Balcones Canyonlands Conservation Plan Coordinating Committee
Cave Substitution Policy

Adopted: 8/21/15

Precinct 3 County Commissioner Gerald Daugherty

District 7 City Council Member Leslie Pool

Acknowledged: _____ William A. Conrad, Coordinating Committee Secretary

Purpose

Provide a process that that will allow the Balcones Canyonlands Conservation Plan (BCCP) Coordinating Committee to implement conditions in the BCCP Endangered Species Permit (ES 788841-2 and future revisions, amended permits, or subsequent permits) that allow caves listed in the 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

BCCP Permit Conditions

BCCP Permit (TE 788841-2) Condition S2 [related to Endangered Species covered by the permit]: If during investigations for development of a tract, 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. The determination of "significant diversity" will be made by the permit applicants and the Service, in association with karst experts. The inclusion of such a karst feature would not increase the number of caves to be protected by the BCCP, but would result in the new feature replacing a previously identified cave or caves.

BCCP Permit (TE 788841-2) Condition T2 [related to Species of Concern covered by the permit]: If during investigations for development of a tract, 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. The determination of "significant diversity" will be made by the permit applicants and the Service, in association with karst experts. The inclusion of such a karst feature would not increase the number of caves to be protected by the BCCP, but would result in the new feature replacing a previously identified cave or caves.

Roles and Responsibilities

BCCP Coordinating Committee - was created to implement the BCCP - Shared Vison. The BCCP Interlocal Cooperation Agreement requires that the Coordinating Committee carry out the BCCP Shared Vision as Authorized by the BCCP federal permit. It may adopt policies recommended by its Secretary. They are responsible for adopting this policy, providing public involvement with respect to its implementation, and for making decisions and taking action as provided by this policy including initial approval that would trigger actions to initiate a minor permit amendment.

Permit Covered Governing Bodies - as provided in the BCCP Interlocal Cooperation Agreement include Austin City Council and Travis County Commissioners Court. They are responsible for providing additional opportunities for public involvement and reviewing the Coordinating Committee's decisions to substitute caves for those covered in the permit and for taking action as they deem appropriate as provided for in the BCCP Interlocal Cooperation Agreement for permit amendments.

U.S. Fish and Wildlife Service (Service) - is the federal agency authorized by the Endangered Species Act to issue, suspend, and revoke incidental take permits in accordance with Section 10(a)(1)(B) of the Endangered Species Act and its implementing regulations, policy and guidance. They issued permit TE-788841-2 based on the March 1996 Habitat Conservation Plan and Final Environmental Impact Statement. Under their authorities, they are responsible for reviewing and approving any requests to amend this permit. The Service's role is to advise the BCCP on matters related to permit compliance and Fish and Wildlife Service processes and procedures at the earliest possible opportunity.

Third Parties - many caves identified for protection in BCCP are on property owned by third parties not bound to BCCP. They are not required to coordinate with or seek approval from BCCP before taking action that may affect a BCCP listed cave. Third parties may offer cave protection to BCCP for permit covered caves or for caves that might be considered for substitution by BCCP.

Cave Substitution Process

Background

The regional Endangered Species Act Section 10(a)(l)(B) permit (TE 788841-2), also known as the Balcones Canyonlands Conservation Plan (BCCP), requires the Permit holders (City of Austin and Travis County) to acquire, protect, and ensure management that preserves the environmental integrity of 62 listed caves protecting populations of six endangered karst invertebrates and 25 karst species of concern (SOC). This Permit "is subject to compliance with, and implementation of, the terms and conditions of the Environmental Impact Statement and Habitat Conservation Plan" (EIS/HCP) as well as all specific conditions contained in the Permit itself (USFWS 1996a).

One such condition described in the Permit states that "if during investigations for development of a tract, 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 caves identified for protection by the BCCP. The determination of 'significant diversity' will be made by the permit applicants and the Service, in association with karst experts. The inclusion of such a karst feature would not increase the number of caves to be protected by the BCCP, but would result in the new feature replacing a previously identified cave or caves" (USFWS 1996a).

