Balcones Canyonlands Preserve
Karst Monitoring and Management
FY 2018 Annual Report



Todd Bayless, Travis County biologist, conducting a faunal survey in McMac Cave on the Kotrla Unit

Travis County
Department of Transportation and Natural Resources
Natural Resources and Environmental Quality Division
and
City of Austin Balcones Canyonlands Preserve – Austin Water (AW)

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EXHIBIT A: KARST FAUNAL SURVEY REPORTS: 54
TRAVIS COUNTY (29 REPORTS)
CITY OF AUSTIN (61 REPORTS)
TRAVIS COUNTY/CITY OF AUSTIN (1 REPORT)

EXHIBIT B: CAVE CRICKET EXIT COUNT DATA REPORTS: 60
TRAVIS COUNTY (28 REPORTS)
CITY OF AUSTIN (57 REPORTS)

1.0 REGIONAL PERMIT

There are six species of endangered karst invertebrates (ES; Table 1) and 25 karst species of concern (SOC; Table 2) covered by the Balcones Canyonlands Conservation Plan (BCCP), a regional 10(a)1(B) permit issued by the U.S. Fish and Wildlife Service (USFWS) to the City of Austin (COA) and Travis County (TC) in May 1996 (USFWS 1996a). If these 25 species of concern become listed as endangered in the future, no additional mitigation will be necessary to protect them, provided that all karst protection requirements outlined in the BCCP are fully implemented.

The Regional Permit requires protection of 35 endangered species caves and 27 additional caves that support SOC, for a total of 62 karst features (60 caves, one mine and one karst spring). Several of these karst features occur in clusters, identified in the Regional Permit's associated Habitat Conservation Plan/Environmental Impact Statement (HCP/EIS) as the Four Points, McNeil, and Northwood cave clusters (USFWS 1996b). As of Fiscal Year 2018 (FY18), 48 of the 62 BCCP karst features have some form of formal protection on properties owned and managed by COA, TC, and BCCP partners, Texas Cave Management Association (TCMA), as well as private mitigation lands.

Table 1. Federally Listed Karst Species Covered by the BCCP
Footnotes follow table

Common Name	Scientific Name
Tooth Cave pseudoscorpion	*Tartarocreagris texana*
Tooth Cave spider	*Tayshaneta myopica*[1]
Tooth Cave ground beetle	*Rhadine persephone*
Kretschmarr Cave mold beetle	*Texamaurops reddelli*
Bee Creek Cave harvestman	*Texella reddelli*
Bone Cave harvestman	*Texella reyesi*

[1] *Tayshaneta myopica* is listed in the regional permit as *Neoleptoneta myopica*, but a 2012 study revised the genus *Neoleptoneta,* thus identifying this species in the genus *Tayshaneta* (Campbell et al. 2012).

Table 2. Karst Species of Concern Covered by the BCCP
Footnotes follow table

Common Name	Scientific Name
Flatworm	*Sphalloplana mohri*
Ostracod	*Candona* sp. nr. *stagnalis*
Isopod	*Caecidotea reddelli*
Isopod	*Trichoniscinae N. S.*
Isopod	*Miktoniscus N. S*.
Spider	*Cicurina bandida*
Spider	*Cicurina cueva*
Spider	*Cicurina ellioti*
Spider	*Cicurina reddelli*
Spider	*Cicurina reyesi*
Spider	*Cicurina travisae*
Spider	*Cicurina wartoni*
Spider	*Tayshaneta concinna*[1]
Spider	*Tayshaneta devia*[1]
Spider	*Eidmannella reclusa*
Pseudoscorpion	*Aphrastochthonius* N. S.
Pseudoscorpion	*Tartarocreagris comanche*[2]
Pseudoscorpion	*Tartarocreagris reddelli*
Pseudoscorpion	*Tartarocreagris intermedia*
Pseudoscorpion	*Tartarocreagris* N. S. 3
Harvestman	*Texella spinoperca*
Millipede	*Speodesmus* N. S
Ground Beetle	*Rhadine s. subterranea*
Ground Beetle	*Rhadine s. mitchelli*
Ground Beetle	*Rhadine austinica*

[1] *Tayshaneta concinna* and *Tayshaneta devia* are listed in the regional permit with the genus *Neoleptoneta*, but a 2012 study revised the genus *Neoleptoneta,* thus identifying these species in the genus *Tayshaneta* (Campbell et al. 2012).
[2] *Tartarocreagris comanche* is improperly listed in the regional permit as the New Comanche Trail Cave harvestman.

2.0 CAVE MANAGEMENT SUMMARY

This annual report covers the fiscal year 10/01/17- 9/30/18 (FY18). In FY18, the BCCP partners continued efforts to determine and track the status of the 62 karst features covered by the BCCP 10(a) permit. The permit holders continued efforts to acquire, protect, and monitor the karst species in the caves included in the Permit (see Tables 3 and 5 for species localities).

Of the 62 BCCP caves, a total of 48 are "protected" in some way as part of the BCP, with 14 "unprotected". The 48 "protected" BCCP caves are currently managed as follows: 22 caves protected as part of the BCP on COA land; one cave protected on The Nature Conservancy (TNC) land; 13 caves protected as part of the BCP on TC land; eight caves protected as part of private Section 10(a) or Section 7 agreements with USFWS; and four caves that have protection agreements that include development setbacks from the cave entrance. It should be noted that two of the "unprotected" caves (Lost Oasis and Whirlpool Caves) are located on Texas Cave Management Association (TCMA) land. Even though these have some protections in place, they are not formally part of the BCP. Some of these "protected" caves only have protected entrances, but are threatened by surrounding development or planned development. Ownership and protection status of each of the 62 BCCP caves is detailed in Table 7.

In addition to protecting and monitoring caves covered by the BCCP permit, COA and TC also provide protection for other karst features found on the BCP containing ES and SOC (Tables 4 and 6). Some of these additional karst features are incorporated into TC and COA's shared biological monitoring program, as described in Section 6.0. As of FY18, 11 endangered species karst features which were not listed on the BCCP permit are being protected on BCP lands (six features on TC BCP; five features on COA BCP; Table 4). Additionally, 11 SOC karst features not listed on the Permit are also being protected on BCP lands (six features on TC BCP; five features on COA BCP; Table 6).

To assist with analyzing the adequacy of the current preserve design for each karst feature, including the amount of surface and subsurface habitat needed to support these ecosystems, the COA and TC have been working together to maintain a comprehensive database for the 62 features and other features identified within the BCP since the regional permit was issued in 1996. The database also incorporates

monitoring data and management issues for each karst feature. The karst database is discussed in more detail in Section 5.0.

Table 3. Endangered Karst Invertebrate Locations within BCCP caves of Travis County, Texas

This table, originally in the BCCP 1996 documents, has been revised to show new species location information. *Key and footnotes follow table.*

Cave Name	Current Preserve Status	Karst Fauna Region	Tooth Cave Pseudoscorpion *Tartarocreagris texana*	Tooth Cave Spider *Tayshaneta myopica*	Tooth Cave Ground Beet *Rhadine persephone*	Kretschmarr C Mold Beetle *Texamaurops reddelli*	Bee Creek Ca Harvestman *Texella redde*	Bone Cave Harvestmar *Texella reye*
Amber Cave	BCP Jollyville/ TC	Jollyville Plateau	X 1996		X 2010 (Reddell)	X 1996		
Bandit Cave	Private	Rollingwood					P 1996 X 2009	
Beard Ranch Cave	BCP Ivanhoe/COA	Jollyville Plateau						X 1996
Bee Creek Cave	Private	Rollingwood					X 1996	
Broken Arrow Cave	BCP Lime Creek Preserve/COA	Cedar Park			X 1996			
Cold Cave	Private	McNeil/Round Rock						X 1996
Cotterell Cave	BCP Spicewood Springs Park/COA	Central Austin						X 1996
Disbelievers Cave	BCP Private 10(a)	Jollyville			X 1996			
Eluvial Cave	BCP Private 10(a)	Jollyville						X 1996
Fossil Cave	BCP Schroeter Park/COA	McNeil/Round Rock						X 1996
Fossil Garden Cave	Private	McNeil/Round Rock						X 1996
Gallifer Cave	BCP Jollyville/TC	Jollyville Plateau		P 1996 X 2010 (Ledford)	P 1996 X 2005	X 2009 (Chandler)		X 1996

Cave Name	Current Preserve Status	Karst Fauna Region	Tooth Cave Pseudoscorpion *Tartarocreagris texana*	Tooth Cave Spider *Tayshaneta myopica*	Tooth Cave Ground Beet *Rhadine persephone*	Kretschmarr C Mold Beetle *Texamaurops reddelli*	Bee Creek Ca Harvestman *Texella redde*	Bone Cave Harvestmar *Texella reye*
Hole-in-the-Road Cave	Private	McNeil/Round Rock						X 1996
Japygid Cave	BCP Private 10(a)	Jollyville			X 1996	P 1996 X 2005		
Jest John Cave	BCP Forest Ridge/COA	Jollyville Plateau					X 1996 Delete X 2017 (Ubick)	X 2017 (Ubick)
Jester Estates Cave	BCP Forest Ridge/COA	Jollyville Plateau	X 2008 (Cokendolpher)	X 2010 (Ledford)			X 1996	
Jollyville Plateau Cave	BCP Private 10(a)	Jollyville			X 1996			X 1996
Kretschmarr Cave	BCP Jollyville/TC	Jollyville Plateau			X 1996	X 1996		
Kretschmarr Double Pit	BCP Jollyville/TC	Jollyville Plateau	P 1996 X 2005		P 1996 X 2005	X 2016 (Reddell)		
Lamm Cave	Private Section 7	Jollyville Plateau			X 1996			
Little Bee Creek Cave	BCP Ullrich WTP/COA	Rollingwood					X 1996	
McDonald Cave	BCP Jollyville/TC	Jollyville Plateau						X 1996
McNeil Bat Cave	Private	McNeil/Round Rock		X 2010 (Ledford)				X 1996
M.W.A. Cave	BCP Private 10(a)	Jollyville	P 1996 X 2005		X 1996	P 1996 X 2005		X 1996
New Comanche Trail Cave	BCP Lake Travis/TC	Jollyville Plateau		X 1996				X 1996
No Rent Cave	Private	McNeil/Round Rock						X 1996

Cave Name	Current Preserve Status	Karst Fauna Region	Tooth Cave Pseudoscorpion *Tartarocreagris texana*	Tooth Cave Spider *Tayshaneta myopica*	Tooth Cave Ground Beet *Rhadine persephone*	Kretschmarr C Mold Beetle *Texamaurops reddelli*	Bee Creek Ca Harvestman *Texella redde*	Bone Cave Harvestmar *Texella reye*
North Root Cave	BCP Jollyville/TC	Jollyville Plateau			X 1996			X 2017 (Ubick)
Rolling Rock Cave	BCP Lime Creek Preserve/ COA,Sec.10(a)	Cedar Park			X 1996			
Root Cave	BCP Jollyville/TC	Jollyville Plateau		X 2010 (Ledford)	X 1996			X 1996
Spider Cave	BCP Park West/COA	Jollyville Plateau			X 2004 (Reddell)		X 2004 (Reddell)	
Stark's North Mine Cave	BCP Stark's/TC	Not within a KFR					X 2009 (USFWS)	
Stovepipe Cave	BCP Canyon Creek/ COA	Jollyville Plateau		X 2009 (USFWS)	X 1996	X 1996		P 1996 X 2009 (USFWS)
Tardus Hole	BCP Jollyville/TC	Jollyville Plateau			X 1996	X 2009 (Chandler)		
Tooth Cave	BCP Jollyville/TC	Jollyville Plateau	X 1996	X 1996	X 1996	X 1996		X 1996
Weldon Cave	Private	McNeil/Round Rock						X 1996

Sources: BCCP Permit 1996; Elliott 1992; Reddell 2004,2005, 2010, 2016; HNTB 2005; USFWS 1994, 2009a, 2009b, 2009c; Ledford 2010, Ubick 2017.

Key and Footnotes

X 1996 = confirmed occurrence based on collected specimen, the designation in the 1996 BCCP permit

P 1996 = probable occurrence based on observation but not confirmed with collected specimen; the designation in 1996 BCCP permit

X 2004 (Reddell) = confirmed by J. Reddell (pers. comm 2004)

X 2005 = was listed as confirmed in the HNTB summary of James Reddell's data, 2005 report for USFWS

X 2008 = Cokendolpher (pers. comm 2008) confirmed that Jester Estates Cave is a new site for *Tartarocreagris texana*,

as also reported in USFWS 2009b.
X 2009 = USFWS - according to the 2009 5 year review on *Texella reyesi* the report lists *T. reyesi* as confirmed for Stovepipe Cave (USFWS 2009a); *Texella reddelli* 5-year review confirms *T. reddelli* for Stark's North Mine (USFWS 2009c); *Neoleptoneta myopica* 5-year review confirms this species for Stovepipe Cave (USFWS 2009b).
X 2009 (Chandler) = confirmed by D. Chandler, as reported in USFWS 5-year review (2009b).
X 2010 (Ledford) = confirmed by J. Ledford (pers. comm 2010)
X 2010 (Reddell) = confirmed by J. Reddell (pers. comm 2010)
X 2016 (Reddell) = confirmed by J. Reddell (pers. comm 2016)
Delete X 2017 (Ubick) = *T. reddelli* was accidentally listed as occurring in this cave, the species is actually *T reyesi* (personal communication Ubick 2017)
X 2017 (Ubick) = confirmed by D. Ubick (pers. comm 2017)

Table 4. Non-BCCP listed Caves/Karst Features with Listed Invertebrates Protected on BCP
Key follows table

Cave Name	Current Preserve Status	Karst Fauna Region	Tooth Cave Pseudoscorpion *Tartarocreagris texana*	Tooth Cave Spider *Tayshaneta myopica*	Tooth Cave Ground Beetle *Rhadine persephone*	Kretschmarr Cave Mold Beetle *Texamaurops reddelli*	Bee Creek Cave Harvestman *Texella reddelli*	Bone Cave Harvestman *Texella reyesi*
Cortana Cave	COA	Jollyville Plateau		X 2010				X 2008
Down Dip Sink	COA	Jollyville Plateau			X 2007a			
Garden Hoe Cave	COA	Jollyville Plateau			X 2007b			
Geode Cave	TC	Jollyville Plateau		X 2008	X 2008			X 2008
LU-11	TC	Jollyville Plateau		X 2008				
LU-12	TC	Jollyville Plateau						X 2008
Little Black Hole	COA	Rollingwood					X 2009c	
Pond Party Pit	COA	Jollyville Plateau			X 2016			X 2010
RI-1	TC	Jollyville Plateau					X 2010	
Tight Pit Cave	TC	Jollyville Plateau		X 2010				
Two Trunks Cave	TC	Jollyville Plateau			X 2008 (USFWS)			

Sources: Reddell 2016; USFWS 2008, 2009c; Zara Environmental 2007a, 2007b, 2008, and 2010.
Key: X = confirmed occurrence based on collected specimen.

