DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R2–ES–2012–0035; 4500030114]

RIN 1018–AY22

Endangered and Threatened Wildlife and Plants; Endangered Status for Four Central Texas Salamanders and Designation of Critical Habitat

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Proposed rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), propose to list the Austin blind salamander, Jollyville Plateau salamander, Georgetown salamander, and Salado salamander as endangered under the Endangered Species Act of 1973, as amended (Act), and propose to designate critical habitat for the species. In total, we propose to designate approximately 5,983 acres (2,440 hectares) as critical habitat for the four species. The proposed critical habitat is located in Travis, Williamson, and Bell Counties, Texas.

DATES: We will accept comments received or postmarked on or before October 22, 2012. Comments submitted electronically using the Federal eRulemaking Portal (see **ADDRESSES** section, below) must be received by 11:59 p.m. Eastern Time on the closing date. We must receive requests for public hearings, in writing, at the address shown in the **FOR FURTHER INFORMATION CONTACT** section by October 9, 2012.

Public Informational Sessions and Public Hearings: We will hold two public informational sessions and two public hearings on this proposed rule. We will hold a public informational session from 5:30 p.m. to 6:30 p.m., followed by a public hearing from 7 p.m. to 8:30 p.m., in Round Rock, Texas, on Wednesday, September 5 (see **ADDRESSES**). We will hold a public informational session from 6:30 p.m. to 7:30 p.m., followed by a public hearing from 8 p.m. to 9:30 p.m., in Austin, Texas, on Thursday, September 6 (see **ADDRESSES**). Registration to present oral comments on the proposed rule at the public hearings will begin at the start of each informational session.

ADDRESSES: *Document availability:* You may obtain copies of the proposed rule on the Internet at *http://www.regulations.gov* at Docket No. FWS–R2–ES–2012–0035 or by mail from the Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

The coordinates or plot points or both from which the maps are generated are included in the administrative record for this critical habitat designation and are available at (*http://www.fws.gov/southwest/es/AustinTexas/*), *http://regulations.gov* at Docket No. FWS–R2–ES–2012–0035, and at the Austin Ecological Services Field Office (see **FOR FURTHER INFROMATION CONTACT**). Any additional tools or supporting information that we may develop for this critical habitat designation will also be available at the above locations.

Written Comments: You may submit written comments by one of the following methods:

(1) *Electronically:* Go to the Federal eRulemaking Portal: *http://www.regulations.gov.* Search for Docket No. FWS–R2–ES–2012–0035. You may submit a comment by clicking on ''Comment Now!''

(2) *By hard copy:* Submit by U.S. mail or hand-delivery to: Public Comments Processing, Attn: FWS–R2–ES–2012–0035ES–2012–0035; Division of Policy and Directives Management; U.S. Fish and Wildlife Service; 4401 N. Fairfax Drive, MS 2042–PDM; Arlington, VA 22203.

We request that you send comments only by the methods described above. We will post all comments on *http://www.regulations.gov.* This generally means that we will post any personal information you provide us (see the Information Requested section below for more information).

Public informational sessions and public hearings: The September 5, 2012, public informational session and hearing will be held at the Wingate by Wyndham Round Rock, 1209 N. IH 35 North, Exit 253 at Hwy 79, Round Rock, Texas 78664. The September 6, 2012, public informational session and hearing will be held at Thompson Conference Center, 2405 Robert Dedman Drive, Room 2.102, Austin, Texas 78705. People needing reasonable accommodations in order to attend and participate in the public hearings should contact Adam Zerrenner, Field Supervisor, Austin Ecological Services Field Office, as soon as possible (see **FOR FURTHER INFORMATION CONTACT**).

FOR FURTHER INFORMATION CONTACT: Adam Zerrenner, Field Supervisor, U.S. Fish and Wildlife Service, Austin Ecological Services Field Office, 10711 Burnet Rd, Suite 200, Austin, TX 78758; by telephone 512–490–0057; or by facsimile 512–490–0974. Persons who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Executive Summary

Why We Need to Publish a Rule

This is a proposed rule to list the Austin blind salamander (*Eurycea waterlooensis*), Jollyville Plateau salamander (*Eurycea tonkawae*), Georgetown salamander (*Eurycea naufragia*), and Salado salamander (*Eurycea chisholmensis*) as endangered.

With this rule, we are proposing to designate the following critical habitat for the four central Texas salamanders:

- Austin Blind salamander: 120 acres (49 hectares)
- Jollyville Plateau salamander: 4,460 acres (1,816 hectares)
- Georgetown salamander: 1,031 acres (423 hectares)
- Salado salamander: 372 acres (152 hectares)

The proposed critical habitat is located within Travis, Williamson, and Bell Counties, Texas.

The Basis for Our Action

Under the Endangered Species Act, we can determine that a species is endangered or threatened based on any of the following five factors: (A) Destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting the species continued existence. Based on our analysis under the five factors, we find that the four central Texas salamanders are primarily threatened by: factors A and D. Therefore, these species qualify for listing, which can only be done by issuing a rule.

The Act requires that the Secretary designate critical habitat for a species, to the maximum extent prudent and determinable, concurrently with making a determination that a species is an endangered or threatened species. Section 4(b)(2) of the Act requires that the Secretary designate critical habitat based upon the best scientific data available, and after taking into consideration the economic impact, the impact on national security, and any other relevant impact of specifying any particular area as critical habitat. Section 4(b)(2) of the Act provides that the Secretary may exclude any area from critical habitat if he determines that the benefits of excluding that area outweigh the benefits of including it in the designation, unless such an exclusion would result in the extinction of the species. This ''weighing'' of considerations under section 4(b)(2) of the Act is the next step in the designation process, in which the Secretary may consider particular areas for exclusion from the final designation.

We are preparing an economic analysis. To ensure that we consider the economic impacts, we are preparing a draft economic analysis of the proposed critical habitat designations. We will use information from this analysis to inform the development of our final designation of critical habitat for these species.

We will seek peer review. We are seeking comments from independent specialists to ensure that our critical habitat designations are based on scientifically sound data, assumptions, and analyses. We have invited these peer reviewers to comment on our specific assumptions and conclusions in these proposed critical habitat designations. Because we will consider all comments and information we receive during the comment period, our final determinations may differ from this proposal.

Information Requested

We intend that any final action resulting from this proposed rule will be based on the best scientific and commercial data available and be as accurate and as effective as possible. Therefore, we request comments or information from other concerned governmental agencies, Native American tribes, the scientific community, industry, or any other interested parties concerning this proposed rule. We particularly seek comments concerning:

(1) Biological, commercial trade, or other relevant data concerning any threats (or lack thereof) to these species and regulations that may be addressing those threats.

(2) Additional information concerning the historical and current status, range, distribution, and population size of these species, including the locations of any additional populations of these species.

(3) Any information on the biological or ecological requirements of these species, and ongoing conservation measures for these species and their habitats.

(4) Current or planned activities in the areas occupied by the species and possible impacts of these activities on these species.

(5) The reasons why we should or should not designate habitat as ''critical habitat'' under section 4 of the Act (16 U.S.C. 1531 *et seq.*) including whether there are threats to the species from human activity, the degree of which can be expected to increase due to the designation, and whether that increase in threat outweighs the benefit of designation, such that the designation of critical habitat may not be prudent.

(6) Specific information on:

(a) The amount and distribution of the four central Texas salamanders' habitats,

(b) What areas, that are currently occupied by these species, that contain features essential to their conservation,

(c) Special management considerations or protection that may be needed in critical habitat areas we are proposing, including managing for the potential effects of climate change,

(d) What areas not occupied at the time of listing are essential for the conservation of these species and why,

(e) How subterranean populations of these four salamander species are distributed underground, and

(f) The interconnectedness of salamander habitats in terms of hydrology, and whether salamanders are able to move between sites through underground aquifer conduits.

(7) Land use designations and current or planned activities in the subject areas and their possible impacts on the four central Texas salamanders and on proposed critical habitat.

(8) Information on the projected and reasonably likely impacts of climate change on the four central Texas salamanders and proposed critical habitat.

(9) Any probable economic, national security, or other relevant impacts of designating any area that may be included in the final critical habitat designation; in particular, we seek information on any impacts on small entities or families, and the benefits of including or excluding areas that exhibit these impacts.

(10) Whether any specific areas we are proposing for critical habitat designation should be considered for exclusion under section 4(b)(2) of the Act, and whether the benefits of potentially excluding any specific area outweigh the benefits of including that area under section 4(b)(2) of the Act; for example, areas that have a 10(a)(1)(B) permit and habitat conservation plan (HCP) that covers any of these salamanders may be considered for exclusion (potentially including the Four Points HCP that covers Jollyville Plateau salamanders).

(11) Whether we could improve or modify our approach to designating critical habitat in any way to provide for greater public participation and understanding, or to better accommodate public concerns and comments.

Please note that submissions merely stating support for or opposition to the action under consideration without providing supporting information, although noted, will not be considered in making a determination, as section 4(b)(1)(A) of the Act directs that determinations as to whether any species is an endangered or threatenedspecies must be made ''solely on the basis of the best scientific and commercial data available.''

You may submit your comments and materials concerning this proposed rule by one of the methods listed in the **ADDRESSES** section. We request that you send comments only by the methods described in the **ADDRESSES** section.

If you submit information via *http://www.regulations.gov,* your entire submission—including any personal identifying information—will be posted on the Web site. If your submission is made via a hardcopy that includes personal identifying information, you may request at the top of your document that we withhold this information from public review. However, we cannot guarantee that we will be able to do so. We will post all hardcopy submissions on *http://www.regulations.gov.* Please include sufficient information with your comments to allow us to verify any scientific or commercial information you include.

Comments and materials we receive, as well as supporting documentation we used in preparing this proposed rule, will be available for public inspection on *http://www.regulations.gov,* or by appointment, during normal business hours, at the U.S. Fish and Wildlife Service, Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Previous Federal Actions

The Austin blind and Salado salamanders were included in nine Candidate Notices of Review (67 FR 40657, June 13, 2002; 69 FR 24876, May 4, 2004; 70 FR 24870, May 11, 2005; 71 FR 53756, September 12, 2006; 72 FR 69034, December 6, 2007; 73 FR 75176, December 10, 2008; 74 FR 57804, November 9, 2009; 75 FR 69222, November 10, 2010; 76 FR 66370, October 26, 2011). The listing priority number has remained at 2 throughout the reviews for both species, indicating that threats to the species were both imminent and high in magnitude. In addition, on May 11, 2004, the Service received a petition from the Center for Biological Diversity to list 225 species we previously had identified as candidates for listing in accordance with section 4 of the Act, including the Austin blind and Salado salamanders.