In order to meet the terms and conditions of the U.S. Fish and Wildlife Service (USFWS) Permit, Permit holders determined a need to define "significant diversity of troglobitic fauna" as it applies to eligibility of a cave for substitution, and determine 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. These criteria are not intended to evaluate whether a BCCP-listed caves has met Permit compliance, but rather only to evaluate caves for substitution. Following Permit conditions, a group of karst experts, USFWS staff, and Permit holder staff collaborated on these criteria as members of the BCCP Scientific Advisory Committee Karst Sub-committee (chair: Dr. Nico Hauwert).

Significant Troglobitic Diversity as Applied to Conservation of Karst Species

Due to the predicted loss of the vast majority of potential karst habitat allowed by the BCCP, the EIS/HCP states that "the adequacy of the plan is contingent upon full implementation of the acquisition and management strategies detailed in the BCCP", which includes caves named as specific localities for the six endangered karst invertebrates and 25 BCCP-listed karst SOCs (USFWS 1996b). The EIS/HCP also stresses that given the fact that several BCCP karst SOCs were known from only a few caves when the plan was written, the loss of even one BCCP-listed cave could result in a major reduction to the species' population (USFWS 1996b).

However, the EIS/HCP acknowledges that although the BCCP was designed to protect most known localities of endangered karst invertebrates and karst SOCs at the time of permit issuance, "the possibility remains that features may be found that provide habitat for listed species or other equally rare karst invertebrates", and there is a "high probability that other new rare species will be described from Travis County in the future" (USFWS 1996b). The Permit provides for these types of new discoveries to be considered substitutions for BCCP-listed caves if such karst features provide a "significant diversity of troglobitic fauna" (USFWS 1996a).

In order to adhere to the protection strategy in the EIS/HCP and Permit for listed karst invertebrates, as well as ensuring Permit holders receive the "No Surprises" guarantee for protecting the 25 karst SOCs, a karst feature considered for exchange with a BCCP-listed cave must consider those species for which the BCCP cave was designated to protect. However, the EIS/HCP also guides Permit holders to attempt to protect newly discovered karst features that provide habitat for other equally rare karst invertebrates (USFWS 1996b).

The USFWS Biological Opinion also states that the BCCP "identifies an option that establishes a process that allows any newly discovered cave to be protected in the place of a less biologically significant cave currently identified for protection" (USFWS 1996c).

Incorporating this guidance from the EIS/HCP and Biological Opinion, the determination of a replacement cave's significant biological diversity will consider several factors that include species composition, diversity, and abundance, as well as the cave's location and ecological benefits. See Methodology for Assessing Significant Diversity and Environmental Integrity of BCCP Caves and Potential Substitution Caves for specifics on these factors and methodology used for determining significant troglobitic diversity of karst features.

Environmental Integrity as Applied to Karst and Caves

The EIS/HCP states that for a karst fauna area to be considered protected, it must "contain a large enough expanse of continuous karst and surface area to maintain the integrity of the karst ecosystem on which each species depends." The EIS/HCP also provides protection criteria to meet this goal, stating that "the size and configuration of each karst fauna area must be adequate to maintain moist, humid conditions, air flow, and stable temperatures in the air-filled voids; maintain an adequate nutrient supply; prevent contamination of surface and groundwater entering the ecosystem; prevent or control the invasion of exotic species, such as fire ants; and allow for movement of the karst fauna and nutrients through the interstitium between karst features" (USFWS 1996b).

The EIS/HCP states that, "in most instances, this will entail protecting the entire surface and sub-surface drainage area of each cave and enough of the surface vegetation community to support small animals and buffer against fire ant infestations" (USFWS 1996b).

Although the 1996 EIS/HCP does not provide a quantifiable area for protection of the surface vegetation community, it does address the need for this information by stating that the delineation of appropriate boundaries for individual cave preserves will require additional studies to determine the surface area necessary to maintain the biological resources important to the cave (USFWS 1996b).

Research and information needs such as this were also outlined in the Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas (1994) as one of four major recovery actions; the EIS/HCP reiterates that the effective enactment of this and other recovery actions are necessary "to assure that the implementation of the BCCP has no negative impact on the population viability of the endangered karst invertebrates" (USFWS 1996b).

