PRESERVE DESCRIPTIONS OF LAND MANAGED BY THE WILLIAMSON COUNTY CONSERVATION FOUNDATION UNDER THE WILLIAMSON COUNTY REGIONAL HABITAT CONSERVATION PLAN

JUNE 2021

PREPARED FOR

Gary Boyd
Williamson County Conservation Foundation

PREPARED BY

SWCA Environmental Consultants

NOTE: The Preserve Description report is very similar to previous iterations and changes are as follows. Updated photographs were added to the Bat Well Cave Preserve discussion (Section 2.14) and the Snowmelt Cave discussion (Section 2.15). Species tables for each preserve were updated with newly encountered organisms. The Hidden Springs Ranch was acquired in 2020 and a description of the property is discussed within Section 2.16. Other portions of this document remain the same as the most recent submittal.

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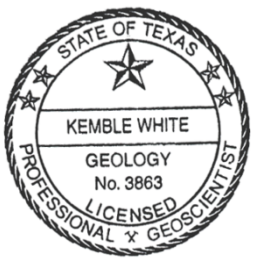

As a licensed professional geoscientist I attest that the contents of this report are complete and accurate to the best of my knowledge.

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PRESERVE SUMMARY

The 15 karst feature preserves currently administered by the Williamson County Conservation Foundation (WCCF) range in size from approximately 1 acre up to 172.2 acres and contain a wide variety of explored and unexplored karst habitat features. Table PS1 shows the number of karst features contained within each preserve, as well as any karst fauna area (KFA) status acreage. The WCCF oversees the management of more than 50 named karst features within approximately 943.1 preserve acres, 530.1 acres of which are designated KFAs. The WCCF acquired the Hidden Springs Ranch as a golden-cheeked warbler (*Setophaga chrysoparia*) preserve, which occupies approximately 932.5 acres and has no known caves.

Table PS1. Williamson County RHCP Preserve Resources

Preserve Name	Year Preserve Established	Number of Named Karst Features	Approximate Preserve Acreage	Approximate KFA Acreage	Listed Karst Invertebrates Found In Preserve
Twin Springs KFA	2009	2	172.2	172.2	*Texella reyesi*, *Batrisodes texanus**
Beck Preserve	2009	7	44.5	0	*Texella reyesi*
Cobbs Cavern KFA*	2009	1	163.0	163.0	*Texella reyesi*, *Batrisodes texanus*
Millennium Preserve	2012	6	74.4	0	*Texella reyesi*
Wilco Preserve	2012	13	152.5	0	*Texella reyesi*
Chaos Cave Preserve*	2012	4	30.0	0	*Texella reyesi*
Big Oak Preserve*	2013	1	10.0	0	*Rhadine persephone*
Priscilla's Well KFA	2011	2	51.5	51.5	*Texella reyesi*, *Batrisodes cryptotexanus*
Woodland Park Cave Preserve	2012	2	10.2	0	*Texella reyesi*
Karankawa Cave KFA	2013	8	61.7	61.7	*Texella reyesi*, *Batrisodes cryptotexanus*
Coffin Cave Preserve	2014	1	39.4	0	*Texella reyesi, Batrisodes texanus*
Beck Commons Preserve	2014	2	4.2	0	*Texella reyesi*
Shaman Cave KFA	2016	8	81.7	81.7	*Texella reyesi*, *Batrisodes cryptotexanus*
Bat Well Cave Preserve	2017	1	46.5	0	*None*
Snowmelt Cave Preserve	2019	1	1.3	0	*Texella reyesi*
Hidden Springs Ranch	2020	0	932.5	0	*None*
Total		**59**	**1,875.6**	**530.1**	

* Easement, not owned by Williamson County

Section 9.3.2 of the Williamson County Regional Habitat Conservation Plan (RHCP) (SWCA Environmental Consultants [SWCA] et al. 2008) indicates that by 2025, WCCF shall acquire 700 karst preserve acres through direct purchase or acquisition of perpetual conservation easements. RHCP Section 9.3.2 (SWCA et al. 2008) also indicates Williamson County planned to purchase 500 karst preserve acres outright and acquire 200 karst easement acres from private landowners. The WCCF currently administers approximately 943.1 karst preserve/easement acres and has, thus, exceeded the karst preserve acreage predicted for this point in time in the RHCP (SWCA et al. 2008). Table PS2 shows predicted karst

preserve acreage at the RHCP's time of writing versus the current karst preserve acreage administered by the WCCF.

Table PS2. Current Preserve Acreage Versus Expected Cave Acreage as Determined by the Williamson County Regional Habitat Conservation Plan

Preserve	Minimum Cave Preserve Acreage Required by 2025	Current Preserve Holdings (2020)
Williamson County Owned	500	740.1
Conservation Easement	200	203.0
Total	**700**	**943.1**

The RHCP (SWCA et al. 2008) prescribes that the WCCF shall establish and administer nine to fifteen 40- to 90-acre KFAs to enhance efforts towards listed karst invertebrate recovery; three of the KFAs are to be distributed within the three Williamson County KFRs (North Williamson County, Georgetown, McNeil/Round Rock) covered by the RHCP. The WCCF administers five (one is pending final approval) KFAs in the North Williamson County KFR for three karst invertebrates (*Texella reyesi, Batrisodes texanus, B. cryptotexanus*) as of 2020 and two pending KFAs are established in the Georgetown KFR for *T. reyesi*. All covered KFRs still contain available undeveloped land with potential to create additional KFAs, including the Round Rock/McNeil KFR. Table PS3 lists current KFAs and their associated endangered karst invertebrates.

Table PS3. Established and Pending Karst Fauna Areas and Documented Endangered Karst Invertebrate Presence

KFA	KFR	*Texella reyesi*	*Batrisodes texanus*	*Batrisodes cryptotexanus*
Twin Springs	North Williamson County	√	√	
Cobbs Cavern	North Williamson County	√	√	
Priscilla's Well	North Williamson County	√		√
Karankawa Cave	North Williamson County	√		√
Shaman Cave (pending)	North Williamson County	√		√
Millennium (pending)	Georgetown	√		
Wilco (pending)	Georgetown	√		

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1 INTRODUCTION

Williamson County (the County) and the Williamson County Conservation Foundation (WCCF) were issued an incidental take permit by the U.S. Fish and Wildlife Service (USFWS) in October 2008 to authorize take of four endangered species arising from a variety of covered land development activities in properties voluntarily enrolled within the Williamson County Regional Habitat Conservation Plan (RHCP) (SWCA Environmental Consultants [SWCA] et al. 2008). The RHCP was prepared by the County with funding and technical assistance from the USFWS. The RHCP supports an incidental take permit that authorizes the *take* of the Bone Cave harvestman (*Texella reyesi*), the Inner Space Caverns mold beetle (*Batrisodes texanus*[1]), the golden-cheeked warbler (*Setophaga chrysoparia*; GCWA), and the black-capped vireo (*Vireo atricapilla*; BCVI); collectively defined as the Covered Species. 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 United States Code 1532[19]). Authorized take of the Covered Species is mitigated primarily through the establishment and management of preserves providing habitat for the above-mentioned Covered Species plus a suite of other species occurring in the same habitat. The WCCF preserve system (Figure 1) is intended to sustain high-quality habitat for species already on the endangered species list and to proactively conserve habitat to preclude the need to list other species. These other species include, but are not limited to, 20 troglobitic cave invertebrates and four species of spring-adapted *Eurycea* salamanders. Covered and additional species addressed in the RHCP are discussed in the management plan for the preserves (Van Kampen-Lewis and White 2020). Sites documented herein are categorized either as preserves or as Karst Fauna Areas (KFAs), a categorization determined by criteria set forth by the USFWS (see RHCP Section 5.3.1.1 [SWCA et al. 2008] for further details). This document describes the preserve sites, their associated caves, and any habitat therein dedicated to birds and/or salamanders listed by the USFWS as threatened or endangered.

1.1 Karst Ecosystem Delineations

1.1.1 Karst Zones and Karst Fauna Regions

The USFWS commissioned a study in 1991 that attempted to determine the likelihood of various geological units in Williamson and Travis Counties to contain karst features with potential habitat for cave-dwelling invertebrates after listing several karst invertebrate species as endangered in 1988 (Veni and Associates 1992). These karst zones were subsequently updated by Veni and Martinez (2007). The study resulted in zone delineation based on lithology, cave distribution, cave fauna distribution, and geologic controls on cave development. The zones are delineated as follows:

Zone 1 - contains endangered cave species

Zone 2 - high probability of endangered or endemic cave fauna

Zone 3 - low probability of endangered or endemic cave fauna

Zone 4 - does not contain endangered or endemic cave fauna

The difference between Zones 1 and 2 is most likely an artifact of limited sampling. Zones 1 and 2 together reflect the potential distribution of cavernous rock exposed at the surface that may harbor karst invertebrates.

[1] Chandler and Reddell (2001) split the listed *Batrisodes texanus* into two species, *B. texanus* and *B. cryptotexanus*, but the USFWS (2018a) does not recognize the split. For this reason, both species are considered federally endangered and are protected under the Endangered Species Act. USFWS (2018) indicates both species are known from a total of 25 caves.

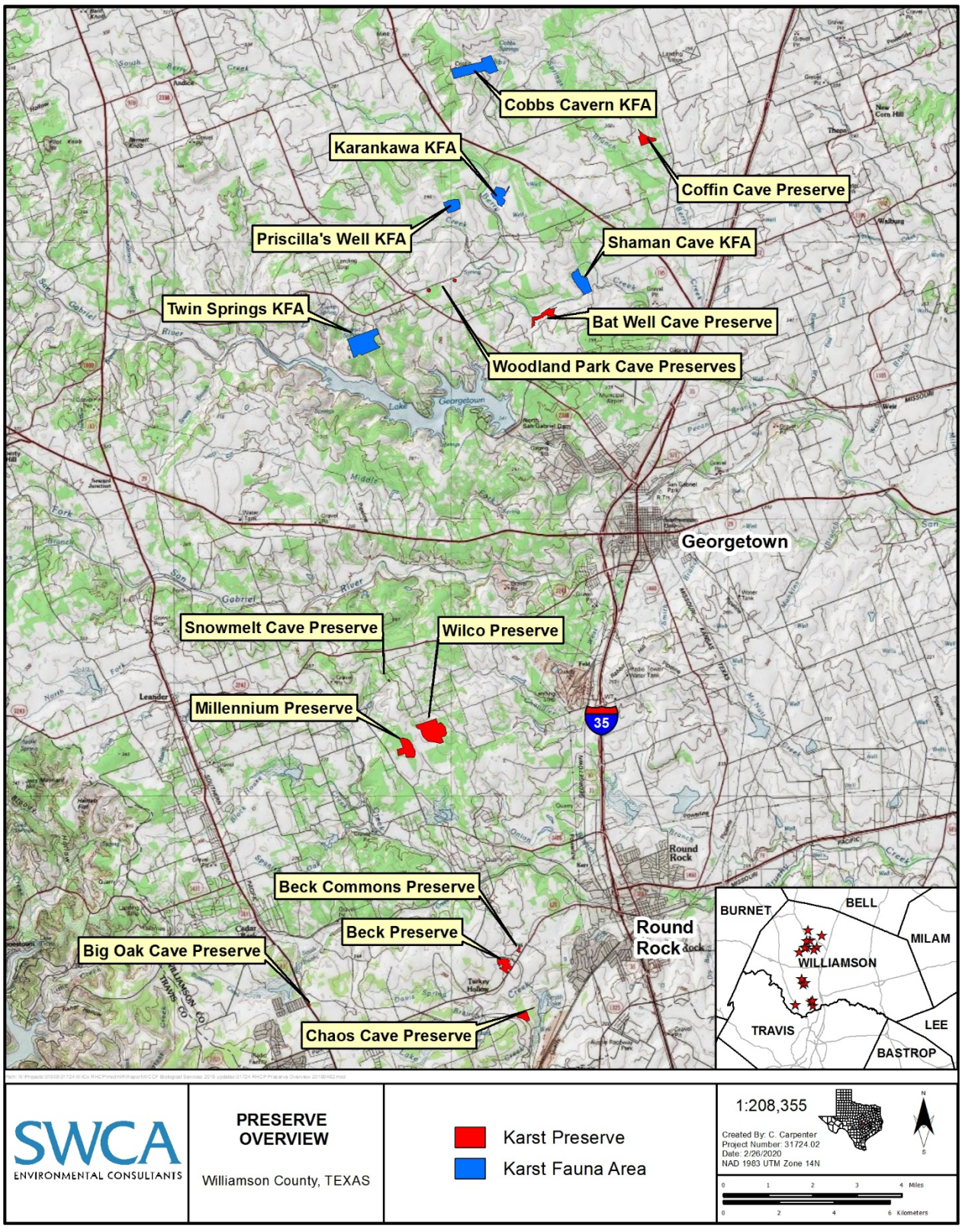


Figure 1. Williamson County Conservation Foundation preserve system map.

The study also discussed the overall karst geography of the Austin region, potential geologic and geographic barriers to karst invertebrate dispersal, and limits of species distribution. Veni and Associates (1992) originally proposed 10 karst geologic areas for Travis and Williamson Counties. USFWS (1994a) later modified the karst geologic areas into eight karst fauna regions (KFR) that serve as de facto recovery units for listed karst invertebrates: South Travis County, Rollingwood, Central Austin, and Jollyville in Travis County; and McNeil/Round Rock, Cedar Park, Georgetown, and North Williamson County in Williamson County.

Each delineated KFR was thought to be bound by geological and hydrological barriers to troglobitic species distribution as the concept was originally presented. However, subsequent studies have shown that the boundaries proposed for the KFRs do not correspond to the known species' boundaries (Cokendolpher 2004; Elliott 2004; Paquin and Hedin 2004, 2005; White et al. 2001). In addition, some species previously thought to be restricted to one KFR have been collected over several contiguous KFRs (see Paquin and Hedin 2004 for *Cicurina madla;* Ubick and Briggs 1992 for *T. reyesi*).

1.1.2 Karst Fauna Area Concept

The KFA concept was first proposed in the *Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas* (USFWS 1994a). KFAs were envisioned as a unit of occupied habitat protected for the benefit of listed troglobitic species recovery. According to the Recovery Plan (USFWS 1994a), a KFA is described as:

> *…an area known to support one or more locations of a listed species and is distinct in that it acts as a system that is separated from other karst fauna areas by geologic and hydrologic features and/or processes that create barriers to the movement of water, contaminants, and troglobitic fauna* (USFWS 1994a:76).
>
> *To be considered "protected", a karst fauna area should contain a large enough expanse of contiguous karst and surface area to maintain the integrity of the karst ecosystem on which each species depends. The size and configuration of each karst fauna area should be adequate to maintain moist, humid conditions, air flow, and stable temperatures in the air-filled voids; maintain an adequate nutrient supply; prevent contamination of surface and groundwater entering the ecosystem; prevent or control the invasion of exotic species, such as red imported fire ants; and allow for movement of the karst fauna and nutrients through the interstitial spaces between karst features* (USFWS 1994a:82).

Although the Recovery Plan (USFWS 1994a) indicates that three KFAs should be set aside for perpetual protection within each KFR for each listed species, it provides only the following general guidelines for determining what conditions constitute a KFA:

> *Karst fauna areas should be far enough apart so that if a catastrophic event (for example, contamination of the water supply, flooding, disease) were to destroy one of the areas and/or the species in it, that event would not likely destroy any other area occupied by that species.* (USFWS 1994a:76)

Other factors to consider when selecting KFAs include:

> *…the ability to ensure long-term protection, current level of habitat disturbance, past and present land use, presence of other rare or candidate species, ease of protection (landowner cooperation), and, where applicable, importance to the regional groundwater system*. (USFWS 1994a:80).

> *…the pattern and direction of groundwater movement, direction and area of surface and subsurface drainage, preservation of the surface community above and surrounding the cave, and the presence of other caves or karst features. In general, land bounded by the contour interval at the cave floor is the area within which contaminants moving over the surface or though karst could move toward the cave. Outside this contour, contaminants would move away from the cave.* (USFWS 1994a:82).

No specific criteria were provided in the Recovery Plan (USFWS 1994a) beyond these general guidelines. However, the (SWCA et al. 2008) indicates that minimum size for KFAs will be 40 acres where possible in order to protect the natural surface vegetation around a cave or cave cluster needed to support the cave ecosystem over the long term.

2 PRESERVE DESCRIPTIONS

2.1 Twin Springs Karst Fauna Area

2.1.1 Introduction

The Twin Springs KFA (Table 1) includes 172.2 acres located adjacent to U.S. Army Corps of Engineers (USACE) land on the north side of Lake Georgetown, west of Russell Park Road and south of the end of Twin Springs Road (Figure 2). It comprises three contiguous management areas acquired by the County between 2007 and 2009. The 12.2-acre Sunless City Cave Preserve was transferred to the County by the Texas Department of Transportation (TxDOT) in 2007 as a mitigation parcel established for the State Highway (SH) 45 project. The County acquired the adjacent 145 acres in 2008 that were not developed under the terms of the Russell Park Estates Environmental Assessment (EA)/Habitat Conservation Plan (HCP). The County also acquired management responsibility for an additional 15 acres of deed-restricted open space within the Russell Park Estates development through a 2009 agreement established between the County and the Russell Park Neighborhood Association. These three adjacent areas are managed collectively as the 172.2-acre Twin Springs KFA: with no management differences between the three tracts. Access points include gates adjacent to County Road (CR) 262 and at the cul-de-sac at the end of Twin Springs Road. The Twin Springs KFA is also a GCWA preserve and is known occupied by multiple territories during the breeding season.

The Twin Springs KFA is completely fenced and maintains appropriate signage to aid in trespassing prevention. However, the fence abutting the USACE land to the south of Twin Springs KFA is not in good shape; though trespassing from this location is unlikely to occur due to the remote nature of the neighboring tract. Few fence gaps currently exist on the southern property line; however, a planned development along this area has prompted that these gaps be fixed.

A Leave No Trace (LNT) awareness course with specific adaptations for Williamson County preserves is taught for those who wish to access the Twin Springs KFA. This 2-hour-long course provides the site-specific plan for the Twin Springs KFA and an overview of the LNT program. Attendees are provided a permit to Twin Springs KFA (and other Williamson County preserves) after completing the LNT coursework. The permit must be worn at all times while inside the KFA and human impacts are currently being monitored. The Twins Springs KFA is not closed during GCWA breeding season. The agreement between the WCCF and USFWS to designate Twin Springs as a KFA did not include language that would have prevented the public from utilizing trails for part of the year. No detectible impact to the Twin Springs KFA has been documented from visitor use.

Table 1. Basic Information for the Twin Springs KFA

Twin Springs KFA Information	
Preserve Inception Year	Acquired parcels between 2007-2009
Acreage	172.2
Fence Status	Fully fenced, with repairs needed between U.S. Army Corps of Engineers land
Sign Status	Signs posted around perimeter, warning signs on all cave gates
Baseline Vegetation Survey Date	2013
Owner	Williamson County
Gated Caves	Sunless City, Whitney West
Non-gated Caves	None

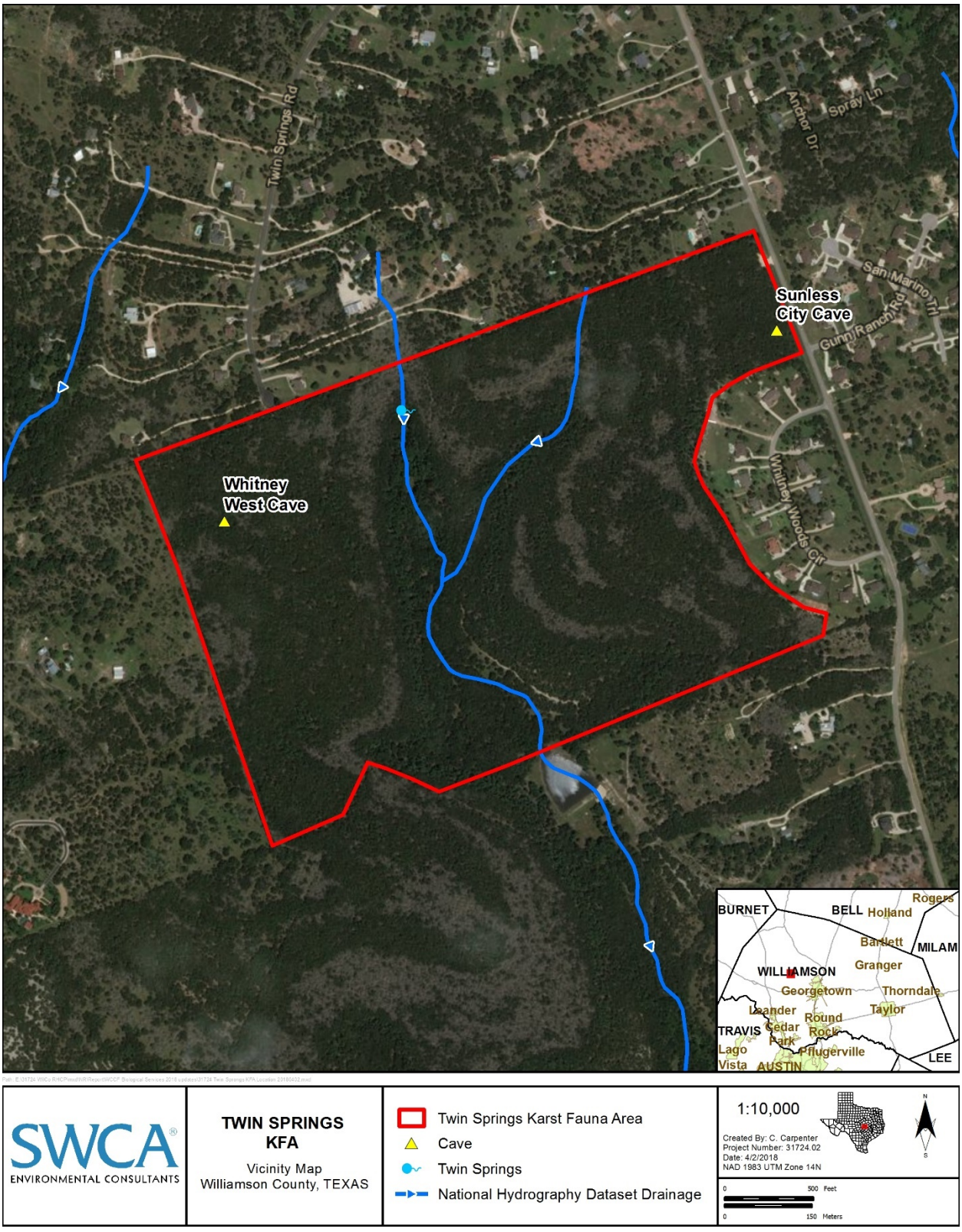


Figure 2. Twin Springs Karst Fauna Area (KFA) location map.

2.1.2 Hydrogeology

The Twin Springs KFA topography slopes from uplands in the northeast and northwest toward the south-central portion of the property to Taylor Ray Hollow, which drains to Lake Georgetown. Total relief on the Twin Springs KFA is approximately 140 feet, ranging from approximately 990 to 850 feet above mean sea level (amsl) (Figure 3). The Edwards Limestone is approximately 110 feet thick in the area of Twin Springs KFA. Local geology is almost entirely underlain by the Edwards limestone with the exception of the spring run and the lowest elevations along the southern preserve boundary, where the less-permeable Comanche Peak formation is exposed. The contact between these units, found generally at 880 feet amsl, provides a discharge point for the Edwards Aquifer known as Twin Springs (see Figure 3). However, recharge features on the property probably do not contribute water to the main body of the Edwards Aquifer because the hydraulic gradient between the uplands and the canyon bottom is far greater than that between the uplands and the base of the aquifer. Accordingly, recharging waters are more likely to discharge through seeps and springs near the contact between the Edwards and Comanche Peak formations (Jones 2003) as evidenced by discharge features within Twin Springs KFA.

The permanently flowing spring located in the western branch of Taylor Ray Hollow provides excellent habitat for the Georgetown salamander. Although discharge is variable, the spring has not been known to go dry, even in the 2008 and 2009 record-breaking drought. This indicates substantial interconnectivity with the main body of the Edwards Aquifer and a relatively large springshed area extending well beyond Twin Springs KFA boundaries. Based on the geomorphology of the local portion of the San Gabriel River drainage basin and the known locations of other springs in adjacent tributaries, the springshed may extend more than a mile to the northeast to Ranch-to-Market Road (RM) 2338, where the Georgetown limestone covers Edwards limestone along the drainage divide between the North Fork San Gabriel River and Berry Creek. Development in this area consists primarily of single-family homes on 2- to 5-acre lots. The relatively low impervious cover associated with this development style may have contributed to maintaining spring flow quality and quantity.

Groundwater conduits within the drainage network tend to develop greater degrees of connectivity and transport efficiency in response to the hydraulic gradient between the land surface and the base level as a karst system matures. Base level is roughly equivalent to the water table in porous media aquifers. Conduits in the vadose zone (above the saturated zone) tend to develop increasingly vertical morphologies as this occurs in response to the steep-to-vertical hydraulic gradient between the land surface and the base level. Conduits reaching base level tend to follow horizontal flow paths along the relatively shallow, commonly nearly flat, hydraulic gradient between the base level and the resurgence through which groundwater discharges at the surface. As Sunless City Cave and Whitney West Cave are part of a relatively mature karst system, it is likely that recharging waters travel along predominantly vertical pathways until encountering horizontal flow paths at the Edwards/Comanche Peak contact where they are routed toward springs above the North Fork San Gabriel River. Accordingly, recharge entering the caves likely originates primarily from strata directly above the cave footprint and secondarily through lateral seepage from a relatively restricted perimeter around the footprint. It appears, therefore, that events occurring outside of the KFA pose relatively little contamination risk for KFA caves.

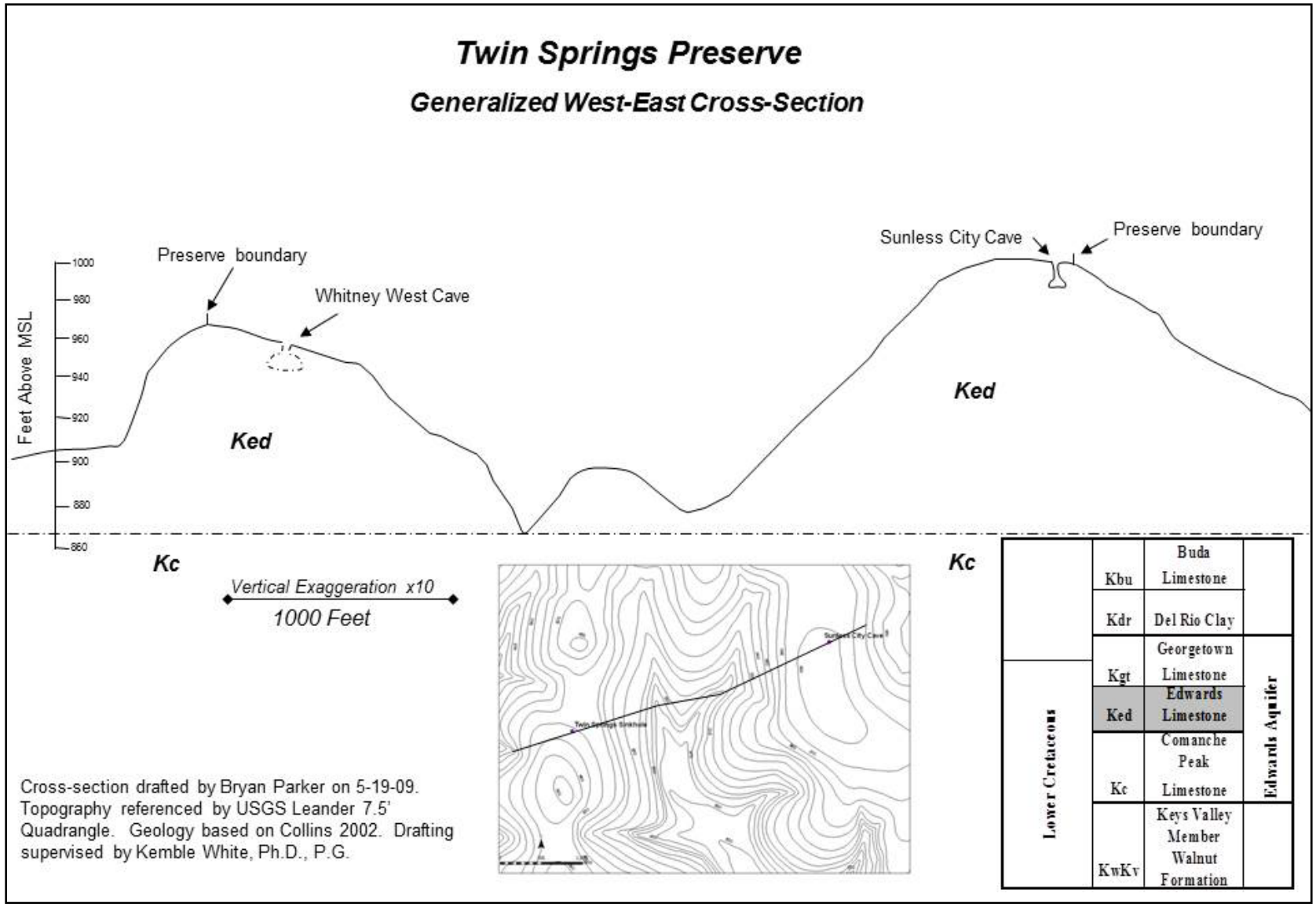


Figure 3. Twin Springs KFA geologic cross section.

2.1.3 Caves of the Twin Springs KFA

Cave maps are included within Appendix A.

The Twin Springs KFA contains high-quality habitat for GCWA, Georgetown salamander (*Eurycea naufragia*), and two listed karst invertebrates. Twin Springs KFA value is additionally enhanced by adjacency to undeveloped habitat around Lake Georgetown. The USACE manages the natural resources around Lake Georgetown in cooperation with Texas Parks and Wildlife Department (TPWD), the USFWS, and the Texas Forest Service. Two known caves (Whitney West and Sunless City) and several unexcavated karst features occur within the Twin Springs KFA. At least eight troglobitic species occur within the KFA including two federally endangered species: the Bone Cave harvestman and the Inner Space Caverns mold beetle (Table 2). Both caves are confirmed locations for the Bone Cave harvestman and *B. texanus* has been confirmed from Sunless City Cave and likely occurs in both caves. The WCCF assumes that Twin Springs KFA will be recognized as contributing to *Batrisodes texanus* long-term recovery if that species is detected within Whitney West Cave.

Sunless City Cave: Sunless City Cave was discovered during the planning process for the existing development along Whitney Woods Circle at the eastern preserve boundary. During excavation at the base of a nearly perfectly circular solution sinkhole, a vertical shaft was discovered dropping approximately 20 feet into a single open chamber (Photograph 1). Sparkling white speleothems on the opposite side of the main room from the entrance shaft had the appearance of a nighttime city skyline and inspired the name Sunless City (a play on words referencing the nearby Sun City Development). The stratigraphic location of the cave at the base of the Edwards Aquifer and the general morphology of the cave, including phreatic pressure doming preserved in the ceiling, indicate that Sunless City Cave was formed under phreatic conditions (below the water table) prior to the draining of the local portion of the northern segment of the Edwards Aquifer by the down-cutting of the San Gabriel River. Slowly circulating ground water gradually dissolved and removed relatively soluble limestone in the strata in which the cave is formed, creating void space. This most likely occurred preferentially along rock joints and other fractures which are currently visible in the cave walls and ceilings. As the water table dropped due to stream incision and general denudation of the land surface, Sunless City Cave became perched above the water table in the vadose zone. Subsequent collapse and modification by vertically infiltrating vadose waters have contributed to the current morphology of the cave and largely obscured additional clues as to the genesis of the cave. The current *high and dry* nature of caves within Twin Springs KFA is what causes them to be high-quality habitat for a diverse community of air-breathing terrestrial karst invertebrates. This cave is known to contain the Bone Cave harvestman and the Inner Space Caverns mold beetle. A cave gate currently prevents unauthorized access to this feature.

Photograph 1. Entrance to Sunless City Cave shortly after discovery.

Whitney West Cave: Whitney West Cave was discovered after a lengthy and difficult excavation guided by geophysical survey in the summer of 2008. A 25-foot-wide, but relatively shallow, collapsed sinkhole ringed by large plateau live oaks (*Quercus fusiformis*) indicated the presence of sub-surface void space, but the size of breakdown slabs within the sinkhole interior and the lack of an obvious drain left little clue as to which direction to focus excavation efforts. An electrical resistivity survey of the sinkhole indicated that void space was present and that the southern rim of the sink was most proximal to the void. Investigators discovered a fracture-controlled conduit that consistently blew cool air following approximately one month of excavation through dense fractured limestone, thick root mats, and soil. That conduit was widened into a crawlspace large enough to conduct a biological survey. After repeated efforts, the Bone Cave harvestman was discovered along with several other troglobitic species. The conduit still blows air from the great cave system at the far end of the crawl space. The crawlspace appears to be located above and adjacent to a much larger void space of unknown dimensions according to the geophysical survey profile. It is presumed that Whitney West Cave will be as biologically diverse as Sunless City Cave if it is decided to continue excavation efforts in order to allow access to the main cavern for biological surveys. A cave gate currently prevents unauthorized access to Whitney West Cave.

Table 2 shows documented species within the Twin Springs KFA.

Table 2. Species Documented from the Twin Springs KFA

Species		Sunless City Cave	Whitney West Cave
Permitted Species			
Texella reyesi		√	√
Batrisodes texanus		√	
Other Species			
Crickets	*Ceuthophilus cunicularis*	√	√
	Ceuthophilus secretus	√	√
	Ceuthophilus sp. B	√	√
Arachnids	*Cicurina varians*	√	√
	Cicurina vibora	√	√
	Tayshaneta sp.		√
	Achaearanea sp.		√
	Eidmanella sp.	√	√
	Leiobunum townsendii	√	√
	Pseudouroctonus reddelli	√	√
Millipedes/ Centipedes	*Speodesmus bicornourus*	√	√
	Cambala speobia	√	
	Scolopendra sp.	√	
	Lithobiomorpha	√	
	Scutigeridae (House Centipede)	√	
Beetles	*Rhadine subterranea*	√	
	Staphylinidae	√	
	Coleoptera		√
Reptiles/ Amphibians	*Eleutherodactylus marnockii*	√	√
	Incilius nebulifer	√	
Mammals	*Procyon lotor*		√
	Perimyotis subflavus	√	
	Myotis velifer	√	
Other	*Arenivaga noctivaga*	√	√
	Surface Isopod		√
	Surface caterpillar	√	
	Texoreddellia texensis	√	
	Collembola sp.	√	√
	Heliodiscus sp.	√	
	Assassin Bug		√
	Fly	√	
	Mosquito		√
	Gnat		√
	Annelids	√	

2.2 Beck Preserve

2.2.1 Introduction

The Beck Preserve (Table 3) is approximately 44.5 acres purchased by the WCCF with funds from an Endangered Species Act (ESA) Section 6 grant provided by the USFWS and administered by the TPWD. It is located in the City of Round Rock, southwest from RM 620 and Great Oaks Drive intersection (Figure 4). Beck Preserve is bounded to the west and south by Cedar Valley Middle School, to the north by Great Oaks Drive, and to the east by RM 620. The site includes seven caves and some have been studied for many years, including notable caves on the former Beck Ranch. Some of the first formal, scientific studies of Texas cave life were conducted on the Beck Ranch in the 1970s by Dr. Robert Mitchell of Texas Tech University. His studies indicate Beck Bat Cave, Beck Crevice Cave (which is now considered smaller feature within Beck Bat Cave), Beck Horse Cave, Beck Pride Cave, and Beck Tex-2 Cave are known to contain the Bone Cave harvestman. Two other caves, Beck Salamander Cave and Beck Creek Cave, are not known to contain endangered fauna but may be connected to the other caves. Each cave is considered an aquifer recharge feature. The Beck Preserve constitutes a potential KFA because of its size and relative distance between *Texella* occupied caves and surrounding development, as indicated within the RHCP (SWCA et al. 2008). However, the WCCF has not yet submitted an application to the USFWS as part of the process for recognition that the Beck Preserve is officially contributing to the Bone Cave harvestman's recovery as a KFA.

Table 3. Basic Information for the Beck Preserve

Beck Preserve Information	
Preserve Inception Year	2009
Acreage	44.5
Fence Status	Fence separates preserve from adjacent school. No other fence.
Sign Status	Warning signs on all cave gates
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Beck Tex-2, Beck Salamander, Beck Horse, Beck Bat, Beck Pride, Beck Creek and Beck Crevice Caves
Non-gated Caves	None

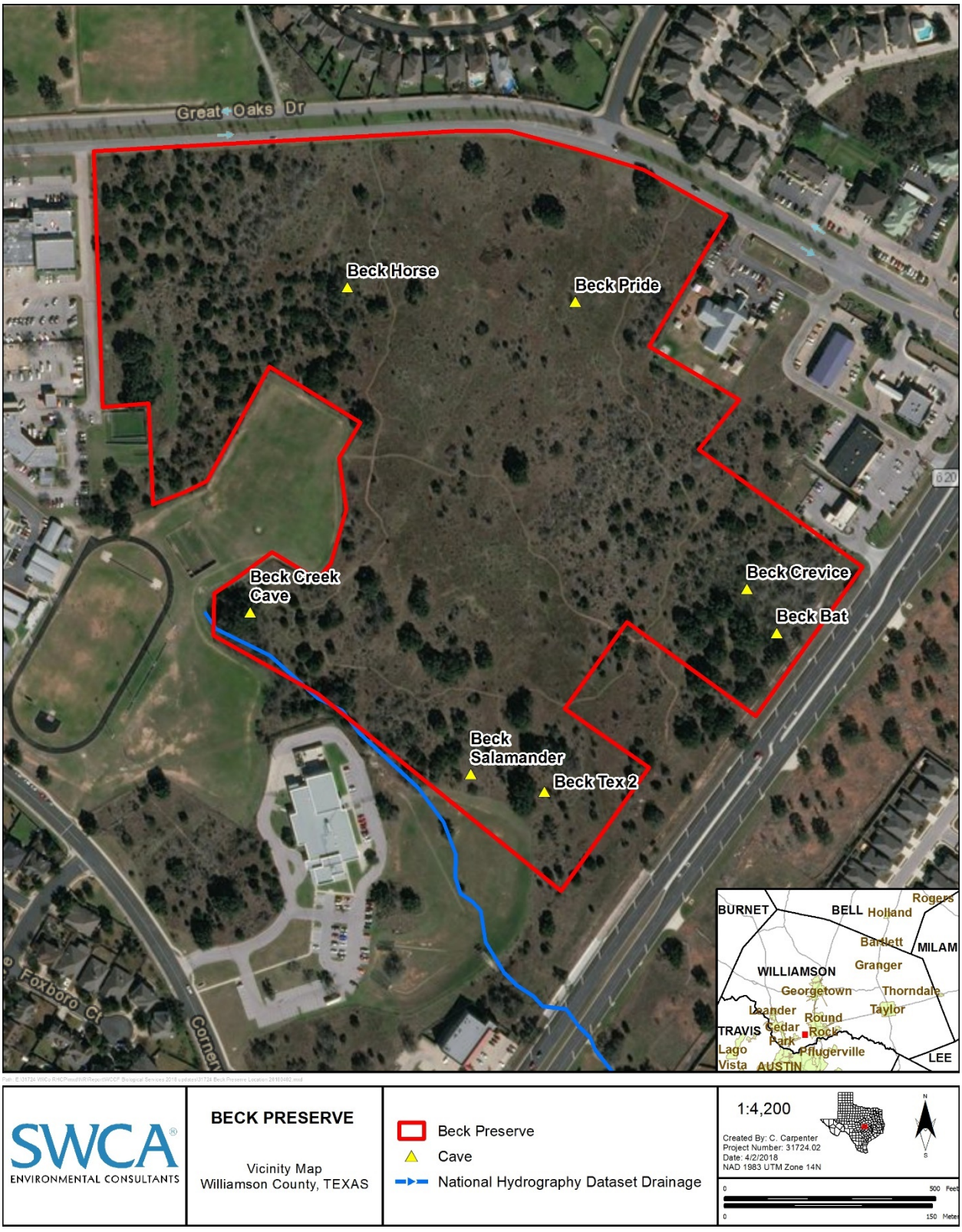


Figure 4. Beck Preserve location map.

The Beck Preserve is located at the southern end of one of the densest cave concentrations known within the Bone Cave harvestman range. Approximately 50 caves have been documented from an area measuring approximately 1.5 miles long north/south by 1 mile wide east/west. The Beck Preserve is adjacent to the Brushy Creek Municipal Utility District, which contains 13 additional caves on four nearly contiguous parcels beginning on the north side of Great Oaks Drive and stretching for a mile to the north beyond O'Connor Drive. Eight of those caves are confirmed to contain the Bone Cave harvestman. Approximately 500 feet northeast of the Beck Preserve between Great Oaks Drive and Scott and White Drive is an approximately 2-acre setback containing Vault and Imprint caves. Approximately 1,500 feet northeast of the Beck Preserve is a parcel containing Beck Sewer Cave and Beck Tin Can Cave maintained by the WCCF as the Beck Commons Preserve (Section 3.12). Immediately across RM 620 from Beck Preserve is the Highland Horizon tract, which contains 12 caves occupied by the Bone Cave harvestman plus several addition caves. Robinson Ranch contains several occupied caves approximately 0.5 mile east from Beck Preserve, and additional acreage on the ranch has not been surveyed for karst features. Some of these caves are potentially connected to caves within Beck Preserve, at least from an invertebrate's point of view. Although this potential is difficult to quantify, it appears to be greatest at the following locations: Jackhammer Cave,[2] which is located partially under RM 620 approximately 275 feet from Beck Tex-2 Cave; Trouser Press Cave, which is located adjacent to RM 620 approximately 490 feet from Beck Tex-2 Cave; and Anteater's Delight[3] Cave, which is located immediately adjacent to the east side of RM 620 less than 200 feet from the edge of the footprint of Beck Bat Cave.

The Beck Preserve currently maintains a fence separating it from the adjacent Cedar Valley Middle School. All other portions remain unfenced; however, staff from the middle school maintain a constant presence to prevent truant students from bypassing the existing fence and accessing Beck Preserve. Additionally, Beck Tex-2, Beck Salamander, Beck Horse, Beck Bat, Beck Pride and Beck Crevice Caves all have cave gates blocking access to their respective caves.

2.2.2 Hydrogeology

The Beck Preserve is located entirely within the Edwards Aquifer Recharge Zone (EARZ) (Figure 5). Based on regional trends, the direction of groundwater flow from Beck Preserve is likely the northeast. Recharge from Beck Preserve likely contributes baseflow to Brushy Creek, but no formal study has been conducted.

[2] Jackhammer Cave was sealed as result of RM 620 expansion and was a confirmed *Texella reyesi* locality.

[3] Anteater's Delight was sealed as a result of development activity and was not a known *Texella reyesi* locality.

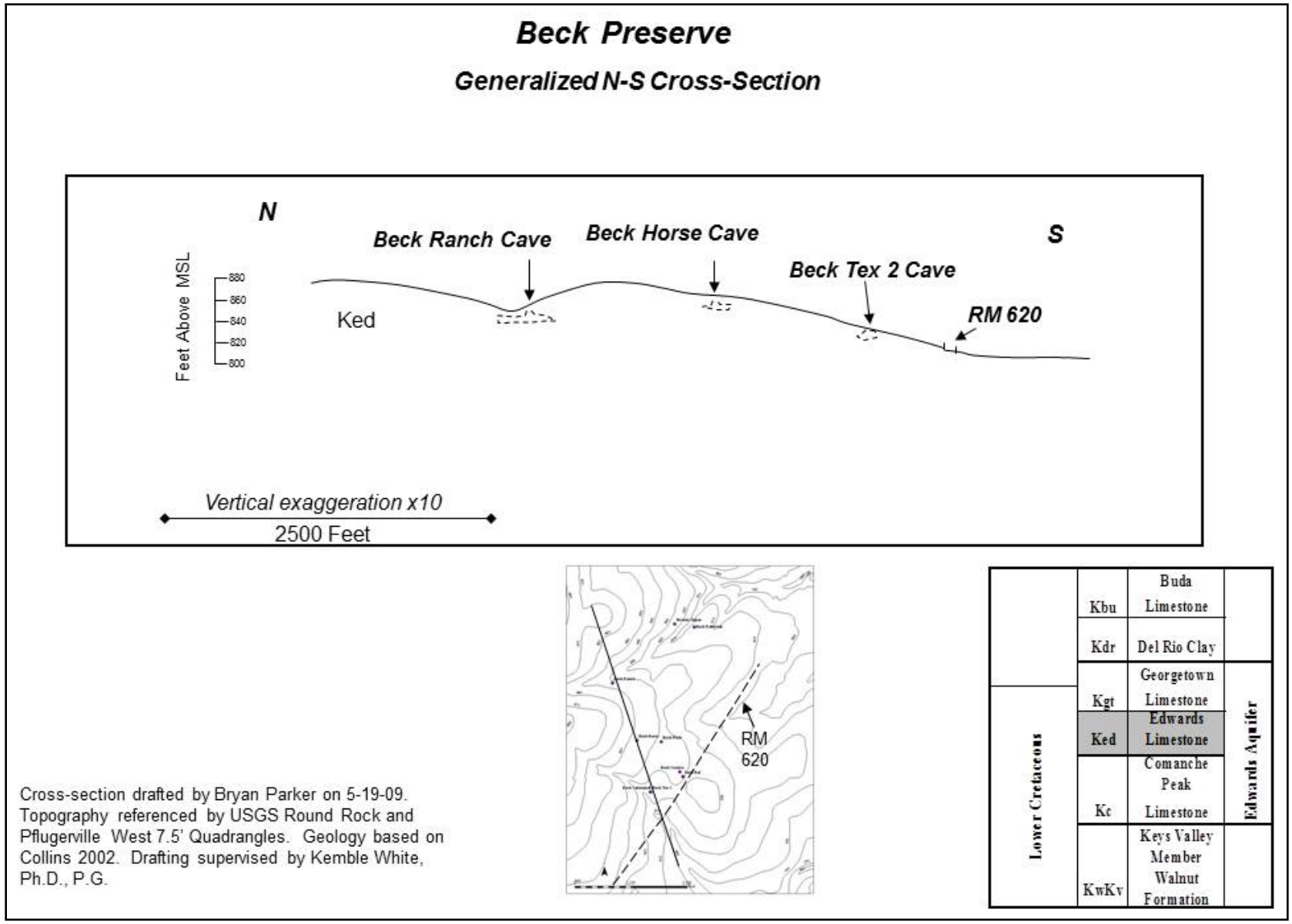


Figure 5. Beck Preserve geology.

2.2.3 Caves of the Beck Preserve

Cave maps are included within Appendix B.

Beck Bat Cave: Beck Bat Cave is the most notable feature on the site with records kept by cave explorers as early as the 1950s (Photograph 2). Beck Bat Cave contained a colony of "Mexican brown bats" (*Myotis velifer*, now known as cave myotis) as recently as 1989, but disturbance from human visitation prior to preserve acquisition and cave gate installation caused them to relocate. The cave entrance measures approximately 8 feet in diameter, sloping to the north beneath a ledge of bedrock. The cave primarily consists of a single large, wide room, divided into two main areas by a sizable ceiling collapse. Two small, lower-level rooms are at the northern extent of the cave. The cave dimensions measure approximately 163 feet long by 91 feet wide, with a maximum depth of 22 feet. This cave is known to contain the Bone Cave harvestman (Table 4). A blind *Batrisodes* was located during the 2017 annual biota survey, which is a finding with potentially significant conservation implications. Dr. Donald S. Chandler at the University of New Hampshire determined this species is *Batrisodes reyesi*, which represents a significant range expansion to the east for the species. A cave gate currently prevents unauthorized access to this feature.

Photograph 2. Beck Bat Cave entrance.

Beck Crevice Cave: Beck Crevice Cave is approximately 100 feet from the entrance of Beck Bat Cave and two features share structural connection. The cave entrance drops 5 feet into a low bedding plane room that extends for approximately 30 feet towards Beck Bat Cave. The passage is formed along a rock joint trending approximately N40E. The footprint of the cave measures approximately 22 feet wide by 38 feet long, with a maximum depth of 18.2 feet. This cave is known to contain the Bone Cave harvestman (see Table 4) but is no longer monitored due to its small size and connectivity with the larger, Beck Bat Cave.

Beck Horse Cave: The Beck Horse Cave entrance is approximately 10 feet in diameter, sloping beneath the north headwall into a large room (Photograph 3). The cave is formed along a rock joint trending N21E. This cave is known to contain the Bone Cave harvestman (see Table 4). A cave gate currently prevents unauthorized access to this feature.

Photograph 3. Beck Horse Cave entrance.

Beck Pride Cave: Beck Pride Cave is Beck Preserve's most biologically diverse cave. The cave entrance drops approximately 15 feet to the main room, which was formed along a rock joint trending approximately N16E. The cave contains upper-, mid-, and lower-level extents, all controlled along this same rock joint. The main passage extends to the north mainly as a walking size passage until it pinches off at a low bedding plane. The cave also extends to the south along the mid-level as a low, wide bedding plane passage. This cave is known to contain the Bone Cave harvestman (see Table 4). A cave gate currently prevents unauthorized access to this feature.

Beck Tex-2 Cave: Beck Tex-2 Cave is very shallowly developed, with a bedding plane level beginning at 3 feet below the ground surface that slopes down to the west (Photograph 4). The surveyed length of the cave is 69.6 feet. The cave footprint measures approximately 20 feet wide by 32 feet long, with a maximum depth of 10.6 feet. This cave is known to contain the Bone Cave harvestman (see Table 4). A cave gate currently prevents unauthorized access to this feature.

Photograph 4. Beck Tex-2 Cave entrance.

Beck Salamander Cave: The Beck Salamander Cave entrance drops vertically into an enlarged rock joint trending N30E (Photograph 5). The cave measures approximately 11.4 feet long, with a maximum depth of 12.1 feet. This cave is not currently known to contain any endangered karst invertebrates (see Table 4). A cave gate currently prevents unauthorized access to this feature.

Photograph 5. Beck Salamander Cave entrance.

Beck Creek Cave: The Beck Creek Cave entrance headwall resembles that of Beck Bat Cave and Beck Horse Cave; however, the passage is completely blocked by massive in-filled rocks and sediments. The cave was backfilled with the use of a dozer in the past, and an attempt to re-open the cave was unsuccessful. This cave is not currently known to contain any endangered karst invertebrates (see Table 4). A cave gate currently prevents unauthorized access to this feature, though this cave is not currently surveyed for karst biota.

Table 4 shows documented species within the Beck Preserve.

Table 4. Species Documented from the Beck Preserve

Species		Beck Bat Cave	Beck Pride Cave	Beck Horse Cave	Beck Crevice Cave	Beck Tex-2 Cave	Beck Salamander Cave	Beck Creek Cave
Permitted Species								
Texella reyesi		√	√	√	√	√		
Other Species								
Crickets	*Ceuthophilus* sp.	√	√	√	√	√	√	√
Arachnids	*Cicurina varians*	√	√	√	√	√		
	Cicurina buwata	√	√	√	√	√		
	Tayshaneta sp.	√						
	Eperigone albula	√						
	Anapistula sp.	√		√				
	Agyneta llanoensis	√						
	Araneae	√	√	√	√	√	√	√
	Eidmannella sp.	√		√				
	Achaearanea sp.				√	√		
	Pseudouroctonus reddelli	√						
	Lechytia sp.			√				
	Pseudoscorpion	√	√					
Millipedes/ Centipedes	*Speodesmus bicornourus*	√	√	√			√	
	Cambala speobia	√	√	√	√	√		
	Oxidus gracilis			√	√			
	Myrmecodesmus sp.		√					
	Scolopendra sp.		√				√	
	Scutigeridae	√	√			√		
Beetles	*Rhadine subterranea*	√	√	√				
	Coleoptera	√			√		√	
	Staphylinidae	√		√	√		√	√
	Anillinus sp.	√						

Species		Beck Bat Cave	Beck Pride Cave	Beck Horse Cave	Beck Crevice Cave	Beck Tex-2 Cave	Beck Salamander Cave	Beck Creek Cave
	Eustilicus condei	√						
	Biblioplectus sp. nr. ruficeps			√				
	Batrisodes uncicornis	√	√	√	√	√		
	Batrisodes reyesi	√						
	Tachys ferrugineus	√						
	Tachyini							√
Reptiles/ Amphibians	*Plethodon albagula*						√	
	Eleutherodactylus marnockii	√	√	√				
Mammals	*Perimyotis subflavus*	√	√	√		√	√	
	Myotis velifer	√		√				
	Mouse			√				
	Procyon lotor		√					
Other	Desert Cockroach		√					
	Blattaria							√
	Collembola sp.	√	√	√	√	√	√	√
	Isopod (pillbug)	√	√	√	√	√		√
	Earthworm							√
	Gastropoda (Slugs/Snails)	√	√	√		√	√	√
	Formicidae			√	√			
	Solenopsis invicta	√	√	√		√	√	√
	Lepidoptera	√		√				
	Psocoptera			√				
	Thysanoptera			√				
	Hymenoptera					√		
	Flea	√					√	
	Fly			√		√	√	
	Gnat	√					√	
	Mite	√	√		√			√
	Mosquito						√	
	Streblidae	√						
	Diptera	√		√				
	Helicodiscus sp.	√	√	√		√	√	

2.3 Cobbs Cavern Karst Fauna Area

2.3.1 Introduction

The Cobbs Ranch comprises approximately 1,670 acres and is approximately 5 miles northwest from the City of Georgetown (Figure 6). The WCCF received a Recovery Land Acquisition grant through the Cooperative Endangered Species Conservation Fund and authorized by Section 6 of the ESA, to provide 75% of the cost to purchase a conservation easement. The federal grant required a 25% local match, which was donated by the Lyda Family Trust as land. The grant was awarded to the County in September 2005. The County executed a conservation easement contract with the Lyda Family Trust to establish the 64.4-acre conservation easement in November 2006. The WCCF was awarded additional Section 6 funds in 2011, which were used to acquire the conservation easement for an additional 98 acres surrounding the entire Cobbs Cavern footprint. This acquisition completed the approximately 163.0-acre Cobbs Cavern KFA (Table 5), which was approved by the USFWS in October 2011. The ranch consists of live oak-juniper savanna on gently rolling uplands drained generally to the east by the Cobbs Spring branch and other tributaries to Berry Creek. The property is located within the northern Balcones Fault Zone (BFZ) and within the northern segment of the EARZ.

The spring system that created the extensive cavern system created a multitude of ecological niches inhabited by some of the rarest, most unique, and endangered organisms in Texas. Cobbs Cavern is one of the 30 longest caves in the state, with over 4,500 feet of passage, all of which is located within the conservation easement. It is home to at least six species of rare and endangered terrestrial karst invertebrates, including two covered species and four additional species as listed in the RHCP (Table 6). The conservation easement contains a significant portion of the springshed for Cobbs Spring, which is known to contain a population of the Georgetown salamander (Figure 7).

Table 5. Basic Information for the Cobbs Cavern KFA

Cobbs Cavern KFA Information	
Preserve Inception Year	Acquired easements 2006, 2011
Acreage	163.0
Fence Status	None- However, the greater ranch is fenced
Sign Status	None- Private property
Baseline Vegetation Survey Date	2013
Owner	Easement- Lyda Family Trust
Gated Caves	Cobbs Cavern
Non-gated Caves	None

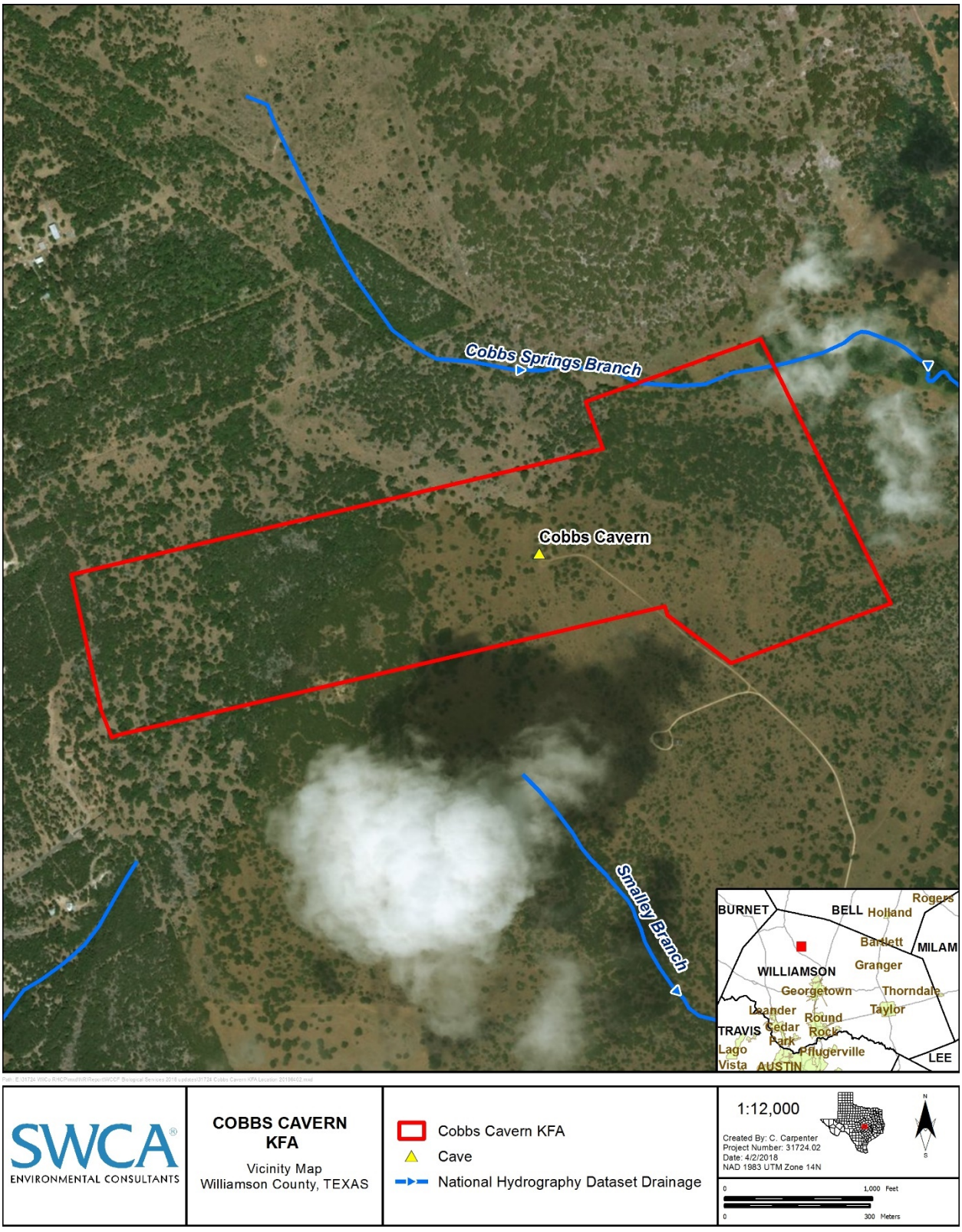


Figure 6. Cobbs Cavern KFA map showing Cobbs Spring and documented karst features.

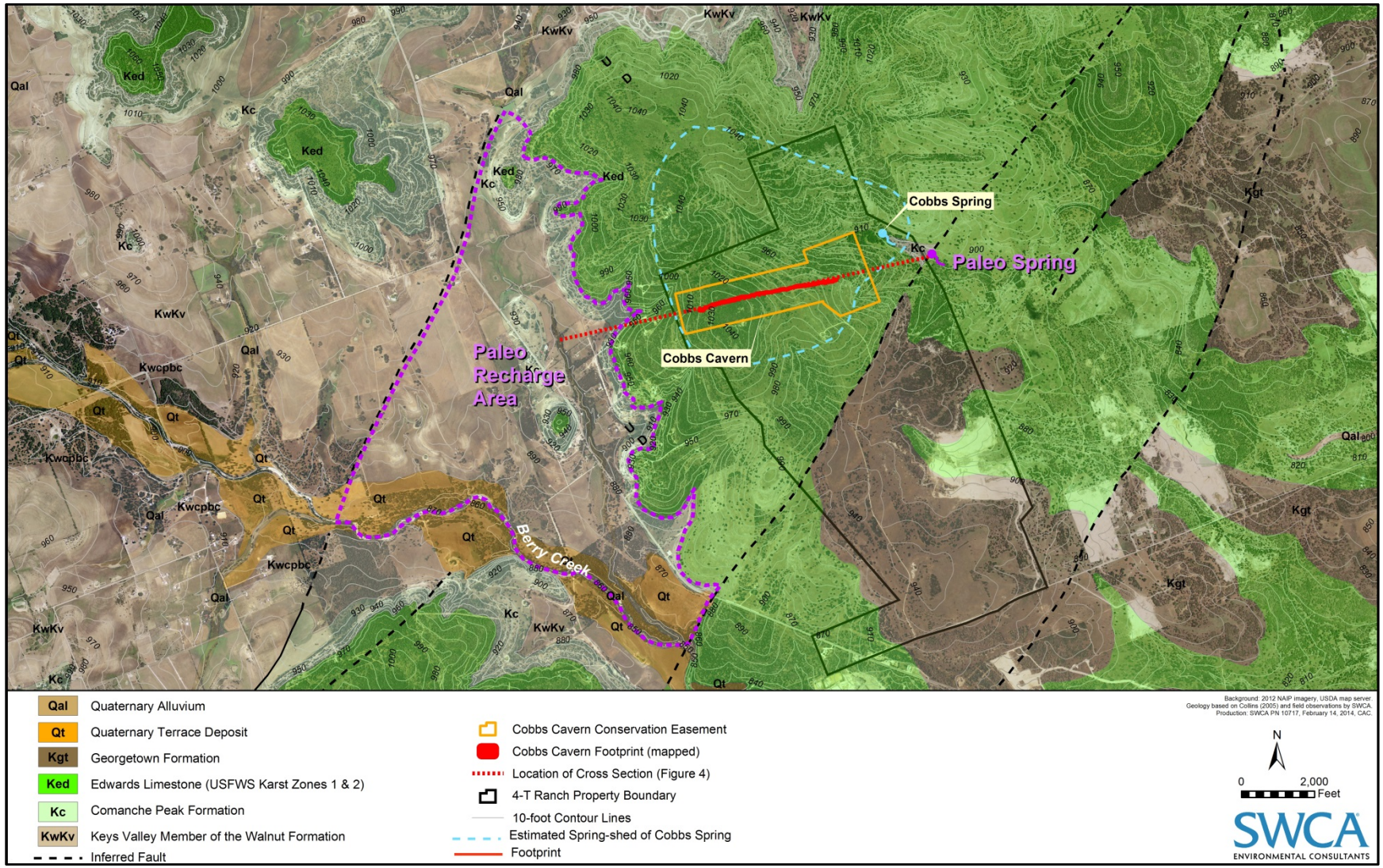


Figure 7. Cobbs Ranch geology and idealized springshed hydrology for Cobbs Spring.

Certain activities were mandated by the final conditions of the Cobbs Cavern KFA agreement. Although the 163-acre KFA is not currently fenced, most of the 1,670-acre Cobbs Ranch that surrounds it is fenced. The remote location of the Cobbs Ranch and metal gating on the entrances to Cobbs Cavern helps minimize trespassing potential. Livestock no longer have access to the KFA. A rock wall near the cave entrance that required modification has been replaced by a French drain and the area has been revegetated with native grasses. A roof extension that was covering the main entrance to the cave has been removed to allow more natural movement of air and rainfall access to the cave entrance. However, the roof removal has allowed increased air circulation at the cave entrance and troglobitic species have moved farther back into the feature recesses to avoid surface climate conditions. Finally, a spill plan and secondary containment unit related to a Pedernales Electric Cooperative (PEC) transformer has not been implemented. Repeated contact with the PEC has resulted in an agreement that the unit will be removed, however the company has not actually done so. Due to the fact that the transformer is not electrified, contains no polychlorinated biphenyls (PCBs), sits at ground level, and is over 1.75 miles from the main entrance to Cobbs Cavern, contamination from the transformer is unlikely.

2.3.2 Hydrogeology

Cobbs Cavern and Cobbs Spring are part of an integrated karst hydrologic system contained within the discrete section of Edwards limestone defined by the fault, which passes approximately 1,800 feet southeast of the spring outlet and erosional removal of the Edwards by tributaries of Salado and Berry Creeks to the northwest of the fault (see Figure 7). The maximum theoretical springshed consists of all rocks that are higher than the stratigraphic position and elevation of the spring due to the unconfined nature of the aquifer. However, in the area surrounding the property, there are numerous incisions into the Edwards outcrop formed by drainages other than Cobbs Springs Branch. It is a predictable regional pattern that significant incision into the Edwards outcrop form groundwater discharge points at the Edwards/ Comanche Peak contact, ranging from very low flow seeps supporting slightly more luxuriant vegetation than surrounding areas to permanent springs such as Cobbs Spring. Twelve permanent springs (including several other Georgetown salamander locations) and numerous seeps occur along this lithologic contact within a 10-mile radius of the property. These additional discharge points constrain the boundaries of the actual recharge area that contributes to Cobbs Spring and were subtracted from the idealized springshed shown in Figure 7. A geologic map property was produced from geologic maps compiled at the University of Texas Bureau of Economic Geology and on-site field mapping by SWCA (see Figure 7).

Figure 8 presents a cross-sectional illustration of the hydrologic mechanism behind the spring flow. The Comanche Peak is a relatively impermeable unit that perches groundwater working its way down through the overlying Edwards limestone. Groundwater moves laterally along the contact between the two units and downhill (the fault block upon which the recharge area sits is tilting toward the southeast at about 40 feet per mile) until it finds daylight, where the down cutting of Cobbs Springs Branch exposes the Comanche Peak. Spring flow was probably initiated when the bed of Cobbs Springs Branch intersected the Comanche Peak along the fault plane, which is approximately 1,800 feet downstream from the current spring outlet (see Figure 8).

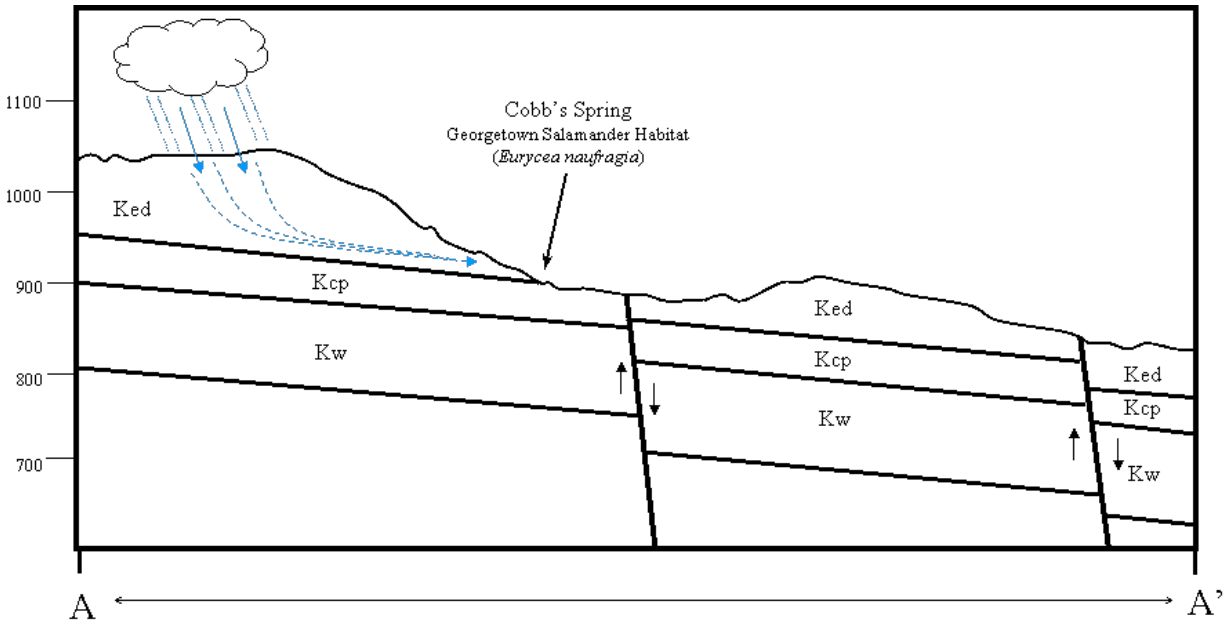


Figure 8. Cobbs Spring cross-sectional representation showing hydrologic mechanism behind spring flow.

Headward erosion has caused the spring outlet to gradually move upstream. This is evidenced by the trend of Cobbs Cavern itself. Extending the linear trend of the cavern along its bearing to the northeast produces a line pointing directly to the intersection of the fault plane with the current spring run. The cave, therefore, appears to be a paleo-channel pointing to the location of the paleo-spring outlet. Based on the above understanding of site hydrology, the springshed of Cobbs Spring is approximately 750 acres, with approximately 16% of the springshed occurring within the boundaries of the current conservation easement.

2.3.3 Caves of the Cobbs Cavern KFA

Cave maps are included within Appendix C.

Cobbs Cavern: Cobbs Cavern can be thought of as two caves within one. Cobbs Cavern's eastern third was operated on a limited basis as a show cave in the late 1960s and early 1970s (Photograph 6). The "Show Side" has been made easily traversable with a wide walking path in the cave's center. Visitors have to stoop in a few places, but the cave is otherwise very easy to move through with no tight squeezes or areas that require crawling. Public access to the cave has been restricted since that time, but the old visitor center building remains. The western two-thirds of Cobbs Cavern is called the "Wild Side" and is in a natural state with difficult to travel terrain and muddy, tight squeezes not suitable for novice cave exploration. The Bone Cave harvestman and the Inner Space Caverns mold beetle are known from Cobbs Cavern. A cave gate currently prevents unauthorized access to this feature.

Despite concerns about the potential effects of entrance modification and trail construction associated with tourism activities, the invertebrate fauna of the cave remains quite diverse. Aside from the rare species listed above, the cave community also includes at least two species of *Ceuthophilus* cave crickets, *Cambala* millipedes, *Texoreddellia* silverfish, *Pseudouroctonus* scorpions, *Eidmannella* spiders, *Collembola* (springtails), and mites. Cobbs Cavern is one of the 30 longest caves of more than 6,000 caves in Texas. Cobbs Cavern and associated non-navigable void network is one of the single largest habitats known for endangered karst invertebrates in the State.

Two karst feature excavations west of the mapped end of the cave have revealed troglobitic *Cicurina* spiders and *Speodesmus* millipedes. This indicates that the Cobbs Cavern habitat extends at least 1,000 feet beyond the mapped passage and that additional loci of nutrient input occur in addition to the known entrances at either end of the former tourist trail.

A wildfire burned across most of the conservation easement during the summer of 2008, creating several opportunities for additional investigation. Several significant karst features that were previously hidden by dense brush were located, including an old entrance to the cave and several sinkholes indicating additional passage (and troglobite habitat) beyond the cave's eastern-mapped end during a site inspection following the fire. Shrubby vegetation regrowth following the fire may lead to BCVI habitat creation and potential occupation. Migrating BCVI were sighted on the ranch in 2004.

Photograph 6. Photograph of the interior of Cobbs Cavern.

Cobbs Cavern KFA protection is significant to covered karst invertebrate species recovery and additional species conservation due to likely genetic distinctiveness. Cobbs Cavern is the northern-most documented location for the Bone Cave harvestman (*Texella reyesi*) and several additional troglobites (Photographs 7–12). It is also notable as the first known location for the species *Tayshaneta anopica* (Photograph 13). This spider lacks eyes entirely (as the scientific name suggests) and is considered a very advanced troglobite. Two of its close relatives (*Tayshaneta microps* from Bexar County and *T. myopica* from

Travis/Williamson County) are listed as endangered but are not as advanced in their troglomorphy, as they have eyes of reduced size.

In January 2005, SWCA conducted a cursory analysis of the likely drainage area that contributes water to Cobbs Spring to determine how much area would be preserved by conservation bank establishment. SWCA estimated the springshed area using several local geologic parameters. The property's lithological outcrops are Cretaceous in age and consist of the Georgetown limestone, Edwards limestone, and a previously unmapped outcrop of the Comanche Peak limestone (see Figure 7). The Georgetown and Edwards limestones are relatively transmissive units that form an unconfined karstic aquifer perched above the Comanche Peak limestone, which does not support easy movement of groundwater due to higher marl content. One normal fault crosses the property and produces an abrupt change in surface lithology from the Edwards limestone on the up-thrown block to the Georgetown Limestone on the down-thrown block (see Figures 7 and 8). Table 6 shows documented species within Cobbs Cavern.