Table 5. Karst Invertebrate SOC within BCCP Caves, Travis County, Texas[1,2]

Key and footnotes follow table

Cave Name	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. stagnalis*	*Cicurina bandida*[3]	*Cicurina travisae*[4]	*Cicurina sp.*[5]	*Eidmannella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. subterranea*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
Adobe Springs Cave																				
Airmen's Cave				X							X						X		X	
Amber Cave					X								X							
Armadillo Ranch Sink		X																		
Arrow Cave				X							X									
Bandit Cave				X							X									X
Beard Ranch Cave					X															
Bee Creek Cave				X							X									
Blowing Sink Cave				X							X									
Broken Arrow Cave																				
Buda Boulder Spring		X																		
Cave X		X	X	X				X			X			X						
Cave Y				X							X									
Ceiling Slot Cave						X														
Cold Cave						X						X								

Cave Name	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. stagnalis*	*Cicurina bandida* [3]	*Cicurina travisae* [4]	*Cicurina sp.* [5]	*Eidmannella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. subterranea*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
Cotterell Cave					X							X								
Disbelievers Cave						X														
District Park Cave				X							X									
Eluvial Cave																				
Flint Ridge Cave				X							X									
Fossil Cave												X								
Fossil Garden Cave						X						X								
Gallifer Cave					X															
Get Down Cave				X							X									
Goat Cave				X										X						
Hole-in-the-Road Cave						X														
Ireland's Cave				X							X									
Jack's Joint		X				X														
Japygid Cave																				
Jest John Cave					X															
Jester Estates Cave					X							X								

Cave Name	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. stagnalis*	*Cicurina bandida* [3]	*Cicurina travisae* [4]	*Cicurina sp.* [5]	*Eidmannella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. subterranea*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
Jollyville Plateau Cave																				
Kretschmarr Cave					X								X							
Kretschmarr Double Pit					X															
Lamm Cave																				
Little Bee Creek Cave				X							X									
Lost Gold Cave				X					X		X									
Lost Oasis Cave				X							X									
M.W.A. Cave																		X		
Maple Run Cave				X							X									
McDonald Cave					X					X										
McNeil Bat Cave												X								
Midnight Cave				X							X									
Moss Pit																				
New Comanche Trail Cave						X	X									X				

Cave Name	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. stagnalis*	*Cicurina bandida* [3]	*Cicurina travisae* [4]	*Cicurina sp.* [5]	*Eidmannella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. subterranea*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
No Rent Cave												X								
North Root Cave					X															
Pennie's Cave											X			X						
Pickle Pit					X															
Pipeline Cave														X						
Rolling Rock Cave						X								X						
Root Cave					X															
Slaughter Creek Cave				X																
Spanish Wells Cave		X													X					
Spider Cave					X		X													
Stark's North Mine									X											
Stovepipe Cave	X				X		X			X										
Talus Springs Cave																				
Tardus Hole																				
Tooth Cave					X		X						X							
Weldon Cave	X											X								

Cave Name	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. stagnalis*	*Cicurina bandida* [3]	*Cicurina travisae* [4]	*Cicurina sp.* [5]	*Eidmannella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. subterranea*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
Whirlpool Cave				X							X									

Sources: Elliot 1997, Paquin and Hedin 2005, Paquin et al. 2008, TMM 2007, Zara Environmental 2008, 2010, Ledford et al. 2012, Hedin 2015, Reddell 2016.

Key and Footnotes

X = confirmed location based on collected specimen.

[1] *Cicurina ellioti* listed as an SOC in the regional permit is not included in this table because this species has now been synonymized with *Cicurina buwata*, a non-SOC (Cokendolpher 2004).

[2] *Tartarocreagris reddelli* listed as a SOC in the regional permit is not included in this table because this species has now been synonymized with *Tartarocreagris infernalis*, a non-SOC (Muchmore 2001).

[3] Occurrences of *Cicurina bandida* include localities formerly listed as *Cicurina cueva* and *Cicurina reyesi*, which have been formally grouped together into the single species *C. bandida* (Paquin et al. 2008).

[4] Occurrences of *Cicurina travisae* include localities formerly listed as *Cicurina reddelli* and *Cicurina wartoni*, which have been formally grouped together into the single species *C. travisae* (Hedin 2015).

Localities of possible SOCs; blind *Cicurina* specimens not yet confirmed to species level.

Table 6. Non-BCCP Caves/Karst Features with Karst SOC Protected on BCP[1,2]

Key and footnotes follow table

Cave Name	BCP Owner	*Aphrastochithonius N.S.*	*Caecidotea reddelli*	*Candona sp. nr. stagnalis*	*Cicurina bandida* [3]	*Cicurina travisae* [4]	*Cicurina sp.* [5]	*Eidmannella reclusa*	*Miktoniscus N.S.*	*Tayshaneta concinna*	*Tayshaneta devia*	*Rhadine austinica*	*Rhadine s. subterranea*	*Rhadine s. mitchelli*	*Speodesmus N.S.*	*Sphalloplana mohri*	*Tartarocreagris comanche*	*Tartarocreagris intermedia*	*Tartarocreagris N.S. 3*	*Texella spinoperca*	*Trichoniscinae N.S.*
Brewpot Cave	TC										X										
Cortana Cave	COA						X														
Down Dip Cave	COA						X														
Geode Cave	TC					X		X													
IV-3	COA					X															
LU-29	TC						X														
Pond Party Pit	COA					X							X								
RI-1	TC						X														
RI-3	TC						X														
Siebert Sink	COA				X					X										X	
Two Trunks Cave	TC					X															

Sources: Bayless pers. comm 2013, Paquin and Hedin 2005, Sanders pers. comm 2013, TMM 2007, Zara Environmental 2008, 2010, Hedin 2015, Reddell 2016.

Key and Footnotes

X = confirmed location based on collected specimen.

[1] *Cicurina ellioti* listed as an SOC in the regional permit is not included in this table because this species has now been synonymized with Cicurina buwata, a non-SOC (Cokendolpher 2004).

[2] *Tartarocreagris reddelli* listed as a SOC in the regional permit is not included in this table because this species has now been synonymized with *Tartarocreagris infernalis*, a non-SOC (Muchmore 2001).

[3] Occurrences of *Cicurina bandida* include localities formerly listed as *Cicurina cueva* and *Cicurina reyesi*, which have been formally grouped together into the single species *C. bandida* (Paquin et al. 2008).

[4] Occurrences of *Cicurina travisae* include localities formerly listed as *Cicurina reddelli* and *Cicurina wartoni*, which have been formally grouped together into the single species *C. travisae* (Hedin 2015).

[5]Localities of possible SOCs; blind *Cicurina* specimens not yet confirmed to species level.

3.0 OWNERSHIP AND PROTECTION STATUS

Many karst features listed in the BCCP permit have adequate protection, based on the criteria outlined in USFWS's *Karst Preserve Design Recommendations* (USFWS 2012). However, some caves listed in Table 3 as "protected" under individual USFWS Section 10(a) or Section 7 permits may not be adequately protected as defined in USFWS (2012). Efforts are being made by the BCCP Permit Holders to contact owners of privately owned caves to assess their protection efforts and to assist them with protection where possible.

Though not specifically required in the BCCP permit, the updated USFWS karst preserve design recommendations direct that the protected area surrounding the cave should be at least 16–40 ha (40-99 acres) in size to capture the majority of plant and animal community elements needed to support the karst ecosystem, as well as protect the cave footprint and surface/subsurface drainage basins of the cave (USFWS 2014a). Some caves within the BCP meet or exceed these recommendations, while others do not due to conditions that existed before the Permit was issued, such as pre-existing development in the form of subdivisions, roads, power lines, petroleum lines, and sewer lines that preclude complete protection of the recommended preserve areas. BCCP Permit Holders will continue to do what is reasonable to protect these features from pre-existing development and continue efforts to acquire and protect the karst features listed in the BCCP permit.

Per BCCP Permit Conditions S2 and T2, if new karst features "are discovered with a significant diversity of troglobitic fauna, those karst features may be submitted to the Service for consideration for exchange with karst features identified for protection by the BCCP" (USFWS 1996a). In order to allow the Permit holders to implement these Permit conditions, COA and TC created a Cave Substitution Policy that provides a process that allows caves listed in the BCCP permit to be substituted with other suitable caves in a manner that is transparent, science based, and consistent with the vision and intent established for BCCP. This policy includes a definition of "significant diversity of troglobitic fauna" as it applies to eligibility of a cave for substitution, and determines parameters that quantify preservation of environmental integrity for BCCP-listed caves and candidate substitution caves as it applies to management of caves. These defined criteria will be used in determining both the need to substitute a feature listed on the Permit as well as whether the substitution

cave will adequately replace the previously identified BCCP cave or caves. The BCCP Cave Substitution Policy was adopted by the BCCP Coordinating Committee in August 2015.

Table 7. FY18 Ownership, protection, monitoring and access status of the 62 BCCP caves/karst features (35 caves with ES and 26 caves with SOC) [1, 2].

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Adobe Springs Cave	SOC	BCP/TNC		Protected on preserve	TC bi-annual surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring	none
Airmen's Cave	SOC	BCP/COA	Gated	Protected on parkland	COA weekly surface monitoring (volunteers check on ga bi-annual cave cricket exit counts; bi-annual species monitoring	access by perm
Amber Cave	ES	BCP/TC	Gated and fenced	Protected on preserve (very close to road and sewer line)	TC quarterly surface monitoring; red-imported fire ant (RIFA) survey/ control	none
Armadillo Ranch Sink	SOC	Private		Private - Unknown		none
Arrow Cave	SOC	BCP/COA	Gated	Protected in parkland (There are near homes immediately south of the cave entrance)	COA quarterly surface monitoring; annual species monitoring	none
Bandit Cave	ES	Private	Gated	Protected by private ecologically concerned landowner		none
Beard Ranch Cave	ES	BCP/COA		Protected on preserve	COA quarterly surface monitoring; annual faunal survey	none
Bee Creek Cave	ES	Private		Private- Unknown		none
Blowing Sink Cave	SOC	BCP/COA	Gated	Protected on preserve (200 acre preserve, but subsurface catchment extends more than a mile west).	COA semi-monthly surface and annual species monitoring; periodic RIFA control	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Broken Arrow Cave	ES	BCP/COA	Fenced	Protected on preserve	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; periodic RIFA control	none
Buda Boulder Spring	SOC	BCP/COA		Protected in parkland (close proximity a hike and bike trail)	COA bi-annual surface monitoring; annual species monitoring. Peter Sprouse (Zara Environmental made active collections via modifie bottle trap.	none
Cave X	SOC	Private/COA Protection Agreement	Gated and fenced	Protected by landowner with 4.5 acre setback to protect cave footprint. Protected to some extent (not actively managed and the setback is inadequa Owner recently rejected COA offer to assist in cave management and monitoring.	Occasional species and surface monitoring by COA and SWCA. SWCA completed cave cricket exit counts in October 2015 and one pa cave faunal survey in February 201 as part of an agreement to allow fo on site construction of a berm to reduce flooding concerns.	none
Cave Y[1]	SOC	BCP/COA	Gated	Protected in parkland	COA quarterly surface bi-annual species monitoring; bi-annual cave cricket exit counts; periodic RIFA control	none
Ceiling Slot Cave	SOC	Private		Private - Unknown		none
Cold Cave	ES	Private	Gated	Private - Unknown	TC bi-annual surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Cotterell Cave	ES	BCP/COA	Gated and fenced	Protected in parkland. (There are nea homes immediately east of the cave entrance)	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; periodic RIFA control	none
Disbelievers Cave	ES	BCP/Private Section 10(a)		Protected by 10a permit, hired Platea Land & Wildlife Management		none
District Park Cave	SOC	BCP/COA	Gated	Protected in parkland	COA quarterly surface monitoring; quarterly cave cricket exit counts; quarterly species monitoring; periodic RIFA control	1st room open, past 1st room protected by ga access by permit*
Eluvial Cave	ES	BCP/Private Section 10(a)		Protected by 10a permit, hired Platea Land & Wildlife Management		none
Flint Ridge Cave	SOC	BCP/COA	Gated	Protected on Water Quality Protectior Land (portions of the cave and its catchment area will be overlain by the newly constructed SH45 SW).	COA quarterly surface monitoring; quarterly cave cricket exit counts; quarterly species monitoring; periodic RIFA control	none
Fossil Cave	ES	BCP/COA	Access protected by large rocks	Protected in parkland	Exact location of cave is unknown. COA quarterly surface monitoring o feature suspected to be Fossil Cave	none
Fossil Garden Cave	ES	Private		Private - Unknown		none
Gallifer Cave	ES	BCP/TC	Gated and fenced	Protected on preserve	TC quarterly surface monitoring; bi-annual cave cricket exit counts; RIFA survey/control; bi-annual species monitoring	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Get Down Cave	SOC	BCP/COA	Gated and fenced	Protected on COA BCP preserve since July 2018	COA monthly surface monitoring; quarterly cave cricket exit counts; quarterly species monitoring; periodic RIFA control	none
Goat Cave	SOC	BCP/COA	Fenced	Protected on preserve	COA monthly surface monitoring; annual species monitoring; periodic RIFA control	access by perm
Hole-in-the-Road	ES	Private		Private –Unknown. (very close to a major roadway)		none
Ireland's Cave	SOC	BCP/ TC	Gated	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
Jack's Joint	SOC	Private		Private - Unknown		none
Japygid Cave	ES	BCP/Private Section 10(a)		Protected by 10a permit, hired Platea Land & Wildlife Management		none
Jest John Cave	ES	BCP/COA		Protected on preserve	COA cave cricket exit count; bi-annual surface monitoring	none
Jester Estates Cave	ES	BCP/COA	Gated and fenced	Protected on preserve (3.2 acre pres surrounded by homes).	COA monthly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; periodic RIFA control	none
Jollyville Plateau Cave	ES	BCP/Private Section 10(a)		Protected by 10a permit, hired Platea Land & Wildlife Management		none
Kretschmarr Cave	ES	BCP/TC	Gated and fenced	Protected on preserve. Close to roadway and in power line ROW.	TC quarterly surface monitoring; RIFA survey/control;	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
					bi-annual cave cricket exit counts; bi-annual species monitoring	
Kretschmarr Double Pit	ES	BCP/TC	Fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
Lamm Cave	ES	BCP/Private Section 7	Gated and fenced	COA negotiated setback (approximat 150')	Occasional surface and species monitoring by COA and TC	none
Little Bee Creek Cave	ES	BCP/COA	Gated	Protected on preserve	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring	none
Lost Gold Cave	SOC	Private	Gated	Private – COA WPD has negotiated a small setback from future developme		none
Lost Oasis Cave	SOC	Private/ TCMA	Gated and fenced	Protected by TCMA	COA quarterly cave cricket exit counts; quarterly species monitorin periodic RIFA control	controlled access**acces
M.W.A. Cave	ES	BCP/Private Section 10(a)		Protected by 10a permit, hired Platea Land & Wildlife Management		
Maple Run Cave	SOC	BCP/COA	Gated	Protected on preserve	COA monthly surface monitoring bi-annual cave cricket exit counts; bi-annual species monitoring; periodic RIFA control	access by perm
McDonald Cave	ES	BCP /TC	Fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
McNeil Bat Cave	ES	Private		Private – Unknown (close proximity to high school)		none
Midnight Cave	SOC	BCP/COA	Fenced	Protected on parkland (close proximit to soccer fields)	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; periodic RIFA control	access by perm
Moss Pit	SOC	Private		Private - Unknown		none
New Comanche Trail Cave	ES	BCP/TC	Fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
No Rent Cave	ES	Private		Private - Unknown	TC bi-annual surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring	none
North Root Cave	ES	BCP/TC		Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
Pennie's Cave	SOC	Private		Landowner had filled entrance. COA WPD negotiated with Zara Environmental to excavate the entran add a cave gate, and placing a 300 ft. buffer around the cave. Management report attached in APPENDIX – S2.	Zara Environmental species monitoring; Zara Environmental RIFA surveys/ control	none
Pickle Pit	SOC	BCP/Private Sec. 7	Gated	Protected by Section 7 permit.	TC/COA occasional species monitoring; Monthly surface inspections by concerned neighbor	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Pipeline Cave	SOC	Private	Gated	Private – nearby petroleum pipeline exists.	COA quarterly surface monitoring; quarterly cave cricket exit counts; quarterly species monitoring; periodic RIFA control	none
Rolling Rock Cave	ES	BCP/COA	Fenced	Protected on preserve	COA quarterly surface and annual species monitoring; periodic RIFA control	none
Root Cave	ES	BCP/TC		Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
Slaughter Creek Cave	SOC	BCP/COA	Gated	Protected on parkland (Nearby homes are immediately south of cave entran	COA quarterly surface and annual species monitoring; COA periodic RIFA control.	none
Spanish Wells Cave	SOC	BCP/TC		Protected on preserve	TC quarterly surface monitoring; bi-annual cave cricket exit counts; RIFA survey/control; bi-annual species monitoring	none
Spider Cave	ES	BCP/COA	Fenced	Protected on preserve	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring; periodic RIFA control	none
Stark's North Mine[2]	ES	BCP/TC	Gated	Protected on preserve	TC quarterly surface monitoring; bi-annual cave cricket exit counts; RIFA survey/control; bi-annual species monitoring	none