The Jollyville Plateau salamander was petitioned to be listed as an endangered species on June 13, 2005, by Save Our Springs Alliance. Action on this petition was precluded by court orders and settlement agreements for other listing actions until 2006. On February 13, 2007, we published a 90-day petition finding (72 FR 6699) in which we concluded that the petition presented substantial information indicating that listing may be warranted. On December 13, 2007, we published the 12-month finding (72 FR 71040) on the Jollyville Plateau salamander, which concluded that listing was warranted, but precluded by higher priority actions. The Jollyville Plateau salamander was subsequently included in all of our annual Candidate Notices of Review (73 FR 75176, December 10, 2008; 74 FR 57804, November 9, 2009; 75 FR 69222, November 10, 2010; 76 FR 66370, October 26, 2011). Throughout the three reviews, the listing priority number has remained at 8, indicating that threats to the species were imminent, but moderate to low in magnitude. On September 30, 2010, the Jollyville Plateau salamander was petitioned to be emergency listed by Save Our Springs Alliance and Center for Biological Diversity. We issued a petition response letter to Save Our Springs Alliance and Center for Biological Diversity on December 1, 2011, which stated that emergency listing a species is not a petitionable action under the Administrative Procedure Act or the Act; therefore, we treat a petition requesting emergency listing solely as a petition to list a species under the Act.

The Georgetown salamander was included in 10 Candidate Notices of Review (66 FR 54808, October 30, 2001; 67 FR 40657, June 13, 2002; 69 FR 24876, May 4, 2004; 70 FR 24870, May 11, 2005; 71 FR 53756, September 12, 2006; 72 FR 69034, December 6, 2007; 73 FR 75176, December 10, 2008; 74 FR 57804, November 9, 2009; 75 FR 69222, November 10, 2010; 76 FR 66370, October 26, 2011). In the 2008 review, the listing priority number was lowered from 2 to 8, indicating that threats to the species were imminent, but moderate to low in magnitude. This reduction in listing priority number was primarily due to the land acquisition and conservation efforts of the Williamson County Conservation Foundation. In addition, the Georgetown salamander was petitioned by the Center for Biological Diversity to be listed as an endangered species on May 11, 2004, but at that time, it was already a candidate species whose listing was precluded by higher priority actions.

Endangered Status for the Four Central Texas Salamanders

Background

It is our intent to discuss below only those topics directly relevant to the proposed listing of the Austin blind salamander, Jollyville Plateau salamander, Georgetown salamander, and Salado salamander as endangered in this section of the proposed rule.

Species Information

All four central Texas salamanders (Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders) are neotenic (do not transform into a terrestrial form) members of the family Plethodontidae. Plethodontid salamanders comprise the largest family of salamanders within the Order Caudata, and are characterized by an absence of lungs (Petranka 1998, pp. 157–158). As neotenic salamanders, they retain external feathery gills and inhabit aquatic habitats (springs, spring-runs, and wet caves) throughout their lives (Chippindale *et al.* 2000, p. 1). In other words, all four of these salamanders are entirely aquatic and respirate through gills. Also, all adult salamanders of these four species are about 2 inches (in) (5 centimeters (cm)) long (Chippindale *et al.* 2000, pp. 32–42; Hillis *et al.* 2001, p. 268).

Each species inhabits water of high quality with a narrow range of conditions (for example, temperature, pH, and alkalinity) maintained by the Edwards Aquifer. All four species depend on this water from the Edwards Aquifer in sufficient quantity and quality to meet their life-history requirements for survival, growth, and reproduction. The Edwards Aquifer is a karst aquifer characterized by open chambers such as caves, fractures, and other cavities that were formed either directly or indirectly by dissolution of subsurface rock formations. Water for the salamanders is provided by infiltration of surface water through the soil or recharge features (caves, faults, fractures, sinkholes, or other open cavities) into the Edwards Aquifer, which discharges from springs as groundwater (Schram 1995, p. 91). The habitat of one species (Austin blind salamander) occurs in the Barton Springs Segment of the Edwards Aquifer, while the habitats of the three other species occur in the Northern Segment of the Edwards Aquifer. The recharge and contributing zones of these segments of the Edwards Aquifer are found in portions of Travis, Williamson, Blanco, Bell, Burnet, Lampasas, Mills, Hays, Coryell, and Hamilton Counties, Texas (Hill Country Foundation 1995, p. 1). The three salamander species that occur in the Northern Segment of the Edwards Aquifer (Jollyville Plateau, Georgetown, and Salado salamanders) have very similar external morphology. Because of this, they were previously believed to be the same species; however, molecular evidence strongly indicates that there is a high level of divergence between the three groups (Chippindale *et al.* 2000, pp. 15–16).

The four central Texas salamander species spend varying portions of their life within their surface (in or near spring openings and pools as well as spring runs) and subsurface (within caves or other underground areas within the Edwards Aquifer) habitats. They travel an unknown depth into interstitial spaces (empty voids between rocks) within the spring or streambed substrate that provide foraging habitat and protection from predators and drought conditions (Cole 1995, p. 24; Pierce and Wall 2011, pp. 16–17). They may also use deeper passages of the aquifer that connect to the spring opening (Dries 2011, City of Austin (COA), pers. comm.). This behavior makes it difficult to accurately estimate population sizes, as only salamanders on the surface can be regularly monitored. Therefore, the status of subsurface populations is largely unknown, making it difficult to assess the effects of threats on the subsurface populations and their habitat.

The Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders have much in common. All four species are entirely aquatic throughout each portion of their life cycles and highly dependent on water from the Edwards Aquifer in sufficient quantity and quality to meet their life-history requirements for growth, survival, and reproduction. Although detailed dietary studies are lacking for these four salamander species, their diets are presumed to be similar to other *Eurycea* species, consisting of small aquatic invertebrates such as amphipods, copepods, isopods, and insect larvae [reviewed in COA 2001, pp. 5–6]. The four central Texas salamanders also share similar predators, which include centrarchid fish (carnivorous freshwater fish belonging to the sunfish family), crayfish, and large aquatic insects (Pierce and Wall 2011, pp. 18–20; Bowles *et al.* 2006, p. 117; Cole 1995, p. 26). Because eggs are very rarely found on the surface, it is believed that these salamanders deposit their eggs underground for protection (O'Donnell *et al.* 2005, p. 18). The detection of juveniles in all seasons suggests that reproduction occurs year-round (Bendik 2011a, p. 26; Hillis *et al.* 2001, p. 273).

Dispersal patterns through streams or aquifers for these four salamander species are relatively unknown. However, one study of other closely related *Eurycea* species in the southeastern portion of central Texas found that populations of salamanders are genetically isolated from one another and neither aquifers nor streams serve as dispersal corridors (Lucas *et al.* 2009, pp. 1,315–1,316).

On the other hand, some evidence suggests that the four Texas salamanders may be able to travel some distance through subsurface aquifer conduits. Recent genetic work on the Jollyville Plateau salamander showed evidence of gene flow between sites that are not connected by surface flow (Chippindale 2010, pp. 9, 18–22). This study suggests that central Texas salamanders are regionally isolated, but populations within those regions have some level of dispersal ability through the subsurface habitat. For example, the Austin blind salamander is believed to occur underground throughout the entire Barton Springs complex (Dries 2011, pers. comm.). The spring habitats used by salamanders of the Barton Springs complex are not connected on the surface, so the Austin blind salamander population extends at least 984 feet (ft) (300 meters (m)) underground, as this is the approximate distance between the farthest two outlets within the Barton Springs complex known to be occupied by the species.

Due to the similar life history of the other three *Eurycea* species considered here, it is plausible that populations of these species could also extend this distance through subterranean habitat. Dye-trace studies have demonstrated that some Jollyville Plateau salamander sites located miles apart are connected hydrologically (Hauwert and Warton 1997), but it remains unclear if salamanders are able to travel between those sites. Also, in Salado, a large underground conduit conveys groundwater from the area under the Stagecoach Hotel to Big Boiling Spring (Mahler 2012, U.S. Geological Survey, pers. comm.). Additionally, in Barton Springs, a mark and recapture study failed to document the movement of endangered Barton Springs salamanders (*Eurycea sosorum*) between any of the springs in the Barton Springs complex (Dries 2012, pers. comm.), although this study has only recently begun and is relatively small in scope. In conclusion, there is some evidence that populations could be connected through subterranean habitat, although dispersal patterns and the actual nature of connectivity are largely unknown.

Because the hydrology of central Texas is very complex and information on the hydrology of specific spring sites is largely unknown, we are seeking information on spring hydrology and salamander dispersal during the public comment period (see ‘‘Information Requested’’ above).

Each species is discussed in more detail below.

Austin Blind Salamander

The Austin blind salamander has a pronounced extension of the snout, no external eyes, and weakly developed tail fins. In general appearance and coloration, the Austin blind salamander is more similar to the Texas blind salamander (*Eurycea rathbuni*) that occurs in the Southern Segment of the Edwards Aquifer than its sympatric (occurring within the same range) species, the Barton Springs salamander. The Austin blind salamander has a reflective, lightly pigmented skin with a pearly white or lavender appearance (Hillis *et al.* 2001, p. 271). Before the Austin blind salamander was formally described, juvenile salamanders were sighted occasionally in Barton Springs, and thought to be a variation of the Barton Springs salamander. It was not until 2001, that enough specimens were available to formally describe these juveniles as a separate species using morphological and genetic characteristics (Hillis *et al.* 2001, p. 267). Given the reduced eye structure of the Austin blind salamander, and the fact that it is rarely seen at the water's surface (Hillis *et al.* 2001, p. 267), this salamander is thought to be more subterranean than the surface-dwelling Barton Springs salamander.

The Austin blind salamander occurs in Barton Springs in Austin, Texas. These springs are fed by the Barton Springs Segment of the Edwards Aquifer. This segment covers roughly 155 square miles (mi) (401 square kilometers (km)) from southern Travis County to northern Hays County, Texas (Smith and Hunt 2004, p. 7). It has a storage capacity of over 300,000 acre-feet. The contributing zone for the Barton Springs Segment of the Edwards Aquifer that supplies water to the salamander's spring habitat extends into Travis, Blanco, and Hays Counties, Texas (Ross 2011, p. 3).

The Austin blind salamander is found in three of the four Barton Springs outlets in the City of Austin's Zilker Park, Travis County, Texas: Main (Parthenia) Springs, Eliza Springs, and Sunken Garden (Old Mill or Zenobia) Springs. The Main Springs provides water for the Barton Springs Pool, and is operated by the City of Austin as a public swimming pool. These spring sites have been significantly modified for human use. The area around Main Springs was impounded in the late 1920s to create Barton Springs Pool. Flows from Eliza and Sunken Garden Springs are also retained by concrete structures, forming small pools on either side of Barton Springs Pool (COA 1998, p. 6; Service 2005, p. 1.6–25). The Austin blind salamander has not been observed at the fourth Barton Springs outlet, known as Upper Barton Springs (Hillis *et al.* 2001, p. 273). For more information on habitat, see the ‘‘Proposed Critical Habitat Designation for the Four Central Texas Salamanders’’ section of this proposed rule.