Photograph 7. Bone Cave harvestman close up in Cobbs Cavern.

Photograph 8. *Batrisodes texanus* next to gloves in Cobbs Cavern.

Photograph 9. *Cicurina vibora* consuming Ceuthophilus cricket.

Photograph 10. *Speodesmus bicornourus* in Cobbs Cavern.

Photograph 11. *Cicurina vibora* collected in Cobbs Cavern.

Photograph 12. *Eurycea* salamander at Cobbs Spring.

Photograph 13. *Tayshaneta anopica* collected in Cobbs Cavern.

Table 6. Species Documented from the Cobbs Cavern KFA

Species		Cobbs Cavern
Permitted Species		
Texella reyesi		√
Batrisodes texanus		√
Other Species		
Crickets	*Ceuthophilus* sp.	√
Arachnids	*Cicurina varians*	√
	Cicurina vibora	√
	Anipistula sp.	√
	Tayshaneta anopica	√
	Eidmannella sp.	√
	Achaearanea sp.	√
	Pseudouroctonus reddelli	√
	Pseudoscorpion	√
Millipedes/ Centipedes	*Speodesmus bicornourus*	√
	Cambala speobia	√
	Geophilomorpha	√
	Scutigeridae	√
	Oxidus gracilis	√
	Scolopendra sp.	√
Beetles	Staphylinidae	√
	Rhadine noctivaga	√
Reptiles/ Amphibians	*Eleutherodactylus marnockii*	√
	Crotalus atrox	√
Mammals	*Bassariscus astutus*	√
	Procyon lotor	√
	Perimyotis subflavus	√
	Myotis velifer	√
Other	Isopod	√
	Texoreddellia aquilonalis	√
	Gnats	√
	Collembola sp.	√
	Heliodiscus sp.	√
	Gastropoda	√

2.4 Millennium Preserve

2.4.1 Introduction

Williamson County purchased the approximately 800-acre Southwest Williamson County Regional Park (Regional Park) in 2002 with County bond money supplemented by funding from TxDOT. The Regional Park is located northeast of the intersection of Farm-to-Market Road (FM) 1431 and CR 175 near Leander, Texas, and encompasses the Wilco and Millennium Preserves (Table 7). The Regional Park's developed portion contains recreational facilities including ball fields, tennis courts, a track, disc golf course, and miniature train track. Most Regional Park acreage is open space, including two dedicated preserves for the Bone Cave harvestman and additional species. Other caves occur in open space outside of the karst preserves. The Regional Park occurs within the Georgetown KFR and its two preserves were identified by the USFWS as a potential KFA in the 5-year review of Bone Cave harvestman (USFWS 2018b). The Regional Park occurs adjacent to areas identified in the RHCP (SWCA et al. 2008) as potential habitat for the GCWA, and woodland within the park may become suitable for GCWAs over time. The WCCF headquarters is located within the Regional Park and maintenance staff are able to visit cave entrances on a regular basis.

An undefined portion of the park is recognized by the USFWS as a karst conservation area, as shown in Table 3-1 of the RHCP. The County received funding from TxDOT in conjunction with the SH 45 Section 7 ESA consultation. These funds contributed to the 129-acre preserve land establishment to protect the ecological integrity of four high-quality caves within the park.

The Regional Park is geologically representative of a broader, highly cavernous area within the northern segment of the EARZ. This cavernous area contains dozens of caves and stretches for approximately 1.5 miles to the south and east. The Regional Park consists primarily of broad, flat uplands drained to the south by Brushy Creek tributaries. Total relief is approximately 60 feet, ranging from 870 to 935 feet amsl.

Table 7. Basic Information for the Millennium Preserve

Millennium Preserve Information	
Preserve Inception Year	2002
Acreage	74.4
Fence Status	Open-ended fences surround species caves
Sign Status	Signs posted on fences, warning signs on all cave gates
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Through Trip, Little Demon, Millennium, Fence and Trail
Non-gated Caves	Knuckle, Cap, Forest Elms Sink

Mike Warton and Associates (2000) and Horizon Environmental Services (2002) collectively described 39 features including caves, sinkholes, solution cavities, and fracture zones within the Regional Park. All features in the park are formed in the Edwards limestone, which is approximately 80 feet thick in the area. The surface expression of caves and other karst features is found generally, but not exclusively, above 900 feet in elevation, and karst features are rarely expressed within a 1,600-foot-wide zone coincident with the primary drainage channel running northwest to southeast through the undeveloped portion of the Regional Park. Two distinct karst areas are divided by this zone: The Millennium Preserve includes Millennium, Little Demon and Through Trip Caves (plus four other minor caves); whereas the Wilco Preserve contains Wilco, Wild West, Rock Ridge, and Mongo Caves (plus nine other minor caves or karst features). Figure 9 shows both the Millennium and Wilco Preserves in cross section to demonstrate the geologic separation between them.

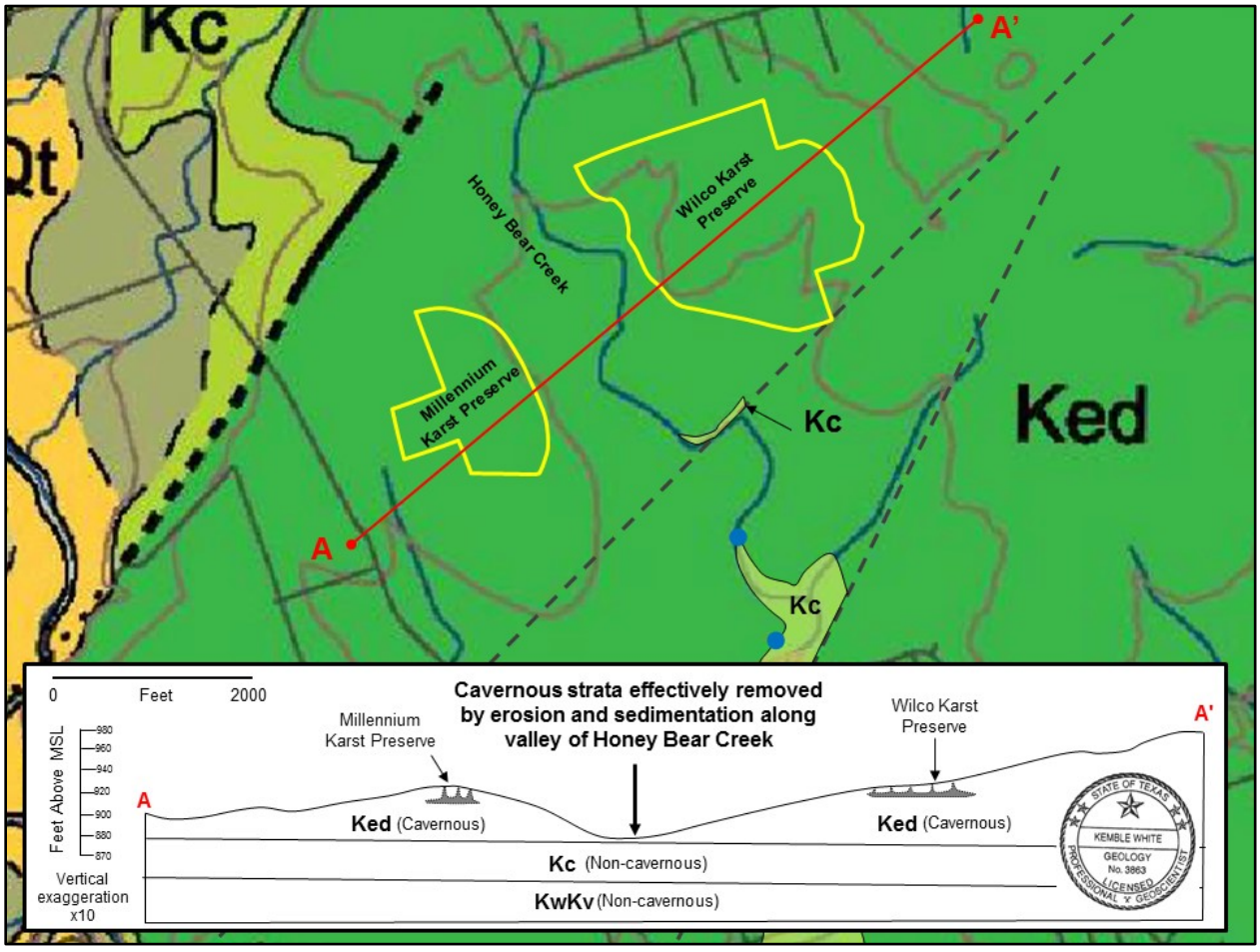


Figure 9. Geologic cross section across Millennium and Wilco Preserves highlighting karst erosion by Honey Bear Creek.

The 74.43-acre Millennium Preserve maintains fences containing appropriate signage strategic placed to direct the public away from the many of the caves. However, the fences are open-ended and this is a popular location with many trails designed for public-access hiking. A publicly accessible hike and bike pathway extends through Beck Preserve's western side but does not pass within either the drainage or ecological buffers established for the occupied caves. Cave gates prevent access to Millennium, Little Demon and Through Trip Caves. Figure 10 shows the Millennium Preserve and associated caves.

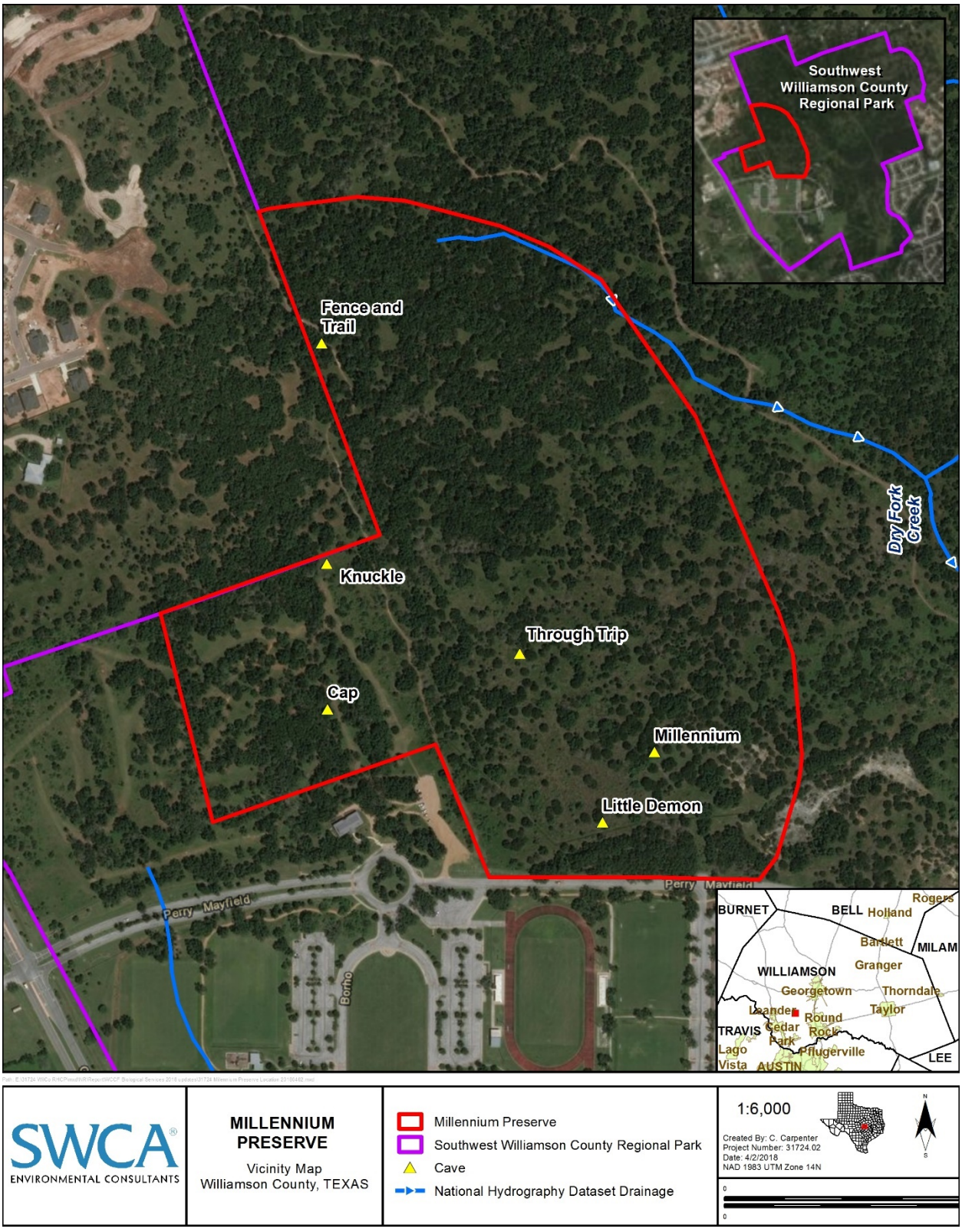


Figure 10. Millennium Preserve map showing documented caves.

2.4.2 Hydrogeology

Caves within the Millennium Preserve occur on the northeastern flank of a subtle southeast-trending ridge. Millennium Preserve slopes generally to the northeast contributing runoff to the Honey Bear Creek drainage basin, which is a tributary of Brushy Creek. Total relief on Millennium Preserve is approximately 40 feet ranging from 890 to 930 feet amsl. Most of the cave entrances are formed between 920 and 925 feet amsl and most traversable cave passage occurs between 905 and 925 feet amsl (Figure 11). Cave distribution suggests the presence of a well-developed, stratigraphically controlled dissolution zone that likely extends somewhat continuously beneath the ridge. This karstic horizon within the bedrock likely provides mesocavern habitat between the occupied caves and likely beyond.

The Millennium Preserve is entirely underlain by the Edwards limestone, which is the primary cavernous bedrock unit in the region (see Figure 11). The Millennium Preserve is on the EARZ's northern segment and groundwater recharge primarily occurs where the Edwards limestone is exposed at the surface through direct infiltration of precipitation on the limestone outcrop, through streamflow loss, and through secondary porosity features such as faults, fractures, and karst features (caves, solution cavities, sinkholes, etc.). The relatively flat terrain within Millennium Preserve is conducive to slow runoff, which enhances the potential for aquifer recharge. Groundwater perches at the base of the Edwards limestone where the underlying Comanche Peak acts as an aquitard and diverts flow laterally.

No faults are known to occur within the Millennium preserve, although fractures are expressed within all caves. A previously mapped fault passes approximately 0.5-mile northwest from the Millennium Preserve (Collins 2005). Field mapping by Cambrian personnel indicates the presence of at least two previously unmapped faults southeast from the Millennium Preserve.

The Edwards limestone is approximately 85 feet thick within the Millennium Preserve (Collins 2005; Senger et al. 1990). The Edwards limestone is near its full thickness at the Millennium Preserve's highest topography and is nearly breached along Honey Bear Creek (see Figures 9 and 10). It is this near breach of cavernous strata that provides an isolating mechanism between the Millennium and Wilco Preserves. The Honey Bear Creek basin follows an approximately 1,500-foot-wide erosion corridor karst feature strata is generally absent. Field mapping indicates the Edwards limestone is only 5 feet thick within the basin's southern end and not more than 15 feet thick at the northern end of the corridor. The Edwards limestone pinches out altogether immediately south from the Millennium Preserve and groundwater can be observed discharging from several seeps along Honey Creek at the contact with the underlying Comanche Peak formation. The thin Edwards limestone remnant along the creek bottom area is covered with relatively thick clay soils which are absent from the Millennium Preserve's karstic uplands. Clay soil areas throughout the corridor are marked by mesquite trees and several small stock ponds that hold water after rains for an extended period (depressions on the Edwards typically do not hold water due to the porous nature of the rock). Low permeability, thin outcrop, and the general absence of karst features throughout this corridor indicate that suitable habitat for karst invertebrates is unlikely to occur there.

Surface drainage basin delineation is a relatively straightforward process based on the surface topography near cave entrances and other nearby features such as sinkholes or fractures with the potential to convey water into the cave. All caves within the Millennium Preserve have relatively limited surface drainage areas due to their upland locations. The species-occupied caves all draw their surface runoff from a ridge contained within the Millennium Preserve boundaries. Therefore, all surface runoff reaching the species-occupied cave entrances and footprints originates within the Millennium Preserve.

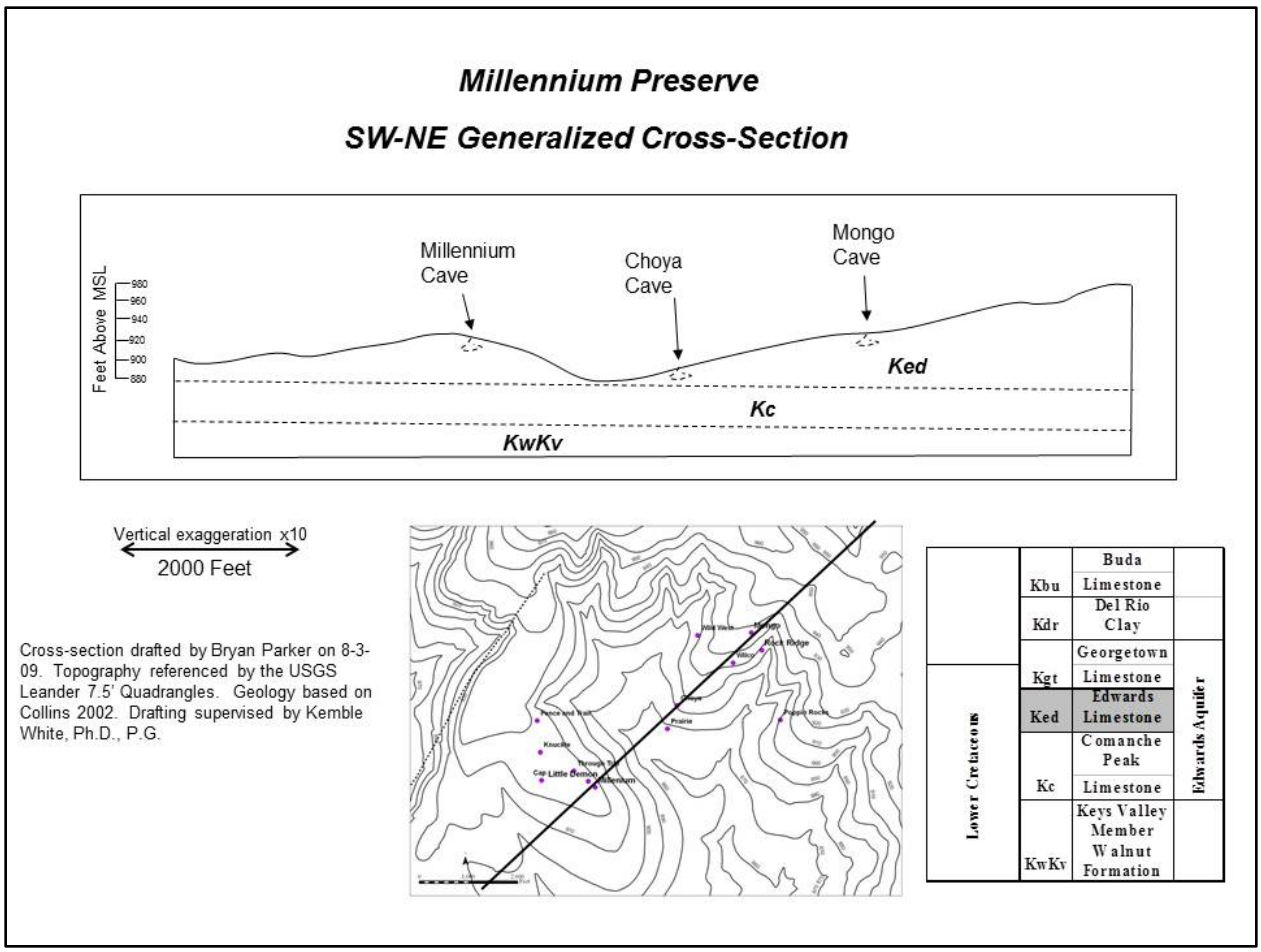


Figure 11. Millennium Preserve showing geological cross section.

2.4.3 Caves of the Millennium Preserve

Cave maps are included within Appendix D.

Through Trip Cave: The entrance to Through Trip Cave was excavated to 4.5 feet to find a horizontal passage (Photograph 14). A tunnel extended for 6.5 feet before becoming constricted. Further excavation located open passage leading west for approximately 30 feet. A small crawlway was further excavated and continues west for another 20 feet before leading to another small crawlway. This crawlway was excavated and led to another room continuing west. This opens immediately into a 7-foot-high passage and continues west for 40 feet before leading to another shaft within the rock joint. This shaft was revealed to be a second cave entrance. The surveyed cave length is approximately 105.9 feet, with a 16-foot maximum depth. The cave footprint measures approximately 80 feet long by 32 feet wide. This cave is not currently known to contain any endangered karst invertebrates and a cave gate prevents unauthorized access.

Photograph 14. Through Trip Cave west entrance.

Little Demon Cave: The Little Demon Cave entrance was excavated to 6 feet, where an additional 6-foot open drop was found (Photograph 15). Open cave passage was encountered at 12 feet. The mostly rock joint-controlled room trends N90W and contains several passages in various directions. The surveyed cave length measures approximately 75.6 feet, with a 19-foot maximum depth. The cave footprint measures approximately 45 feet long by 14 feet wide. This cave is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.

Photograph 15. Little Demon Cave entrance.

Millennium Cave: This cave had the only open entrance within the Regional Park that required no digging (Photograph 16). The entrance room is approximately 28 feet long, and at the end, a digging lead was pursued. A large room was encountered at 6 feet deep after additional excavation. This room measures approximately 40 feet in diameter with a floor-to-ceiling height of 4.5 feet. The surveyed cave length is approximately 82.7 feet, with a 29-foot maximum depth. The cave footprint measures approximately 80 feet long by 35 feet wide. This cave is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.

Photograph 16. Entrance to Millennium Cave.

The Millennium Preserve contains four additional caves and sinkholes not currently known to contain habitat for troglobitic fauna. This is primarily due to their small size and inaccessibility for researchers. However, the collective karst feature distribution suggests the Millennium Preserve's cave-containing strata are an interconnected cavernous and mesocavernous habitat area spanning more than 20 acres. The cave geomorphology suggests they formed from a larger underlying karst void network collapse. That network likely formed under phreatic conditions in response to paleo-aquifer karst hydrology as groundwater followed an easterly to northeasterly path toward the confined aquifer zone. This process was initiated in the Miocene following the tectonic events that created the Balcones Escarpment (Senger et al. 1990; White 2009). Aquifer entrenchment and regional streams caused the water table to drop below the current cave elevation. The buoyant force acting on the cave ceilings was lost and the caves began to collapse when this happened. The cave floors that are accessible now are largely formed from breakdown material that has collapsed from the original cave ceiling. The modern cave network has chaotic morphology relative to the paleo cave network because the collapse process is incomplete. What formed as a relatively continuous void network formed in response to dissolution by flowing groundwater is now a seemingly discontinuous patchwork of air pockets from a human cave explorer's perspective. However, the mesocavern network is far more extensive and accessible from a karst invertebrate's perspective, which still emulate the original groundwater pathways.

Fence and Trail Cave: The entrance to Fence and Trail Cave was excavated to 7 feet deep where open passage was discovered (Photograph 17). The passage is formed along a rock joint trending N70E. The entrance extends through a tight constriction into a passage approximately 5 feet wide by 13 feet long, with 2-foot maximum floor to ceiling height. The surveyed cave length measures approximately 20 feet, with a maximum depth of 7 feet. The cave footprint measures approximately 20 by 5 feet. This cave is not currently known to contain any endangered karst invertebrates, is not monitored for karst biota, and has a cave gate to prevent unauthorized access.

Photograph 17. Entrance to Fence and Trail Cave.

Knuckle Cave: The Knuckle Cave entrance was excavated to 5 feet, where a small open cave was encountered (Photograph 18). The feature appears to be formed along a rock joint trending N30W. The cave extends to the southeast along a low bedding plane for about 20 feet. The surveyed cave length is approximately 29.2 feet, with a maximum depth of 7.3 feet. The cave footprint measures approximately 26 feet long by 11 feet wide. This cave is not currently known to contain any endangered karst invertebrates, is not surveyed for biota, and does not have a gate.

Photograph 18. Entrance to Knuckle Cave.

Cap Cave: Cap Cave consists of a large single solution cavity discovered during the Regional Park development. The entire footprint of the irregularly shaped feature is less than 15 feet in diameter and approximately 5 feet deep. The name "Cap" cave comes from the large flat boulder currently covering the entrance of the feature. No Cap Cave map is available. This cave is not currently known to contain any endangered karst invertebrates, is not surveyed for biota, and does not have a gate.

Forest Elms Sink: Forest Elms Sink is so named due to the presence of a small grove of cedar elm trees, the largest of which have died since the feature was excavated in 2000. The feature consists of a small pit measuring approximately 5 feet in diameter. It was originally mapped as being up to 8 feet deep, but it appears that some slumping from the walls has filled the lower portion of the feature since it was excavated. This cave is not currently known to contain any endangered karst invertebrates, is not surveyed for biota, and does not have a gate.

Table 8 shows species documented from the Millennium Preserve.

Table 8. Species Documented from the Millennium Preserve

Species		Millennium	Little Demon	Through Trip
Permitted Species				
Texella reyesi		√	√	
Other Species				
Crickets	*Ceuthophilus secretus*	√	√	√
	Ceuthophilus cunicularis	√	√	√
Arachnids	*Cicurina browni*	√		√

Species		Millennium	Little Demon	Through Trip
	Cicurina varians	√	√	√
	Agyneta sp.	√		√
	Anapistula sp.	√		√
	Eidmanella sp.	√	√	
	Tayshaneta sp.	√		
	Araneae (General Spider)			√
	Cryptachaea porteri		√	√
	Leiobunum townsendii	√	√	√
	Pseudouroctonus reddelli	√	√	
	Pseudoscorpion		√	
Millipedes/ Centipedes	*Speodesmus bicornourus*	√		
	Cambala speobia	√	√	√
	Scutigeridae		√	√
	Lithobiomorpha	√	√	
	Scolopendra sp.	√		
Beetles	*Anillinus* sp.			√
	Staphylinidae	√	√	√
	Rhadine subterranea	√		
	Batrisodes uncicornis	√	√	√
Reptiles/ Amphibians	*Eleutherodactylus marnockii*	√	√	√
	Incilius nebulifer	√	√	√
	Gastrophryne olivacea		√	
	Thamnophis sp.		√	
	Rana berlandieri		√	√
Other	*Arenivaga* sp.	√		√
	Isopod	√	√	√
	Mouse			√
	Texoreddellia sp.	√		
	Assassin Bugs			√
	Heliodiscus sp.	√	√	√
	Surface Silverfish	√		
	Earthworm		√	
	Gnat		√	
	Mite		√	
	Wasp		√	
	Dark Springtail			√
	Collembola sp.	√	√	√

2.5 Wilco Preserve

2.5.1 Introduction

The Wilco Karst Preserve (Table 9) is located within the Regional Park near Leander, Texas (Figure 12) and was acquired by Williamson County under the same pretense as the Millennium Preserve. The flora and fauna have begun a successional transition from overgrazed, managed grassland to a predominantly native woodland/grassland mosaic from ranching cessation more than 15 years ago and provides suitable habitat for native species. The Wilco Preserve occurs adjacent to areas identified in the RHCP as potential habitat for the GCWA and woodland within the park may become suitable for GCWAs over time (SWCA et al. 2008).

Table 9. Basic Information for the Wilco Preserve

Wilco Preserve Information	
Preserve Inception Year	2002
Acreage	152.5
Fence Status	Open-ended fences surround endangered species caves
Sign Status	Signs posted on fences, warning signs on all cave gates
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Wilco, Rock Ridge, Mongo, Wild West, Choya, Talus, No Paseo, Nuevo, Prospector, Venture
Non-gated Caves	Poppin Rocks, Circulation Sink, Lockout Sink, Side Pocket Sink, West Boundary Sink

2.5.2 Hydrogeology

Total relief on the Wilco Preserve is approximately 60 feet ranging from approximately 875 to 935 feet amsl. Land slopes generally from uplands in the northeast to drainages exiting the western and southern Wilco Preserve boundaries. The Honey Bear Creek drainage basin is immediately west from the Wilco Preserve and separates it from the Millennium Preserve. The Wilco Preserve is located entirely within the EARZ. Based on regional patterns, recharge from the property likely follows the groundwater gradient to the northeast, but no formal study has been conducted.

The Wilco Preserve caves with documented Bone Cave harvestman presence occur on either flank of a subtle southwest-trending ridge. Most cave entrances are formed between 910 and 925 feet amsl and most traversable cave passage occurs between 890 and 905 feet amsl (see Figure 9). This distribution suggests the presence of a highly developed, stratigraphically controlled dissolution zone which likely extends somewhat continuously beneath the ridge. This karstic horizon within the bedrock likely provides mesocavern habitat between the four occupied caves and likely beyond. The Edwards limestone is approximately 85 feet thick around Wilco Preserve (Collins 2005; Senger et al. 1990). Accordingly, the Edwards is near its full thickness near the highest topography and is nearly breached along Honey Bear Creek south from Wilco Preserve (see Figure 9). This near cavernous stratum breach provides an isolating mechanism between the Wilco and Millennium Preserves. No faults are known to occur within Wilco Preserve although fractures related to regional faulting are expressed within all of the caves. A mapped fault passes approximately 0.5 mile northwest of the Wilco Preserve (Collins 2005).

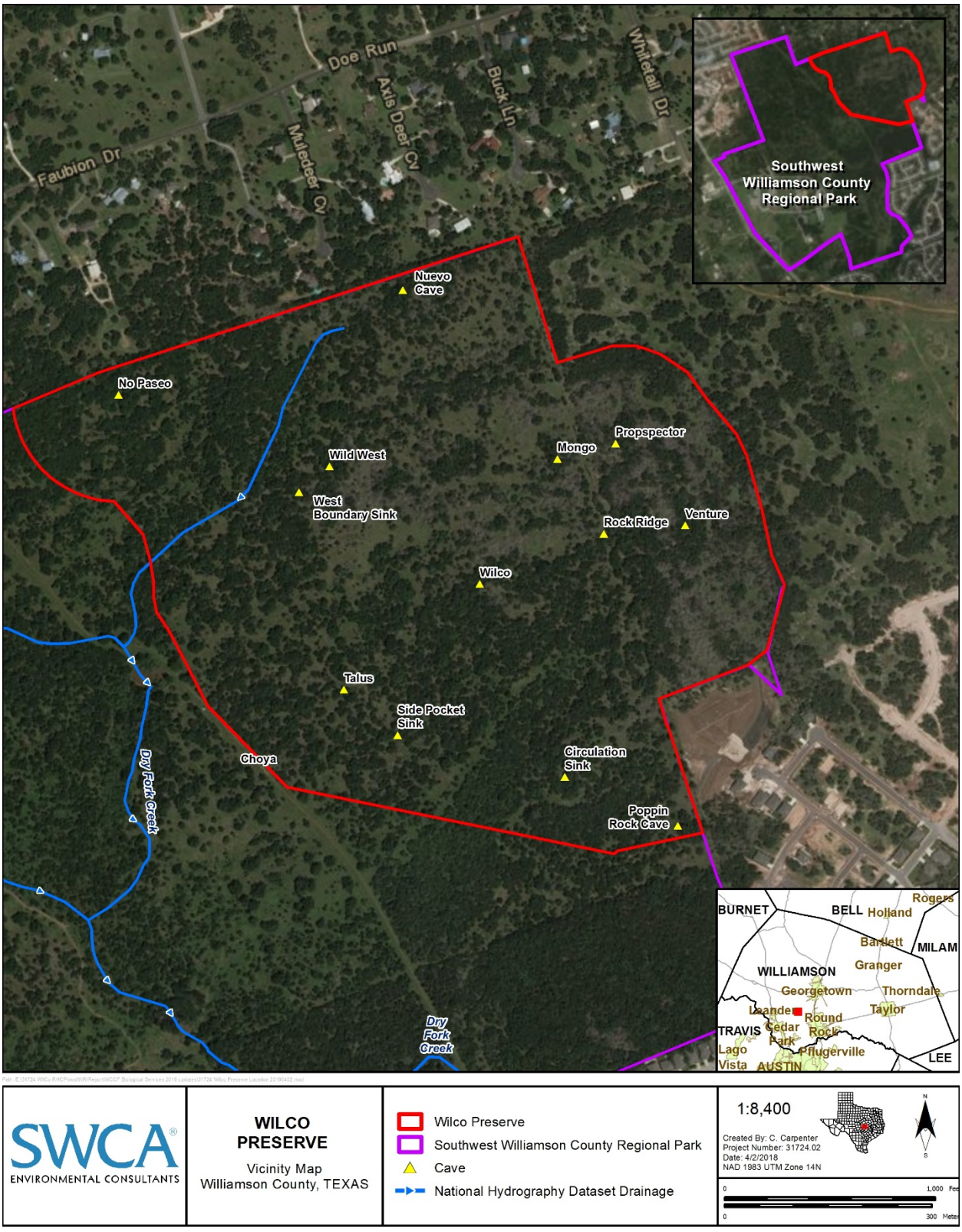


Figure 12. Wilco Preserve map showing documented karst features.

The Wilco Preserve caves have relatively limited surface drainage areas because of their upland terrain location. The species-occupied caves all draw their surface runoff from the ridge described above. Therefore, all surface runoff reaching the cave entrances and footprints originates from within the Wilco Preserve. The relatively flat terrain within the Wilco Preserve is conducive to slow runoff, which enhances the potential for aquifer recharge.

2.5.3 Caves of the Wilco Preserve

Cave maps are included within Appendix E.

The Wilco Karst Preserve contains Wilco Cave, Wild West Cave, Mongo Cave, and Rock Ridge Cave (all of which contain the Bone Cave harvestman), plus 10 additional significant karst features. Wilco Preserve contains the endangered Bone Cave harvestman along with a representative sampling of local endemic cave fauna including the troglobitic species *Cicurina browni, Tartarocreagris infernalis, Speodesmus bicornourus,* and *Rhadine subterranea mitchelli*, which are additional species addressed in the RHCP (SWCA et al. 2008). Additional fauna are likely to be detected in each cave now that regular biological monitoring is being conducted (Krejca and Weckerly 2007; Schneider and Culver 2004). Most Wilco Preserve caves are likely quite small relative to the volume of potential mesocavern habitat around and between the caves. A dominant east/west fracture trend is expressed in the morphology of all of the caves.

Wild West Cave: The Wild West Cave entrance was excavated to 4 feet and an open passage was encountered. The entrance opens to the west into a long linear room measuring approximately 18 feet wide by 40 feet long, with a 5.5-foot maximum floor to ceiling height. Access to a second lower-level room continues west from the main room's northwest corner. The lower-level room is wide and low and measures approximately 25 feet long by 35 feet wide, with a 3-foot maximum floor to ceiling height. The surveyed cave length is approximately 88.4 feet, with a 15.5-foot maximum depth. The cave footprint measures approximately 60 feet long by 38 feet wide. The cave is formed along a rock joint trending N90W and is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.

Mongo Cave: Mongo Cave is located within the tract's largest sinkhole, which measures approximately 75 feet long by 50 feet wide by 6 feet high. The sinkhole is formed along a rock joint trending N90W and funnels down to a main drainage portal that was excavated to 3 feet before encountering open cave passage. The excavated entrance portal descends at a sharp angle for about 20 feet into a large single room measuring approximately 86 feet long by 41 feet wide, with a 6-foot maximum floor to ceiling height. A 12-foot-deep pit was excavated in this main room and a small lower-level room was located. No further extent was found. The surveyed cave measures approximately 167.8 feet long, with a maximum depth of 29.3 feet. The cave footprint measures approximately 86 feet long by 41 feet wide. Mongo Cave is the single largest cave known from the tract. This cave is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.

Rock Ridge Cave: The Rock Ridge Cave entrance was excavated to 4.5 feet and open passage was located. The cave entrance and extent occur along a rock joint trending N85E. The cave extends primarily west for approximately 60 feet until passage becomes blocked. The cave also extends east from the entrance for approximately 20 feet. The eastern passage extends beneath the property boundary fence of the adjacent property. The surveyed cave length measures approximately 103.7 feet long, with a 14-foot maximum depth. The cave footprint measures approximately 80 feet long by 14 feet wide. Rock Ridge Cave is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.

Wilco Cave: Wilco Cave (Photograph 19) was excavated to 9 feet and a semi-open passage was encountered. A short passage leads west and drops down to a small room. A low bedding plane void extends south for an undetermined distance within this small room. The surveyed cave length measures approximately 47 feet long, with a 15.7-foot maximum depth. The cave footprint measures approximately 37 feet long by 27 feet wide. Wilco Cave is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.

Photograph 19. Entrance to Wilco Cave.

Prospector Cave: Prospector Cave is formed along a rock joint trending east 50 feet, with a 19-foot maximum depth. Further passage occurs below a drain and beyond restriction in the cave's terminal east end. Prospector Cave is formed within the same karstic horizon as the species-occupied caves and may represent an exposure of the occupied mesocavern habitat. It is especially close to Mongo Cave and may be directly connected. This cave is not currently known to contain any endangered karst invertebrates, is currently monitored for karst biota, and has a cave gate to prevent unauthorized access to this feature.

Venture Cave: Venture Cave is formed along a rock joint trending northeast for approximately 70 feet, with a 21-foot maximum depth. Further passage occurs below a drain and beyond an air blowing restriction in the cave's terminal northeast extent. This cave is not currently known to contain any endangered karst invertebrates, is currently monitored for karst biota, and has a cave gate to prevent unauthorized access to this feature.

Talus Cave: Talus Cave is within an approximately 40-foot diameter sinkhole that funnels down to a single portal. The portal was excavated to 9 feet where open passage was located. A constricted passage continued down at a sharp angle to 24 feet and a humanly accessible, cone-shaped collapse extends for approximately 15 feet. The surveyed cave length cave measures approximately 67.3 feet long, with a 24-foot maximum depth. The cave footprint measures approximately 43 feet long by 20 feet wide. This cave is not currently known to contain any endangered karst invertebrates, is not monitored for karst biota, and has a cave gate to prevent unauthorized access.

No Paseo Cave: No Paseo cave was excavated 5 feet deep to reveal open passage extending both southwest and northeast. The passage extends approximately 20 feet from the cave entrance northeast and ends at a low bedding plane. The passage extends approximately 5 feet southeast before declining to an approximately 7-inch diameter drain that extends down vertically for about 7 feet. The surveyed cave length measures approximately 36.5 feet, with a 13.5-foot maximum depth. The cave footprint measures approximately 26 feet long by 11 feet wide. This cave is not currently known to contain any endangered karst invertebrates, is not monitored for karst biota, and a cave gate currently prevents unauthorized access.

Choya Cave: Choya Cave was excavated to 5 feet where open passage formed along a rock joint trending N40E (Photograph 20). The passage extends northeast for approximately 35 feet. The passage then extends northwest to an approximately 30-foot-long by 1-foot-wide room, with 4.5-foot maximum floor to ceiling height. The surveyed cave length measures approximately 155.8 feet long, with an 8.4-foot maximum depth. The cave footprint measures approximately 41 feet long by 31 feet wide. This cave is not currently known to contain any endangered karst invertebrates, is not monitored for karst biota, and has a cave gate to prevent unauthorized access.

Photograph 20. Entrance to Choya Cave.

Poppin Rocks Cave: Poppin Rocks Cave was excavated 10 feet, where a larger cave structure was revealed. However, the passage is blocked by massive infill and collapse material. The accessible cave extent measures approximately 18.5 feet long, with a 10-foot maximum depth. This cave is not currently known to contain any endangered karst invertebrates, is not surveyed for biota and does not have a gate.

Nuevo Cave: Nuevo Cave was excavated to depth 4 feet, where a small, very low bedding plane passage was encountered. Cave extent follows a rock joint trending N90W into a very low room just a few feet below the ground surface level. The surveyed cave length measures approximately 21.3 feet long, with a 539-foot maximum depth. The cave footprint measures approximately 28 feet long by 10 feet wide. This

cave is not currently known to contain any endangered karst invertebrates, is not monitored for karst biota, and has a cave gate to prevent unauthorized access to this feature.

Circulation Sink: This sinkhole was enlarged sufficiently (Photograph 21) to allow entry to a small chamber with a low bedding plane void extending northwest for approximately 15 feet. Airflow comes from an additional cave passage that is not currently accessible. This feature is not known to contain endangered karst invertebrates, is not currently monitored for karst biota, and does not have a cave gate.

Photograph 21. Entrance to Circulation Sink.

Lockout Sink: This sinkhole was excavated 5 feet to expose a 3-inch-diameter solution cavity with airflow issuing from a low bedding plane. This feature is not known to contain endangered karst invertebrates, is not currently monitored for karst biota, and does not have a cave gate.

Side Pocket Sink: This sinkhole was enlarged sufficiently to allow entry to a small chamber measuring approximately 5 feet in diameter by 3 feet high with a low bedding plane void extending north for approximately 15 feet. Side Pocket Sink is formed within the same karstic horizon as the species-occupied caves and may represent occupied mesocavern habitat exposure, which could be an important nutrient input point between Wilco and Rock Ridge Caves. This feature is not monitored for karst invertebrates and does not have a cave gate.

West Boundary Sink: This sinkhole was excavated 4 feet to expose a bedding plane void extending to the east with airflow. The feature is very close to Wild West Cave and may represent mesocavern habitat connected to Wild West Cave. West Boundary Sink is formed within the same karstic horizon as the species-occupied caves and may represent occupied mesocavern habitat exposure. This feature is not monitored for karst invertebrates and does not have a cave gate.

Table 10 shows documented species within the Wilco Preserve.

Table 10. Species Documented from the Wilco Preserve

Species		Wild West Cave	Mongo Cave	Rock Ridge Cave	Wilco Cave	Prospector	Venture
Permitted Species							
Texella reyesi		√	√	√	√		
Other Species							
Crickets	*Ceuthophilus secretus*	√	√	√		√	√
	Ceuthophilus cunicularis	√	√	√	√	√	√
Arachnids	*Cicurina browni*	√	√	√		√	√
	Cicurina varians	√	√	√	√	√	√
	Anapistula sp.	√	√		√		
	Agyneta sp.				√		
	Pseudoscorpion		√				
	Eidmanella sp.						√
	Araneae	√		√			
	Achaearanea sp.		√				
	Cryptachaea porteri		√			√	√
	Mite					√	√
	Tick		√				√
	Leiobunum townsendii				√	√	√
Millipedes/ Centipedes	*Speodesmus bicornourus*		√	√	√		√
	Cambala speobia	√	√	√	√		
	Geophilomorpha						
	Scolopendra sp.		√				√
	Scutigeridae		√	√		√	√
Beetles	Staphylinidae					√	
	Anillinus sp.			√			
	Batrisodes uncicornis		√	√			√
	Rhadine subterranea		√				
Reptiles/ Amphibians	*Crotalus atrox*	√	√				

Species		Wild West Cave	Mongo Cave	Rock Ridge Cave	Wilco Cave	Prospector	Venture
	Lithobates berlandieri		√				
	Eleutherodactylus marnockii		√		√		√
Mammals	*Perimyotis subflavus*			√		√	√
	Myotis velifer		√				
Other	*Arenivaga* sp.	√	√	√	√		√
	Isopod	√	√	√	√	√	
	Assassin Bugs	√	√	√		√	√
	Heliodiscus sp.		√	√		√	√
	Collembola	√	√	√	√	√	√
	Bark Louse	√					
	Mosquito					√	
	Moth	√				√	√
	Flea	√					
	Earthworm	√	√		√	√	
	Gnat		√			√	√

2.6 Chaos Cave Preserve

2.6.1 Introduction

The approximately 30-acre Chaos Preserve (Table 11) is immediately south from SH 45 (Figure 13). It was established by TxDOT as a conservation measure related to potential Bone Cave harvestman impacts from SH 45 construction and Williamson County assumed management responsibility for Chaos Preserve in 2008. The County has agreed to preserve and protect the natural, scenic, open space, and ecological features in a contract for mitigation services between Williamson County and TxDOT dated August 26, 2008. Williamson County will also provide funding for management and monitoring activities and will report on those activities to TxDOT biannually.

Chaos Preserve is bounded by SH 45 to the north, by a rail line to the southwest, and by undeveloped portions of the Robinson Ranch to the east and west (see Figure 13). This area is a relatively flat upland drained to the north by Lake Creek. Elevations range from approximately 800 to 815 feet amsl (Figure 14).

Chaos, Under the Fence, and Poison Ivy Caves are confirmed as containing the Bone Cave harvestman. Karst invertebrates documented within the Chaos Preserve are included in Table 12. Immediately east from the Chaos Preserve are several additional caves, including Sam Bass Hideaway Cave, a known site for the Bone Cave harvestman. Rather-Gaping-Pit is a small feature with little known biological significance and is not monitored for karst invertebrates. The Chaos Preserve was identified by the USFWS as a potential KFA in the Bone Cave harvestman 5-year review (USFWS 2018b). Chaos Preserve is fenced and has appropriate signage to aid trespassing prevention per guidelines set in the RHCP by USFWS (SWCA et al. 2008).

Table 11. Basic Information for the Chaos Cave Preserve

Chaos Preserve Information	
Preserve Inception Year	2008
Acreage	30.0
Fence Status	Fully fenced
Sign Status	Signs posted around perimeter
Baseline Vegetation Survey Date	None
Owner	Easement- TxDOT
Gated Caves	None
Non-gated Caves	Under-the-Fence, Chaos, Poison Ivy, Rather-Gaping-Pit

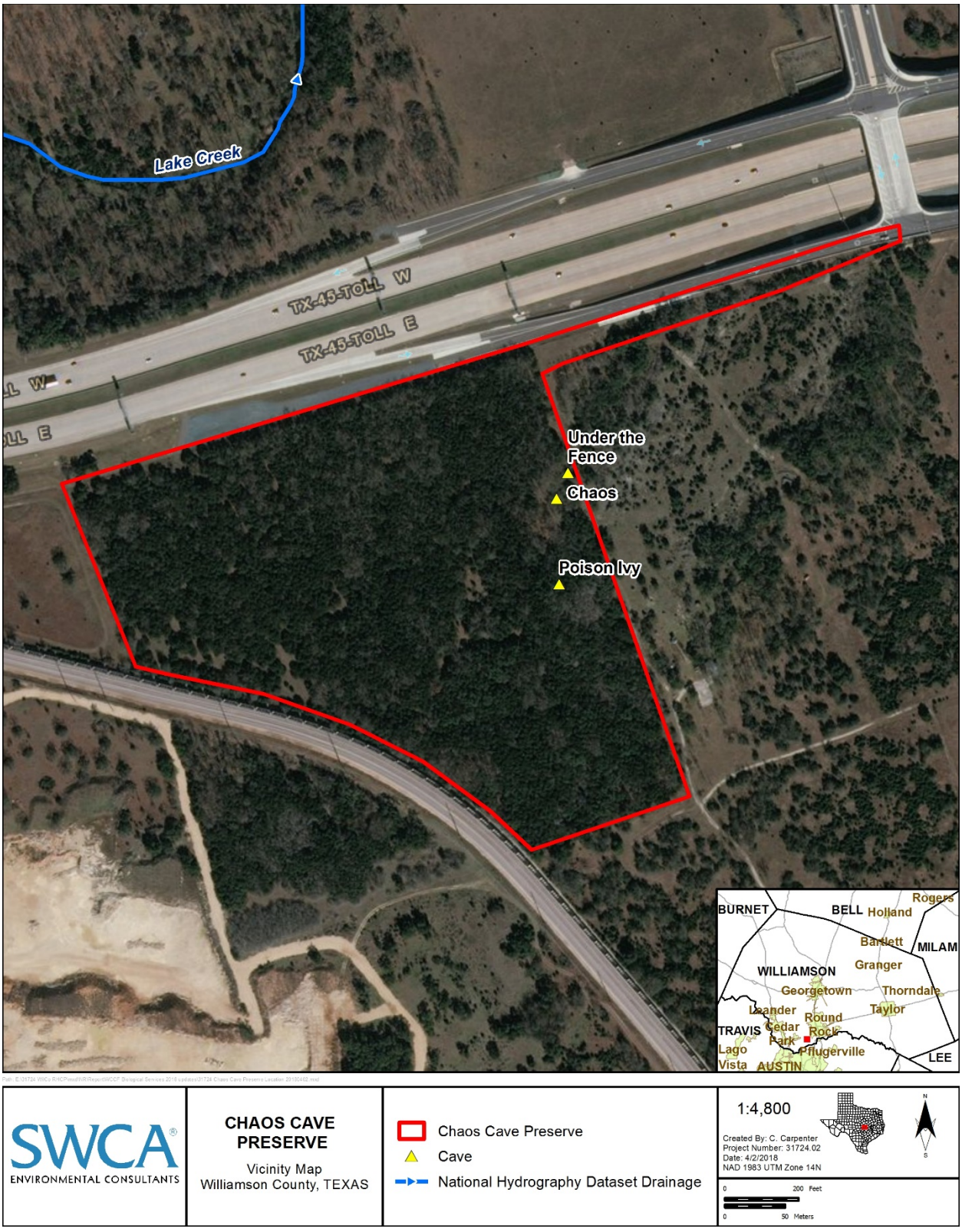


Figure 13. Chaos Preserve location map.

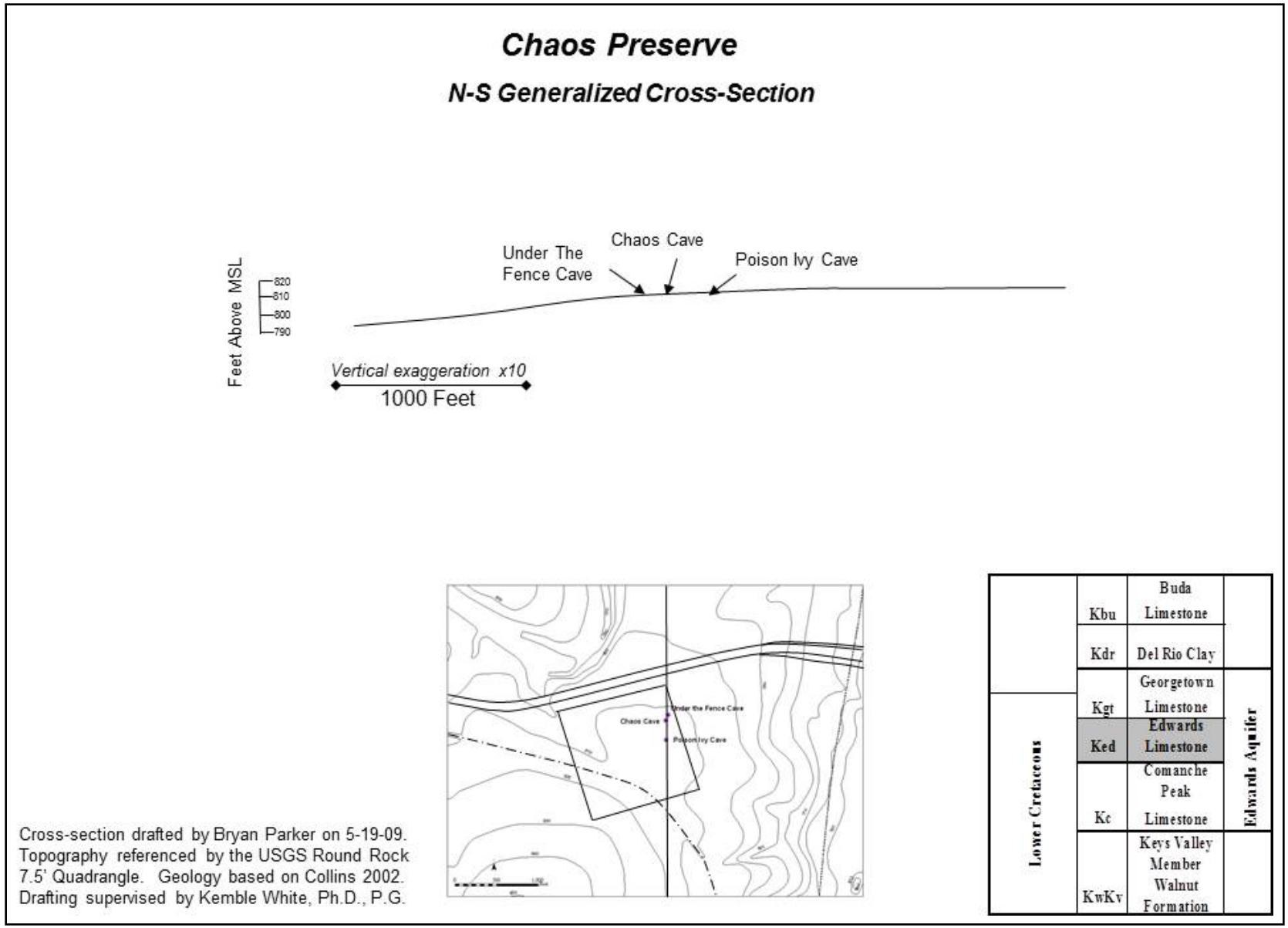


Figure 14. Geologic cross section of the Chaos Preserve.

2.6.2 Hydrogeology

Chaos Preserve is located entirely within the EARZ. Based on regional patterns, recharge from the property likely follows the groundwater gradient to the northeast and east toward Rattan Creek and Smith Lake, but no formal study has been conducted.

2.6.3 Caves of the Chaos Preserve

Access to the Chaos Preserve is relatively difficult; therefore, no caves are currently gated. Cave maps are included in Appendix F.

Chaos Cave: The Chaos Cave entrance is located within a sinkhole approximately 9 feet in diameter (Photograph 22). The entrance drops vertically for 5 feet and opens into a single room passage measuring approximately 18 feet in diameter. The open cave passage maximum depth is approximately 9 feet. This cave is not currently gated and is known to contain the Bone Cave harvestman.

Photograph 22. Chaos Cave entrance.

Under the Fence Cave: The Under the Fence Cave entrance is located directly beneath the fence separating the Chaos Preserve from the adjacent property (Photograph 23). The cave entrance drops vertically 5 feet and slopes downwards and south. The passage extends approximately 15 feet and terminates in a single room approximately 18 feet long by 9 feet wide. The open cave passage maximum depth is approximately 10 feet. This cave is known to contain the Bone Cave harvestman and does not have a cave gate.

Photograph 23. Under the Fence Cave entrance.

Poison Ivy Cave: The Poison Ivy Cave entrance measures approximately 5 feet long by 1.5 feet wide and slopes down vertically 6 feet (Photograph 24). Mapped cave extent is limited to a single room measuring approximately 18 feet long by 9 feet wide. This cave is known to contain Bone Cave harvestman and does not have a cave gate.

Photograph 24. Poison Ivy Cave entrance.

Rather-Gaping-Pit: No specific description or map was available for this feature. This feature is not monitored for karst biota, nor does it have a cave gate to prevent unauthorized access.

Table 12 shows documented species within the Chaos Cave Preserve.

Table 12. Species Documented from the Chaos Cave Preserve

Species		Chaos Cave	Under the Fence Cave	Poison Ivy Cave
Permitted Species				
Texella reyesi		√	√	√
Other Species				
Crickets	*Ceuthophilus cunicularis*	√		√
	Ceuthophilus secretus	√	√	√
Arachnids	*Cicurina buwata*	√		√
	Cicurina varians	√	√	√
	Tayshaneta sp.	√		
	Eperigone albula	√		
	Agyneta sp.	√		
	Eidmannella sp.	√		√
	Araneae	√	√	√
	Cryptachaea porteri	√	√	√
	Vonones sp.			√

Species		Chaos Cave	Under the Fence Cave	Poison Ivy Cave
	Eumesosoma sp.			√
	Leiobunum townsendii	√	√	√
	Mite	√		
	Tick	√		
Millipedes/ Centipedes	*Cambala speobia*	√		
	Speodesmus bicornourus	√		
	Scutigeridae	√		√
	Scolopendra sp.	√		√
	Lithobiomorpha	√		
	Oxidus gracilis			√
Beetles	Coleoptera		√	
	Batrisodes uncicornis	√		√
	Anillinus sp.	√		
	Staphylinidae	√		√
	Rhadine subterranea	√		
Reptiles/ Amphibians	*Eleutherodactylus marnockii*	√		√
	Plethodon albagula	√		
	Scincella lateralis	√		
	Lithobates berlandieri	√		
Mammals	*Perimyotis subflavus*	√		
	Myotis velifer	√		
Other	*Coragyps atratus*	√		√
	Gnats			√
	Collembola	√	√	√
	Surface Silverfish	√		
	Black Ant			√
	Red Ant	√		
	Earthworm	√		√
	Heliodiscus sp.	√		
	Gastropod			√
	Arenivaga sp.	√		√
	Assassin Bug			√
	Diptera	√	√	√
	Dark Springtail	√		
	Isopod	√	√	√

2.7 Big Oak Cave Preserve

2.7.1 Introduction

Williamson County assumed management responsibility for the Big Oak Cave Preserve (Table 13) in 2008 from TxDOT's Texas Turnpike Authority Division. The Big Oak Preserve is limited to known Big Oak Cave extent and is the only cave currently managed by the County known to contain the Tooth Cave ground beetle (*Rhadine persephone*). TxDOT had originally agreed to biological monitoring of Big Oak Cave as a conservation measure related to the 2001 U.S. Highway (U.S.) 183A project's Environmental Impact Statement. The cave occurs within an approximately 0.5-mile-long median area between the "new" U.S. 183A and the "old" U.S. 183 facilities (also known as South Bell Boulevard); with a 225-foot maximum width within a 10-acre area (Figure 15). The cave's footprint and surface drainage area have been avoided by construction, but impervious cover exists above some subsurface drainage basin, which has reduced the cave's capacity to contribute to species recovery. TxDOT funded annual Big Oak Cave for the first four years (2004–2007) following monitoring plan approval in order to study the long-term roadway development and operation on cave species impacts.

The County has agreed to preserve and protect the natural, scenic, open space, and ecological features of Big Oak Cave, to provide funding for monitoring activities, and to report on those activities to TxDOT biannually in a contract for mitigation services between Williamson County and TxDOT dated August 26, 2008. The Big Oak Cave Preserve is not fenced but does maintain two cave gates to prevent unauthorized access to both cave entrances.

Table 13. Basic Information for the Big Oak Cave Preserve

Big Oak Cave Preserve Information	
Preserve Inception Year	2008
Acreage	10.0
Fence Status	None
Sign Status	Warning signs on all cave gates
Baseline Vegetation Survey Date	None
Owner	Easement- TxDOT
Gated Caves	Big Oak Cave
Non-gated Caves	None

Figure 15. Big Oak Cave Preserve location map.

2.7.2 Hydrogeology

Big Oak Cave Preserve is located within the EARZ. Based on the regional hydrologic gradient, cave recharge likely discharges to the northeast along Brushy Creek, but no formal study has been conducted.

2.7.3 Caves of the Big Oak Cave Preserve

Cave maps are included within Appendix G.

Big Oak Cave: No specific size and configuration information for this cave is available. However, Big Oak Cave has two gated entrances (east and west) leading to small, shallow single rooms that are not connected by humanly accessible passages. Photograph 25 shows the western gated entrance. A cave gate currently prevents unauthorized access to this feature.

Table 14 shows documented species within the Big Oak Cave Preserve.

Photograph 25. Big Oak Cave western entrance.

Table 14. Species Documented from the Big Oak Cave Preserve

Species		Big Oak Cave
Permitted Species		
Rhadine persephone		√
Other Species		
Crickets	*Ceuthophilus* sp.	√
Arachnids	*Cicurina varians*	√
	Araneae	√
	Achaearanea sp.	√
Millipedes/ Centipedes	*Cambala speobia*	√
	Speodesmus bicornorus	√
Beetles	Staphylinidae	√
Reptiles/ Amphibians	*Eleutherodactylus marnockii*	√
Other	*Coragyps atratus*	√
	Moth	√
	Collembola sp.	√
	Heliodiscus sp.	√
	Assassin Bug	√
	Isopod	√

2.8 Priscilla's Well Karst Fauna Area

2.8.1 Introduction

The Priscilla's Well Preserve was the first KFA recognized by the USFWS as contributing to a listed karst invertebrate species recovery. The Priscilla's Well KFA (Table 15) is 51.5 acres and is generally located between Ronald W. Reagan Boulevard and a residential portion of the Sun City development (Figure 16). Priscilla's Well Cave is documented to contain both the Bone Cave harvestman and Dragonfly Cave mold beetle; Priscilla's Cave is documented to have the Bone Cave harvestman (Verdoorn 1994). USFWS (2018b) does not list Yearwood Gold Mine as a Bone Cave harvestman locality. The KFA encompasses a 13.4-acre area proposed as a preserve in the 1994 management plan for Sun City Georgetown (Verdoorn 1994). Priscilla's Well Cave was biologically monitored for 5 years between 1995 and 2000, and *Batrisodes cryptotexanus* was found on nine out of 16 sampling occasions. Priscilla's Cave was not biologically monitored beyond the initial Sun City investigation. *Batrisodes cryptotexanus* may also be found within Priscilla's Cave with continued monitoring, given the two caves' proximity and similarity. The Priscilla's Well KFA is generally in "natural" condition, consisting of a mixed woodland/grassland mosaic. Cattle grazing at this location has officially ceased; however, few neighboring animals do make it onto the Priscilla's Well KFA through fence breaks. Fencing and signage are placed to restrict cave and KFA access. Cave gates are present on both Priscilla's Well Cave and Priscilla's Cave. Yearwood Gold Mine is not currently monitored or gated.

The proximity of Priscilla's Well KFA to Ronald Reagan Boulevard has prompted concern that a spill or other catastrophic event adjacent to the preserve could negatively impact the cave ecosystem contained within the property. However, the road itself is down gradient from both caves and guardrails have been installed to prevent vehicles carrying fuel (or other contaminants) from accidentally crashing into Priscilla's Well KFA; therefore, impact from such an event is unlikely. Photograph 26 shows the following three existing best management practices along Ronald Reagan Boulevard adjacent to Priscilla's Well KFA: KFA fence, rock gabions to slow stormwater moving off Ronald Reagan Boulevard, and guardrails to help prevent vehicular accidents from negatively impacting the Priscilla's Well KFA.

Table 15. Basic Information for the Priscilla's Well KFA

Priscilla's Well KFA Information	
Preserve Inception Year	2008
Acreage	51.5
Fence Status	Fully fenced
Sign Status	Warning signs on all cave gates
Baseline Vegetation Survey Date	2007
Owner	Williamson County
Gated Caves	Priscilla's Well, Priscilla's
Non-gated Caves	Yearwood Gold Mine

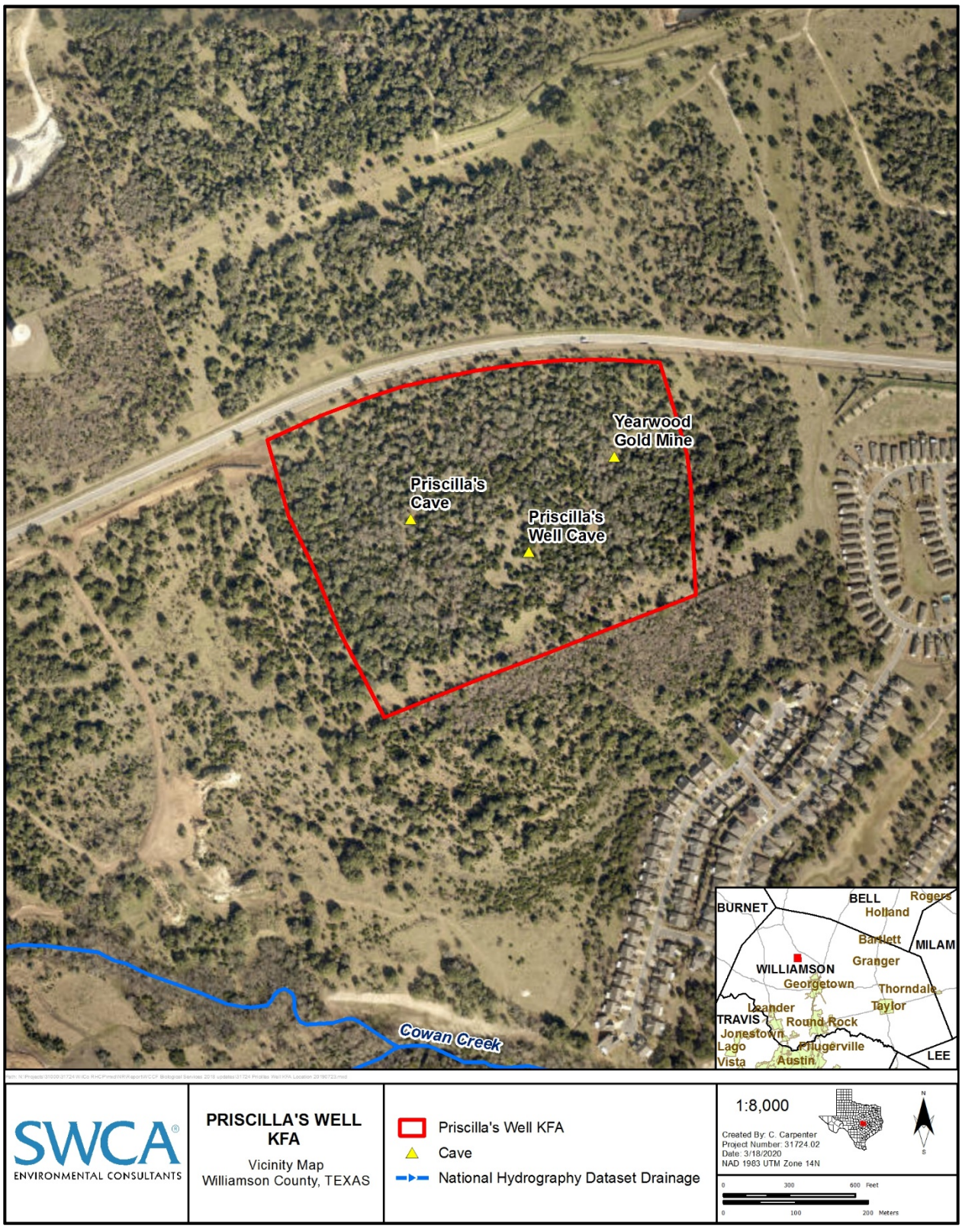


Figure 16. Priscilla's Well KFA location map.

Photograph 26. Three visible best management practices at the Priscilla's Well KFA: roadway guardrails (left), rock gabions (center), and preserve fence (right).

2.8.2 Hydrogeology

Priscilla's Well KFA encompasses a broad, flat hilltop with a highest elevation of slightly more than 940 feet amsl. Both Priscilla's Cave and Priscilla's Well Cave entrances lie within the 940-foot contour line. None of the caves nor karst features within the KFA likely drain a significant area due to the lack of relief from hilltop placement. The features generally drain a few hundred square feet up-gradient from cave entrances.

The Priscilla's Well KFA is underlain by the Edwards Formation, which is estimated to range from 120 to 200 feet in regional thickness (Collins 2002; Verdoorn 1994; Senger et al. 1990). There are identifiable preferential development horizons for karst features within the Edwards Formation that correspond with less-resistant limestone beds even though the Edwards Formation has not been stratigraphically subdivided north of Austin. Hundreds of karst feature analyses on more than 5,000 acres surrounding the Priscilla's Well KFA (Verdoorn 1994) found that cave development was largely confined to three distinct solution zones at the top, middle, and base of the Edwards Formation. The hilltop containing the Priscilla's Well KFA is capped by an outcrop of the upper solution zone that is isolated by erosion along the drainage divide between Cowan and Berry creeks. All known karst features within the KFA are confined within that zone, which appears to be approximately 20 feet thick.

The Edwards Formation also hosts nearly impermeable limestone and chert alternating beds that serve as barriers to downward-moving groundwater, creating wet-weather seeps where lateral groundwater movement is expressed as hillside seeps, which only flow after heavy rain. Alternating zones of dissolution and impermeable beds constrain most mapped caves vertical extent in the area, preventing vertical cave formation. Vertical shaft passages are nearly absent in Williamson County except in caves adjacent to faults. No faults are known to occur within the Priscilla's Well KFA. All caves within the

Priscilla's Well KFA are formed predominantly along bedding planes horizontally with relatively minor vertical expression at their entrances. Surface water entering the caves and karst features within the Priscilla's Well KFA is incorporated with a perched groundwater system where short residence time water drained by gravity radially away from the hilltop to discharge along the hillside. The groundwater flows downward through the upper Edwards Formation solution zone containing the macroscopic karst features until it intersects an impermeable layer that slows progress until exiting the hillside. This interpretation is strongly supported by the presence of several wet-weather seeps at the 887-foot contour line. These seeps were observed flowing following unusually rainy weather in summer 2007 and were not observed during dry periods in 2008.

2.8.3 Caves of the Priscilla's Well KFA

Priscilla's Cave, Priscilla's Well Cave, and Yearwood Gold Mine are small voids reflecting the broader fabric and mesocavernous nature of the local karst. The true measure of troglobite habitat within the Priscilla's Well KFA is more accurately represented by karst feature distribution. Cave maps are included within Appendix H.

Priscilla's Well Cave: Priscilla's Well Cave entrance drops 4.5 feet to a ledge-like landing that drops again to 15 feet deep. The cave interior is 19.9 feet high at its highest point and has an irregular but generally oblong shape. The cave measures 68.5 feet long. Biological surveys conducted between 1995 and 2000 found *Batrisodes cryptotexanus*. SWCA documented the Bone Cave harvestman in 2017. Further investigation will likely result in other troglobitic species detection. A cave gate currently prevents unauthorized access to this feature.

Priscilla's Cave: Priscilla's Cave has two narrow, vertical entrances that drop down into the main cavern. The larger entrance drops 10.5 feet and the second entrance drops 8.7 feet. The interior is a low, wide circular room, measuring approximately 15 to 20 feet in diameter. Priscilla's Cave was not biologically monitored beyond the initial Sun City investigation and—given the proximity and similarity of the two caves—*Batrisodes cryptotexanus* may be found with continued monitoring. An SWCA biospeleologist documented the Bone Cave harvestman on September 8, 2007, within Priscilla's Cave. A cave gate currently prevents unauthorized access to this feature.

Yearwood Gold Mine: Yearwood Gold Mine appears as a circular open pit approximately 5.0 feet wide and drops approximately 3.8 feet down. The bottom of the pit is filled with old trash. Lateral extent is primarily to the north and accessible portions of the cave are approximately 47 feet deep. USFWS (2018a, 2018b) does not list Yearwood Gold Mine as a known locality for either the Bone Cave harvestman or the *Batrisodes cryptotexanus*. This feature is not currently gated and is not currently surveyed for karst invertebrates.

Table 16 shows documented species within the Priscilla's Well KFA.

Table 16. Species Documented from the Priscilla's Well KFA

Species		Priscilla's Cave	Priscilla's Well Cave
Permitted Species			
Texella reyesi		√	√
Batrisodes cryptotexanus			√
Other Species			
Crickets	*Ceuthophilus secretus*	√	√
	Ceuthophilus cunicularis	√	√
Arachnids	*Cicurina varians*	√	√
	Cicurina vibora	√	√
	Tayshaneta sp.		√
	Cryptachaea porteri	√	√
	Anipistula sp.		√
	Araneae	√	√
	Leiobunum townsendii		√
	Pseudouroctonus reddelli	√	
Millipedes/ Centipedes	Scutigeridae	√	√
	Lithobiidae		√
	Cambala speobia	√	√
	Scolopendra sp.	√	
Beetles	*Rhadine noctivaga*		√
	Staphylinidae		√
Reptiles/ Amphibians	*Eleutherodactylus marnockii*	√	
	Incilius valliceps		√
Mammals	*Perimyotis subflavus*	√	
	Myotis velifer	√	
Other	Collembola	√	√
	Arenivaga sp.	√	√
	Red Ant	√	
	Assassin Bug	√	
	Earthworm		√
	Isopod	√	√
	Mosquito		√

2.9 Woodland Park Cave Preserve

2.9.1 Introduction

The WCCF agreed to take over management of Duckworth Bat Cave and Cat Cave in 2012 due to a pre-enforcement settlement agreement between the USFWS and Mr. Jimmy Jacobs (President of Shel-Jenn, Incorporated). Shel-Jenn, Inc. dedicated two conservation areas located in the Woodland Park subdivision and called them the Woodland Park Cave Preserve, approximately 2.3 miles northwest from Heritage Oaks (Table 17, Figure 17). The Cat Cave conservation area is 4.6 acres and contains the cave's entire surface drainage area. The Duckworth Bat Cave conservation area is 5.6 acres and contains the cave's entire surface drainage area. Both caves are known to contain the Bone Cave harvestman and both conservation areas contain the majority of the cricket foraging areas proposed by Taylor et al. (2005). Cave gates prevent unauthorized access to Cat Cave and Duckworth Bat Cave while fencing is not currently present.