Cave Name	ES or SOC	BCP or Private/ Current Owner	Gated/ Fenced	Protection Area Status /Adequate Preserve size	Species Monitoring Status	Public Access
Stovepipe Cave	ES	BCP/ COA	Fenced	Protected on preserve	COA quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring periodic RIFA control	none
Talus Springs Cave[3]	N/A	BCP/Private Section 10(a)	Gated	Protected by Homeowners Associatio and TC, only has 50' setback from houses and is probably affected by uphill development.	TC bi-annual surface monitoring; RIFA survey/control; annual species monitoring	none
Tardus Hole	ES	BCP/TC	Fenced	Protected on preserve	TC quarterly surface monitoring; RIFA survey/control; annual species monitoring	none
Tooth Cave	ES	BCP/TC	Gated and Fenced	Protected on preserve	TC quarterly surface monitoring; bi-annual cave cricket exit counts; RIFA survey/control; bi-annual species monitoring	none
Weldon Cave	ES	Private		Private - Unknown	TC quarterly surface monitoring; bi-annual cave cricket exit counts; bi-annual species monitoring	none
Whirlpool Cave	SOC	Private/ TCMA	Gated	Protected by TCMA	TCMA routine surface monitoring; COA/TC bi-annual species monitori and cave cricket exit counts to asse tawny crazy ant impacts	controlled acce

[1]Cave Y was considered an ES cave *(Texella reddelli*) in the 1996 BCCP Permit, but has since been determined not to contain *Texella reddelli* (Reddell 2004).

[2]Stark's North Mine was listed as a SOC cave in the 1996 BCCP Permit, but has since been determined to contain *Texella reddelli* (USFWS 2009c).

[3] Talus Springs Cave has never been known to contain ES or SOC. This cave was placed on the BCCP permit because it contained the amphipod *Stygobromus birfurcatus*, originally considered as a SOC candidate; however, *S. birfurcatus* was not included in the Permit's final list of 25 SOC karst species to be protected.

* Access by Permit - Permit may be issued by COA – Austin Water Utility or Austin Parks and Recreation Department (PARD) staff.
** Controlled Access - Private cave owners control the access.

4.0 ACCESS STATUS AND KARST EDUCATION/RESTORATION ACTIVITIES

Public education on caves and cave ecosystems is recognized as vital for karst species preservation in the BCP Karst Land Management Plan (2016). Currently, most opportunities for children to enter caves and learn about cave ecosystems is through programs provided by COA Watershed Protection Department (WPD), the Balcones Canyonlands Preserve Program of Austin Water (BCP), and Austin Nature and Science Center (ANSC) summer camps. Adult wild cave tours in the Austin area are not widely available, although many tours are conducted through TCMA and University of Texas Grotto. Overall, there is more demand for cave education than can be met with existing programs.

One factor limiting cave education is a deficit of caves suitable for immersion, particularly considering the high demand and its effectiveness as both a teaching tool and management practice to support stewardship for cave ecosystems. Cave education/recreation primarily occurs in 10% of the BCCP caves, which have been used for this purpose prior to the 1996 permit. Whirlpool Cave (owned and managed by TCMA) has the highest traffic of all the BCCP caves, totaling 1,614 person trips in FY18. Although studies on human impacts to cave ecosystems are limited, it is assumed that high human traffic in a cave will negatively impact the cave fauna.

In response to the potential negative impacts to BCCP caves, BCP staff continues to meet with local educators (COA PARD, COA WPD Education, TCMA, and Barton Springs/ Edwards Aquifer Conservation District staff) to review existing cave access/public education issues. The primary focus of these meetings is to review existing policy to see if current access is having a detrimental impact to BCCP caves, and if so, to try to determine ways to mitigate this damage. To address the overuse issue, COA BCP staff is continuing to look for new caves and enhance existing caves that could be used in lieu of BCCP caves. Also, TCMA has initiated a policy of charging for access, which may reduce total access numbers to Whirlpool Cave.

Wildflower and LaCrosse Caves are relatively small non-BCCP caves on the Lady Bird Johnson Wildflower Center that received 473 and 751 visitors respectively in FY18. Wildflower Cave has been used for education by COA Earth Camp since 1997 after it was restored by cleaning out trash fill. Wildflower Cave is unsuitable for many cave tours due to its currently limited extent and small size, but is heavily

utilized in 5th grade Earth Camp cave education (see Cave Education Summary below).

Restoring Non-BCCP Caves for Education

By developing non-BCCP caves as a safe and accessible option for adequately trained and responsible groups for guided education/recreation tours, we can promote education while reducing BCCP cave impacts. Restoration of filled non-BCCP caves for educational purposes is expected to reduce traffic/impact to other publically accessed BCCP listed caves; namely District Park, Goat, Maple Run, and Whirlpool Caves. Caves are a heritage for the Austin area and provide resources for public education and opportunities to connect with local communities. Of the 989 participants that COA WPD education programs took caving during 2017-2018 school year, 635 of the participants toured non-BCCP caves and only 354 of the participants toured BCCP permit caves.

Listed below are the various media events, awards, and recognitions that highlighted the benefits of cave ecosystems and restoration in FY18.

- January 26, 2018 – WPD educators and BCP staff were presented with an award for restoration efforts by the Barton Springs/Edwards Aquifer Conservation District.
- February 10, 2018 – Spectrum News covered the events put on for the Cave Day Festival. http://www.spectrumlocalnews.com/tx/austin/news/2018/02/11/families-seek-adventure-at-austin-cave-festival
- April 11, 2018 – Mayor Steve Addler proclaimed this to be cave education and restoration day. A celebration was organized by WPD educators at LaCrosse Cave located at the Lady Bird Johnson Wildflower Center to mark this occasion.
- May 16, 2018 – BCP staff made a presentation to the City of Austin Environmental Commission on cave restoration.
- July 2, 2018 – Rebecca Trejo from KVUE reported on BCP cave restoration. https://www.kvue.com/article/news/local/cave-clean-out-a-look-inside-austins-hidden-caverns/269-569333830

FY18 Cave Education Summary

COA Education Programs:

COA WPD conducts cave education through the following programs: Austin Cave Festival, Earth Camp and Earth School (fifth grade water quality programs), Watershed Detectives (middle school), Hydrofiles (high school), Clean Creek Camp (a summer parent/child water quality program), providing cave tours for Nature Nights and Camp Wildflower at the Lady Bird Johnson Wildflower Center (all ages), and adult education such as the Groundwater to the Gulf: Summer Institute (professional development for teachers). The 2017-2018 school year updates are detailed below and summarized in Table 8.

Austin Cave Festival is a free, family event that features hands-on activities, including educational cave tours. Visitors have the opportunity to explore a cave, see how water makes its way to the aquifer and Barton Springs, and learn how to protect cave habitat and water resources. Austin Cave Festival is co-hosted by the Lady Bird Johnson Wildflower Center, the Barton Springs Edwards Aquifer Conservation District, the City of Austin (Austin Parks and Recreation Department, Austin Water Wildland Conservation Division, and WPD), and the caving community. On February 10, 2018, staff from Austin Wildland Conservation Division and WPD worked together to take 320 participants in LaCrosse or Wildflower Caves. Additional participants went through CaveSim (a realistic artificial cave), explored a children's art cave, hiked to a sinkhole, experienced virtual caves, and participated in hands-on activities related to cave education. www.bseacd.org/education/austin-cave-festival/

Earth Camp is available to Title I (low socio-economic) schools in Austin Independent School District (AISD). Students spend one school day at camp immersed in Wildflower Cave looking for clues that water travels through the cave into the Edwards Aquifer, which includes the discovery of cave biota. Students also investigate a sinkhole and flow through karstic rock, as well as visiting Barton Springs and the Splash! Exhibit to learn of the connection of the recharge zone to the discharge area. During the 2017-2018 school year, Earth Camp guided 1,764 fifth-grade students into Wildflower Cave. An additional 4,773 fifth graders in AISD, Eanes ISD, and Del Valle ISD received Earth School, a hands-on classroom presentation using an Aquifer Model (Table 8). The Lady Bird Johnson Wildflower Center is partnered with Earth Camp. www.austintexas.gov/EarthCamp and www.austintexas.gov/earthschool

Watershed Detectives and **Hydrofiles** reach middle and high school classes with hands-on inquiry-based investigations of Austin's water resources. Field studies

involve monitoring local creeks and caving into the Edwards Aquifer. Students learn about hydrogeology and cave biology through "Austin Underground" videos and cave tours led by COA WPD staff. During the 2017-2018 school year, 419 middle school students were given educational caving tours (27 in Grassy Cove Cave, 89 in LaCrosse Cave, 85 in Lost Oasis Cave, 74 in Whirlpool Cave, and 144 in Wildflower Cave). Additionally, 259 high school students were given educational caving tours (44 in Grassy Cove Cave, 18 in LaCrosse Cave, 180 in Whirlpool Cave, and 17 in Wildflower Cave). www.austintexas.gov/ watersheddetectives and www.austintexas.gov/hydrofiles

In summer 2018, families and the general public were given opportunities to receive educational caving tours through **Clean Creek Camp, Nature Nights,** and **Camp Wildflower** at the Lady Bird Johnson Wildflower Center. Clean Creek Camp is a partnership between COA WPD and Keep Austin Beautiful. Activities focus on watersheds, the Edwards Aquifer and citizen actions that improve water quality. Clean Creek Camp is offered in summer to parents and their children ages 9-14. Clean Creek Camp brought 66 participants into both LaCrosse and Wildflower Cave. On June 28, 2018, the COA WPD and COA Wildland Conservation Division worked together to provide educational tours of LaCrosse Cave and Wildflower Cave to 377 participants during one of the Lady Bird Johnson Wildflower Center's Nature Nights event. WPD staff also took 30 participants in the Lady Bird Johnson Wildflower Center's Camp Wildflower caving in LaCrosse Cave and Wildflower Cave. www.austintexas.gov/department/clean-creek-camp, www.wildflower.org/nature-nights, and www.wildflower.org/event/camp-nature-trackers/2018-07-19.

Groundwater to the Gulf Summer Institute: Groundwater to the Gulf is a collaboration of over a dozen local agencies to offer a three-day, field trip-based institute for Central Texas teachers that emphasizes techniques for teaching water-based curricula to students. COA WPD educators and staff from the Barton Springs Edwards Aquifer Conservation District take teachers inside LaCrosse Cave and Wildflower Cave. In this program, the teachers also go to Barton Springs to gain background knowledge to teach about the Edwards Aquifer in their classrooms. In FY18, 29 teachers participated in the Institute.

Table 8. Summary of school year 2017-2018 COA WPD education programs providing cave field trips and aquifer outreach.

Program	Grade	Total reached
Earth Camp	5th	1,764

Earth School* (*presentation does not include cave immersion)	5th	4,773*
Watershed Detectives	6th-8th	419
Hydrofiles	9th-12th	259
Austin Cave Festival	N/A	320
Clean Creek Camp	Adults and 4th-8th	66
Nature Nights	N/A	377
Wildflower Camp	Pre-K	30
Groundwater to the Gulf	Teachers	29

Austin Water Balcones Canyonlands Preserve Program

Many caves have experienced filling either through the deposition of sediment or anthropogenic debris. Wade Cave is an example of one of these that was located on a goat ranch prior to Maple Run subdivision development in the early 1980's. The trash-filled sink was incorporated into Goat Cave Karst Preserve that was established by the City of Austin as its first cave preserve. During FY17-FY18, Rich Zarria on behalf of COA BCP completed a portion of the restoration of Wade Cave, work included sediment removal in the entrance sinkhole, installation of stacked rock steps and surface handrails to facilitate its use for public education. In FY16, Volunteers associated with UT Grotto excavated a sediment filled passage in the lower second level of the cave, extending the cave an additional 50 feet to a second shaft pit. COA BCP staff appreciates the opportunity to access Goat Cave Karst Preserve and make improvements to the extent allowed by PARD Natural Resources Division Austin Nature Preserves System.

McNeil High School is located within the BCCP permit's McNeil cave cluster and its courtyard contains two endangered species caves: Millipede and Millipede Annex. In FY18, progress with restoration plans continued with revegetation work to enhance the underlying cave ecosystem. McNeil HS science teacher Tina Vick initiated the project with assistance from Mark Sanders of COA BCP, Jean Krejca of Zara Environmental, Cyndee Watson of USFWS, and landscape architect, Vivian Loftin of the COA WPD cave team. Informal presentations on karst biology and geology were provided by Mark Sanders and Colin Strickland to the McNeil High School Green Club and AP Environmental Science classes as the students were introduced to the courtyard caves.

In FY18, COA BCP led cave tours for the Sierra Club, Save Barton Creek

Association, Texas A&M Galveston Biospeology class, Explore Austin, Master Naturalists, Wildlands volunteer appreciation, Austin Community College/Jarrell High School, and McNeil High School, for about 350 individuals. COA BCP provided presentations on cave ecosystems for Clayton Elementary School (2/22/18), Austin Cave Day (2/10/18), COA cave guides (1/6/18 and 2/7/18), Master Naturalists classes (1/31/18 and 1/25/18), and Barton Springs University (9/25/18).