This recovery action was met with the completion of USFWS Karst Preserve Design Recommendations in 2012, which quantifies the protection criteria quoted above from the BCCP EIS/HCP, and provides specific preserve components for configuring karst preserves that maintain environmental integrity of the karst invertebrate locations and ecosystems they are designed to protect.

According to USFWS' Karst Preserve Design Recommendations, in addition to protecting the entire surface and sub-surface drainage areas, preserve components which maintain the cave's environmental integrity should include: the cave cricket foraging area; a preserve configuration of at least 40 acres that protects the surface plant and animal communities and ensures that the cave footprint is over 105 meters from the nearest hard edge; and is free of incompatible forms of land use and sources of contamination (USFWS 2012).

These recommendations (USFWS 2012) also reiterate the need for karst preserves to be protected and management assured through acquisition or formal management agreements, which is also a requirement of the Permit and EIS/HCP (USFWS 1996a, USFWS 1996b).

Additional preserve components meeting these objectives and methods for quantifying and evaluating these factors are described in Methodology for Assessing Significant Diversity and Environmental Integrity of BCCP Caves and Potential Substitution Caves.

Caves submitted as substitution caves for BCCP-listed caves will be assessed for their environmental integrity using these factors, and measured against the environmental integrity assessment of the cave or caves suggested for replacement.

Only replacement caves with sufficient environmental integrity and significant diversity of troglobitic diversity, and equivalent to or superior to the BCCP cave it has been submitted to replace will be used as an adequate substitution. See Methodology for Assessing Significant Diversity and Environmental Integrity of BCCP Caves and Potential Substitution Caves for methodology on factors for determining environmental integrity of karst features.

Literature Cited

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

U. S. Fish and Wildlife Service. 1996a. Federal Fish and Wildlife Permit No. TE-788841-2.

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. 1996c. Biological Opinion for the Issuance of a Section 10(a)(I)(B) Permit for the Balcones Canyonlands Conservation Plan. Albuquerque, New Mexico.

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

Methodology for Assessing Significant Diversity and Environmental Integrity of BCCP Caves and Potential Substitution Caves

The following methodology describes criteria that will: 1) define significant diversity of troglobitic fauna in caves considered for replacement of BCCP-listed caves and 2) determine protection measures that quantify preservation of environmental integrity for BCCP-listed caves and candidate substitution caves.

These criteria will be used in determining both the need to substitute a feature listed on the Permit, such as when a cave ecosystem has been significantly damaged or destroyed or if Permit holders have been unable to secure adequate protections for a cave, as well as whether the substitution cave will adequately replace the previously identified cave or caves.

Caves submitted as substitution for BCCP-listed caves will be assessed for equal or superior significant diversity of troglobitic fauna and environmental integrity using the factors below, and measured against the assessment of the cave or caves suggested for replacement.

Evaluation to Determine Substitution Need and Suitability of Replacement Caves

Caves submitted as substitution caves for BCCP-listed caves will be assessed for whether they meet objectives for significant diversity of troglobitic fauna and environmental integrity using the

factors detailed below, and measured against equal assessments of the cave or caves suggested for replacement.

Only replacement caves meeting significant diversity requirements and with sufficient environmental integrity equal or superior to the BCCP cave it has been submitted to replace will be used as an adequate substitution.

Essential to this evaluation is that the replacement cave(s) be a confirmed locality for the same federally listed karst invertebrate(s) and/or karst species of concern (SOC) as the BCCP-listed cave designated for substitution.

Evaluations for BCCP-listed caves and candidate replacement cave(s) will be made using the most up-to-date research and karst preserve design recommendations available at the time of the assessment. If additional research valuable to this evaluation process becomes available in the future, the BCCP Scientific Advisory Committee's karst sub-committee will review the new information and incorporate or revise assessment factors below if deemed appropriate.

This document is not intended to be a precise rating system or contain a complete scoring rubric, but rather serves as a comprehensive list of the data that would be ideal to have in hand to evaluate cave substitution.

Caves are not easily comparable in terms of biology, ecosystem health, and value to preserve strategies. Each situation is different, and it is impossible to anticipate the variety of issues that may arise when comparing two caves.