Table 17. Basic Information for the Woodland Park Cave Preserve

Woodland Park Cave Preserve Information	
Preserve Inception Year	2012
Acreage	10.2
Fence Status	None
Sign Status	Warning signs on all cave gates
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Cat, Duckworth Bat
Non-gated Caves	None

2.9.2 Hydrogeology

Both conservation areas are located within the EARZ. Based on informal studies conducted for the previous landowner, site-specific geology indicates that Duckworth Bat Cave and Cat Cave may be located within the drainage basin for Cowan Spring, which is known to be occupied by the Georgetown salamander (Figure 18).

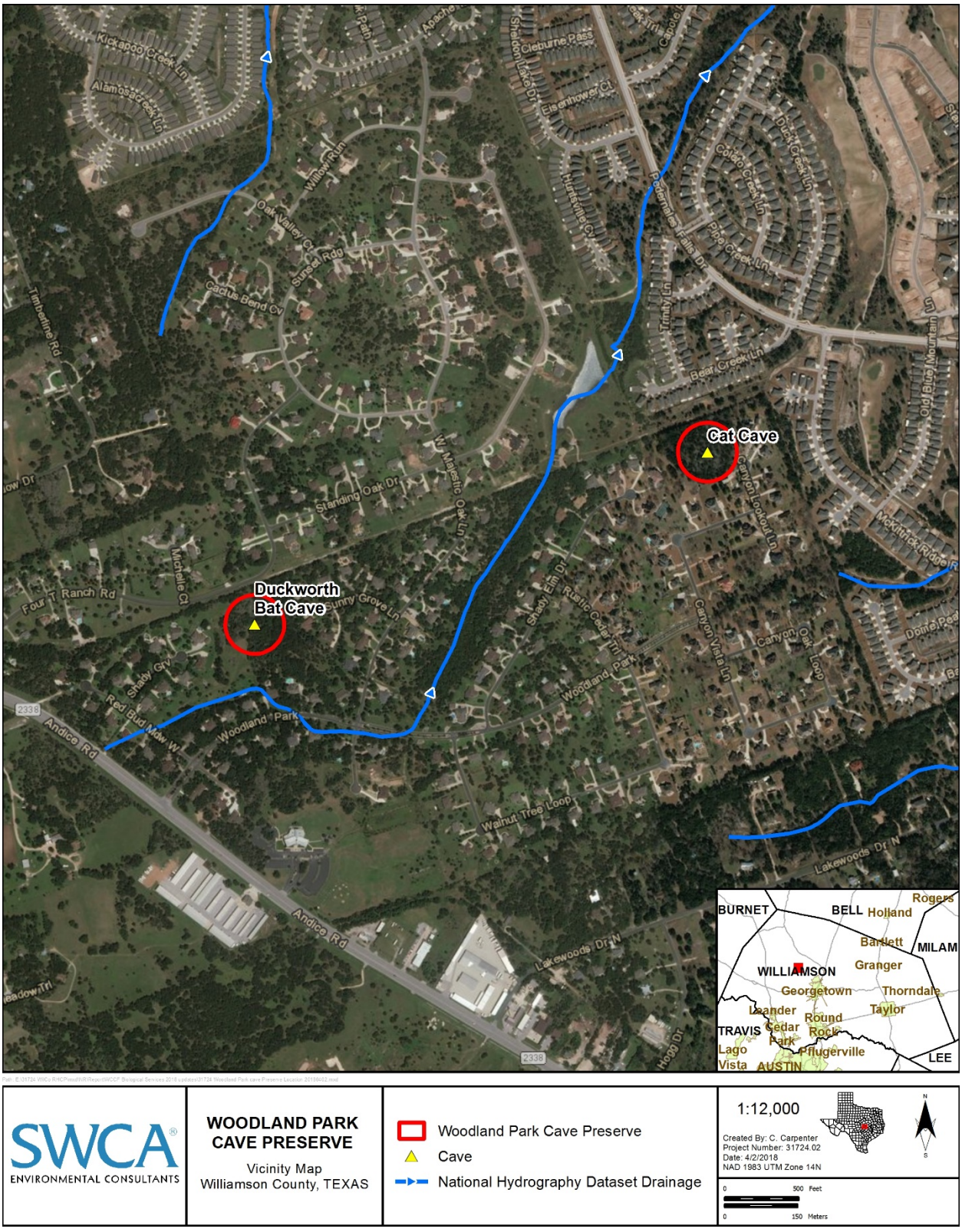


Figure 17. Woodland Park location map.

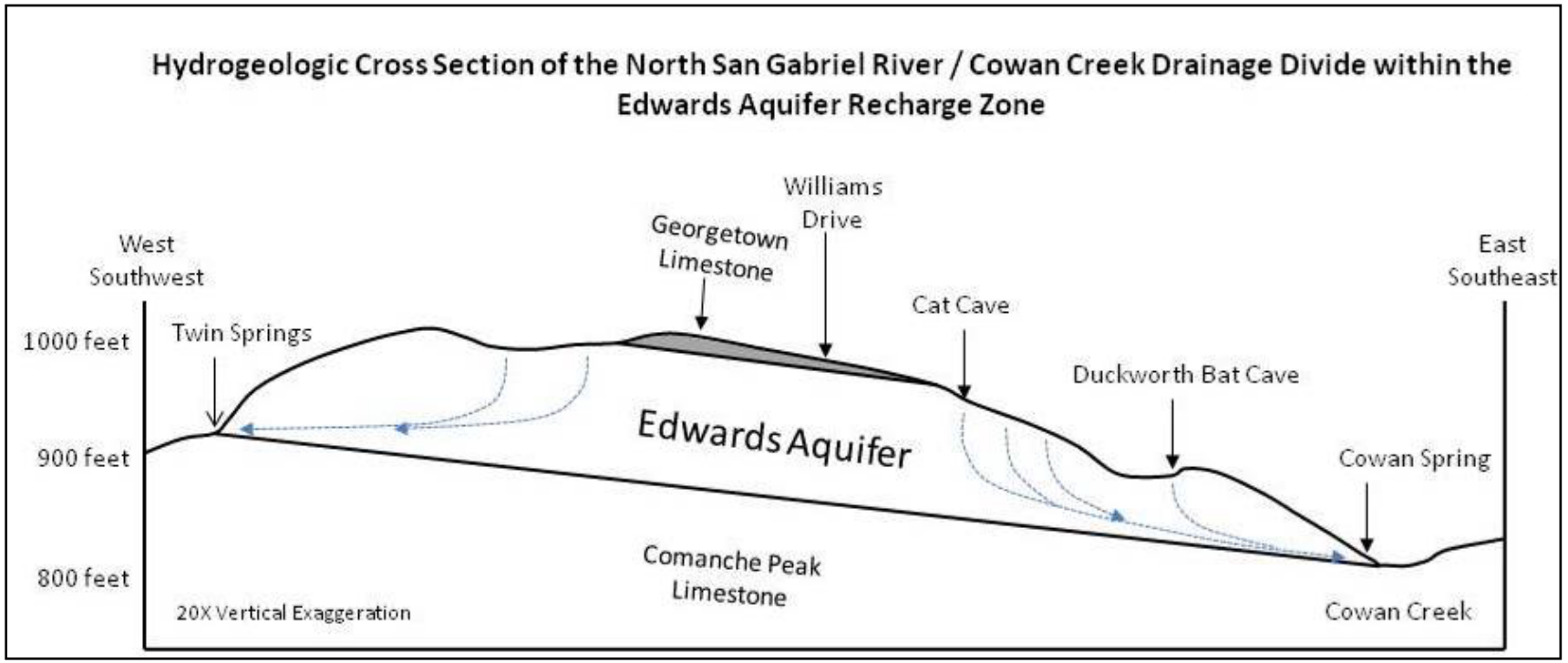


Figure 18. Cat and Duckworth Bat Caves hydrogeologic setting with local springs.

2.9.3 Caves of the Woodland Park Cave Preserve

Cat Cave and Duckworth Bat Cave maps are included in Appendix I.

Cat Cave: This cave description is paraphrased from Mike Warton and Associates (1999). A cedar elm tree canopy hangs over the entrance to the cave (Photograph 27). The portal is approximately 8 feet wide, rimmed with solid rock, and is located in a surface sink depression that measures approximately 30 feet across. The entrance is in-filled with naturally eroded materials. The entrance room measures approximately 40 by 30 feet and gradually slopes to the west. The ceiling height ranges from 1 to 4 feet. Several more passages and rooms exist beyond this point. A gate currently prevents unauthorized access and the Bone Cave harvestman is known from this feature.

Photograph 27. Cat Cave entrance.

Duckworth Bat Cave: This cave description is paraphrased from Mike Warton and Associates (1999). The entrance to the cave is located in a surface sinkhole measuring approximately 10 feet in diameter and is formed along a rock joint trending N20W. The portal is a rock-rimmed vertical shaft approximately 6 by 4 feet. After a 27-foot drop to the floor, the room below extends in all directions with ceiling heights between 2 and 6 feet. After excavation, the cave measured at 528.5 feet long and 51.3 feet deep (Photographs 28 and 29). A gate currently prevents unauthorized access and the Bone Cave harvestman is known from this feature.

Table 18 shows documented species within the Woodland Park Cave Preserve.

Photograph 28. Duckworth Bat Cave entrance.

Photograph 29. Duckworth Bat Cave entrance pit.

Table 18. Species Documented from the Woodland Park Preserve

Species		Duckworth Bat Cave	Cat Cave
Permitted Species			
Texella reyesi		√	√
Other Species			
Crickets	*Ceuthophilus secretus*	√	√
	Ceuthophilus cunicularis	√	√
Arachnids	*Cicurina varians*	√	√
	Cicurina vibora	√	√
	Cryptachaea porteri	√	√
	Eidmanella sp.	√	
	Araneae	√	√
	Tayshaneta sp.	√	√
	Anipistula sp.	√	
	Leiobunum townsendii	√	
	Pseudoscorpion		√
	Pseudouroctonus reddelli	√	√
Millipedes/ Centipedes	*Cambala speobia*	√	√
	Speodesmus bicornorus	√	√
	Scutigeridae	√	√
	Lithobiomorpha	√	
	Scolopendra sp.	√	
Beetles	*Anillinus* sp.		√
	Rhadine noctivaga	√	
	Staphylinidae	√	√
Reptiles/ Amphibians	*Rana berlandieri*	√	√
	Heterodon platirhinos	√	
	Thamnophis sp.	√	
	Incilius nebulifer		√
	Eleutherodactylus marnockii	√	√
Mammals	*Perimyotis subflavus*	√	
	Myotis valliceps	√	√
Other	*Arenivaga* sp.	√	√
	Gnat	√	√
	Fly	√	√
	Mosquito	√	√
	Collembola	√	√
	Moth		√
	Earthworm	√	√
	Flea		√
	Assassin Bug	√	√
	Isopod	√	√
	Helicodiscus sp.	√	

2.10 Karankawa Cave Karst Fauna Area

2.10.1 Introduction

Williamson County closed on the acquisition of the Karankawa Cave KFA in 2012, as approved by the USFWS. The 61.7-acre Karankawa Cave KFA (Table 19) is located south of SH 195 and approximately 7 miles northwest from the City of Georgetown (Figure 19).

Vegetation within the Karankawa Cave KFA consists of plateau live oak-juniper savanna on gently rolling uplands generally draining westward. A minor upland tributary to Berry Creek runs through the KFA's middle from northeast to southwest and the drainage orientation controlled by a fault that has heavily influenced karst development. The Karankawa Cave KFA boundaries accommodate a biological connection between subsurface mesocaverns and surface flora and fauna within the KFA to the Berry Creek floodplain. The Karankawa Cave KFA is within the northern BFZ and within the Edwards Aquifer's northern segment recharge zone.

The Karankawa Cave KFA contains eight caves (see Figure 19) and two endangered karst invertebrate species, along with at least six "additional species" addressed in the RHCP (SWCA et al. 2008). The Karankawa Cave KFA and associated caves were partially documented and surveyed for biota in 1994 for the Sun City, Georgetown take avoidance plan. Karankawa Cave is known to contain the Bone Cave harvestman and the Dragonfly Cave mold beetle; while War Party, Polaris, and Pemmican Caves are known to contain the Bone Cave harvestman. *Batrisodes cryptotexanus* may yet be detected in War Party Cave; while the presence of other non-listed troglobitic species in Pemmican, Polaris, and Snake Dancer caves indicate significant likelihood of detecting the listed species in those locations.

Fencing currently separates the Karankawa Cave KFA from Ronald Reagan Boulevard, but does not otherwise encircle the entire preserve. Developmental encroachment has continued and the need to separate the eastern and western preserve boundaries has increased. Cave gates currently prevent unauthorized access to Angostura and Pemmican Caves; whereas Armadon, Karankawa, Polaris, Quahadi, Snake Dancer, and War Party Caves are not gated.

Table 19. Basic Information for the Karankawa Cave KFA

Karankawa Cave KFA Information	
Preserve Inception Year	2012
Acreage	61.7
Fence Status	Northwest boundary fenced along Ronald Reagan Blvd
Sign Status	None
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Pemmican, Angostura
Non-gated Caves	Armadon, Karankawa, Polaris, Quahadi, Snake Dancer, War Party

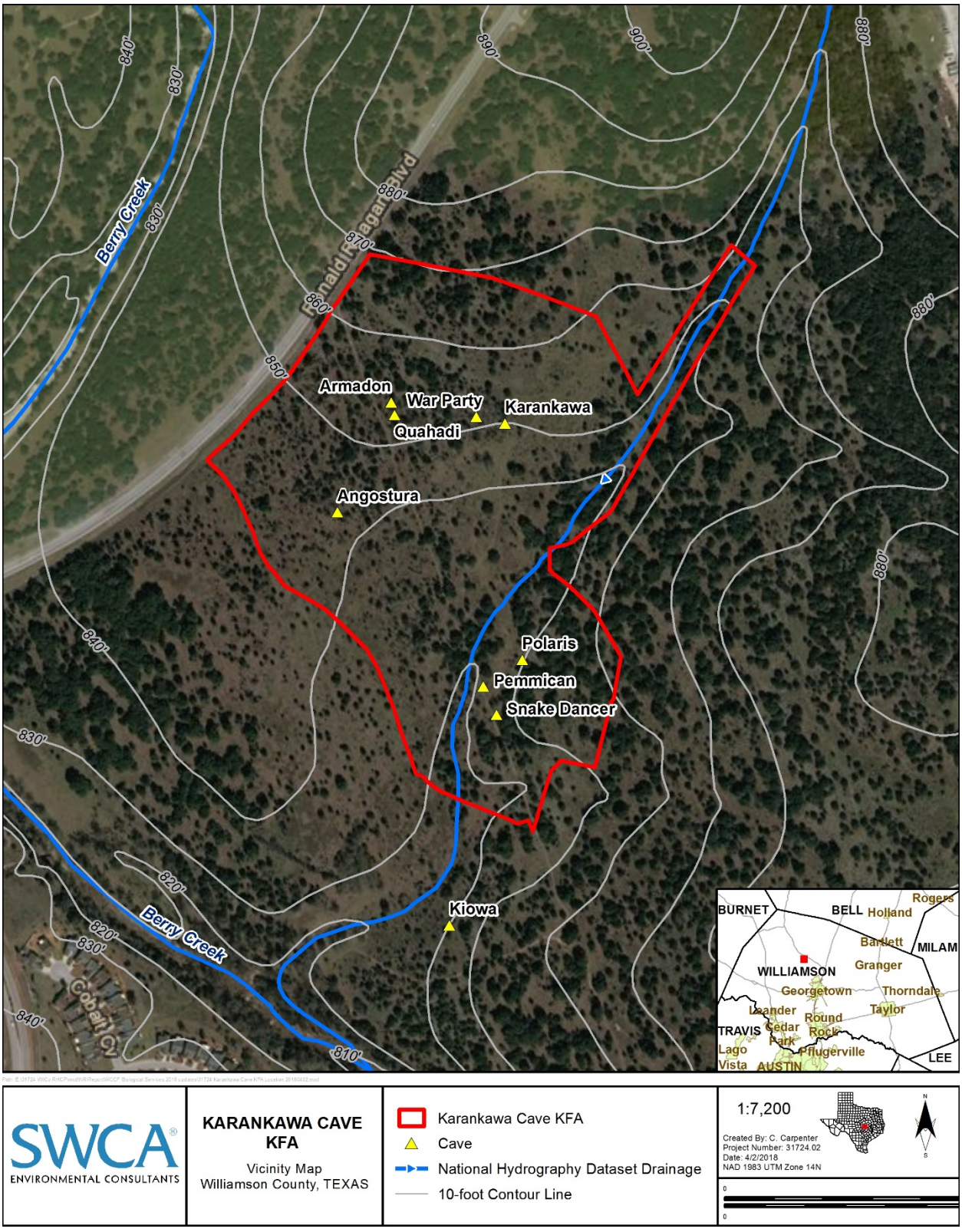


Figure 19. Karankawa Cave KFA location map.

2.10.2 Hydrogeology

The Karankawa Cave KFA occupies a relatively flat upland area that drains primarily south and west into an unnamed tributary to Berry Creek. Total relief is approximately 40 feet and ranges from approximately 830 to 870 feet amsl. The easement is entirely underlain by Edwards limestone, which is up to 120 feet thick in the area (Collins 2002; Senger et al. 1990).

The Karankawa Cave KFA is within the EARZ northern segment and groundwater recharge primarily occurs in areas where the Edwards Group and upper confining units are exposed at the surface. The tributary location and path appears controlled by the previously mentioned fault. Mapped contact elevations between the Edwards, Comanche Peak and Georgetown formations indicate the fault creates an approximately 15-foot displacement (Figure 20). Cave formation was likely driven by fault-induced, fracture-enhanced permeability. Caves within the Karankawa Cave KFA show fractures related to this fault influence the morphology. Pemmican, Polaris, and Snake Dancer Caves are elongated along fractures that are parallel or sub-parallel to the fault; while Karankawa, War Party, and Angostura caves are influenced by conjugate faults that are roughly perpendicular to the fault. Fracture-driven solutional enlargement has likely enhanced mesocavern connectivity along and across the fault plane.

Rainfall that is not lost through runoff or evapotranspiration likely becomes groundwater by infiltrating through the permeable Edwards limestone. The on-site creek bed is likely an efficient area of focused recharge. Based on the available information, groundwater within the KFA likely flows northeast to southwest mirroring the trend of the caves in the northern cluster. As it approaches the fault, the increasing abundance of vertical fractures likely provides numerous avenues for vertical infiltration to the water table that occurs at just above 800 feet, according to nearby well records.

2.10.3 Caves of the Karankawa Cave Karst Fauna Area

Cave maps are included in Appendix J.

Angostura Cave: The entrance to Angostura Cave drops 4 feet to a ledge-like landing that slopes downward into the cave. The interior is a low, wide irregular room measuring approximately 20 by 15 feet by 2 feet high with an uneven floor and nodular ceiling. The floor is soil and clay with breakdown blocks and boulders. The cave seems to have formed by the collapse of a deeper void network and may be a strong indication of mesocavern habitat related to other caves in the northern cluster. A cave gate is currently installed on Angostura Cave.

Armadon Cave: Armadon Cave is a small, shallow cave formed along a bedding plane and measures approximately 10 by 15 feet, with at least two humanly inaccessible extensions into the mesocavern matrix and seems to have formed by a deeper void network collapse. This cave is currently not gated.

Karankawa Cave: Karankawa Cave is the largest and deepest cave within the Karankawa Cave KFA and is approximately 92 feet long by 40 feet wide and 21.6 feet deep at its lowest point. Passage proceeds east and then south from the entrance in an arc surrounding a central collapse zone. The WCCF installed a cave gate on Karankawa Cave in 2020. Both the Bone Cave harvestman and the Dragonfly Cave mold beetle are documented from this location.

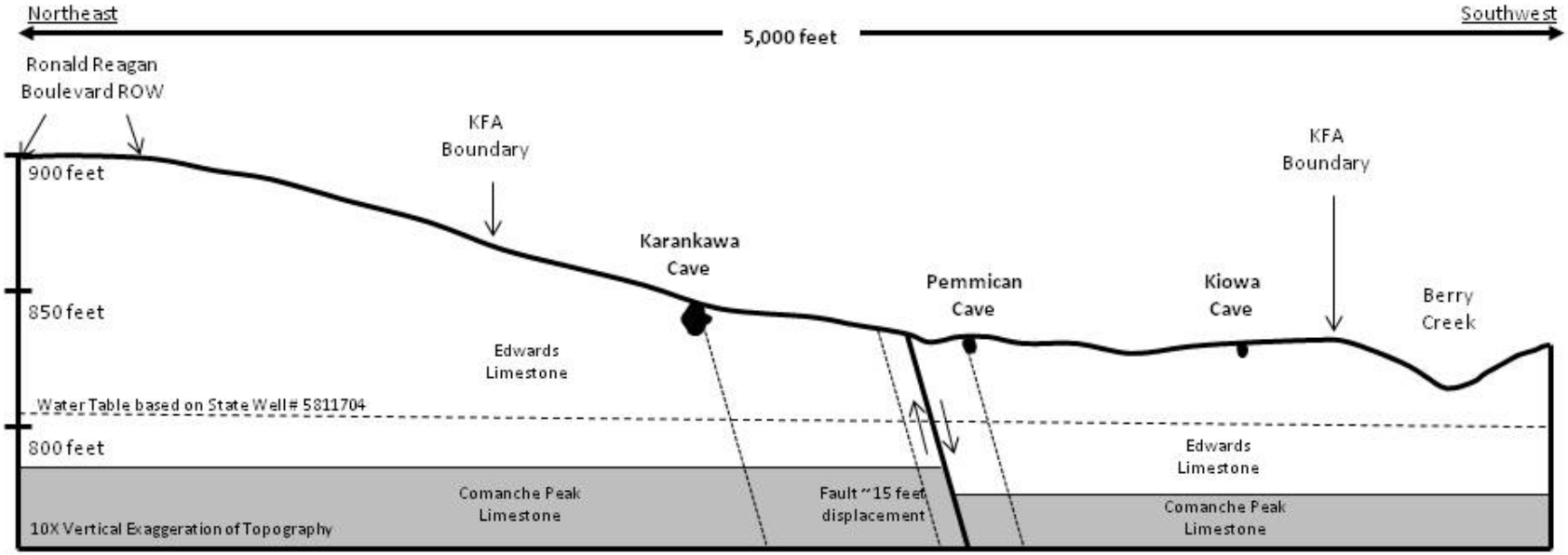


Figure 20. Karankawa Cave KFA hydrogeology.

Pemmican Cave: Pemmican Cave entrance measures approximately 2 feet long by 1.5 feet wide in solid bedrock, and drops about 10 feet to a floor lined with sediment and small rocks. The main cave extends northeast from the entrance and is a roughly rectangular room measuring approximately 30 feet wide by 50 feet long by up to 4 feet high. An opening to the south becomes too low for human exploration after a few feet. A breakdown-floored alcove in the main room's southeast side gradually becomes too narrow to access. The main room terminates in a narrow passage formed along a joint trending N18E. Near the end of the cave, it is possible to descend through breakdown to enter a low descending lower level passage that extends back towards the entrance for about 25 feet before splitting and becoming too small, which is the deepest cave extent at 17.3 feet below the entrance. Pulverulite is exposed in some places and speleothems are abundant in several areas. Polaris, Pemmican and Snake Dancer Caves are all formed within the fault's damage zone fault and are likely interconnected through mesocaverns. A cave gate is currently installed on Pemmican Cave and the Bone Cave harvestman is documented from this location.

Polaris Cave: Polaris Cave consists of a low, broad chamber formed along a bedding plane with a footprint approximately 50 feet in diameter. Speleothems in the chamber south from the entrance are aligned with fractures parallel to the fault, which passes approximately 100 feet northwest. No cave gate is on this feature, and the Bone Cave harvestman is documented from this location.

Quahadi Cave: Quahadi Cave consists of a low, broad chamber formed along a bedding plane with a footprint measuring approximately 30 feet in diameter. The cave was likely formed by a deeper void network collapse, and there is a strong mesocavern habitat indication related to other caves in the northern cluster. No cave gate is on Quahadi Cave.

Snake Dancer Cave: The entrance to Snake Dancer Cave measures approximately 6 feet wide by 8 feet long by 4.5 feet deep. A 6-foot-wide crawlway leads into an irregular chamber measuring approximately 45 feet long and between 15 and 30 feet wide. The rear cave extent slopes down at about a 45-degree angle to the deepest point at 9 feet below the entrance. Two passages at the end of the room extend for a few feet before becoming too low to continue. One of these passages is formed along a joint trending N18E and investigators detected airflow. Several large breakdown blocks are present in the main room. The cave contains numerous small speleothems and several massive flowstone deposits. The floor consists largely of black soil and clay. Snake Dancer Cave is not currently gated.

War Party Cave: War Party Cave consists of a low, broad chamber formed along a bedding plane with a footprint measuring approximately 60 feet in diameter. The cave was likely formed by a deeper void network collapse and there is a strong mesocavern habitat indication related to other caves in the northern cluster. The cave drains to a bedrock fracture running perpendicular to the fault to the southeast. The cave's overall morphology is elongated, and the fracture indicates that War Party may have been formed by the collapse of a deeper, fracture-controlled groundwater conduit. That flow would likely have been intercepted by vertical conduits as it approached the fault, which delivered the groundwater to the aquifer base level. Speleothems in the chamber's south end are aligned with fractures parallel to the fault, which passes approximately 100 feet northwest. A cave gate is not currently installed on War Party Cave and the Bone Cave harvestman is documented from this location.

Table 20 shows documented species within the Karankawa Cave KFA.

Table 20. Species Documented from the Karankawa Cave KFA

Species		Angostura	Armadon	Karankawa	Pemmican	Polaris	Quahadi	Snake Dancer	War Party
Permitted Species									
Batrisodes cryptotexanus				√					
Texella reyesi				√	√	√			√
Other Species									
Crickets	*Ceuthophilus secretus*	√	√	√	√	√	√	√	√
	Ceuthophilus cunicularis			√					√
Arachnids	*Cicurina vibora*			√	√	√		√	√
	Cicurina varians		√	√	√	√	√	√	√
	Eidmannella sp.			√	√	√			√
	Agyneta sp.				√				√
	Anapistula sp.			√		√			√
	Achaearanea sp.				√	√			
	Tayshaneta sp.			√	√				√
	Cryptachaea porteri	√	√	√	√		√		√
	Leiobunum townsendii			√		√			
	Pseudoscorpion								√
	Pseudouroctonus reddelli		√	√	√	√	√		√
Millipedes/ Centipedes	*Speodesmus bicornourus*			√	√	√		√	√
	Cambala speobia		√	√	√	√	√	√	√
	Oxidus gracilis				√				
	Scolopendra sp.				√			√	√
	Lithobiidae		√						√
	Scutigeridae				√	√	√	√	
Beetles	Coleoptera (Surface Beetles)				√	√		√	
	Batrisodes uncicornis			√	√			√	√
	Beetle larva				√				
	Tachyini sp.			√	√			√	
	Staphylinidae		√	√	√	√	√	√	√
	Dermestidae			√					
	Rhadine noctivaga			√	√	√			√

Species		Angostura	Armadon	Karankawa	Pemmican	Polaris	Quahadi	Snake Dancer	War Party
Reptiles/ Amphibians	*Crotalus atrox*		√				√		
	Plethodon albagula					√			
	Incilius valliceps			√					√
	Eleutherodactylus marnockii		√		√	√		√	√
Mammals	*Procyon lotor*				√				√
	Didelphis virginiana							√	
	Sylvilagus floridanus					√			
	Perimyotis subflavus		√	√					
	Myotis velifer		√	√				√	
Other	*Texoreddellia* sp.		√	√		√			√
	Campodeidae				√				√
	Arenivaga sp.	√			√			√	√
	Isopod		√	√				√	
	Surface Silverfish	√			√				√
	Collembola	√	√	√	√	√	√	√	√
	Assassin Bug		√	√	√	√		√	√
	Hemiptera								√
	Diptera				√				
	Gnat		√	√	√	√			
	Flea		√						
	Mite			√	√	√	√	√	
	Red Ant				√	√			
	Helicodiscus sp.			√	√	√			√
	Surface Snail			√		√			
	Moth	√	√	√				√	√
	Mosquito	√		√		√	√		√
	Proscoptera						√		
	Earthworm		√	√	√				

2.11 Coffin Cave Preserve

2.11.1 Introduction

Coffin Cave has long been one of the most notable caves in Central Texas. Written descriptions go back to at least 1958 and the original Texas Cave Survey (Widener 1958). Since 1963—when cave explorers from Southwestern University first mapped Coffin Cave—it has been known as one of the deepest and most extensive caves in Williamson County. The somewhat ominous name of the cave stemmed from the observation that the vertical entrance shaft is roughly coffin-shaped in plan view. Adding to the mystique of the cave is that its location had been lost to the caving community by the time of the listing process for the Travis and Williamson County karst invertebrates in the early 1990s. The location had not been lost to Mr. Marvin Andres, who owned the cave for more than 50 years and kept access generally restricted. Williamson County purchased the cave from Mr. Andres' heirs in 2014 and established the approximately 39.4-acre Coffin Cave Preserve (Table 21, Figure 21).

Fencing is erected across the entire Coffin Cave Preserve and current warning signs aid in trespassing prevention. A steel "A-frame" structure was erected across the Coffin Cave entrance in December 2016 to facilitate ingress/egress for biota monitoring and full cave gate installation was completed in 2017 (Photograph 30).

Table 21. Basic Information for the Coffin Cave Preserve

Coffin Cave Preserve Information	
Preserve Inception Year	2014
Acreage	39.4
Fence Status	Fully fenced
Sign Status	Signs posted around perimeter
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Coffin
Non-gated Caves	None

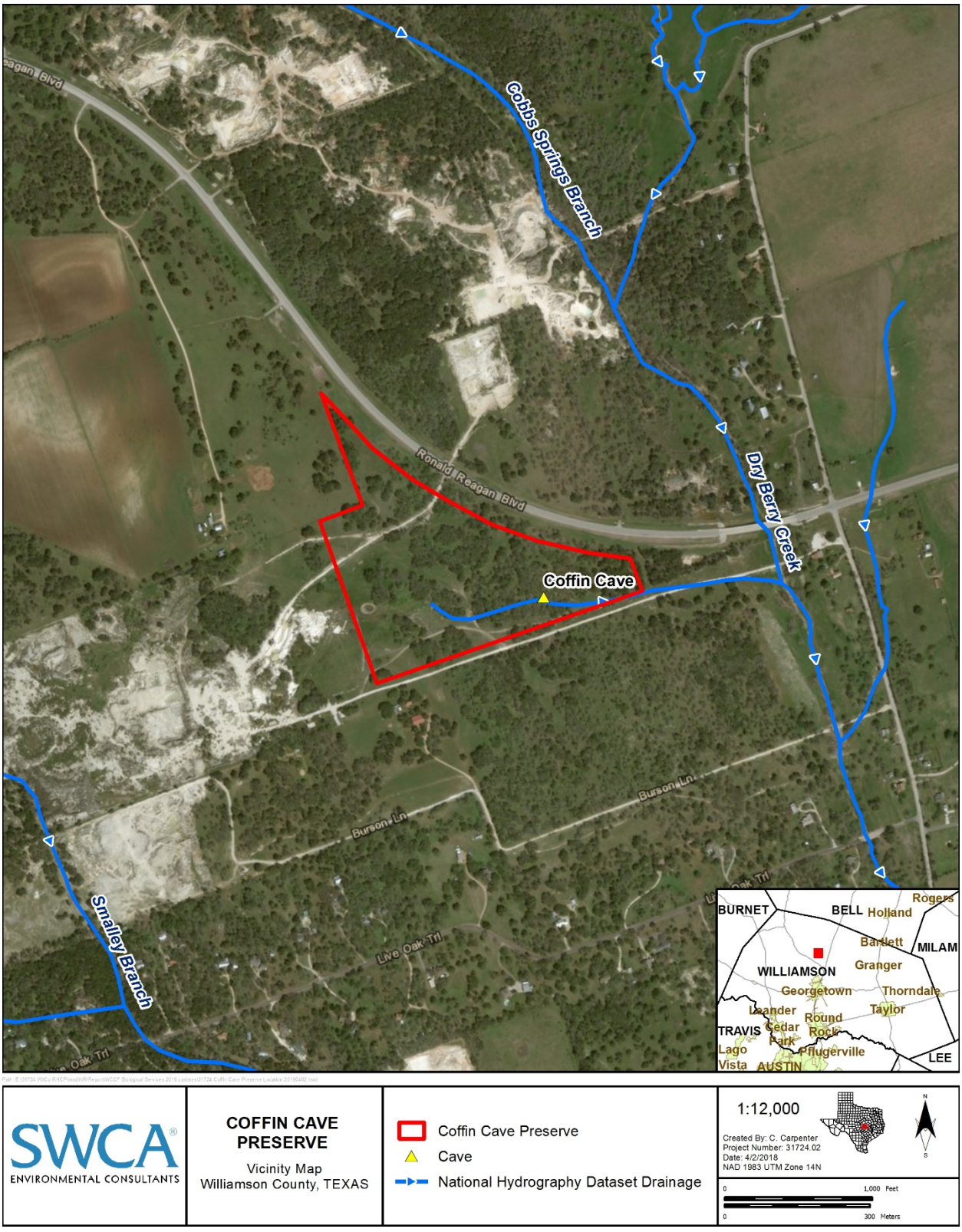


Figure 21. Location map for the Coffin Cave Preserve.

Photograph 30. Cave gate being used for the first time (2017) to lower biologists into Coffin Cave.

2.11.2 Hydrogeology

Coffin Cave is a highly efficient aquifer recharge feature whose entrance is immediately adjacent to an ephemeral surface drainage channel. Coffin Cave Preserve is mostly atop the Georgetown Formation even though the entire property is within the EARZ. The top of the Edwards Formation is only exposed on the immediate area around the cave entrance and along the Coffin Cave Preserve's lowest lying portions (along the drainage channel adjacent to the cave entrance). Runoff predominates over recharge on the less-permeable Georgetown limestone during rain events. Water is effectively routed to the Edwards outcrop where it enters Coffin Cave. The cave's surface drainage basin (approximately 58 acres) is quite large compared to the average Edwards Formation cave. Some of the original drainage basin may have been removed by the quarry immediately west from the Coffin Cave Preserve (see Figure 21). The entirety of the drainage basin of Coffin Cave could not be included within the conservation area due to the basin's large size.

Coffin Cave's other notable hydrological condition relates to its stratigraphic penetration through the Edwards Aquifer's upper half. Surface runoff is delivered almost to the aquifer base level in a matter of minutes during heavy rainfall events. The cave entrance is a solution-enlarged fracture (trending at approximately 125 degrees) measuring 7 feet long by 2 feet wide. The entrance shaft drops approximately 45 feet from its surface expression. Extensive lateral passage continues from the base of the entrance pit to the southeast and north before reaching approximately 60 feet deep.

The Edwards limestone contains three distinct zones with regards to hardness and bedrock competency: an upper hard layer, a middle softer layer, and a lower hard layer. The Coffin Cave map produced by ZARA Environmental ([ZARA] 2010) seems to show that the cave morphology evolved in response to this stratified heterogeneity within the Edwards Formation. The profile of the cave shows that the upper approximately 42.6 feet of the cave comprises a vertical shaft formed along a prominent bedrock fracture trending from the

northwest to the southeast (Photograph 31). Cave development was restricted to the fracture plane within this zone. Cave morphology is predominantly lateral where cave development followed the softer beds within the Edwards Formation below this zone at between 42.6 and 55.7 feet (Figure 22).

Photograph 31. The Coffin Cave entrance is a vertical shaft dropping into the Edwards Formation from the contact with the overlying Georgetown Formation.

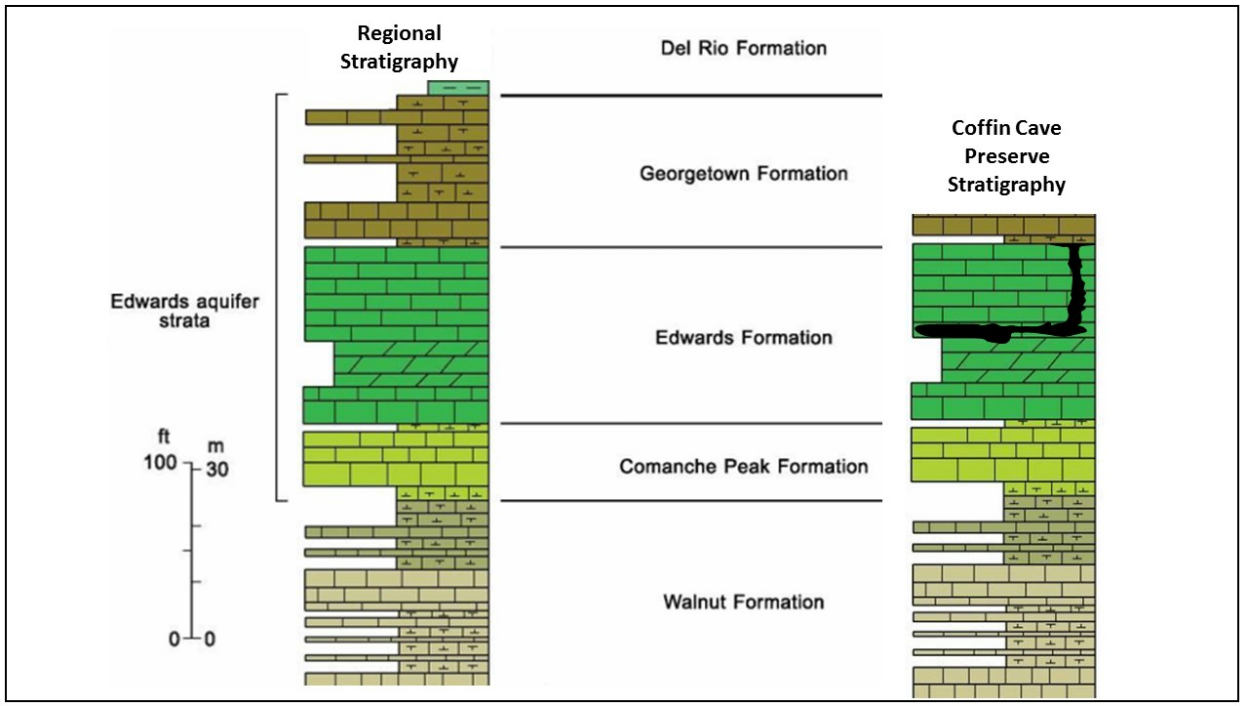


Figure 22. Coffin Cave is roughly formed in the Edwards Formation's upper half.

2.11.3 Caves of the Coffin Cave Preserve

Cave map is included within Appendix K.

Coffin Cave: Coffin Cave is the only known cave within the Coffin Cave Preserve. Coffin Cave is perhaps best known as the source type locality for the endangered Coffin Cave mold beetle (USFWS 1994b). Subsequent taxonomic work has demonstrated that this was a misnomer, however, as the troglobitic mold beetle from this cave is now known to belong to *Batrisodes cryptotexanus*, the first diagnostic specimen of which came from Dragonfly Cave in Sun City Georgetown. Chandler et al. (2009) proposed new common names for both species: Inner Space Caverns mold beetle for *B. texanus* and Dragonfly Cave mold beetle for *B. cryptotexanus*. Table 22 summarizes cave fauna found by ZARA (2010) and WCCF-sponsored karst biota surveys. The cave is known to contain historical cave graffiti and a nearly full bear skeleton. Photograph 32 depicts the interior of Coffin Cave, immediately adjacent to the vertical drop.

Table 22. Species Documented from the Coffin Cave Preserve

Species		Coffin Cave
Permitted Species		
Batrisodes cryptotexanus		√
Texella reyesi		√
Other Species		
Crickets	*Ceuthophilus cunicularis*	√
	Ceuthophilus secretus	√

Species		Coffin Cave
Arachnids	*Cicurina vibora*	√
	Tayshaneta sp.	√
	Cicurina varians	√
	Eumesosoma roeweri	√
	Eidmannella pallida	√
Millipedes/ Centipedes	*Scolopendra* sp.	√
	Cambala speobia	√
Beetles	Coleoptera	√
	Rhadine noctivaga	√
	Staphylinidae	√
	Ptomaphagus cavernicola	√
Mammals	*Procyon lotor*	√
	Perimyotis subflavus	√
Other	*Lithobates berlandieri*	√
	Earthworm	√
	Collembola	√

Photograph 32. Coffin Cave entrance immediately adjacent to the vertical drop.

2.12 Beck Commons Preserve

2.12.1 Introduction

The Beck Commons Preserve is a vegetated 4.2 acre tract completely surrounded by development. There is a large apartment complex immediately northwest of the Beck Commons Preserve and commercial development on all other sides. Beck Sewer Cave continued to function as a sewer until around 1994 when local speleologist Mike Warton conducted a trip to the cave and noted the presence of pools of foul water with maggots. WCCF acquired Beck Commons Preserve in 2014.

Written descriptions for Beck Sewer Cave and Beck Trash Cave go back to at least 1958 and the original Texas Cave Survey (Widener 1958). The Beck Sewer Cave name stems from the fact that it was fitted to operate essentially as a septic tank for a ranch house associated with the Beck Ranch operation in 1954. Most land surrounding the Beck Commons Preserve (Table 23) was part of the historic Beck Ranch (Figure 23). Beck Sewer Cave was made accessible to researchers including James Reddell (Texas Memorial Museum) and his mentor Robert W. Mitchell in January 1964. At that time, the researchers made observations as to the cave's general size and orientation; noted guano deposits from a former bat colony; and made a biological collection including blind spiders, harvestmen (almost certainly the Bone Cave harvestman), and beetles. Beck Sewer Cave remains an opportunity for the study of excess nutrient input on troglobitic ecosystems. The following quote is included in the Texas Speleological Survey report from that trip:

> The cave once documented the largest population of *Rhadine* in the state. Literally thousands were observed in all parts of the cave and some were seen eating cricket eggs.

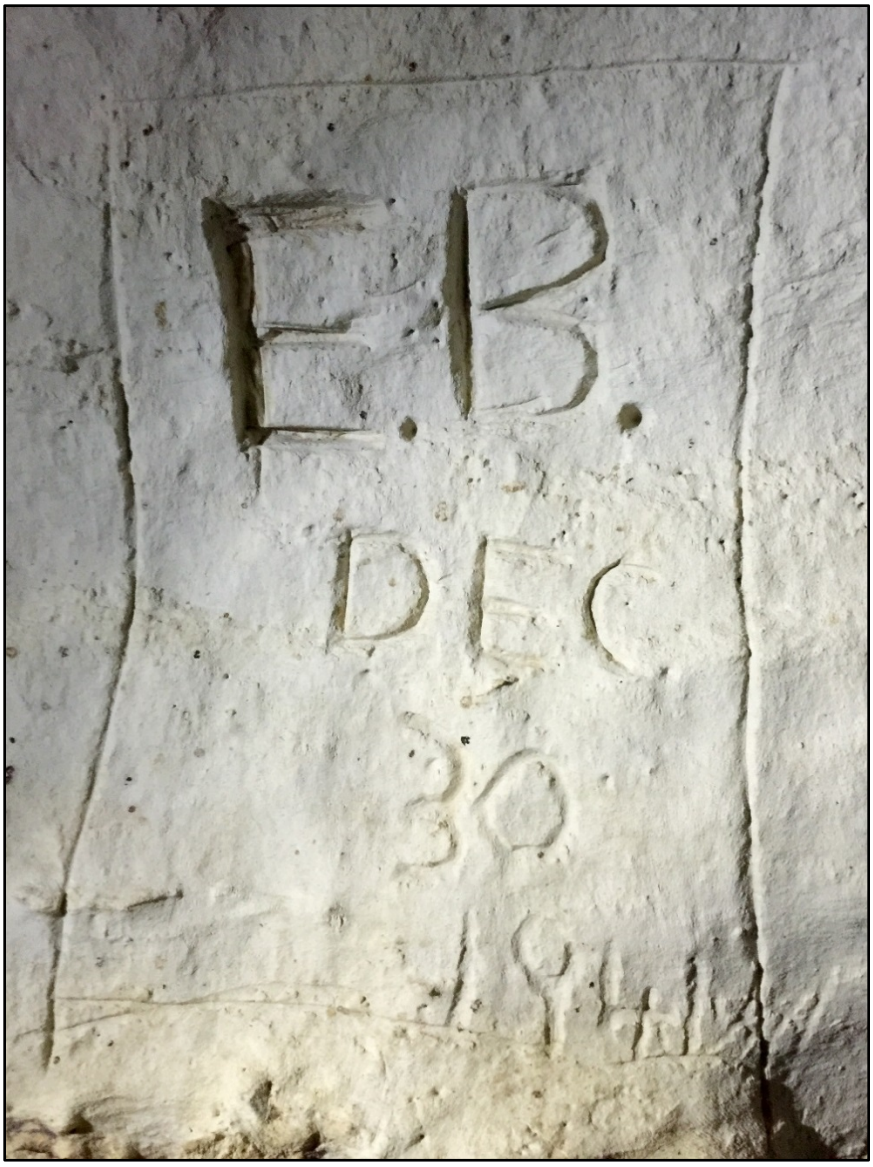
Notable historical graffiti is located in the dropdown to the lowest room (Photograph 33) and depicts the signature of E.O. Beck from December of 1941—just a few weeks after the Pearl Harbor attacks that brought the United States into World War II. Local lore has it that the caves of Beck Ranch had been explored as potential bomb shelters during the Cold War; perhaps that idea had an earlier origin.

The entirety of this preserve is fenced and appropriate signage has been placed on the fence. A cave gate is atop Beck Sewer Cave and Beck Trash Cave.

Table 23. Basic Information for the Beck Commons Preserve

Beck Commons Preserve Information	
Preserve Inception Year	2014
Acreage	4.2
Fence Status	Fully fenced
Sign Status	Warning signs on all cave gates and on fencing
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Beck Sewer, Beck Trash
Non-gated Caves	None

Figure 23. Beck Commons Preserve location map.



Photograph 33. Inscription from Eugene Beck dating to 1941.

2.12.2 Hydrogeology

The Beck Commons Preserve is located within the EARZ and Beck Sewer Cave is formed within the Edwards limestone. Cave extent, morphology, and fracture control indicates it is likely that the Beck Commons Preserve acts to provide recharge despite the surface catchment area not being well defined. Recharge may be suppressed in the northeast corner where fill material 1 to 2 feet deep has been deposited. Beck Sewer Cave allows access to lower levels, with clearly phreatic chambers that are relatively unaffected by the process of collapse and breakdown. The Beck Sewer Cave's lower level (Photograph 34) retains an underground stream appearance that has been drained of permanent flow by the aquifer's base level natural lowering. Active recharge can be observed within the cave most prominently in the lower levels.

Photograph 34. Beck Sewer Cave's lower level showing phreatic passage (white limestone) adjacent to reformed limestone (brown) cave wall.

2.12.3 Caves of the Beck Commons Preserve

Cave maps are included within Appendix L.

Several early cave descriptions on the Beck Commons Preserve had the wrong cave map associated with Beck Sewer Cave and the wrong cave name associated with Beck Trash Cave. The map for nearby Beck Ranch Cave (a cave outside the Beck Commons Preserve) had been associated with Beck Sewer Cave and the name "Beck Tin Can Cave" had been applied to Beck Trash Cave. Both sources of confusion were corrected with a renewed mapping effort in 2010.

Beck Sewer Cave and Beck Trash Cave are mapped as a single, very large cave. The entrance to Beck Sewer Cave is approximately 20 feet long and opens up into a large (~100 foot long) chamber that narrows to a muddy hallway, which then opens up to reveal a long (~50 long) travertine wall. This portion of Beck Sewer Cave includes large speleothems, pools of water with aquatic life, and ultimately a narrow constriction that is mapped to connect with Beck Trash Cave (Appendix L). Additionally, an unmapped portion of the Beck Sewer Cave is attached to the north side of the large room (called the Ren & Stimpy Room on the cave map, Appendix L) near the entrance. An approximately 10 foot drop reveals a maze a low crawlspaces that likely doubles the size of the mapped cave. The back of the unmapped cave is characterized by chalky limestone within conduits likely formed under phreatic conditions.

Beck Trash Cave is within the Beck Commons Preserve but will not be surveyed for endangered karst biota due to its dry atmospheric conditions and relative insignificance compared to Beck Sewer Cave. These features are linked and the Bone Cave harvestmen is known from both caves.

Table 24 shows documented species within the Beck Commons Preserve.

Table 24. Species Documented from the Beck Commons Preserve

Species		Beck Sewer
Permitted Species		
Texella reyesi		√
Other Species		
Crickets	*Ceuthophilus cunicularis*	√
	Ceuthophilus secretus	√
Arachnids	*Anapistula* sp.	√
	Cicurina browni	√
	Cicurina varians	√
	Araneae	√
	Mygalomorph (Tarantula)	√
	Cryptachaea porteri	√
	Tick	√
	Pseudoscorpion	√
Millipedes/ Centipedes	*Speodesmus bicornourus*	√
	Cambala speobia	√
	Lithobiomorpha	√
	Scutigeridae	√
Beetles	*Rhadine subterranea*	√
	Tachyini sp.	√
	Batrisodes uncicornis	√
	Staphylinidae	√
Aquatics	White Planarian	√
	Copepod	√
	Bloodworm	√
	Ostracod	√
Mammals	*Myotis velifer*	√
	Perimyotis subflavus	√
Other Species	*Eleutherodactylus marnockii*	√
	Isopod	√
	Collembola	√
	Dipluran	√
	Tominotus sp.	√
	Surface Snail	√
	Helicodiscus sp.	√
	Assassin Bug	√
	Fly	√
	Gnat	√
	Black Ant	√

2.13 Shaman Cave Karst Fauna Area

2.13.1 Introduction

The Shaman Cave KFA is located north from Shell Road between Williams Drive (FM 2338) and SH 195 near the City of Georgetown (Table 25, Figure 24). Most of the 81.7-acre Shaman Cave KFA was originally set aside for karst conservation under the take avoidance plan developed by the Sun City Georgetown developers in 1994. The Shaman Cave KFA land acquisition was not fully complete as of December 31, 2020, due to unresolved conservation easement issues. However, such issues are anticipated to be resolved in 2021. The Bone Cave harvestman is documented from both Shaman and Powwow Caves, while *B. cryptotexanus* is documented from Shaman Cave. However, the distribution of six smaller caves within the Shaman Cave KFA indicates extensive mesocavern habitat presence between and around the large caves. Other local endemic cave fauna documented from the Shaman Cave KFA include *Cicurina vibora, Speodesmus bicornourus,* and *Rhadine noctivaga,* all are additional species addressed in the RHCP (SWCA et al. 2008).

The flora and fauna have begun a successional transition from overgrazed, managed grassland to a predominantly native woodland/grassland mosaic providing suitable habitat for native invertebrates, reptiles and amphibians, and bird species with the cessation of ranching activities more than 20 years ago. The Shaman Cave KFA occurs within the GCWA range and woodland may become suitable for GCWAs over time.

Table 25. Basic Information for the Shaman Cave KFA

Shaman Cave KFA Information	
Preserve Inception Year	2016
Acreage	81.7
Fence Status	None
Sign Status	None
Baseline Vegetation Survey Date	None
Owner	WCCF- Final land acquisition still underway as of December 31, 2020
Gated Caves	Powwow, Shaman
Non-gated Caves	Borgarigmie Pit, Florence No. 18, Haft Shaft, Hatchet, Shawntee Pit, Squaw

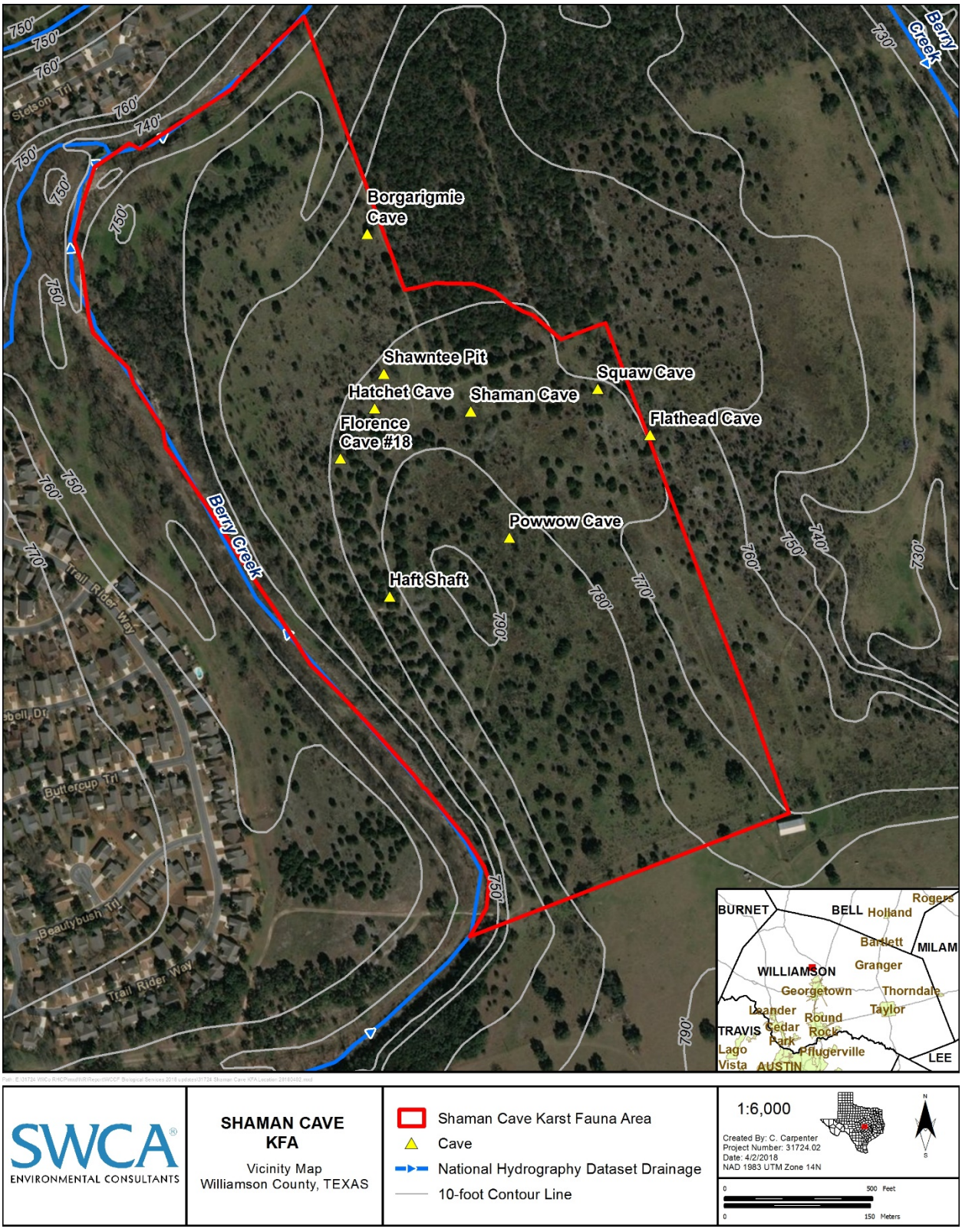


Figure 24. Shaman Cave KFA location map.

2.13.2 Hydrogeology

The Shaman Cave KFA occurs primarily on a broad, flat upland drained primarily to the west, north, and east by a distinctive bend in Berry Creek. Total relief across Shaman Cave KFA is approximately 50 feet ranging from 740 to 790 feet amsl. The Shaman Cave KFA is entirely underlain by the Edwards Limestone. The species-occupied caves occur primarily within the upper 20 feet of the hilltop and most cave entrances are formed between 770 and 780 feet amsl. Most traversable cave passage occurs between 760 and 770 feet amsl (Collins 2005; Senger et al. 1990) (Figure 25). This distribution suggests the presence of a highly developed, stratigraphically controlled cavernous zone of at least 25 acres, which likely extends somewhat continuously beneath the hilltop. This karstic horizon within the bedrock likely provides mesocavern habitat between the two endangered species-occupied caves and likely beyond.

No mapped faults occur within the Shaman Cave KFA, although fractures related to regional faulting are expressed within all caves. A mapped fault passes approximately 0.5-mile northwest of the Shaman Cave KFA (Collins 2005).

All caves within the Shaman Cave KFA have relatively limited surface drainage areas due to their upland terrain location. The endangered species-occupied caves all draw their surface runoff from the hilltop described above. Therefore, all surface runoff reaching the cave entrances and footprints originates from within the Shaman Cave KFA.

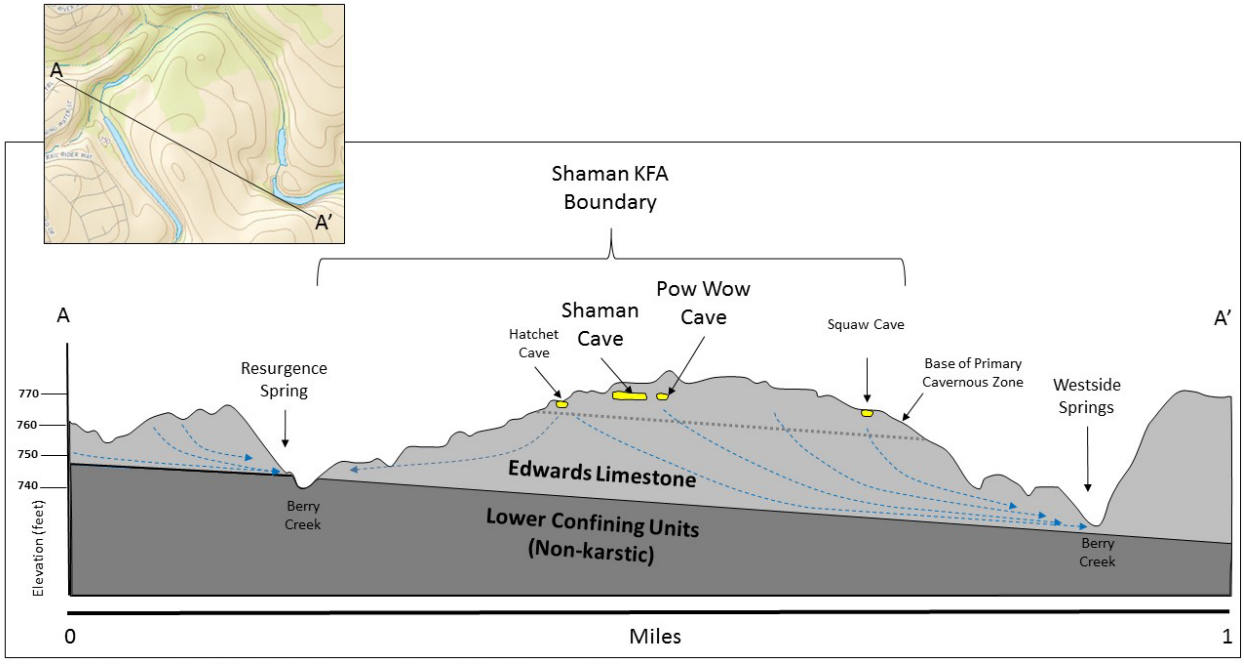


Figure 25. Geologic cross section of the Shaman Cave KFA.

2.13.3 Caves of the Shaman Cave Karst Fauna Area

The Shaman Cave KFA contains eight caves with two caves known to contain endangered karst invertebrate species, along with at least six "additional species" addressed in the RHCP (SWCA et al. 2008). Only Shaman and Powwow Caves are monitored for karst invertebrates. Appendix M includes cave maps for this KFA.

Shaman Cave: Shaman Cave is by far the largest and most biologically diverse cave within the KFA. It has a single passage trending northwest to southeast for approximately 240 feet. The cave is relatively flat in orientation and shallow with the passage majority formed between 5 and 10 feet below the surface. The entrance to Shaman Cave consists of a 1.5-foot-diameter opening in the bedrock, which drops approximately 5 feet to the top of a debris cone located in the middle of the cave's main passage. The main passage varies from 1.5 to 5 feet high and its width varies from 15 to 25 feet. The cave is approximately 237 feet long and reaches a maximum depth of 14 feet below the surface. Overall, the cave footprint takes the form of a slightly sinuous groundwater conduit with a northwest/southeast trend. Large floor drains accessible to humans at Shaman Cave's rear indicate connections to a deeper habitat zone. Shaman Cave is gated (Photograph 35) and interior conditions can be quite spacious (Photograph 36). The Bone Cave harvestman and the Dragonfly Cave mold beetle are both known from this cave.

Photograph 35. Biota survey crew preparing to enter Shaman Cave.

Photograph 36. Biota survey crew looking for karst invertebrates within Shaman Cave.

Powwow Cave: Powwow Cave is the second largest cave within the Shaman Cave KFA, with a footprint approximately 80 feet long by 30 feet wide. It is essentially a single breakdown chamber occurring between 5 and 15 feet below the surface. The overall cave morphology trends along northwest/southeast in a similar manner to Shaman Cave. The cave contains active speleothems including cave coral, stalactites and stalagmites. The entrance of Powwow Cave is gated (Photograph 37) and occurs in a depression measuring approximately 10 feet long by 4 feet wide. The Bone Cave harvestman is known from this cave.

Photograph 37. Entrance to Powwow Cave.

Additional Caves

The Shaman Cave KFA includes six caves that are not known to contain endangered karst invertebrates. These features are relatively small and shallow for researchers; however, the collective karst feature distribution suggests that Shaman Cave KFA's core is an interconnected cavernous and mesocavernous habitat area spanning more than 25 acres beneath the previously described hilltop. The significant caves' geomorphology suggests they formed from the collapse of a larger underlying karst void network that was likely formed under phreatic conditions in response to paleo-aquifer karst hydrology as groundwater followed an east-northeasterly path toward the Edwards Aquifer's confined zone. The current cave floors now are largely formed from breakdown material that has collapsed from the original cave ceiling. The modern cave network has chaotic morphology relative to the paleo cave network because the collapse process is incomplete. A relatively continuous network of voids formed in response to dissolution by flowing groundwater and is now an extensive mesocavern network largely inaccessible to human but readily available to karst invertebrates.

Borgarigmie Pit Cave: The Borgarigmie Pit Cave entrance in an oval opening measuring approximately 3 by 3 feet at the base of a shallow depression. The entrance shaft drops 13 feet to a low room measuring approximately 15 feet long by 7 feet wide. The room is formed along a fracture trending north 85 degrees east. This cave is not gated and is not monitored.

Florence No. 18 Cave: An entrance to Florence No. 18 Cave, measuring approximately 3 feet wide by 4 feet long, drops approximately 8 feet to a slope leading down into an irregular chamber aligned with a southwest-trending fracture. This cave is not gated and is not monitored.

Haft Shaft Cave: The Haft Shaft Cave entrance measures approximately 1.5 feet wide by 2 feet long and drops approximately 13 feet into one end of a low bedding plane room, measuring approximately 12 feet long by 6 feet wide. This cave is not gated and is not monitored.

Hatchet Cave: The entrance to Hatchet Cave is 8 feet wide, with a 1-foot-high slope leading to a series of subsequent drops and slopes that reach 19 feet deep, exhibiting an approximately 38-foot passage. This cave is not gated and is not monitored.

Shawntee Pit Cave: The Shawntee Pit Cave is a 12.5-foot-deep pit formed along a north/south-oriented fracture that has been solution-enlarged along an 8-foot-long area. The shaft width is between 1 and 4 feet. A sloping passage extends for another 5 feet from the shaft base. This cave is not gated and is not monitored.

Squaw Cave: Squaw is a single bedding plane room measuring approximately 14 feet long and trending southeast. The cave is formed between 2 and 4 feet below the surface and likely resulted from the collapse of a deeper void. This cave is not gated and is not monitored.

Table 26 shows documented species within the Shaman Cave KFA.

Table 26. Species Documented from the Shaman Cave KFA

Species		Shaman	Powwow	Borgarigmie Pit	Florence No. 18	Haft Shaft	Hatchet	Shawntee Pit	Squaw Cave
Permitted Species									
Batrisodes cryptotexanus		√	√						
Texella reyesi		√	√						
Other Species									
Crickets	*Ceuthophilus secretus*	√	√	√	√	√			
	Ceuthophilus cunicularis	√	√						
Arachnids	*Cicurina vibora*	√	√		√				
	Cicurina varians	√	√		√		√		
	Anapistula sp.	√							
	Tayshaneta sp.	√	√						
	Cryptachaea porteri	√							
	Mite	√	√	√					
	Pseudoscorpion		√						
	Pseudouroctonus reddelli	√	√						
Millipedes/ Centipedes	*Speodesmus bicornourus*	√	√				√		
	Cambala speobia	√	√		√		√		
Beetles	*Rhadine noctivaga*	√	√						
	Batrisodes uncicornis		√		√				
	Staphylinidae		√						
	Anillinus sp.	√	√						
	Beetle larva	√							
Reptiles/ Amphibians	*Crotalus atrox*	√							
	Eleutherodactylus marnockii	√							
Other	Isopod	√							
	Perimyotis subflavus	√							
	Helicodiscus sp.	√							
	Assassin Bug	√	√						
	Texoreddellia aquilonalis	√							
	Collembola	√	√		√		√		
	Mosquito		√						
	Gnat	√	√						
	Red Ant	√	√	√		√		√	√
	Pogonomyrmex barbatus	√							
	Surface Snail	√	√						
	Moth	√	√						
	Bark Louse	√							
	Earthworm	√	√						

2.14 Bat Well Cave Preserve

2.14.1 Introduction

Bat Well Cave Preserve (Table 27) is approximately 46.5 acres and represents one of the more significant caves in Williamson County due to the combination of hydrogeological and biological attributes it exhibits. As a well-preserved phreatic conduit, the cave is illustrative of the inner workings of the Edwards Aquifer. It is a classic example of an underground stream that remains partially active. Hydrologically, it represents a mixing zone where the interaction between groundwater, surface water from Berry Creek, and upland recharge from rain events can be observed in real time. Once home to a large bat colony, the cave is also biologically significant due to the presence of groundwater fauna, including at least two stygobitic invertebrates and the Georgetown salamander.

The name of the cave stemmed from the observation that it housed one of the larger bat colonies in Williamson County. The cave was mined for guano as early as 1909 and written descriptions of the cave go back to at least 1962 when the cave was first mapped by members of the Southwestern Speleological Society (Reddell and Finch 1963). Bat Well Cave is located beneath a dry upland tributary to Berry Creek (Figure 26). The entrance drops from the bed of the drainage channel (Photograph 38) into what is essentially a horizontal tunnel trending from the southwest to the northeast where it branches. Passages leading away from the entrance have been referred to as the West Tunnel and the East Tunnel. The cave is known to take great volumes of water when the surface channel overflows its banks and runs into the cave entrance. The underground stream runs independently of surface runoff from the cave entrance.

Table 27. Basic Information for the Bat Well Cave Preserve

Bat Well Cave Preserve Information	
Preserve Inception Year	2020
Acreage	46.5
Fence Status	None
Sign Status	None
Baseline Vegetation Survey Date	None
Owner	WCCF
Gated Caves	Bat Well, Berry Creek
Non-gated Caves	None

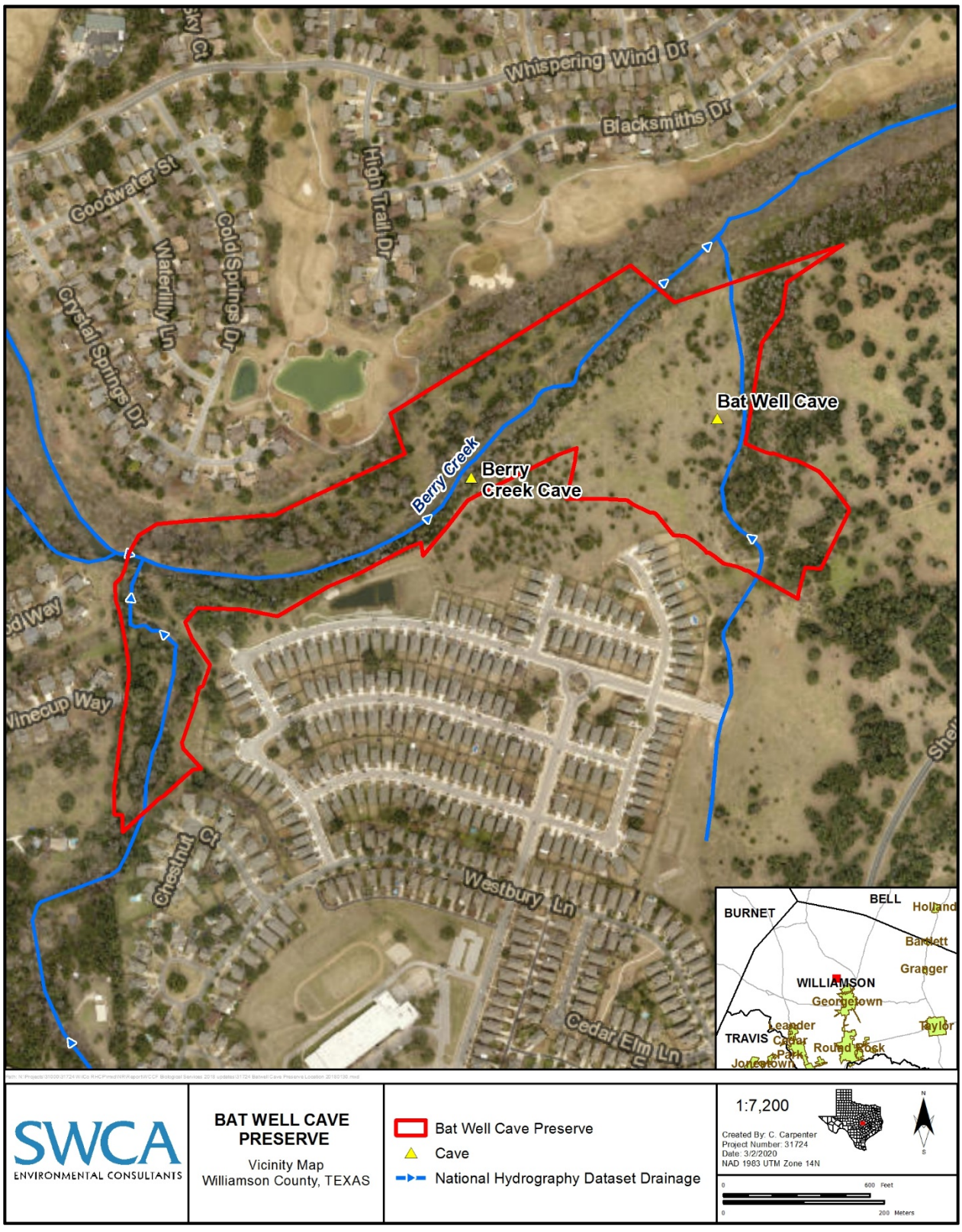


Figure 26. Bat Well Cave Preserve location map.

Photograph 38. View facing up, within Bat Well Cave's vertical shaft at the entrance that drops into the Edwards formation after penetrating the overlying Georgetown formation.

2.14.2 Hydrogeology

Bat Well Cave is formed within the lower half of the Edwards Limestone formation, which is approximately 110 feet thick in the Georgetown area (Figure 27). The cave evolved below the water table as a conduit for lateral flow of large volumes of water through the regional paleoaquifer. The cave stream currently flowing through the cave is a trickle compared with the flow capacity of the entire conduit. The rounded, tube-like interior of the main passage is indicative of formation under fully submerged conditions where slow-moving groundwater caused dissolution of the cave walls in all directions. The down-cutting of Berry Creek and other local waterways gradually dissected the aquifer outcrop, dropping the water table closer to the main passage. The cave likely went through a second period of enlargement as it began pirating base flow from Berry Creek. The destination of the stream passing through the cave is unconfirmed, but it likely feeds several springs that resurge in the bank of Berry Creek within the City of Georgetown's Westside Park located to the northeast. The modern cave entrance likely formed relatively recently in the cave's history when the floor of a surface gully intersected the upper level of the cave. Since then, the cave has acted as a highly efficient aquifer recharge feature. Depending on the aquifer conditions and rainfall, up to three forms of hydrology are acting on the cave at any given time. The cave stream is permanent groundwater flow, which is supplemented by the baseflow of Berry Creek. Fauna in the cave stream represent both stygobitic and surface freshwater species. Blind cave crustaceans are found alongside crayfish and minnows from Berry Creek. During heavy rains when the surface gully flows, large volumes of recharge enter the cave, bringing leaf litter and organic matter with it.