From January 1998 to December 2000, there were only 17 documented observations of the Austin blind salamander. During this same time-frame, 1,518 Barton Springs salamander observations were made (Hillis *et al.* 2001, p. 273). The abundance of Austin blind salamanders increased slightly from 2002–2006, but fewer observations have been made in more recent years (2009–2010) (COA 2011a, pp. 51–52). When they are observed, Austin blind salamanders occur in relatively low numbers (COA 2011a, pp. 51–52). Most of the Austin blind salamanders that were observed during these surveys were juveniles (less than 1 in (2.5 cm) in total length) (Hillis *et al.* 2001, p. 273). Although the technology to safely and reliably mark salamanders for individual recognition has recently been developed (O'Donnell *et al.* 2008, p. 3), population estimates for this species have not been undertaken, because surveying within the Edwards Aquifer is not possible at the current time. However, population estimates are possible for aquifer-dwelling species using genetic techniques, and one such study is planned for the Austin blind salamander in the near future (Texas Parks and Wildlife Department (TPWD) 2011a, p. 11).

Jollyville Plateau Salamander

Surface-dwelling populations of Jollyville Plateau salamanders have large, well-developed eyes; wide, yellowish heads; blunt, rounded snouts; dark greenish-brown bodies; and bright yellowish-orange tails (Chippindale *et al.* 2000, pp. 33–34). Some cave forms of Jollyville Plateau salamanders exhibit cave-associated morphologies, such as eye reduction, flattening of the head, and dullness or loss of color (Chippindale *et al.* 2000, p. 37). Genetic analysis suggests a taxonomic split within this species that appears to correspond to major geologic and topographic features of the region (Chippindale 2010, p. 2). Chippindale (2010, pp. 5, 8) concluded that the Jollyville Plateau salamander exhibits a strong genetic separation between two lineages within the species: A ''Plateau'' clade that occurs in the Bull Creek, Walnut Creek, Shoal Creek, Brushy Creek, South Brushy Creek, and southeastern Lake Travis drainages; and a ''peripheral'' clade that occurs in the Buttercup Creek and northern Lake Travis drainages (Chippindale 2010, pp. 5–8). The study also suggests this genetic separation may actually represent two species (Chippindale 2010, pp. 5, 8). However, a formal, peer-reviewed description of the two possible species has not been published. We therefore do not recognize a separation of the Jollyville Plateau salamander into two species because this split has not been recognized by the scientific community.

The Jollyville Plateau salamander occurs in the Jollyville Plateau and Brushy Creek areas of the Edwards Plateau in Travis and Williamson Counties, Texas (Chippindale *et al.* 2000, pp. 35–36; Bowles *et al.* 2006, p. 112; Sweet 1982, p. 433). Upon classification as a species, Jollyville Plateau salamanders were known from Brushy Creek and, within the Jollyville Plateau, from Bull Creek, Cypress Creek, Long Hollow Creek, Shoal Creek, and Walnut Creek drainages (Chippindale *et al.* 2000, p. 36). Since it was described, the Jollyville Plateau salamander has also been documented within the Lake Creek drainage (O'Donnell *et al.* 2006, p. 1). Cave-dwelling Jollyville Plateau salamanders are known from 1 cave in the Cypress Creek drainage and 12 caves in the Buttercup Creek cave system in the Brushy Creek drainage (Chippindale *et al.* 2000, p. 49; Russell 1993, p. 21; Service 1999, p. 6; HNTB 2005, p. 60).

The Jollyville Plateau salamander's spring-fed habitat is typically characterized by a depth of less than 1 foot (ft) (0.3 meters (m)) of cool, well oxygenated water (COA 2001, p. 128; Bowles *et al.* 2006, p. 118) supplied by the underlying Northern Segment of the Edwards Aquifer (Cole 1995, p. 33). The aquifer that feeds this salamander's habitat is generally small, shallow, and localized (Chippindale *et al.* 2000; p. 36, Cole 1995, p. 26). Jollyville Plateau salamanders are typically found near springs or seep outflows and likely require constant temperatures (Sweet 1982, pp. 433–434; Bowles *et al.* 2006, p. 117). Salamander densities are higher in pools and riffles and in areas with rubble, cobble, or boulder substrates rather than on solid bedrock (COA 2001, p. 128; Bowles *et al.* 2006, pp. 114–116). Surface-dwelling Jollyville Plateau salamanders also occur in subsurface habitat within the underground aquifer (COA 2001, p. 65; Bowles *et al.* 2006, p. 118). For more on habitat, see the ''Proposed Critical Habitat Designation for the Four Central Texas Salamanders'' of this proposed rule.

Some Jollyville Plateau salamander populations have experienced decreases in abundance in recent years. City of Austin survey data indicate that four of the nine sites that were regularly monitored by City of Austin staff between December 1996 and January 2007 had statistically significant declines in salamander abundance over 10 years (O'Donnell *et al.* 2006, p. 4). The average number of salamanders counted at each of these 4 sites declined from 27 salamanders counted during surveys from 1996 to 1999 to 4 salamanders counted during surveys from 2004 to 2007. In 2007, monthly mark-recapture surveys were conducted in concert with surface counts at three sites in the Bull Creek watershed (Lanier Spring, Lower Rieblin, and Wheless Spring) over a 6–to–8-month period to obtain surface population size estimates and detection probabilities for each site (O'Donnell *et al.* 2008, p. 11). Surface population estimates at Lanier Spring varied from 94 to 249, surface population estimates at the Lower Rieblin site varied from 78 to 126, and surface population estimates at Wheless Spring varied from 187 to 1,024 (O'Donnell *et al.* 2008, pp. 44–45). These numbers remained fairly consistent in more recent population estimates for the three sites (Bendik 2011a, p. 22).

Georgetown Salamander

The Georgetown salamander is characterized by a broad, relatively short head with three pairs of bright-red gills on each side behind the jaws, a rounded and short snout, and large eyes with a gold iris. The upper body is generally grayish with varying patterns of melanophores (cells containing brown or black pigments called melanin) and iridophores (cells filled with iridescent pigments called guanine), while the underside is pale and translucent. The tail tends to be long with poorly developed dorsal and ventral fins that are golden-yellow at the base, cream-colored to translucent toward the outer margin, and mottled with melanophores and iridophores. Unlike the Jollyville Plateau salamander, the Georgetown salamander has a distinct dark border along the lateral margins of the tail fin (Chippindale *et al.* 2000, p. 38). As with the Jollyville Plateau salamander, the Georgetown salamander has recently discovered cave-adapted forms with reduced eyes and pale coloration (TPWD 2011a, p. 8).

The Georgetown salamander is known from springs along five tributaries (South, Middle, and North Forks; Cowan Creek; and Berry Creek) to the San Gabriel River (Pierce 2011a, p. 2) and from three caves (aquatic, subterranean locations) in Williamson County, Texas. A groundwater divide between the South Fork of the San Gabriel River and Brushy Creek to the south likely creates the division between the ranges of the Jollyville Plateau and Georgetown salamanders (Williamson County 2008, p. 3–34). The Service is currently aware of 16 Georgetown salamander localities. This species has not been observed in recent years at two locations (San Gabriel Spring and Buford Hollow), despite several visual survey efforts to find it (Pierce 2011b,c, Southwestern University, pers. comm.). The current population status is unknown for four sites due to restricted access (Cedar Breaks, Shadow Canyon, Hogg Hollow Spring, and Bat Well). Georgetown salamanders continue to be observed at the remaining 10 sites (Swinbank Spring, Knight Spring, Twin Springs, Hogg Hollow Spring, Cowan Creek Spring, Cedar Hollow, Cobbs Cavern Spring, Cobbs Well, Walnut Spring, and Water Tank Cave) (Pierce 2011c, pers. comm.; Gluesenkamp 2011a, TPWD, pers. comm.). Recent mark-recapture studies suggest a population size of 100 to 200 adult salamanders at Twin Springs, with a similar population estimate at Swinbank Spring (Pierce 2011a, p. 18). Population sizes at other sites are unknown, but visual surface counts result in comparatively low numbers (Williamson County 2008, pp. 3–35). There are numerous other springs in Williamson County that may support Georgetown salamander populations, but private land ownership prevents investigative surveys (Williamson County 2008, pp. 3–35).

Surface-dwelling Georgetown salamanders inhabit spring runs, riffles, and pools with gravel and cobble rock substrates (Pierce *et al.* 2010, pp. 295–296). This species prefers larger cobble and boulders to use as cover (Pierce *et al.* 2010, p. 295). Salamanders are found within 164 ft (50 m) of a spring opening (Pierce *et al.* 2011a, p. 4), but they are most abundant within the first 16.4 ft (5 m) (Pierce *et al.* 2010, p. 294). Individuals do not exhibit much movement throughout the year (Pierce *et al.* 2010, p. 294). The water chemistry of Georgetown salamander habitat is constant year-round in terms of temperature and dissolved oxygen (Pierce *et al.* 2010, p. 294, Biagas *et al.* in review, p. 8). Little is known about the ecology of Georgetown salamanders that occupy the cave sites (Cobbs Cavern, Bat Well, and Water Tank Cave) where this species is known to occur or the quality and extent of their subterranean habitats. For more on habitat, see the ''Proposed Critical Habitat Designation for the Four Central Texas Salamanders'' section of this proposed rule.

Salado Salamander

The Salado salamander has reduced eyes compared to other spring-dwelling *Eurycea* species in north-central Texas and lacks well-defined melanophores. It has a relatively long and flat head, and a blunt and rounded snout. The upper body is generally grayish-brown with a slight cinnamon tinge and an irregular pattern of tiny, light flecks. The underside is pale and translucent. The posterior portion of the tail generally has a well-developed dorsal fin, but the ventral tail fin is weakly developed (Chippindale *et al.* 2000, p. 42).