The purpose of this document is to provide the evaluation team with a list of all reasonably measured factors relevant to the decision for approving a cave for substitution.

This document is strictly designed for the cave substitution process and not intended to be used to evaluate whether a BCCP-listed cave's protections are compliant with the Permit.

Evaluations for proposed substitutions will occur on a case by case basis, which includes determining if sufficient data are available to evaluate both BCCP-listed caves proposed for substitution and their candidate replacement cave(s).

If there are too many unknowns or assumptions about either cave, evaluators are allowed to reject the substitution proposal until the proposer fills in more of the dataset, up to the discretion of the evaluation team.

Proposers allowing cave access to evaluators may provide one option for obtaining missing evaluation data.

Factors for Determining Significant Diversity of Troglobitic Fauna for a Candidate Substitution Cave

Candidate replacement caves will be compared with BCCP caves designated for substitution and will only be accepted as replacements if the following conditions are met:

1. Replacement cave has similar or greater species composition in relation to target species (federally listed taxa or karst SOCs), as determined by the following factors:
    a. The replacement cave must be a confirmed locality for the same federally listed karst invertebrate(s) as the BCCP cave it will be replace.

b. For BCCP caves containing one of the 25 karst SOC, the replacement cave must contain the same SOC(s) as the BCCP cave it will replace.
   i. Exception: If the BCCP cave does not contain any of the 25 karst SOC (Talus Spring Cave), then the replacement cave must contain either: 1) one or more karst SOC listed on the Permit or 2) one or more troglobitic species of similar taxa to the SOCs listed on the Permit considered to be at least as rare as the BCCP-listed SOCs.
   Rare karst invertebrates not listed as SOCs on the Permit will be evaluated using information from the BCP Karst Database, Texas Memorial Museum's TexBio Database, Texas Park and Wildlife Department's Species of Greatest Conservation Need (SGCN) list rankings (TPWD 2011), and NatureServe's Conservation Status Assessments (Master et al. 2012) to quantify significance of the species in terms of rarity and need for protection.

2. Replacement cave has similar or greater overall troglobitic karst invertebrate species diversity, as determined by the following factors:
   a. Demonstrate through repeated biological surveys that the replacement cave has greater or equal diversity; for example, by graphing the number of troglobitic taxa seen on each visit and noting those previously seen vs. new occurrences. Karst invertebrate surveys should follow survey methodology described in USFWS 2014b, which explains that in order to assess presence/absence of endangered karst invertebrates with a high level of confidence, caves should be surveyed at least 14 times.
   b. Evaluate whether the caves in consideration have been thoroughly measured in terms of diversity. Since many karst species are rare and poorly studied, problems with detection and taxonomy hamper creating a complete list. Evaluate and explain the status of the diversity list for the cave(s).
   c. Evaluate the numbers of troglobitic taxa vs. other taxa (troglophiles, trogloxenes, or accidentals). In some cases the cave entrance has great diversity, but the deep cave community structure is limited.
   d. Additional rare karst invertebrates not listed as SOCs on the Permit will be evaluated using information from the BCP Karst Database, Texas Memorial Museum's TexBio Database, Texas Park and Wildlife Department's SGCN list rankings (TPWD 2011), and NatureServe's Conservation Status Assessments (Master et al. 2012) to quantify significance of the species in terms of rarity and need for protection.
   e. Consider non-troglobitic karst species, which rank high on TPWD's SGCN list and NatureServe's Conservation Status Assessments list that could be affected/protected by the substitution (ex: bats, salamanders), as contribution to the overall biological diversity of the cave being considered for substitution.

3. Replacement cave has similar or greater Permit-listed species abundance, as determined by the following factors:
   a. Demonstrate through repeated biological surveys the relative abundance of taxa on the cave's species list. With well-delineated in-cave survey methodology, it should be clear where the rare species are found within the cave, and how many are typically seen in a visit. If collection methods are not performed in a uniform fashion, results may not be comparable among sites or within a site on different survey days; this should be explained or accounted for in the evaluation. Karst invertebrate surveys should follow survey methodology described in USFWS 2014b.

b. If the entire cave isn't inventoried during each visit, then an estimate of the non-surveyed area would help determine the total potential of the cave to support a healthy population. This estimate will account for the fact that, on average, larger caves have more habitat available and a greater diversity of habitat, thus having a greater diversity and abundance of fauna (Schneider and Culver 2004).