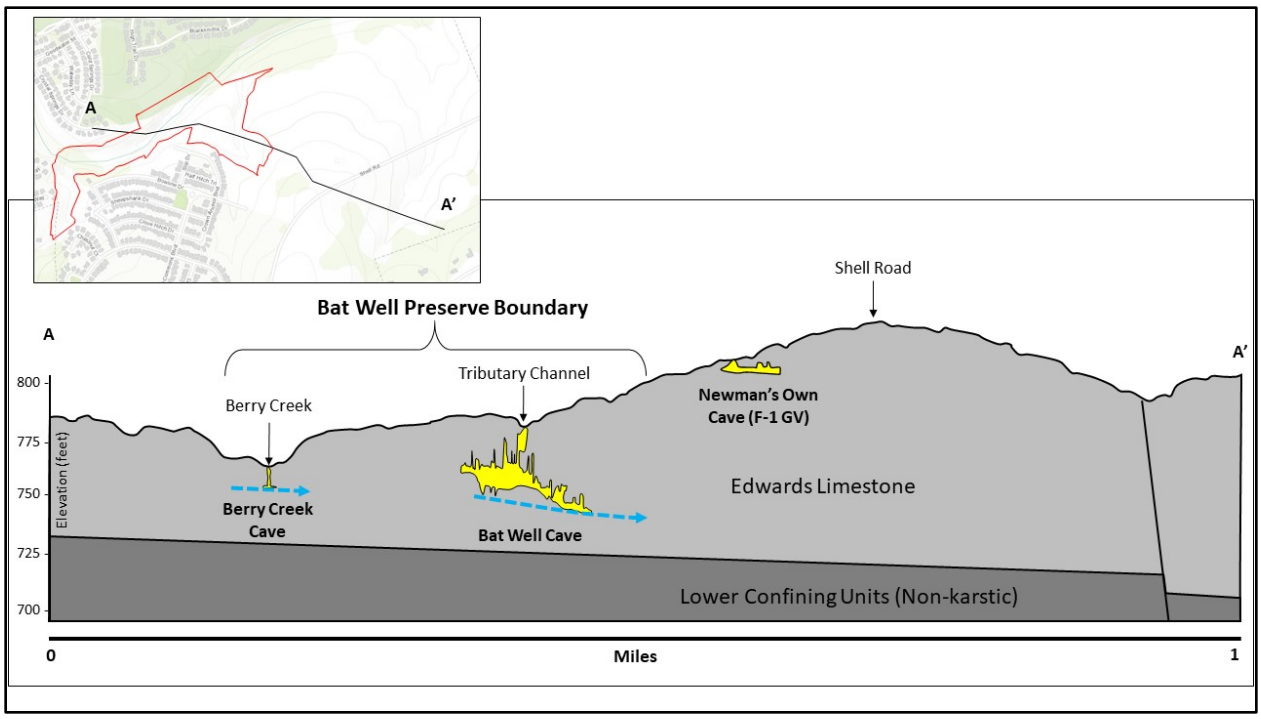


Figure 27. Geologic cross section of the Bat Well Cave Preserve.

2.14.3 Caves of the Bat Well Cave Preserve

The Bat Well Cave Preserve contains two mapped caves, both with subterranean stream passages. Bat Well Cave is the only feature documented to host *Eurycea* sp. No endangered karst invertebrates are known from either cave. Appendix N includes cave maps for this preserve.

Bat Well Cave: The cave entrance is formed in the south bank of a dry surface channel that drains approximately 200 acres after heavy rains. An approximately 10-foot-deep sinkhole connects the channel floor with a horizontal passage leading south into the cave. The cave is secured at this point with a vertical cave gate measuring approximately 10 feet wide by 4 feet high (Photograph 39). Approximately 20 feet beyond the gate, the horizontal passage leads to a vertical shaft measuring approximately 8 feet in diameter. The shaft drops approximately 25 feet into the main passage of the cave. The main passage extends in two directions from the bottom of the shaft formed along a prominent bedrock fracture trending from the northwest to the southeast (Photograph 40). The West Tunnel ranges from 15 to 20 feet high by 10 to 15 feet wide and extends for 345 feet before becoming plugged with soil. A small pool occurs on the south side of this passage and appears to connect with Berry Creek as catfish (*Ictalurus* sp.) have been seen in this pool. The tall but narrow East Tunnel runs approximately 121 feet before forking into the Upstream and Downstream Tunnels. The Upstream Tunnel extends at least 163 feet to a small stream that enters from the right wall, crosses the passage, and disappears down a hole (Photograph 41). Average ceiling height of the Upstream Tunnel is 7 feet. The Downstream Tunnel extends about 90 feet and intersects the same stream, which can be explored in both directions from this point. At about 20 feet downstream, a second stream intersects the first.

The West Tunnel was known to house one of the larger bat colonies in Williamson County in the 1960s. By August 1992, Bill Russel from the University of Texas reported that there was no evidence of guano, fresh or otherwise, although Russel attributed this to the flooding of the spring and summer and that bats were likely returning (Hunter and Russel 1992).

Photograph 39. Biota survey crew flipping rocks for invertebrates during 2020 survey.

Photograph 40. View of the vertical entrance shaft from lower level (from West Tunnel facing east).

Photograph 41. Downstream water passage located in the back of the upstream tunnel.

Early biological surveys of the Bat Well Cave were informal. Surveyors in 1962 and 1963 noted the presence of rattlesnakes, both on the main level and around the base of the entrance. Reddell and Finch (1963) indicate two collection trips were made to Bat Well Cave in 1963; the first by representatives of the Southwestern Speleological Society and the second by J. Reddell, R. Finch, and M. Lorfing. In a separate study, Lewis and Bowman (1996) described the subterranean Asellids in Williamson County as *Caecidotea reddelli*. In 1992, J. Hunter and B. Russel from the University of Texas collected genetic samples of the common cave amphipod, *Stygobromus* (syn. *Stygonectes*) *russelli,* which were discovered within the underground stream and were subsequently collected by Hunter (Hunter and Russel 1992). During one of these visits, Hunter and Russel (1992) explored the downstream passage to a syphon and collected an eyed, pigmented *Eurycea* salamander.

Berry Creek Cave: The cave entrance is a small portal formed in the bed of Berry Creek that peers into a subterranean stream passage flowing nearly perpendicularly to the overlying flow path of Berry Creek. The cave is a bell-shaped shaft approximately 12 feet down that extends approximately 16 feet wide at its base. A concrete riser is placed atop the cave entrance and holds in place a black metal gate (Photograph 42). WCCF installed a new cave gate in 2020. Berry Creek diverts significant flow into Berry Creek Cave when flowing water is present (Photograph 43). Berry Creek Cave's position within Berry Cave indicates this may be a significant local recharge point for the Edwards Aquifer and nearby springs in Sun City. The subterranean stream passage is of unknown depth and biota surveys have not occurred.

Photograph 42. Berry Creek Cave as seen when no water is present in Berry Creek.

Photograph 43. Berry Creek Cave as seen when water is present in Berry Creek and leaves are plugging the cave portal.

Table 28 shows documented species within Bat Well Cave.

Table 28. Species Documented from the Bat Well Cave Preserve

Species		Bat Well Cave
Permitted Species		
Texella reyesi		No
Batrisodes cryptotexanus		No
Other Species		
Crickets	*Ceuthophilus cunicularis*	√
	Ceuthophilus secretus	√
Arachnids	*Eidmanella pallida*	√
	Cicurina vibora	√
	Leiobunum townsendi	√
	Cicurina varians	√
	Meioneta sp.	
	Agyneta llanoensis	√
Millipedes/ Centipedes	*Oxidus gracilis*	√
	Cambala speobia	√
	Speodesmus bicornourus	
	Lithobiomorpha	√
	Geophilomorpha	√
Beetles	*Batrisodes* sp.	√
	Staphylinidae	√
Aquatics	*Ictalurus punctatus*	√
	Procambarus simulans	√
	Stygobromus sp.	√
	Caecidotea sp.	√
Mammals	*Tadarida brasiliensis*	√
	Perimyotis subflavus	√
	Procyon lotor	√
Reptiles/Amphibians	*Eleutherodactylus marnockii*	√
	Craugastor augusti	√
	Crotalus atrox	√
	Eurycea naufragia	√
	Elaphe obsoleta lindheimeri	√
Other Species	Collembola	√
	Gastropoda	√
	Arenivaga sp.	√
	Earthworm	√

2.15 Snowmelt Cave Preserve

2.15.1 Introduction

The Snowmelt Cave Preserve was created in 2004 as part of the installation a raw water line transporting water over Snowmelt Cave. The Brushy Creek Municipal Utility District managed Snowmelt Cave Preserve until 2019. The WCCF acquired the Snowmelt Preserve in 2019 as mitigation for Williamson County widening CR 176 and stabilizing (filling) the underlying cave to ensure structural integrity. The WCCF plans to manage the 1.3 acre Snowmelt Cave Preserve in the same manner as for other preserves.

Snowmelt Cave (Table 29) was so named due to the presence of a rare snowfall in Central Texas, with warm morning sunshine causing runoff to enter the cave when it was mapped (Peter Sprouse, personal communication, June 29, 2018). The humanly accessible extent is mapped as approximately 120 feet long, up to 36 feet wide, and up to 12 feet deep. Approximately half of the eastern cave extent is mapped within the Snowmelt Cave Preserve, while the remainder is underneath CR 176 and below an adjacent tract across the road from the preserve (Figure 28). Road widening triggered Williamson County to fill the cave extent below CR 176 for safety reasons, due to the shallow nature of the Snowmelt Cave. However, the eastern extent remains within the Snowmelt Cave Preserve and is in a relatively natural state.

The land around the cave entrance is privately owned and the preserve easement for Snowmelt Cave was managed by Brushy Creek Municipal Utility District (BCMUD). Pine (2004) details the 1.3-acre Snowmelt Cave easement within a Biological Opinion that states “BCMUD will complete negotiations with the landowner and initiate operation of the preserve by December 31, 2004.”

Appendix O includes a cave map showing the full extent, as mapped in 2002.

Table 29. Basic Information for the Snowmelt Cave Preserve

Snowmelt Cave Preserve Information	
Preserve Inception Year	2019
Acreage	1.3
Fence Status	None
Sign Status	Warning sign on cave gate
Baseline Vegetation Survey Date	None
Owner	Easement (McLester Elmer TR and Karen Wunsch et al.)
Gated Caves	Snowmelt Cave
Non-gated Caves	None

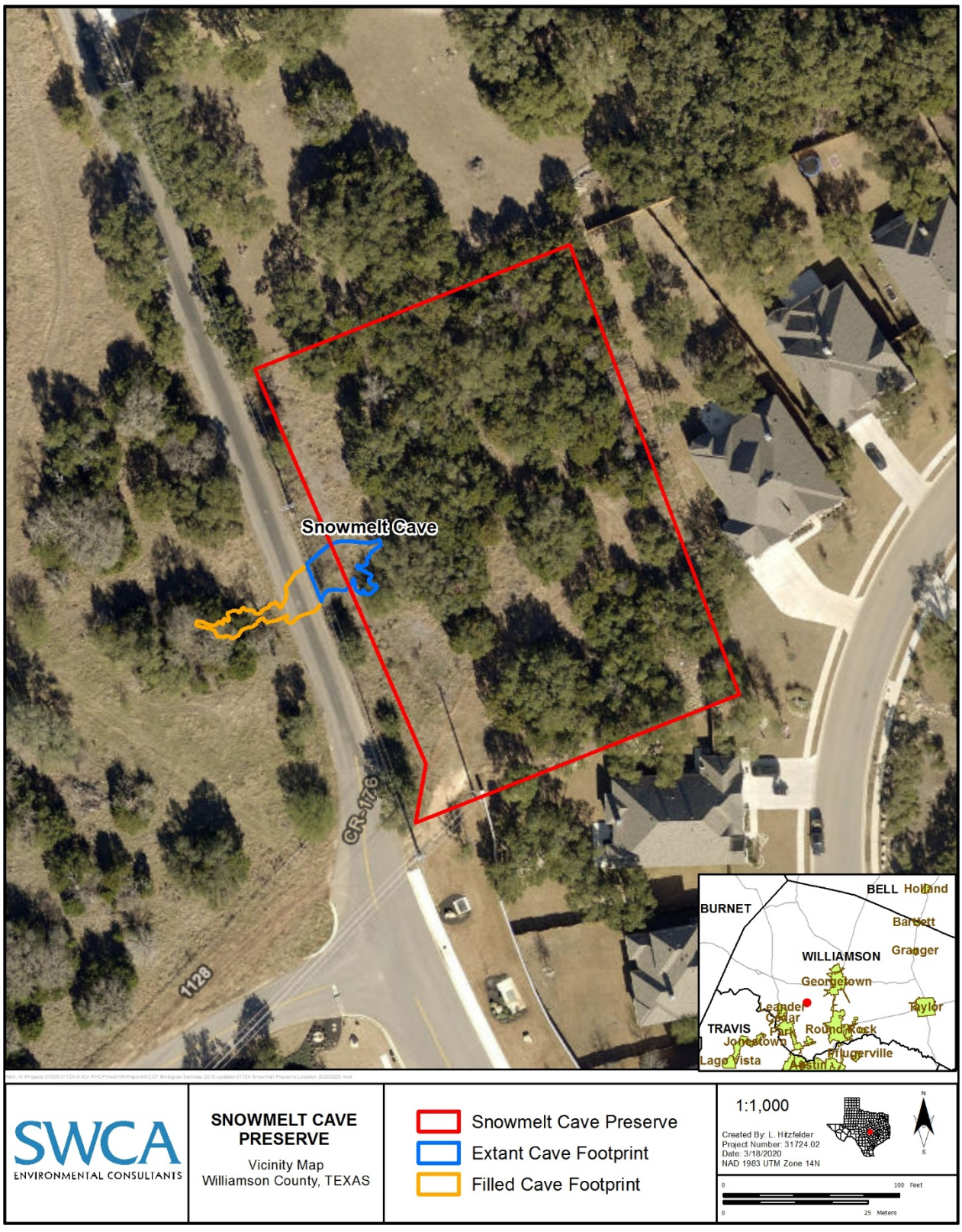


Figure 28. Snowmelt Cave Preserve location map.

2.15.2 Hydrogeology

Snowmelt Cave Preserve occurs within the EARZ on the western edge of a topographic ridge that is the surface water drainage basin divide between Brushy Creek to the west and Chandler Branch to the east. The surface elevation is approximately 980 feet amsl. Because the cave is located in a gently sloping area near a ridge, the surface water catchment basin is not large.

The thickness of the Edwards Limestone is approximately 40 to 50 feet at the cave location based on mapping by Collins (2005) but thickens toward the east because the formation dips eastward. The contact between the Edwards Limestone and the underlying, less-permeable Comanche Peak is exposed at an elevation of approximately 950 feet, which occurs approximately 0.25 mile west of Snowmelt Cave Preserve. The formations dip toward the east and the Edwards and Comanche Peak contact is exposed at elevations of less than 800 feet along the southern bank of the South Fork San Gabriel River east-northeast of the preserve.

According to a Texas Water Development Board (TWDB) Well Schedule and Well Report for State Well No. 58-26-301, the depth to water just north of the Snowmelt Cave Preserve was measured at approximately 180 feet in 1971. A 180-foot water depth is stratigraphically lower within the Edwards Aquifer than the preserve area. The well report did not mention the presence of water at shallower depths. The exact direction of groundwater flow beneath the Project Area is unknown; however, groundwater could potentially become perched within the Edwards Aquifer on top of the Comanche Peak and flow northward to discharge at one or more of at least six springs located along the southern edge of the South Fork San Gabriel River. The South Fork San Gabriel River's closest point to the Snowmelt Cave Preserve is approximately 1.3 miles north. Alternatively, instead of traveling northward toward the South Fork San Gabriel River's springs, groundwater recharging in the area of the Snowmelt Cave Preserve may move more eastward in the regional direction of surface topography and in the direction the beds dip, although surface topography slopes westward toward Brushy Creek. Groundwater flow may also follow surface contours and flow southwest toward Brushy Creek to discharge along the contact between the Edwards Limestone and Comanche Peak. However, no springs are mapped along the eastern side of Brushy Creek near the Project Area.

The floor of the cave dips gently toward the east-northeast, which supports a north or eastward groundwater flow direction toward South Fork San Gabriel River or Chandler Branch. No formal hydrogeological study has been performed in Snowmelt Cave. Snowmelt Cave itself appears to have formed as a phreatic chamber from groundwater flowing from the southwest end of the cave toward the northeast end of the cave. The cave is now located above the groundwater table and only intercepts water recharging and moving downward through the vadose zone.

2.15.3 Caves of the Snowmelt Cave Preserve

Cave maps are included within Appendix O.

Snowmelt Cave: The Snowmelt Cave map indicates the cave footprint extends underneath the existing CR 176 and continues west, beyond the road. Cave footprint dimensions (prior to stabilization efforts) are approximately 130 feet long and up to 12 feet deep, with the cave ceiling approximately 7 feet below the existing CR 176. However, all portions of the cave outside of the preserve have been filled to stabilize the CR 176 expansion (Photograph 44); therefore, Snowmelt Cave is likely closer to 80 feet long in its current state. The cave appears to have formed within the phreatic zone by groundwater moving slowly toward the east-northeast, because the current floor of the cave and bedding dips toward the east-northeast. Most of the cave is a crawlway with low ceiling that becomes lower in the up-dip direction toward the west-southwest. Snowmelt Cave is gated (Photograph 45). USFWS (2018a) indicates

Snowmelt Cave is a known Bone Cave harvestman locality. However, the species was not seen during biota surveys occurring 2013 and 2015 (ZARA 2017); nor was the species located by SWCA during 14 presence/absence surveys in 2019 (personal communication Stephen Van Kampen-Lewis). See Table 30 for summary all biota detected within Snowmelt Cave over time.

Table 30. Species Documented from the Snowmelt Cave Preserve

Species		Snowmelt Cave
Permitted Species		
Texella reyesi		√
Other Species		
Crickets	*Ceuthophilus cunicularis*	√
	Ceuthophilus secretus	√
Arachnids	*Eidmanella* sp.	√
	Cicurina vibora	√
	Anapistula sp.	√
	Leiobunum townsendi	√
	Cicurina varians	√
Millipedes/ Centipedes	*Cambala speobia*	√
	Scutigeridae	√
	Speodesmus bicornourus	√
	Lithobiomorpha	√
Beetles	*Batrisodes uncicornis*	√
	Elaphropus sp.	√
	Staphylinidae	√
Vertebrates	*Procyon lotor*	√
	Incilius nebulifer	√
Other Species	Collembola	√
	Texoreddellia sp.	√
	Helicodiscus sp.	√
	Labidus coecus	√
	Isopod	√
	Diptera	√
	Annelid	√

Photograph 44. Sandbags within Snowmelt Cave that were installed as part of cave stabilization efforts.

Photograph 45. Snowmelt Cave entrance showing gate and surrounding vegetation.

2.16 Hidden Springs Ranch

2.16.1 Introduction

Hidden Springs Ranch is approximately 932.5 acres and lies mostly in Williamson County, but extends north into Burnet County, and is located approximately 4 miles northwest of the City of Florence, Williamson County (Figure 29). This property was primarily purchased for its GCWA habitat and has no known caves.

Hidden Springs Ranch lies within the Cross Timbers ecoregion and the Lampasas River watershed of the Brazos River basin. The ranch has frontage to the south on Williamson County Road 224. The southern third of the ranch lies on a broad, relatively flat top of a ridge formed from the Keys Valley Marl. Elevations on the ranch generally descend toward the north away from the top of this ridge. The central and northern portions of the ranch contain the headwaters of the McDaniel Branch of Mill Creek, with this creek running generally northward through the center of the ranch. Topography in the central and northern portions of the ranch is hilly, with rolling uplands incised by McDaniel Branch and many short tributaries that combine to form a dendritic pattern. Stream erosion has removed the Keys Valley Marl from these portions of the ranch to expose, in descending order, the underlying Cedar Park Limestone, Bee Cave Marl, and upper Glen Rose formations.

The Keys Valley Marl is a soft carbonate formation that degrades to form comparatively deep soils suitable for agricultural uses. For this reason, the broad ridge top on which the southern portion of the ranch lies has been widely converted to pasture, both on and adjacent to Hidden Springs Ranch. Maintenance of these pastures on Hidden Springs Ranch appears to not have been performed in recent times, and these pastures are being invaded by shrubby Ashe juniper (*Juniperus ashei*) and mesquite (*Prosopis glandulosa*). This portion of the ranch does not contain woodland habitat suitable for use by GCWA.

In contrast to the southern portion of the ranch, geology in the central and northern portions of Hidden Springs Ranch consists mostly of hard limestones that form thin soils. Probably owing to a combination of thin soils and hilly topography, these portions of the ranch appear to have historically been used as rangeland and mostly without having been converted to pasture. The Soil Survey of Williamson County, Texas, which contains aerial photography circa 1980, indicates that approximately 40 years ago these portions of the ranch mostly contained open woodland with some nearly barren hillsides, none of which would have provided habitat for GCWA. Based on current conditions as discussed below, it appears possible that over the past 40 years, vegetation in the central and northern portions of Hidden Springs Ranch has been allowed to naturally succeed into a more wooded state.

McDaniel Branch is contained within a long, branched canyon. The floor of this canyon now mostly supports closed or nearly closed woodland composed primarily of Ashe juniper and plateau live oak trees, although along and near the creek channel the woodland also contains cedar elm (*Ulmus crassifolia*), American sycamore (*Platanus occidentalis*), and Arizona black walnut (*Juglans major*) trees, some of the walnut trees are in excess of 40 feet tall. Across the floor of the canyon, the Ashe juniper and live oak trees in this woodland are mostly 16 to 30 feet tall. This closed or nearly closed woodland provides habitat suitable for use by GCWA.

One relatively large pasture is present on the floor of the canyon that contains the McDaniel Branch, mostly in Burnet County and on the east side of the creek channel. This pasture is rather long and narrow and is crossed by a set of low berms, presumably built to control erosion historically. This pasture mostly contains grasses and forbs, but is being invaded by some shrubby Ashe juniper, particularly along its eastern edge. This pasture does not provide habitat for GCWA.

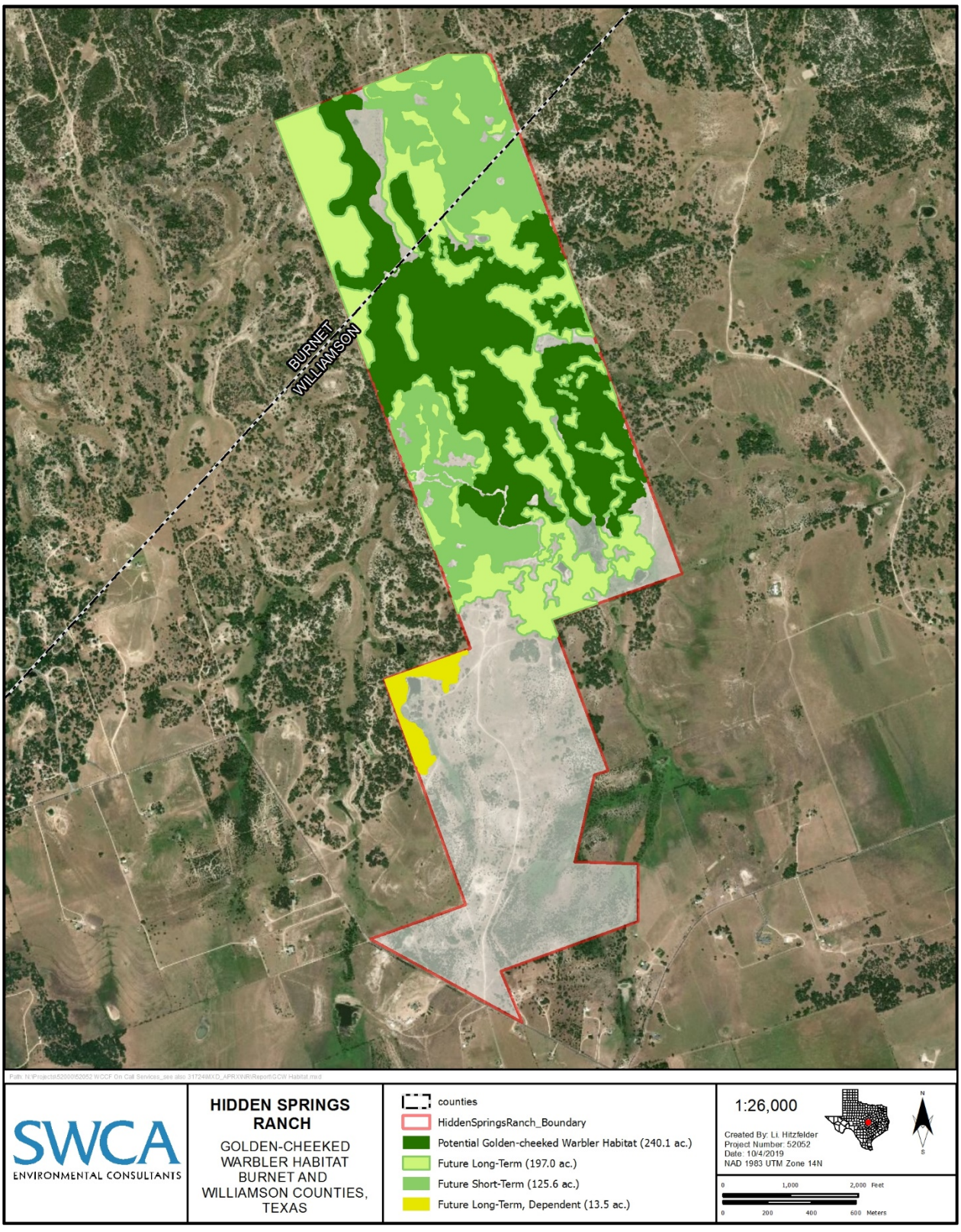


Figure 29. Hidden Springs Ranch and mapped golden-cheeked warbler habitat.

The dendritic pattern of drainages in the central and northern portions of the ranch have created a fingered series of ridges that confine the drainage system. These ridges have something of a stair-step topography, with steeper slopes in some places separated by relatively flat benches. The steeper slopes largely support open, scrubby Ashe juniper woodland, with most trees ranging from 6 to 18 feet tall. These slopes are formed of hard limestone that likely promotes surface water runoff rather than water retention, resulting in comparatively xeric conditions that do not favor growth of oak or other hardwood trees and appear to stunt the growth of the Ashe juniper. These open scrubby woodlands do not currently provide habitat suitable for GCWA. The topographic benches support stands of semi-open to relatively dense Ashe juniper/live oak woodland with very low densities of Texas oak (*Quercus buckleyi*) trees. Some of these stands of woodland have a nearly closed canopy and are essentially contiguous with the closed/nearly closed woodland developed in the canyon that contains McDaniel Branch. These stands may provide habitat suitable for use by GCWA. Other stands occur at greater distance from the canyon and have a more open canopy. These stands of woodland, if allowed to continue to succeed naturally, can be expected to gain suitability as GCWA habitat. A few of the topographic benches support open grassy clearings, perhaps a result of past land management activities performed to support livestock grazing. These clearings do not constitute GCWA habitat.

2.16.2 Golden-cheeked Warbler Habitat

Figure 29 depicts the distribution of woodland on Hidden Springs Ranch that currently appears suitable for use by GCWA. Approximately 240.1 acres of woodland present on the ranch currently appears suitable for use by the GCWA. Based on the configuration and extent of this woodland, it is highly probable that GCWA occur as breeding season residents of Hidden Springs Ranch.

Figure 29 also depicts the distribution of woodland on Hidden Springs Ranch that with time could gain suitability for use by the GCWA. These woodlands are divided into three categories: Future Short Term; Future Long Term; and Future Long Term, Dependent.

Approximately 125.6 acres of woodland on the ranch were identified as Future Short Term. These woodlands generally are composed of live oak, Ashe juniper, and some Texas oak trees that currently are a little too open to provide habitat suitable for use by GCWA, or in which the Ashe juniper is still a bit too young or short to provide suitable habitat. It is expected that these woodlands, if allowed, will succeed into GCWA habitat in the "short term," although that term might be 15 or 20 years.

Another approximately 197.0 acres of Hidden Springs Ranch were identified as Future Long Term. These areas generally contain open woodlands, including the scrubby Ashe juniper present on steeper slopes, that could eventually gain suitability as GCWA habitat. However, the time needed for that to happen is likely more than 20 years and it is possible that some of the vegetation identified within this category may never gain suitability as GCWA habitat, particularly some of the scrubby Ashe juniper woodland on the steeper slopes that appears to be stunted by low water availability.

Approximately 13.5 acres of semi-open Ashe juniper/live oak woodland on the southwest side of the ranch was identified as Future Long Term, Dependent. This woodland is formed on slopes of moderate gradient and with time it appears it could grow into closed canopy woodland possessing characteristics of GCWA habitat. These woodlands are bordered to the east by the broad ridge top underlain by the Keys Valley Marl that has been converted to pasture, and bordered to the west by off-site ridges that support similar semi-open Ashe juniper/live oak woodland. It is not expected that vegetation on the broad ridge top to the east will ever grow into suitable GCWA habitat, and the woodland identified as Future Long Term, Dependent is not extensive enough on its own to provide habitat that could be used by GCWA. The ability of this woodland to eventually become viable as GCWA habitat is dependent upon the adjacent

off-site woodland also being allowed to succeed into closed canopy woodland so that together enough woodland would be available to support the GCWA.

As seen on Figure 29, most of the central and northern portions of Hidden Springs Ranch were identified as containing potentially suitable GCWA habitat or having potential to support GCWA habitat with time. Areas in those portions of the ranch not identified as having potential to grow into GCWA habitat were largely limited to the floors of impounded stock tanks and what now consist of stands of nearly pure grassland, although with enough time even the grasslands could be taken over by Ashe juniper and succeed into GCWA habitat. Because of recurring impoundment by water, the stock tanks would not be capable of supporting woodland vegetation unless their dams were breached.

Approximately 240.1 acres of woodland on Hidden Springs Ranch was identified as potentially suitable GCWA habitat. Another approximately 125.6 acres of the ranch appear likely to succeed into suitability as GCWA habitat over the next couple of decades. With even more time, another 197.0 acres or more could develop into suitable GCWA habitat.

Photograph 46. Scrubby juniper forest on a hill side at Hidden Springs Preserve.

Photograph 47. Treeless portion of savannah mosaic at Hidden Springs Preserve.

Photograph 48. Forested lowland at Hidden Springs Preserve.

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Appendix A

Cave Maps of the Twin Springs Preserve

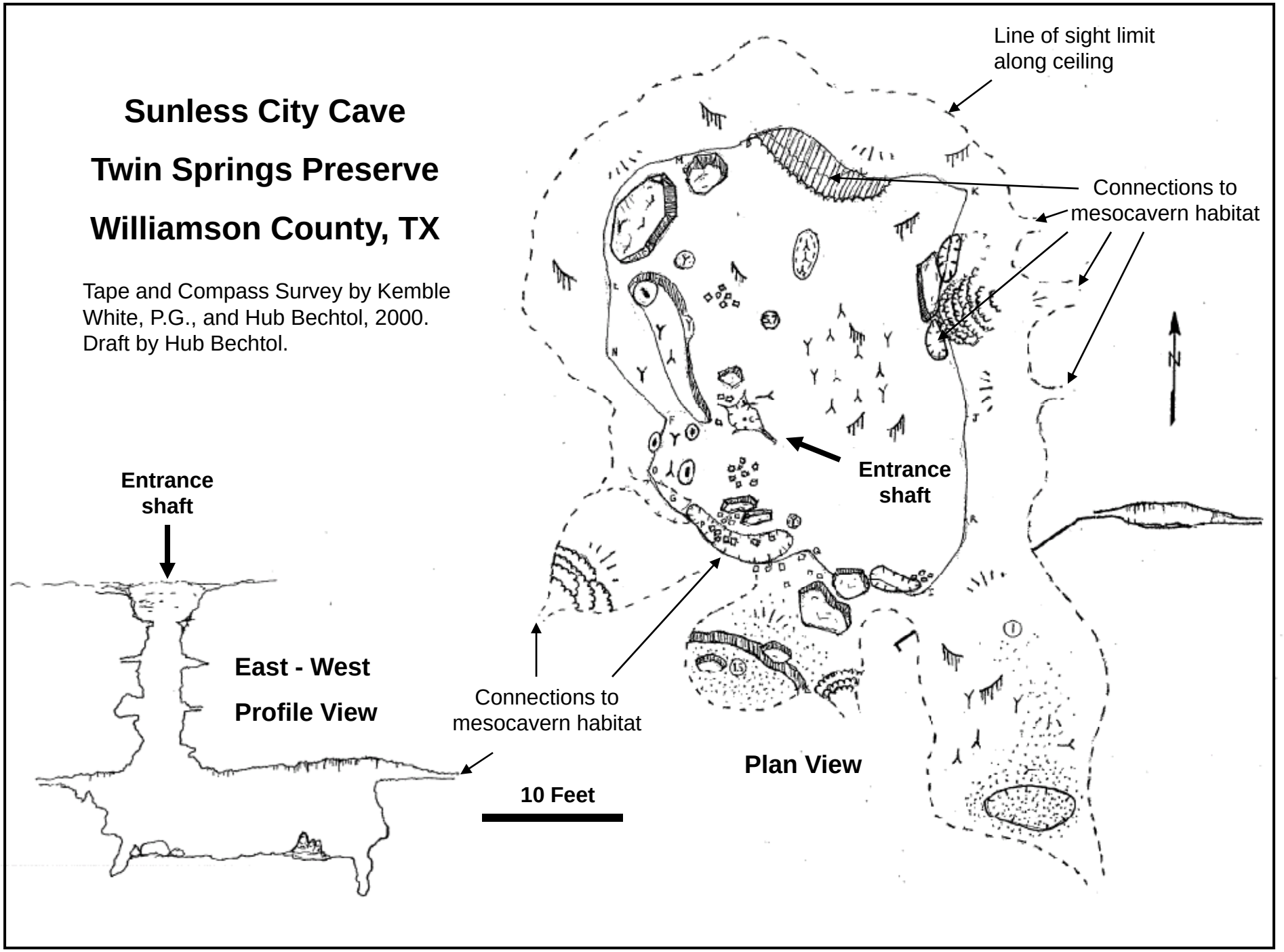


Figure 5. Map of Sunless City Cave.

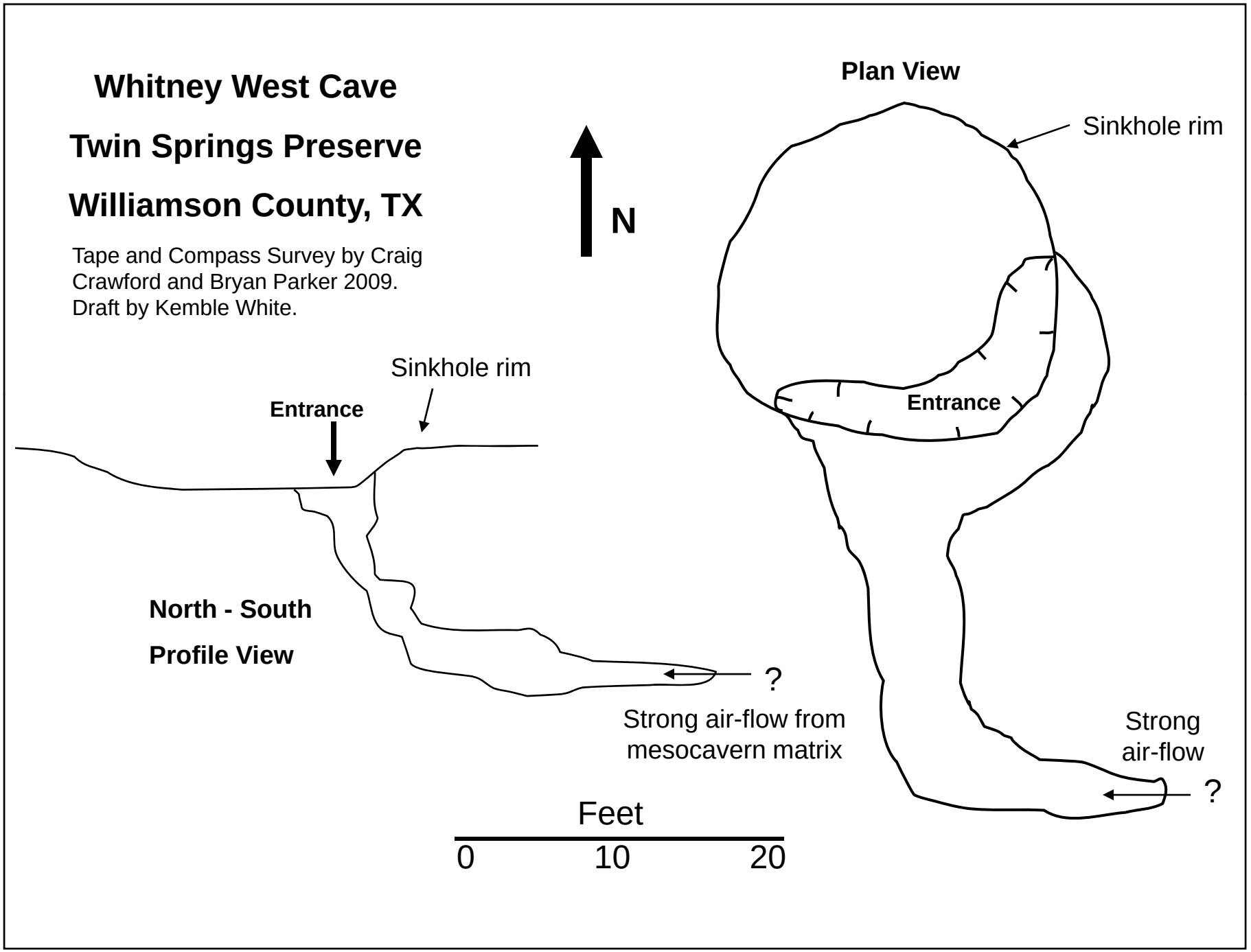
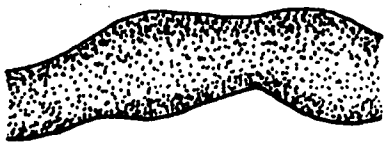


Figure 6. Map of Whitney West Cave.

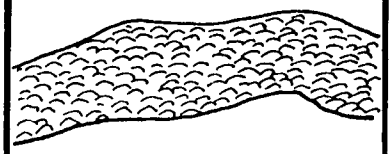
Appendix B

Cave Maps of the Beck Preserve

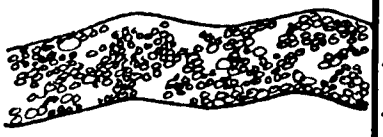
M.W.A. STANDARD CAVE MAPPING SYMBOLS



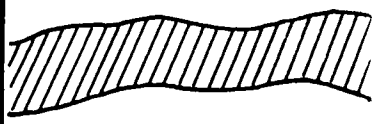
SOIL, SAND, SILT, OR GUANO



MUD OR CLAYS

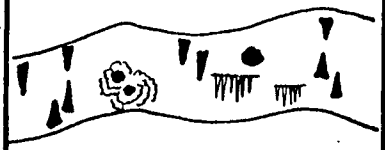


GRAVEL OR COBBLES

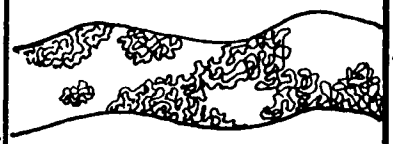


WATER

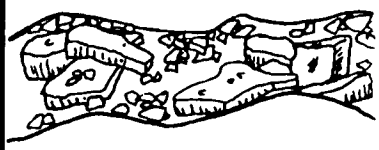
FLOWSTONE ARRANGEMENTS



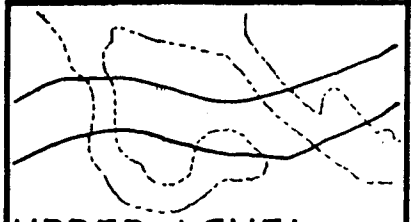
STALACTITE
STALAGMITE
COLUMN



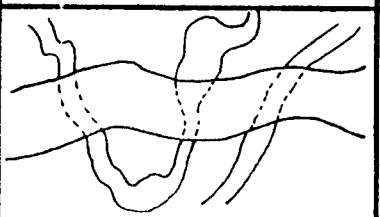
POPCORN
ABRASIVE TEXTURED SPELEOTHEMS



LARGE & SMALL BREAKDOWN ROCKS

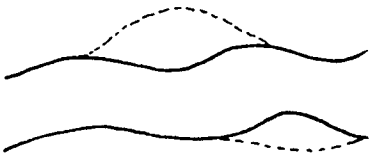


UPPER LEVEL PASSAGES CROSSING MAIN PASSAGE

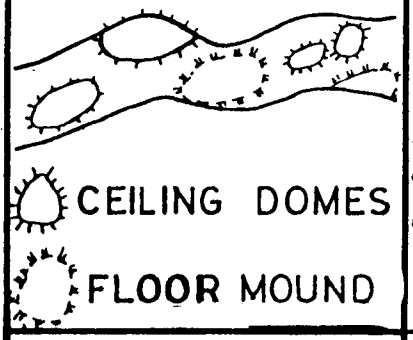


LOWER LEVEL PASSAGES CROSSING MAIN PASSAGE

ROCK SHELVING ALONG LEFT & RIGHT WALLS

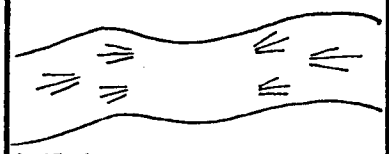


UNDERCUT WALLS LEFT & RIGHT

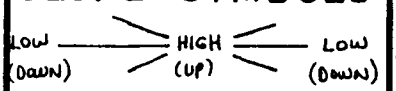


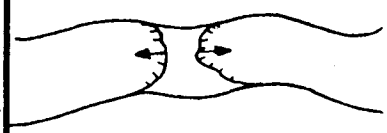
CEILING DOMES
FLOOR MOUND

OPEN PIT
FLOOR DEPRESSIONS
DROPS RIGHT

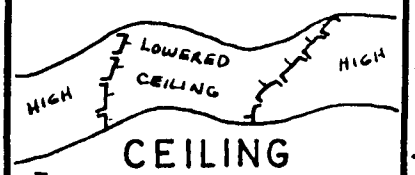


LEFT & RIGHT SLOPE SYMBOLS

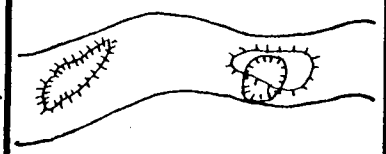




NATURAL BRIDGE PASSABLE ABOVE OR BELOW



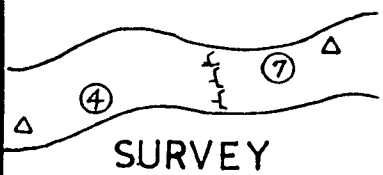
CEILING LOWERS RIGHT
CEILING LOWERS LEFT



DOME & PIT COMBINATIONS

SUMP OR SIPHON PASSAGE

ABOVE WATER
SUBMERGED PASSAGE



SURVEY STATION MARKER
CEILING HEIGHTS EXPRESSED IN FEET

BECK CREEK CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY

DATE: NOVEMBER 6, 1991

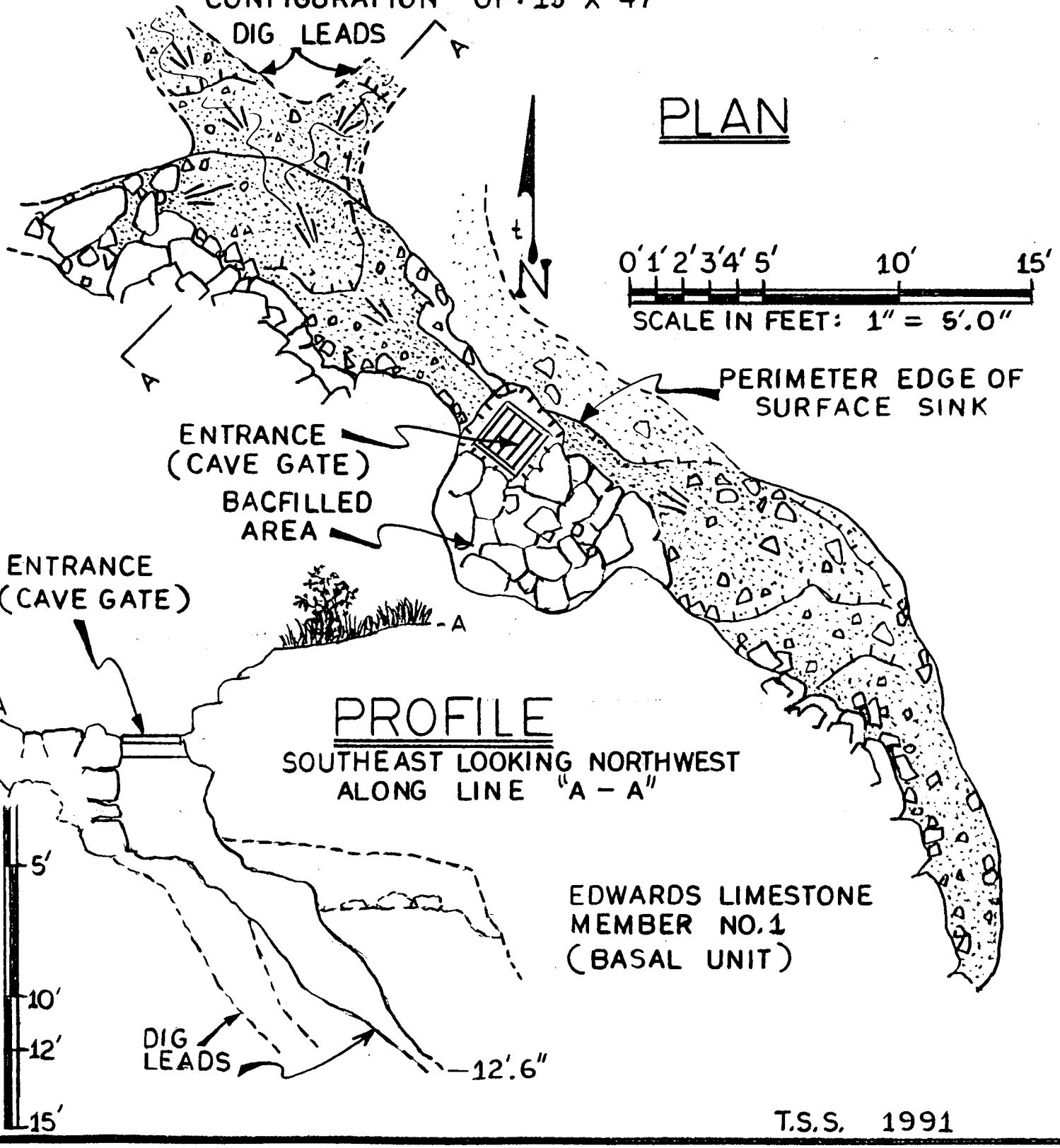
PERSONNEL:

CHARLY SAVVAS - LEE JAY GRAVES - MIKE WARTON

DRAFT BY: MIKE WARTON

LENGTH: 61'.3" DEPTH: 12'.6"

CONFIGURATION OF: 15' X 47'



T.S.S. 1991

BECK CREVICE CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY

DATE: NOVEMBER 6, 1991

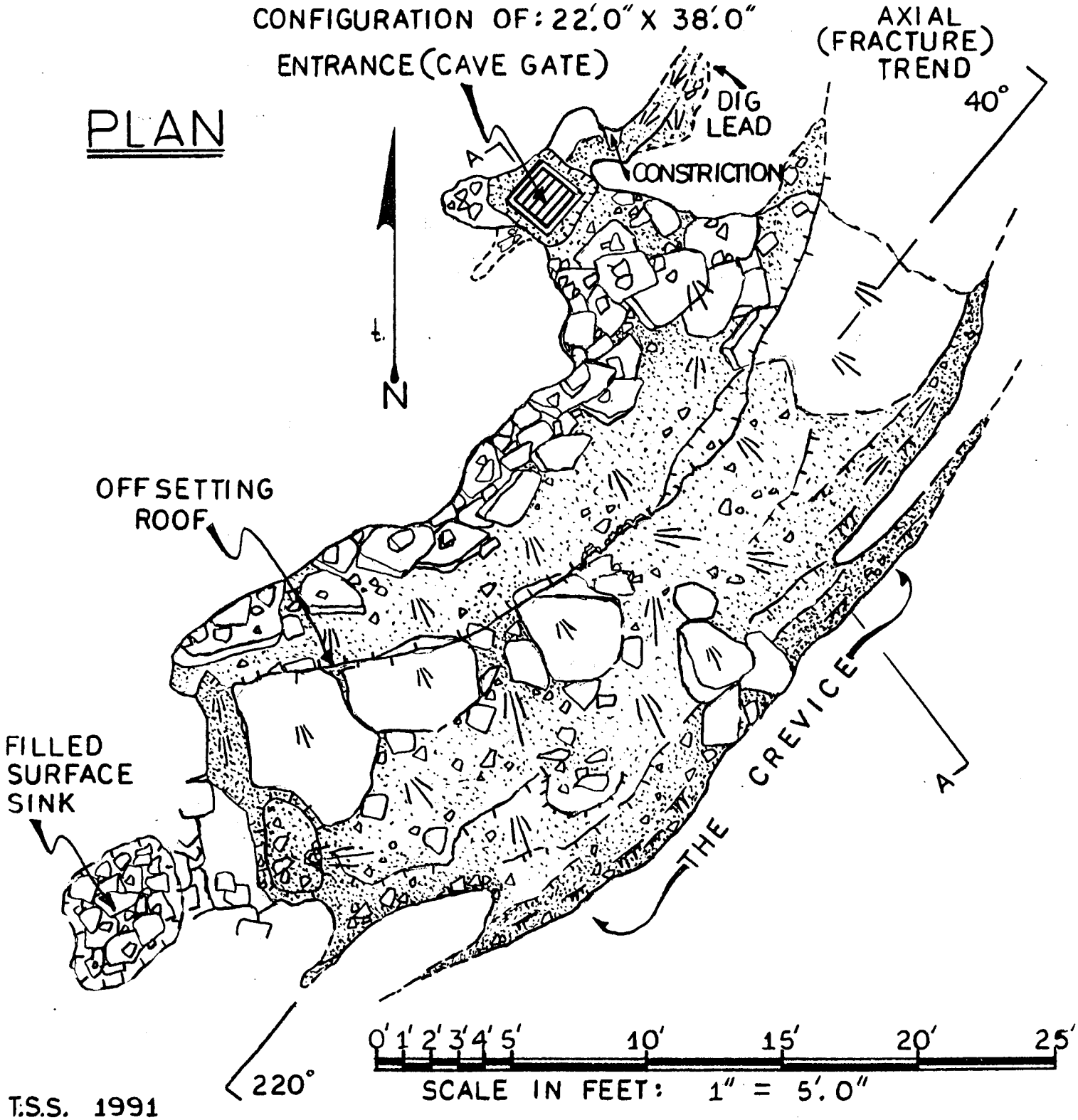
PERSONNEL:

CHARLY SAVVAS - LEE JAY GRAVES - MIKE WARTON

DRAFT BY: MIKE WARTON

LENGTH: 101'.5" DEPTH: 18'.2"

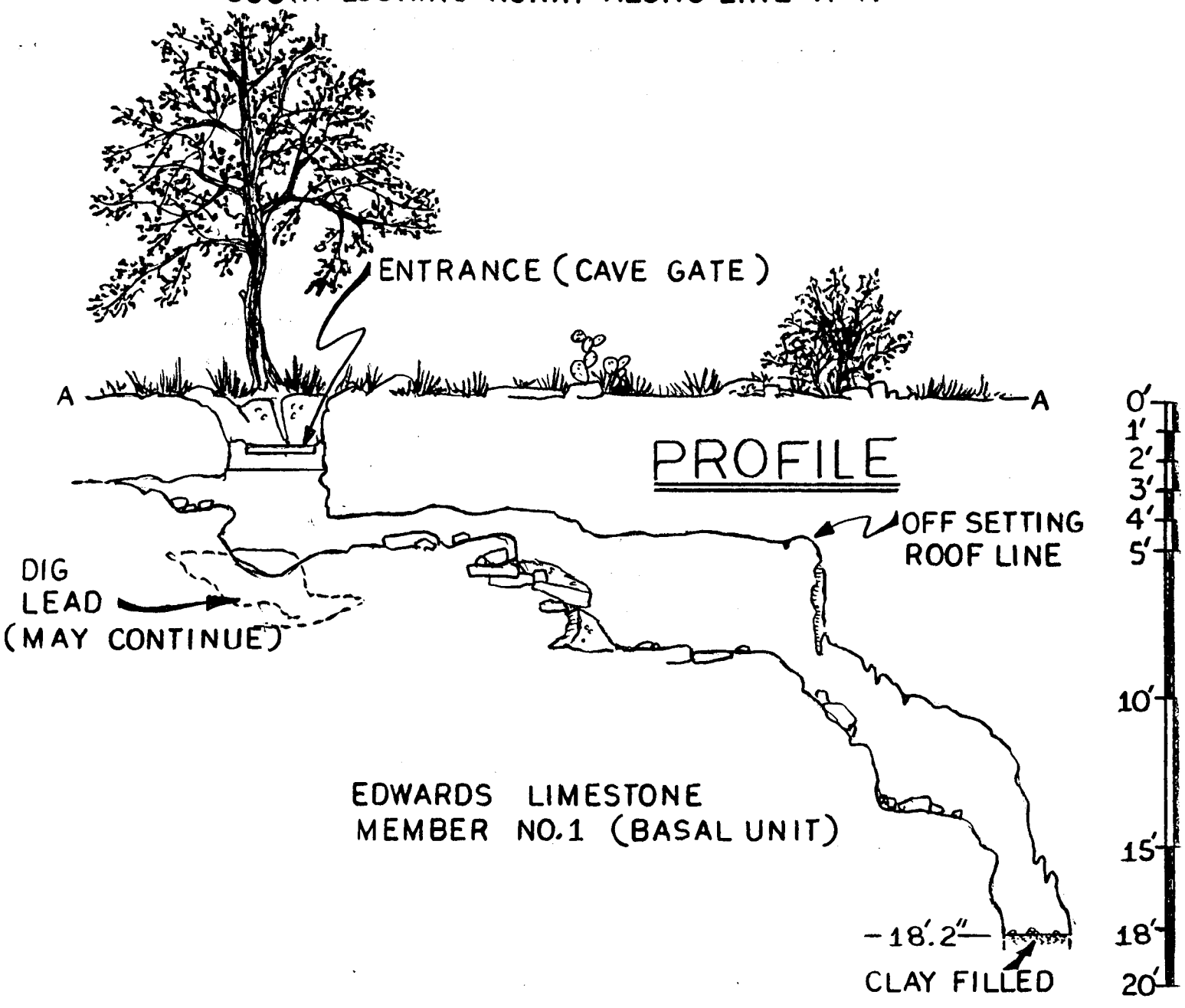
CONFIGURATION OF: 22'.0" X 38'.0"



T.S.S. 1991

BECK CREVICE CAVE

FIGURE NO. 2
VERTICAL PROFILE
SOUTH LOOKING NORTH ALONG LINE "A-A"



SCALE IN FEET
1" = 5'.0"

T.S.S. 1991

BECK TEX-2 CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY

DATE: NOVEMBER 6, 1991

PERSONNEL:

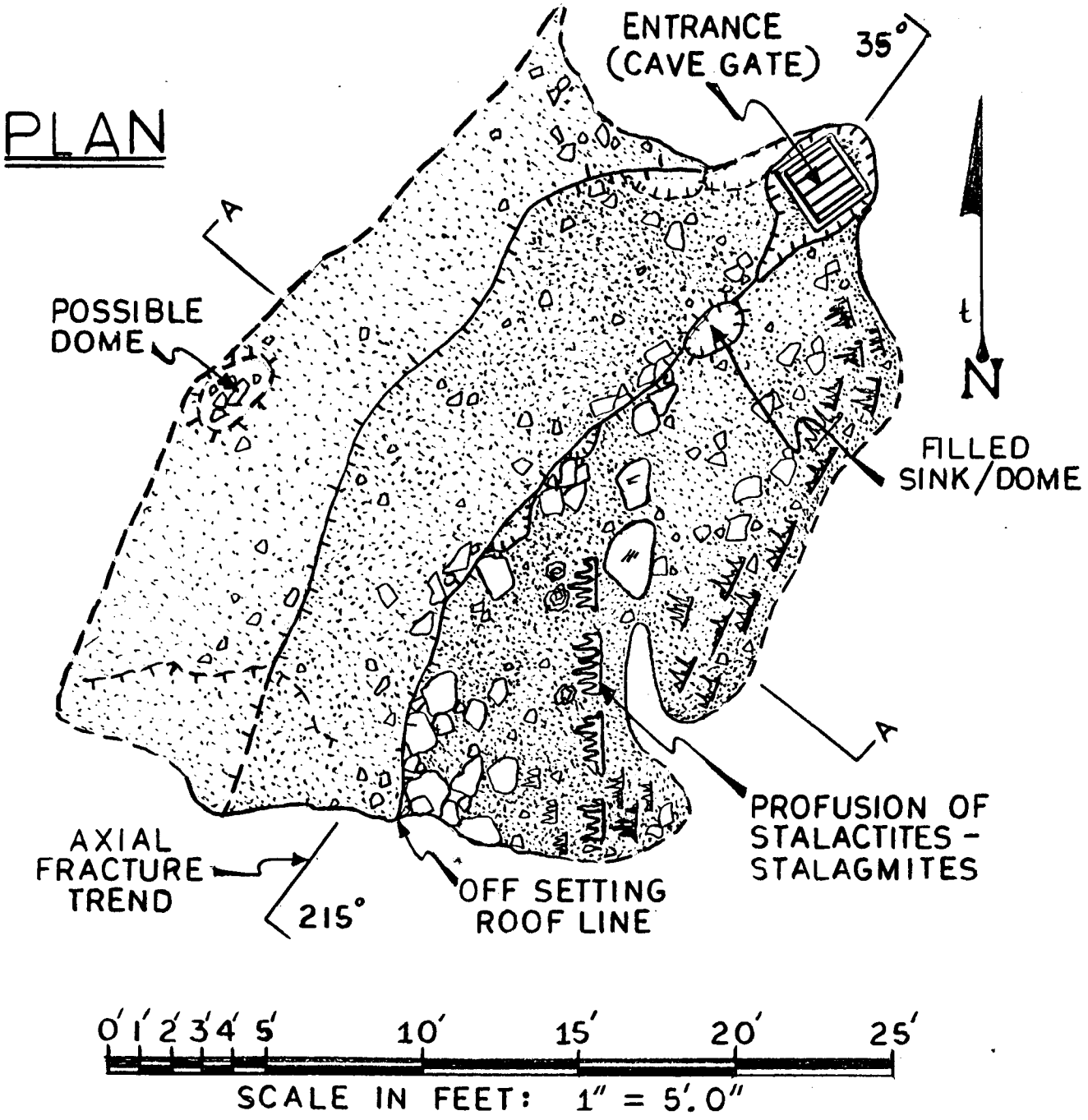
CHARLY SAVVAS - LEE JAY GRAVES - MIKE WARTON

DRAFT BY: MIKE WARTON

LENGTH: 69.6" DEPTH: 10.6

CONFIGURATION OF: 20' X 32'

PLAN

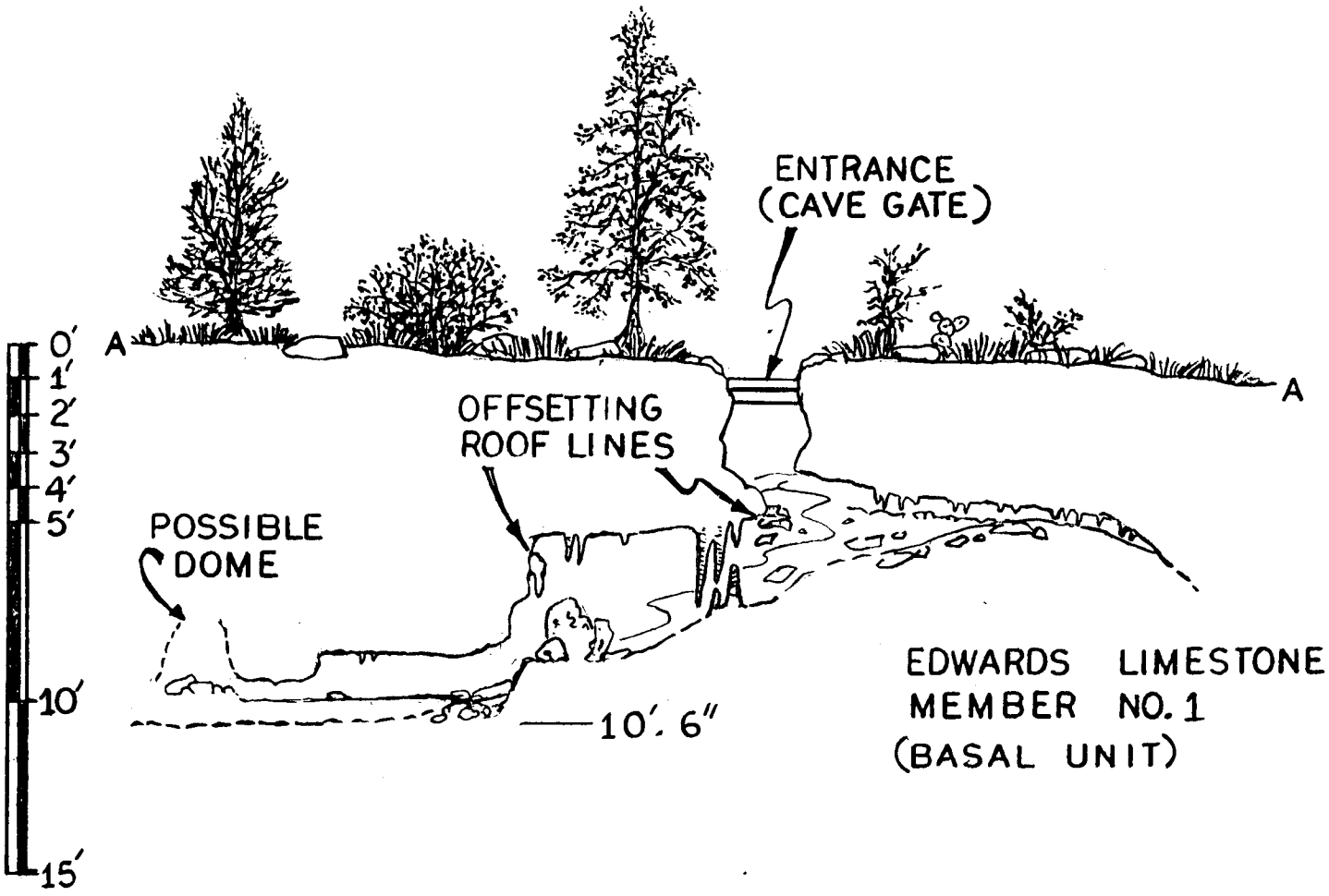


T.S.S. 1991

BECK TEX-2 CAVE

WILLIAMSON COUNTY, TEXAS

FIGURE NO. 2
VERTICAL PROFILE
SOUTH LOOKING NORTH ALONG LINE "A-A"



SCALE IN FEET:
1" = 5'. 0"

T.S.S. 1991

BECK SALAMANDER CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTO & TAPE SURVEY

DATE: NOVEMBER 6, 1991

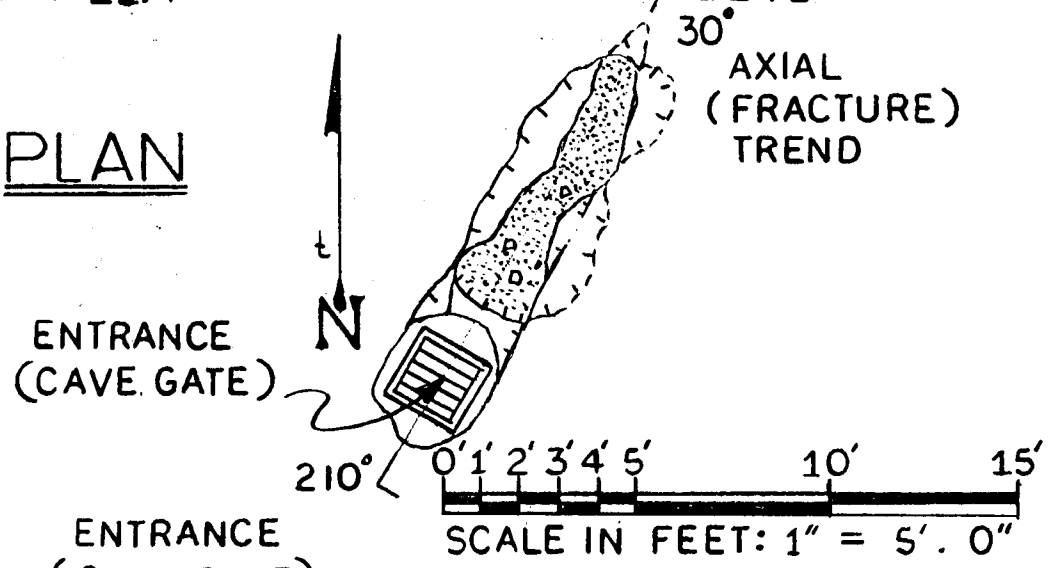
PERSONNEL:

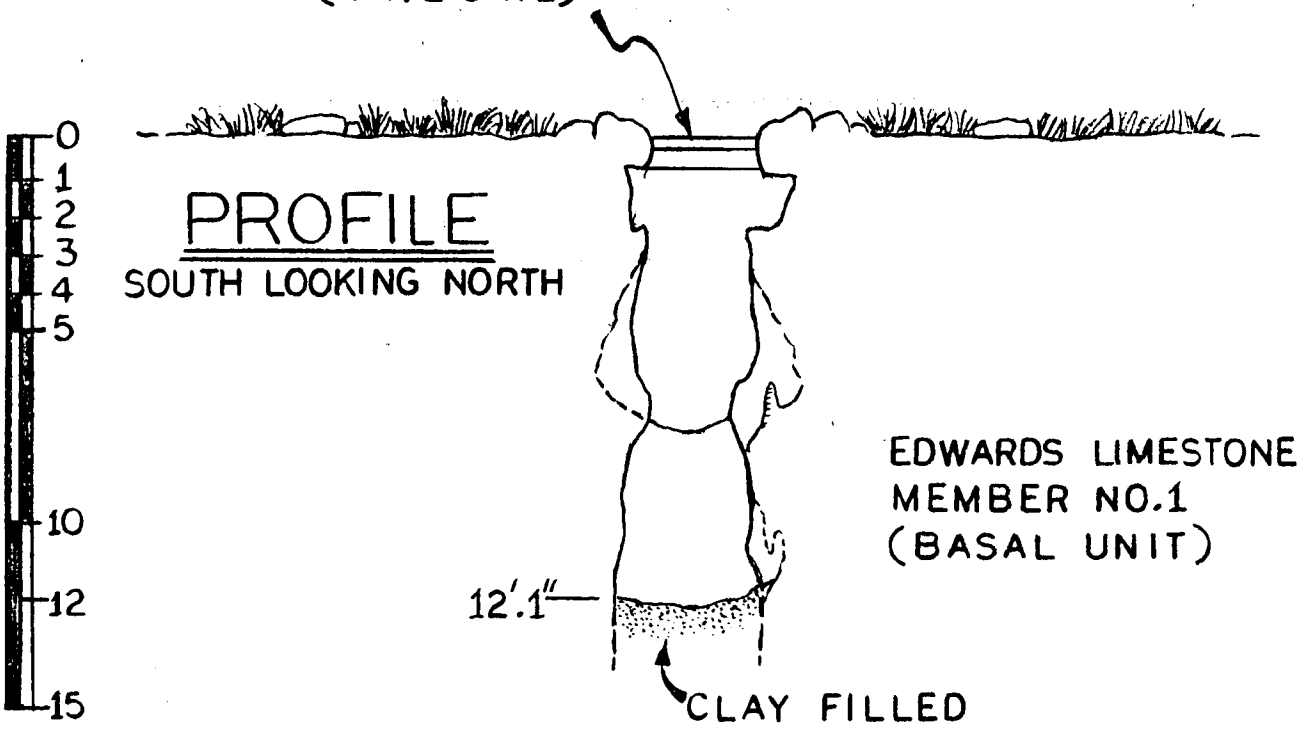
CHARLY SAVVAS-LEE JAY GRAVES - MIKE WARTON

DRAFT BY: MIKE WARTON

LENGTH: 11'.4" DEPTH: ~12'.1"

PLAN





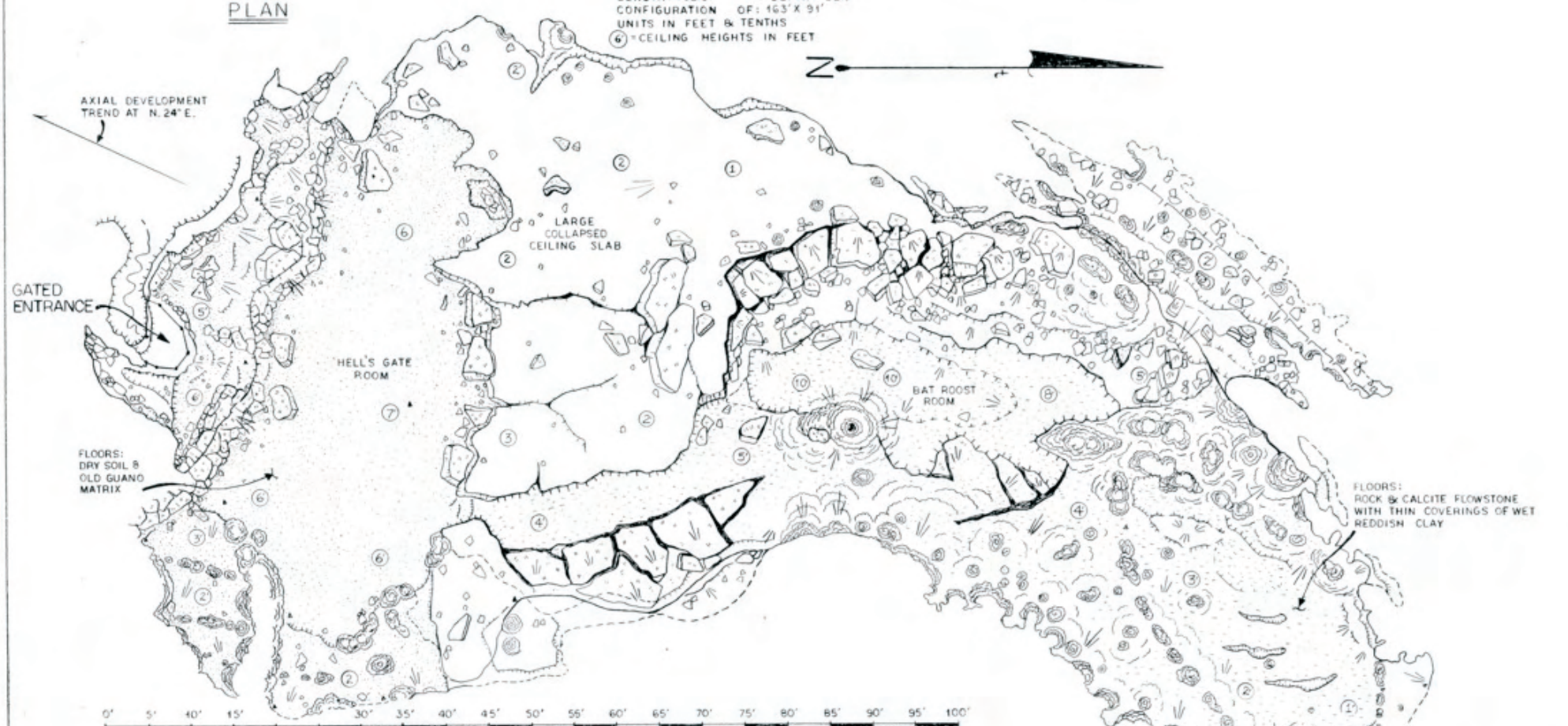
T.S.S. 1991

BECK BAT CAVE

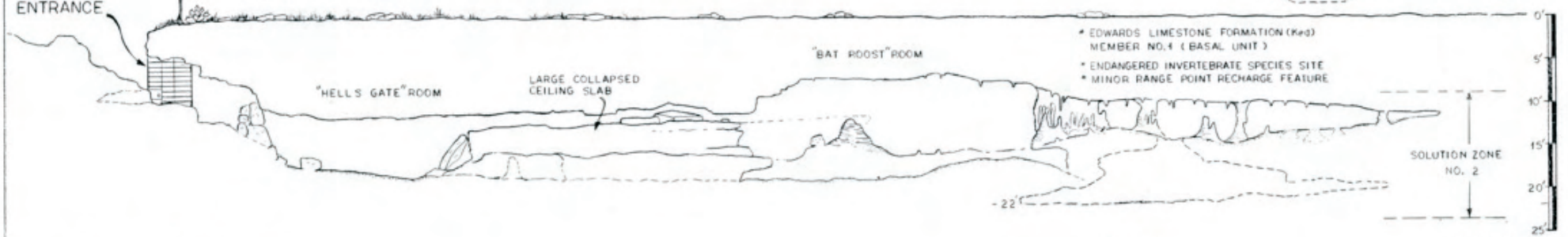
WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY - DATE: MAY 8, 1996
PERSONNEL: L. AASE - B. WETUSKI - M. GUERRA - C. WARTON - M. WARTON
DRAFT BY: M. WARTON
LENGTH: 182.3' DEPTH: 22.0'
CONFIGURATION OF: 163' X 91'
UNITS IN FEET & TENTHS
(6) = CEILING HEIGHTS IN FEET