Austin Parks and Recreation

The Splash! Exhibit in Zilker Park includes a simulated cave and indoor displays, movies, and activities regarding the Edwards Aquifer.
http://www.austintexas.gov/department/austin-nature-science-center

Texas Cave Management Association Cave Education

In FY18, Whirlpool Cave was managed by Rich Zarria while Lost Oasis Cave was managed by Drew Thompson, both volunteers for TCMA. Whirlpool Cave supports the BCP as the most suitable cave currently available for lengthy recreation/education trips. Access numbers continued to be high this year to both TCMA-owned caves, with 1,632 individuals accessing Whirlpool Cave and 150 individuals accessing Lost Oasis Cave.

FY18 Access Status

In FY18, access was granted to COA-owned BCCP Caves, TCMA-owned BCCP caves and other non-BCCP caves for educational/recreational/rescue training. The increased number of non-BCCP caves available has reduced traffic to BCCP caves. In FY18, 465 visitors were issued access permits by COA BCP staff to COA-owned BCCP caves including: Airmen's Cave (104), District Park (26), Goat Cave (183), Maple Run Cave (120), and Midnight Cave (32). 1,782 visitors were granted access to TCMA-owned BCCP caves including: Lost Oasis (150), and Whirlpool (1,632). 1,963 visitors were granted access to non-BCCP caves including: Avery Ranch Cave (62), Grassy Cove Cave (290), Hideout Cave (212), LaCrosse Cave (778), Wildflower Cave (505), and Wade Cave (116) (Table 9). Cave tours were supervised by trained staff from WPD, the Austin Nature and Science Center, COA PARD Rangers, BCP, and the UT Grotto. See Table 3 for access and gating status of all of the BCCP caves.

Table 9. Summary of FY18 educational and recreational cave trips into Non-BCCP Caves compared to BCCP Caves.

Status	Cave	Visitors	Total Visitors
Non-BCCP Caves	Avery Ranch	62	1,963
	Grassy Cove	290	
	Hideout	212	
	LaCrosse	778	
	Wildflower	505	
	Wade	116	
BCCP Caves	Airmen's	104	2,247
	District Park	26	
	Goat	183	
	Lost Oasis	150	
	Maple Run	120	
	Midnight	32	
	Whirlpool	1,632	
Non-BCCP and BCCP Caves Combined			4,210

BCCP Cave Preserve Restoration

There has been a considerable amount of sediment disturbance over the last 200 years. Once disturbed, sediment can find its way to caves and karst features, partially filling them. Two examples of this process are Halls Cave in Kerr County (Toomey et al. 1993) and Friesenhahn Cave in Bexar County (Hall and Valastro 1995), which was partially filled during a period of high natural erosion associated with strong rainfall of post glacial late Pleistocene and middle Holocene, between 5,000 to 14,000 years ago. Other events are attributed to the introduction of livestock and ranching practices, removal of juniper/oak woodlands, and intentional obscuring of caves to reduce trespassing and increase the marketability for development and urbanization. Caves across the United States were commonly filled by ranchers to eliminate livestock hazards and dispose of trash. While most BCCP caves were historically opened by volunteer cave explorers, there have been few funded efforts since the initiation of the 1996 permit in Travis County for the purposes of restoring filled caves. Major cleanup projects such as the six year (1994-1999) removal of trash from Midnight Cave, although sponsored by COA staff, were only achieved through the use of volunteers. Even recognizing filled-in caves has been a challenge for geologists conducting site assessments and the subject of numerous field trips. Without recognition and necessary excavation, few of the BCCP caves would likely be preserved today. It is still common practice at COA

BCP to try and date the fill material that is excavated in order to ascertain factors associated with historic cave filling.

In FY18, COA BCP initiated searches for new caves, both to supplement and replace impacted BCP permit caves, and as potential future public education caves. Crews conducted searches for potential karst features within the Circle C Ranch at Slaughter Creek Park, between Mopac and Escarpment Lane. They encountered 118 potential karst features that were evaluated and mapped. Once identified, future efforts can potentially focus on the most likely for cave restoration.

COA BCP continues to fund a team of cave specialists to excavate caves of trash, ranch fill, and eroded sediment. Education cave development was funded by COA AW's Wildland Conservation Division. The team consisted of a group of highly trained cave specialists, including Justin Shaw, Charley Savvas, John Clark, Rich Zarria, Patti Calibrese, Eric Flint, Mason Lewis, Kara Posso, Galen Falgout, Dylan Beeler, Drew Thompson, and Colin Strickland.

Blowing Sink Research Management Unit restoration

The Blowing Sink Research Management Unit contains Blowing Sink Cave, one of the longest and deepest of the BCCP caves as well as five other sinkholes/caves that recharge rainwater runoff. Historical ranching practices and lack of proper maintenance led to impairment of the sinkholes, causing them to plug with sediment. The primary managing department of this unit is PARD Natural Resources Division Austin Nature Preserve System, and COA BCP appreciates access to the site.

In FY13, a major cave restoration project was initiated by Nico Hauwert on the Blowing Sink preserve. This had the intention of restoring the recharge functions and ecosystems of five large sinkholes. The project was successful and now recharges the vast majority of runoff generated on site. The final phase of the project was to revegetate the disturbed areas around each cave, and was completed in FY16. COA BCP staff continues to monitor these areas to ensure plant survivability, which ultimately increases soil stability and improves foraging habitat for cave crickets by increasing plant diversity, and eventually tree canopy cover. In FY18, COA BCP staff also continued to conduct cave cricket exit counts at four of the restored features to get baseline data on their populations. This data will be used as a metric to determine if the habitat enhancement (increased plant diversity/ food source) has a positive impact on cave cricket numbers.

During FY18, work was contracted to install a gantry at Blowing Sink Cave which would allow future excavation of any sediment that might wash into the cave or block access to the stream passage. It is imperative that this access remain open to monitor the Barton Springs salamander and complete vital hydrological studies for other area BCP permit caves. A 13-feet deep soil-filled sinkhole over the Main Pit of Blowing Sink Cave was excavated using hand held tools and found to connect to an upward trending cave passage mapped in the roof of the Main Pit in 1995. The reopening of this natural entrance into Blowing Sink Cave will facilitate future removal of rock blocking Kirschberg Hall below the Main Pit.

In order to document historical ecosystems of the Blowing Sink preserve, soil samples were collected from each foot of this year's excavation. Samples were sent to University of California Irvin and Texas A&M for carbon dating and pollen analysis. The results indicated that some of the fill (to the depth of 8') is at least 12,000 years old, but the more recently deposited sediment contained much younger carbon. No pollen was found in the samples submitted for palynological analysis.

Prior to the sinkhole excavation, a notification was sent to the general permit office of City of Austin Development Services and the Texas Commission on Environmental Quality, both agreed that the work was exempt from permitting since it was significantly small. However, during the restoration WPD staff inspected it and decreed that it was development construction instead of maintenance, which is prohibited without a permit or variance within a buffer of a critical environmental feature. The inspectors also reported that the soil berms placed upstream were not standard development site sedimentation and erosion controls. COA BCP is currently working toward adoption of controls that are more appropriate for sensitive preserve restoration than standard specifications designed for construction sites which can be very destructive and inefficient. In April 2018, BCP prepared a criteria document outlining cave restoration strategy on sensitive preserves that was submitted for inclusion in the City's Environmental Criteria Manual. The review of criteria to facilitate cave restoration will continue into FY19.

Other excavation work on the Blowing Sink preserve was conducted at Williams Cave. Rich Zarria, Mason Lewis, and Galen Falgout were contracted to remove roughly 50-100' of sediment needed to extend the cave over the footprint of Blowing Sink Cave, with the intention of connecting its currently inaccessible cave stream passage.

In order to facilitate site management of Blowing Sink Research Management Unit and Goat Cave Karst Preserve under the BCP Tier II Karst Management Plan, COA BCP requested primary management of the preserves on September 13, 2017 and December 11, 2018, repectively since they encompass the entire surface and subsurface catchment area for three federal permit caves. However, PARD Austin Nature Preserves denied this request. Until permitting and site management issues can be resolved, further restoration projects, such as the removal of rock obstruction from Blowing Sink Cave, are pending.

Other work conducted in the Blowing Sink Research Management Unit consisted of Austin Energy contractors restoring a transmission line access road. Soil that was excavated from the Blowing Sink Cave restoration was used to minimize the chance for introduction of invasive species such as tawny crazy ants (TCA; *Nylanderia fulva*).

5.0 MANAGEMENT COORDINATION AND OVERSIGHT

COA and TC determined that there was a need to create a master database on BCP karst fauna monitoring and management with the ability to analyze these data to determine current status and compliance with the regional permit, as well as determine future needs of the listed species. In 2009, Rob Clayton (COA WPD) developed the Karst Database that houses all faunal survey data from BCCP caves and provides much of the information needed for these karst analyses. This database is now available for use by BCP partners to enter survey data, and all available data have been entered to date. Though the intent is for this database to be a “shared” information source for all the BCP partners, there are still confidentiality challenges on how to establish this protocol. This database will focus on permit compliance, species status, and contribution to recovery.

Based on recommendations made in Dr. Butch Weckerly’s analyses of karst survey efforts on the BCP (Weckerly 2010), COA and TC modified and expanded the BCP’s cave monitoring program in FY11. COA and TC identified 25 caves within Travis County managed through BCP partners that provide a more evenly distributed dataset across cave clusters and karst fauna regions (KFRs); this dataset includes both BCCP caves and other ES/SOC caves on the BCP. The number and frequency of karst faunal surveys and cave cricket exit counts are now synchronized among managing partners to better accommodate comparisons and determine

species trends. The goal of the cave monitoring program is to provide a clearer understanding of the species distribution and health of karst ecosystems across the BCP.

In FY16, COA/TC BCP staff collaborated on creating guidelines to provide best management practices (BMPs) at construction sites where TCAs have not been confirmed, to supplement BMPs created in FY15 focusing on construction activities within known TCA sites. TCAs are a newly discovered non-native ant species which could potentially adversely affect forest and karst ecosystems on the BCP. Implementation of these BMPs will be critical to minimizing the potential of introducing new populations of this destructive species to other parts of Austin and elsewhere. In FY18, these BMPs continue to be disseminated to appropriate TC/COA departments and other agencies.

In light of recent confirmed cases of tick-borne relapsing fever (TBRF) in FY18, COA BCP staff continued to collaborate with Austin Public Health and researchers from Texas State University and the Baylor School of Medicine to get a better understanding of TBRF's prevalence in area caves, understand habitat preferences for its host (soft ticks) and try to determine threats posed to the public (especially in public access caves). TBRF is a bacteria closely related to Lyme disease and is transmitted to humans via infected soft ticks. COA BCP staff has continued to assist with collecting soft ticks from area caves with an emphasis on caves open to public access. If TBRF is confirmed from caves with public access, access will be closed until further notice. COA and TC BCP staff also participated in a Center for Disease Control and Prevention/Austin Public Health investigation to study the occupational risks of TBRF among workers with cave exposures (Campbell et al. 2018), and COA BCP staff provided a written report of their efforts (APPENDIX – S13). COA BCP also managed two caves containing soft ticks in FY 18, Live Oak and Spider Wire Caves, and co-manages a third, Bullet Cave, with PARD. KVUE aired a story on TBRF: (https://www.kvue.com/article/news/local/austin-sees-jump-in-rare-tick-borne-infection/269-552420585

Cave air quality is a major concern and there are still many unresolved questions concerning it. Historically, it was assumed that excavation could lead to cave drying by increasing airflow, ultimately degradating these sensitive ecosystems. However, many caves were filled across the area and the restoration of several hundred of these, by local cavers, led to their preservation. Several recently unfilled caves, including Pennies and LaCrosse Caves, have shown greatly improved ecosystem

diversity following restoration. A better understanding of cycles of high CO_2, and the factors contributing to them, is needed for the health and safety of the public on cave tours, as well as researchers/workers. The inability to conduct karst faunal surveys has also been the result of poor cave air in caves such as Cave X and No Rent Caves. Traditional views are that CO_2's primarily source is from roots and active formations. However, this does not explain why the highest levels are found deeper in caves, or in caves along the western edge of the recharge zone. Further explanation is also needed to determine the effects CO_2 may have on cave ecosystem communities and if it restricts the advance of invasive species such as tawny crazy ants. This research need was identified by the Karst Species Subcommittee (consisting of James Reddell, Nico Hauwert, Mark Sanders, and Dr. George Veni) of the BCP Scientific Advisory Committee in March 1999:

> **"*a) Cave Environments.*** *Humidity, Temperature, and Airflow. Increased airflow can cause the desiccation of cave passages. The frequency of airflow fluctuations are not well documented in local caves and should be monitored.*
>
> ***b) Effects of opening or enlarging cave entrances.*** *Excavating cave openings probably allows organic matter and nutrients to enter, and may enhance invertebrate diversity. Example: in Electromag Cave of Sun City, cave crickets became numerous after opening the entrance. However, it is possible that excavating these cave openings would enhance airflow and sunlight that may lead to drying of the cave. The general effect of opening caves probably results in returning the cave environment to pre-Colonial period conditions. This is because over grazing, agriculture, and other land-disturbance activities appear to have caused widespread filling of sinkhole depressions and cave entrances over the last few hundred years. The possible effects of opening or enlarging cave entrances requires further study."*

In 2010, UT graduate student Brian Cowan completed an MS thesis study of cave air in Austin. Beginning in 2017, AW BCP contracted Brian Cowan of Zara Environmental LCC to continuously measure three caves representing a range of carbon dioxide conditions. The results of this monitoring are presented in APPENDIX S-14. Additional analysis of the 2018 data and additional monitoring will continue in FY19.

6.0 BIOLOGICAL MONITORING

Caves containing endangered and rare karst invertebrates on BCP properties are monitored to determine long term trends in populations of cave organisms and overall cave conditions. All COA and TC-owned BCP caves with endangered species are surveyed annually. In addition, since FY11, TC and COA monitors25 Travis County caves selected to represent an evenly distributed dataset across cave clusters and KFRs. Caves included in this monitoring plan are surveyed bi-annually, occurring in Spring (May) and Fall (November) or Summer (August) and Winter (mid-January-mid February). Biomonitoring of the caves follow methodology and techniques supported by USFWS to provide results that can be compared between caves throughout the region for better study and analysis (USFWS 2014a).

Beyond USFWS recommendations, survey methodology also follow guidelines described in the *2016 Balcones Canyonlands Preserve Land Management Plan: Tier II-A Chapter IX Karst Species Management*. The protocol for research and monitoring cave fauna involves the use of one to seven (depending on size of cave and logistics) predesignated, permanent survey zones per cave in which all living organisms encountered are identified and enumerated. Survey zones are either transects approximately 5 meters in length that span the width of the cave, or distinct units of the cave such as a small room or an easily discernible section, so that the size and location of the survey area remains constant during the course of the study for trend comparison. For each survey zone, start and end time and the presence of trash or new vandalism are recorded. Relative humidity, temperature, nutrient input, dampness condition, and the presence of red-imported fire ants (RIFA; *Solenopsis invicta*) and TCAs are also recorded both outside the cave and at each transect or zone. All data collected during cave surveys are entered into the BCP Karst Database.