4. Replacement cave's location is within the same karst fauna region as defined by Veni (1992) or future USFWS-approved revisions of the KFRs.
5. Replacement cave's location is within the same BCCP-protected cave cluster (Northwood, McNeil, or Four Points). Note: only applicable if BCCP cave to be substituted is within one of these cave clusters. This requirement ensures that the replacement cave is contributing to a Karst Fauna Area that helps meet the recovery criteria for the federally listed karst invertebrates in the BCCP cave to be substituted.

Factors for Determining Environmental Integrity of BCCP Listed Caves and Potential Replacement Caves

The following protection criteria, largely based on USFWS Karst Preserve Design Recommendations (2012), will be used to quantify the environmental integrity of BCCP caves and candidate substitution caves for determining both the need for substitution of a BCCP cave and adequate replacement by a candidate substitution cave.

Ideally preferred protection goals are also described for each factor to guide evaluation assessments.

A. Karst feature surface area protection measures:

1. Percent of cave footprint within protected area:
   a. Determined by GIS spatial analysis and use of footprint digitized from cave map to quantify percent protected.
   b. Protected area – lands owned or acquired by the Permit holders (City of Austin and Travis County) or BCP managing partners that are managed for protection of the cave or caves, or lands that have formal management agreements with the Permit holders as described in S-4 and T-4 of the Permit (USFWS 1996a).
   c. Ideally preferred protection goal: 100 percent of cave footprint is within protected area (USFWS 2012).

2. Distance of cave footprint to nearest preserve edge:
   a. Determined by GIS spatial analysis by calculating the distance of edge of the digitized cave footprint to nearest preserve boundary.
   b. Edge: defined as the cave preserve's property boundary and/or where impervious cover dissects the natural area surrounding the karst feature, such as paved roads or urban development areas detrimental to surface protection efforts.
   c. Ideally preferred protection goal: footprint is as near to the center of the protected area as possible, and at least 105 m from the preserve edge (USFWS 2012).

3. Percent of surface drainage within protected area:
   a. Determined by GIS spatial analysis by quantifying percent of delineated surface drainage basin that is within protected area(s).

b. Surface drainage basins will be conservatively over-estimated with high confidence by licensed geologists performing hydrogeologic studies of caves using methods described in Veni 2003, Hauwert et al. 2005, Hauwert 2009, or other methods approved by the BCCP Scientific Advisory Committee's karst sub-committee.
c. Where surface drainage basin delineations are unable to be performed due to denied access, this analysis will be performed based on the area draining to the cave entrance using available topographic and cave map data.
d. Ideally preferred protection goal: the entire surface drainage basin is within the protected area (USFWS 2012).

4. Percent of subsurface drainage basin within protected area:
   a. Determined by GIS spatial analysis by quantifying percent of delineated subsurface drainage basin that is within protected area(s).
   b. Subsurface drainage basins will be conservatively over-estimated with high confidence by licensed geologists performing hydrogeologic studies of caves using methods described in Hauwert and Cowan 2013, Veni 2003, or other methods accepted by the SAC karst sub-committee.
   c. Where subsurface drainage basin delineations are unable to be performed due to denied access, this analysis will be performed using a delineation made by the contour level at the bottom of the cave, as required by S-3 and T-3 of the Permit (USFWS 1996a).
   d. Ideally preferred protection goal: the entire subsurface drainage basin is within the protected area (USFWS 2012).

5. Percent of cave cricket foraging area (105 meters from cave footprint) within protected area:
   a. Determined by GIS spatial analysis by creating a 105m buffer area around the cave's footprint digitized from its cave map, and quantifying percent of this buffer area that is within protected area(s).
   b. Ideally preferred protection goal: 100 percent of cave cricket foraging area is within the protected area (USFWS 2012).
   c. As an alternative to assuming a 105m buffer, site-specific cave cricket surveys could be performed in order to determine the foraging area around a specific cave. Methods should include an adequate survey area and effort during appropriate season and over enough nights to capture the large diversity of exit and foraging patterns known for *Ceuthophilus* spp. Taylor et al. (2005) and Zara Environmental (2013, 2014) give examples of methods used for site specific cave cricket foraging studies in Texas.