The Salado salamander is known historically from four spring sites near the village of Salado, Bell County, Texas: Big Boiling Springs (also known as Main, Salado, or Siren Springs), Lil' Bubbly Spring, Lazy Days Fish Farm Spring, and Robertson Springs (Chippindale *et al.* 2000, p. 43; TPWD 2011a, pp. 1–2). These springs bubble up through faults in the Northern Segment of the Edwards Aquifer and associated limestone along Salado Creek (Brune 1975, p. 31). The four spring sites all contribute to Salado Creek. Under Brune's (1975, p. 5) definition, which identifies springs depending on flow, all sites are considered small (4.5 to 45 gallons per minute (17 to 170 liters per minute)) to medium springs (45 to 449 gallons per minute (170 to 1,1700 liters per minute)). Several other spring sites (Big Bubbly Springs, Critchfield Springs, and Anderson Springs) are located downstream from Big Boiling Springs and Robertson Springs. These springs have been surveyed by TPWD periodically since June 2009, but no salamanders have been found (Gluesenkamp 2010, pers. comm.). In August 2009, TPWD discovered a population of salamanders at a new site (Solana Spring #1) farther upstream on Salado Creek in Bell County, Texas (TPWD 2011a, p. 2). Salado salamanders were recently confirmed at two other spring sites (Cistern and Hog Hollow Springs) farther upstream on the Salado Creek in March 2010 (TPWD 2011a, p. 2). In total, the Salado salamander is known from seven springs. A groundwater divide between Salado Creek and Berry Creek to the south likely creates a division between the ranges of the Georgetown and Salado salamander (Williamson County 2008, p. 3–34).

Of the four salamander species, Salado salamanders are observed the least and are therefore less understood. Biologists were unable to observe this species in its type locality (location from which a specimen was first collected and identified as a species) despite over 20 visits to Big Boiling Springs that occurred between 1991 and 1998 (Chippindale *et al.* 2000, p. 43). Likewise, TPWD surveyed this site weekly from June 2009 until May 2010, and found one salamander (Gluesenkamp 2010, pers. comm.) at a spring outlet locally referred to as ''Lil' Bubbly'' located just upstream from Big Boiling Springs. One additional unconfirmed sighting of a Salado salamander in Big Boiling Springs was reported in 2008, by a citizen of Salado, Texas. In 2009, TPWD was granted access to Robertson Springs to survey for the Salado salamander. This species was reconfirmed at this location in February 2010 (Gluesenkamp 2010, pers. comm.). Salado salamander populations appear to be larger at spring sites upstream of the Village of Salado, probably due to the higher quality of the habitat (Gluesenkamp 2011c, pers. comm.). For more on habitat, see the ''Proposed Critical Habitat Designation for the Four Central Texas Salamanders'' section of this proposed rule.

Summary of Factors Affecting the Species

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, we may list a species based on any of the following five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination. Each of these factors is discussed below.

Factor A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Habitat modification, in the form of degraded water quality and quantity and disturbance of spring sites, is the primary threat to the four central Texas salamander species. Water quality degradation in salamander habitat has been cited as the top concern in several studies (Chippindale *et al.* 2000, pp. 36, 40, 43; Bowles *et al.* 2006, pp. 118–119; O'Donnell *et al.* 2006, pp. 45–50), because these salamanders spend their entire life cycle in water. All of the species have evolved under natural aquifer conditions both underground and as the water discharges from natural spring outlets. Deviations from that high water quality have detrimental effects on salamander ecology, because the aquatic habitat can be rendered unsuitable for salamanders by changes in water chemistry, quantity, and flow patterns. Substrate modification is also a major concern for the salamander species (COA 2001, pp. 101, 126; Geismar 2005, p. 2; O'Donnell *et al.* 2006, p. 34). Unobstructed interstitial space (the space between the rocks) is critical to habitat of all four salamander species, because it provides cover from predators and habitat for macroinvertebrate prey items. When the interstitial spaces become compacted or filled with fine sediment, the amount of available foraging habitat and protective cover for salamanders is reduced (Welsh and Ollivier 1998, p. 1,128).

Threats to the habitat of the four central Texas salamanders may target only the surface habitat, only the subsurface habitat, or both habitat types. For example, substrate modification degrades the surface springs and spring-runs but does not impact the subsurface environment, while water quality degradation impacts both the surface and subsurface habitats. Because of their ability to retreat to the subsurface habitat, the four central Texas salamander species may be able to persist through surface habitat degradation. For example, drought conditions are common to the region, and these salamanders' ability to retreat underground may be an evolutionary adaptation to such natural conditions (Bendik 2011a, pp. 31–32). However, we do not fully understand the relative importance of the surface and subsurface habitats to salamander populations. The best available scientific evidence suggests that surface habitats are important for prey availability and individual growth. Prey availability for carnivores is low underground due to the lack of sunlight and primary production (Hobbs and Culver 2009, p. 392). In addition, length measurements taken during a City of Austin mark-recapture study at Lanier Spring demonstrated that Jollyville Plateau salamanders had negative growth during a 10-month period of retreating to the subsurface from 2008 to 2009 (Bendik 2011b, COA, pers. comm.). Therefore, threats to surface habitat at a given site may not extirpate any populations of these salamander species, but this type of habitat degradation may severely limit population growth and increase the species' overall risk of extinction from other threats.

The majority of the discussion below under Factor A focuses on evaluating the nature and extent of stressors related to urbanization within the watershed, the primary source of water quality degradation. Additionally, other sources of habitat destruction and modification will be addressed. These include physical habitat modification from human activities and feral hogs, and environmental events, such as flooding and drought.

Urbanization Within the Watershed

The ranges of the four salamander species reside within increasingly urbanized areas of Travis, Williamson, and Bell Counties that are experiencing rapid human population growth. For example, the population of the City of Austin grew from 251,808 people in 1970, to 656,562 people in 2000. By 2007, the population had grown to 735,088 people (COA 2007a, p. 1). This represents a 192 percent increase over the 37-year period. The human population within the City of Georgetown, Texas, was 28,339 in 2000, and increased to 47,380 by January 2008 (City of Georgetown 2008, pp. 3.3–3.5). The human population is expected to exceed 225,000 by 2033 (City of Georgetown 2008, p. 3.5), which would be a 375 percent increase over a 33-year period. Population projections from the Texas State Data Center (2008, p. 1) estimate that Travis County will increase in population from 812,280 in 2000, to 1,498,569 in 2040. This would be an 84 percent increase in the human population size over this 40-year period. The Texas State Data Center also estimates an increase in human population in Williamson County from 249,967 in 2000, to 1,742,619 in 2040. This would represent a 597 percent increase over a 40-year timeframe. The human population is not increasing as rapidly in the range of the Salado salamander, but growth is occurring. Population projections from the Texas State Data Center (2009, p. 19) estimate that Bell County will increase in population from 237,974 in 2000, to 397,741 in 2040, a 67 percent increase over the 40-year period. By comparison, the national United States' population is expected to increase from 310,233,000 in 2010, to 405,655,000 in 2040, which is about a 24 percent increase over the 30-year period (U.S. Census Bureau 2012, p. 1). Growing human populations increase demand for residential and commercial development, drinking water supply, wastewater disposal, flood control, and other municipal goods and services that alter the environment, often degrading salamander habitat by changing hydrologic regimes, and affecting the quantity and quality of water resources.

As development increases within the watersheds, more opportunities exist for the detrimental effects of urbanization to impact salamander habitat. Urban development upstream of salamander habitat leads to various stressors on spring systems, including increased flow velocities, increased sedimentation, increased contamination, changes in stream morphology and water chemistry, and decreases in groundwater recharge.

Several researchers have examined the negative impact of urbanization on stream salamander habitat by making connections between salamander abundances and levels of development within the watershed. In 1972, Orser and Shure (p. 1,150) were among the first biologists to show a decrease in stream salamander density with increasing urban development. A similar relationship between salamanders and urbanization was found in North Carolina (Price *et al.* 2006, pp. 437–439; Price *et al.* 2012, p. 198), Maryland, and Virginia (Grant *et al.* 2009, pp. 1,372–1,375). In central Texas, Bowles *et al.* (2006, p. 117) found lower Jollyville Plateau salamander densities in tributaries with developed watersheds as compared to tributaries with undeveloped watersheds. Developed tributaries also had higher concentrations of chloride, magnesium, nitrate-nitrogen, potassium, sodium, and sulfate (Bowles *et al.* 2006, p. 117). Several biologists have concluded that urbanization is one of the largest threats to the future survival of central Texas salamanders (Bowles *et al.* 2006, p. 119; Chippindale and Price 2005, pp. 196–197).

Willson and Dorcas (2003, pp. 768–770) demonstrated that to assess the impact of urbanization on aquatic salamanders, it is important to examine development within the entire watershed as opposed to areas just adjacent to the stream. For example, urban development within the drainage areas of Austin blind and Jollyville Plateau salamander spring sites has included residential and commercial structures, golf courses, and the associated roads and utility pipelines (Cole 1995, p. 28; COA 2001, pp. 10–12).

Because detrimental effects due to urbanization are occurring to the salamanders' habitats now, and we expect those effects to increase in the future, we consider urbanization to be a threat to each of the species. We discuss below how each source of the stressors of urbanization causes threats to the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders' habitats. These sources of impacts from urbanization include impervious cover and stormwater runoff, land application contaminants, hazardous material spills, construction activities, and water quantity reduction.

Impervious Cover and Stormwater Runoff

Impervious cover is any surface material, such as roads, rooftops, sidewalks, patios, paved surfaces, or compacted soil, that prevents water from filtering into the soil (Arnold and Gibbons 1996, p. 244). Once natural vegetation in a watershed is replaced with impervious cover, rainfall is converted to surface runoff instead of filtering through the ground (Schueler 1991, p. 114).

As urbanization increases due to human population growth within the watersheds of salamander habitat, levels of impervious cover will rise. Various levels of impervious cover within watersheds have been cited as having detrimental effects to water quality within streams. The threshold of measurable degradation of stream habitat and loss of biotic integrity consistently occurs with 6 to 15 percent impervious cover in contributing watersheds (Bowles *et al.* 2006, p. 111; Miller *et al.* 2007, p. 74). A review of relevant literature by Schueler (1994, pp. 100–102) indicates that stream degradation occurs at impervious cover of 10 to 20 percent, a sharp drop in habitat quality is found at 10 to 15 percent impervious cover, and watersheds above 15 percent are consistently classified as poor, relative to biological condition. Schueler (1994, p. 102) also concluded that even when water quality protection practices are widely applied, an impervious cover level of 35 to 60 percent exceeds a threshold beyond which water quality conditions that existed before development occurred cannot be maintained.

Increases in impervious cover resulting from urbanization cause measurable water quality degradation (Klein 1979, p. 959; Bannerman *et al.* 1993, pp. 251–254, 256–258; Center for Watershed Protection 2003, p. 91). Stressors from impervious cover have demonstrable impacts on biological communities within streams. Schueler (1994, p. 104) found that sites receiving runoff from high impervious cover drainage areas had sensitive aquatic macroinvertebrate species replaced by species more tolerant of pollution and hydrologic stress (high rate of changes in discharges over short periods of time). In an analysis of 43 North Carolina streams, Miller *et al.* (2007, pp. 78–79) found a strong negative relationship between impervious cover and the abundance of larval southern two-lined salamanders (*Eurycea cirrigera*). Impervious cover degrades salamander habitat in three ways: (1) Introducing and concentrating contaminants in stormwater runoff, (2) increasing sedimentation, and (3) altering the natural flow regime of streams.