Any unknown invertebrates observed during faunal surveys are collected and identified by a karst invertebrate specialist. In caves containing endangered species, collecting only occurs with a special collecting permit obtained by USFWS. All collected specimens are deposited within the Texas Memorial Museum or other reputable facility (USFWS 2014a). The date of deposition and collection number is also recorded (USFWS 2014a).

Land managers also monitor the entrances of caves containing endangered species at least once a year for anything that might harm the rare invertebrates including presence of toxic substances, unauthorized access by recreational cavers, and

surface disturbances which might have erosive potential or cause changes in surface drainage patterns.

The overall health of caves is also monitored by performing semi-annual cave cricket exit counts. Cave cricket exit counts are done as crickets emerge from caves during good weather nights (i.e. not raining, warm etc.). The duration of the counts is timed for two hours starting at sunset, to maintain consistency with all surveys done between managing partners. Current weather conditions, surface temperature, and relative humidity are documented for each survey. Crickets emerging are placed in one of three age classes: nymph (up to 5 mm), sub-adult/juvenile (5-12mm) and adult (>12mm). Number of individuals exiting the cave is counted in ten-minute intervals. Time of first cave cricket exit and any other vertebrates exiting the cave are also recorded. An evaluation of TC/COA's cave cricket exit count survey protocol determined that this methodology meets criteria necessary to assess cave cricket abundance at caves as well as estimate changes over time in the number of cave crickets that emerge from cave entrances, both of which are necessary for determining the state of cave ecosystems and evaluating the effectiveness of the BCP's karst management goals (Weckerly 2012).

FY18 TC/COA Collaborative Monitoring Projects

Since FY12, BCP staff have included monitoring for presence of tawny crazy ants (TCAs) at all visits to cave sites, using a TCA monitoring and collection protocol and reporting procedures created by TC and COA BCP staff and updated in FY15. In FY13, at least two BCCP caves (Whirlpool Cave and No Rent Cave) were confirmed to be infested by TCAs. COA and TC staff continued to conduct quarterly biological surveys at Whirlpool Cave from FY13 – FY17 to document TCA use of cave environments and assess impacts of this new invasive species on cave fauna (EXHIBIT A). Surveys at Whirlpool Cave were reduced to bi-annually in FY18. In FY14, TC and COA also expanded monitoring of Weldon and No Rent Caves to document the arrival and impacts of another TCA population in the vicinity of these caves (EXHIBIT A). Subsequently, the TCA population at these caves as disappeared for unknown reasons.

TC and COA BCP staff began conducting bi-annual cave faunal surveys of Millipede Cave and Millipede Annex Cave in FY13 and continued surveys for FY18 to gather baseline data for the McNeil High School courtyard restoration project, which commenced in FY15 (EXHIBIT A). Cave cricket exit counts and management activities such as vegetation planting and RIFA control were coordinated with McNeil High School staff and students to improve surface conditions of these two non-

BCCP ES caves, with the intent of improving nutrient input and benefiting cave crickets and cave fauna.

TC and COA BCP staffs continue to assist with James Reddell's efforts to refine species distribution and range of *Rhadine* beetles of central Texas, by incorporating extensive collecting of *Rhadine* species from known and unknown localities during cave faunal surveys in FY18. For this study, morphological as well as molecular work of collected species will be employed to achieve this goal. To date, TC and COA BCP staff have successfully collected from multiple caves in Hays, Travis, and Williamson County.

TC and COA BCP staff assisted with a USFWS funded study to re-examine *Texella* species found in Travis and Williamson County. Marshal Hedin will be conducting molecular analysis of *Texella reyesi* and *Texella reddelli*, to aid in species verification. To date, verification was based on adult male genetiala, so it will be interesting to see if the new DNA work will verify the previous morphological work. TC and COA BCP staffs assisted with collecting species from various caves requested by Marshal Hedin and James Reddell.

TC and COA BCP staff wrote letters of support for a Section 6 proposal by Marhal Hedin and Joel Ledford "Assessment of Karst Faunal Regions in Travis, Williamson, & Bexar Counties (TX), based on comparative genomic analyses of multiple cave-limited arachnid taxa".

City of Austin FY18 Biological Monitoring

During FY18, COA BCP staff conducted bi-annual monitoring on the following 14 pre-selected caves: Airman's Cave, Broken Arrow Cave, Cave Y, Cortana Cave (non-BCCP cave), Cotterell Cave, Jester Estates Cave, Little Bee Creek Cave, Maple Run Cave, Midnight Cave, Pond Party Pit (non-BCCP cave), Seibert Sink (non-BCCP cave), Spider Cave, Stovepipe Cave, and Testudo Tube (non-BCCP cave) (EXHIBIT A). COA BCP staff has initiated quarterly faunal surveys at Lost Oasis Cave, Get Down Cave, and Pipeline Cave, once one complete year of quarterly surveys have been completed; survey frequency for these caves will drop to bi-annual surveys. (EXHIBIT A). Faunal surveys in these caves were conducted by permitted COA biologists in either Fall 2017/ Spring 2018 or Winter 2018/ Summer 2018. In addition, COA BCP staff conducted quarterly surveys at Flint Ridge Cave and District Park Cave. District Park Cave has a high probability that it will be impacted by TCA's in the near future, and the increased frequency of surveys will help determine what adverse effects they may have on cave fauna (EXHIBIT A).

As part of a long term site restoration project, COA BCP staff continued to conduct bi-annual surveys at Millipede and Millipede Annex Cave (EXHIBIT A). Annual faunal surveys were also conducted in Arrow Cave, Backdoor Cave, Beard Ranch Cave, Blowing Sink, Collaboration Cave, Goat Cave, LaCrosse Cave, Little Black Hole Cave (cursory survey), Millennium Cave (2 surveys), Mushroom Cave, Rolling Rock Cave, Slaughter Creek Cave, and Trapdoor Sider Cave. (EXHIBIT A).

COA BCP initiated talks with the property manager of Pipeline Cave. BCP staff has been given permission to manage and monitor this cave as well as the adjacent Confusion Cave (non-BCCP cave). COA BCP staff provided a written report of their efforts (APPENDIX – S12).

In FY18, COA BCP staff received confirmation from Dr. Joel Ledford stating that the *Tayshaneta* sp. collected from Millipede Annex Cave was confirmed as *Tayshaneta myopica*.

Also during FY18, COA BCP staff, with the help of volunteers, conducted bi-annual cave cricket exit counts (quarterly at Flint Ridge Cave and District Park Cave) at the same 14 caves pre-selected for faunal surveys (EXHIBIT B). COA BCP staff also initiated bi-annual cave cricket exit counts at the newly restored caves located on the Blowing Sink tract (Sink in the Woods, Sinky Dinky, Winterwoods, and Wyoaka Caves). (EXHIBIT B). COA BCP staff have initiated quarterly cave cricket exit counts at Lost Oasis Cave, Get Down Cave, and Pipeline Cave, once one complete year of quarterly surveys have been completed, survey frequency for these caves will drop to bi-annual surveys (EXHIBIT B). COA BCP staff also conducted one cave cricket exit count at Jest John Cave (EXHIBIT B).

Travis County FY18 Biological Monitoring

TC's BCP staff conducted bi-annual monitoring on the following 11 pre-selected caves: Adobe Springs Cave, Cold Cave, Gallifer Cave, Geode Cave (non-BCCP cave), Kretschmarr Cave, No Rent Cave, Spanish Wells Cave, Stark's North Mine, Tooth Cave, Weldon Cave, and Whirlpool Cave. Faunal surveys in these caves, with permitted TC biologists, were conducted in Fall 2017/ Spring 2018 or Winter 2018/ Summer 2018 (EXHIBIT A). Annual faunal surveys were also conducted in five other TC-owned BCCP caves with federally listed species: Kretschmarr Double Pit, McDonald Cave, New Comanche Trail Cave, North Root Cave, and Tardus Hole (EXHIBIT A). TC staff also conducted annual faunal surveys at two additional BCCP

listed caves: Ireland's Cave and Talus Spring Cave, and one additional TC-owned non-BCCP caves with listed ES or SOC: Two Trunks Cave (EXHIBIT A).

TC BCP staff conducted bi-annual cave cricket exit counts in FY18 at all of the caves pre-selected for faunal surveys: Adobe Springs Cave, Cold Cave, Gallifer Cave, Geode Cave, Kretschmarr Cave, No Rent Cave, Spanish Wells Cave, Stark's North Mine, Tooth Cave, Weldon Cave, and Whirlpool Cave. Exit counts were conducted in Fall 2017/ Spring 2018 or Winter 2018/ Summer 2018 (EXHIBIT B).

RIFA surveys were performed in Fall 2017 on eight of the eleven TC-owned BCCP caves with federally listed species. RIFA surveys were also conducted at one additional TC-owned BCCP cave (Talus Spring Cave). RIFA mounds were surveyed within an 80 m radius around cave entrances, and all active mounds found during surveys were treated with boiling water as recommended by USFWS (2014b). In Fall of 2017, a total of 101 RIFA mounds were treated within these 80 m cave survey areas, with an additional 12 RIFA mounds treated in the vicinity of caves but outside of survey areas. In Spring of FY18, a lack of staffing and rainfall prevented TC staff from conducting RIFA surveys or treatments. Survey results and treatments for individual caves are documented in Table 11.

In addition to managing the karst features required in the BCCP permit, TC voluntarily managed other karst features located on BCP land in FY18 including Cactus Pit, Brew Pot Cave, Kretschmarr Sink, and karst features RI-1, LU-11 and LU-12.

Other Biological Monitoring Efforts

Zara Environmental conducted biological monitoring at Pennie's Cave in FY18 as part of an adaptive cave management plan for a development project that began with the reopening of the cave's entrance in 2012. Zara Environmental conducted two (Spring and Fall) RIFA treatments with boiling water in FY18. Due to high CO_2 levels, Zara installed a semi-permanent in-cave air ventilation system that greatly improved air quality, thus allowing for in-cave faunal monitoring, staff was also able to complete the interior cave mapping. A written report of their work in FY18 was also provided (Zara Environmental 2017a; APPENDIX – S2 of BCCP FY18 Annual Report).

Zara Environmental performed fieldwork for a TC professional services contract which focused on assessing and performing excavations on karst features at TC's

Kotrla Unit to help identify karst invertebrate habitat on this BCP property. Zara provided a written report of their work, which includes 23 karst feature assessments and cave fauna observations/collections (Zara Environmental 2017b; APPENDIX – S2 of BCCP FY18 Annual Report). TC staff is still monitoring particular caves of interest on the Kotrla Unit for potential substitution of BCCP caves that cannot be acquired or managed properly under USFWS standards.

COA BCP staff continues to assist James Reddell and the Texas Speleological Society (TSS) in surveying, excavating, and mapping the karst of the USFWS Balcones Canyonlands National Wildlife Refuge. Major progress was made with a newly discovered feature found by USFWS staff named Collaboration Cave. Staff have excavated down to a small stream passage, and collected several troglobitic and stygobitic species which were delivered to TMM for species verification. These efforts are expanding the knowledge base of cave fauna in the karst fauna region shared by two BCCP caves: Jack's Joint and Armadillo Ranch Sink. COA BCP staff provided a written report of their efforts (APPENDIX – S11).

7.0 HYDROGEOLOGIC STUDIES

The understanding and protection of water sources to caves is vital for preserving cave life that relies on it. Water sources include surface catchment areas that direct runoff to the cave entrance and subsurface catchment areas where overlying water infiltration from either rainfall or runoff supports cave drips. Surface catchment area delineation generally involves examination of a combination of field GPS delineation of catchment divides and drainages as well as surface topographic contour coverages. Subsurface catchment studies may involve direct tracing, water-quality characterization, drip rate monitoring, geological mapping, cave survey mapping, and cave radio surveying.

In FY18, COA BCP staff continued to compile already collected data from Flint Ridge and Blowing Sink Caves to be included in future reports that are currently being prepared. Staff also compiled a draft hydrogeology study report for Flint Ridge Cave that was not completed this year.

In February 2018, TxDOT and the USFWS agreed to allow COA BCP to use mitigation fees to conduct hydrogeological studies along FM 2222 and FM 620 in preparation of construction of a bypass road to alleviate traffic. TxDOT issued a $390,655 mitigation fee to COA BCP in August 2018. As a prerequisite for

hydrogeological studies in FY20, BCP is locating springs, assessing the presence of salamanders and other subterranean life, and restoring previously filled caves and extending deeper portions of known caves in the area (APPENDIX - H).

In an attempt to locate Fossil Cave and other significant caves located in Schroeter Park, COA BCP contracted with geophysicist, Dr. Saribudak to conduct resistivity surveys. The results were somewhat promising with several areas showing high potential for significant voids. Staff intends to restore these features in the near future.

In May of FY18, a respository of geotechnical cores was relocated from WPD storage to COA BCP's Reicher Ranch office to provide geological data for future hydrogeological studies of the BCP.

8.0 RECOMMENDATIONS

COA and TC should continue to contact the owners of each privately-owned BCCP cave in order to assess current faunal assemblages and negotiate protection of these caves. The precise location of some of these privately owned caves is currently unknown; therefore, COA and TC should attempt to locate these caves in order to make a meaningful assessment. Additionally, COA and TC will continue to evaluate the adequacy of protection for all 62 BCCP caves during FY19 by initiating hydrological studies, and prioritize efforts accordingly.

Future research needs for the BCP should include an effort to determine to species level currently unknown troglobites such as *Speodesmus* sp., *Eidmannella* sp., and Trichoniscidae found in BCP caves. A recent research need has also been identified by James Reddell concerning *Rhadine* beetles in the region, with the possibility that potentially two undescribed species could be found within BCP caves. Future research and funding may be needed to answer these research questions.

9.0 KARST MANAGEMENT ACTIVITIES

The BCP Karst Land Management Plan (2016) outlines planned activities concerning the 62 BCCP karst features. Table 11 below includes a summary of monitoring and management activities for these features completed in FY18.