6. Preserve tract size:
   a. Determined by GIS spatial analysis. In cases where BCP or other preserve tracts are adjoining each other, all connected interior preserve tract boundaries will be dissolved to account for connectivity to all preserve areas. Cave preserve tract delineations also cease at hard edges such as paved roads or impervious cover detrimental to surface protection efforts.
   b. NOTE: This environmental factor is extremely important when determining environmental integrity of a candidate replacement cave. A large, intact tract has ecological stability and natural buffers that are difficult if not impossible to create artificially or manage successfully. Large preserves protect the quality of native

surface plant, arthropod, and animal communities necessary for adequate nutrient input (USFWS 2012). Large preserves are also more resilient and typically support caves that need less active management (USFWS 2012). Large preserves with contiguous karst areas have abundant mesocavernous zones which are likely to support immeasurable populations of rare troglobites. Having naturally resilient preserves also makes them less sensitive to problems associated with loss of funding and staffing resources that may happen over time.

c. USFWS has chosen preserve size as a critical indicator in determining quality of a karst preserve (USFWS 2012). Ideally preferred protection goals include a preserve size of at least 100 acres to be considered a high quality preserve, or at least 40 acres to be considered a medium quality preserve (USFWS 2012).

7. Net gain in protected land for BCP:
   a. Determined by subtracting acreage of BCCP cave's protected area from the replacement cave's preserve tract size.
   b. Ideally preferred protection goal: Cave preserves with larger protected areas will be favored due to benefits described above in item 6, preserve tract size.

8. Shape of protected area:
   a. Subjective determination using map that shows cave's location within delineated preserve area boundaries.
   b. Ideally preferred protection goal: USFWS 2012 defines preserves that are circular in shape and/or are connected to other preserves as an ideally preferred protection measure, along with the cave or caves being as near to the center of the preserve area as possible to reduce edge effects.

9. Landscape mosaic of protected area (% woodland/grassland):
   a. Determined by GIS spatial analysis using NAIP aerial imagery and/or LIDAR data to classify landscape components in the protected areas within 100 acres of cave.
   b. Proper landscape mosaic helps to ensure the quality of the native surface plant, arthropod, and animal communities, beneficial to the cave's nutrient input (USFWS 2012).
   c. Ideally preferred protection goal: according to USFWS (2012), cave preserve areas should include ≥80% woodland to 10% grassland mosaic.

10. Number of adjacent karst features within protected area:
    a. Quantified by performing karst feature surveys in protected area within a 100 acre radius of cave which includes the surface and subsurface drainage basins, following recommendations in USFWS 2014b.
    b. Ideally preferred protection goal: cave preserves should be designed to protect as many caves or karst features as possible to support nutrient input from cave crickets (USFWS 2012).

11. Incompatible land use/fragmentation:
    a. Subjective determination using aerial map that demonstrates the cave's location and incompatible forms of land use within delineated preserve area boundaries.
    b. Incompatible forms of land use within the delineated karst preserve itself such as paved roads, impervious cover, livestock, water retention ponds, or hiking and

biking trails should also be documented for consideration of this factor (USFWS 2012). Also describe adjacent land use outside of the preserve including developments, roads, impervious cover, etc.

c. Ideally preferred protection goals: There should be no paved roads, development, impervious cover or other structures that result in permanent habitat loss within the cave's protected area (USFWS 2012). Protected areas should also not include trails or picnic tables inside the cave cricket foraging area, the surface or subsurface drainage basin or within 105m of the cave footprint (USFWS 2012).

12. Proximity to infrastructure/ utilities:
    a. Subjective determination using aerial map that illustrates the cave's location and infrastructure within and adjacent to delineated preserve area boundaries.
    b. Ideally preferred protection goal: cave preserve is free of underground pipelines, storage tanks, water retention ponds, or other structures/facilities that could cause contamination (USFWS 2012).