Impervious Cover Analysis

To calculate impervious cover within the watersheds occupied by the four central Texas salamander species, we used the Watershed Boundary Dataset (USGS 2012, p. 1) to delineate the watersheds where these species are known to occur along with the 2006 National Land Cover Dataset (MRLC 2012, p. 1). The Watershed Boundary Dataset is a nationally consistent watershed dataset developed by the U.S. Geological Survey (USGS) that is subdivided into 12-digit hydrologic unit codes, which are the smallest (or finest scale) of the hydrologic units available. Each of the 12-digit hydrologic unit codes represents part or all of a surface drainage basin or a combination of drainage basins, also referred to in the Watershed Boundary Dataset as ''watersheds.'' The 2006 National Land Cover Dataset (the most recent of the national land cover datasets) was developed by the Multi-Resolution Land Characteristics Consortium to provide 30-meter spatial resolution estimates for tree cover and impervious cover percentages within the contiguous United States.

We identified 15 of the watersheds delineated within the Watershed Boundary Dataset as being occupied by one of the four central Texas salamander species. The Jollyville Plateau salamander occurs within six watersheds (Bull Creek, Cypress Creek, Lake Creek, South Brushy Creek, Town Lake, and Walnut Creek). The Austin blind salamander occurs within one watershed (Lake Austin). The Georgetown salamander occurs within six watersheds (Dry Berry Creek, Lake Georgetown, Lower Berry Creek, Lower South Fork San Gabriel River, Middle Fork San Gabriel River, and Smith Branch San Gabriel River). The Salado salamander occurs within two watersheds (Buttermilk Creek and Mustang Creek).

An impervious cover value (0 to 100 percent) is assigned for each 30-meter pixel within the 2006 National Land Cover Dataset. Using these values, we calculated the overall average value (percentage) for each watershed identified. We also identified three categories of impervious cover for each pixel: (1) 0 percent impervious cover (no impervious cover was identified within the 30-meter pixel), (2) 1 to 15 percent impervious cover (between 1 and 15 percent of the 30-meter pixel was identified as impervious cover), and (3) greater than 15 percent impervious cover (more than 15 percent of the 30-meter pixel was identified as impervious cover). For each watershed, we then calculated the percentage of pixels that fell into each of these three categories. These percentages are presented in Table 1.

TABLE 1—IMPERVIOUS COVER ESTIMATES

Salamander species (total number of known sites)	Watershed	Number of salamander sites	Categories of impervious cover (IC) percentage			Average impervious cover (IC) percentage
			0% IC	1–15% IC	>15% IC	
Jollyville Plateau salamander (92)	Bull Creek	64	61	14	25	12.00
	Cypress Creek	11	79	9	12	5.72
	Lake Creek	3	43	17	40	21.35
	South Brushy Creek	9	58	17	24	12.52
	Town Lake	4	11	30	59	34.32
	Walnut Creek	1	34	17	50	28.03
Austin blind salamander (3)	Lake Austin	3	54	24	24	11.58
Georgetown salamander (16)	Dry Berry Creek	2	92	7	1	0.59
	Lake Georgetown	6	88	11	2	0.76
	Lower Berry Creek	2	73	10	17	3.03
	Lower South Fork San Gabriel River	1	84	11	6	2.77
	Middle Fork San Gabriel River	4	77	11	12	2.41
	Smith Branch San Gabriel River	1	61	20	19	9.60
Salado salamander (7)	Buttermilk Creek	3	95	5	1	0.31
	Mustang Creek	4	92	7	2	0.91

We also identified areas within each watershed that we knew to be managed as open space. Open space includes lands set aside for either low-use recreation or wildlife preserves. The protection of open space helps preserve the quality of water, which is an important component of salamander surface habitat. Thus, we considered the amount and location of managed open space, and the potential water quality benefits they provide to salamander surface habitat during our analysis of threats caused by impervious cover within each watershed.

The six watersheds within the Jollyville Plateau salamander's range have overall average impervious cover estimates ranging from approximately 6 percent (Cypress Creek) to 34 percent (Town Lake). The majority (64) of the 92 known Jollyville Plateau salamander sites are located within the Bull Creek watershed, which has an overall average impervious cover estimate of 12 percent. When average impervious cover is between 10 and 15 percent within a watershed, sharp declines in aquatic habitat quality are likely to occur (Schueler 1994, pp. 100–102).

However, a substantial portion of the land area categorized as open space and protected as part of the Balcones

Canyonlands Preserve is located within the Bull Creek watershed. The Balcones Canyonlands Preserve is managed under the terms and conditions of a regional habitat conservation plan (HCP) (the Balcones Canyonlands Conservation Plan HCP) jointly held by the City of Austin and Travis County as mitigation lands issued under the authority of an Endangered Species Act section 10(a)(1)(B) permit for the protection of endangered birds and karst invertebrates. A number of cooperating partners own and manage lands dedicated to the Balcones Canyonlands Preserve, including several private landowners, the Lower Colorado River Authority, the Nature Conservancy of Texas, and the Travis Audubon Society. Although the permit that created the Balcones Canyonlands Preserve did not include the Jollyville Plateau salamander, the Balcones Canyonlands Preserve land management strategies help maintain water quality within salamander habitats on lands within the preserve. Nonetheless, the City of Austin has reported significant declines in Jollyville Plateau salamander abundance at one of their Jollyville Plateau salamander monitoring sites within Bull Creek (O'Donnell *et al.* 2006, p. 45), even though our analysis found that 61 percent of the land within this watershed has 0 percent impervious cover. The location of this monitoring site is within a large preserved tract. However, the headwaters of this drainage are outside the preserve, and the development in this area increased sedimentation downstream and impacted salamander habitat in the preserved tract.

The Cypress Creek watershed is the least developed of all of the watersheds within the Jollyville Plateau salamander's range, and much of it is extensively covered by lands that are managed as open space. The vast majority of this open space is part of the Balcones Canyonlands Preserve. There are 11 spring sites known to be occupied by the Jollyville Plateau salamander within this watershed. Seven of these sites are located directly within or downstream from areas dominated by impervious surfaces. The 2006 National Land Cover Dataset data indicated that 12 percent of the 30-m pixels in the Cypress Creek watershed have impervious cover of 15 percent or more and 9 percent of the 30-m pixels have impervious cover between 1 and 15 percent.

The other watersheds within the Jollyville Plateau salamander's range have impervious cover levels that may lead to water quality declines within salamander surface habitat (Schueler 1994, pp. 100–102). Nine sites known to be occupied by Jollyville Plateau salamanders are located within the South Brushy Creek watershed, which has an overall average impervious cover estimate of 13 percent and very little managed open space. Again, when average impervious cover is between 10 and 15 percent, sharp declines in aquatic habitat quality are likely to occur (Schueler 1994, pp. 100–102).

The Lake Creek watershed with three known salamander locations and the Walnut Creek watershed with one known salamander location are estimated to have 21 percent and 28 percent impervious cover, respectively. The Lake Creek watershed has two tracts (143 ac (58 ha) and 95 ac (38 ha)) of managed open space along with two smaller preserve areas and several municipal parks. Given their small size in relation to the size of the watershed, it is unknown if these areas provide any water quality benefits for salamander surface habitat. The single Jollyville Plateau salamander location within the Walnut Creek watershed is located on a 53-ac (21-ha) park that is situated directly adjacent to a residential development. There are two small (14 ac (6 ha) and 67 ac (27 ha)) municipal parks located upstream from this site. However, the 2006 National Land Cover Dataset data indicated that 50 percent of the 30-m pixels in the Walnut Creek watershed have impervious cover of 15 percent or more and 17 percent of the 30-m pixels have impervious cover between 1 and 15 percent. Because this watershed is extensively covered by impervious surfaces, it is unlikely that these managed open spaces provide adequate water quality for the Jollyville Plateau salamander. Salamander counts at the Walnut Creek location have been low. Although surveys are conducted four times a year, no salamanders were observed from 2006 to 2009, and only six individuals were observed in 2010 (Bendik 2011a, p. 13).

The Town Lake watershed is the most developed of all of the watersheds within the Jollyville Plateau salamander's range. Four Jollyville Plateau salamander sites are located within the Town Lake watershed, which has an estimated 30 percent of its 30-m pixels within the 1 to 15 percent impervious cover category and 59 percent of its 30-m pixels within the greater than 15 percent impervious cover category. We could not identify any parcels of land that are managed as open space within the Town Lake watershed.

The Austin blind salamander occurs within only one of the watersheds (Lake Austin) delineated within the Watershed Boundary Dataset. The Lake Austin watershed was estimated to have an overall average impervious cover estimate of 12 percent. Although each of the three spring sites where this species is known to occur are located within a park managed by the City of Austin, the water quality within the salamander's habitat can be influenced by development throughout the watershed. The impervious cover within the Lake Austin watershed, which is an indicator of development intensity within the area, is within the range that can lead to water quality declines in aquatic habitats (Schueler 1994, pp. 100–102). Some Balcones Canyonlands Preserve lands are located within the Lake Austin watershed, which likely contribute some water quality benefits to surface flow. However, the Austin blind salamander is, in large part, a subterranean species. Therefore, water quality within this species' habitat can be influenced by land use throughout the recharge zone of the Barton Springs Segment of the Edwards Aquifer.

The Lower Colorado River Authority (LCRA 2002, pp. 3–54—3–55) conducted a water supply study of the recharge and contributing zone areas within the Barton Springs Segment of the Edwards Aquifer that examined the amount of impervious cover within the local area. The eight watersheds within the area had a range of impervious cover from 3 percent to 29 percent in 2000. The projected impervious cover limits for the same eight watersheds in 2025 ranged from 5 percent to 32 percent (LCRA 2002, pp. 4–12—4–13). The two watersheds, Williamson Creek and Sunset Valley Creek (a tributary to Williamson Creek), with the highest percentage of impervious cover (16 and 29 percent, respectively) are also the second and third closest to Barton Springs (LCRA 2002, pp. 4–12—4–13).

The six watersheds within the Georgetown salamander's range have overall average impervious cover estimates ranging from 0.59 percent (Dry Berry Creek) to about 10 percent (Smith Branch San Gabriel River). The overall average impervious cover estimates for each of the six watersheds are below the levels that have been shown to lead to sharp water quality declines in aquatic habitats (Schueler 1994, pp. 100–102). Two (Cobbs Spring and Cobbs Spring Well) of the 16 sites known to be occupied by the Georgetown salamander occur in the headwaters of the Dry Berry Creek watershed, which has an overall average impervious cover estimate of 0.59 percent.

Six spring sites known to be occupied by Georgetown salamander are located within the Lake Georgetown watershed.