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.
Adobe Springs Cave The Nature Conservancy 1. TC was granted continued permission from TNC to perform bi-annual faunal surveys and cave cricket exit counts for the expanded BCP Cave Monitoring program. 2. TC performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 3. TC/COA conducted bi-annual cave faunal surveys (see EXHIBIT A). 4. TC conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
Airmen's Cave City of Austin 1. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 2. Conducted bi-annual cave cricket exit counts. (SEE EXHIBIT B) 3. COA installed a cave gate within 18 feet of the entrance of the cave. The cave gate not only protects the cave from ongoing vandalism, but also serves to protect the public from future accidents involving un-trained access. Access is still allowed via permit. 4. Volunteers monitor the cave gate weekly, and in the past have helped COA staff make cave gate and sign repairs.
Amber Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. Treated 21 mounds in Fall 2017. 4. Conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
Armadillo Ranch Sink Private
Arrow Cave City of Austin 1. Completed annual cave faunal survey (See EXHIBIT A). 2. Conducted quarterly site inspections. City staff continues to deal with ongoing dumping problems from the adjacent neighborhood. COA PARD Rangers continue to conduct occasional patrols at these problematic sites. 3. Inspected site for RIFA infestations. On all visits RIFA were observed within close proximity of the cave (but not inside the cave).
Bandit Cave COA BCP is in the process of discussing the cave management with the current owner.
Beard Ranch Cave (Featherman's Cave) City of Austin 1. Completed annual cave faunal survey (See EXHIBIT A). 2. Conducted quarterly site inspections. 3. No RIFA were found. A healthy population of native fire ants was found in close proximity to the cave.
Bee Creek Cave Private
Blowing Sink Cave

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.
City of Austin 1. Inspected monthly and continued to operate security cameras. 2. Completed cave faunal survey (See EXHIBIT A). 3. COA staff removed invasive non-native vegetation from the preserve. 4. COA WPD staff successfully completed the restoration of five major karst features located on the tract. The work is considered a major success by allowing clean recharge into the aquifer and reducing negative flood impacts to Blowing Sink Cave. 5. The lower passageways have been inaccessible since the October 2013 flood; however, it is possible that some of the recently restored adjacent caves may lead to the water table. 6. Other excavation work was previously mentioned in the "BCCP Cave Preserve Restoration" section above. 7. COA BCP staff continued to water recently planted vegetation around the restored caves with the goals of improving habitat for cave crickets and stabilizing the soil. 8. Bi-annual cave cricket exit counts were initiated by COA BCP in FY 18. 9. Bi-annual cave cricket counts were also conducted on 4 of the 5 restored caves found on the Blowing Sink tract: Sinky Dinky, Sink in the Woods, Winter Woods, and Wyoka Cave (EXHIBIT B). 10. Treated site for RIFA with boiling water. 11. Road restored along nearby transmission line by Austin Energy. 12. COA BCP appreciates permission from PARD Natural Resources Division Austin Nature Preserves to access the site.
Broken Arrow Cave City of Austin 1. Inspected quarterly with no sign of human visitation or vandalism. 2. Completed bi-annual faunal surveys (See EXHIBIT A). 3. Completed bi-annual cave cricket exit counts. (See EXHIBIT B). 4. Treated site for RIFA with boiling water.
Buda Boulder Spring City of Austin 1. COA BCP staff conducted quarterly site visits and noted signs of recent transient camps near the spring. COA PARD Rangers were notified and now periodically patrol the site. 2. BCP staff met with USFWS personnel twice to attempt the possible collection of a *Texella* sp. in close proximity to the spring. On the second attempt, staff was accompanied by a UT grad student, which in the past, thought he observed the potential specimen.
Cave X Private 1. COA entered into a Private Landowner Agreement entitled "Cave X, Management and Monitoring Plan, Covenants and Restrictions" with the property owners (Regent's School) in Oct. 1999. The agreement sets aside a 4.5 acre area to protect the cave footprint. USFWS was involved in the discussions on protection. 2. Cave entrance is gated and also has a fence for added protection. 3. Regent's School staff conduct periodic surface inspections of the cave including gate and lock maintenance. 4. In an effort to get a better understanding of CO2 levels in Cave X and other area caves, COA BCP staff requested access to install air monitoring equipment but were declined the offer by the owner.
Cave Y City of Austin 1. Conducted quarterly site inspections. 2. Completed bi-annual cave faunal survey(See EXHIBIT A). 3. Completed bi-annual cave cricket exit counts. (See EXHIBIT B).

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.
4. Surveyed site for RIFA; no mounds were discovered within the cave's treatment area.
Ceiling Slot Cave Private
Cold Cave 1. TC is negotiating with the landowners concerning the possibility of purchase, conservation easement, or a management agreement for this 8 acre tract. 2. TC gained continued permission from landowner to perform bi-annual faunal surveys and cave cricket exit counts for the expanded BCP Cave Monitoring program. 3. TC performed surface inspections with no signs of vandalism to the cave entrance or in the cave. 4. TC conducted bi-annual cave faunal surveys (see EXHIBIT A). 5. TC conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
Cotterell Cave City of Austin 1. Conducted quarterly site inspections. 2. RIFA surveys determined that the ants were located approximately 300 feet from the cave so no treatment was needed. 3. Conducted bi-annual cave faunal surveys (see EXHIBIT A). 4. Conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
Disbelievers Cave Private 10a Permit: PRT-808694
District Park Cave City of Austin 1. BCP staff conducted quarterly cave faunal surveys since there is a high potential for TCA introduction (See EXHIBIT A). 2. BCP staff and volunteers conducted quarterly cave cricket exit counts (See EXHIBIT B). 3. Conducted site surveys quarterly, other than trash at the entrance no new major problems noted. 4. Permitted access to this cave was allowed. 5. BCP staff removed trash from the un-gated portion of the cave. 6. COA BCP hydrogeologist continued to work on a hydrological study to determine the sub-surface drainage and to see if the adjacent developed area of the park could negatively impact the cave (ongoing). 7. Surveyed site for RIFA; no mounds were discovered within the cave's treatment area.
Eluvial Cave Private 10a Permit: PRT-808694
Flint Ridge Cave City of Austin 1. Conducted six site visits and noted no signs of illegal trespass. 2. Conducted quarterly cave faunal surveys (See EXHIBIT A). 3. BCP staff and volunteers conducted quarterly cave cricket exit counts (See EXHIBIT B). 4. Continuous monitoring of drips was conducted in various rooms and grab water samples were collected in October 2017 and March 2018. 5. COA BCP drafted a hydrogeologic study report that will delineate the subsurface catchment areas of water sources. This is expected to be released in FY19. 6. Treated site for RIFA with boiling water. 7. Construction of SH45SW began over portions of the cave and its surface/subsurface catchment areas. 8. The appreance of an unusual fine sediment was documented in Culvert Crawl passage in Oct. of

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.
FY18.
Fossil Cave City of Austin 1. Inspected quarterly and found no new signs of vandalism 2. Inspected for RIFA infestations on all visits. RIFA were observed within close proximity of the "suspected" cave. 3. In an attempt to locate Fossil Cave and other significant caves, COA BCP conducted a geologic assessment, identifying 6 potentially filled caves, and contracted with geophysicist, Dr. Saribudak to conduct resistivity surveys. This work is preparation for future work to restore Fossil and associated caves within Schroeter Park.
Fossil Garden Cave Private
Gallifer Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Lack of personnel and rainfall prevented staff from conducting RIFA surveys and treatments in FY18. 4. Conducted bi-annual cave faunal surveys (see EXHIBIT A). 5. Conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
Get Down Cave City of Austin 1. In July of FY18, COA BCP and WPD signed an Interdepartmental Agreement which allows COA BCP to manage the karst preserve and Get Down Cave according to the Tier II karst management plan and allows WPD to manage the water quality ponds and underlying Millennium Cave, which they use in their aquifer education, 2. BCP staff continued to work with neighbors regarding ways to limit negative impacts to cave crickets while treating for RIFA on adjacent private property. The protocol was posted on their web site in FY17. 3. COA BCP staff helped support neighbor Stephanie Simmons with her "Texas Most Wanted" campaign, whose goal is to promote native plants by offering free plants to the public and encouraging neighbors to remove invasive non-native species. It is hoped that this type of public education will indirectly improve habitat on the preserve. 4. BCP staff conducted quarterly cave faunal surveys (See EXHIBIT A). 5. BCP staff conducted quarterly cave cricket exit counts (See EXHIBIT B). 6. On Nov and Jan, of FY18, BCP staff sampled cave drips located in the lower level of Get Down Cave and found relatively high concentrations of sulfate (10.8-3,690 mg/l), nitrate+nitrite (1.43-189 mg/l). aluminum (as high as 406 ug/l), ammonia (as high as 13.4 mg/l), and chloride (as high as 218 mg/l). BCP staff will continue to monitor water quality and attempt to determine the source of pollutants and attempt to restore drip water quality. 7. Treated site for RIFA with boiling water. 8. Removed non-native invasive plants. 9. BCP staff repaired the perimeter fence around Senatorial Sink. 10. BCP staff continued to collect soft ticks from Live oak Cave and to collaborate with Texas State and Baylor researchers whom are trying to determine more information about tick borne relapsing fever (TBRF).
Goat Cave

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.
City of Austin 1. Completed annual faunal survey (See EXHIBIT A). 2. Conducted quarterly site surveys. 3. Allowed permitted access to this cave. 4. Treated site for RIFA with boiling water. 5. COA BCP completed a contract with Rich Zarria on improving safe access to Wade Cave. Wade Cave as well as Hideout Cave is located on the Goat Cave karst preserve and recent excavation work has opened these caves up for guided public access, thus reducing pressure for access to Goat and Maple Run caves. 6. Additional site restoration and educational development by BCP is on hold as the City of Austin re-establishes the department's role in managing the preserve, as previously specified in the 2007 Tier II BCP Land Management Plan. 7. COA BCP appreciates permission PARD Natural Resources Division Austin Nature Preserves to access the site.
Hole-in-the-Road Cave Private
Ireland's Cave Travis County 1. TC acquired the 4.8 acre tract containing the cave from Muirfield Homeowner Association and began full management of the cave and surrounding property in FY12. 2. Fencing was completed in FY15 on the perimeter of the Ireland's Cave tract to protect the cave preserve from trespass. 3. Lack of personnel and rainfall prevented staff from conducting RIFA surveys and treatments in FY18. 4. TC conducted an annual cave faunal survey (see EXHIBIT A). 5. TC and COA contracted with Zara Environmental to continuously monitor air quality in Irelands Cave. Ireland's Cave is known to have elevated levels of CO_2, and this study will provide vital information to staff on cave safety.
Jack's Joint Cave Private
Japygid Cave Private 10a Permit: PRT-808694
Jest John Cave City of Austin 1. Conducted 2 site visits found and no signs of vandalism or human visitation. 2. Inspected site for RIFA infestations, no RIFA were observed near the cave. 3. Conducted one cave cricket exist count. (See EXHIBIT B).
Jester Estates Cave City of Austin 1. BCP staff conducted 6 site visits looking for signs of illegally discharged pools, dumped brush and trash from neighbors. It appears that past educational efforts have paid off, since aside from minor brush dumping, no significant illegal activities were observed. 2. Treated site for RIFA with boiling water. 3. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 4. Conducted bi-annual cave cricket exit counts. (SEE EXHIBIT B). 5. BCP staff removed non-native invasive vegetation. 6. A water sample from drips was taken in November 2017 showing relatively high ammonia (3.39 mg/l), E. Coli (409 colonies/100ml), and nitrate+nitrite (1.98 mg/l).

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.
Jollyville Plateau Cave Private 10a Permit: PRT-808694
Kretschmarr Cave Travis County 1. Performed surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. Treated 47 mounds in Fall 2017. 4. TC conducted bi-annual cave faunal surveys (see EXHIBIT A). 5. TC conducted bi-annual cave cricket exit surveys (See EXHIBIT B).
Kretschmarr Double Pit Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. Treated 12 mounds in Fall 2017. 4. Conducted annual cave faunal survey (see EXHIBIT A).
Lamm Cave Section 7 Permit 2-15-93-F-075 (see USFWS files) 1. The City of Austin negotiated protective measures for this cave including a Land Management Plan for this cave. The cave has a setback size of approximately 4.13 acres. The radius of the setback varies from a minimum of 123 feet south of the cave to a maximum of 340 feet north of the cave. 2. The cave was gated and the preserve area was fenced following COA WPD and BCP staff recommendations and design. 3. No application of fertilizers, pesticides or herbicides will be allowed in the CEF area. 4. TC staff continue to periodically monitor the site to make certain that the gates and fences are secure. 5. Walmart has closed the store and are selling the property. COA and TC BCP staff will continue to monitor the site and attempt to contact the new owner regarding management and monitoring needs. 6.Concordia University is considering the possibility of taking over ownership of the preserve area for management and a possible outdoor classroom.
Little Bee Creek Cave City of Austin 1. Conducted quarterly site visits. 2. Conducted bi-annual cave faunal survey (See EXHIBIT A). 3. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 4. In an effort to enhance habitat, COA BCP staff excavated the cave extending the passage by roughly 10 feet.
Lost Oasis Cave TCMA 1. Conducted five site visits. 2. COA WPD led four cave education trips into cave. 3. COA BCP staff treated the site for RIFA with boiling water. 4. Conducted bi-annual cave faunal survey (See EXHIBIT A). 5. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 6. Removed non-native invasive plants.
Lost Gold Cave

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.
Private
Maple Run Cave City of Austin 1. Conducted bi-annual cave faunal survey (See EXHIBIT A). 2. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 3. COA BCP staff conducted monthly site inspections and removed trash from preserve area. 4. Permitted access to this cave is allowed. 5. Treated site for RIFA with boiling water. 6. In FY18, yellow-tinted drips observed in lower portions of the cave were attributed to a 2013 dye tracing injection. 7. COA BCP appreciates permission from PARD Natural Resources Division Austin Nature Preserves to access the site.
McDonald Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site bi-annually for RIFA. No RIFA mounds observed during surveys. 4. Conducted annual cave faunal surveys (see EXHIBIT A).
McNeil Bat Cave Private
Midnight Cave City of Austin 1. Conducted quarterly site inspections; on multiple occasions vandals cut the chain to the gate. Staff installed a cellular game camera and made improvements to the gate and fence to better secure the site. 2. Conducted bi-annual cave faunal surveys. (See EXHIBIT A). 3. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 4. Permitted access to this cave is allowed, though no access permits were granted this fiscal year. 5. Treated site for RIFA with boiling water.
M.W.A. Cave Private 10a Permit: PRT-808694
Moss Pit Cave Private
New Comanche Trail Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Lack of personnel and rainfall prevented staff from conducting RIFA surveys and treatments in FY18. 4. Conducted annual cave faunal survey (see EXHIBIT A).
No Rent Cave Private