B. Hydrogeologic quality of troglobitic habitat measures:

1. Contribution to water quality/quantity within the karst ecosystem. Quantified by:
    a. Surface Catchment Area size
    b. Maximum Potential Subsurface Catchment Area based on data collected
    c. Average combined drip rate per cave following methodology described in Hauwert and Cowan (2013).
    d. Lack of subsurface pipelines or retention basins (USFWS 2012).
    e. Ideally preferred protection goals: larger catchment areas are preferred due to their more significant contribution to water quantity within the karst ecosystem.

2. Total accessed length, depth, and volume of cave:
    a. Determined by cave maps. Also, if applicable, describe potential of undiscovered cave passages with supporting evidence.
    b. Volume of cave determined by methods described in Krejca and Weckerly (2007).
    c. Ideally preferred protection goal: USFWS (2012) states that larger, deeper caves may help protect against impacts to protected species from climate change by better maintaining in-cave stable temperatures and high humidity.

3. Presence of permanent water bodies within cave:
    a. Determined by in-cave surveys and/or documentation on cave maps and data from access to phreatic zone habitat where aquatic life such as aquatic salamanders may potentially be found.
    b. Ideally preferred protection goal: caves with permanent bodies of water (pools, cave streams) are preferred for their contribution of habitat for aquatic life, potentially increasing biological diversity.

C. Ecological health measures:

These parameters may not be a critical factor on their own, but are important for the evaluation team to help understand the current ecological status and potential future management needs of the cave.

1. Healthy/stable cave cricket population:
    a. Use existing cave cricket exit count survey results to assess population trends at caves.
    b. If cave cricket data are absent or lacking, perform cave cricket monitoring following recommendations in USFWS 2014a.
    c. Ideally preferred protection goal: results at caves will demonstrate a healthy and stable cave cricket population as demonstrated by repeated surveys.

2. Density of red-imported fire ants (RIFA), tawny crazy ants, and/or other invasive species that could impact the cave ecosystem:
    a. Perform surveys using a scientifically accepted protocol for tawny crazy ants (*Nylanderia fulva*) to confirm absence at sites: caves suggested as candidates for replacement caves should not have infestations of tawny crazy ants.
    b. Quantify RIFA densities using survey methods detailed in USFWS 2014a to ensure that RIFA threshold levels have not been reached at replacement caves.

Evaluation Documentation Requirements

The following documents and information should be included for conducting the evaluation to determine substitution need of a BCCP-listed cave and suitability of its replacement cave(s) (see above for details/definitions of specific factors):

1. Maps of each cave preserve area demonstrating the following:
    a. Cave location and footprint.
    b. Cave protection area.
    c. Surface and subsurface drainage basin delineations.
    d. Cave cricket 105 meter foraging area delineation.
    e. Adjacent karst feature locations.
    f. Landscape mosaic of karst preserve.
    g. Incompatible forms of land use within the delineated karst preserve.
    h. Infrastructure within and adjacent to delineated preserve area boundaries.
    i. Surrounding land use.

2. Cave map for each cave demonstrating length, depth, and permanent bodies of water.

3. Documentation confirming presence of federally-listed karst invertebrates and/or BCCP karst SOC's.

4. Species lists for each cave.

5. In-cave faunal survey results demonstrating species abundance and methodology for conducting surveys.
6. Hydrogeologic study reports demonstrating methodology to assess drainage basin delineations and average combined drip rate results.

7. Cave cricket exit count survey results at caves and methodology for conducting surveys.

8. RIFA survey data for caves demonstrating mound densities.

See the Cave Comparison Worksheet below (Table 1) for a summary of cave substitution evaluation criteria.