This watershed also has one of the least overall average impervious cover estimates (0.76 percent) of the six watersheds within the Georgetown salamander's range. These six sites, along with three of the four spring sites known to be occupied by the Georgetown salamander in the Middle Fork San Gabriel River watershed (with an overall average impervious cover estimate of about 2 percent) and the only known Georgetown salamander site within the Lower South Fork San Gabriel River watershed (with an overall average impervious cover estimate of about 3 percent), are located upstream from the urbanized areas associated with the City of Georgetown. Therefore, these sites are likely not as affected by water quality degradation currently as those spring sites occupied by the Georgetown salamander within the highly urbanized areas of the City of Georgetown.

We identified two tracts of land managed specifically as open space within the Georgetown salamander's range. Williamson County manages a 64-ac (26-ha) conservation easement at Cobbs Cavern and owns the 145-ac (59-ha) Twin Springs Preserve. The Twin Springs preserve contains one Georgetown salamander site. While the Cobbs Cavern conservation easement does not include the Cobbs Spring or Cobbs well site, it does contain land in the watershed for these sites. Despite the protection of these two tracts, water quality at these sites can be influenced by activities occurring throughout the recharge zone. Without more managed open space within this species' range, it is unlikely that water quality within the Georgetown salamander's surface habitat will be protected as development continues in these watersheds into the future.

Four of the 16 sites known to be occupied by the Georgetown salamander are located in areas identified as having impervious cover estimates (either in the 1 to 15 percent impervious cover category or the greater than 15 percent impervious cover category) within the range that can lead to water quality declines (10 to 15 percent) or poor water quality relative to biological condition (greater than 15 percent) in aquatic habitats (Schueler 1994, pp. 100–102). These include one site in the Middle Fork San Gabriel River watershed, the only occupied site within the Smith Branch San Gabriel River watershed (with an overall average impervious cover estimate of about 10 percent), and the two occupied sites within the Lower Berry Creek watershed (with an overall average impervious cover estimate of about 3 percent). Although the overall average impervious cover estimate within Lower Berry Creek watershed is below the level that has been shown to lead to water quality declines in aquatic habitats (Schueler 1994, pp. 100–102), 17 percent of the watershed has greater than 15 percent impervious cover. These two Georgetown salamander sites are located in the most developed area of this watershed. As such, these sites are vulnerable to water quality degradation caused by pollutants associated with highly urbanized areas.

The Salado salamander occurs within two of the watersheds delineated within the Watershed Boundary Dataset. Buttermilk Creek and Mustang Creek watersheds have overall average impervious cover estimates of 0.31 percent and 0.91 percent, respectively. Although these impervious cover levels are well below that which are likely to lead to water quality declines in aquatic habitats (Schueler 1994, pp. 100–102), three of the seven springs sites known to be occupied by the Salado salamander are directly within urbanized habitats in the Mustang Creek watershed (within the Village of Salado), and therefore, may be more susceptible to spills of hazardous materials and pollutants from roads that are close to locations where salamanders are known to occur.

Four spring sites known to be occupied by Salado salamanders are upstream from the urbanized areas associated with the Village of Salado. Three of these spring sites are located within the Buttermilk Creek watershed on an approximately 8,126-ac (3,288-ha) ranch that is privately owned and almost entirely undeveloped. Another spring site known to be occupied by the Salado salamander within the Mustang Creek watershed is located on another privately owned and almost entirely undeveloped ranch that is approximately 827 ac (335 ha) in size. Both ranches are located upstream of the impervious cover areas associated with the Village of Salado and entirely within the recharge zone of the Northern Segment of the Edwards Aquifer. Although impervious cover is not currently a threat to these upstream sites, a significant portion of the recharge zone extends to areas off of these properties and spring water quality can be impacted by activities occurring some distance away.

We could not identify any large tracts of lands managed specifically as open space within the Salado salamander's range, particularly upstream of sites where this species is known to occur. In addition, there are no agreements in place to preserve or manage the above-mentioned properties for the benefit of the Salado salamander or its surface habitat. Without these, it is unlikely that water quality within the Salado salamander's surface habitat will be protected if development occurs in these watersheds in the future.

Although the data for this level of the impervious cover analysis were derived using the finest scale hydrologic units readily available in the Watershed Boundary Dataset, they offer no reference to the location of salamander-occupied spring sites in relation to the location of impervious cover within the watersheds. Therefore, impervious cover occurring within each watershed may not necessarily be an indicator of how much impervious cover is impacting water quality within known salamander sites because this analysis does not take into account whether the salamander sites are found upstream or downstream of impervious surfaces associated with developed areas. Moreover, because the most recent impervious cover estimates available within the National Land Cover Dataset were provided from 2006 data, more impervious cover could be present within the watersheds than are indicated in our analysis. By mapping the spring sites where salamanders are known to occur over the 2006 National Land Cover Dataset impervious cover data layer, we can generally discuss which sites may currently be affected by water quality degradation due to their location within the three impervious cover categories mentioned above and identified in Table 1.

To provide a general indication of how much impervious cover may be influencing surface water quality at individual salamander sites, we used 2010 aerial photos to visually estimate the amount of impervious cover upstream of each site known to be occupied by the Jollyville Plateau, Georgetown, or Salado salamander. By visually examining the aerial photos from 2010, we classified the areas within each tributary watershed upstream from each known salamander site into one of four categories (that represent approximations of impervious cover levels). We defined these categories as follows: (1) None (a tributary watershed with no visible impervious cover), (2) low (a tributary watershed with what appeared to be less than 10 percent impervious cover), (3) moderate (a tributary watershed with what appeared to be impervious cover between 10 and 30 percent), and (4) high (a tributary watershed with what appeared to be greater than 30 percent impervious cover). A summary of the number of salamander sites for each of these three species found to be within the impervious cover categories is provided below (Table 2).

TABLE 2—IMPERVIOUS COVER ESTIMATES UPSTREAM OF KNOWN SALAMANDER LOCATIONS

Salamander species	Number of salamander sites	Number of sites with impervious cover levels			
		None	Low	Moderate	High
Jollyville Plateau salamander	92	17	6	21	48
Georgetown salamander	16	4	9	2	1
Salado Salamander	7	2	4	0	1

The Austin blind salamander was not considered in the analysis of impervious cover upstream of its known sites, as it primarily occurs below the surface and is more likely to be impacted by water quality changes due to impervious cover throughout the Edward Aquifer's recharge zone. Using the 2006 National Land Cover Database, we determined that the recharge zone of the Barton Springs Segment of the Edwards Aquifer had an overall average impervious cover level of 5.87 percent. However, at least 12 percent of the recharge zone has greater than 15 percent impervious cover.

Contaminants in Stormwater Runoff

Urban environments are host to a variety of human activities that generate many types of point source (''end of pipe'') and non-point source (coming from many diffuse sources) contaminants. These sources of contaminants, when combined, often degrade nearby waterways and aquatic resources within the watershed. Urban contaminants commonly detected in stormwater include elevated levels of suspended solids, nutrients, trace metals, pesticides, and coliform bacteria. Similarly, various industrial and municipal activities result in the discharge of treated wastewater or unintentional release of industrial contaminants as point source pollution.

Stormwater runoff carries these contaminants into stream systems (Bannerman *et al.* 1993, pp. 251–254, 256–258; Schueler 1994, p. 102; Barrett and Charbeneau 1996, p. 87; Center for Watershed Protection 2003, p. 91). Amphibians, especially their eggs and larvae (which are usually restricted to a small area within an aquatic environment), are sensitive to many different aquatic pollutants (Harfenist *et al.* 1989, pp. 4–57). Contaminants found in aquatic environments, even at sublethal concentrations, may interfere with a salamander's ability to develop, grow, or reproduce (Burton and Ingersoll 1994, pp. 120, 125). Central Texas spring salamanders are particularly vulnerable to contaminants, because they have evolved under very stable environmental conditions, remain aquatic throughout their entire life cycle, have highly permeable skin, have severely restricted ranges, and cannot escape contaminants in their environment (Turner and O'Donnell 2004, p. 5). In addition, macroinvertebrates, such as small freshwater crustaceans, that aquatic salamanders feed on are especially sensitive to water pollution (Phipps *et al.* 1995, p. 282; Miller *et al.* 2007, p. 74). Studies in the Bull Creek watershed in Austin, Texas, found a loss of some sensitive macroinvertebrate species, potentially due to contaminants of nutrient enrichment and sediment accumulation (COA 2001, p. 15; COA 2010a, p. 16).

Both nationally and locally, consistent relationships between impervious cover and water quality degradation through contaminant loading have been documented. In a study of contaminant loads from various land use areas in Austin, stormwater runoff loads were found to increase with increasing impervious cover (COA 1990, pp. 12–14). This study also found that contaminant loading rates of the more urbanized watersheds were higher than those of the small suburban watersheds. Soeur *et al.* (1995, p. 565) determined that stormwater contaminant loading positively correlated with development intensity in Austin. In a study of 38 small watersheds in the Austin area, 7 different contaminants were found to be positively correlated with impervious cover (COA 2006, p. 35). Using stream data from 1958 to 2007 at 24 Austin-area sites, Glick *et al.* (2009, p. 9) found that the City of Austin's water quality index had a strong negative correlation with impervious cover.

Polycyclic aromatic hydrocarbons (PAHs) are a common form of aquatic contaminants in urbanized areas that could potentially affect salamanders, their habitat, or their prey. This form of pollution can originate from petroleum products, such as oil or grease, or from atmospheric deposition as a byproduct of combustion (for example, vehicular combustion). These pollutants accumulate over time on impervious cover, contaminating water supplies through urban and highway runoff (Van Metre *et al.* 2000, p. 4,067; Albers 2003, pp. 345–346). The main source of PAH loading in Austin-area streams is parking lots with coal tar emulsion sealant, even though this type of lot only covers 1 to 2 percent of the watersheds (Mahler *et al.* 2005, p. 5565). A recent analysis of the rate of wear on coal tar lots revealed that the sealcoat wears off relatively quickly and contributes more to PAH loading than previously thought (Scoggins *et al.* 2009, p. 4914).

Petroleum and petroleum byproducts can adversely affect living organisms by causing direct toxic action, altering water chemistry, reducing light, and decreasing food availability (Albers 2003, p. 349). Exposure to PAHs at levels found within the Jollyville Plateau salamander's range can cause impaired reproduction, reduced growth and development, and tumors or cancer in species of amphibians, reptiles, and other organisms (Albers 2003, p. 354). Coal tar pavement sealant slowed hatching, growth, and development of a frog (*Xenopus laevis*) in a laboratory setting (Bryer *et al.* 2006, pp. 244–245). High concentrations of PAHs from coal tar sealant negatively affected the righting ability (amount of time needed to flip over after being placed on back) of adult eastern newts (*Notophthalmus viridescens*) and may have also damaged the newt's liver (Sparling *et al.* 2009, pp. 18–20). For juvenile spotted salamanders (*Ambystoma maculatum*), PAHs reduced growth in the lab (Sparling *et al.* 2009, p. 28). In a lab study using the same coal tar sealant once used by the City of Austin, Bommarito *et al.* (2010, pp. 1151–1152) found that spotted salamanders displayed slower growth rates and diminished swimming ability when exposed to PAHs. PAHs are also known to cause death, reduced survival, altered physiological function, inhibited reproduction, and changes in community composition of freshwater invertebrates (Albers 2003, p. 352).