PLAN



PROFILE
EAST LOOKING WEST
ALONG AXIAL DEVELOPMENT TREND



SCALE IN FEET: 1/8" = 1.0'

PREPARED BY: MIKE WARTON & ASSOCIATES

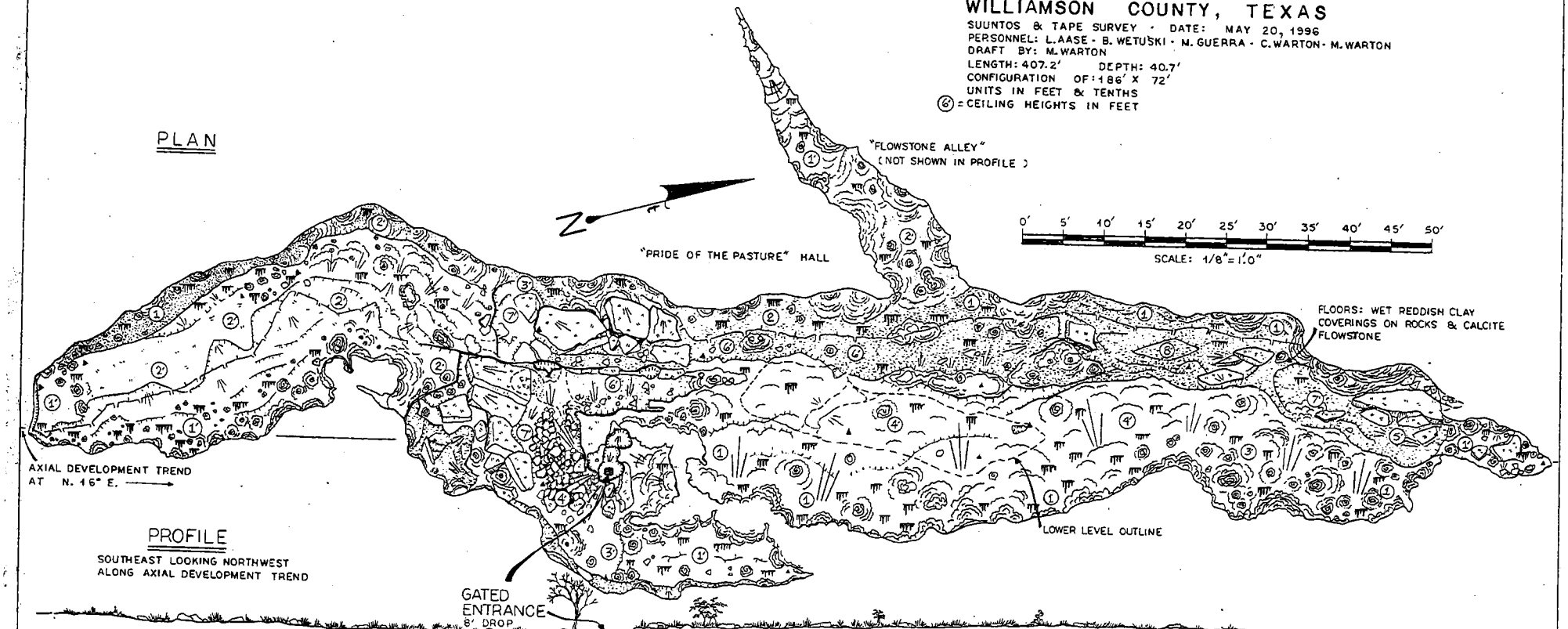
T.S.S. 1996

BECK PRIDE CAVE

WILLIAMSON COUNTY, TEXAS

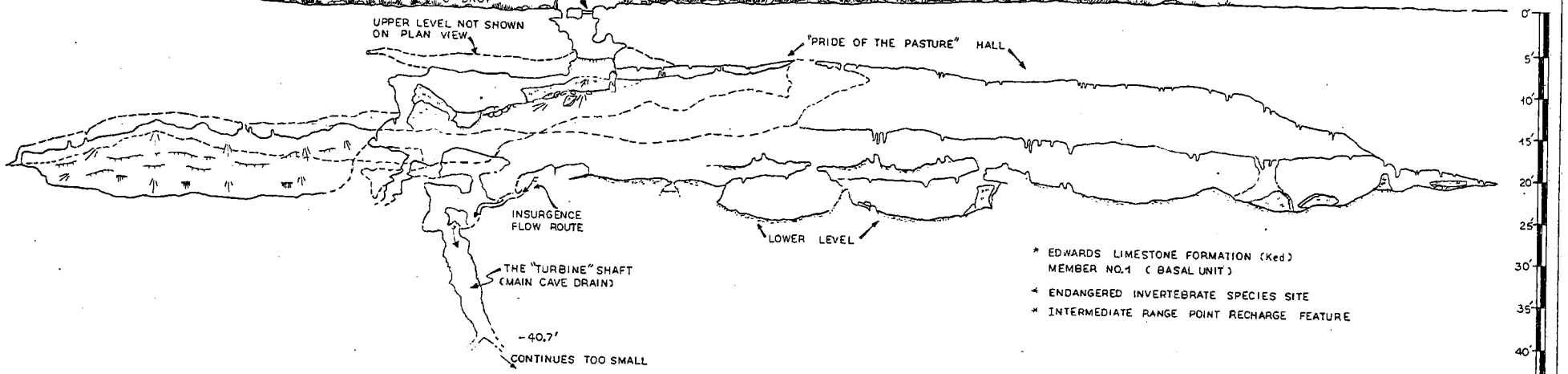
SUUNTOS & TAPE SURVEY · DATE: MAY 20, 1996
PERSONNEL: L. AASE - B. WETUSKI - M. GUERRA - C. WARTON - M. WARTON
DRAFT BY: M. WARTON
LENGTH: 407.2' DEPTH: 40.7'
CONFIGURATION OF: 186' X 72'
UNITS IN FEET & TENTHS
(6) = CEILING HEIGHTS IN FEET

PLAN



PROFILE

SOUTHEAST LOOKING NORTHWEST
ALONG AXIAL DEVELOPMENT TREND



* EDWARDS LIMESTONE FORMATION (Ked) MEMBER NO.1 (BASAL UNIT)
* ENDANGERED INVERTEBRATE SPECIES SITE
* INTERMEDIATE RANGE POINT RECHARGE FEATURE

PREPARED BY: MIKE WARTON & ASSOCIATES

T.S.S. 1996

SCALE: 1/8" = 1'.0"

BECK HORSE CAVE

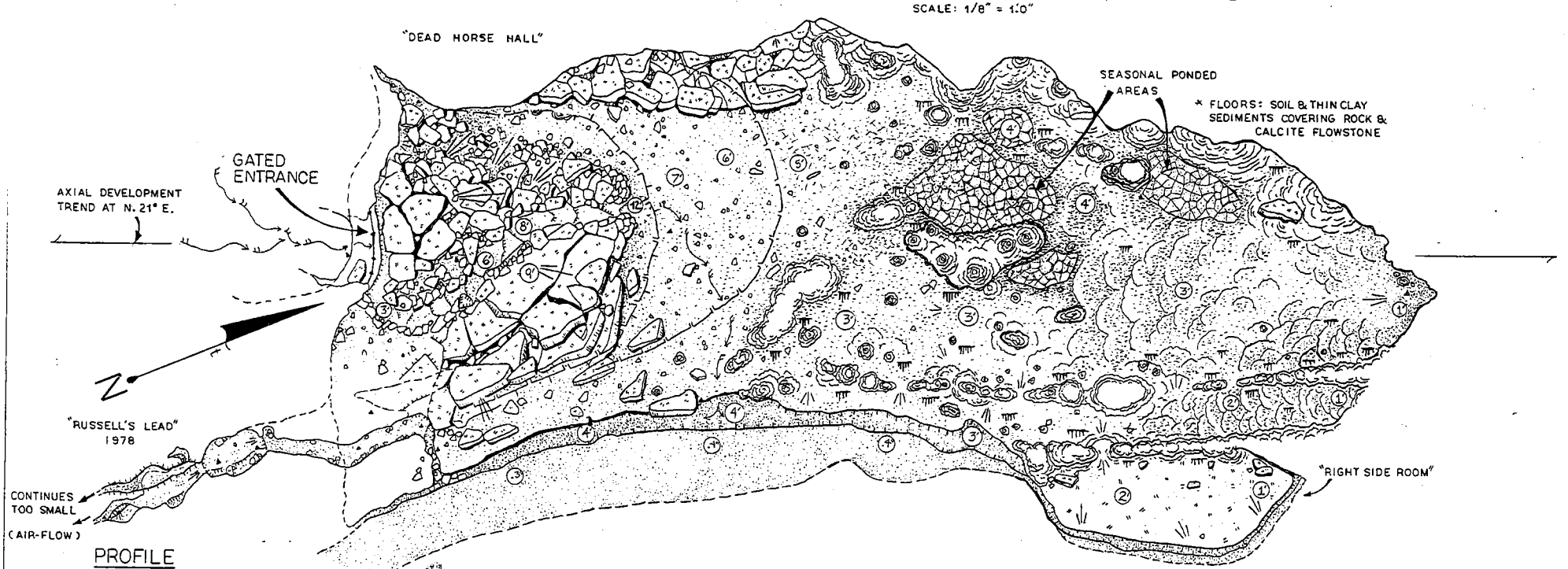
WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY · DATE: MAY 13, 1996
PERSONNEL: L. AASE - B. WETUSKI - M. GUERRA - C. WARTON - M. WARTON
DRAFT BY: M. WARTON
LENGTH: 208.5' DEPTH: 30.0'
CONFIGURATION OF: 157'x 67'
UNITS IN FEET & TENTHS
(6)=CEILING HEIGHTS IN FEET

PLAN

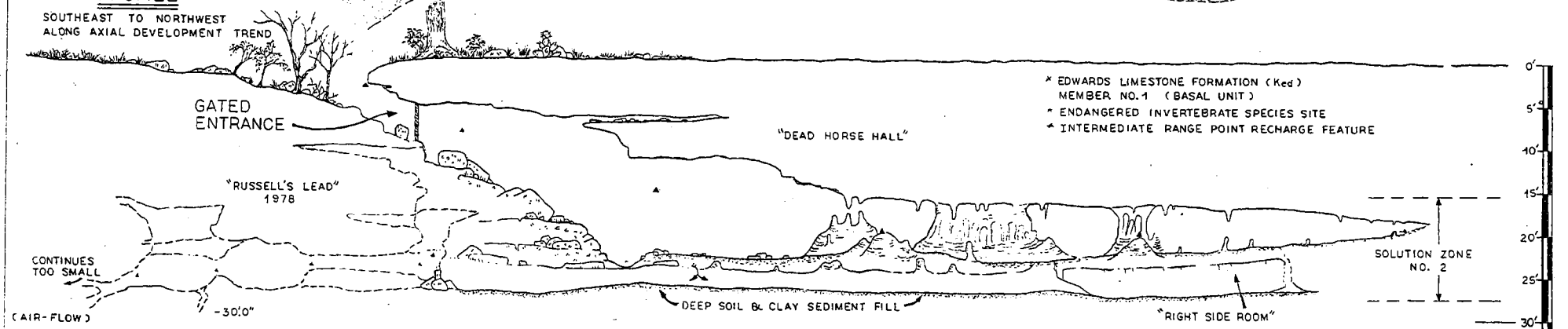
0' 5' 10' 15' 20' 25' 30' 35' 40' 45' 50' 55' 60' 65' 70' 75' 80' 85' 90' 95' 100'

SCALE: 1/8" = 1:0"



PROFILE

SOUTHEAST TO NORTHWEST ALONG AXIAL DEVELOPMENT TREND



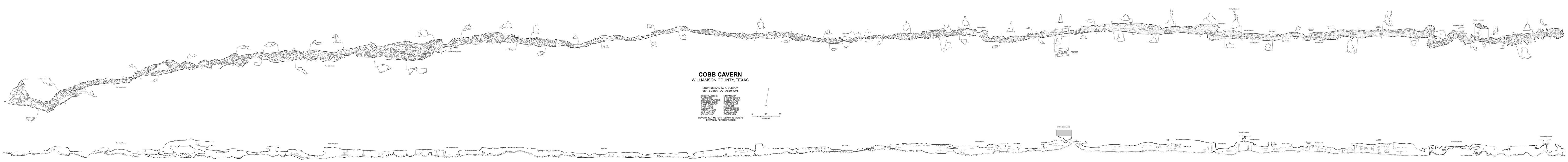
PREPARED BY: MIKE WARTON & ASSOCIATES

T.S.S. 1996

SCALE IN FEET: 1/8"=1:0"

Appendix C

Cave Map of the Cobbs Cavern Karst Fauna Area


COBB CAVERN
WILLIAMSON COUNTY, TEXAS
SUUNTOS AND TAPE SURVEY
SEPTEMBER - OCTOBER 1996
CHRISTINA CHENG
ALLAN COBB
MICHAEL CRAWFORD
CARMELITE DUHON
SHANE GALLOWAY
SUSIE LASKO
ALYSSA LOWE
PATRICK LYNOTT
JAKE MCCLURE
JON MCCLURE
LIBBY MOJICA
CHRISTIE ROGERS
CHARLEY SAVVAS
RACHEL SAVVAS
VICKY SCHILLER
ANN SCOTT
PETER SPROUSE
KEVIN STAFFORD
CHAD VALADEZ
GEORGE VENI
LENGTH: 1334 METERS DEPTH: 16 METERS
DRAWN BY PETER SPROUSE
0 10 20
METERS

Appendix D

Cave Maps of the Millennium Cave Preserve

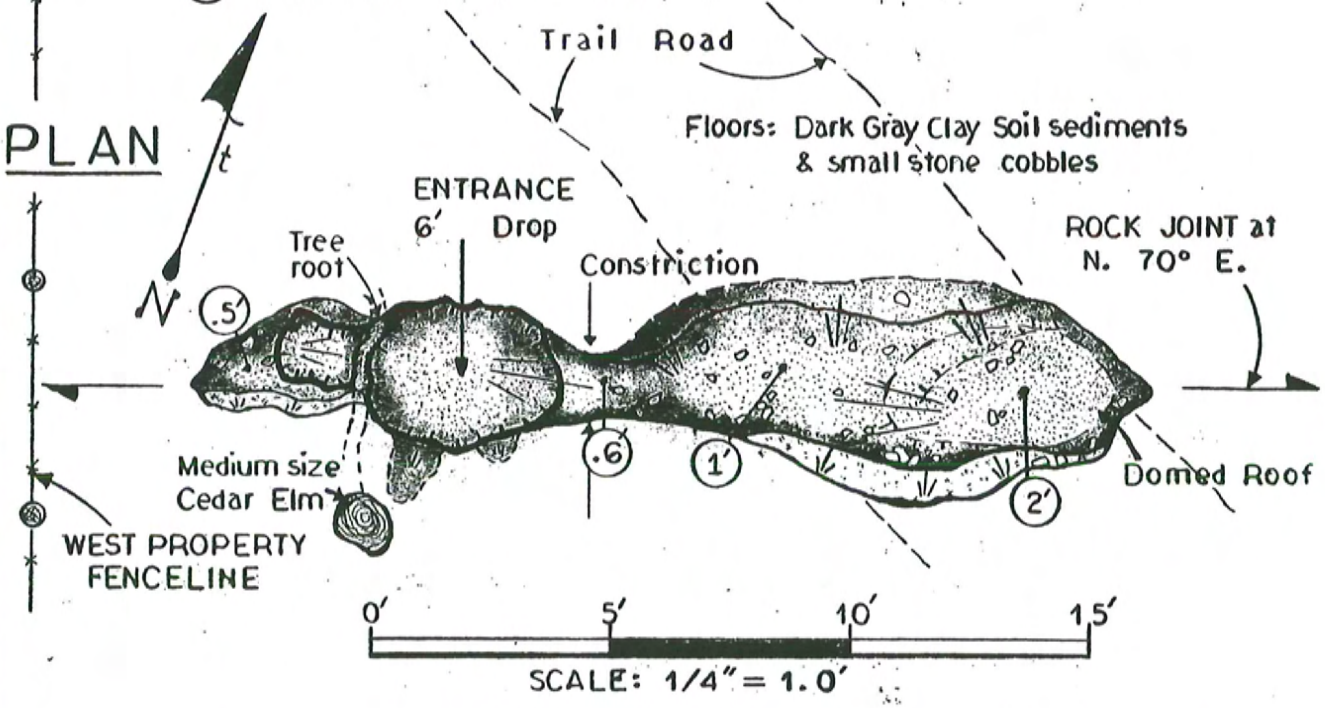
FENCE & TRAIL CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY · JULY 17, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: N. AASE · A. STAPLES · B. HINDES · C. LANGILLE · M. WARTON · DRAFT BY: M. WARTON
LENGTH: 20.0′ DEPTH: 7.0′ CONFIGURATION OF: 20′x 5′

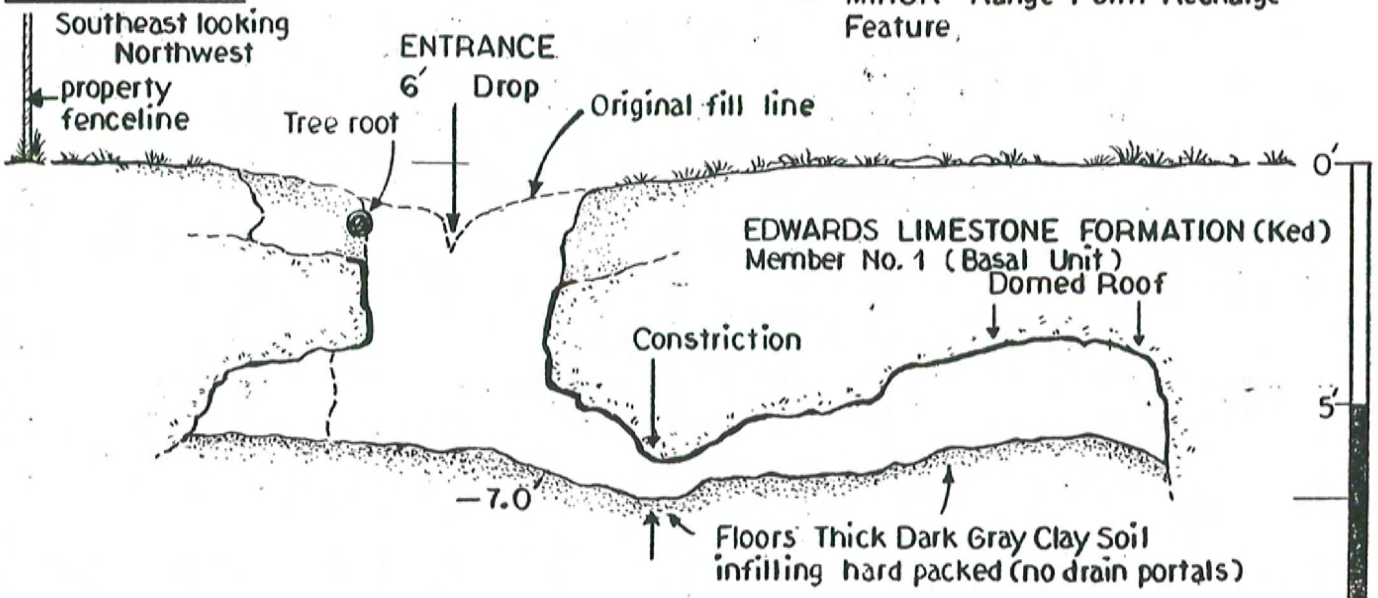
(2′) = CEILING HEIGHTS IN FEET

PLAN



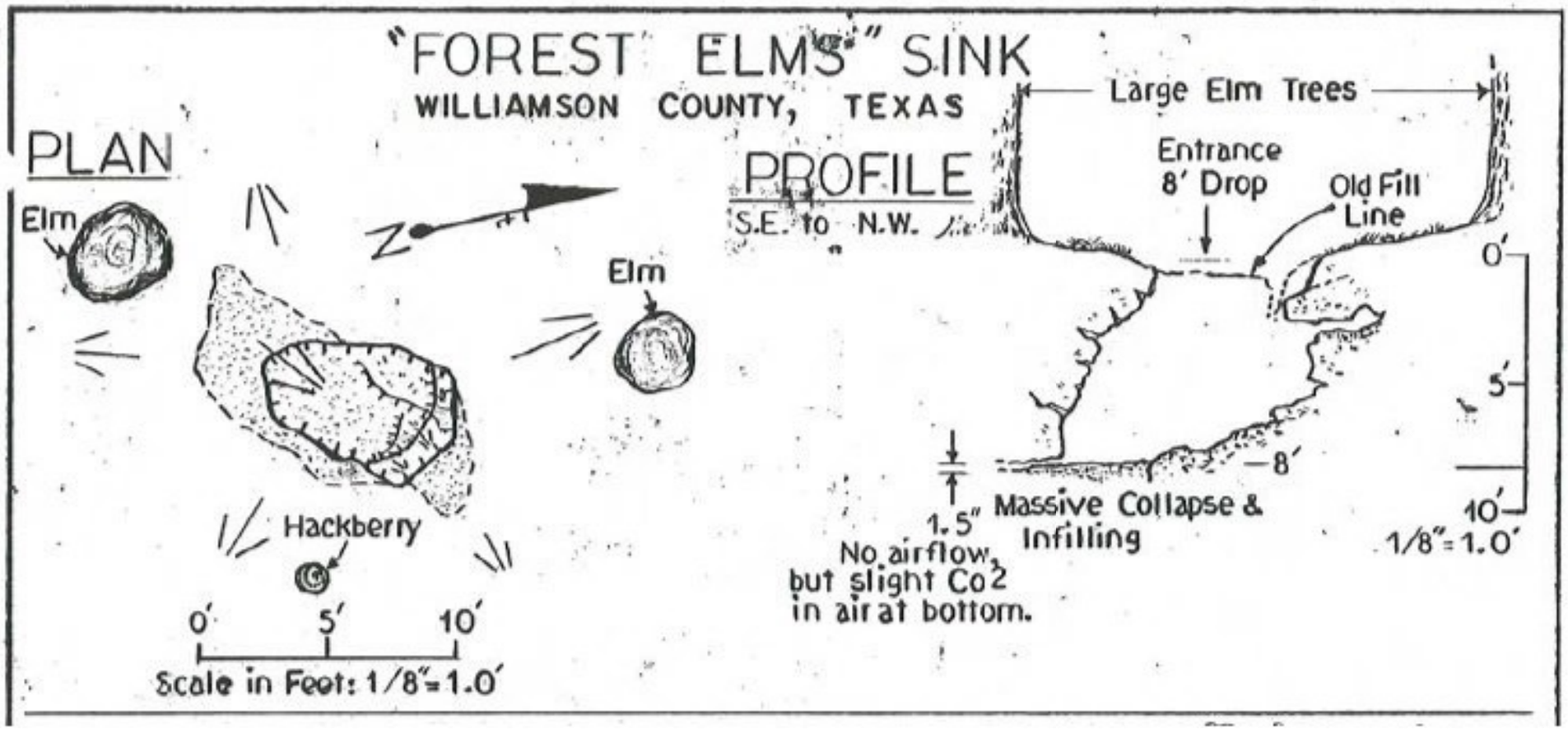
PROFILE

* "NON-HABITAT" Karst Feature
* "MINOR" Range Point Recharge Feature



PREPARED BY; MIKE WARTON & ASSOCIATES:
JULY, 2000

SCALE IN FEET: 1/4″=1.0′

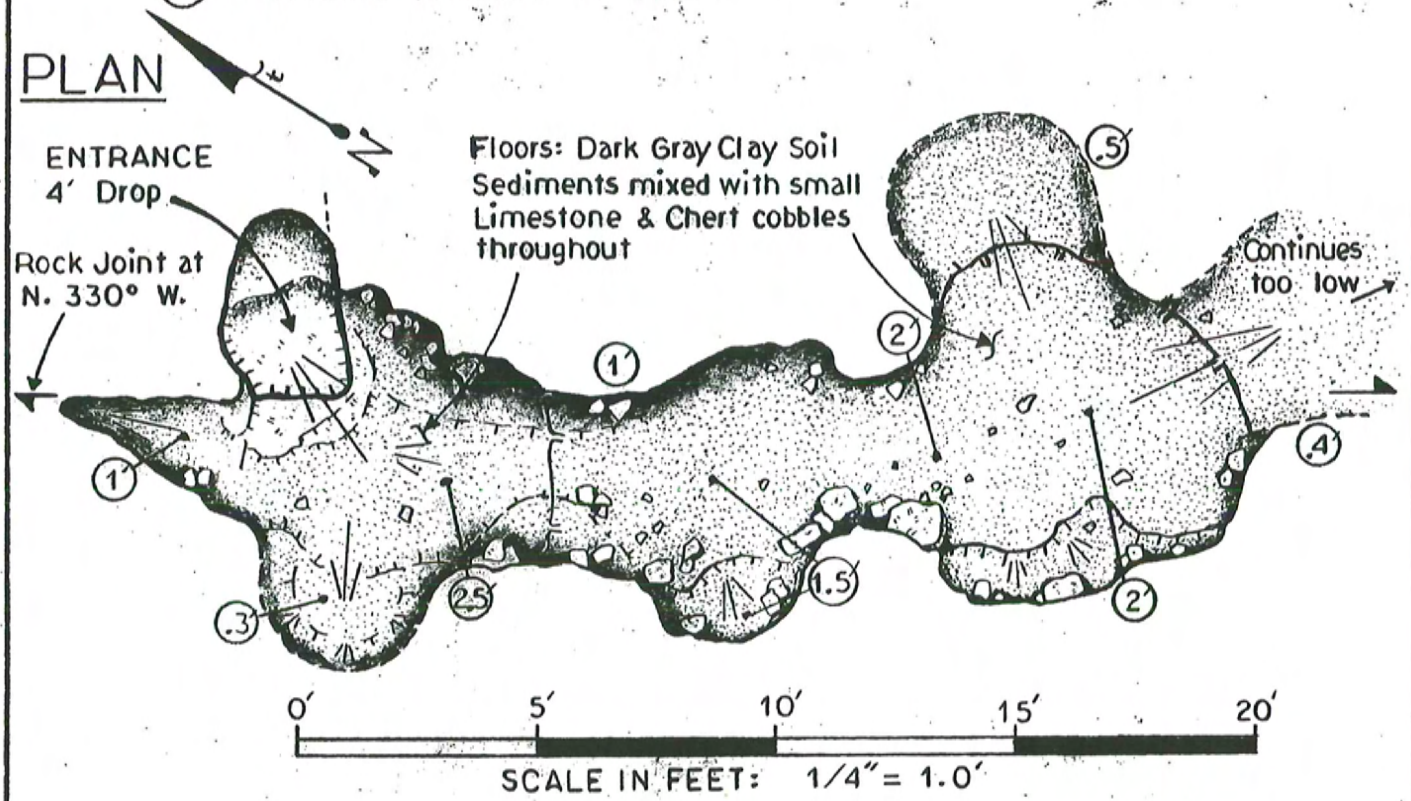

"FOREST ELMS" SINK
WILLIAMSON COUNTY, TEXAS
PLAN
Elm
Elm
Hackberry
N
0'
5'
10'
Scale in Feet: 1/8"=1.0'
PROFILE
S.E. to N.W.
Large Elm Trees
Entrance
8' Drop
Old Fill
Line
0'
5'
10'
1/8"=1.0'
8'
1.5"
Massive Collapse &
Infilling
No airflow,
but slight Co2
in air at bottom.

KNUCKLE CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY · JULY 26,, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: A. STAPLES · B. HINDES · C. LANGILLE · B. WETUSKI · M. WARTON · DRAFT BY: M. WARTON
LENGTH: 29.2′ DEPTH: 7.3′ CONFIGURATION OF: 26 x 11
(2′) = CEILING HEIGHTS IN FEET

PLAN

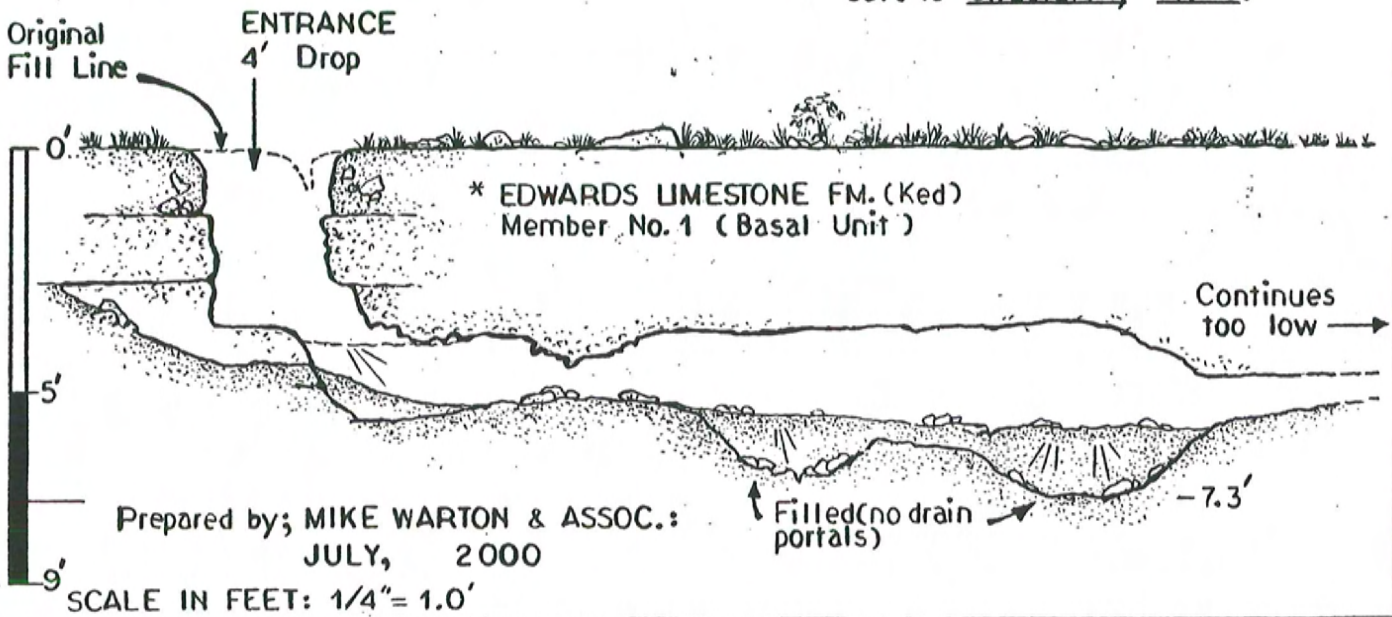


SCALE IN FEET: 1/4″ = 1.0′

PROFILE

Southwest looking Northeast

* "NON HABITAT" Karst Feature
* "MINOR" Range Point Recharge Feature
* Cave is "Structurally Stable".



Prepared by; MIKE WARTON & ASSOC.:
JULY, 2000

SCALE IN FEET: 1/4″ = 1.0′

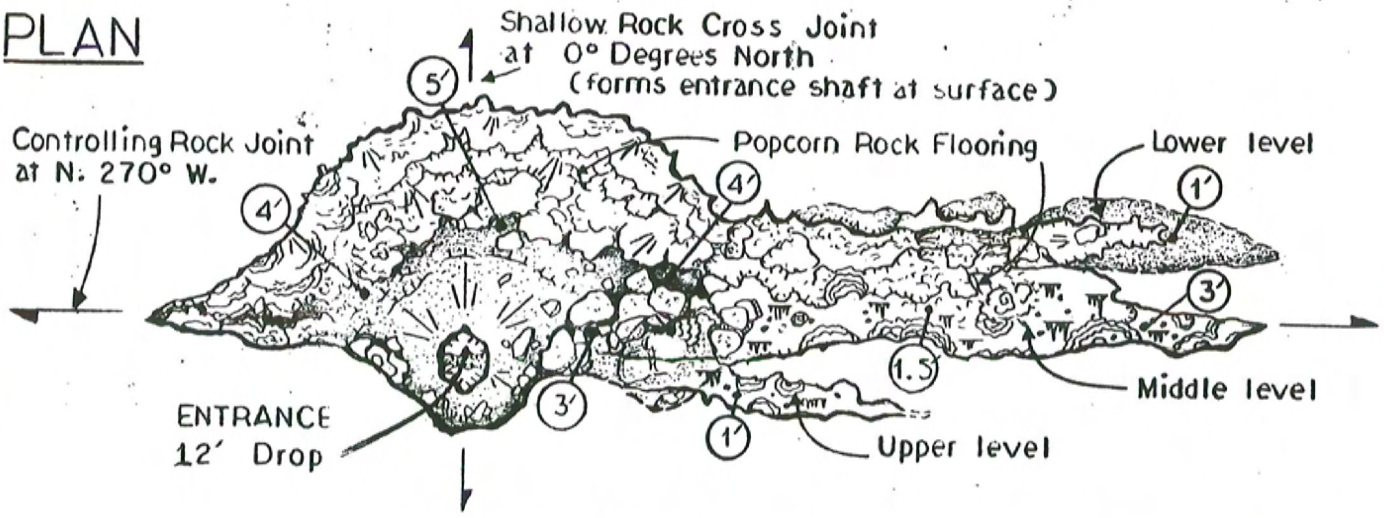
LITTLE DEMON CAVE

WILLIAMSON COUNTY, TEXAS

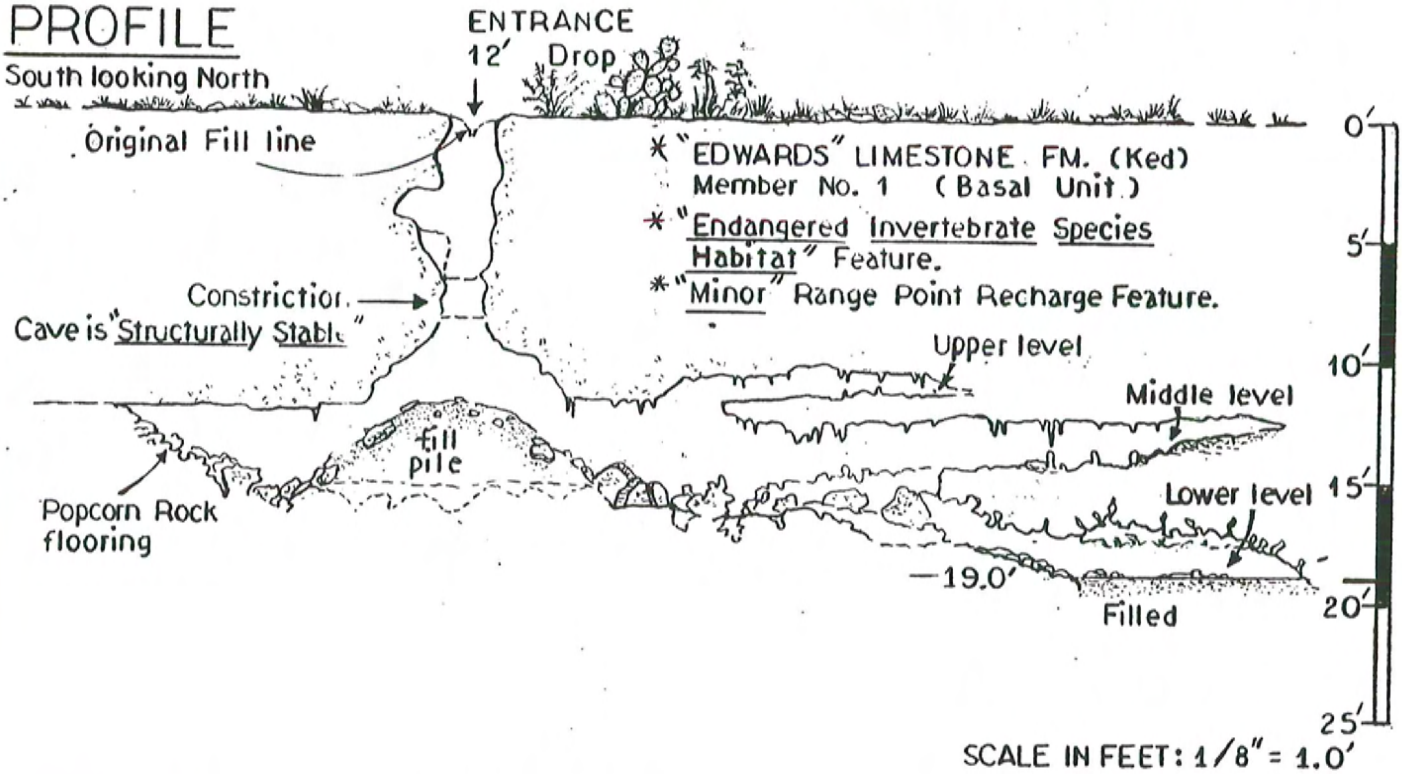
SUUNTOS & TAPE SURVEY • JULY 27, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: A. STAPLES • B. HINDES • C. LANGILLE • B. WETUSKI • M. WARTON • DRAFT BY: M. WARTON
LENGTH: 75.6′ DEPTH: 19.0′ CONFIGURATION OF: 45″ x 14″
(4′) = CEILING HEIGHTS IN FEET

N

PLAN



PROFILE



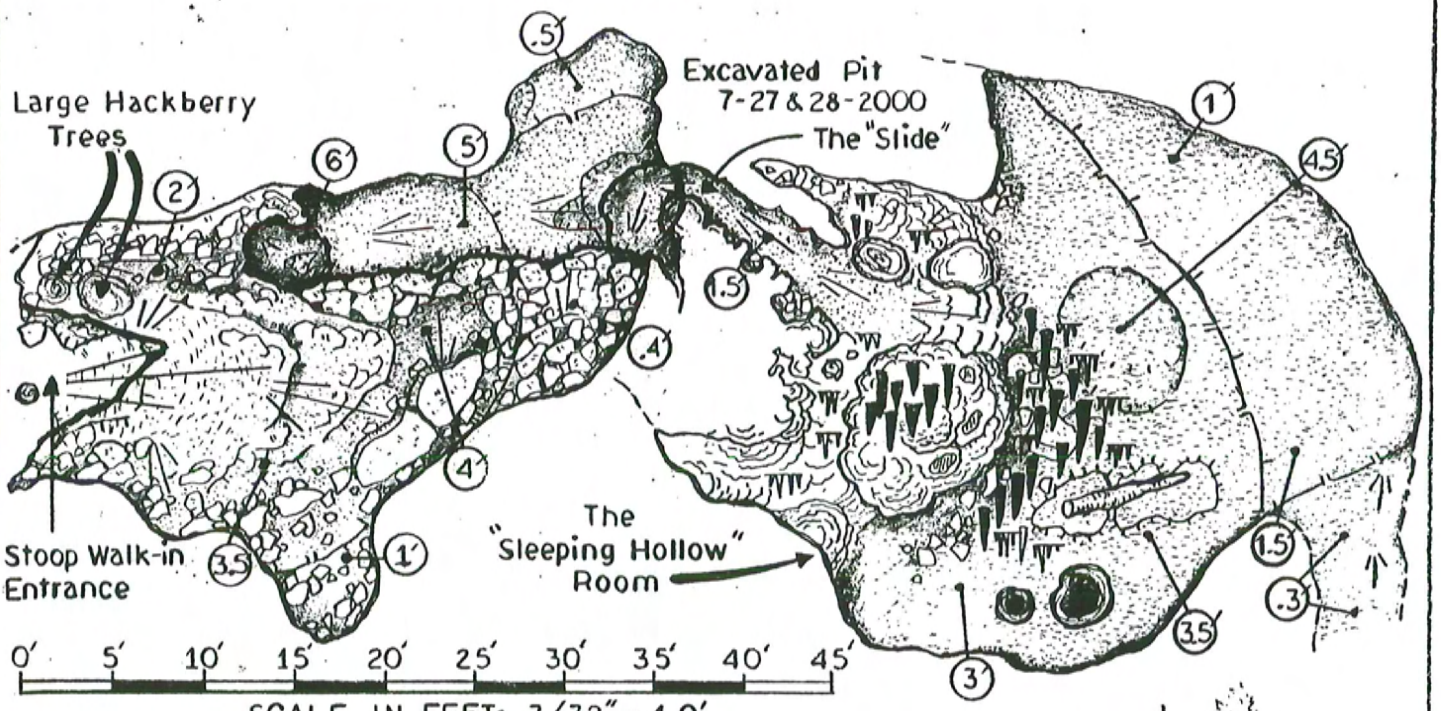
PREPARED BY; MIKE WARTON & ASSOCIATES:
JULY, 2000

MILLENNIUM CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY • JULY 28, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: A. STAPLES • B. HINDES • C. LANGILLE • B. WETUSKI • M. WARTON • DRAFT BY: M. WARTON
LENGTH: 82.7′ DEPTH: 29.0′ CONFIGURATION OF: 80′ x 35′

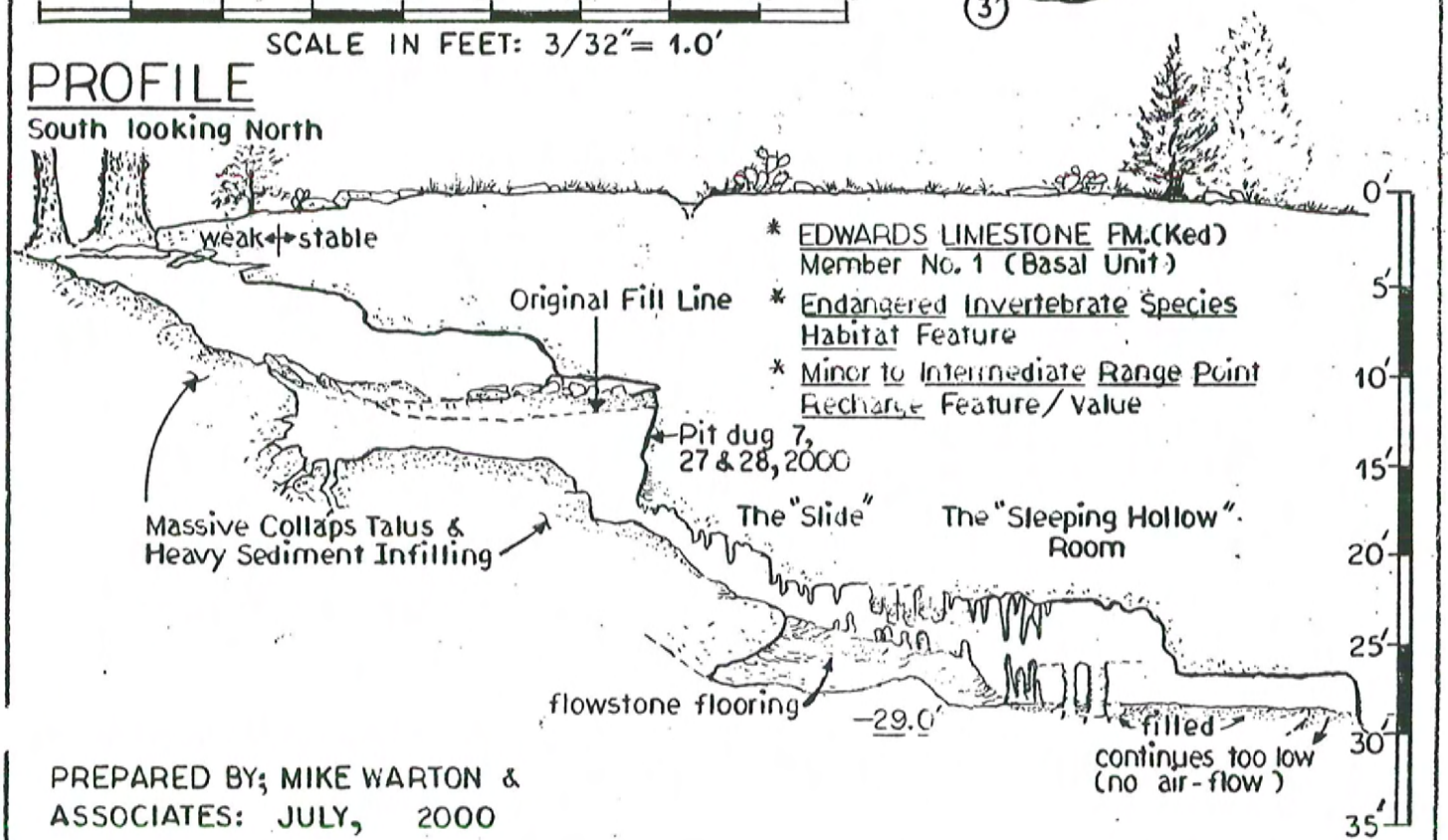
PLAN (5′) = CEILING HEIGHTS IN FEET



SCALE IN FEET: 3/32″ = 1.0′

PROFILE

South looking North



* EDWARDS LIMESTONE FM. (Ked) Member No. 1 (Basal Unit)
* Endangered Invertebrate Species Habitat Feature
* Minor to Intermediate Range Point Recharge Feature/Value

PREPARED BY; MIKE WARTON & ASSOCIATES: JULY, 2000

THROUGH ↔ TRIP CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY • AUGUST 2, 2000

PERSONNEL; MIKE WARTON & ASSOCIATES: A. STAPLES · B. HINDES · B. WETUSKI · C. LANGILLE · M. WARTON • DRAFT BY: M. WARTON

LENGTH: 105.9 DEPTH: 16.0′ CONFIGURATION OF: 80′ x 32′

(7′) = CEILING HEIGHTS IN FEET

PLAN

The "Hissing Racoon" Entrance 11′ Drop

Entrance to Entrance 80′

Perimeter Line of Sink/Closed Drainage Depression

The "Discovery" Entrance 5′ Drop

constriction

Tree

Rock Joint N. 75° E.

0′ 5′ 10′ 15′ 20′ 25′ 30′ 35′ 40′

SCALE IN FEET: 3/32" = 1.0′

PROFILE

Southeast looking Northwest

racoon family

* Edwards Limestone Formation (Ked) Member No. 1 (Basal Unit)

Floors: High Infilling of Dark Gray Clay & Soil Sediments

−16.0′

(Filled)

0′ 5′ 10′ 15′ 20′

SCALE IN FEET: 3/32" = 1.0′

* Potential to Contain Habitat for Endangered Invertebrate Species

*"Minor" Range Point Recharge Value

PREPARED BY; MIKE WARTON & ASSOCIATES: AUGUST, 2000

Appendix E

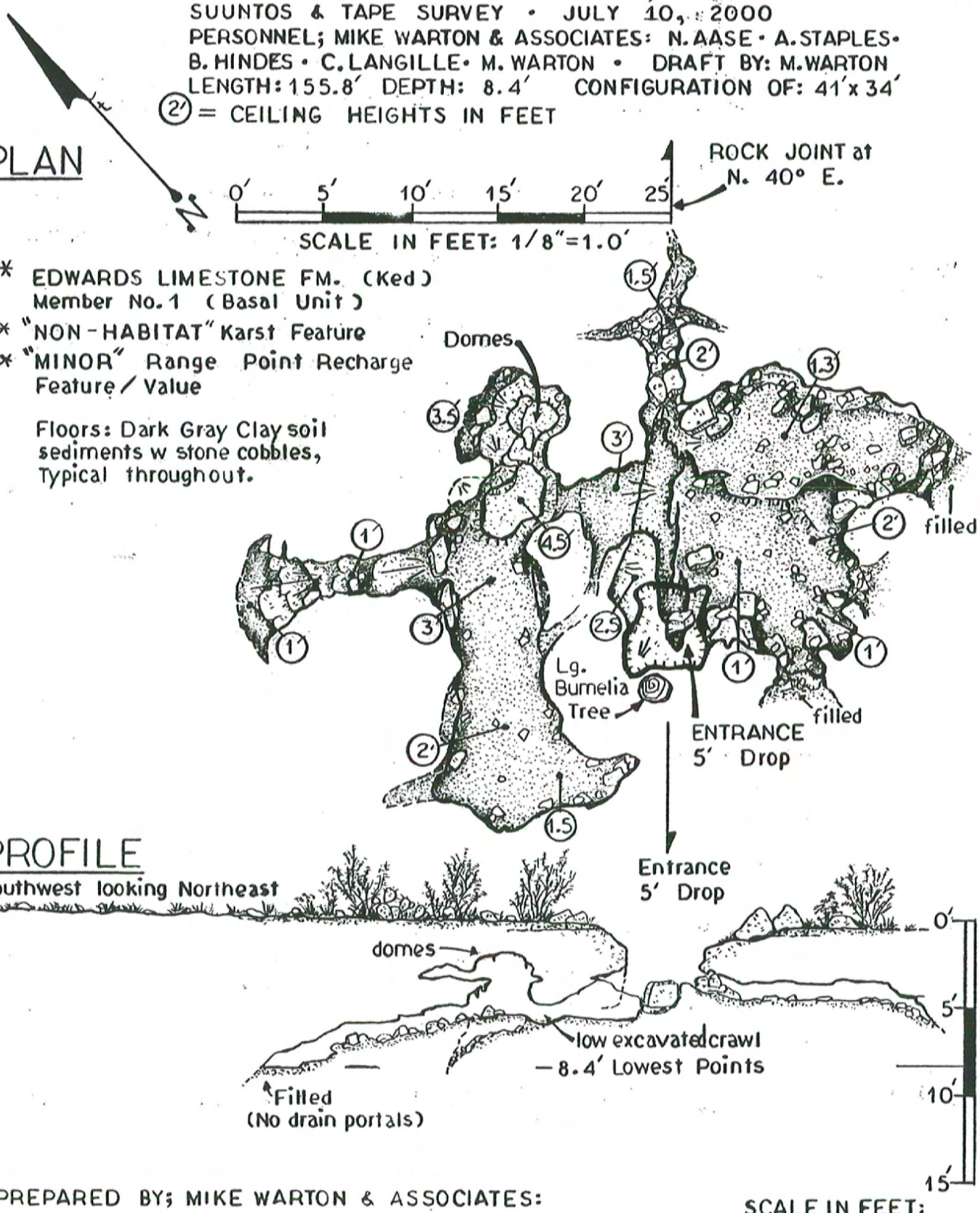
Cave Maps of the Wilco Cave Preserve

CHOYA CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY • JULY 10, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: N. AASE • A. STAPLES • B. HINDES • C. LANGILLE • M. WARTON • DRAFT BY: M. WARTON
LENGTH: 155.8′ DEPTH: 8.4′ CONFIGURATION OF: 41′ x 34′
(2′) = CEILING HEIGHTS IN FEET

PLAN



PREPARED BY; MIKE WARTON & ASSOCIATES:
JULY, 2000

SCALE IN FEET:
1/8" = 1.0′

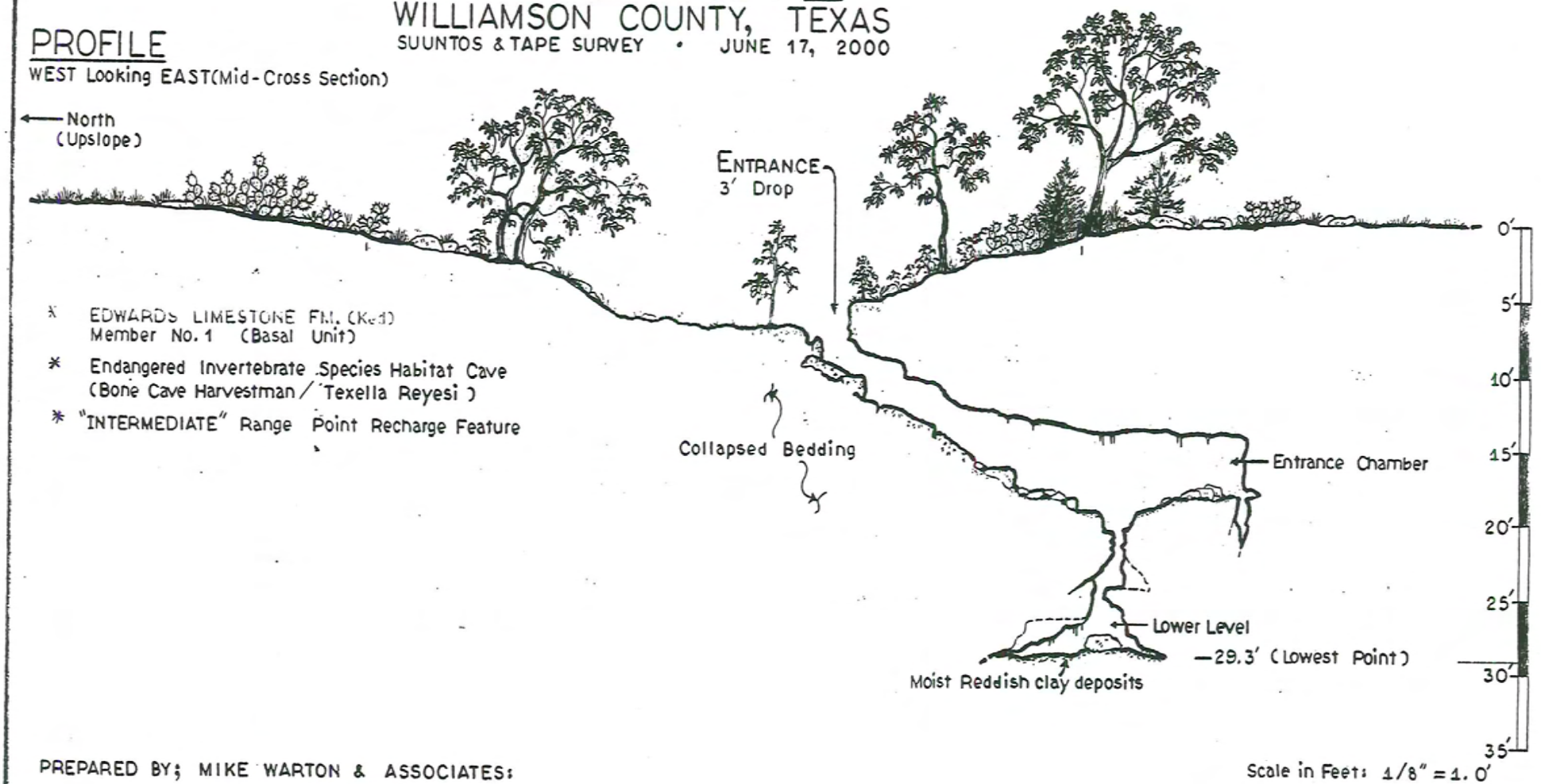
MONGO CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY • JUNE 17, 2000

PROFILE

WEST Looking EAST(Mid-Cross Section)



* EDWARDS LIMESTONE FM. (Ked)
Member No. 1 (Basal Unit)

* Endangered Invertebrate Species Habitat Cave
(Bone Cave Harvestman / Texella Reyesi)

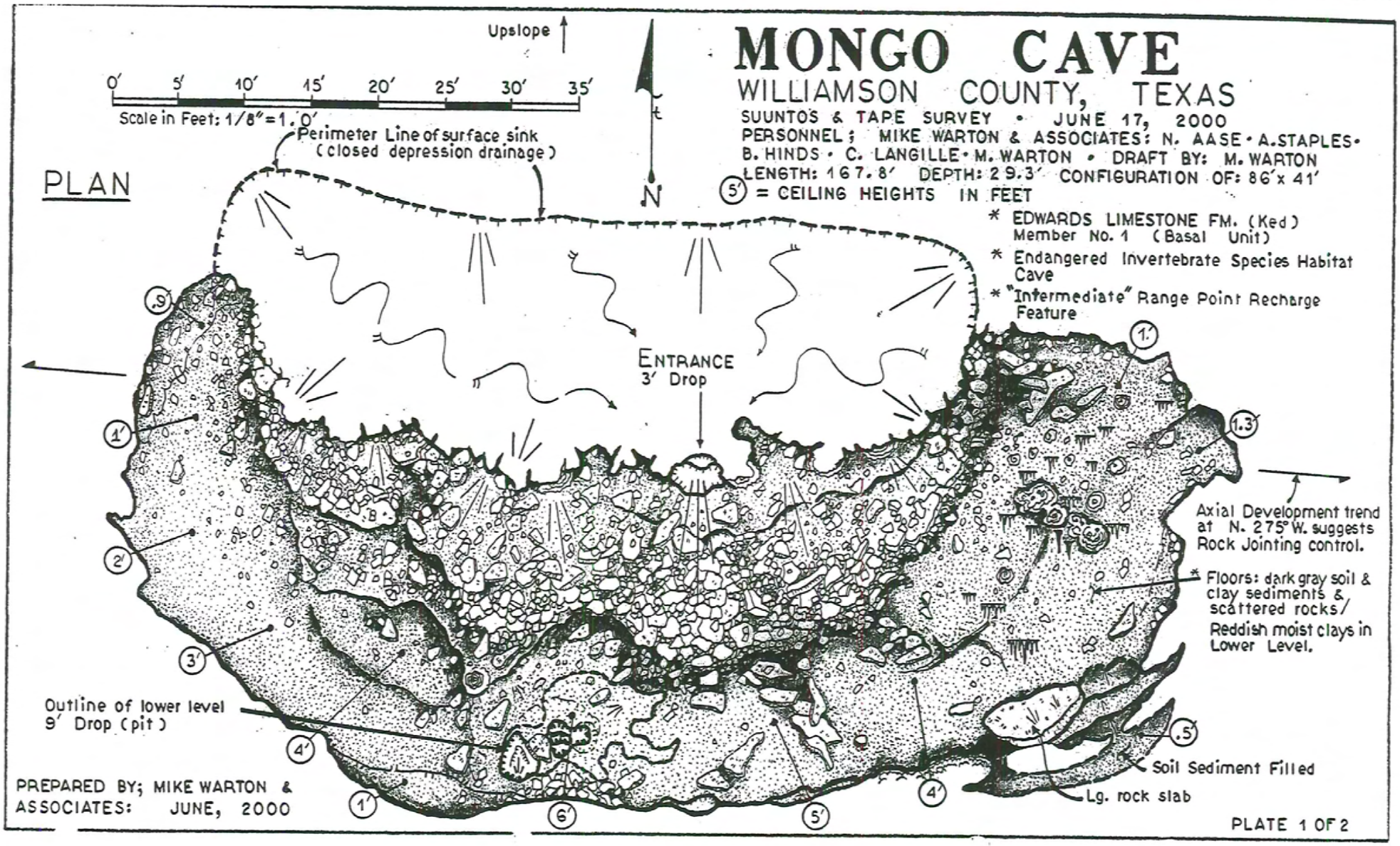
* "INTERMEDIATE" Range Point Recharge Feature

PREPARED BY; MIKE WARTON & ASSOCIATES:

JUNE, 2000

Scale in Feet: 1/8" = 1.0'

PLATE 2 OF 2

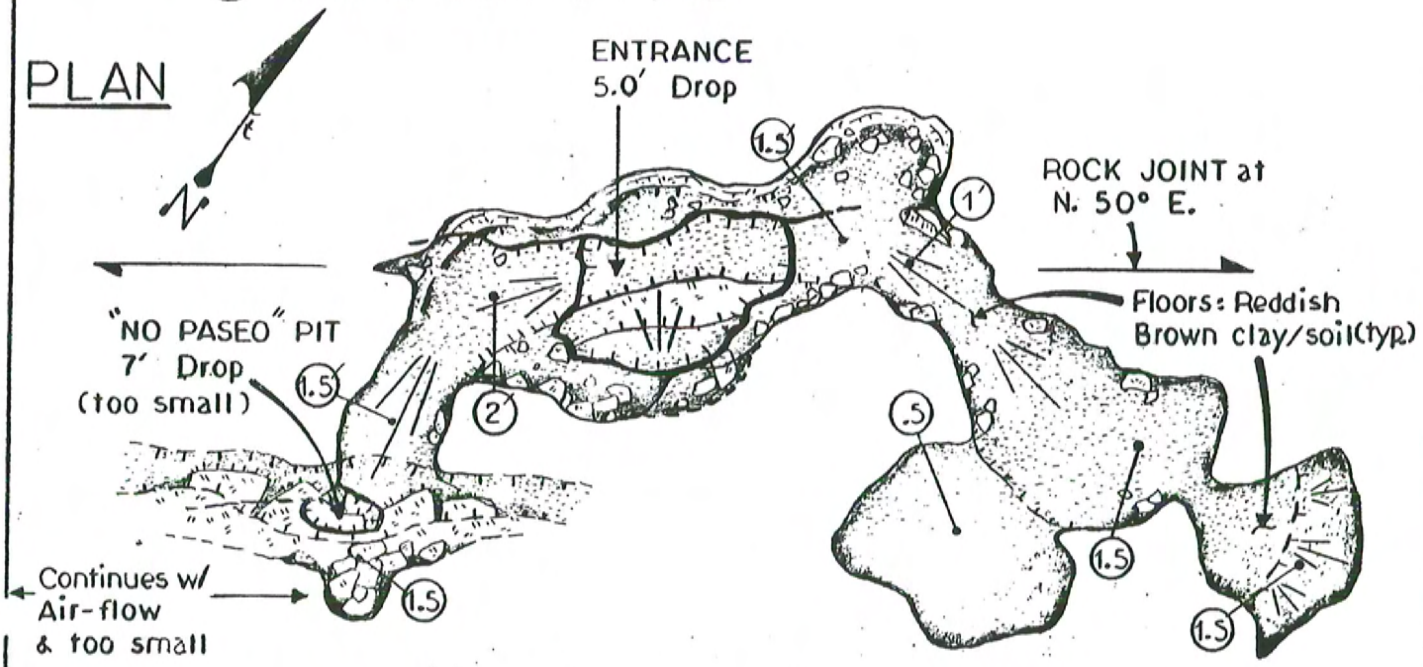

Upslope
0' 5' 10' 15' 20' 25' 30' 35'
Scale in Feet: 1/8"=1.0'
Perimeter Line of surface sink (closed depression drainage)
N
PLAN
MONGO CAVE
WILLIAMSON COUNTY, TEXAS
SUUNTO'S & TAPE SURVEY • JUNE 17, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: N. AASE • A.STAPLES • B. HINDS • C. LANGILLE • M. WARTON • DRAFT BY: M. WARTON
LENGTH: 167.8' DEPTH: 29.3' CONFIGURATION OF: 86'x 41'
(5') = CEILING HEIGHTS IN FEET
* EDWARDS LIMESTONE FM. (Ked) Member No. 1 (Basal Unit)
* Endangered Invertebrate Species Habitat Cave
* "Intermediate" Range Point Recharge Feature
ENTRANCE
3' Drop
.9
1'
2'
3'
4'
1'
6'
5'
4'
.5
1'
1.3
Axial Development trend at N. 275° W. suggests Rock Jointing control.
* Floors: dark gray soil & clay sediments & scattered rocks/ Reddish moist clays in Lower Level.
Outline of lower level 9' Drop (pit)
Soil Sediment Filled
Lg. rock slab
PREPARED BY; MIKE WARTON & ASSOCIATES: JUNE, 2000
PLATE 1 OF 2

NO PASEO CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY • JULY 6, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: N. AASE • A. STAPLES • B. HINDES • C. LANGILLE • M. WARTON • DRAFT BY: M. WARTON
LENGTH: 36.5′ DEPTH: 13.5′ CONFIGURATION OF: 26′ x 11′
(2′) = CEILING HEIGHTS IN FEET

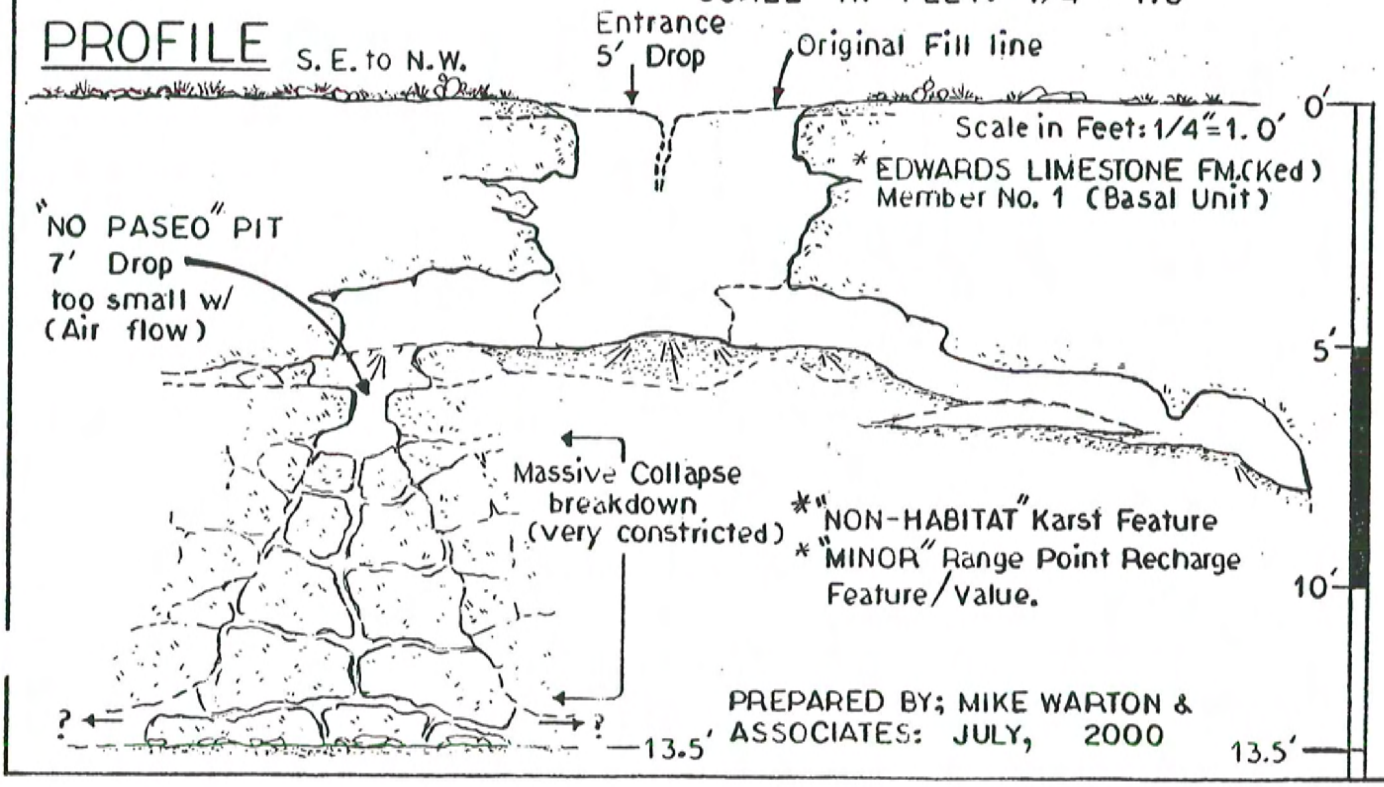
PLAN



0′ 5′ 10′ 15′

SCALE IN FEET: 1/4" = 1.0′

PROFILE S. E. to N. W.