Table 1 Cave Comparison Worksheet

	Cave Substitution Evaluation Criteria Worksheet	BCCP Cave	Substitution Cave	Comments
	Significant Diversity Criteria			
1a.	Confirmed endangered species locality?			
1a.	List of endangered species (ES) present			
1b.	BCCP Species of Concern (SOC) locality?			
1b.	List of BCCP SOC present			
2a - 2c.	Replacement cave has similar or greater overall species diversity			
2d.	List of additional troglobitic species			
2d.	SGCN list ranking of additional troglobitic species			
2d.	Natureserve rarity rank of additional troglobitic species			
2e.	List of rare non-troglobitic species			
3.	Replacement cave has similar or greater overall species abundance			
4.	Karst Fauna Region			
5.	Replacement cave is within same BCCP cave cluster (if applicable)			
	Environmental Protection Criteria			
A.	**Karst feature surface area protection measures:**			
1.	Percent of cave footprint within protected area			
2.	Distance of cave footprint to nearest preserve edge			
3.	Percent of surface drainage within protected area			
4.	Percent of subsurface drainage within protected area			
5.	Percent of cave cricket foraging area within protected area			
6.	Preserve tract size			
7.	Net gain in protected land for BCP			
8.	Shape of protected area			
9.	Landscape mosaic of protected area (% woodland/grassland)			
10.	Number of adjacent karst features within protection area			
11.	Incompatible land use/fragmentation			
12.	Proximity to infrastructure/pipelines/utilities			
B.	**Hydrogeologic quality of troglobitic habitat measures:**			
1a.	Surface catchment area size			
1b.	Maximum potential subsurface catchment area			
1c.	Average combined drip rate			
2.	Total accessed length of cave			
2.	Total accessed depth of cave			
2.	Total accessed volume of cave			
3.	Presence of permanent water bodies in cave			
C.	**Ecological health measures:**			
1.	Cave cricket population: in-cave survey and exit count results			
2.	Red-imported fire ant density at site			
2.	Tawny crazy ants present at site?			

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How is a Cave Substitution Made?

a. A BCCP Coordinating Committee Member makes a proposal to substitute for a cave listed in condition S1 or T1 in the BCCP Federal Permit
b. BCP staff(s) assembles information required, as described in the Evaluation Documentation Requirements
c. Refer the proposal to the BCCP Scientific Advisory Committee – Karst Subcommittee for review, assessment, and recommendation to the Coordinating Committee for action.
d. When the Coordinating Committee takes action to accept a cave substitution proposal, the coordinating committee will initiate the BCCP amendment process for a minor amendment to the BCCP federal permit (Article 7, section 7.2, Interlocal Cooperation Agreement Between Travis County and City of Austin Implementing the Balcones Canyonlands Conservation Plan – Shared Vision)
e. Proposals for cave substitution will be completed within one year from the date of submission by a Coordinating Committee member. This allows for any needed information gathering, additional field investigations, data analysis, and limited Coordinating Committee meeting schedules. This timeline will allow BCCP to appropriately address issues of non-compliance in a manner that would not result in an immediate permit violation while allowing third party actions to proceed in a reasonable manner.

Karst Preserve Protection and Management Measures

These management measures must be able to be enacted at BCCP caves or candidate replacement caves. If for some reason the candidate replacement cave's site can not adhere to these measures, then it may not be considered as a substitution.

1. No public access allowed in cave:
    a. Ideally preferred protection goal: USFWS 2012 states that no public access should be allowed at caves: "to protect the subsurface habitat, several things should be carefully controlled including ensuring that the cave is entered for monitoring purposes only".
    b. Candidate replacement caves should not allow public access.

c. If recreational use is allowed in the cave's protected area, it should not interfere with karst management objectives as described in 11. c. (Incompatible land use) above and as defined in the most recently approved BCP Land Management Plan (Chapter IX, Karst Species Management).

2. Cave is (or will be) gated and/or fenced:
   a. Ideally preferred protection goal: perimeter fencing around cave preserves is preferred for protection of the karst ecosystem from dumping, vandalism, and trespass (USFWS 2014a). Properly designed and installed cave gates are also preferred where there is a history of trespass and vandalism, and where human health or safety may be at risk (USFWS 2014a).

3. Cave is (or will be) monitored/managed per most recent USFWS Karst Preserve Management and Monitoring Recommendations (2014a). Ideally preferred protection goals for this factor:
   a. Biological monitoring is being conducted.
   b. Vegetation management supports health of karst habitat.
   c. Red-imported fire ant management is performed.