Limited sampling by the City of Austin has detected PAHs at concentrations of concern at multiple sites within the range of the Jollyville Plateau salamander. Most notable were the elevated levels of nine different PAH compounds at the Spicewood Springs site in the Shoal Creek drainage area (O'Donnell *et al.* 2005, pp. 16–17). This is also one of the sites where salamanders have shown a significant decline in abundance during the City of Austin's long-term monitoring studies (O'Donnell *et al.* 2006, p. 47). Another study found several PAH compounds in seven Austin-area streams, including Barton, Bull, and Walnut Creeks, downstream of coal tar sealant parking lots (Scoggins *et al.* 2007, p. 697). Sites with high concentrations of PAHs (located in Barton and Walnut Creeks) had fewer macroinvertebrate species and lower macroinvertebrate density (Scoggins *et al.* 2007, p. 700). This form of contamination has also been detected at Barton Springs, which is the Austin blind salamander's habitat (COA 1997, p. 10). Because PAHs can adversely affect salamanders, PAHs have been found in the range of the species, and we expect an increase of this contaminant in the future in conjunction with the increase of urbanization, we consider contamination from PAHs to be a threat to the continued existence of all four central Texas salamanders now and in the future.

Conductivity is a measure of the ability of water to carry an electrical current and can be used to approximate the concentration of dissolved inorganic solids in water that can alter the internal water balance in aquatic organisms, affecting the four central Texas salamanders' survival. As ion concentrations such as chlorides, sodium, sulfates, and nitrates rise, conductivity will increase. These compounds are the chemical products, or byproducts, of many common pollutants that originate from urban environments (Menzer and Nelson 1980, p. 633), which are often transported to streams via stormwater runoff from impervious cover. Measurements by the City of Austin between 1997 and 2006 found that conductivity averaged between 550 and 650 microsiemens per centimeter ($\mu S\ cm^{-1}$) at rural springs with low or no development and averaged between 900 and 1000 $\mu S\ cm^{-1}$ at monitoring sites in watersheds with urban development (O'Donnell *et al.* 2006, p. 37). The City of Austin also found increasing ions with increasing impervious cover at four Jollyville Plateau salamander sites (Herrington *et al.* 2007, p. 13). These results indicate that developed watersheds contribute to higher levels of water contaminants in salamander habitats.

High conductivity has been associated with declining salamander abundance. For example, three of the four sites with statistically significant declining Jollyville Plateau salamander abundance from 1997 to 2006 are cited as having high conductivity readings (O'Donnell *et al.* 2006, p. 37). Similar correlations were shown in studies comparing developed and undeveloped sites from 1996 to 1998 (Bowles *et al.* 2006, pp. 117–118). This analysis found significantly lower numbers of salamanders and significantly higher measures of specific conductance at developed sites as compared to undeveloped sites (Bowles *et al.* 2006, pp. 117–118). Tributary 5 of Bull Creek has had an increase in conductivity, chloride, and sodium and a decrease in invertebrate diversity from 1996 to 2008 (COA 2010a, p. 16). Only one Jollyville Plateau salamander has been observed here from 2009 to 2010 in quarterly surveys (Bendik 2011a, p. 16). Poor water quality, as measured by high specific conductance and elevated levels of ion concentrations, is cited as one of the likely factors leading to statistically significant declines in salamander abundance at the City of Austin's long-term monitoring sites (O'Donnell *et al.* 2006, p. 46).

In an analysis performed by the City of Austin (Turner 2005a, p. 6), significant changes over time were reported for several chemical constituents and physical parameters in Barton Springs Pool, which could be attributed to impacts from watershed urbanization. Conductivity, turbidity, sulfates, and total organic carbon have increased while the concentration of dissolved oxygen has decreased (Turner 2005a, pp. 8–17). The significance and presence of trends in other pollutants were variable depending on flow conditions (baseflow vs. stormflow, recharge vs. non-recharge) (Turner 2005a, p. 20). A similar analysis by Herrington and Hiers (2010, p. 2) examined water quality at Barton Springs Pool and other Barton Springs outlets where Austin blind salamanders are found (Sunken Gardens and Eliza Springs) over a general period of the mid-1990s to the summer of 2009. Herrington and Hiers (2010, pp. 41–42) found that dissolved oxygen decreased over time in the Barton Springs Pool, while conductivity and nitrogen increased. However, this decline in water quality was not seen in Sunken Gardens Spring or Elisa Spring (Herrington 2010, p. 42). A separate analysis found that ions such as chloride and sulfate increased in Barton Creek despite the enactment of city-wide water quality control ordinances (Turner 2007, p. 7). Overall, these studies indicate a long-term trend of water quality degradation at Barton Springs over a 34-year period (1975 to 2009).

In summary, there are many different types of contaminants found in stormwater runoff that can have detrimental effects on the four central Texas salamanders. Impervious cover increases the transport of contaminants common in urban environments, and we expect this detrimental effect to increase in the future with increased urbanization. Therefore, the current existence and future increase of contaminants in stormwater runoff is a significant threat to all four central Texas salamanders' surface and subsurface habitats throughout their ranges. However, due to the relatively low levels of impervious cover in its range, the Salado salamander is currently, and anticipated to be, less affected.

Sedimentation from Stormwater Runoff

Elevated mobilization of sediment (mixture of silt, sand, clay, and organic debris) occurs as a result of increased velocity of water running off impervious surfaces (Schram 1995, p. 88; Arnold and Gibbons 1996, pp. 244–245). Increased rates of stormwater runoff cause increased erosion through scouring in headwater areas and sediment deposition in downstream channels (Booth 1991, pp. 93, 102–105; Schram 1995, p. 88). Waterways are adversely affected in urban areas, where impervious cover rates are high, by sediment loads that are washed into streams or aquifers during storm events. Sediments are either deposited into layers or become suspended in the water column (Ford and Williams 1989, p. 537; Mahler and Lynch 1999, p. 177). Sediment derived from soil erosion has been cited as the greatest single source of pollution of surface waters by volume (Menzer and Nelson 1980, p. 632).

Excessive sediment from stormwater runoff is a threat to salamanders because it can cover habitat, cover substrates, and lead to declines in vegetative abundance and diversity (Geismar 2005, p. 2). Sediments suspended in water can clog gill structures, which impairs breathing of aquatic organisms, and can reduce their ability to avoid predators or locate food sources due to decreased visibility (Schueler 1987, p. 1.5). Excessive deposition of sediment in streams can physically reduce the amount of available habitat and protective cover for aquatic organisms, by filling the interstitial spaces of gravel and rocks. As an example, a California study found that densities of two salamander species were significantly lower in streams that experienced a large infusion of sediment from road construction after a storm event (Welsh and Ollivier 1998, pp. 1,118–1,132). The vulnerability of the salamander species in this California study was attributed to their reliance on interstitial spaces in the streambed habitats (Welsh and Ollivier 1998, p. 1,128). We consider increased sedimentation from impervious cover to be a threat to all four central Texas salamanders, because it fills interstitial spaces, eliminates resting places, and reduces habitat of its prey base (small aquatic invertebrates) (O'Donnell *et al.* 2006, p. 34).

Also, sediments eroded from contaminated soil surfaces can concentrate and transport contaminants (Mahler and Lynch 1999, p. 165). The four central Texas salamander species and their prey species are directly exposed to sediment-borne contaminants present within the aquifer and discharging through the spring outlets. For example, in addition to sediment, trace metals such as arsenic, cadmium, copper, lead, nickel, and zinc were found in Barton Springs in the early 1990s (COA 1997, pp. 229, 231–232). Contaminants may cause adverse effects to the salamander and its prey species including reduced growth and weight, abnormal behavior, morphological and developmental aberrations, and decreased reproductive activity (Albers 2003, p. 354).

Excess sedimentation may have contributed to declines in Jollyville Plateau salamander populations in the past. Monitoring by the City of Austin found that, as sediment deposition increased at several sites, salamander abundances significantly decreased (COA 2001, pp. 101, 126). Additionally, the City of Austin found that sediment deposition rates have increased significantly along one of the long-term monitoring sites (Bull Creek Tributary 5) as a result of construction activities upstream (O'Donnell *et al.* 2006, p. 34). This site has had significant declines in salamander abundance, based on 10 years of monitoring, and the City of Austin attributes this decline to the increases in sedimentation (O'Donnell *et al.* 2006, pp. 34–35). The location of this monitoring site is within a large preserved tract. However, the headwaters of this drainage are outside the preserve and the development in this area increased sedimentation downstream and impacted salamander habitat in the preserved tract.

Direct evidence of the effects of sedimentation on the Austin blind, Georgetown, and Salado salamanders is lacking, primarily due to limited studies on those species. However, analogies can be drawn from data on similar species, such as the Jollyville Plateau and Barton Springs salamanders. Barton Spring salamander population numbers are adversely affected by high turbidity and sedimentation (COA 1997, p. 13). Sediments discharge through Barton Springs, even during baseflow conditions (not related to a storm event) (Geismar 2005, p. 12). Storms can increase sedimentation rates substantially (Geismar 2005, p. 12). Areas in the immediate vicinity of the spring outflows lack sediment, but the remaining bedrock is sometimes covered with a layer of sediment several inches thick (Geismar 2005, p. 5). Sedimentation is a direct threat for the Austin blind salamander because its habitat in Barton Springs would fill with sediment if it were not for regular maintenance and removal (Geismar 2005, p. 12). Further development in the Barton Creek watershed will most likely be associated with diminished water clarity and a reduction in biodiversity of flora (COA 1997, p. 7). Likewise, development within the watersheds of Georgetown and Salado salamander sites will increase sedimentation and degrade water quality in salamander habitat. Therefore, because salamander population numbers are adversely affected by sedimentation covering habitat, filling in substrates, and transporting contaminants in both surface and subsurface habitats, we consider sedimentation and its resulting effects to be an ongoing, significant threat to all four central Texas salamanders' surface and subsurface habitats now and in the future. However, we consider the Salado salamander to salamander to be less affected by this threat than the other three species, due to the relatively low levels of impervious cover in its range.