PREPARED BY; MIKE WARTON & ASSOCIATES: JULY, 2000

NUEVO CAVE

WILLIAMSON COUNTY, TEXAS

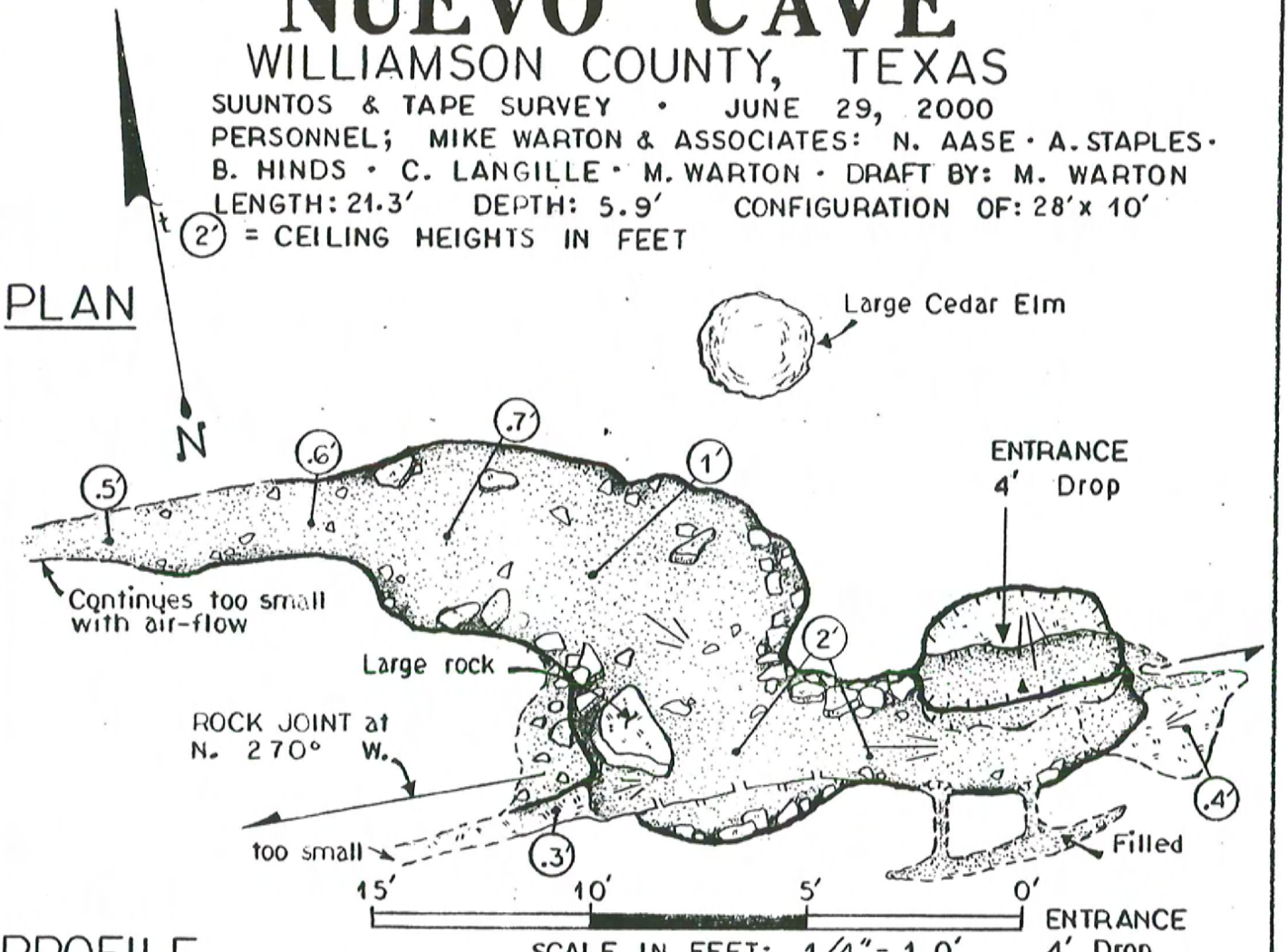
SUUNTOS & TAPE SURVEY • JUNE 29, 2000

PERSONNEL; MIKE WARTON & ASSOCIATES: N. AASE • A. STAPLES • B. HINDS • C. LANGILLE • M. WARTON • DRAFT BY: M. WARTON

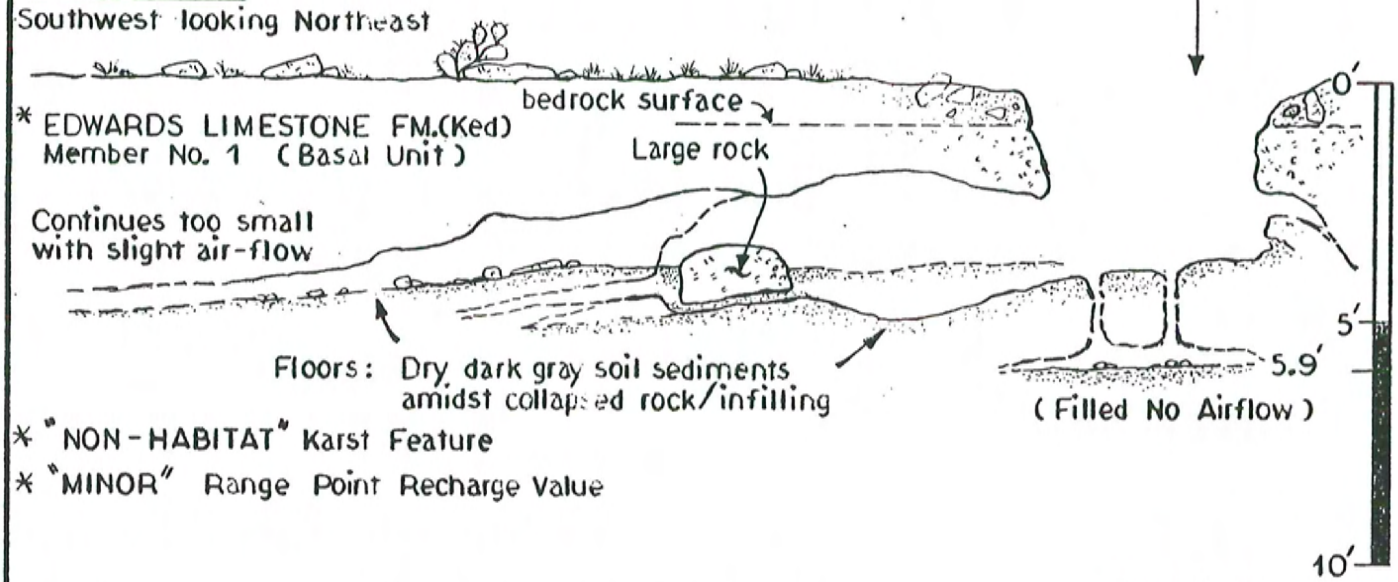
LENGTH: 21.3′ DEPTH: 5.9′ CONFIGURATION OF: 28′ x 10′

(2′) = CEILING HEIGHTS IN FEET

PLAN



PROFILE



* "NON-HABITAT" Karst Feature
* "MINOR" Range Point Recharge Value

PREPARED BY; MIKE WARTON & ASSOCIATES:

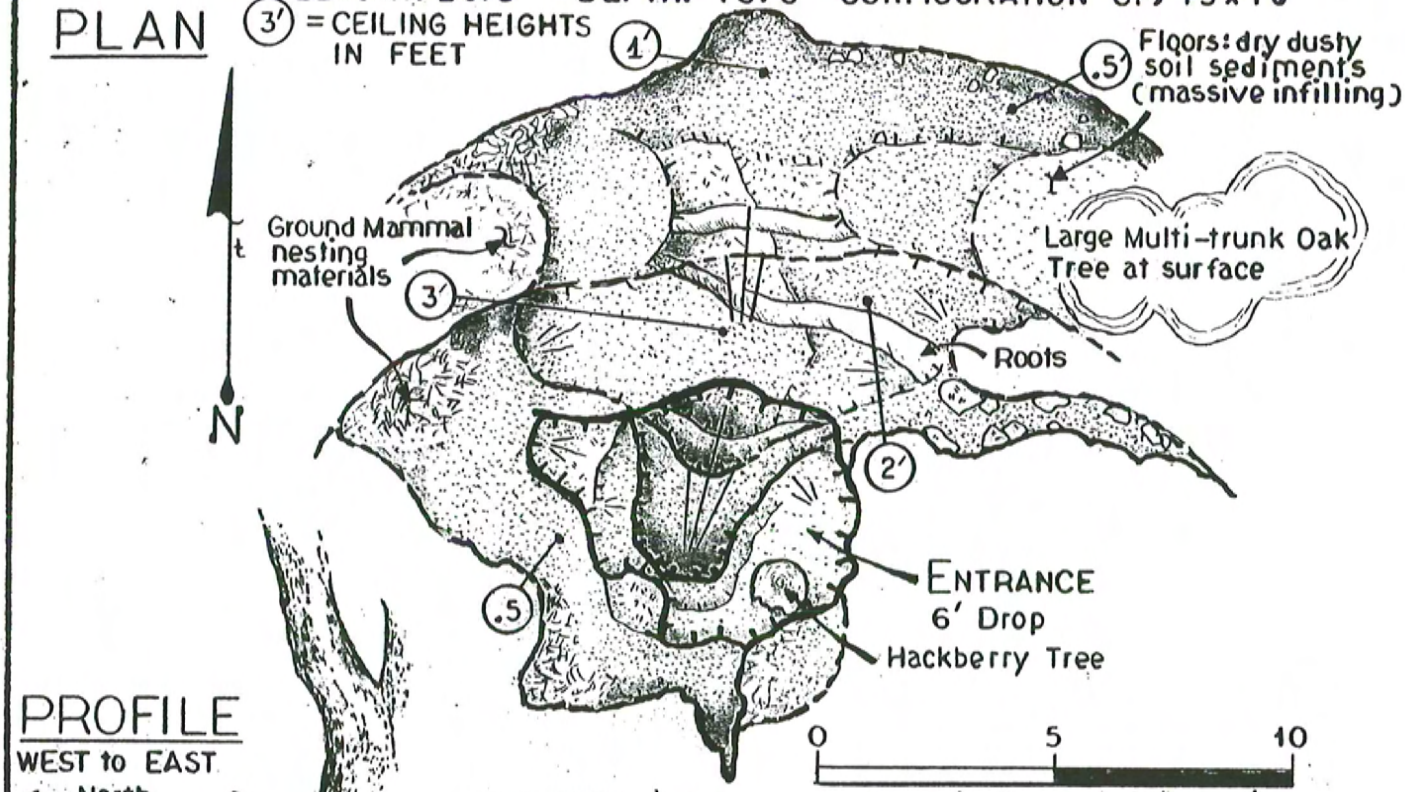
JUNE, 2000

POPPIN ROCKS CAVE

WILLIAMSON COUNTY, TEXAS

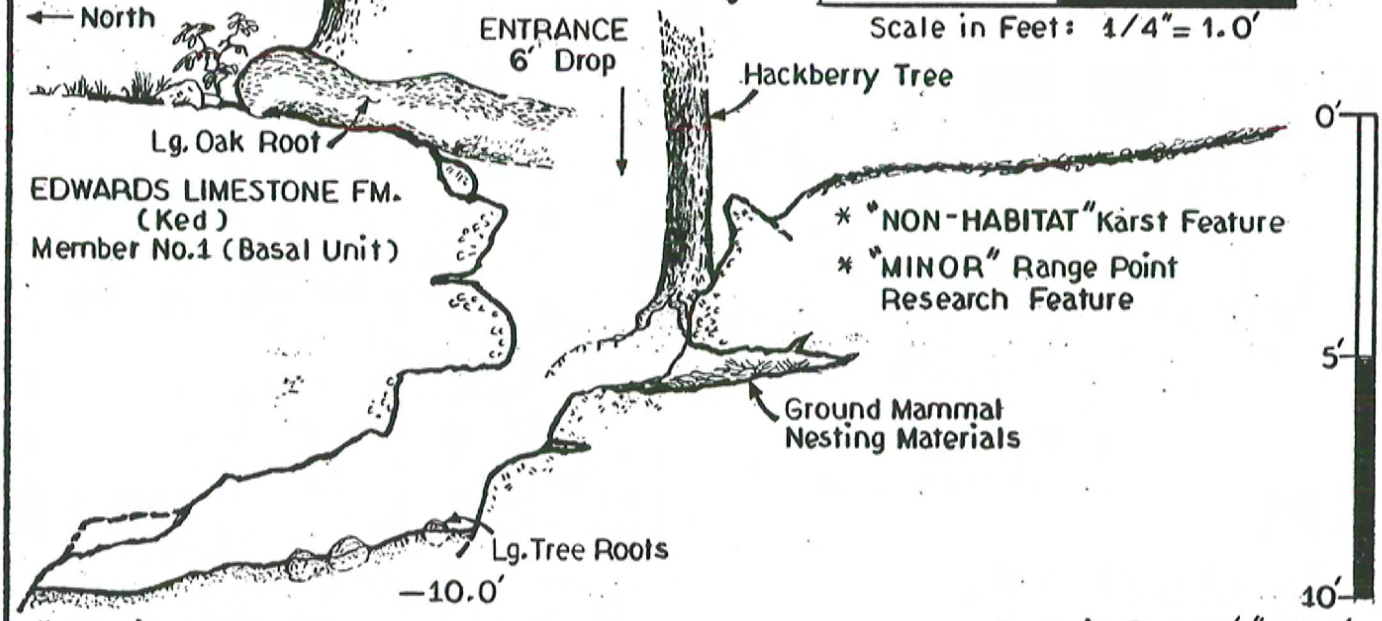
SUUNTOS & TAPE SURVEY • JUNE 15, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: N. AASE • A. STAPLES • B. HINDS • C. LANGILLE • M. WARTON • DRAFT BY: M. WARTON
LENGTH: 18.5′ DEPTH: 10.0′ CONFIGURATION OF: 15′x18′

PLAN



PROFILE

WEST to EAST
← North



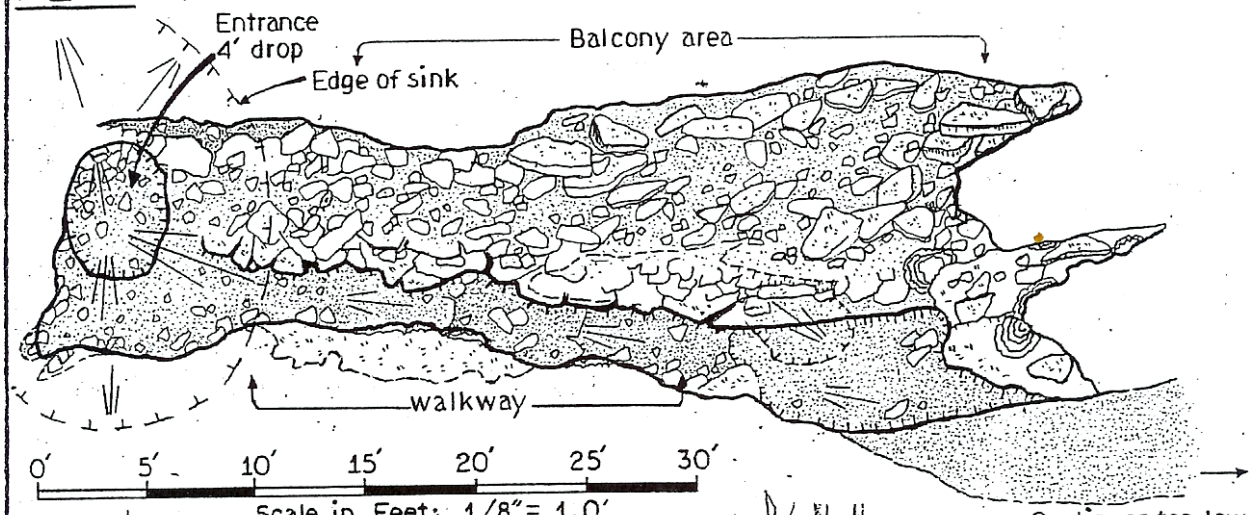
* Massive collapse & infilling (No air-flow or drains)

PREPARED BY; MIKE WARTON & ASSOCIATES:
JUNE, 2000

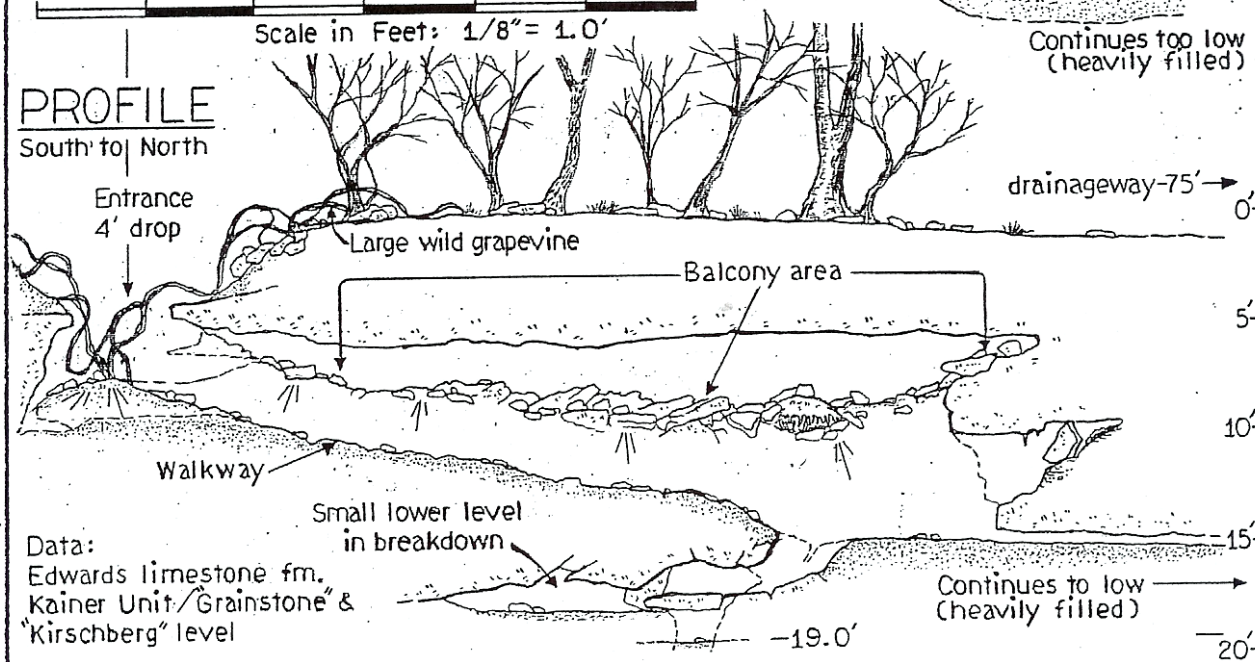
PROSPECTORS CAVE (F-10)
WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY • FEBRUARY 11, 2002
PERSONNEL; MIKE WARTON & ASSOCIATES: M. REYES·
M. WARTON • DRAFT BY: M. WARTON
LENGTH: 64.8′ DEPTH: 19.0′

PLAN N



PROFILE
South to North



Data:
Edwards limestone fm.
Kainer Unit/Grainstone" &
"Kirschberg" level

"Minor" Range Point Recharge Value

Scale in Feet: 1/8″=1.0

Prepared By; Mike Warton & Associates:

FEBRUARY, 2002

ROCK RIDGE CAVE

WILLIAMSON COUNTY, TEXAS

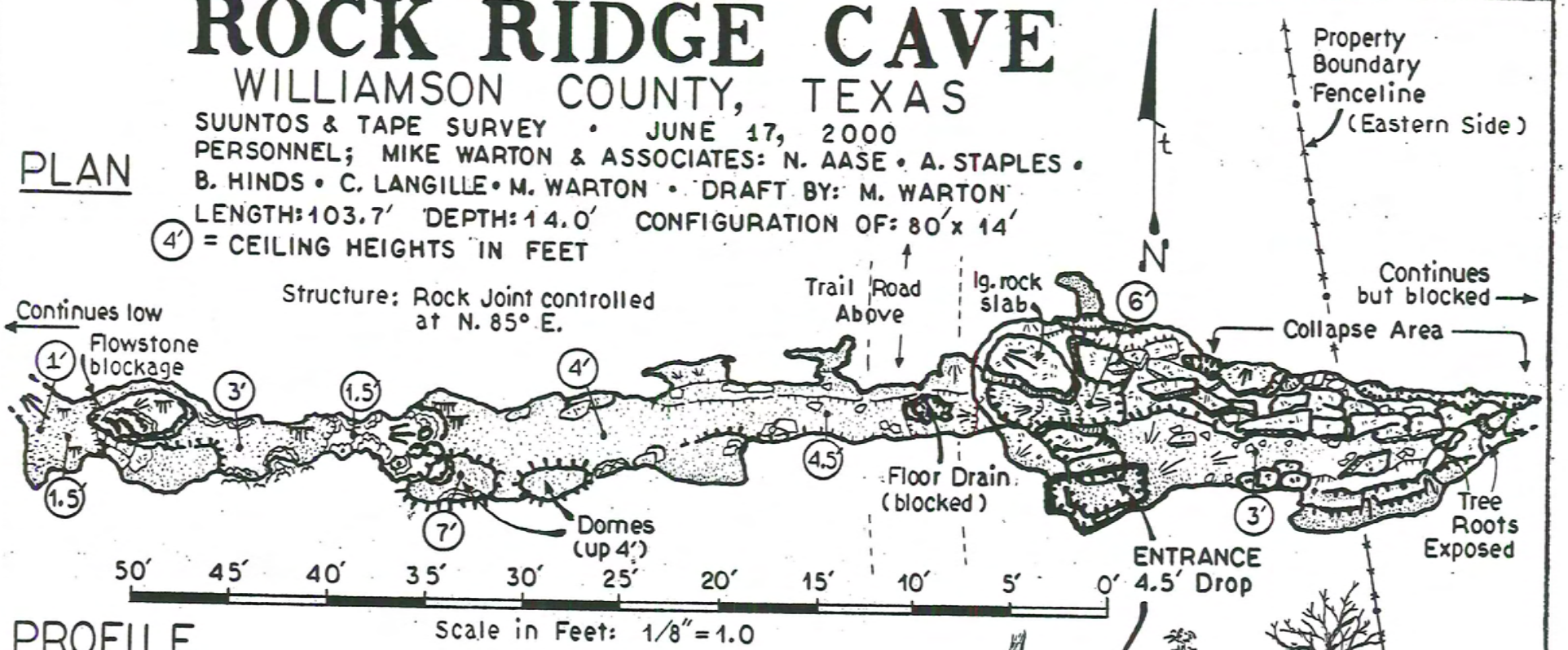
SUUNTOS & TAPE SURVEY • JUNE 17, 2000

PERSONNEL; MIKE WARTON & ASSOCIATES: N. AASE • A. STAPLES • B. HINDS • C. LANGILLE • M. WARTON • DRAFT BY: M. WARTON

LENGTH: 103.7′ DEPTH: 14.0′ CONFIGURATION OF: 80′ x 14′

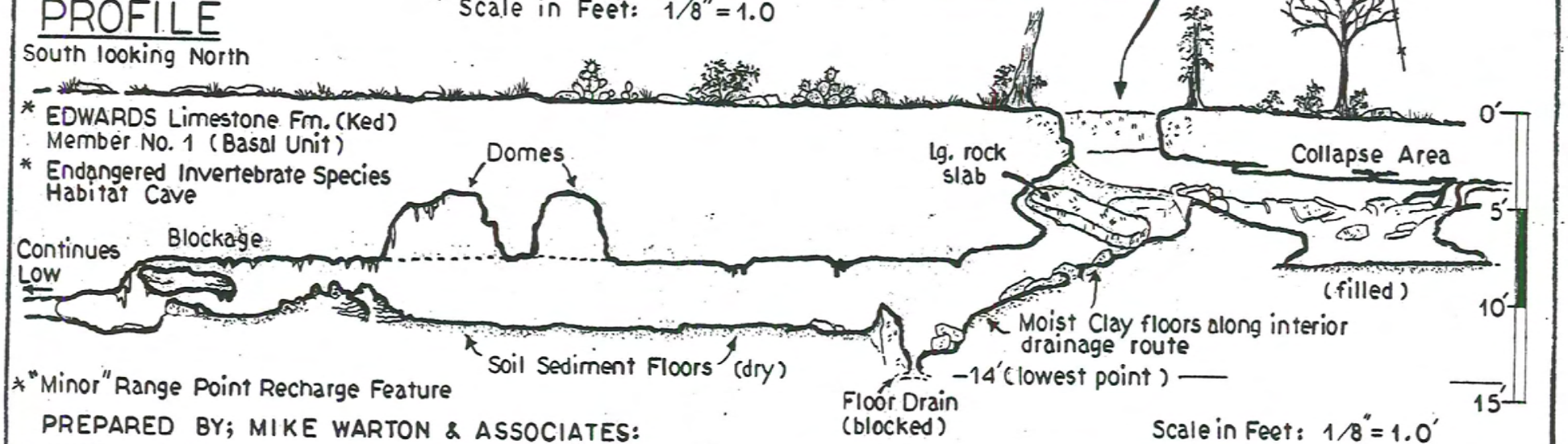
(4′) = CEILING HEIGHTS IN FEET

PLAN



PROFILE

South looking North



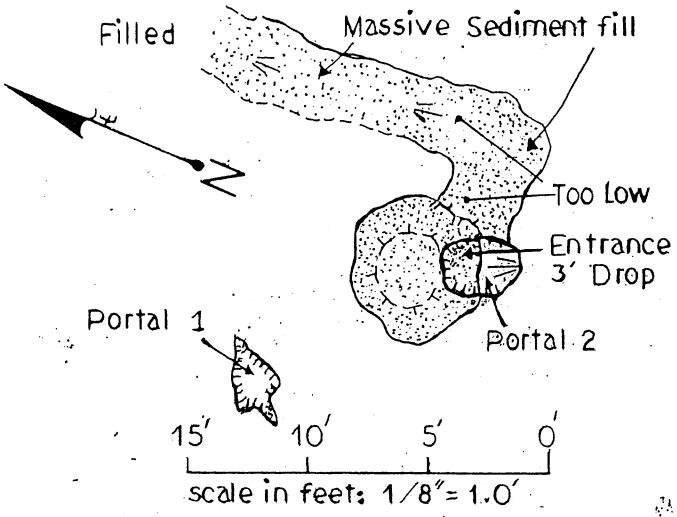
* "Minor" Range Point Recharge Feature

PREPARED BY; MIKE WARTON & ASSOCIATES:
JUNE, 2000

"SIDE POCKET" SINK

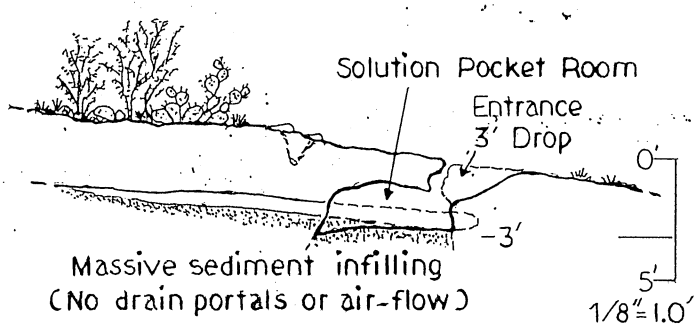
WILLIAMSON COUNTY, TEXAS

PLAN



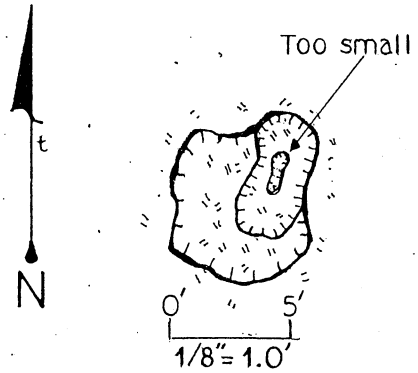
PROFILE

S.W. to N.E.



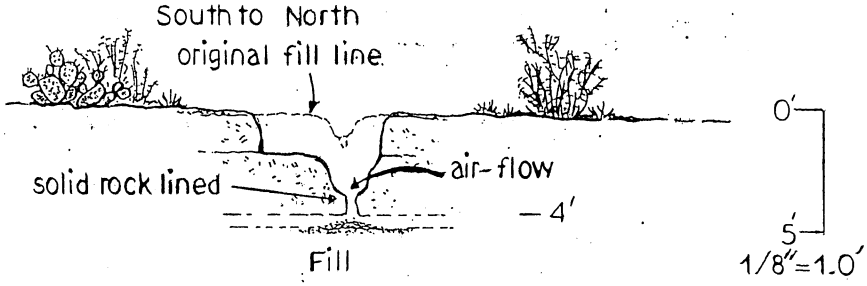
"LOCKOUT" SINK

PLAN



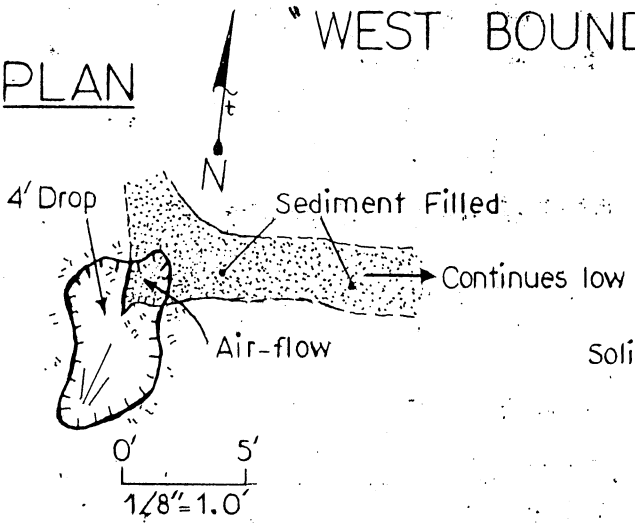
PROFILE

South to North



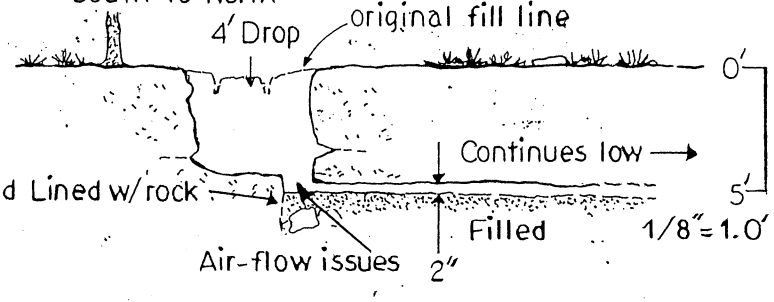
"WEST BOUNDARY" SINK

PLAN



PROFILE

South to North



PREPARED BY; MIKE WARTON & ASSOCIATES:

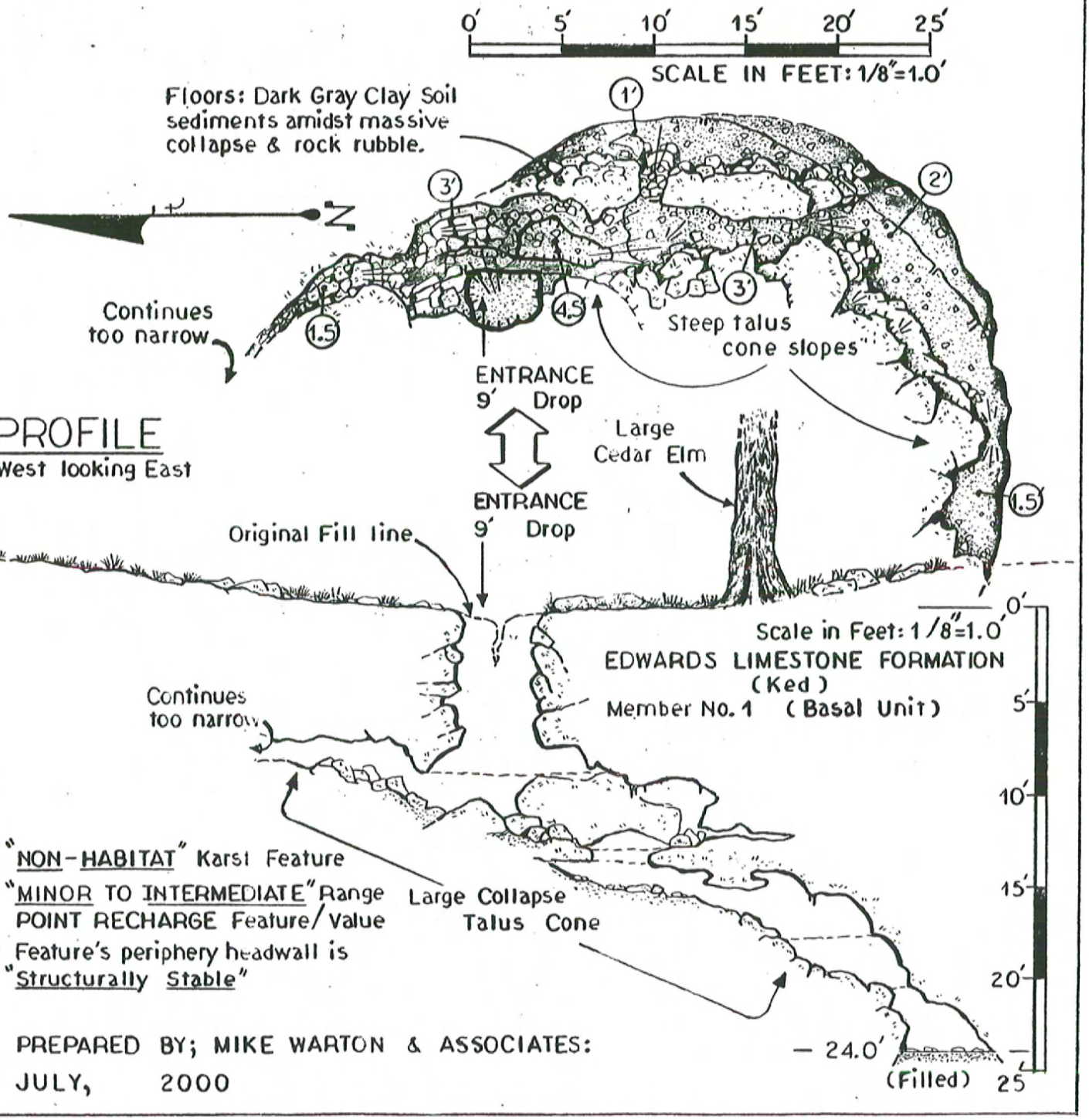
JULY / AUGUST, 2000

TALUS CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY • JULY 11, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: N. AASE • A. STAPLES • B. HINDES • C. LANGILLE • M. WARTON • DRAFT BY: M. WARTON
LENGTH: 67.3′ DEPTH: 24.0′ CONFIGURATION OF: 43′ x 20′
(2′) = CEILING HEIGHTS IN FEET

PLAN



* "NON-HABITAT" Karst Feature
* "MINOR TO INTERMEDIATE" Range POINT RECHARGE Feature/Value
* Feature's periphery headwall is "Structurally Stable"

PREPARED BY; MIKE WARTON & ASSOCIATES:
JULY, 2000

VENTURE CAVE (F-11)

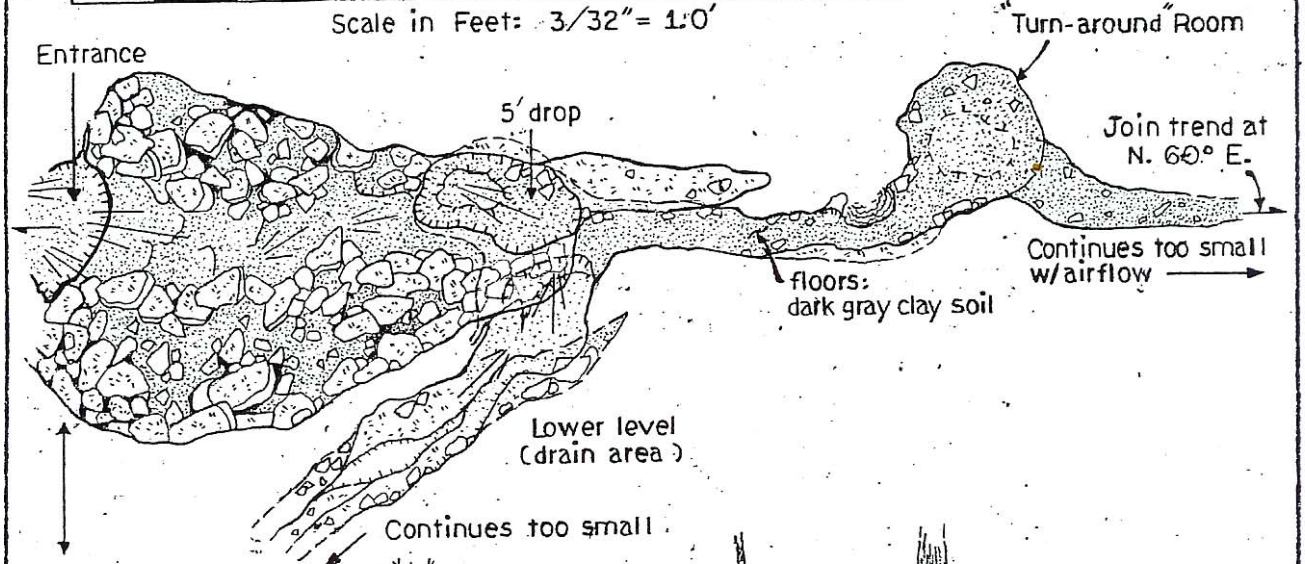
WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY · FEBRUARY 12, 2002
PERSONNEL; MIKE WARTON & ASSOCIATES: M. REYES · M. WARTON · DRAFT BY: M. WARTON
LENGTH: 89.3′ DEPTH: 21.2′

PLAN

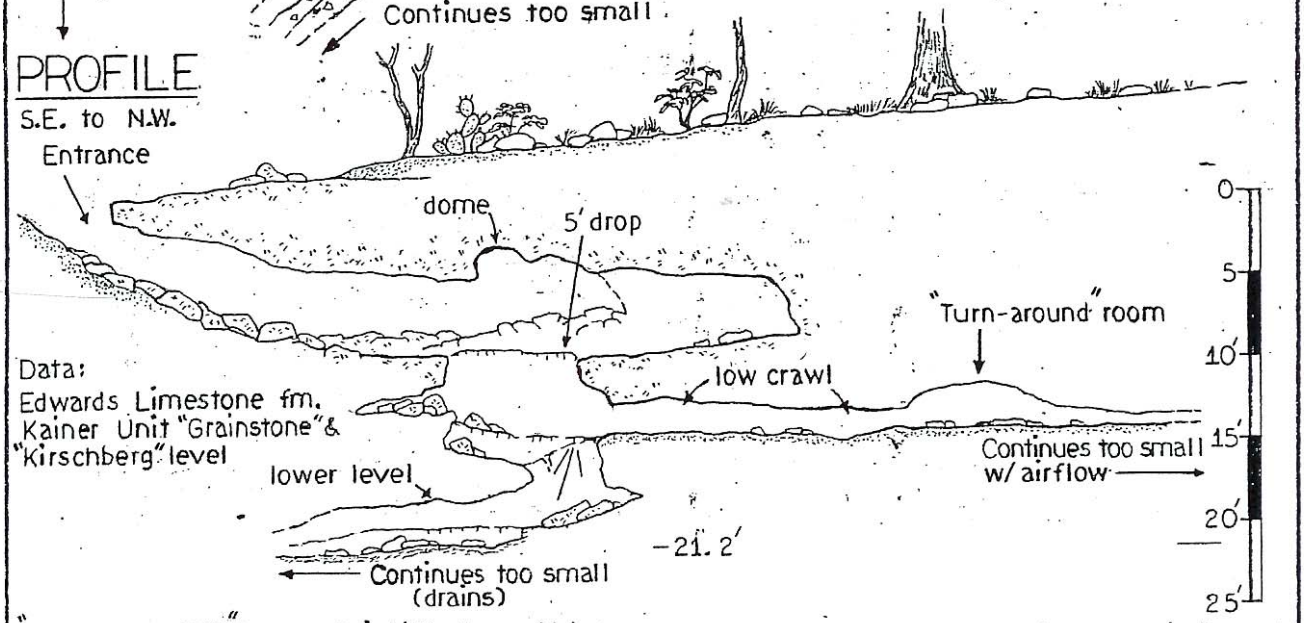
0′ 5′ 10′ 15′ 20′ 25′ 30′ 35′ 40′ 45′ 50′

Scale in Feet: 3/32" = 1.0′



PROFILE

S.E. to N.W.



Data:
Edwards Limestone fm.
Kainer Unit "Grainstone" & "Kirschberg" level

"INTERMEDIATE" Range Point Recharge Value

Scale in Feet 3/32" = 1.0′

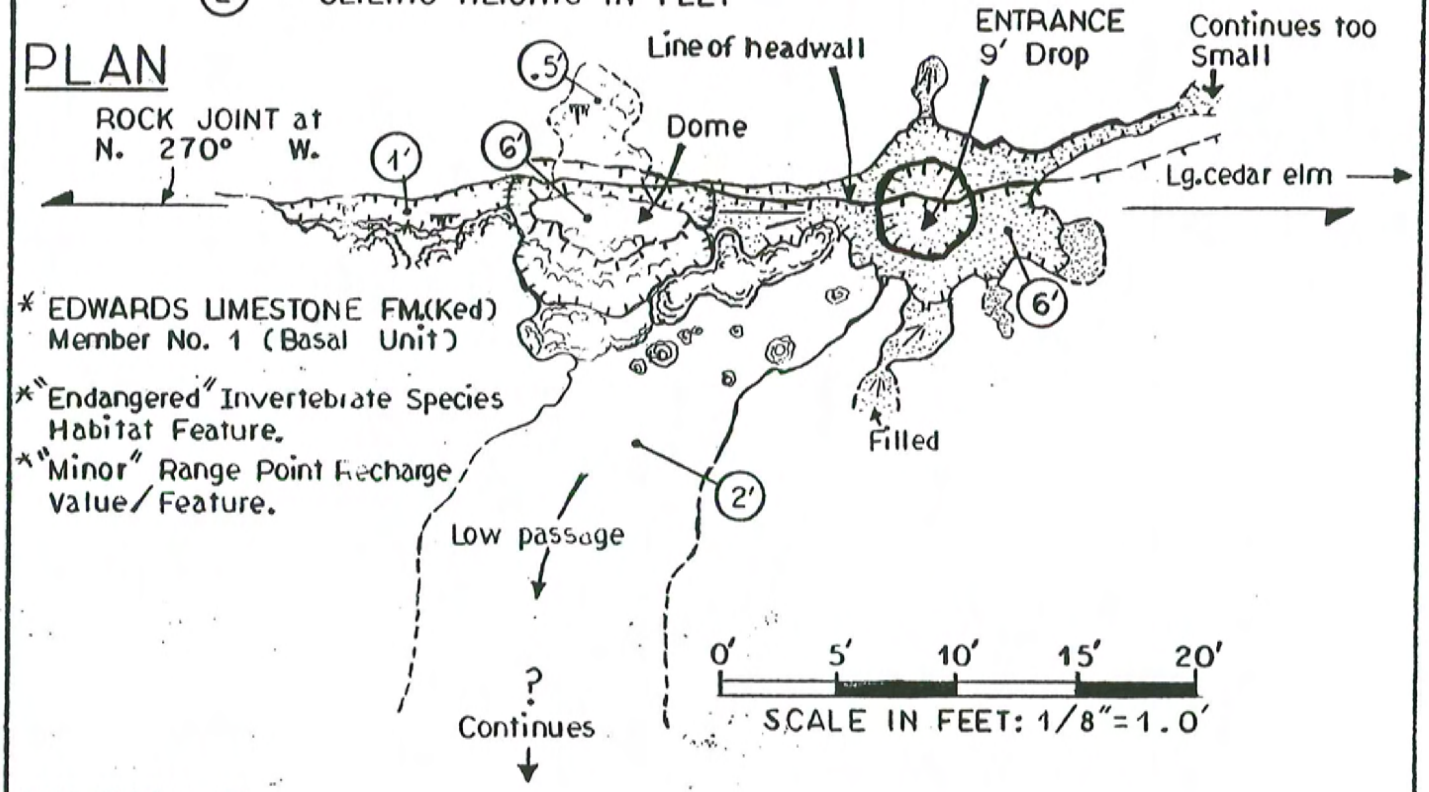
Prepared By; Mike Warton & Associates:
FEBRUARY, 2002

WILCO CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY · JUNE 29, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: N. AASE · A. STAPLES · B. HINDS · C. LANGILLE · M. WARTON · DRAFT BY: M. WARTON
LENGTH: 47′ + DEPTH: 15.7′ CONFIGURATION OF: 37′ x 27′ +
(2′) = CEILING HEIGHTS IN FEET

PLAN



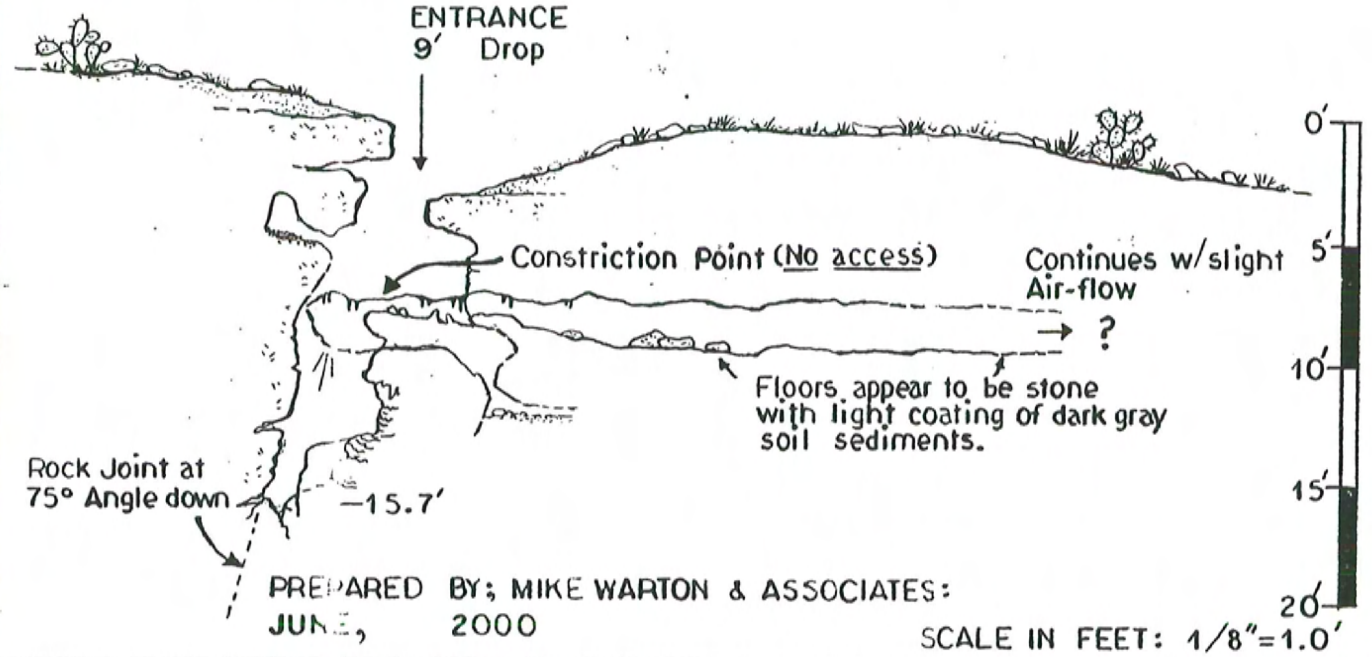
* EDWARDS LIMESTONE FM.(Ked) Member No. 1 (Basal Unit)

*"Endangered" Invertebrate Species Habitat Feature.

*"Minor" Range Point Recharge Value/Feature.

PROFILE

Rotated to view looking 90° East



PREPARED BY; MIKE WARTON & ASSOCIATES: JUNE, 2000

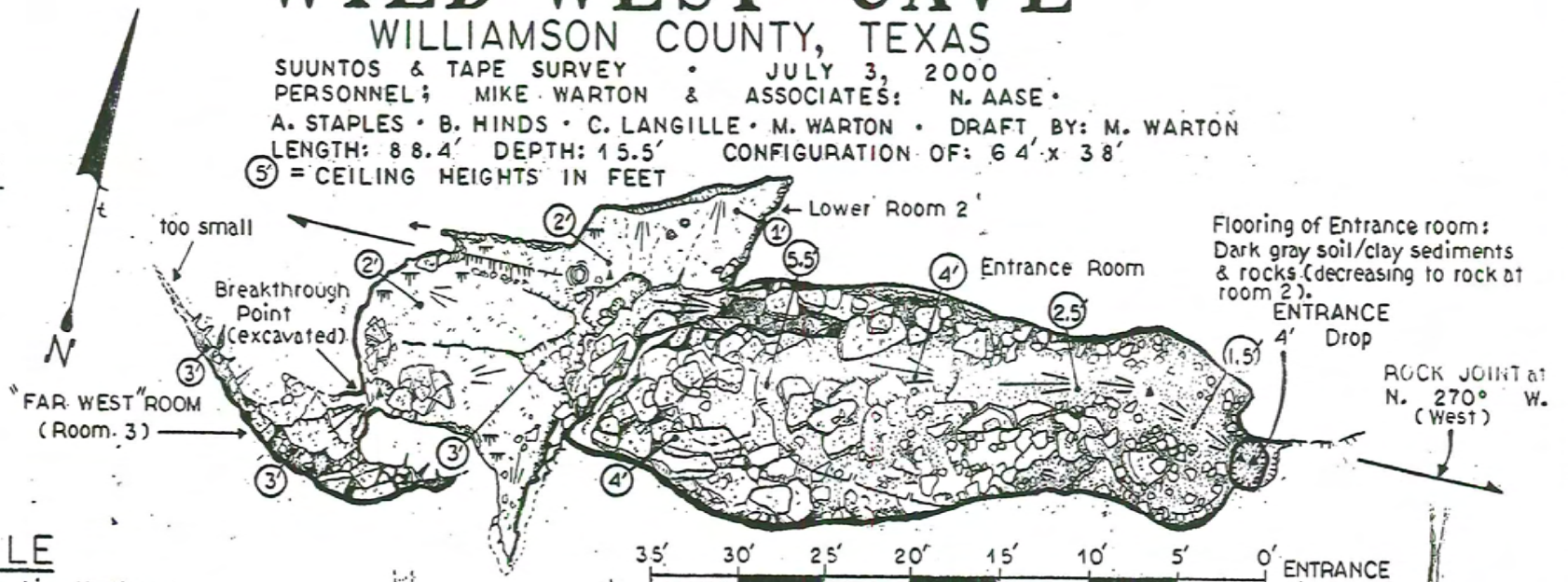
SCALE IN FEET: 1/8″=1.0′

WILD WEST CAVE

WILLIAMSON COUNTY, TEXAS

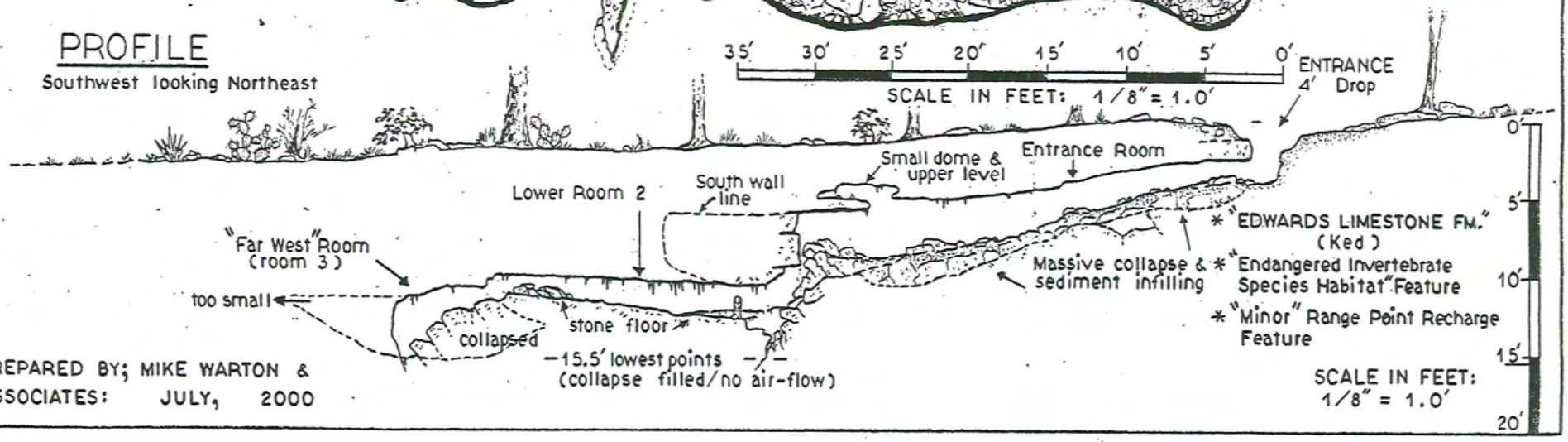
SUUNTOS & TAPE SURVEY • JULY 3, 2000
PERSONNEL; MIKE WARTON & ASSOCIATES: N. AASE •
A. STAPLES • B. HINDS • C. LANGILLE • M. WARTON • DRAFT BY: M. WARTON
LENGTH: 88.4′ DEPTH: 15.5′ CONFIGURATION OF: 64′ x 38′
(5′) = CEILING HEIGHTS IN FEET

PLAN



PROFILE

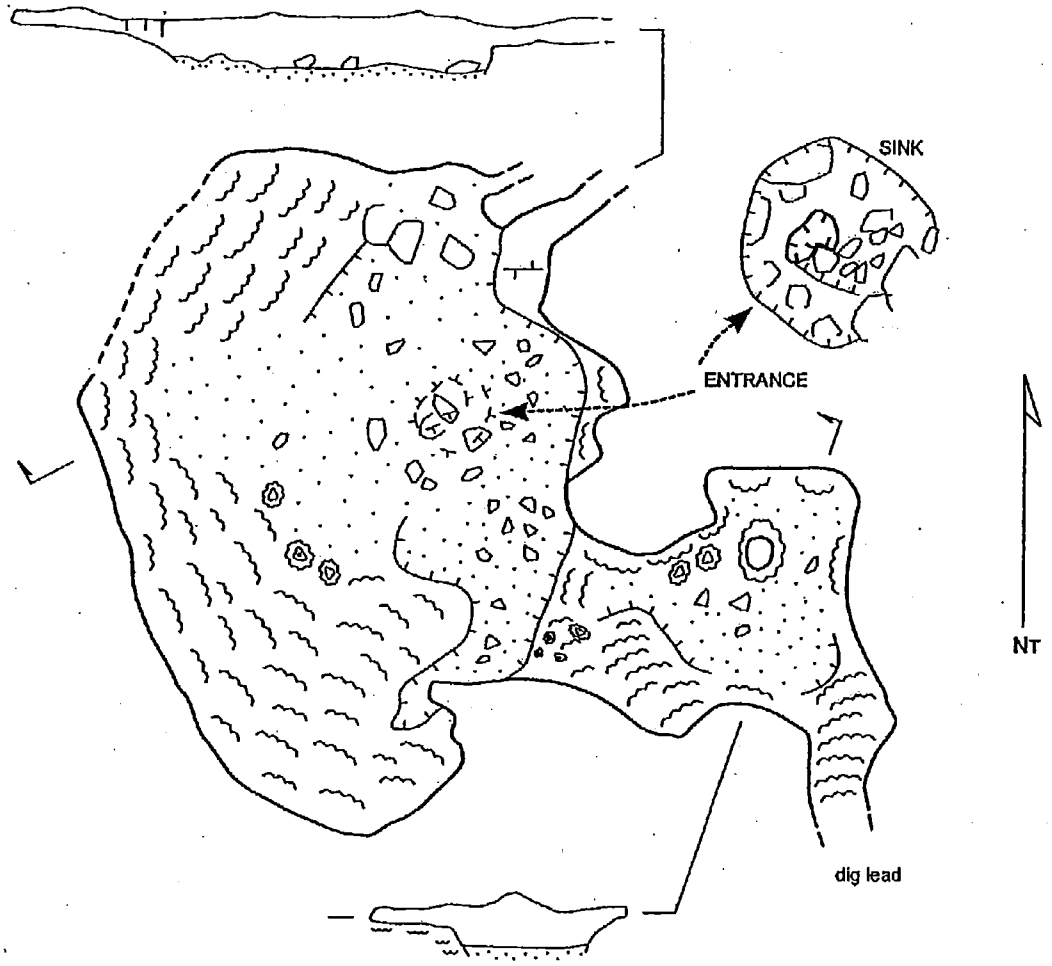
Southwest looking Northeast

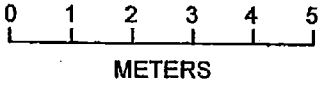


PREPARED BY; MIKE WARTON & ASSOCIATES: JULY, 2000

Appendix F

Cave Maps of the Chaos Cave Preserve

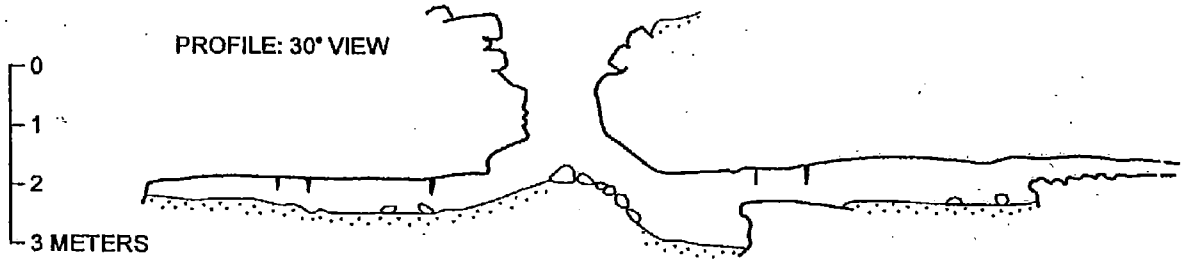




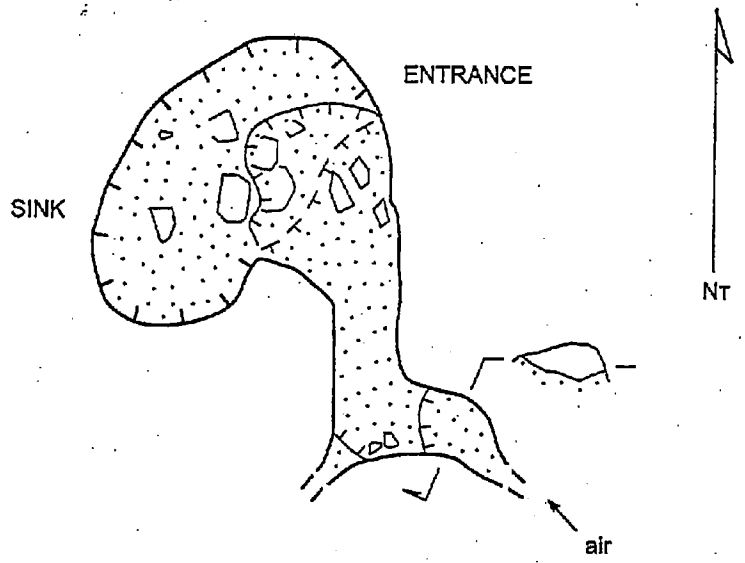
CHAOS CAVE

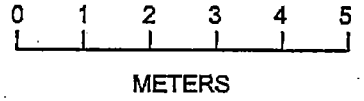
WILLIAMSON COUNTY, TEXAS

SUUNTO AND TAPE SURVEY
14 APRIL 2000
PETER SPROUSE, JAMES REDDELL
LENGTH: 20 METERS
DEPTH: 3 METERS



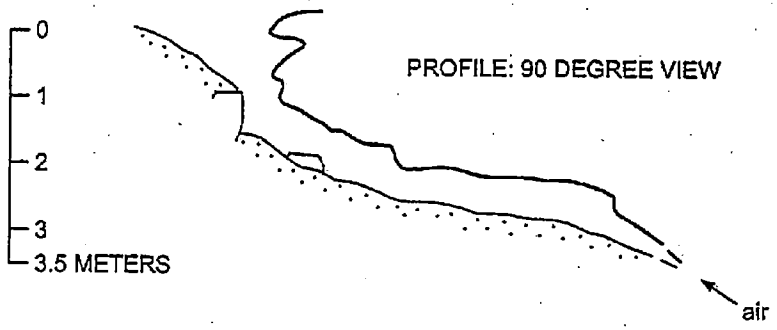
GEORGE VENI & ASSOCIATES, 2000 DRAWN BY PETER SPROUSE





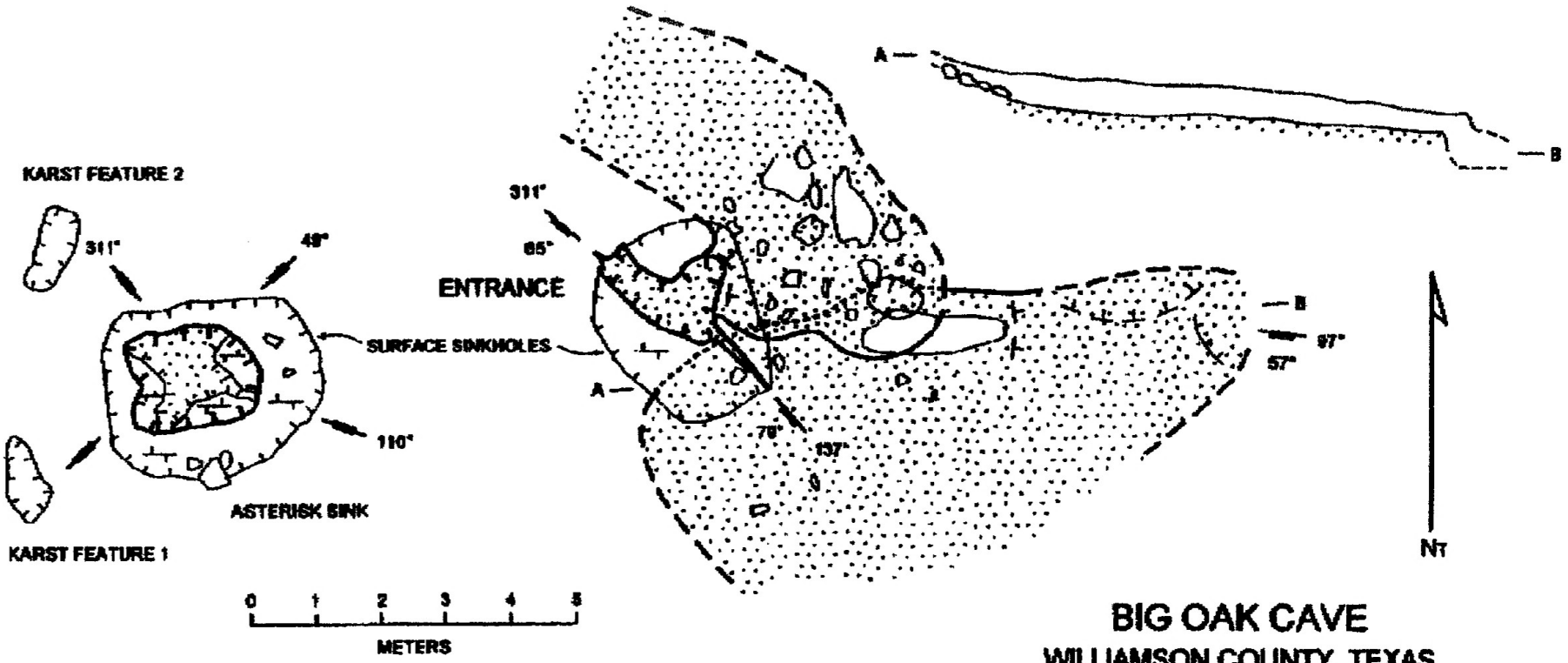
UNDER THE FENCE CAVE
WILLIAMSON COUNTY, TEXAS

SUUNTO AND TAPE SURVEY
3 APRIL 2000
LEE JAY GRAVES, NIKI LAKE, PETER SPROUSE
LENGTH: 6 METERS
DEPTH: 3.5 METERS



Appendix G

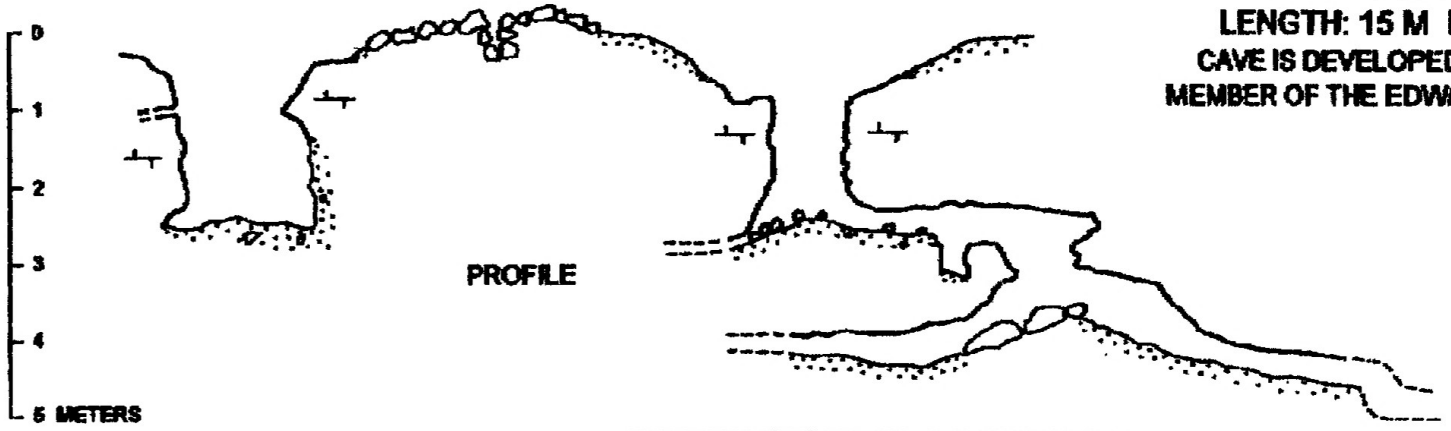
Cave Map of the Big Oak Cave Preserve



BIG OAK CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTO AND TAPE SURVEY
17-18 JULY 1997
C. SAVVAS, P. SPROUSE
LENGTH: 15 M DEPTH: 4 M
CAVE IS DEVELOPED IN THE BASAL MEMBER OF THE EDWARDS LIMESTONE



GEORGE VENI & ASSOCIATES, 1997 DRAWN BY PETER SPROUSE

Appendix H

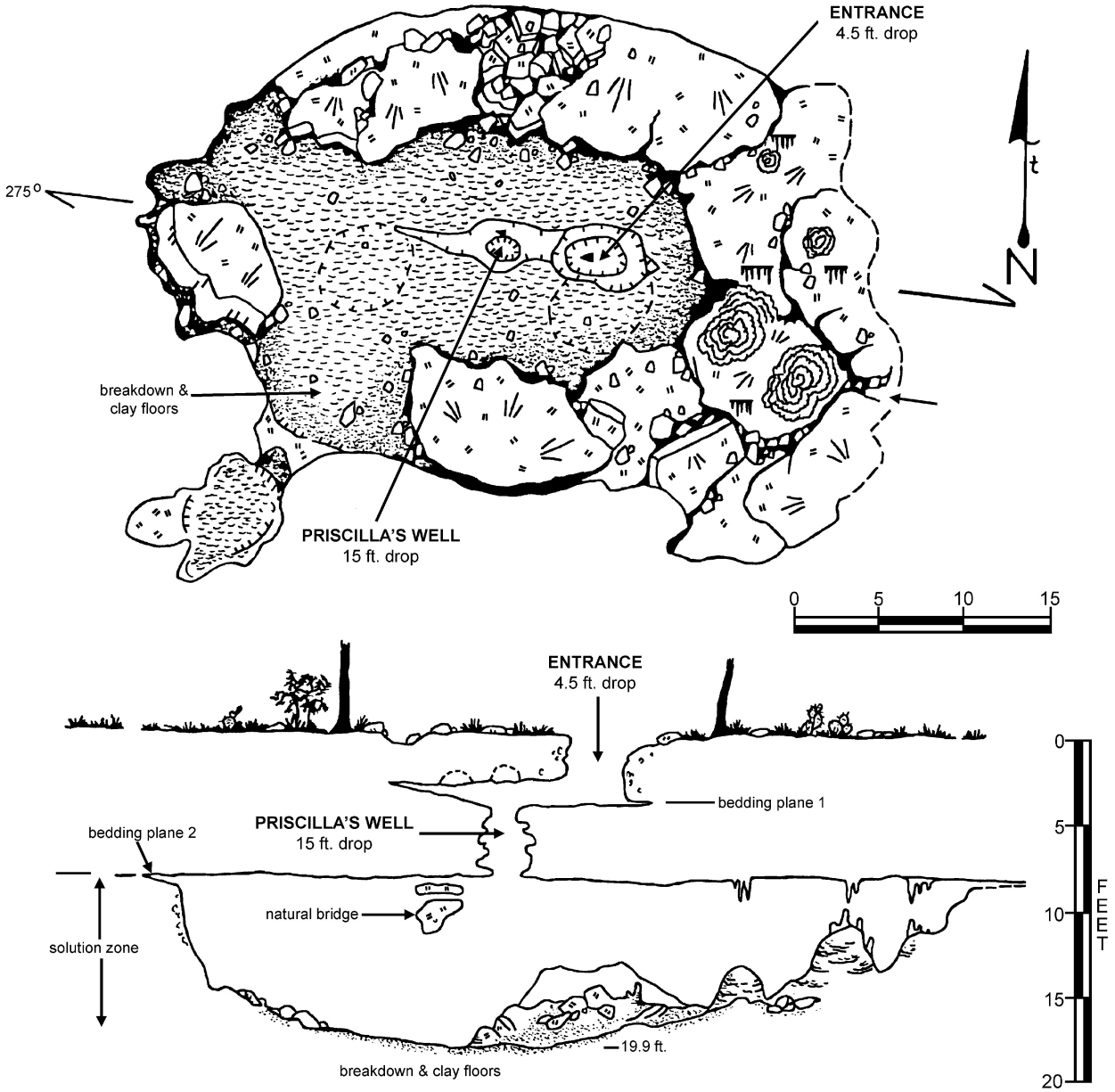
Cave Maps of the Priscilla's Well Karst Fauna Area

PRISCILLA'S WELL CAVE

Williamson County, Texas

Suuntos and Tape Survey
11 August 1994
D. Allen,B. Bartlett, L. J. Graves, D. Love,
C. Savvas, J. Warton, M. Warton, J. Wolff
Drafted by Mike Warton

Length: 68.5 ft. Depth: 19.9 ft.

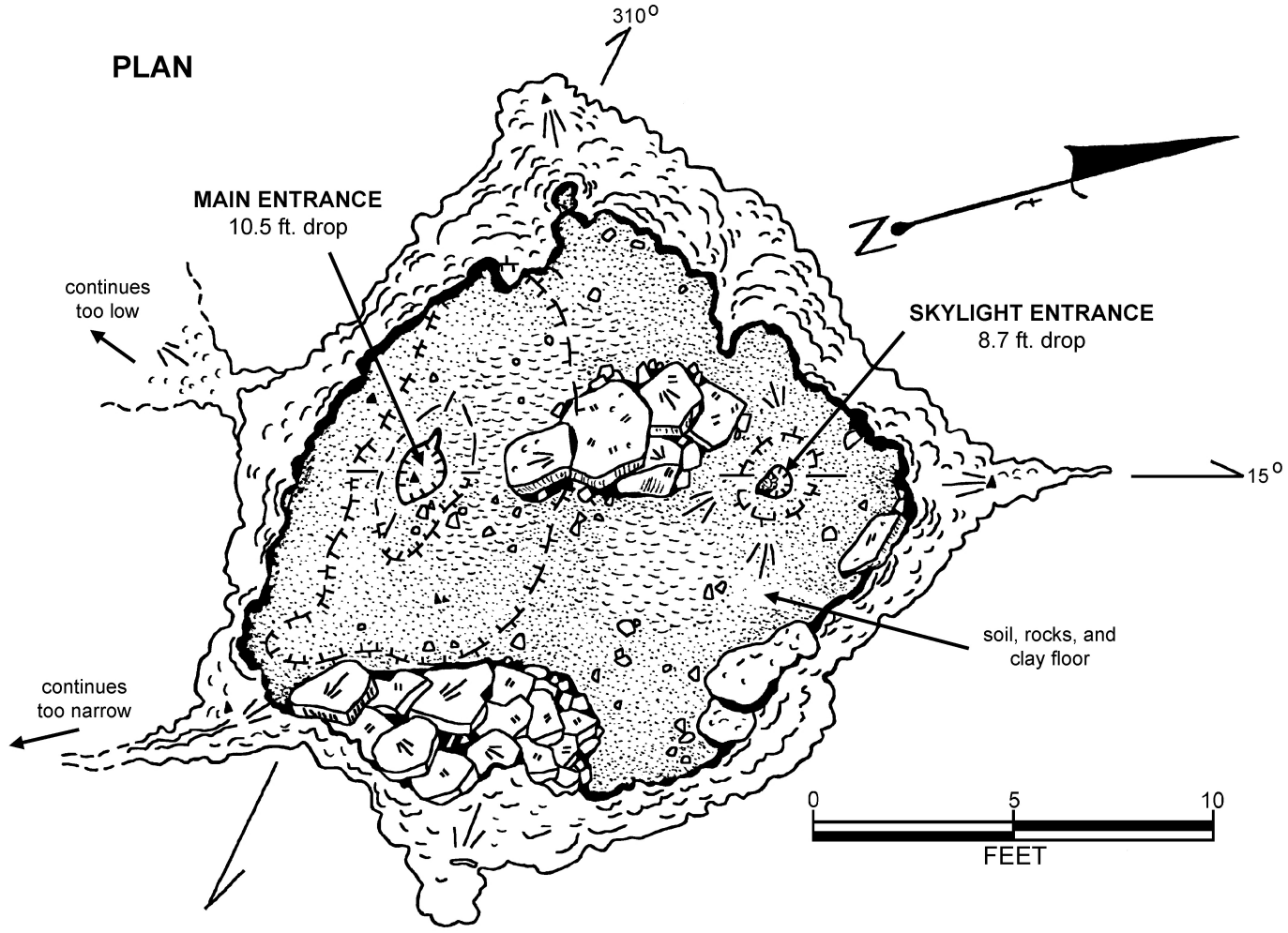


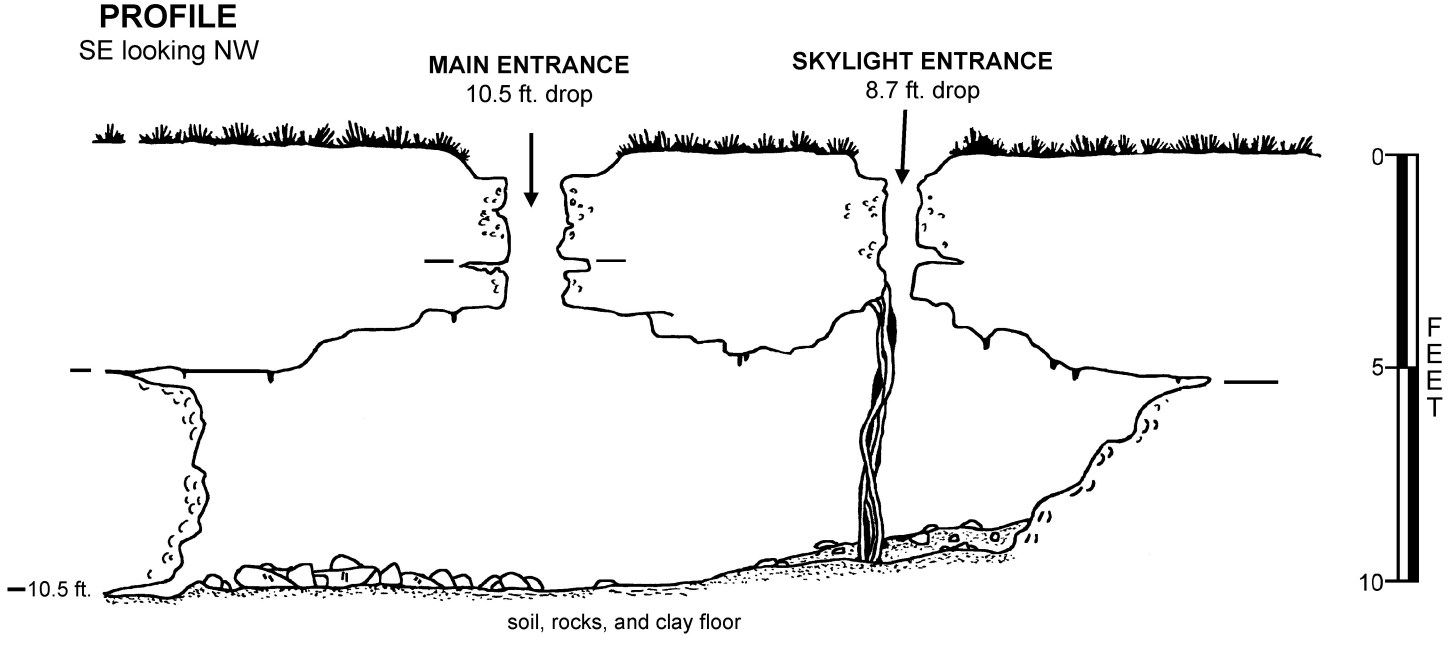
PRISCILLA'S CAVE

Williamson County, Texas

Suuntos and Tape Survey
11 August 1994
D. Allen, B. Bartlett, L. J. Graves, D. Love,
C. Savvas, J. Warton, M. Warton, J. Wolff
Drafted by Mike Warton

Length: 38.3 ft. Depth: 10.5 ft.