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.
1. TC gained permission from landowner to perform bi-annual faunal surveys and cave cricket exit counts. 2. TC performed surface inspections with no current signs of vandalism to the cave entrance or in the cave. 3. TC conducted bi-annual cave faunal surveys (see EXHIBIT A). 4. TC conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
North Root Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. Treated 10 mounds in Fall 2017. 4. Conducted annual cave faunal survey (see EXHIBIT A).
Pennie's Cave Private 1 The entrance was re-excavated in 2012, providing access to the cave. 2.The cave entrance has been gated and fenced; boulders were also placed around the cave at the edge of a 300-ft buffer to better define the protected area. 3. Zara Environmental has secured a one year contract to conduct quarterly cave faunal surveys, map the interior of the cave and treat the site for RIFA. Although only a one year contract, it is hoped that the owner will extend the contract for multiple years. 4. Zara Environmental provided an annual report to the BCP on all monitoring and management activities.
Pickle Pit Cave Private USFWS Section 7 Permit 2-15-93-F-075 1. A volunteer neighbor occasionally monitors the cave entrance/ gate monthly; no problems noted.
Pipeline Cave Private 1. A 2004 agreement between COA and Stratus set aside an approximately 8 acre buffer around Pipeline Cave that varies from 100 feet to the east and up to 300 feet west of the cave and an additional setback of 300 feet to the north and west; 150 ft. to east and south for the adjacent feature known as Confusion Sink. 2. Developer installed cave gate (including a gate on the nearby "Confusion Cave." 3. In August 2018, COA BCP staff met with the property manager and obtained provisional access to begin monitoring and management of Pipeline and the adjacent Confusion Cave according to the Tier III karst management plan. 4. Conducted bi-annual cave faunal surveys, staff collected several species of concern that was not known to occur in this cave. (See EXHIBIT A). 5. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 6. COA BCP provided a monitoring and management report to the property manager. 7. Pipeline Cave has considerable trash fill, which is initially dated to late 1950's and early 1960's based on trash at the top. Detailed report is attached in the appendices.
Rolling Rock Cave City of Austin 1. Inspected quarterly and no sign of human visitation or vandalism was found. 2. Conducted one cave faunal survey. (See EXHIBIT A). 3. Treated site for RIFA with boiling water.
Root Cave Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.
cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. Treated 10 mounds in Fall 2017. 4. Conducted annual cave faunal survey (see EXHIBIT A).
Slaughter Creek Cave City of Austin 1. Conducted quarterly site inspections,. 2. Conducted one cave faunal survey. (See EXHIBIT A) 3. Treated site for RIFA with boiling water 4. COA BCP contracted with Charlie Savvas to excavate the nearby Another Cave to see if the Mopac underpass could impact Slaughter Creek Cave. In 2018, over 2,100 cubic feet of sediment and fill has been excavated from Another Cave that appears to date to 1991 when construction workers filled both caves.
Spanish Wells Cave Travis County 1. TC acquired Spanish Wells Cave and surrounding land that protects the cave cricket foraging area and surface/subsurface drainage basins in FY15. 2. Performed surface inspections with no signs of trespass or vandalism to the cave entrance or in the cave. 3. Lack of personnel and rainfall prevented staff from conducting RIFA surveys and treatments in FY18. 4. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 5. Conducted bi-annual cave cricket exit count. (See EXHIBIT B).
Spider Cave City of Austin 1. Conducted four site visits, and no sign of human access or vandalism was found. 2.Conducted bi-annual cave faunal surveys (See EXHIBIT A). 3. Conducted bi-annual cave cricket exit counts. (See EXHIBIT B). 4. Treated site for RIFA with boiling water.
Stark's North Mine Travis County 1. TC acquired this cave and 0.8 acres surrounding it in FY12. The area surrounding the cave is all previously developed. 2. Performed surface inspections and detected signs of vandalism to the cave entrance and inside the cave. Cave gate was subsequently repaired by Zara Environmental. 3. Surveyed site bi-annually for RIFA. No mounds found within 80 m of cave. 4. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 5. Conducted bi-annual cave cricket exit counts (See EXHIBIT B). 6. Performed non-native plant removal projects on tract to increase native plant diversity.
Stovepipe Cave 1. Conducted 6 site inspections, and continued to remove new and old trash from the preserve. 2. Repaired perimeter fence. 3. Conducted bi-annual cave faunal surveys (See EXHIBIT A). 4. Conducted bi-annual cave cricket exit counts (See EXHIBIT B). 5. Surveyed site for RIFA; no mounds were discovered within the cave's treatment area.
Talus Spring Cave Private 1. The USFWS 10a permit PRT 815447 mitigation requirement intended this cave to go to TC, however, the cave is located on private land just outside of the mitigation area. TC has continued requesting that the homeowners association donate the land to TC. 2. Performed surface inspections with no signs of vandalism to the cave entrance or in the cave.

Table 11. FY18 BCCP Karst Feature Monitoring and Management Activities.
3. Surveyed site bi-annually for RIFA. Treated 7 mounds in Fall 2017. 4. Conducted annual cave faunal survey (see EXHIBIT A). 5. Performed a non-native plant removal project on tract to increase native plant diversity.
<u>Tardus Hole Cave</u> Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 3. Surveyed site for RIFA. Treated 8 mounds in Spring 2017. 4. Conducted annual cave faunal survey (see EXHIBIT A).
<u>Tooth Cave</u> Travis County 1. Performed periodic surface inspections with no signs of vandalism to the cave entrance or in the cave. 2. Maintained fencing and signage to protect this area from unauthorized access and dumping. 4. Zara Environmental replaced old cave gate with a newer elevated gate. 3. Surveyed site for RIFA. Treated 26 mounds in Fall 2017. 4. Conducted bi-annual cave faunal surveys (see EXHIBIT A). 5. Conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
<u>Weldon Cave</u> Private 1. TC gained continued permission from landowner to perform bi-annual faunal surveys and cave cricket exit counts for the expanded BCP Cave Monitoring program. 2. TC performed surface inspections with no current signs of vandalism to the cave entrance or in the cave. 4. TC conducted bi-annual cave faunal surveys (see EXHIBIT A). 5. TC conducted bi-annual cave cricket exit surveys. (See EXHIBIT B).
<u>Whirlpool Cave</u> TCMA 1. TC/COA continued increased monitoring efforts and incorporated new methods to document the arrival and impacts of a nearby TCA population. 2. TC/COA conducted bi-annual cave faunal surveys (see EXHIBIT A). 3. TC/COA conducted bi-annual cave cricket exit surveys. (See EXHIBIT B). 4. TCMA continued to allow permitted access to the cave; however, in an effort to limit access and to raise funds for cave management, they are now charging a fee for access. 5. Continuous monitoring of CO_2, humidity, and airflow is being conducted in the East caverns passage by Zara Environmental on behalf of COA BCP.

10.0 LITERATURE CITED

Balcones Canyonlands Preserve Land Management Plan. 2016. Karst Species Management. Chapter IX. In Tier II-A. Balcones Canyonlands Management Handbook. Unpublished document. Travis County, TX.

Bayless, Todd, Travis County Natural Resources and Environmental Quality, personal communication, 2013.

Campbell, J., Cokendolpher, J., Griswold, C., Ledford, J., Paquin, P. 2012. Systematics, conservation and morphology of the spider genus Tayshaneta (Araneae, Leptonetidae) in Central Texas Caves. Zookeys: (167): 1-102.

Campbell S, Huang P, et al. 2018. Tick-borne relapsing fever in Texas and Travis county: Key information and recommendations: *Travis County Medical Society (TCMS) Journal* 64 (3):22-23.

Elliott, William R. 1992. Endangered and Rare Karst Species in Travis County, Texas: Options for the Balcones Canyonlands Conservation Plan.

Elliott, William R. 1997. The Caves of the Balcones Canyonlands Conservation Plan, Travis County Texas, Travis County Natural Resources program.

Hall, Stephen A. and Salvatore Valastro,1995, Grassland vegetation in the southern Great Plains during the last Gacial maximum: Quaternary Research v 44,p. 237-245.

Hedin, Marshall. 2015. High-stakes species delimitation in eyeless cave spiders (*Cicurina*, Dictynidae, Araneae) from central Texas. Molecular Ecology 24(2): 346-361.

HNTB. 2005. Summary of Information for Assessing the Status of the Tooth Cave ground beetle (*Rhadine Persephone,*), a report for USFWS by Casey Berkhouse.

Ledford, Joel, Department of Entomology, California Academy of Sciences, personal communication, 2010.

Ledford, J. M., Paquin, P., Cokendolpher, J. and Griswold, C. (2012) Systematics, Conservation and Morphology of the Spider Genus Tayshaneta (Araneae, Leptonetidae) in Central Texas Caves. Zookeys, 167: 1- 102.

Muchmore, William B. 2001. Review of the genus Tartarocreagris, with descriptions of new species (Pseudoscorpionida: Neobisiidae). Texas Memorial Museum, Speleological Monographs, 5:57-72.

Paquin, P. and M. Hedin. 2005. Genetic and morphological analysis of species limits in Cicurina spiders (Araneae, Dictynidae) from southern Travis and northern Hays counties (TX), with emphasis on *Cicurina cueva* Gertsch and relatives. Special report for the Department of Interior United States Fish & Wildlife Service Contract No. 201814G959. Revised version10 May 2005.

Paquin P., Dupérré, N., Cokendolpher J., White, K., and M. Hedin. 2008. The fundamental importance of taxonomy in conservation biology: the case of the eyeless Cicurina bandida (Araneae: Dictynidae) of central Texas, including new synonyms and the description of the male of the species. Invertebrate Systematics 22: 139–149.

Reddell, James, Texas System of Natural Laboratories (TSNL), Texas Cave Management Association (TCMA), personal communication, 2004.

Reddell, James, Texas System of Natural Laboratories (TSNL), Texas Cave Management Association (TCMA), personal communication, 2005.

Reddell, James, Texas System of Natural Laboratories (TSNL), Texas Cave Management Association (TCMA), personal communication, 2010.

Reddell, James, Texas System of Natural Laboratories (TSNL), Texas Cave Management Association (TCMA), personal communication, 2016.

Sanders, Mark, City of Austin, Austin Water Utility, BCP Program, personal communication, 2013.

Texas Memorial Museum (TMM). 2007. TEXBIO database, The University of Texas at Austin.

Toomey, R.S., III, Blum, M.D., and Valastro, S., Jr., 1993, Late Quaternary climates and environments of the Edwards Plateau, Texas: Global and Planetary Change, v. 7, p. 299–320.

Ubick, Darrell, Department of Entomology, California Academy of Sciences, personal communication, 2017.

U.S. Fish and Wildlife Service. 1994. Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas. Albuquerque, NM.

U.S. Fish and Wildlife Service. 1996a. Federal Fish and Wildlife Permit No. PRT-788841.

U.S. Fish and Wildlife Service. 1996b. Final Environmental Impact Statement/Habitat Conservation Plan for Proposed Issuance of a Permit to Allow Incidental Take of the Golden-cheeked Warbler, Black-capped Vireo, and Six Karst Invertebrates in Travis County, Texas. U. S. Fish and Wildlife Service, Albuquerque, N. M.

U.S. Fish and Wildlife Service. 2008. Tooth Cave Ground Beetle (Rhadine Persephone) 5-Year Review: Summary and Evaluation. Austin Ecological Services Field Office, Austin, TX.

U.S. Fish and Wildlife Service. 2009a. Bone Cave Harvestman (*Texella reyesi*) 5-Year Review: Summary and Evaluation. Austin Ecological Services Field Office, Austin, TX.

U.S. Fish and Wildlife Service. 2009b. Tooth Cave Spider (*Neoleptoneta myopica*), Kretschmarr Cave Mold Beetle (*Texamaurops reddelli*), and Tooth Cave Pseudoscorpion (*Tartarocreagris texana*) 5-Year Review: Summary and Evaluation. Austin Ecological Services Field Office, Austin, TX.

U.S. Fish and Wildlife Service. 2009c. Bee Creek Cave Harvestman (*Texella reddelli*) 5-Year Review: Summary and Evaluation. Austin Ecological Services Field Office, Austin, TX.

U.S. Fish and Wildlife Service. 2012. Karst Preserve Design Recommendations. Austin Ecological Services Field Office, Austin, TX.

U.S. Fish and Wildlife Service. 2014a. Section 10(a)(1)(A) Karst Invertebrate Survey Requirements for Conducting Presence/Absence Surveys for Endangered Karst Invertebrates in Central Texas. Austin Ecological Services Field Office, Austin, TX.
May 8, 2014.

U.S. Fish and Wildlife Service. 2014b. Karst Preserve Managing and Monitoring Recommendations. Austin Ecological Services Field Office, Austin, TX.

Weckerly, Floyd W. 2010. Karst Invertebrate Species Survey Protocols and Trend Analyses at Balcones Canyonlands Preserve. Department of Biology, Texas State University, San Marcos, Texas.

Weckerly, Floyd W. 2012. Cave Cricket Exit Counts: Environmental Influences and Duration of Surveys. Journal of Cave and Karst Studies, v.74 no.1, p.1-6.

Zara Environmental, LLC. 2007a. Report of Excavation and Biology of Down Dip Sink, Water Treatment Plant 4 Bull Creek Site, Travis County, Texas. Report for Carollo Engineers, Austin TX.

Zara Environmental, LLC. 2007b. Report of Excavation and Biology of Garden Hoe Cave and Canopy Joint Sink, Water Treatment Plant 4 Bull Creek Site, Travis County, Texas. Report for Carollo Engineers, Austin TX.

Zara Environmental, LLC. 2008. Excavation and Biology of Caves and Karst Features on the Lucas Tract, Travis County, Texas. Report for Carollo Engineers, Austin TX.

Zara Environmental, LLC. 2010. Population Status of Karst Invertebrates in the Balcones Canyonlands Preserve. Report for Weston Solutions, Inc., Austin TX.

Zara Environmental, LLC. 2017a. 2017 Summary of Cave Management Activities at Pennie's Cave, Travis County, Texas. Report for Endeavor Real Estate Group, Austin, TX.

Zara Environmental, LLC. 2017b. 2017 Technical Report for Karst Management Services at the Balcones Canyonlands Preserve – Kotrla Unit, Travis County, Texas. Report for Travis County TNR – Natural Resources and Environmental Quality, Austin, TX.

Zara Environmental, LLC . 2018. Annual Summary of Carbon Dioxide Monitoring in the Three Balcones Canyonlands Conservation Plan Caves in Travis County, Texas. Report for City of Austin, Austin Water Utility, BCP Program.

EXHIBIT A:

KARST FAUNAL SURVEY REPORTS

FY18 City of Austin/Travis County Karst Faunal Surveys[1, 2]

			Endangered Species						Species of Concern											Other Significant Troglobites							
Cave	**Survey Date**	**Monitoring Agency**	***Rhadine persephone***	***Tartarocreagris texana***	***Tayshaneta myopica***	***Texamaurops reddelli***	***Texella reddelli***	***Texella reyesi***	***Gaecidotea reddelli***	***Cicurina bandida***	***Cicurina travisae***	***Eidmannella reclusa***	***Rhadine austinica***	***Rhadine subterranea***	***Sphalloplana mohri***	***Tartarocreagris comanche***	***Tayshaneta concinna***	***Tayshaneta devia***	***Texella spinoperca***	***Cicurina buwata***	***Eidmannella* sp.**	***Speodesmus* sp.**	***Speodesmus bicornourus***	***Tartarocreagris infernalis***	***Tayshaneta* sp.**	***Texoreddella texensis***	**Other notable species detected**
Adobe Springs Cave	11/15/2017	TC																									
Adobe Springs Cave	5/14/2018	TC																									
Airmen's Cave	1/22/2018	COA								20											22	6					*Perimyotis subflavus* (6)
Airmen's Cave	8/17/2018	COA								13			4								22	4					
Arrow Cave	9/14/2018	COA								5												7					*Tellexella mulaiki* (2)
Backdoor Cave	6/5/2018	COA																			2						Pseudoscorpionida (2)
Beard Ranch Cave	1/10/2018	COA						3			1																
Blowing Sink Cave	9/25/2018	COA								35			3									5					*Batrisodes* sp. (4)
Broken Arrow Cave	11/17/2017	COA							14											1		7					*Batrisodes* sp. (4)
Broken Arrow Cave	5/17/2018	COA							20											5		1					*Stygobromus russelli* (4)
Cave Y	1/22/2018	COA								10																	*Myotis velifer* (9) *Texella grubbsi* (2)
Cave Y	8/17/2018	COA								11												10					*Texella grubbsi* (10)
Cold Cave	1/29/2018	TC						2												15		27					*Batrisodes* sp. (3)
Cold Cave	8/23/2018	TC						5												4		7					*Batrisodes* sp. (9)
Collaboration Cave	5/11/2018	COA																			5	1					Trichoniscidae (1)
Cortana Cave	1/9/2018	COA			39			8			4										10	4					
Cortana Cave	8/31/2018	COA			26			11			9										21	4					
Cotterell Cave	1/10/2018	COA						19			63			4								21		2			
Cotterell Cave	8/30/2018	COA						19			72			1							2	16					Pseudoscorpionida (6)

