the property not included in the preserve). These protective measures are sufficient to prevent vandalism or unauthorized access to the proposed APS Karst Preserve; no additional gating or perimeter fencing of the APS Karst Preserve is proposed at this time.

While not expected, if at any time the perimeter fencing surrounding the APS is removed or otherwise modified, SAWS will evaluate the necessity for additional perimeter fencing through the adaptive management process.

As a separate action that contributes to Objective 3, SAWS will work with the USFWS to prepare a Recovery Project Plan within the first year of preserve stewardship to installing permanent caps on Features S-10, S-19 and S-29. These permanent caps will reduce exposure to the surface environment and for Feature S-29 provide an access hatch will allow for continued monitoring of the cave climate and fauna. The Recovery Project Plan, which will be approved by the USFWS, will describe the methods, materials, and personnel that will be used to design and install the caps, as well as the expected benefits to the species. SAWS will apply to the USFWS for a section 10(a)(1)(A) permit for any take that may be associated with the installation of the caps.

3.2 Red Imported Fire Ant Management

Consistent with Objective 1, SAWS will implement the following measures to manage RIFA within the APS Karst Preserve:

- Minimize ground disturbance: Access within the APS Karst Preserve will be limited to designated representatives. Any necessary vehicular traffic will be restricted to existing unimproved access trails.

- Encourage native habitats: Native plant and animal diversity will be maintained by restricting the removal of native vegetation from the APS Karst Preserve to the maximum extent practicable.
- Conduct RIFA mound eradication: Quarterly, SAWS will survey the area within 80 meters of Features S-10, S-19, and S-29 for the presence of RIFA mounds. If present, any RIFA mounds will be treated within one week of the monitoring survey. At this time, the preferred method of mound eradication is the application of boiling water.
- Conduct passive management strategies to control RIFA: Currently, the APS Karst Preserve incidentally meets four of the five passive management strategies recommended by USFWS to control RIFA (USFWS 2014), including the use of high-fencing to deter deer browsing, measures to control feral hog occurrence, prohibition of mowing, and restricted human access to the proposed preserve area.

3.3 Temperature and Humidity Monitoring

To contribute to Objective 5, SAWS will permanently install dataloggers in Feature S-29 to record humidity and temperature levels within the cave. Dataloggers will record conditions every two hours. Data will be retrieved at least quarterly.

3.4 Biota Monitoring

To contribute to Objective 5, SAWS will conduct in-feature karst fauna surveys of Feature S-29 once per year in the fall (September-November). All surveys will be performed by biologists permitted by USFWS to conduct such surveys and the methods for the survey will follow current USFWS protocols for conducting presence/absence surveys.

3.5 Cave Cricket Exit Counts

To contribute to Objective 5, SAWS will conduct cave cricket exit counts for Feature S-29 twice per year at the same time of year (within 30 days), once during the spring (March through June) and once during the fall (September through December). Cave cricket exit counts will be conducted for 2 hours beginning at sunset on days when surface temperatures are between 40°F (4°C) and 100°F (37°C) and relative humidity is greater than 80 percent. Cave cricket exit counts include documenting the numbers and age (for example, immature or adult) of individuals exiting per 10-minute increments to track demographics and activity peaks. Notations will be made on weather conditions including the current surface temperature and relative humidity, recent weather events in the past week (for example, rain or lack thereof, unusual temperatures) and any weather trends (for example, drought).

3.6 Vegetation Management

Initially, vegetation management is not proposed within the APS Karst Preserve. Vegetation is currently in a predominantly natural state that achieves Objective 4 and there are no accumulations of vegetation that contribute to an increased fire risk. Invasive plants are not currently known to be an issue for the site. SAWS maintains a mowed buffer area around the perimeter of the APS that may

serve as a firebreak from adjacent properties. SAWS will not use herbicides within the APS Karst Preserve to maintain the firebreak buffer.

To contribute to Objective 5, once every ten years beginning in the first year of HCP approval, a nested-plot sampling technique will be used to collect vegetation data within the proposed APS Karst Preserve. Vegetation sampling will follow methods outlined in Stohlgren et al. (1995). Though not expected, additional vegetation monitoring will also be conducted following any significant ecological event (such as a fire) within the APS. Vegetation survey data will be compared over time to assess the need for the implementation of an active vegetation management program, for example if invasive or non-native vegetation is discovered that is likely to alter the quality of the karst habitat. In the event additional management is necessary, appropriate strategies will be identified through use of the adaptive management process.

In the first year of preserve establishment, SAWS will reseed with native grasses and forbs the area within 10 meters of the entrances to Features S-10, S-19, and S-29 that were disrupted by the prior karst feature surveys. This measure contributes to Objective 4.

4.0 ANNUAL REPORTING

SAWS will submit an annual report to the USFWS Austin Ecological Services Field Office by March 31 each year documenting the results of management and monitoring activities that were conducted on the APS Karst Preserve during the prior calendar year. Annual reports will document the dates and times of monitoring and management activities, the nature of the activity, and any relevant results or findings. Reporting for karst fauna surveys will follow the format and content recommended by USFWS in the current protocols for conducting karst invertebrate presence/absence surveys.

SAWS may propose modifications to the Management and Monitoring Plan in the annual report for USFWS consideration and approval. USFWS may also propose revisions to the Management and Monitoring Plan during the review and approval process. However, any future revisions to the Management and Monitoring Plan must have the concurrence of both SAWS and USFWS, and be consistent with the HCP (including changed circumstances) and ITP. While proposed revisions to the Management and Monitoring Plan are under consideration by SAWS and the USFWS, SAWS will continue to implement the current version of the plan.

5.0 LITERATURE CITED

U.S. Fish and Wildlife Service (USFWS). 2014. Karst preserve management and monitoring recommendations. Revised April 8, 2014. USFWS Austin Ecological Services Field Office, Austin, TX. https://www.fws.gov/southwest/es/Documents/R2ES/TX_Karst_Preserve_Mgmt_module.pdf. Last accessed July 7, 2016. 14 pp.