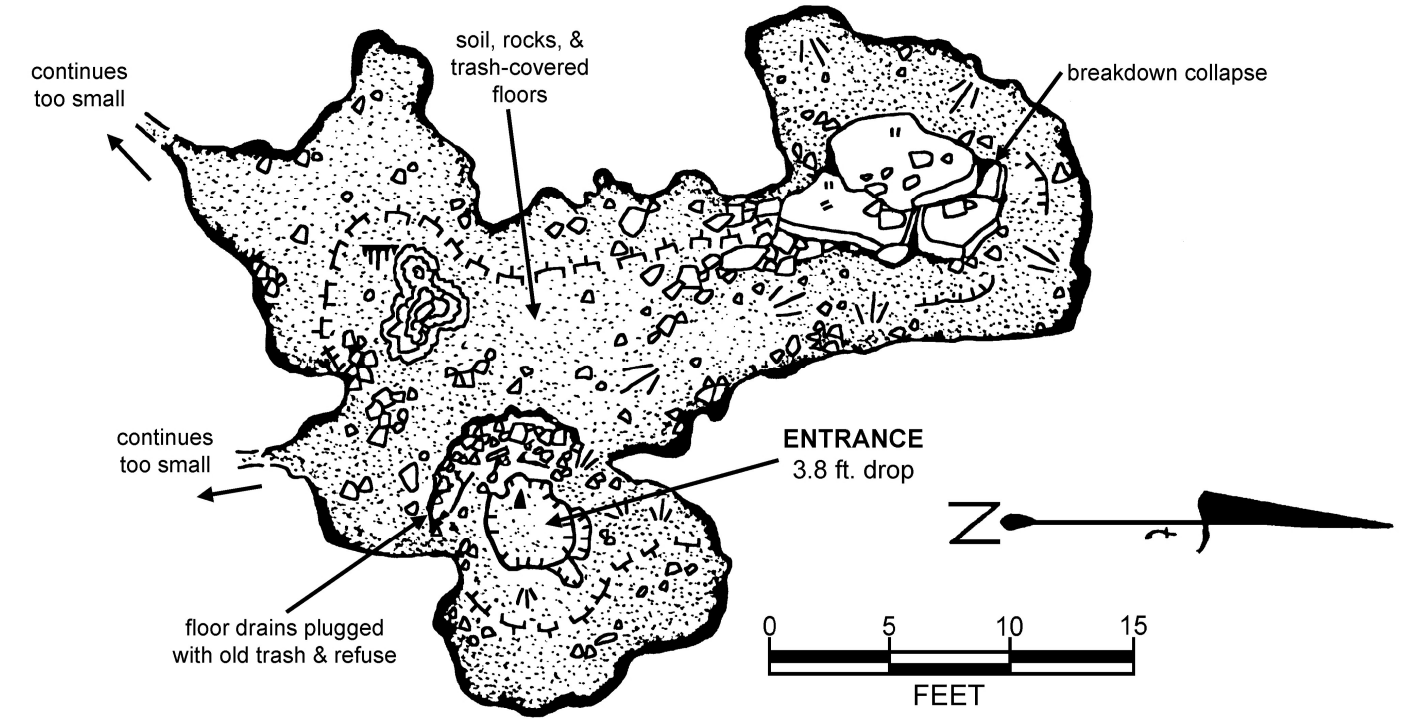
YEARWOOD GOLD MINE CAVE

Williamson County, Texas

Suuntos and Tape Survey
11 August 1994
D. Allen, B. Bartlett, L. J. Graves, D. Love,
C. Savvas, J. Warton, M. Warton, J. Wolff
Drafted by Mike Warton

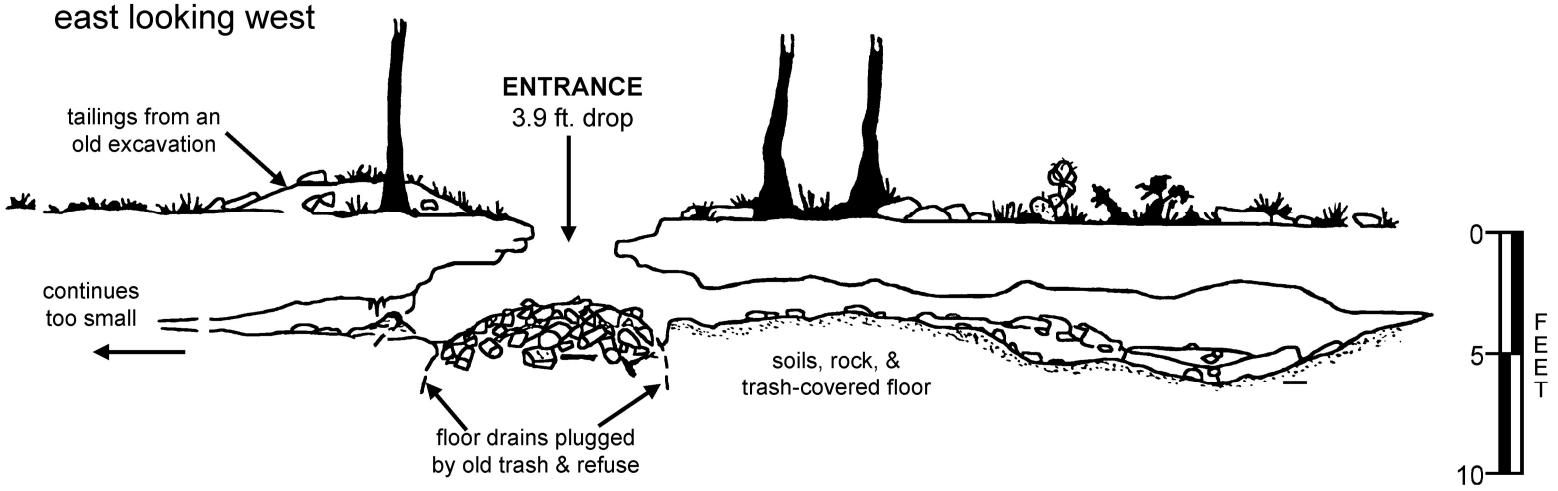
Length: 47 ft. Depth: 7.2 ft.

PLAN



PROFILE

east looking west



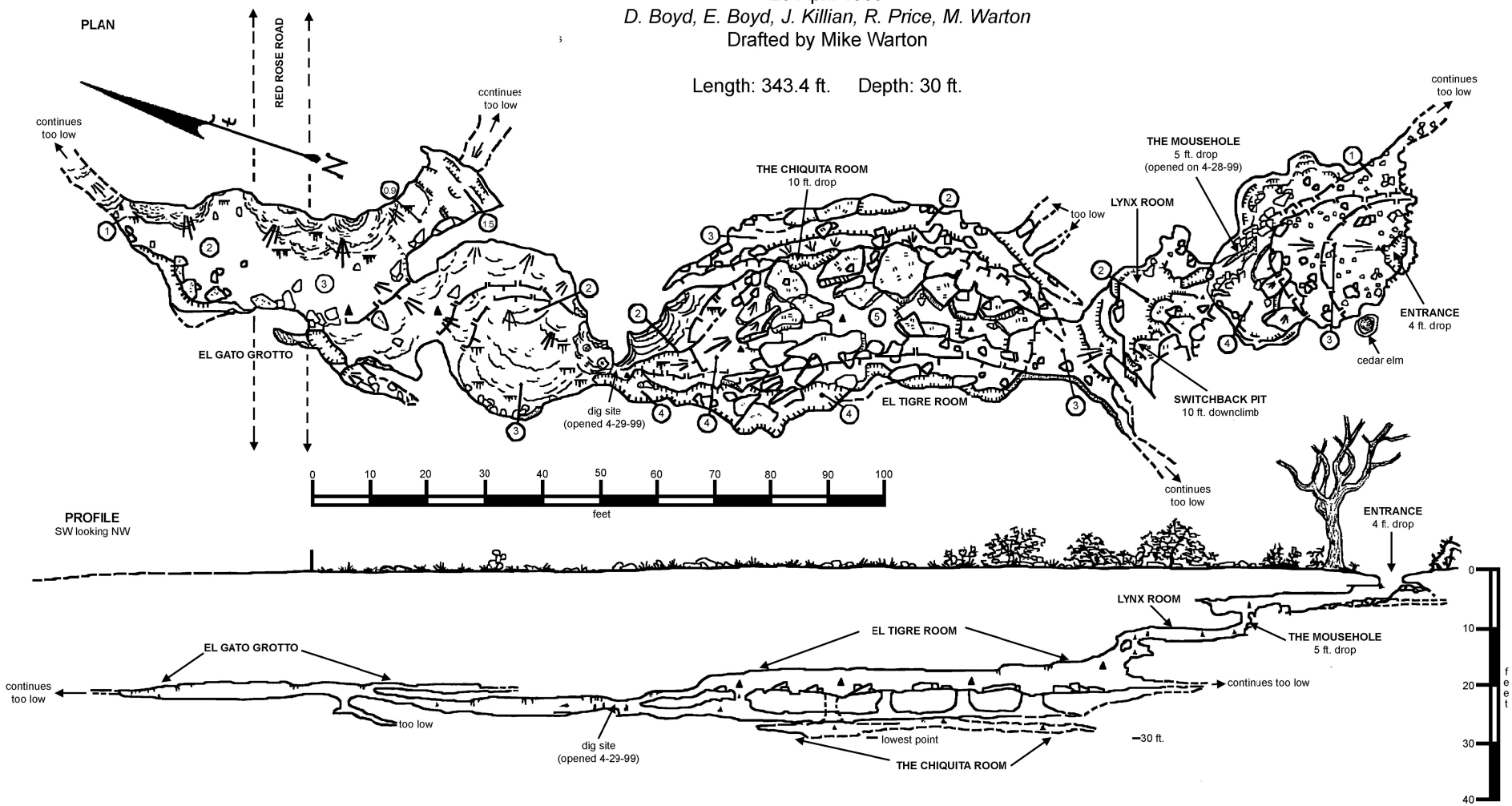
Appendix I

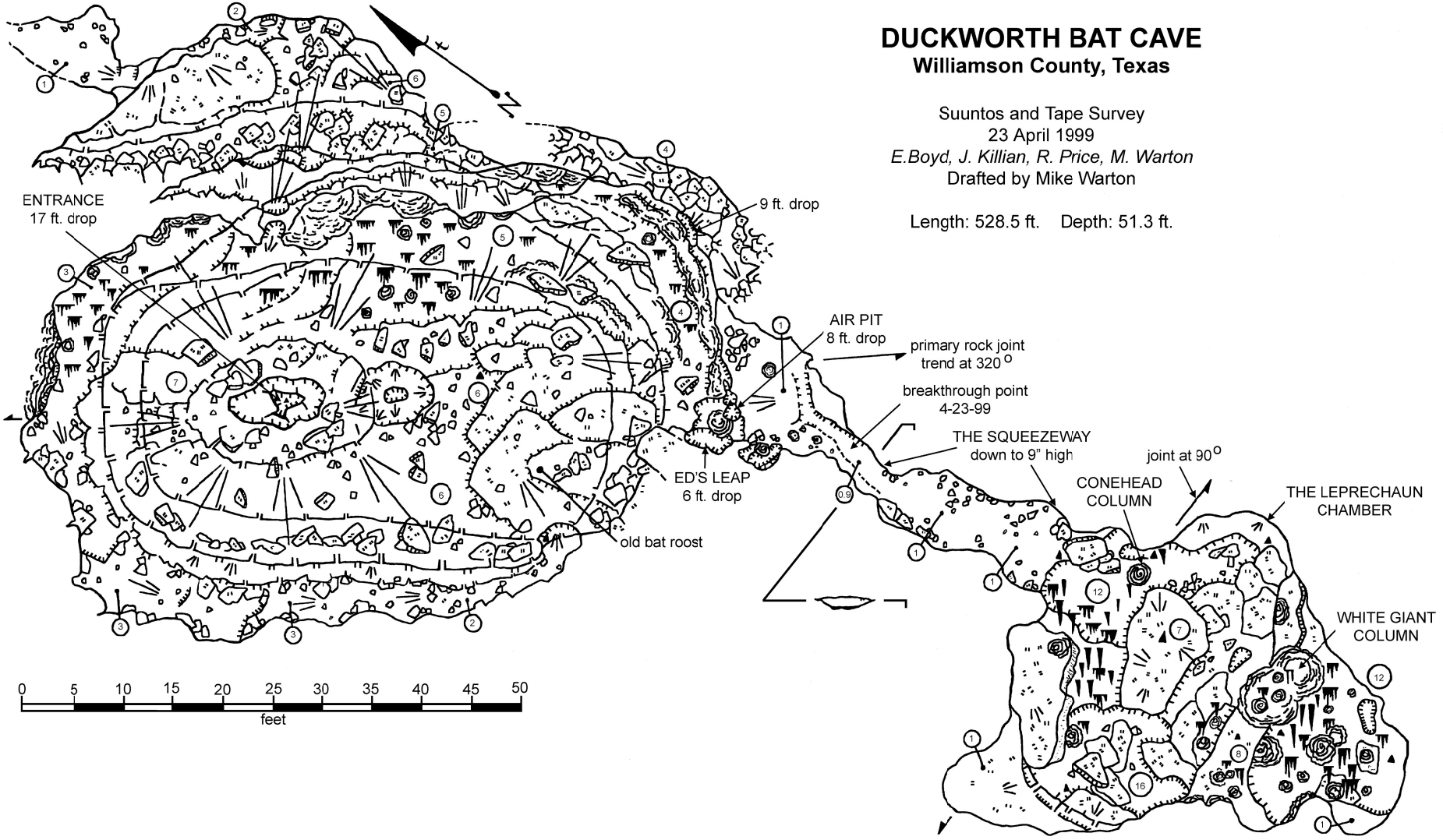
Cave Maps of the Woodland Park Preserve

CAT CAVE
Williamson County, Texas

Suuntos and Tape Survey
29 April 1999
D. Boyd, E. Boyd, J. Killian, R. Price, M. Warton
Drafted by Mike Warton

Length: 343.4 ft. Depth: 30 ft.

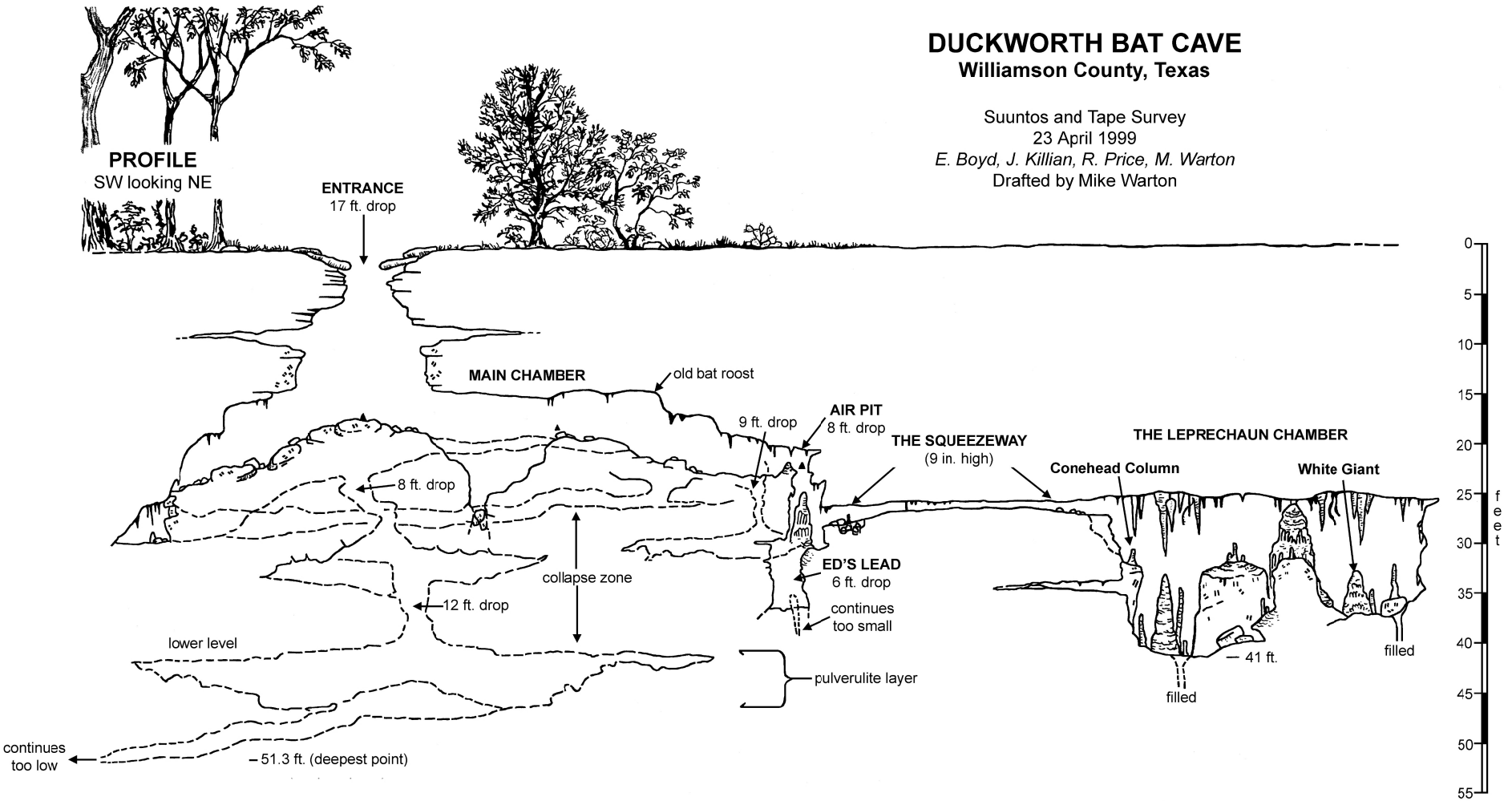



DUCKWORTH BAT CAVE
Williamson County, Texas
Suuntos and Tape Survey
23 April 1999
E.Boyd, J. Killian, R. Price, M. Warton
Drafted by Mike Warton
Length: 528.5 ft. Depth: 51.3 ft.
ENTRANCE
17 ft. drop
9 ft. drop
AIR PIT
8 ft. drop
primary rock joint
trend at 320°
breakthrough point
4-23-99
THE SQUEEZEWAY
down to 9" high
joint at 90°
CONEHEAD
COLUMN
THE LEPRECHAUN
CHAMBER
ED'S LEAP
6 ft. drop
old bat roost
WHITE GIANT
COLUMN
0 5 10 15 20 25 30 35 40 45 50
feet

DUCKWORTH BAT CAVE

Williamson County, Texas

Suuntos and Tape Survey
23 April 1999
E. Boyd, J. Killian, R. Price, M. Warton
Drafted by Mike Warton



Appendix J

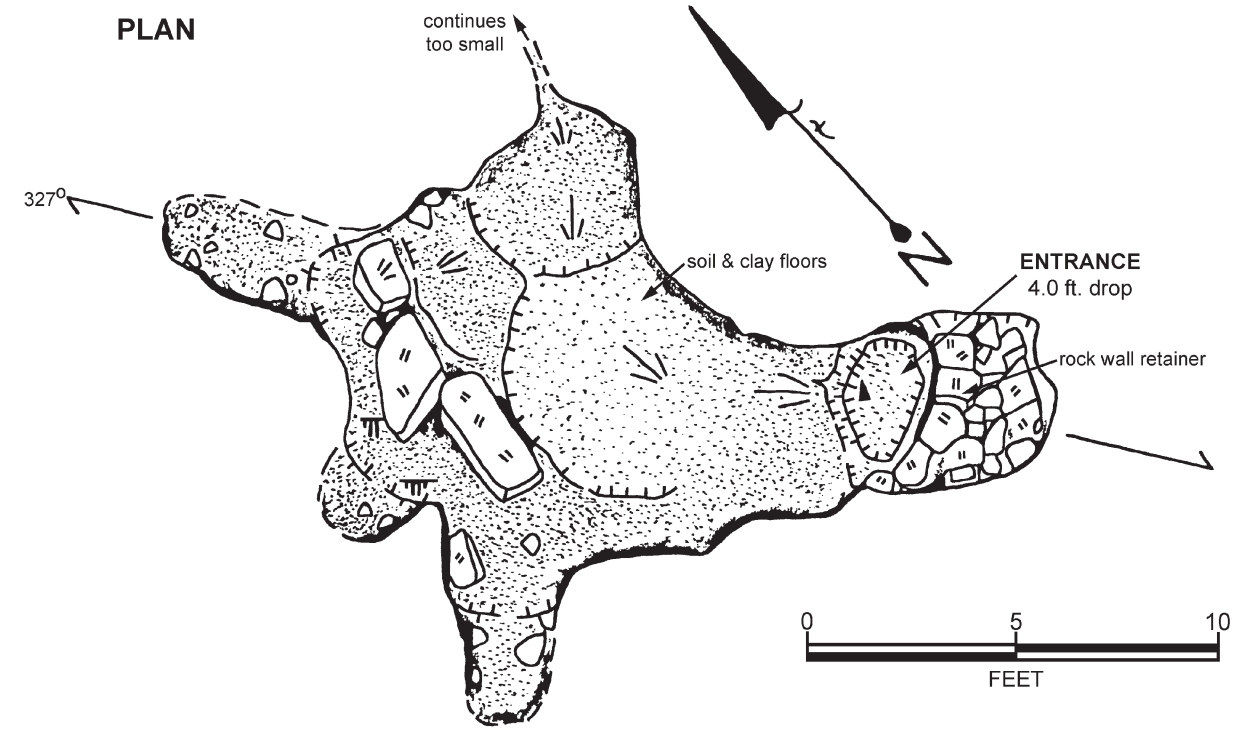
Cave Maps of the Karankawa Cave Karst Fauna Area

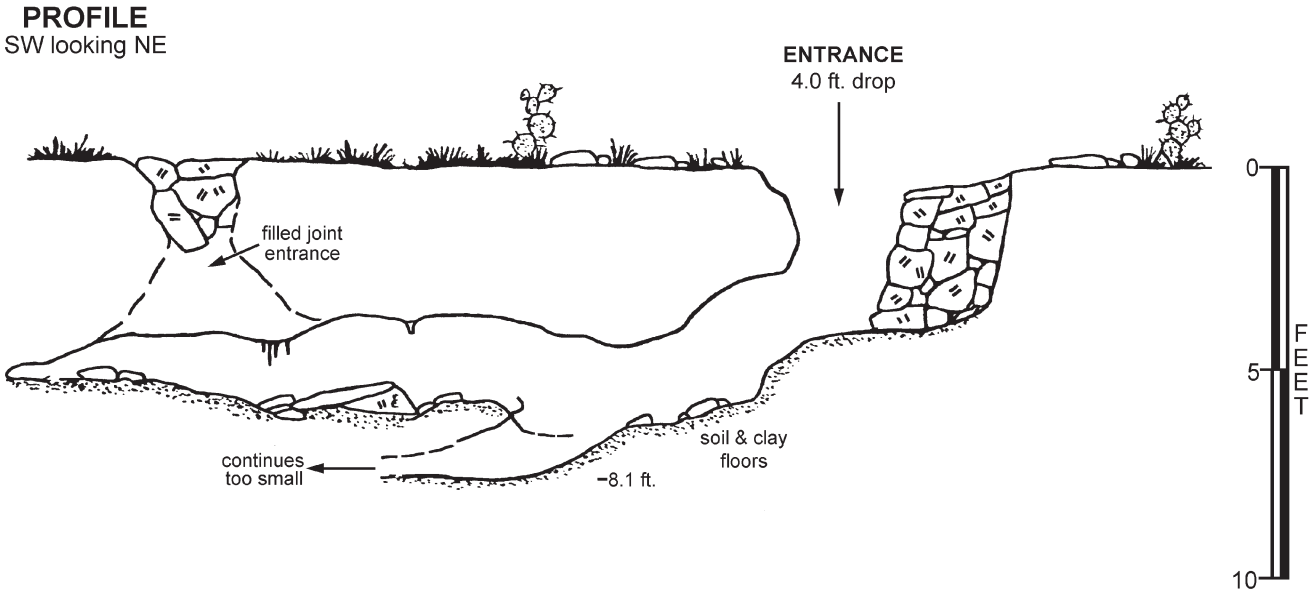
ANGOSTURA CAVE

Williamson County, Texas

Suuntos and Tape Survey
4 May 1994
Doug Allen, L. J. Graves, Dan Love,
Charley Savvas, Mike Warton, Jim Wolff
Drafted by Mike Warton

Length: 26.5 ft. Depth: 8.1 ft.



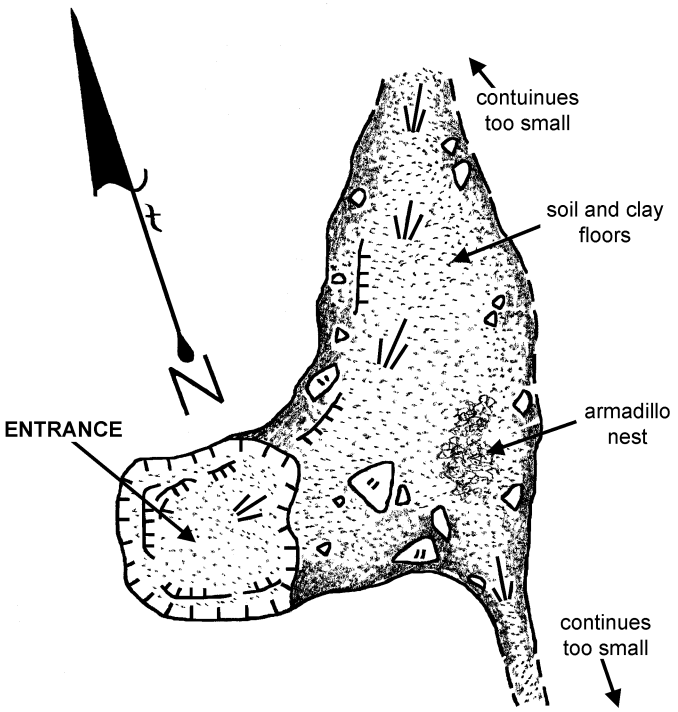


ARMADON CAVE
Williamson County, Texas

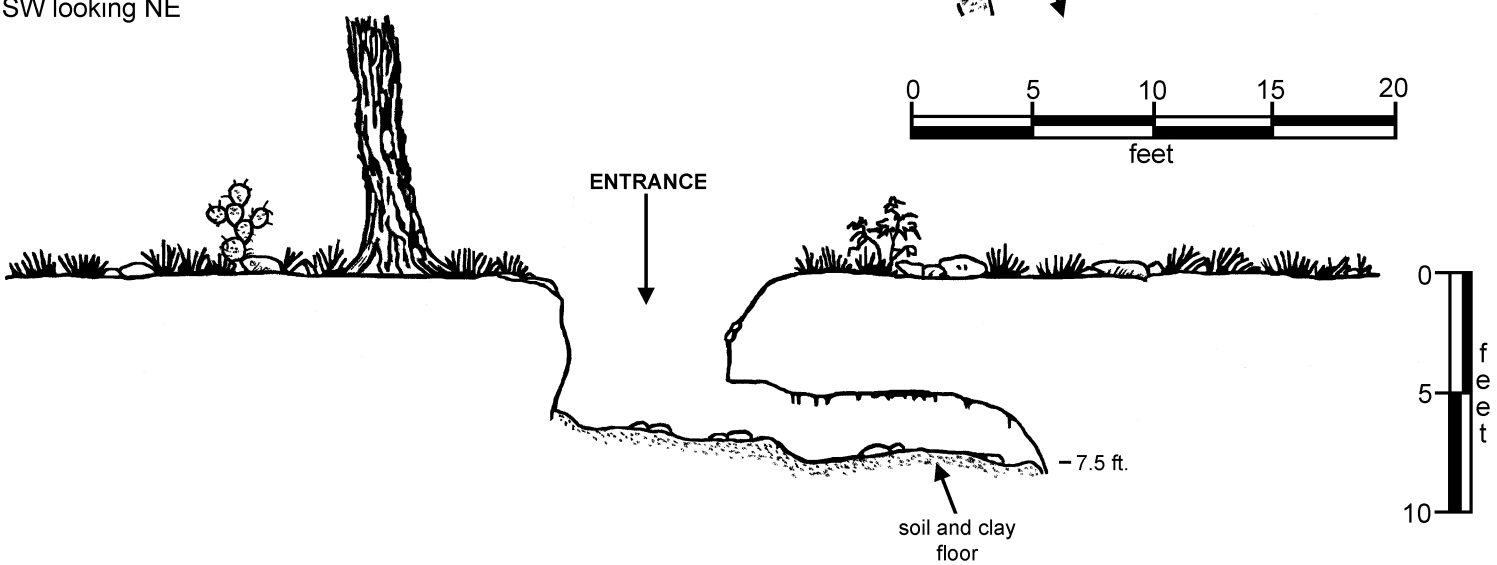
Suuntos and Tape Survey
3 May 1994
D. Allen, L.J. Graves, D. Love, C. Savvas, M. Warton, J. Wolf
Drafted by Mike Warton

Length: 27.5 ft. Depth: 7.5 ft.

PLAN



PROFILE
SW looking NE

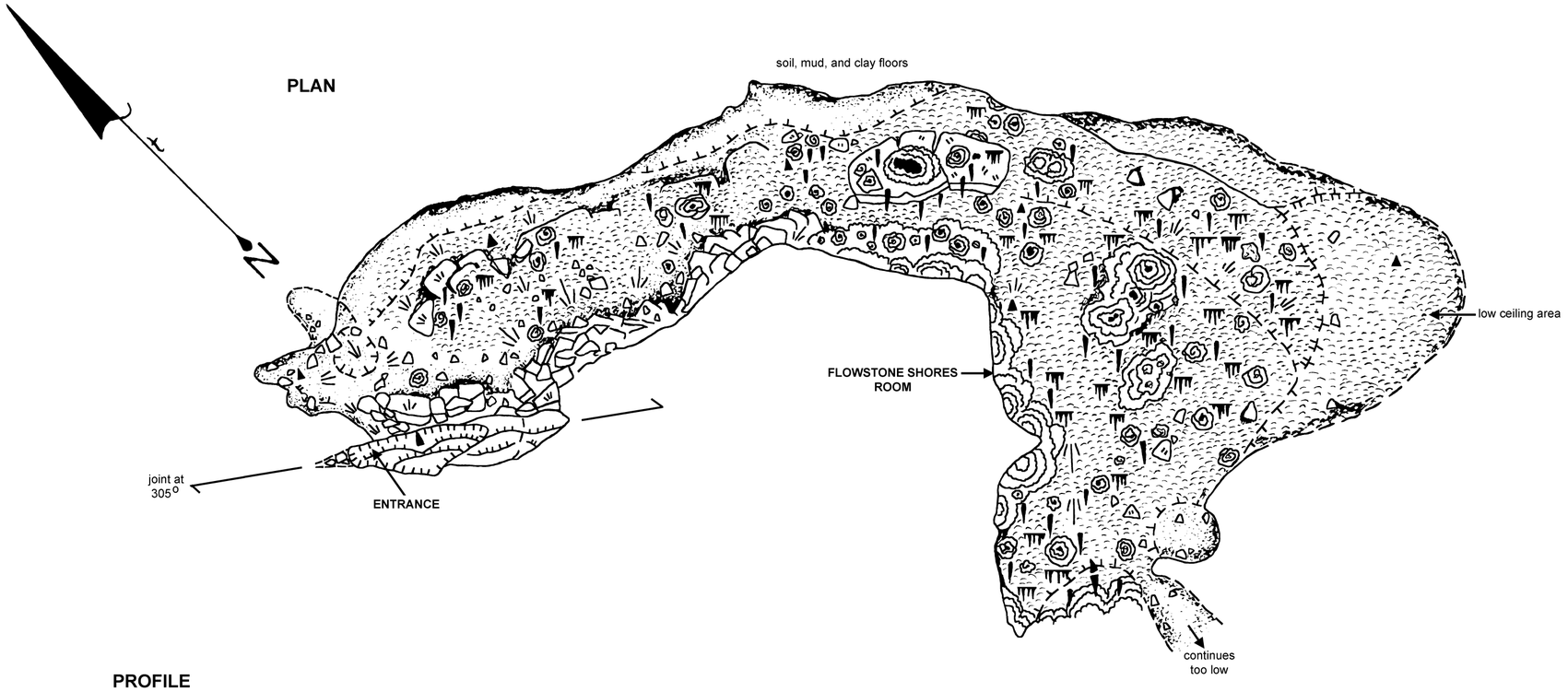


KARANKAWA CAVE
Williamson County, Texas

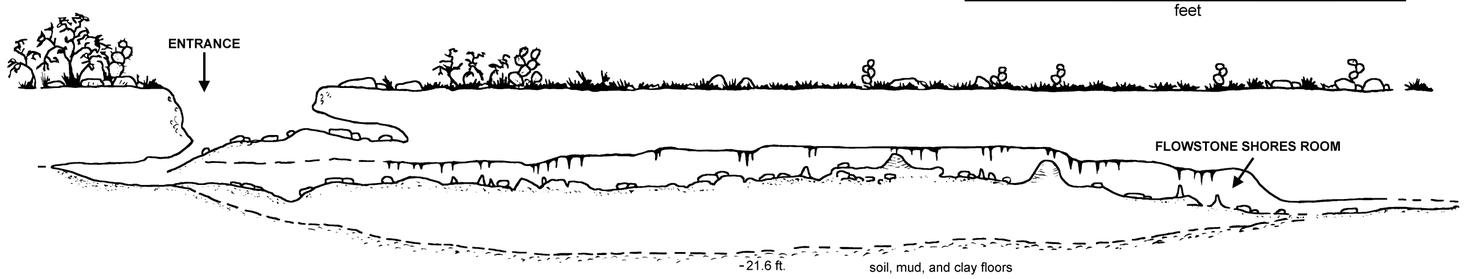
Suuntos and Tape Survey
3 May 1994
D. Allen, L.J. Graves, D. Love, C. Savvas, M. Wrton, J. Wolff
Drafted by Mike Warton

Length: 164.5 ft. Depth: 11.6 ft.

PLAN

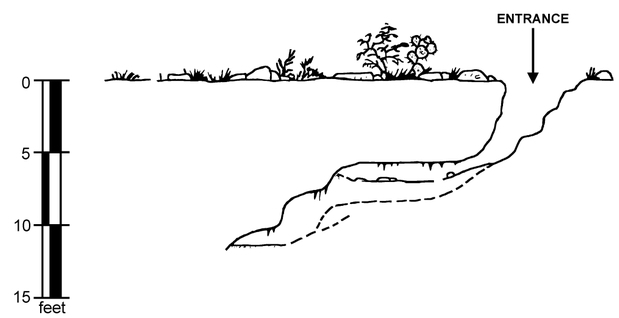


PROFILE
SW looking NE



0 5 10 15 20 25 30
feet

SIDE PROFILE
NW to SE at entrance



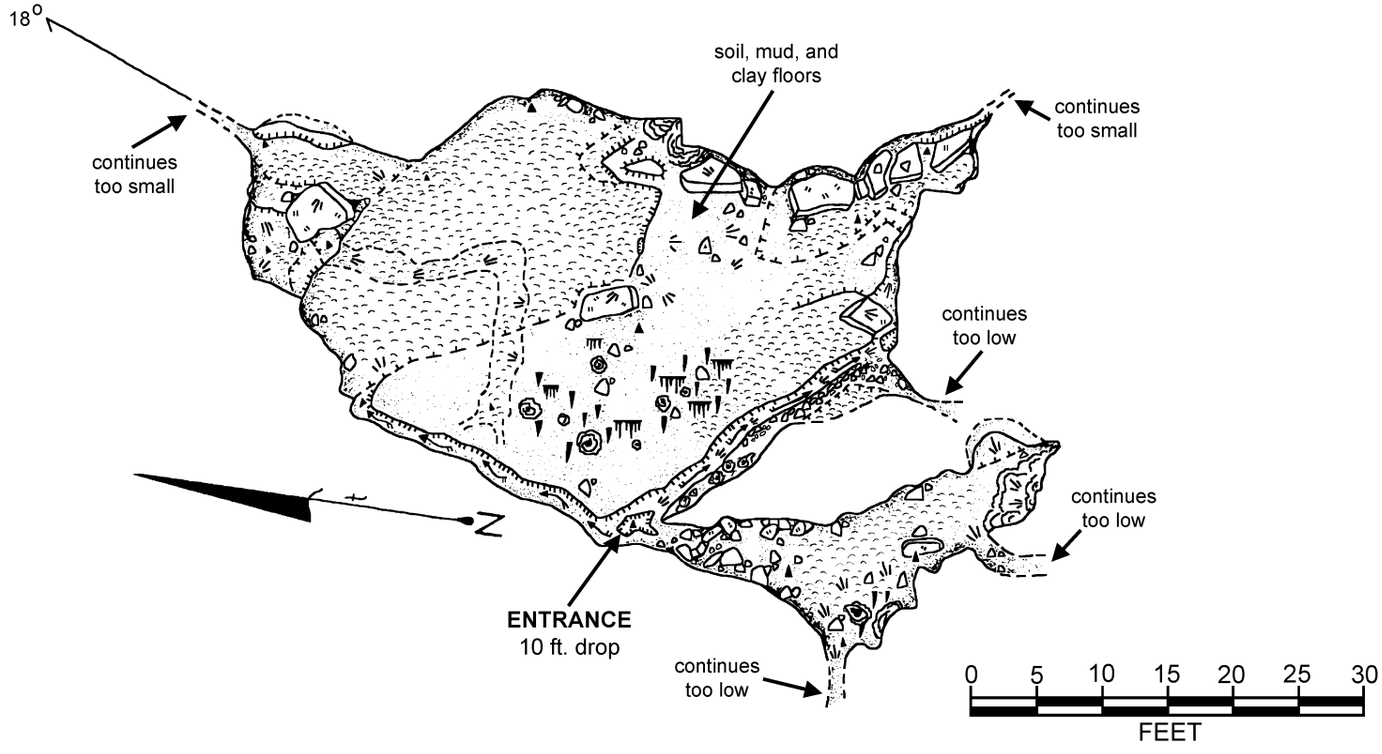
PEMMICAN CAVE

Williamson County, Texas

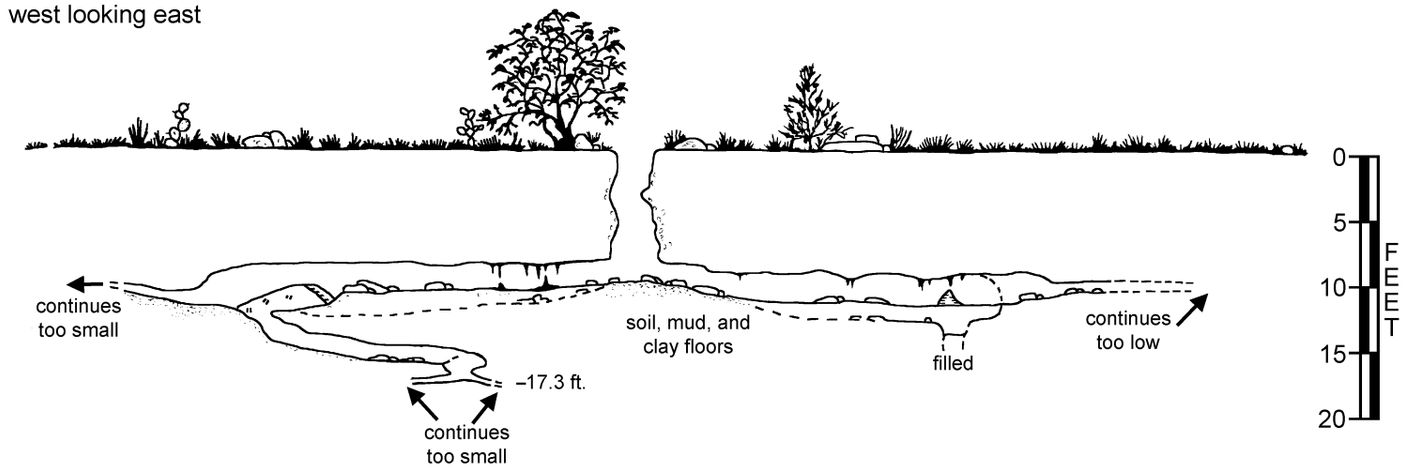
Suuntos and Tape Survey
4 May 1994
D. Allen, L.J. Graves, D. Love,
C. Savvas, M. Warton, J. Wolff
Drafted by Mike Warton

Length: 240 ft. Depth: 17.3 ft.

PLAN



PROFILE
west looking east

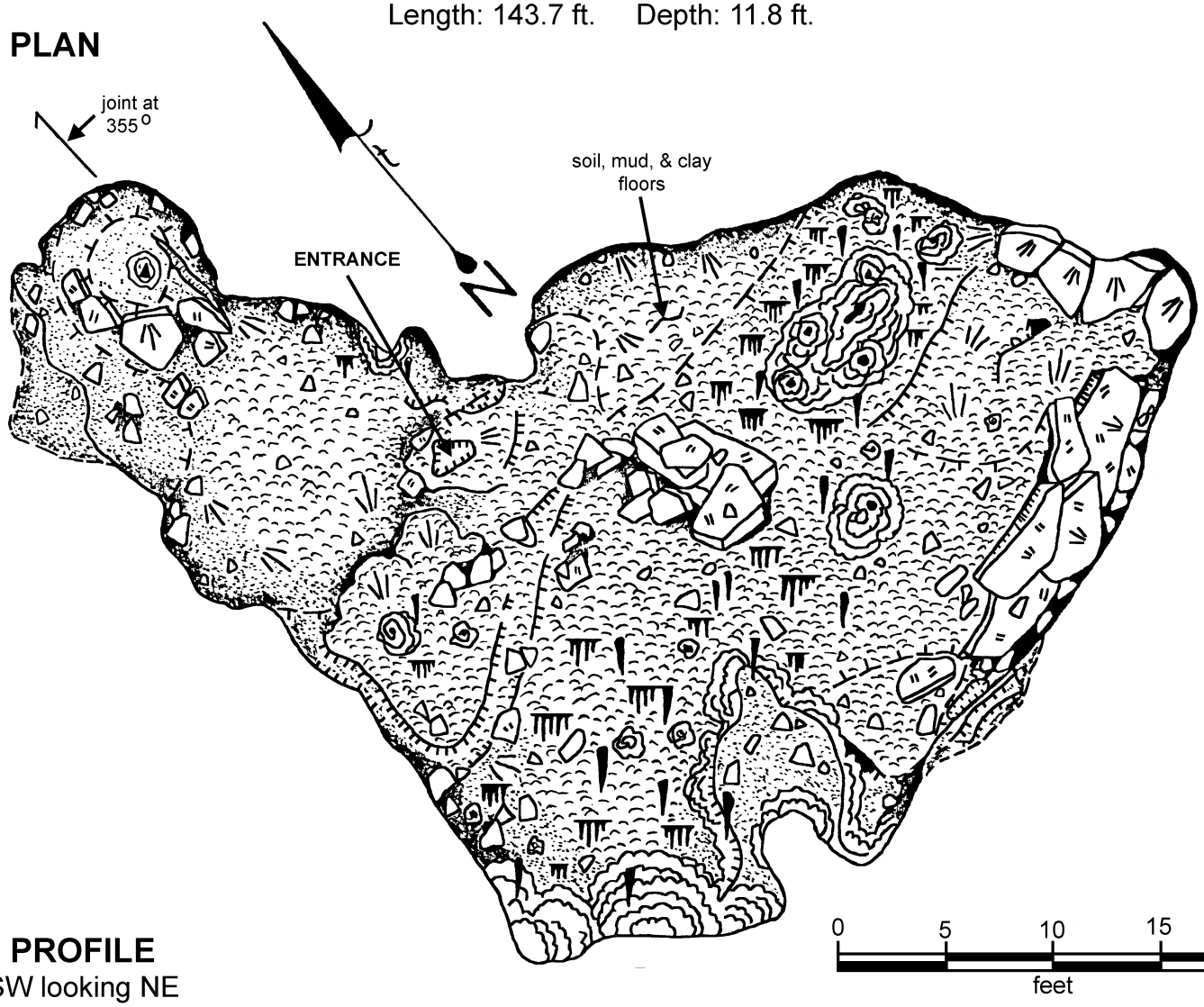


POLARIS CAVE
Williamson County, Texas

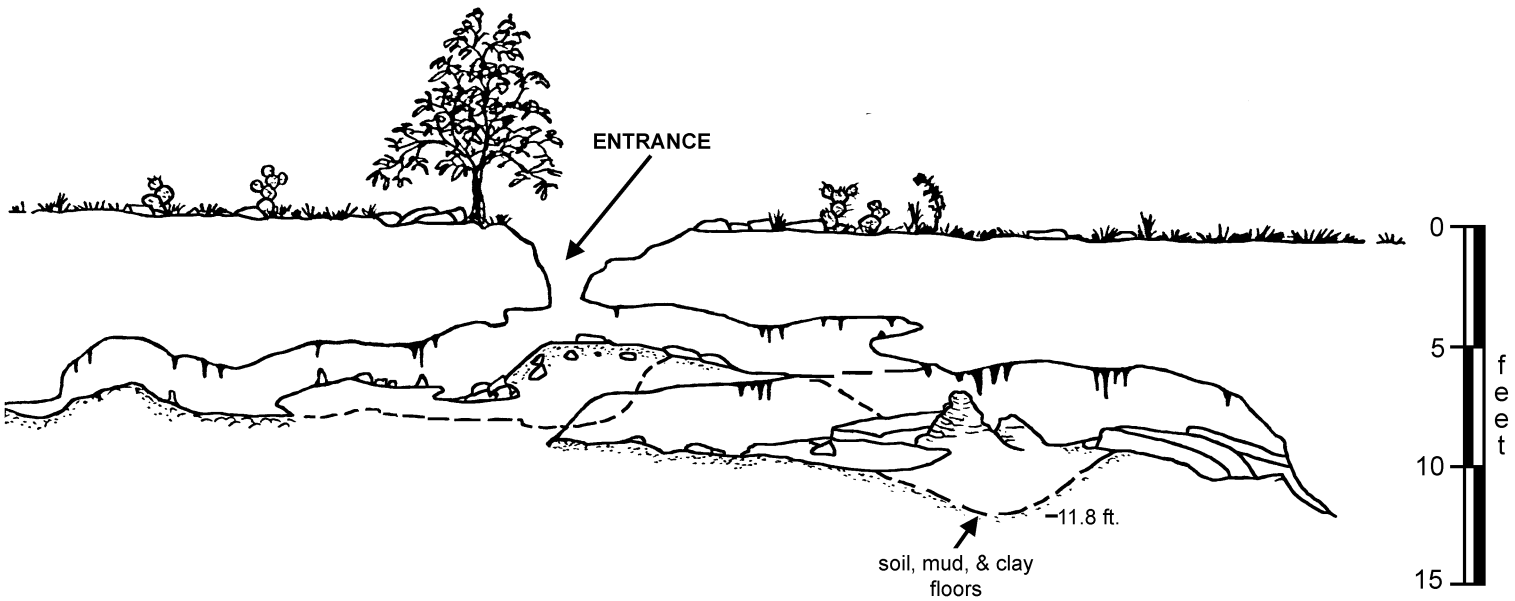
Suuntos and Tape Survey
5 May 1994
D. Allen, L.J. Graves, D. Love, C. Savvas, M. Warton, J. Wolff
Drafted by Mike Warton

Length: 143.7 ft. Depth: 11.8 ft.

PLAN

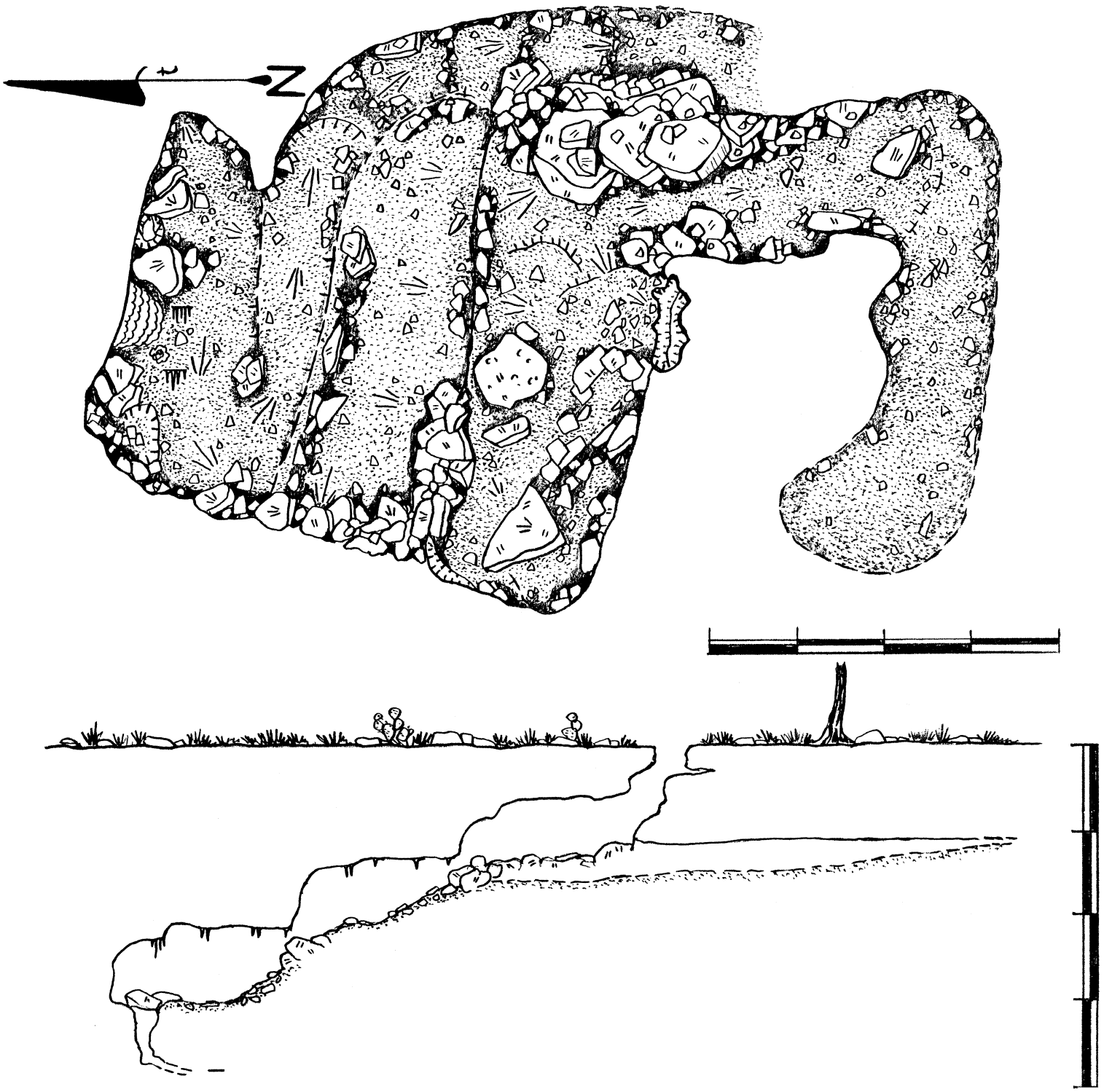


PROFILE
SW looking NE



QUAHADI CAVE

Williamson County, Texas

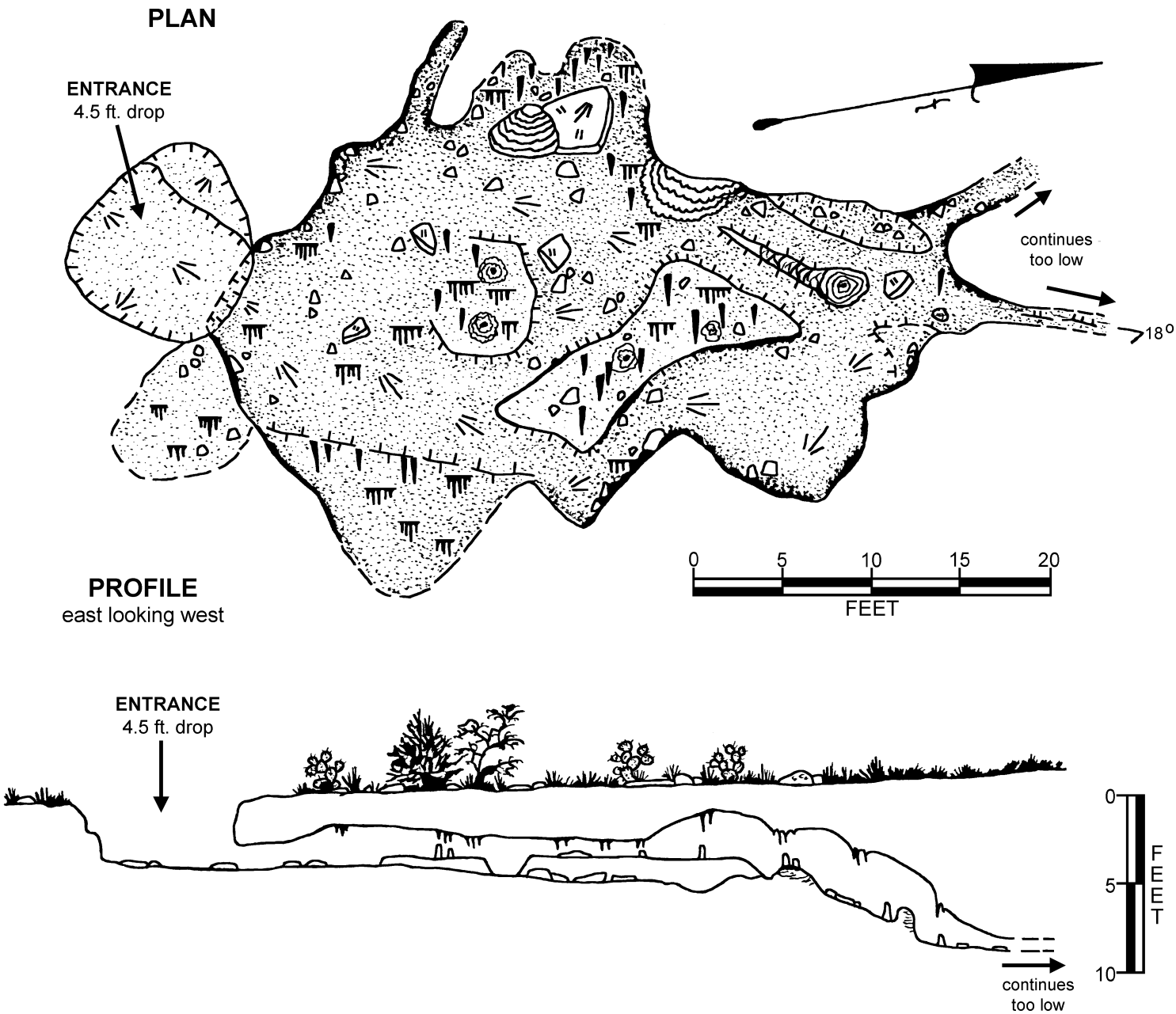


SNAKE DANCER CAVE

Williamson County, Texas

Suuntos and Tape Survey
2 May 1994
D. Allen, L. J. Graves, D. Love,
C. Savvas, M. Warton, J. Wolff
Drafted by Mike Warton

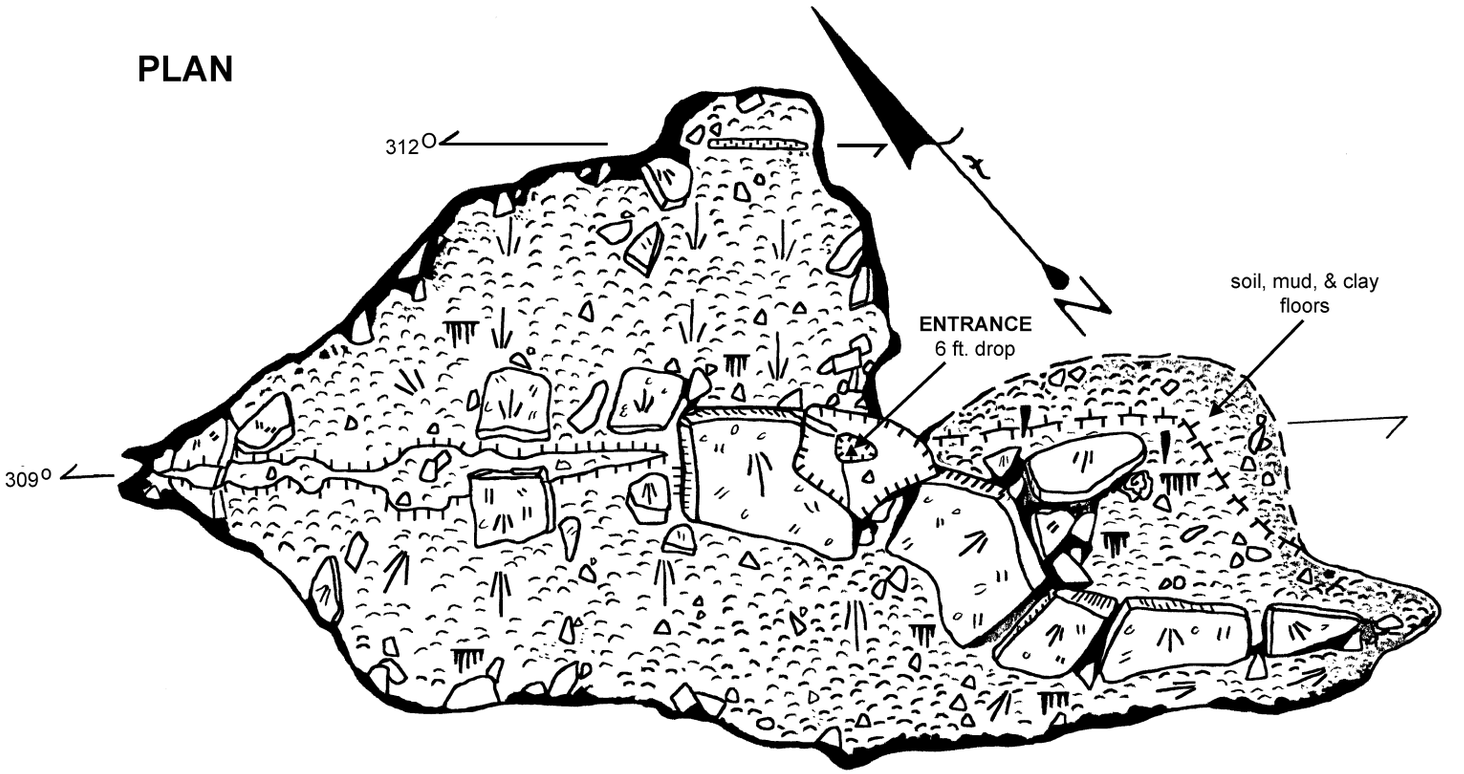
Length: 81.3 ft. Depth: 9 ft.

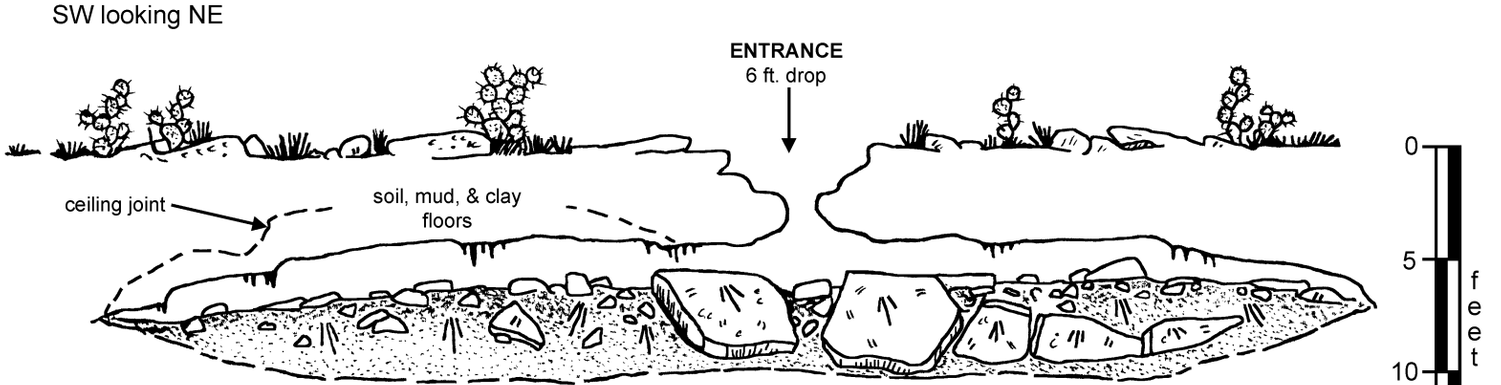


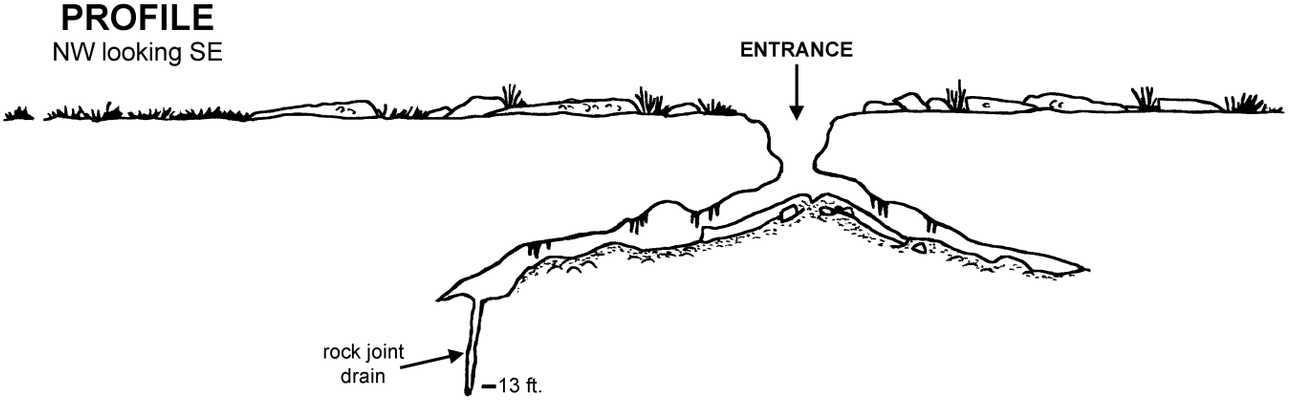
WAR PARTY CAVE
Williamson County, Texas

Suuntos and Tape Survey
3 May 1994
D. Allen, L.J. Graves, D. Love, C. Savvas, M. Warton, J. Wolfe
Drafted by Mike Warton

Length: 64.5 ft. Depth: 13 ft.

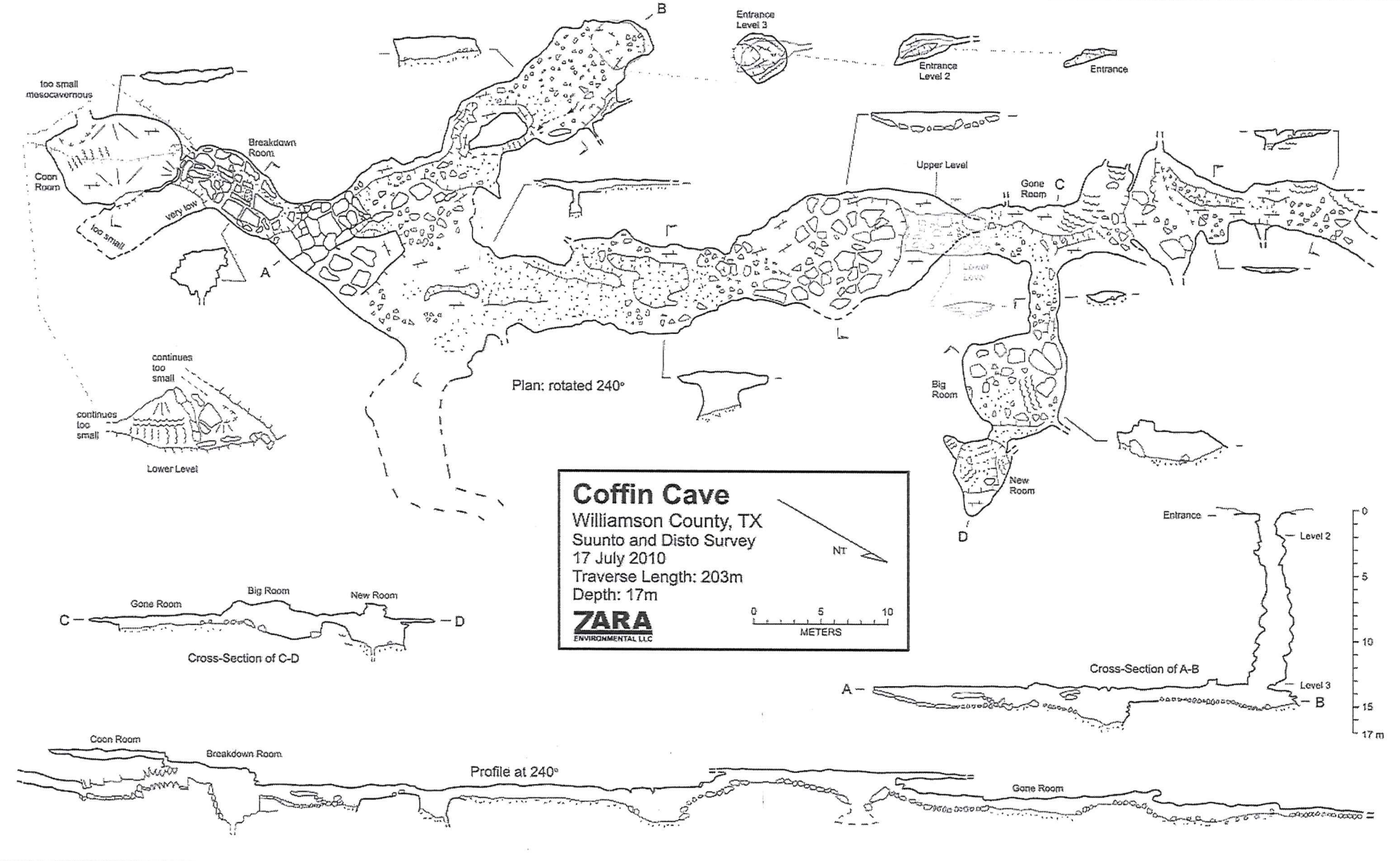






Appendix K

Cave Map of the Coffin Cave Preserve


Entrance Level 3
Entrance Level 2
Entrance
too small mesocavernous
Breakdown Room
Coon Room
very low
too small
Upper Level
Gone Room
B
C
A
continues too small
continues too small
Lower Level
Plan: rotated 240°
Big Room
New Room
D
Coffin Cave
Williamson County, TX
Suunto and Disto Survey
17 July 2010
Traverse Length: 203m
Depth: 17m
ZARA ENVIRONMENTAL LLC
NT
0 5 10
METERS
Gone Room
Big Room
New Room
C
D
Cross-Section of C-D
Entrance
Level 2
Level 3
A
B
Cross-Section of A-B
0
5
10
15
17 m
Coon Room
Breakdown Room
Profile at 240°
Gone Room

Appendix L

Cave Map of the Beck Commons Preserve

BECK TIN CAN / SEWER CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY · DATE: APRIL 11, 1993

PERSONNEL:

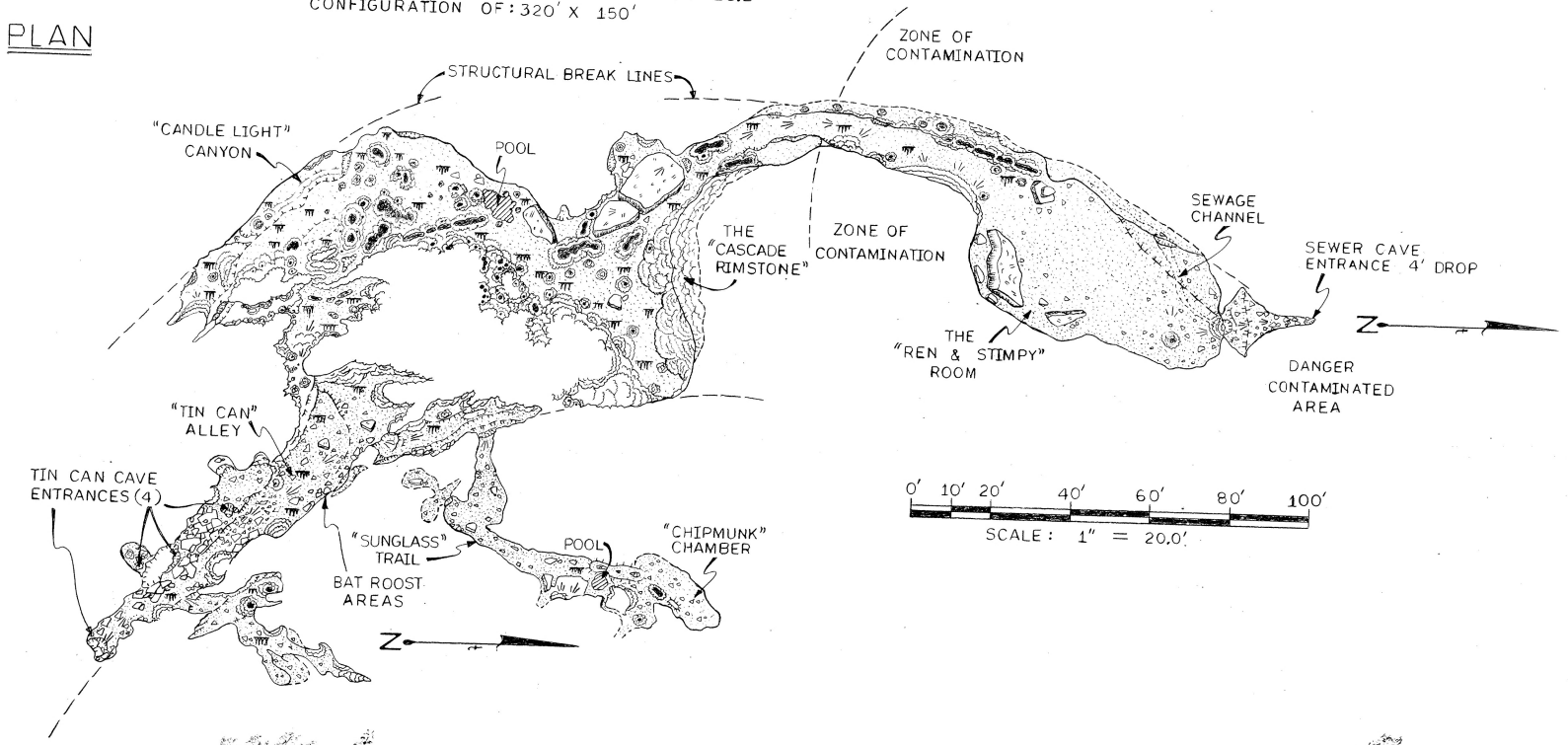
CHARLEY SAVVAS LEE JAY GRAVES DOUG ALLEN

DAN LOVE MIKE WARTON · DRAFT BY: MIKE WARTON

SURVEYED LENGTH: 837.4' DEPTH: 23.2'

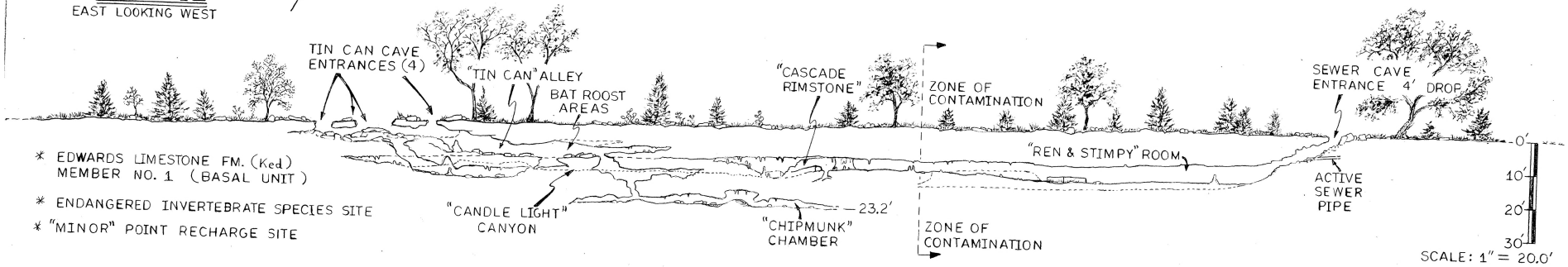
CONFIGURATION OF: 320' X 150'

PLAN



PROFILE

EAST LOOKING WEST



* EDWARDS LIMESTONE FM. (Ked) MEMBER NO. 1 (BASAL UNIT)
* ENDANGERED INVERTEBRATE SPECIES SITE
* "MINOR" POINT RECHARGE SITE

PREPARED BY: MIKE WARTON & ASSOCIATES: 4 / 1993

T.S.S. 1993

Appendix M

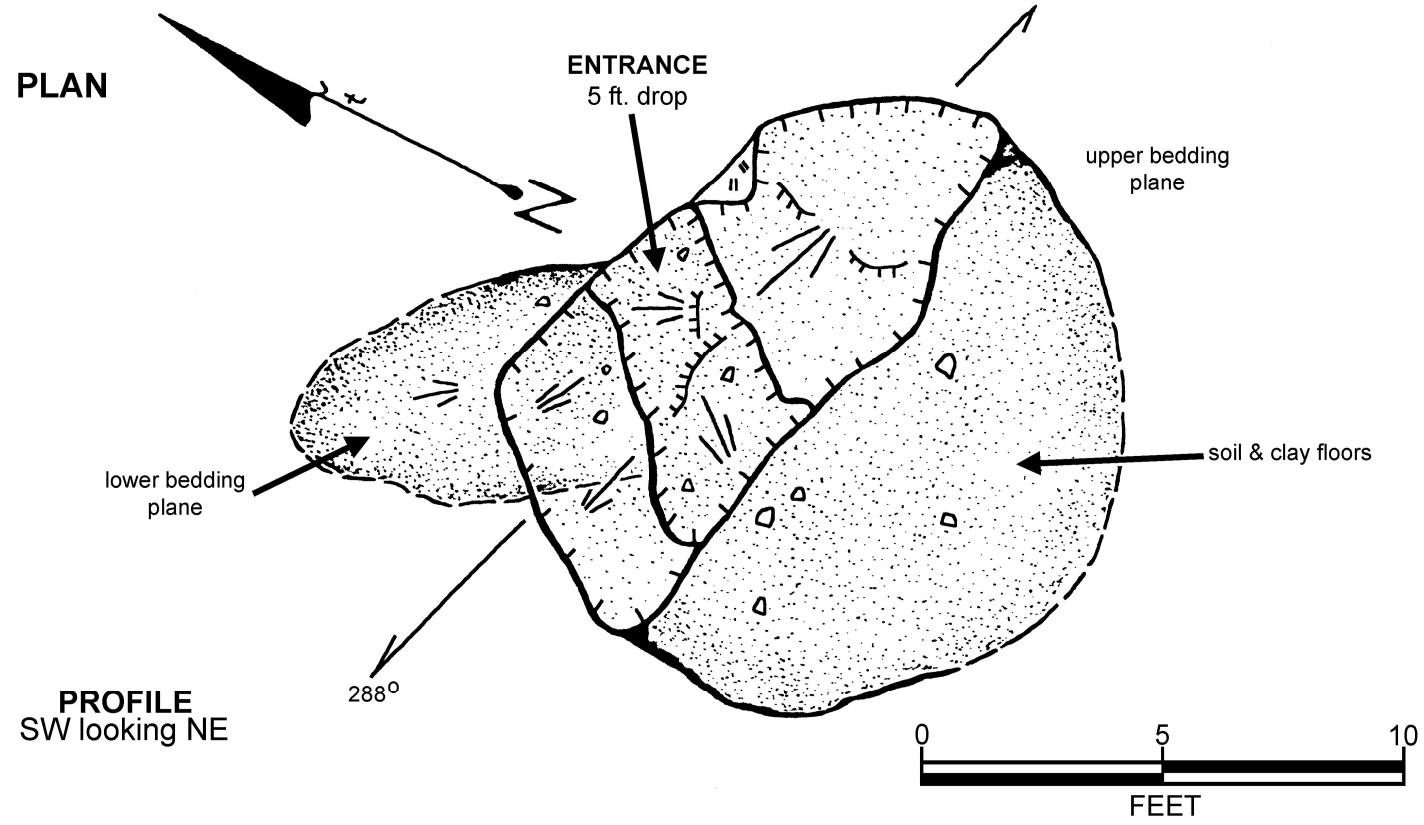
Cave Maps of the Shaman Cave Karst Fauna Area

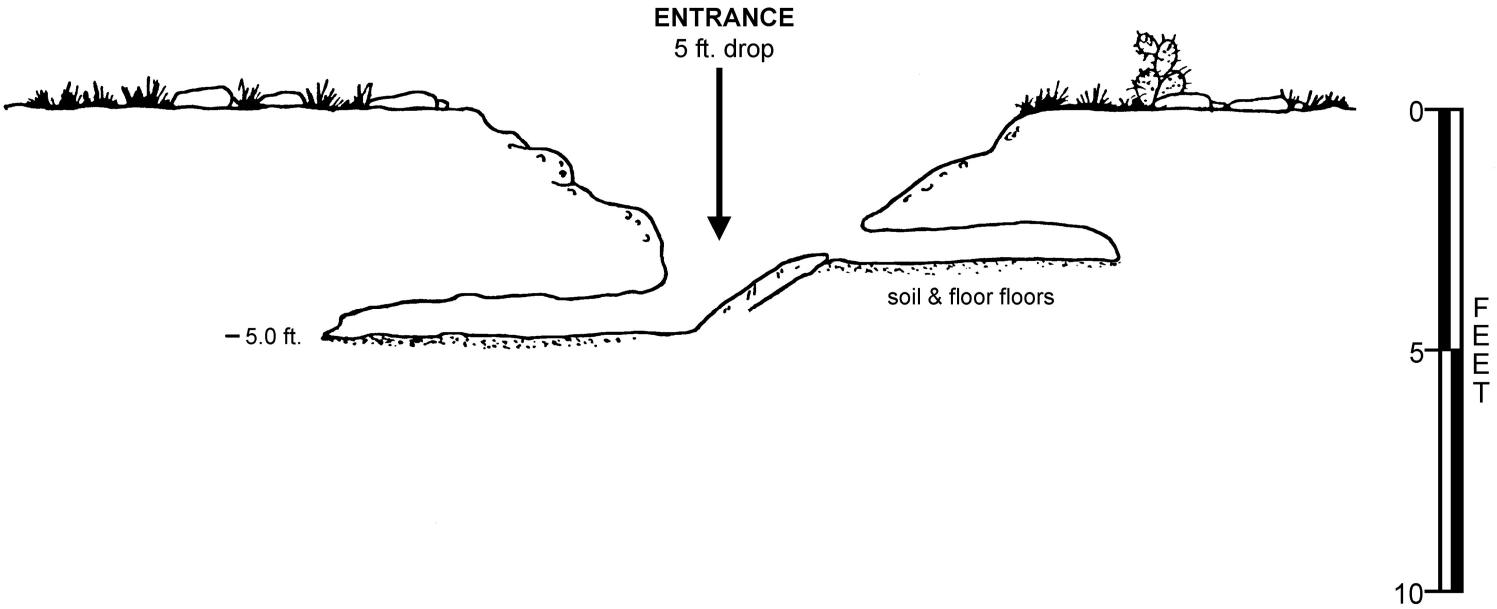
FLATHEAD CAVE

Williamson County, Texas

Suuntos and Tape Survey
12 September 1994
D. Allen, B. Bartlett, L. J. Graves, D. Love,
J. Warton, M. Warton, J. Wolff
Drafted by Mike Warton

Length: 18.2 ft. Depth: 5.0 ft.