District Park Cave	11/21/2017	COA								35												1					Pseudoscorpionida (2) *Texella mulaiki* (2)
District Park Cave	1/19/2018	COA								24												3			1		*Tartarocreagris* sp. (1) *Texella mulaiki* (1)
District Park Cave	5/7/2018	COA								22												2					
			Endangered Species						**Species of Concern**											**Other Significant Troglobites**							
Cave	**Survey Date**	**Monitoring Agency**	***Rhadine persephone***	***Tartarocreagris texana***	***Tayshaneta myopica***	***Texamaurops reddelli***	***Texella reddelli***	***Texella reyesi***	***Saccidotea reddelli***	***Cicurina bandida***	***Cicurina travisae***	***Eidmannella reclusa***	***Rhadine austinica***	***Rhadine subterranea***	***Sphalloplana mohri***	***Tartarocreagris comanche***	***Tayshaneta concinna***	***Tayshaneta devia***	***Texella spinoperca***	***Cicurina buwata***	***Eidmannella* sp.**	***Speodesmus* sp.**	***Speodesmus bicornourus***	***Tartarocreagris infernalis***	***Tayshaneta* sp.**	***Texoreddellia texensis***	**Other notable species detected**
District Park Cave	8/9/2018	COA								27																	*Texella mulaiki* (6)
Flint Ridge Cave	11/22/2017	COA								22			1								5	127					*Batrisodes* sp. (1) *Texella mulaiki* (1)
Flint Ridge Cave	1/19/2018	COA								34											2	135					*Perimyotis subflavus* (1) *Texella mulaiki* (1)
Flint Ridge Cave	5/1/2018	COA								22												2					
Flint Ridge Cave	8/15/2018	COA								45											20	68					*Perimyotis subflavus* (1) *Texella mulaiki* (2)
Gallifer Cave	1/23/2018	TC	3		110			42			92										2	6					
Gallifer Cave	8/21/2018	TC			40			46			65										1	2					*Batrisodes* sp. (1)
Geode Cave	1/22/2018	TC			97						5	7															*Batrisodes* sp. (1)
Geode Cave	8/15/2018	TC			14							7															*Batrisodes* sp. (1)
Get Down Cave	10/19/2017	COA								10												2			1		
Get Down Cave	1/30/2018	COA								21															17		*Perimyotis subflavus* (1) *Texella mulaiki* (2)
Get Down Cave	5/3/2018	COA								14											1				7		
Goat Cave	9/25/2018	COA								5											3	2			1		*Texella mulaiki* (2) Trichoniscidae (9)
Ireland's Cave	2/27/2018	TC								20			4														*Batrisodes* sp. (6) *Texoreddellia* sp. (2)
Jester Estates Cave	11/20/2017	COA					27				9											6					Trichoniscidae (1)

Jester Estates Cave	5/17/2018	COA		4	1		28				1											1					
Kretschmar Cave	11/7/2017	TC									6										8		9				
Kretschmar Cave	5/10/2018	TC									13										7		4				
Kretschmar Double Pit	11/7/2017	TC									3												5				*Texella grubbsi* (5)
LaCrosse Cave	1/23/2018	COA								1			1														*Texella mulaiki* (1)
Little Bee Creek Cave	11/21/2017	COA					15			1											1	3			2		Pseudoscorpionida (2)
Little Bee Creek Cave	5/3/2018	COA					5			2												2					
Little Black Hole Cave	8/21/2018	COA					3															1					
			Endangered Species						**Species of Concern**											**Other Significant Troglobites**							
Cave	**Survey Date**	**Monitoring Agency**	***Rhadine persephone***	***Tartarocreagris texana***	***Tayshaneta myopica***	***Texamaurops reddelli***	***Texella reddelli***	***Texella reyesi***	***Saccodotea reddelli***	***Cicurina bandida***	***Cicurina travisae***	***Eidmannella reclusa***	***Rhadine austinica***	***Rhadine subterranea***	***Sphalloplana mohri***	***Tartarocreagris comanche***	***Tayshaneta concinna***	***Tayshaneta devia***	***Texella spinoperca***	***Cicurina buwata***	***Eidmannella* sp.**	***Speodesmus* sp.**	***Speodesmus bicornourus***	***Tartarocreagris infernalis***	***Tayshaneta* sp.**	***Texoreddellia texensis***	**Other notable species detected**
Lost Oasis Cave	2/2/2018	COA								66												63					*Perimyotis subflavus* (1) *Texella mulaiki* (1)
Lost Oasis Cave	5/1/2018	COA								41											3	51					*Batrisodes* sp. (1) Pseudoscorpionida (2) *Texoreddellia* sp. (1)
Maple Run Cave	1/18/2018	COA								5																	*Anapistula* sp. (1) *Batrisodes* sp. (1) Pseudoscorpionida (1) *Texella mulaiki* (1)
Maple Run Cave	8/13/2018	COA								5																	*Anapistula* sp. (4) *Batrisodes* sp. (1) *Texella mulaiki* (1)
McDonald Cave	8/22/2018	TC						9			51							31					38	1			*Eidmannella rostrata* (19)
Midnight Cave	1/18/2018	COA							1	15			4								64	6					*Batrisodes* sp. (24) *Stygobromus* sp. (1) *Texoreddellia* sp. (1) Trichoniscidae (43)
Midnight Cave	8/13/2018	COA								21																	*Batrisodes* sp. (3) Trichoniscidae (7)

Millennium Cave	1/30/2018	COA								4											3	4					*Texella mulaiki* (2)
Millennium Cave	6/1/2018	COA								4			1								3						
Millipede Annex Cave	12/1/2017	COA						7												8					4		*Anapistula* sp. (2) *Texoreddellia* sp. (1)
Millipede Annex Cave	5/15/2018	COA						13												13	1				7		*Anapistula* sp. (1) *Texoreddellia* sp. (1)
Millipede Cave	12/1/2017	COA						1												5					6		*Anapistula* sp. (7) Trichoniscidae (1)
Millipede Cave	5/15/2018	COA						3												11	2				5		*Anapistula* sp. (2)
Mushroom Cave	6/5/2018	COA								1											3						
New Comanche Trail Cave	8/15/2018	TC			7							2															*Tartarocreagris* sp. (1)
No Rent Cave	1/30/2018	TC						1												35		6					*Batrisodes* sp. (4) *Texoreddellia* sp. (2)
No Rent Cave	8/30/2018	TC																		15	20	2					*Texoreddellia* sp. (1)
North Root Cave	5/10/2018	TC									2																*Texoreddellia* sp. (1)
Pilfer Cave	7/30/2018	TC																									*Texella grubbsi* (2)
Pipeline Cave	8/21/2018	COA								60			2								2	39			2		*Batrisodes* sp. (1) *Texella mulaiki* (5) *Texoreddellia* sp. (1)
Pond Party Pit	1/10/2018	COA	2																		5	8					Trichoniscidae (2)
			Endangered Species						**Species of Concern**											**Other Significant Troglobites**							
Cave	**Survey Date**	**Monitoring Agency**	***Rhadine persephone***	***Tartarocreagris texana***	***Tayshaneta myopica***	***Texamaurops reddelli***	***Texella reddelli***	***Texella reyesi***	***Batrisodes reddelli***	***Cicurina bandida***	***Cicurina travisae***	***Eidmannella reclusa***	***Rhadine austinica***	***Rhadine subterranea***	***Spinalopsana mohri***	***Tartarocreagris comanche***	***Tayshaneta concinna***	***Tayshaneta devia***	***Texella spinosaca***	***Cicurina buwata***	***Eidmannella sp.***	***Speodesmus sp.***	***Speodesmus bicornourus***	***Tartarocreagris infernalis***	***Tayshaneta sp.***	***Texoreddellia texensis***	**Other notable species detected**
Pond Party Pit	8/28/2018	COA						17			1										3	7					*Rhadine* sp. (7) *Tartarocreagris* sp. (11)
Rolling Rock Cave	11/16/2017	COA									6																*Perimyotis subflavus* (2) Trichoniscidae (1)
Seibert Sink	1/18/2018	COA																			2				1		

Seibert Sink	8/10/2018	COA								3											1	3					Pseudoscorpionida (1) *Texella spinoperca* (2) Trichoniscidae (6)
Slaughter Creek Cave	9/14/2018	COA								17												18					*Batrisodes* sp. (1)
Spanish Wells Cave	2/15/2018	TC							7						17												*Stygobromus russelli* (300)
Spanish Wells Cave	8/17/2018	TC							75																		*Stygobromus russelli* (5)
Spider Cave	11/16/2017	COA					5				18										1		3				Pseudoscorpionida (2)
Spider Cave	5/17/2018	COA	1								17										2		2				
Stark's North Mine Cave	11/21/2017	TC															2				9						*Perimyotis subflavus* (10) *Tartarocreagris* sp. (4)
Stark's North Mine Cave	6/1/2018	TC															1										
Stovepipe Cave	1/10/2018	COA				11		22			13	4		2								23					Pseudoscorpionida (1) Trichoniscidae (34)
Stovepipe Cave	8/28/2018	COA	3			9		19			16	5									20	12					*Tartarocreagris* sp. (6) Trichoniscidae (16)
Talus Springs Cave	8/30/2018	TC																									
Tardus Hole	11/7/2017	TC																									Trichoniscidae (2)
Testudo Tube Cave	1/9/2018	TC/COA													8					52	2	30					*Batrisodes* sp. (4) *Eurycea tonkawae* (25) *Stygobromus russelli* (50) Trichoniscidae (5)
Testudo Tube Cave	8/31/2018	COA													20					28	21	8					*Batrisodes* sp. (6) *Eurycea tonkawae* (19) *Stygobromus russelli* (27)
Tooth Cave	11/16/2017	TC		1	5			56			37	6											4				*Perimyotis subflavus* (3) Trichoniscidae (1)
Tooth Cave	5/25/2018	TC	2		2	1		34			36	9											6				*Texoreddellia* sp. (4)
Trapdoor Spider Cave	8/14/2018	COA								2												3					*Texella spinoperca* (3)

Two Trunks Cave	1/23/2018	TC									4																
Weldon Cave	1/30/2018	TC												2									2				
			Endangered Species						**Species of Concern**											**Other Significant Troglobites**							
Cave	**Survey Date**	**Monitoring Agency**	***Rhadine persephone***	***Tartarocreagris texana***	***Tayshaneta myopica***	***Texamaurops reddelli***	***Texella reddelli***	***Texella reyesi***	***Cicurina reddelli***	***Cicurina bandida***	***Cicurina travisae***	***Eidmannella reclusa***	***Rhadine austinica***	***Rhadine subterranea***	***Sphalloplana mohri***	***Tartarocreagris comanche***	***Tayshaneta concinna***	***Tayshaneta devia***	***Texella spinoperca***	***Cicurina buwata***	***Eidmannella* sp.**	***Speodesmus* sp.**	***Speodesmus bicornourus***	***Tartarocreagris infernalis***	***Tayshaneta* sp.**	***Texoreddella texensis***	**Other notable species detected**
Weldon Cave	8/28/2018	TC						2												4	2		2				*Aphrastochthonius* sp. (2) *Perimyotis subflavus* (1)
Whirlpool Cave	11/15/2016	TC/COA								4											1						*Nylanderia fulva* (925)
Whirlpool Cave	8/27/2018	TC/COA								13			3														*Nylanderia fulva* (205)

[1] All survey data and full species lists available by request through COA and TC.

[2] Surveyors in FY18 include Todd Bayless, Christina Campbell, Travis Clark, Devin Grobert, Amanda Fernandez, Paul Fushille, Sara Hamilton, Linda Laack, Michael McMahn, Julie Murray, Kathleen O'Connor, Mark Sanders, Jonny Scalise, Blake Sissel, Kenneth Sparks, Colin Strickland, and Drew Thompson.

EXHIBIT B:

CAVE CRICKET EXIT COUNT DATA REPORTS

FY18 COA/TC CAVE CRICKET EXIT COUNT DATA REPORTS

Surveyed Caves	Fall 2016 (November/ December)				Winter 2017 (January/February)				Spring 2017 (May/ June)				Summer 2017 (August/ September)			
	N:	J:	A:	TI:	N:	J:	A:	TI:	N:	J:	A:	TI:	N:	J:	A:	TI:
Adobe Springs Cave	1	16	46	163					130	523	566	1173				
Airman's Cave					334	162	9	505					493	95	60	648
Broken Arrow Cave	294	120	345	759					323	258	993	1574				
Cave Y					96	139	35	270					174	431	122	727
Cold Cave					727	126	0	853					254	67	360	681
Cortana Cave					83	28	6	117					42	53	217	312
Cotterell Cave					1574	317	182	2073					928	204	108	1240
District Park Cave	355	248	4	607	646	213	1	860	554	761	330	1645	293	452	5990	6735
Flint Ridge Cave	39	66	13	118	150	70	23	243	57	51	66	174	37	56	247	340
Gallifer Cave					15	6	1	22					12	189	591	792
Get Down Cave	103	199	56	358	301	136	31	468	568	292	324	1184	25	105	158	288
Geode Cave					3	13	10	26					26	21	197	244
Jest John Cave													213	511	2044	2768
Jester Estates Cave	205	92	205	502					606	76	89	771				
Kretschmarr Cave	23	50	55	128					79	287	77	443				
Little Bee Creek Cave	1	2	0	3					0	35	67	102				
Lost Oasis Cave					876	101	0	977	471	169	484	1124	55	13	38	106
Maple Run Cave					1582	301	142	2025					119	187	47	353
Midnight Cave					8700	9602	4527	22829					2019	8073	8948	19040
Millennium Cave					377	65	20	462	2584	1746	1137	5467	2772	1713	1214	5699

No Rent Cave					399	371	2	772					180	138	218	536
Pipeline Cave													391	231	129	751
Pond Party Pit					149	69	85	303					36	27	81	144
Seibert Sink					207	454	219	880					142	34	98	274
Sink in the Woods	168	122	17	307					66	152	496	714				

Surveyed Caves	**Fall 2016 (November/December)**				**Winter 2017 (January/February)**				**Spring 2017 (May/ June)**				**Summer 2017 (August/ September)**			
Sinky Dinky					839	849	62	1750					320	360	553	1233
Spanish Wells Cave					29	24	2	55					44	59	428	531
Spider Cave	21	7	23	51					130	43	59	232				
Stark's North Mine	0	0	4	4					0	158	536	694				
Stovepipe Cave					118	63	41	222					198	17	106	321
Testudo Tube					115	68	22	205					3	3	157	163
Tooth Cave	13	15	49	77					14	29	4	47				
Weldon Cave					750	1074	5	1829					165	105	715	985
Whirlpool Cave					8152	1795	43	9990					622	539	316	1477
Winter Woods					1262	468	26	1757					5	11	288	304
Wyoka Cave	1083	622	69	1774					223	114	524	861				

N= nymphs; J= juveniles; A= adults; TI= total individuals.