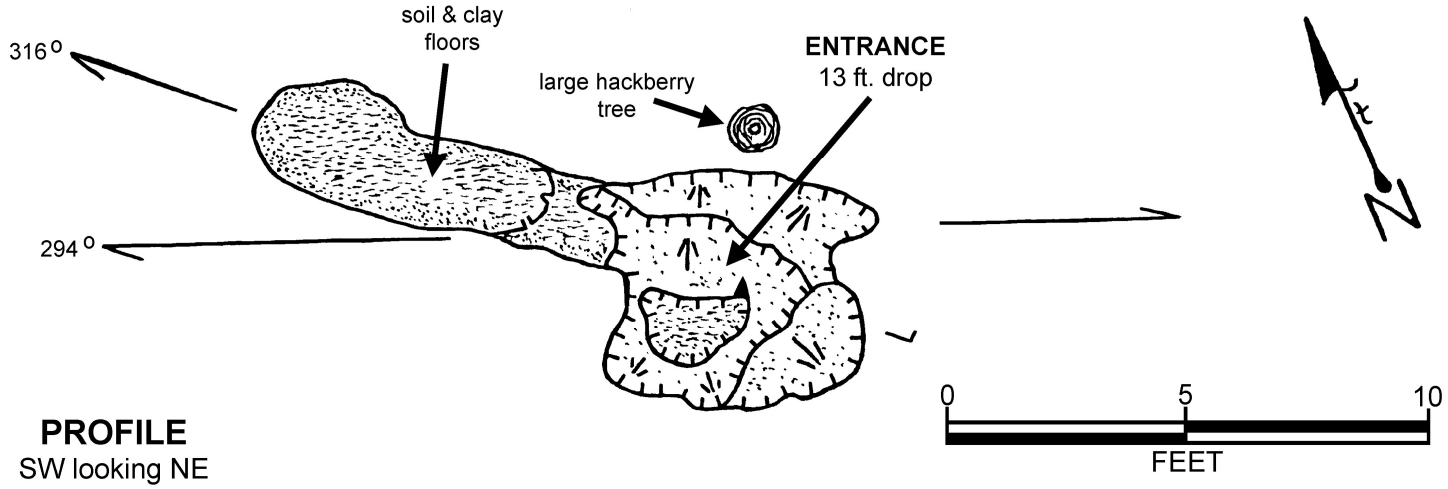
HAFT SHAFT CAVE

Williamson County, Texas

Suuntos and Tape Survey
12 September 1994
D. Allen, B. Bartlett, L. J. Graves, D. Love,
J. Warton, M. Warton, J. Wolff
Drafted by Mike Warton

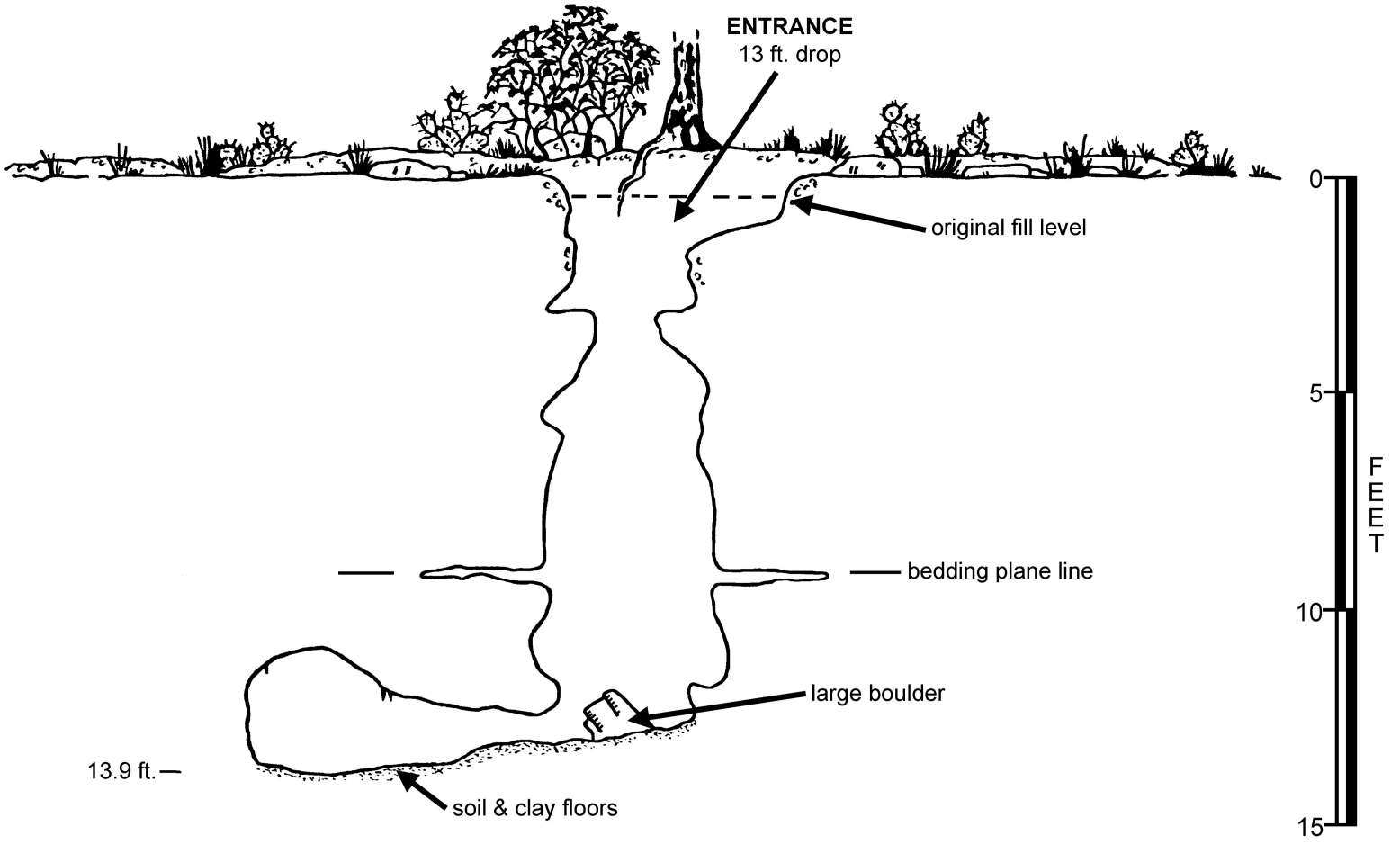
Length: 21.4 ft. Depth: 13.9 ft.

PLAN



PROFILE

SW looking NE



PLAN

0' 5' 10' 15' 20' 25' 30' 35' 40' 45' 50'

SCALE IN FEET: 1/8" 1.0'

SHAMAN CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTOS & TAPE SURVEY · SEPTEMBER 12, 1994

PERSONNEL: MIKE WARTON & ASSOCIATES:

LEE JAY GRAVES · DOUG ALLEN · DAN LOVE · JIM WOLFF

BRENT BARTLETT · JAMES WARTON · MIKE WARTON

DRAFT BY: MIKE WARTON

LENGTH: 237.6' DEPTH: 14'

CONFIGURATION OF: 236' X 45'

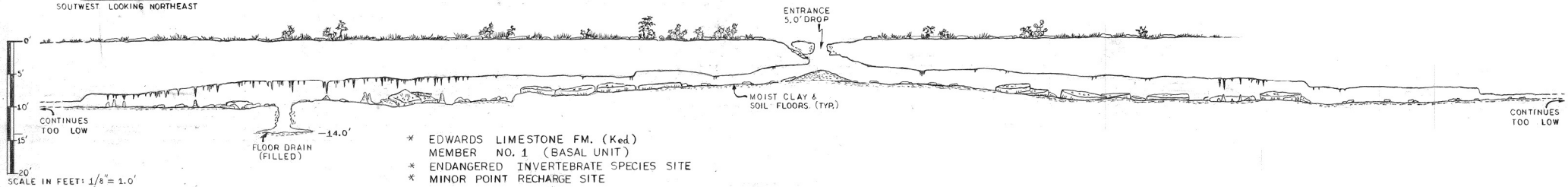
UNITS IN FEET & TENTHS

BIOLOGY BY: J. REDDELL

(1.5) = CEILING HEIGHTS IN FEET

PROFILE

SOUTWEST LOOKING NORTHEAST



SCALE IN FEET: 1/8" = 1.0'

* EDWARDS LIMESTONE FM. (Ked)
MEMBER NO. 1 (BASAL UNIT)
* ENDANGERED INVERTEBRATE SPECIES SITE
* MINOR POINT RECHARGE SITE

PREPARED BY: MIKE WARTON & ASSOCIATES

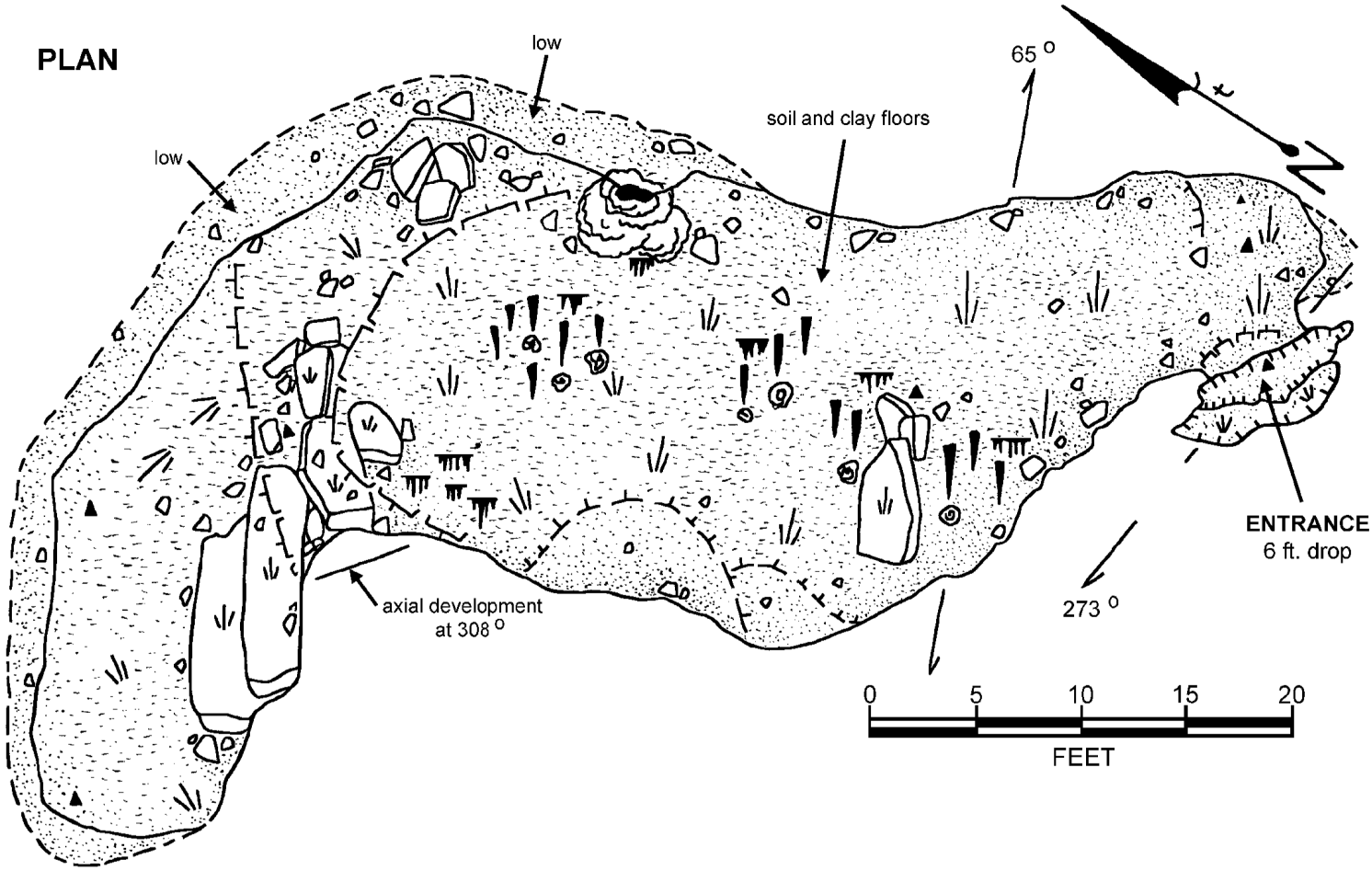
T. S. S. 1994

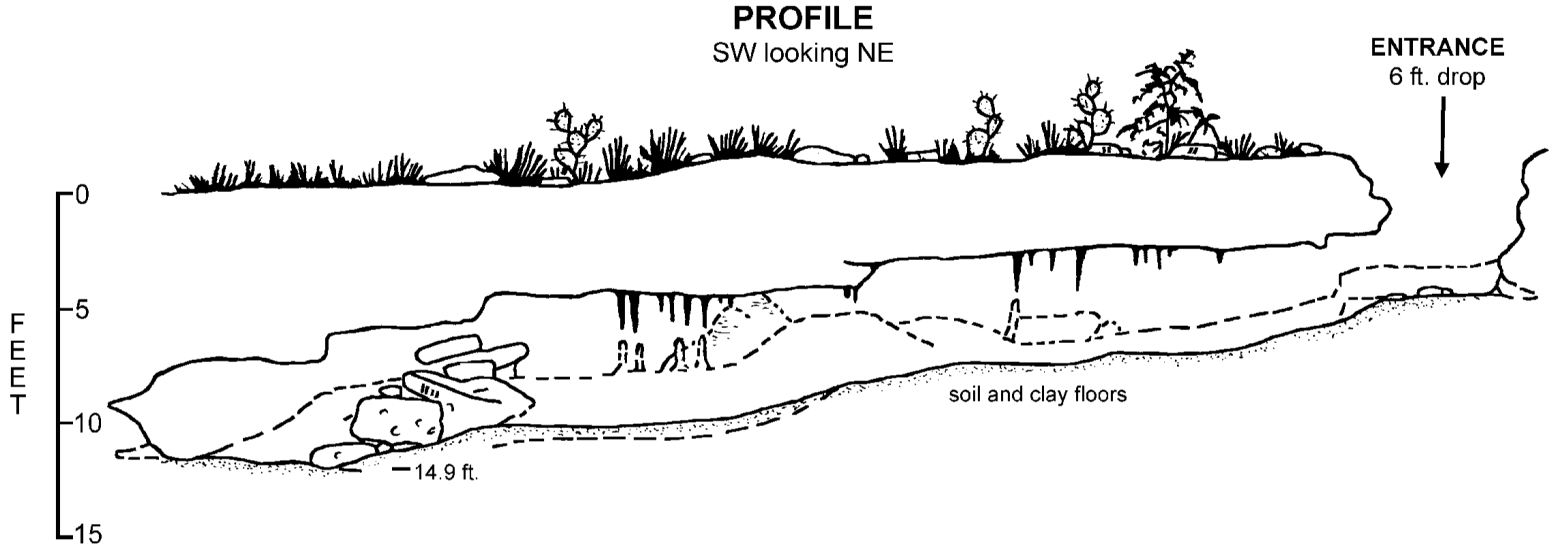
POWWOW CAVE

Williamson County, Texas

Suuntos and Tape Survey
10 September 1994
D. Allen, B. Bartlett, L. J. Graves, D. Love,
J. Warton, M. Warton, J. Wolff
Drafted by Mike Warton

Length: 83.2 ft. Depth: 14.9 ft.





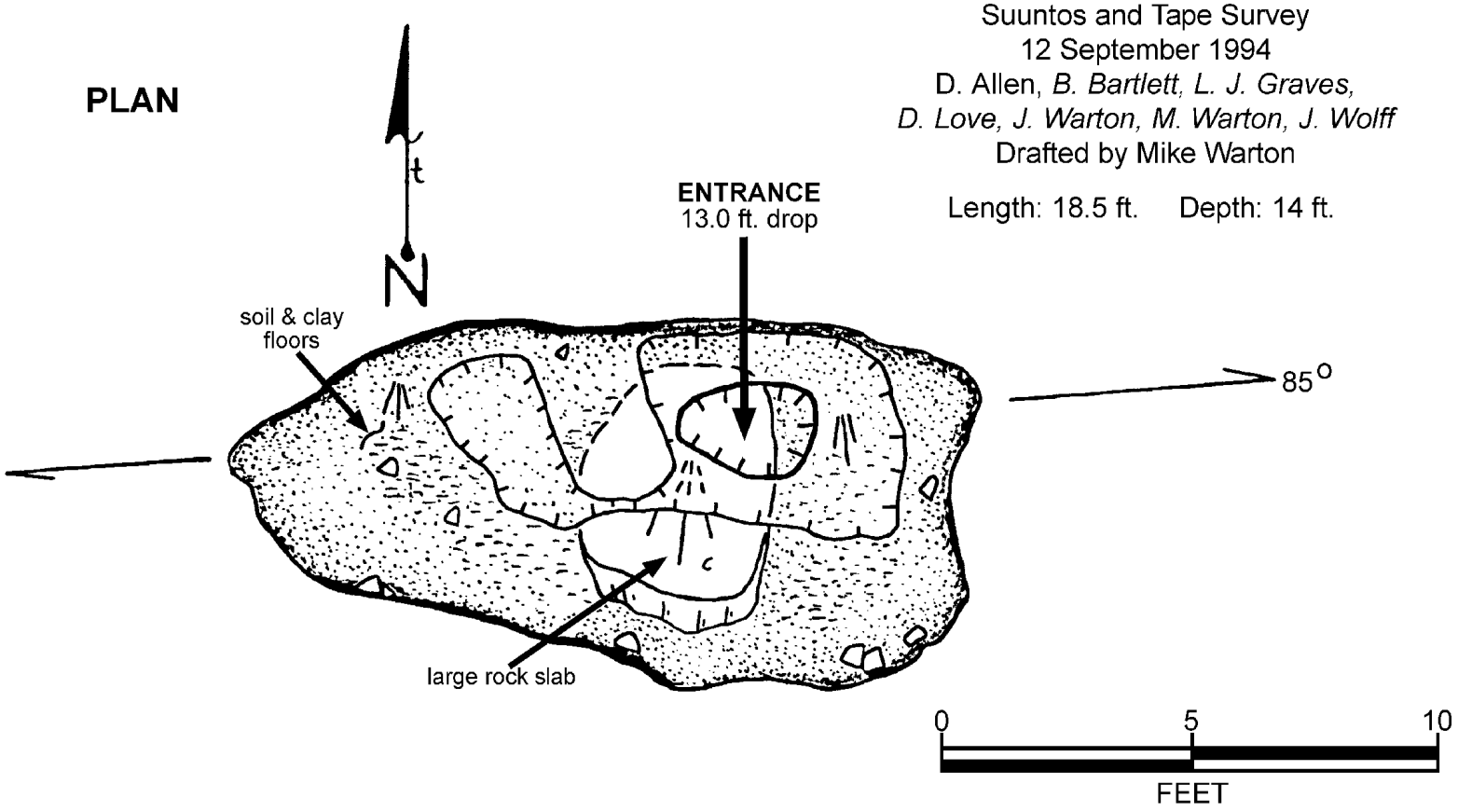
BORGARIGMIE PIT CAVE

Williamson County, Texas

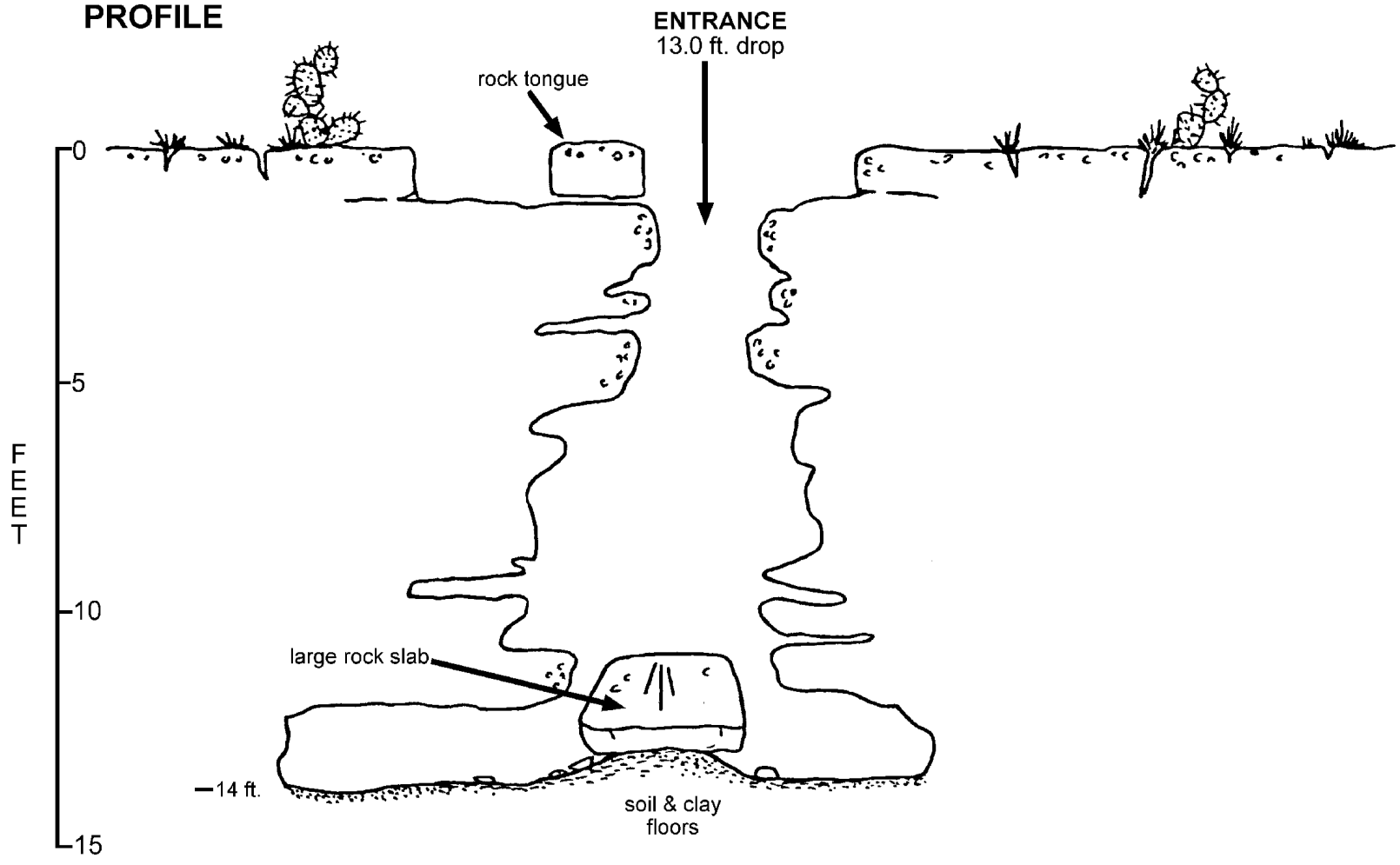
Suuntos and Tape Survey
12 September 1994
D. Allen, *B. Bartlett, L. J. Graves,*
D. Love, J. Warton, M. Warton, J. Wolff
Drafted by Mike Warton

Length: 18.5 ft. Depth: 14 ft.

PLAN



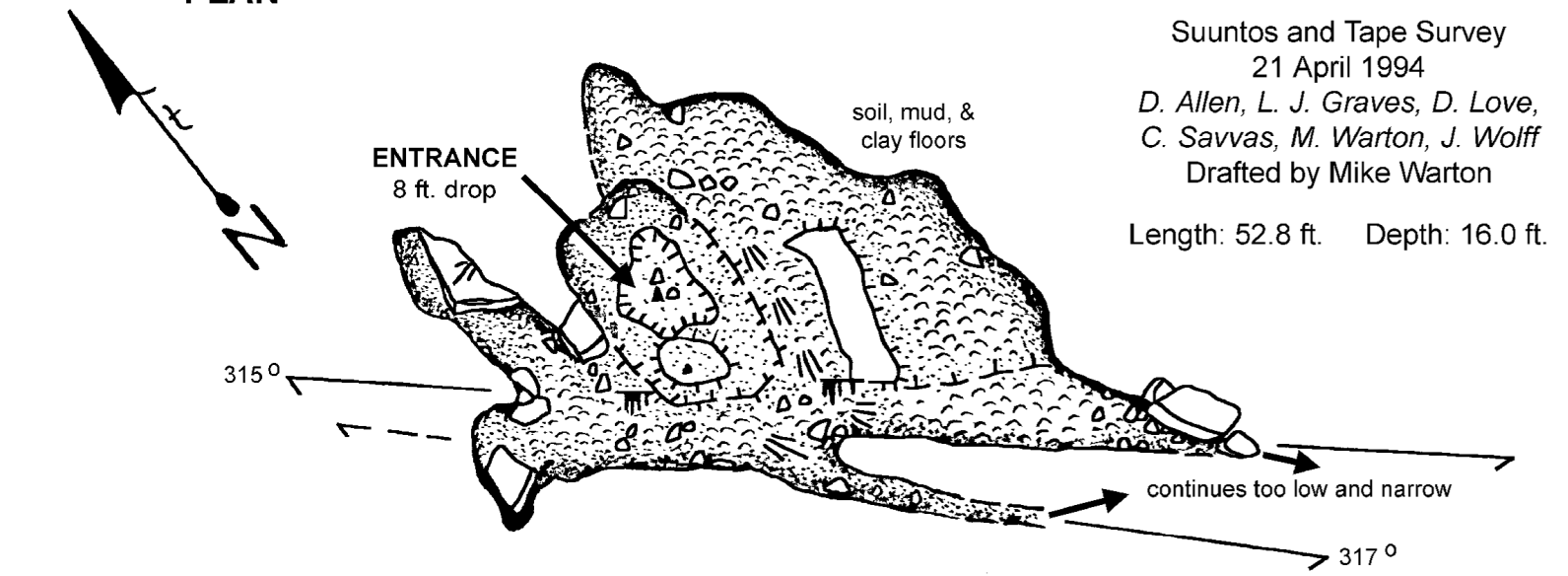
PROFILE

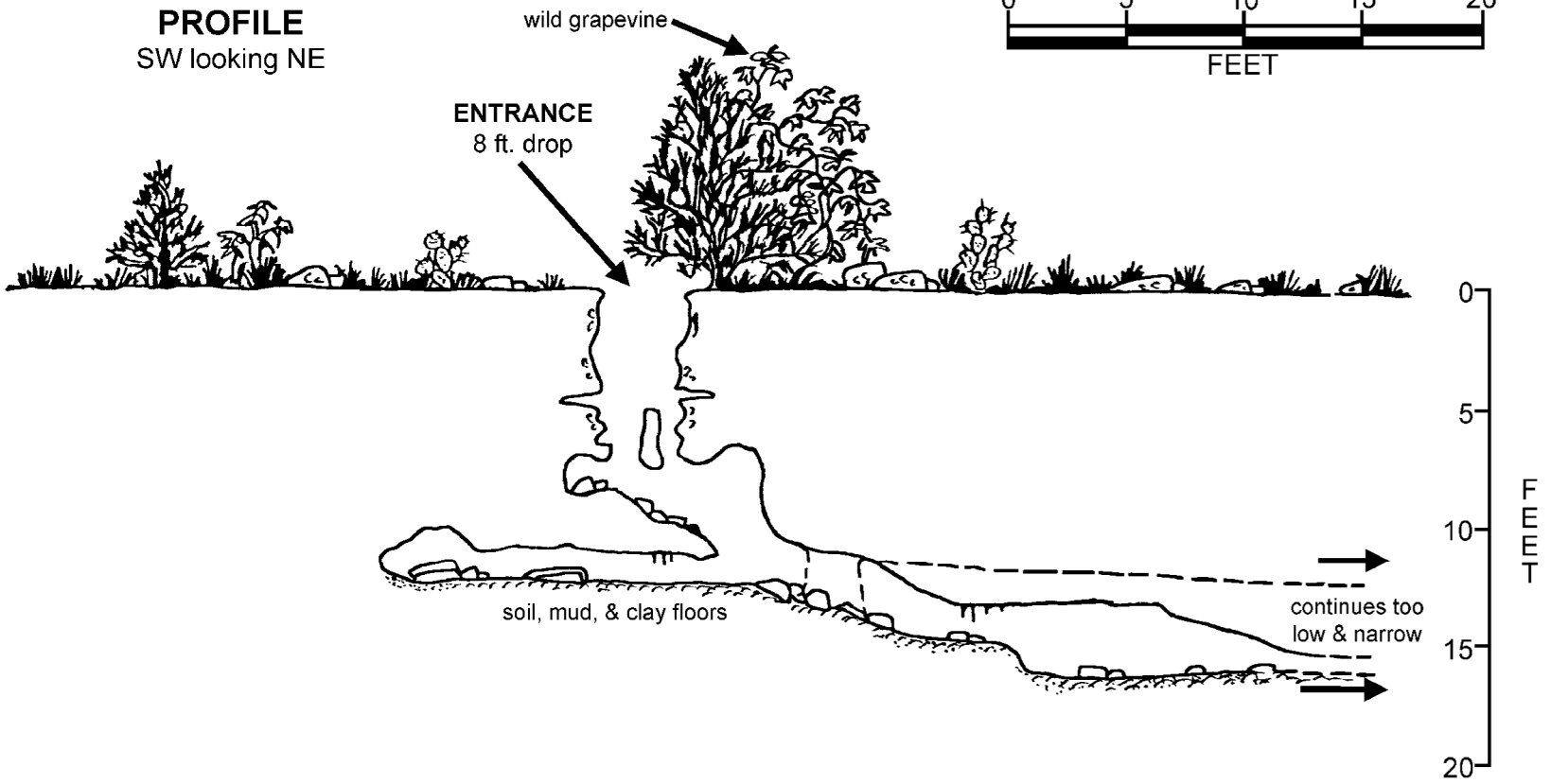


FLORENCE NO. 18 CAVE
Williamson County, Texas

Suuntos and Tape Survey
21 April 1994
D. Allen, L. J. Graves, D. Love, C. Savvas, M. Warton, J. Wolff
Drafted by Mike Warton

Length: 52.8 ft. Depth: 16.0 ft.



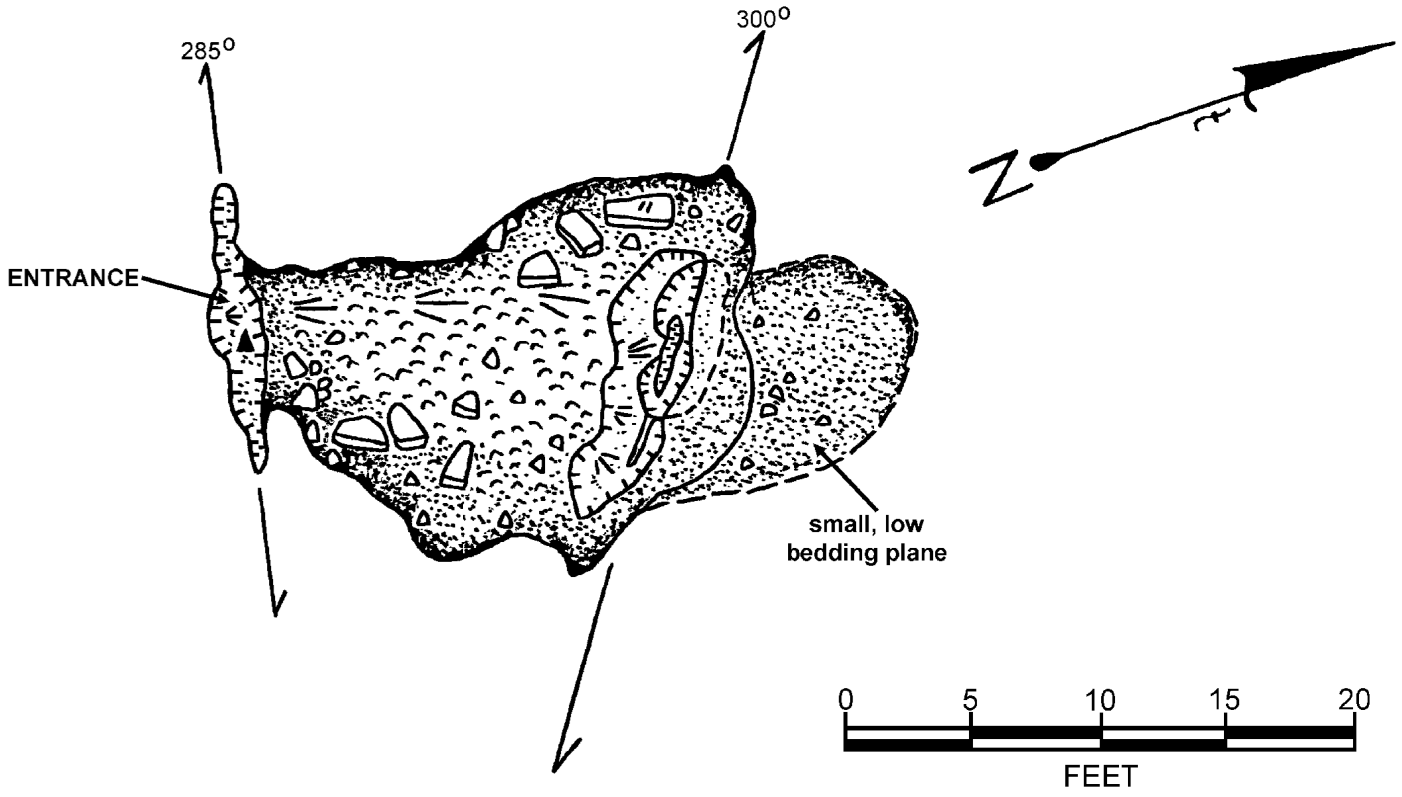


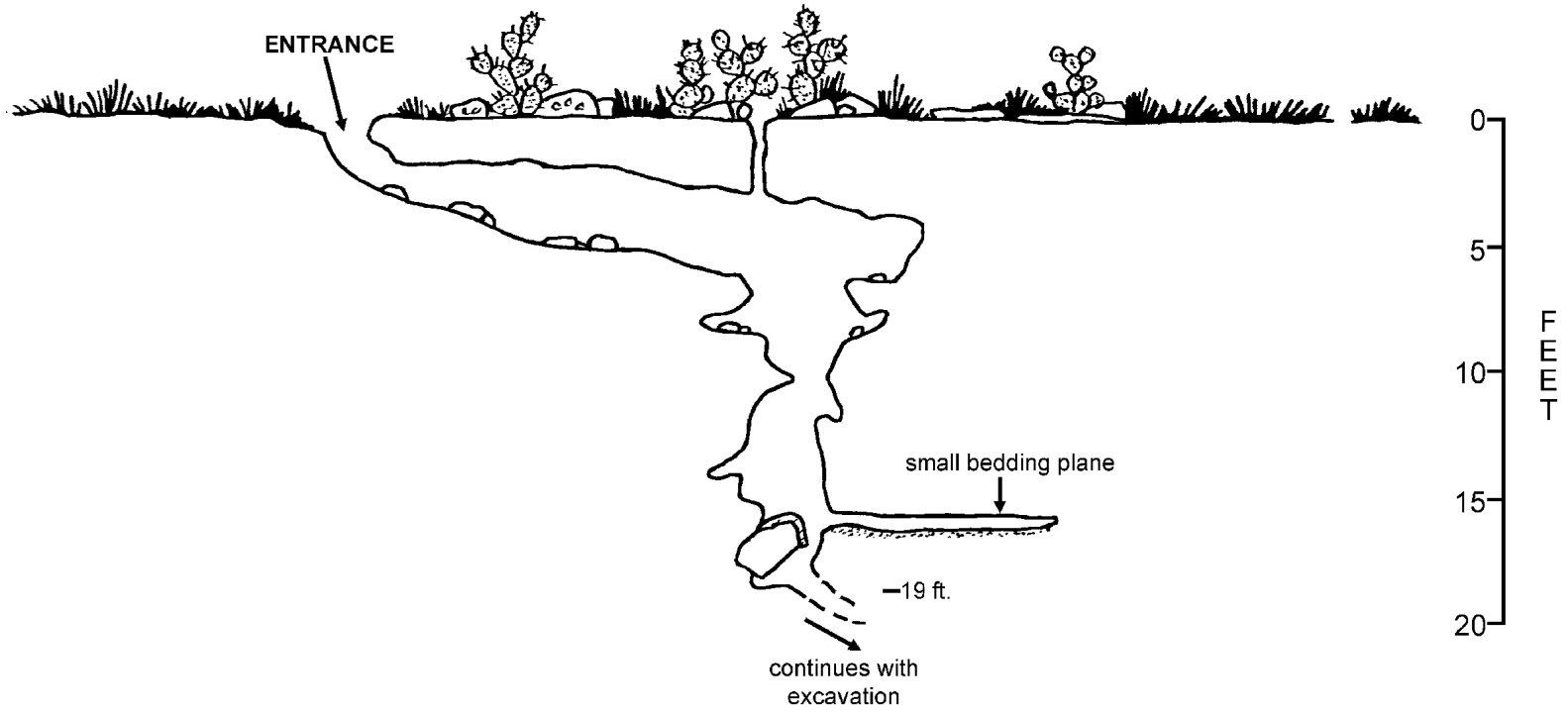
HATCHET CAVE

Williamson County, Texas

Suuntos and Tape Survey
21 April 1994
D. Allen, L. J. Graves, D. Love,
C. Savvas, M. Warton, J. Wolff
Drafted by Mike Warton

Length: 38.7 ft. Depth: 19 ft.



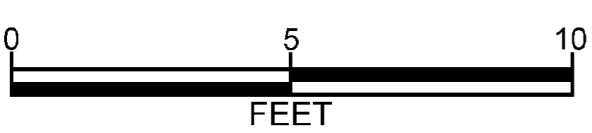


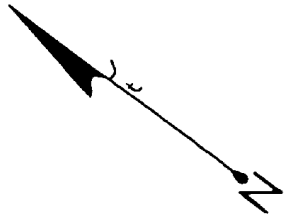
SQUAW CAVE

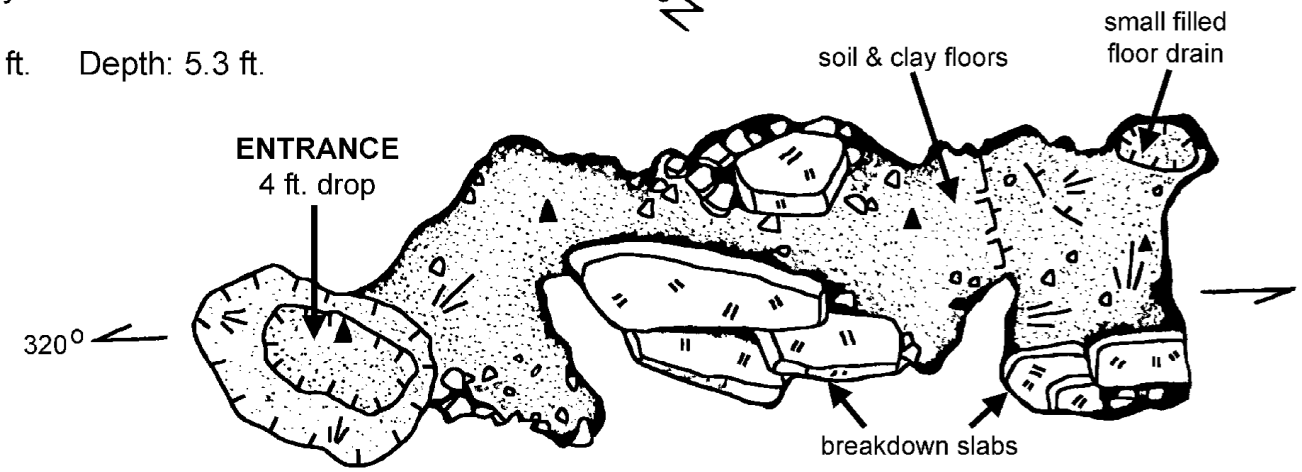
Williamson County, Texas

Suuntos and Tape Survey
10 September 1994
D. Allen, B. Bartlett, L. J. Graves,
D. Love, J. Warton, M. Warton, J. Wolff
Drafted by Mike Warton

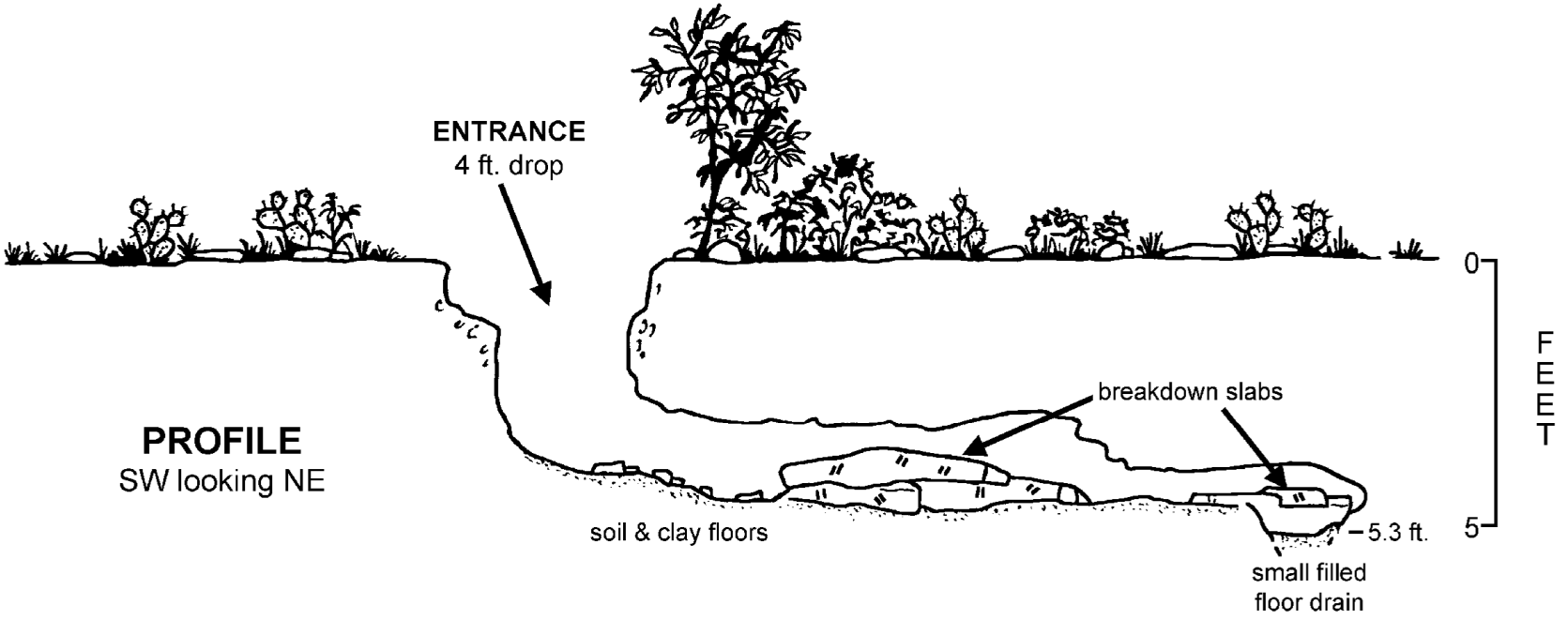
Length: 18.4 ft. Depth: 5.3 ft.







PLAN



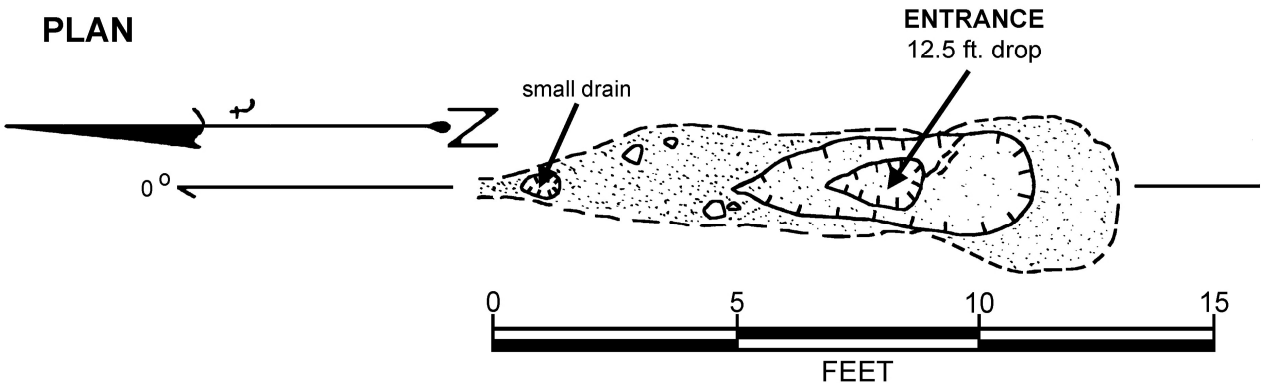
PROFILE
SW looking NE

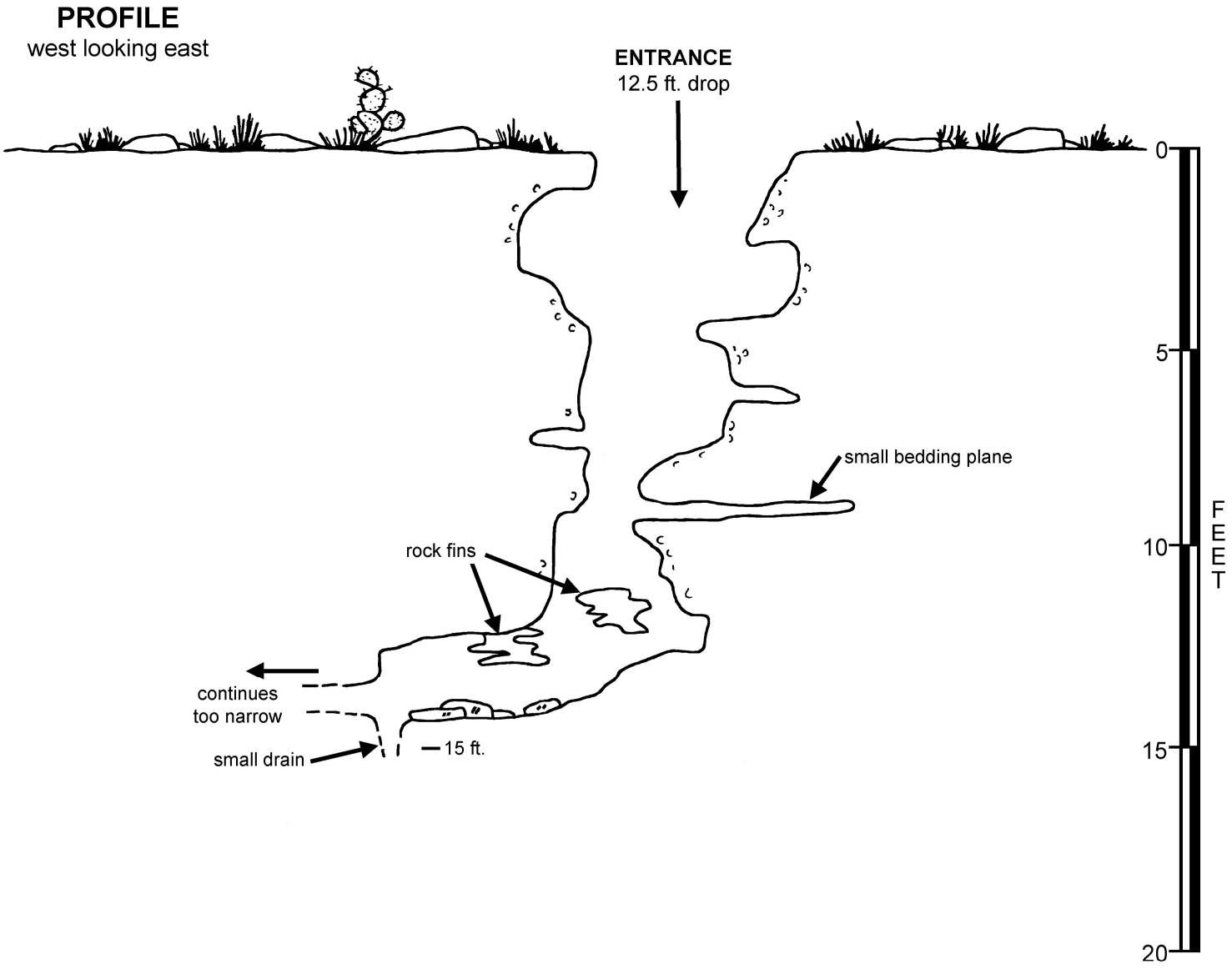
SHAWNTEE PIT CAVE

Williamson County, Texas

Suuntos and Tape Survey
10 September 1994
D. Allen, B. Bartlett, L. J. Graves,
D. Love, J. Warton, M. Warton, J. Wolff
Drafted by Mike Warton

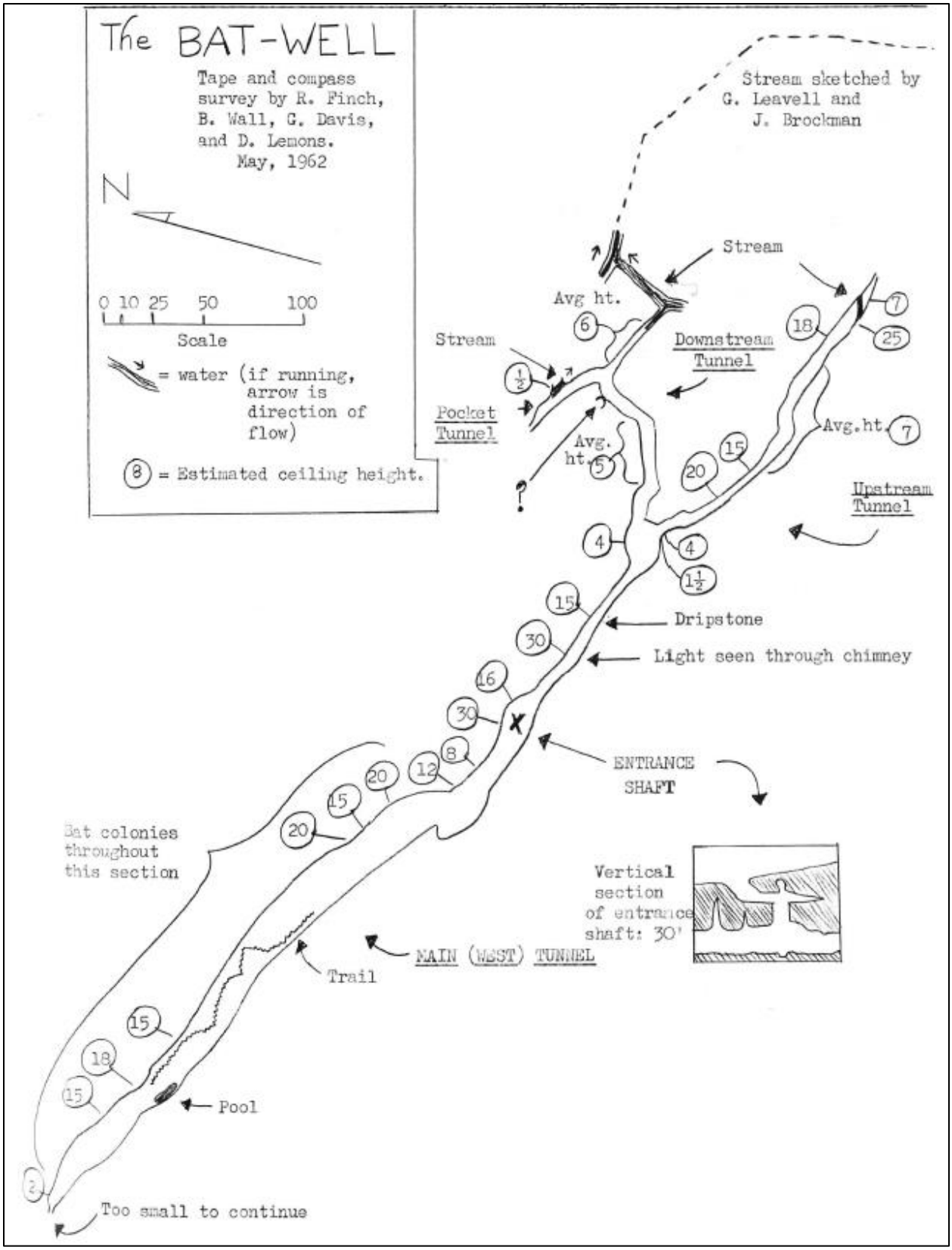
Length: 19.5 ft. Depth: 15 ft.

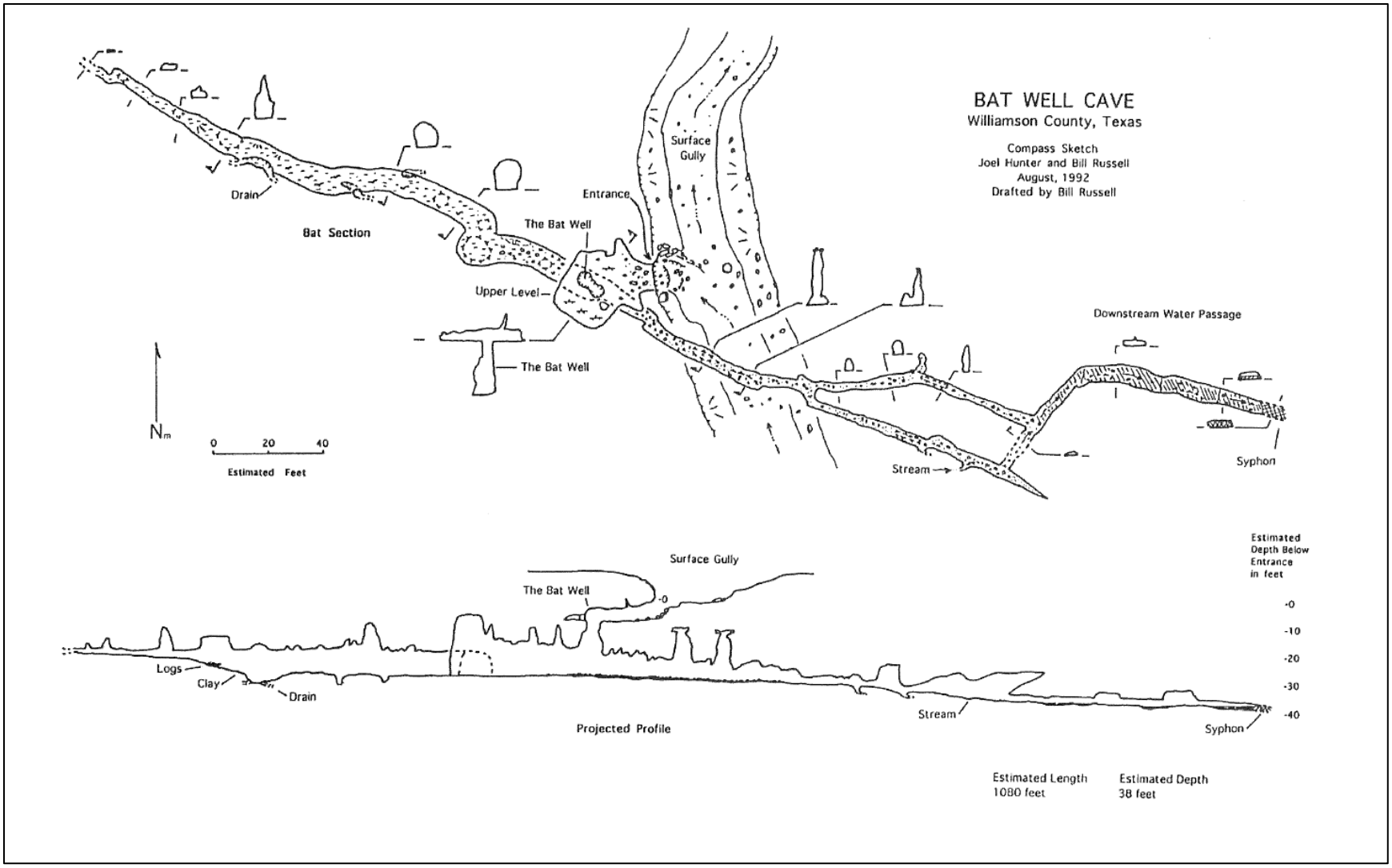




Appendix N

Cave Maps of the Bat Well Cave Preserve


The BAT-WELL
Tape and compass survey by R. Finch, B. Wall, G. Davis, and D. Lemons.
May, 1962
N
0 10 25 50 100
Scale
= water (if running, arrow is direction of flow)
(8) = Estimated ceiling height.
Stream sketched by G. Leavell and J. Brockman
Stream
Avg ht.
Stream
Downstream Tunnel
Pocket Tunnel
Avg. ht.
Avg.ht.
Upstream Tunnel
Dripstone
Light seen through chimney
ENTRANCE SHAFT
Bat colonies throughout this section
Vertical section of entrance shaft: 30'
MAIN (WEST) TUNNEL
Trail
Pool
Too small to continue


BAT WELL CAVE
Williamson County, Texas
Compass Sketch
Joel Hunter and Bill Russell
August, 1992
Drafted by Bill Russell
Surface Gully
Entrance
Drain
Bat Section
The Bat Well
Upper Level
The Bat Well
Downstream Water Passage
Stream
Syphon
Nm
0 20 40
Estimated Feet
Surface Gully
The Bat Well
-0
Logs
Clay
Drain
Stream
Syphon
Projected Profile
Estimated Depth Below Entrance in feet
-0
-10
-20
-30
-40
Estimated Length
1080 feet
Estimated Depth
38 feet

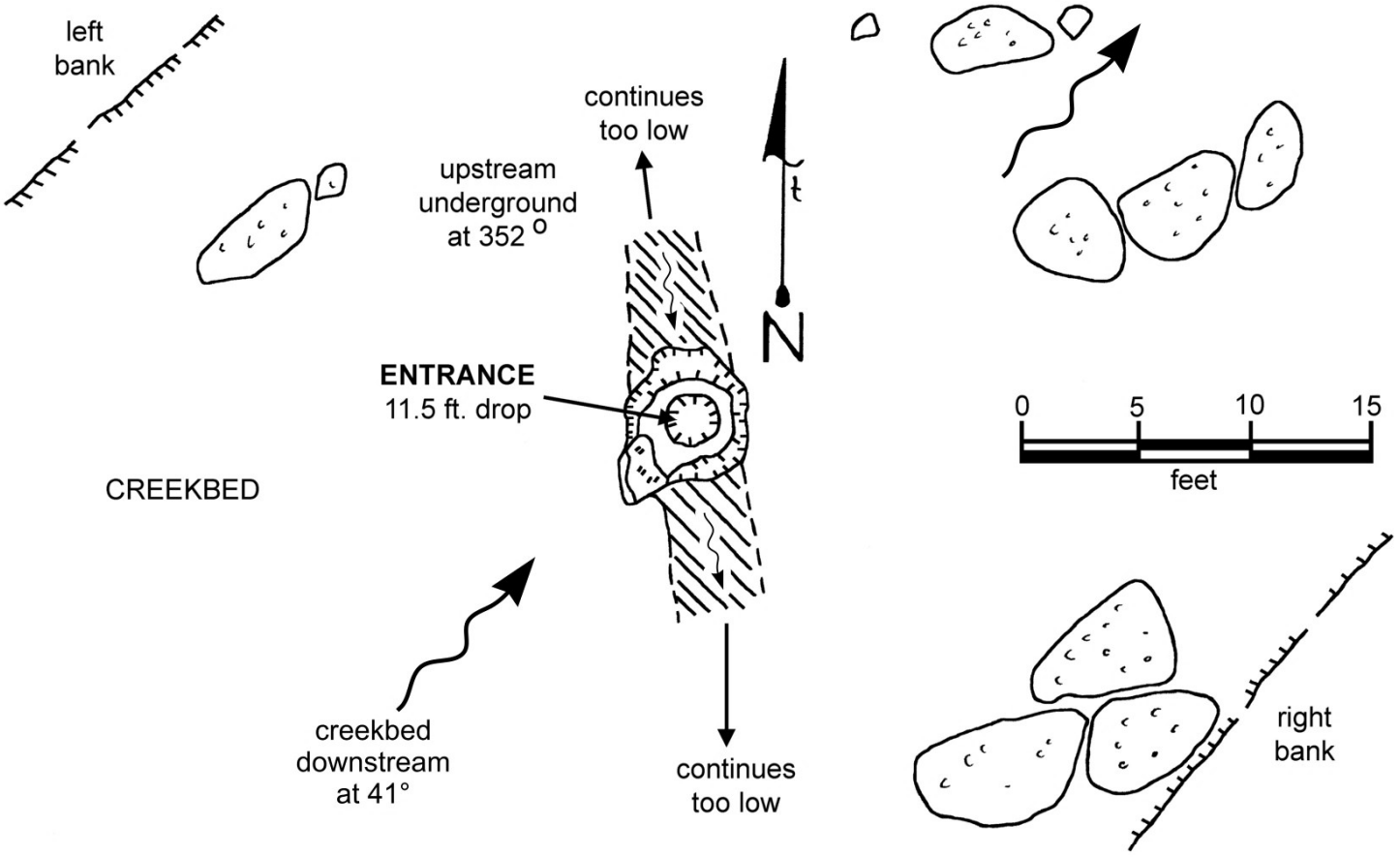
BERRY CREEK CAVE
Williamson County, Texas

Suuntos and Tape Survey: Mike Warton
6 May 1994

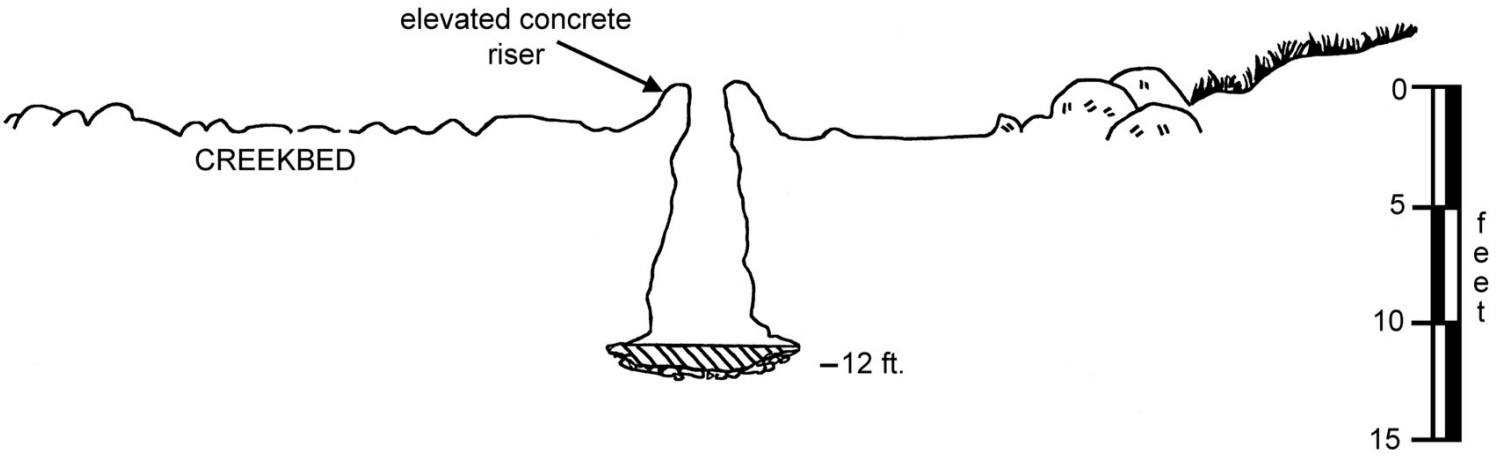
Drafted by Mike Warton

Length: 16 ft. Depth: 12 ft.

PLAN



PROFILE (looking north)



Appendix O

Cave Map of the Snowmelt Cave Preserve

SNOWMELT CAVE

WILLIAMSON COUNTY, TEXAS

SUUNTO AND TAPE SURVEY
26 FEBRUARY 2003
ANDY GLUESENKAMP, PETER SPROUSE

PAUL PRICE ASSOCIATES
DRAWN BY PETER SPROUSE

LENGTH: 40 METERS
DEPTH: 4 METERS