Changes in Flow Regime Due to Impervious Cover

Impervious cover in a stream's watershed causes streamflow to shift from predominately baseflow, which is derived from natural filtration processes and discharges from local groundwater supplies, to predominately stormwater runoff. With increasing stormwater runoff, the amount of baseflow available to sustain water supplies during drought cycles is diminished and the frequency and severity of flooding increases. The increased quantity and velocity of runoff increases erosion and streambank destabilization, which in turn leads to increased sediment loadings, channel widening, and detrimental changes in the morphology and aquatic ecology of the affected stream system (Hammer 1972, pp. 1535–1536, 1540; Booth 1990, pp. 407–409, 412–414; Booth and Reinelt 1993, pp. 548–550; Schueler 1994, pp. 106–108; Pizzuto *et al.* 2000, p. 82; Center for Watershed Protection 2003, pp. 41–48).

The changes in flow regime due to impervious cover can have a direct impact on salamander populations. For example, Barrett *et al.* (2010, pp. 2002–2003) recently observed that the density of aquatic southern two-lined salamanders declined more drastically in streams with urbanized watersheds compared to streams with forested or pastured watersheds. A statistical analysis indicated that this decline in urban streams was due to an increase in flooding frequency from stormwater runoff. Barrett et al. (2010, p. 2003) also used artificial stream experiments to demonstrate that salamanders were flushed downstream at significantly lower velocities when the substrate was sand-based, as compared to gravel, pebble, or cobble-based. Sand-based substrates are common to urban streams due to high sedimentation rates (see ''Sedimentation from Stormwater Runoff'' section, above). The combined effects of increased sand-based substrates due to high sedimentation rates, and increased flow velocities from impervious cover, result in effectively removing salamanders from their habitat.

Extreme flood events have occurred in all four salamander species' surface habitats (Pierce 2011a, p. 10; TPWD 2011a, p. 6; Turner 2009, p. 11; O'Donnell *et al.* 2005, p. 15). It is reasonable to assume that impervious cover due to urbanization in the salamanders' watershed will continue to cause streamflow to shift from predominately baseflow to predominately stormwater runoff. For example, an examination of 24 stream sites in the Austin area revealed that increasing impervious cover in the watersheds resulted in decreased base flow, increased high-flow events of shorter duration, and more rapid rises and falls of the stream flow (Glick *et al.* 2009, p. 9). In addition, increases in impervious cover within the Walnut Creek watershed (Jollyville Plateau salamander habitat) have probably caused a shift to more rapid rises and falls of the stream flow (Herrington 2010, p. 11). Because of the detrimental effects previously discussed in association with increased stormwater runoff, and because the amount of baseflow available to sustain water supplies during drought cycles is diminished, we consider changes in flow regime due to impervious cover to be an ongoing threat to all four central Texas salamanders' surface habitats now and in the future. Because it only affects surface habitat, this threat is of moderate significance to the Austin blind, Jollyville Plateau, and Georgetown salamanders. We consider this threat to be of low significance for the Salado salamander due to the relatively low levels of impervious cover in its range.

Conclusion of Impervious Cover and Stormwater Runoff

In summary, impervious cover contributes to the degradation of surface and subsurface salamander habitat by transporting contaminants and sediments to the Edwards Aquifer. Impervious cover within the watersheds of the salamanders also leads to changes in streamflow regime that degrades surface salamander habitat. The Austin blind, Jollyville Plateau, and Georgetown salamanders all have levels of impervious cover in their ranges that may be causing declines in water quality. Impervious cover levels are relatively low in the range of the Salado salamander. However, growing human populations and the associated increase in urbanization indicate that impervious cover levels will continue to rise within the ranges of all four central Texas salamanders. Therefore, we consider impervious cover and stormwater runoff to be sources of stressors, such as contamination, sedimentation, and changes in streamwater's flow regime, that contribute to the overall risk of extinction for all four salamander species.

Land Application Contaminants

Excessive land application contaminants, such as nutrient and pesticide input to watershed drainages, are other forms of pollution that occur in highly urbanized areas. In comparison to nonkarstic aquifer systems, the Edwards Aquifer is more vulnerable to the effects of contamination due to: (1) A large number of conduits that offer no filtering capacity, (2) high groundwater flow velocities, and (3) the relatively short amount of time that water is inside the aquifer system (Ford and Williams 1989, pp. 518–519).

Even at low concentrations, land application contaminants, such as nutrients and pesticides, can disrupt aquatic life. Some of these chemicals may accumulate in the fatty tissue of aquatic organisms and impair their ability to reproduce, escape predation, maintain metabolic processes, and survive (Ross 2011, p. 6). In addition, macroinvertebrates, such as small freshwater crustaceans on which these four central Texas salamander species feed are especially sensitive to water pollution (Phipps *et al.* 1995, p. 282; Miller *et al.* 2007, p. 74).

Nutrients

Nutrient input (such as phosphorus and nitrogen) to watershed drainages, which often results in abnormally high organic growth in aquatic ecosystems, can originate from multiple sources, such as human and animal wastes, industrial pollutants, and fertilizers (from lawns, golf courses, or croplands) (Garner and Mahler 2007, p. 29). As the human population grows and subsequent urbanization occurs within the ranges of these four central Texas salamander species, they likely become more susceptible to the effects of excessive nutrients within their habitats. To illustrate, an estimated 102,262 domestic dogs and cats (pet waste is a potential source of excessive nutrients) were known to occur within the Barton Springs Segment of the Edwards Aquifer in 2010 (Herrington *et al.* 2010, p. 15). Their distributions were correlated with human population density (Herrington *et al.* 2010, p. 15).

Various residential properties and golf courses are known to use pesticides, herbicides, and fertilizers to maintain turfgrass within watersheds where Jollyville Plateau salamander populations are known to occur (COA 2003, pp. 1–7). Analysis of water quality constituents conducted by the City of Austin (1997, pp. 8–9) showed significant differences in nitrate, ammonia, total dissolved solids, total suspended solids, and turbidity concentrations between watersheds dominanted by golf courses, residential land, and rural land. Golf course tributaries were found to have higher concentrations of these constituents than residential tributaries, and both golf course and residential tributaries had substantially higher concentrations for these five constituents than rural tributaries (COA 1997, pp. 8–9).

Residential irrigation of wastewater effluent has led to excessive nutrient input into the recharge zone of the Barton Springs Segment of the Edwards Aquifer (Ross 2011, pp. 11–18). Wastewater effluent permits do not require treatment to remove metals, pharmaceutical chemicals, or the wide range of chemicals found in body care products, soaps, detergents, pesticides, or other cleaning products (Ross 2011, p. 6). These chemicals remaining in treated wastewater effluent can enter streams and the aquifer and alter water quality within salamander habitat.

Excessive nutrient input into aquatic systems can increase plant growth, which pulls more oxygen out of the water when the dead plant matter decomposes, resulting in less oxygen being available in the water for salamanders to breathe (Schueler 1987, pp. 1.5–1.6; Ross 2011, p. 7). A reduction in dissolved oxygen concentrations could not only affect respiration in salamander species, but also lead to decreased metabolic functioning and growth in juveniles (Woods *et al.* 2010, p. 544), or death (Ross 2011, p. 6). Excessive plant material can also reduce stream velocities and increase sediment deposition (Ross 2011, p. 7). When the interstitial spaces become compacted or filled with fine sediment, the amount of available foraging habitat and protective cover is reduced (Welsh and Ollivier 1998, p. 1,128). Studies in the Bull Creek watershed found a loss of some sensitive macroinvertebrate species, potentially due to nutrient enrichment and sediment accumulation (COA 2001b, p. 15).

Poor water quality, particularly elevated nitrates, may also be a cause of morphological deformities in individual Jollyville Plateau salamanders. The City of Austin has documented very high levels of nitrates (averaging over 6 milligrams per liter (mg L ^{1}) with some samples exceeding 10 mg L ^{1}) and high conductivity at two monitoring sites in the Stillhouse Hollow drainage area (O'Donnell *et al.* 2006, pp. 26, 37). For comparison, nitrate levels in undeveloped Edwards Aquifer springs (watersheds without high levels of urbanization) are typically close to 1 mg L ^{1} (O'Donnell *et al.* 2006, p. 26). The source of the nitrates in Stillhouse Hollow is thought to be lawn fertilizers (Turner 2005b, p. 11). Salamanders observed at the Stillhouse Hollow monitoring sites have shown high incidences of deformities, such as curved spines, missing eyes, missing limbs or digits, and eye injuries (O'Donnell *et al.* 2006, p. 26). These deformities often result in the salamander's inability to feed, reproduce, or survive. The Stillhouse Hollow location was also cited as having the highest observation of dead salamanders (COA 2001, p. 88). Although no statistical correlations were found between the number of deformities and nitrate concentrations (O'Donnell *et al.* 2006, p. 26), environmental toxins are the suspected cause of salamander deformities

(O'Donnell *et al.* 2006, p. 25). Nitrate toxicity studies have indicated that salamanders and other amphibians are sensitive to these pollutants (Marco *et al.* 1999, p. 2,837). Increased nitrate levels have been known to affect amphibians by altering feeding activity and causing disequilibrium and physical abnormalities (Marco *et al.* 1999, p. 2,837).

In summary, as the human population grows and subsequent urbanization occurs within the ranges of these four central Texas salamander species, they likely will become more susceptible to the effects of excessive nutrients within their surface and subsurface habitats. Because of the detrimental effects associated with increased nutrient input, we consider nutrients to be an ongoing threat to all four central Texas salamanders' continued existence throughout their ranges.

Pesticides

Pesticides are also associated with urban areas. Sources of pesticides include lawns, road rights-of-way, and managed turf areas, such as golf courses, parks, and ball fields. Pesticide application is also common in residential, recreational, and agricultural areas. Pesticides have the potential to leach into groundwater through the soil or be washed into streams by stormwater runoff.

Some of the most widely used pesticides in the United States are atrazine, carbaryl, diazinon, and simazine (Mahler and Van Metre 2000, p. 1). These four pesticides were documented within the Austin blind salamander's habitat (Barton Springs Pool and Eliza Springs) in water samples taken at Barton Springs during and after a 2-day storm event (Mahler and Van Metre 2000, pp. 1, 6, 8). They were found at levels below criteria set in the aquatic life protection section of the Texas Surface Water Quality Standards (Mahler and Van Metre 2000, p. 4). In addition, elevated concentrations of organochlorine pesticides were found in Barton Springs sediments (Ingersoll *et al.* 2001, p. 7). A later water quality study at Barton Springs from 2003 to 2005 detected atrazine, simazine, prometon, and deethylatrazine in low concentrations (Mahler *et al.* 2006, p. 63). During storm events, additional contaminants were detected, including pharmaceutical compounds such as caffeine, acetaminophen, and cotinine (Mahler *et al.* 2006, p. 64). The presence of these contaminants in Barton Springs indicates the vulnerability of salamander habitat to contaminant infiltration from surface land uses.

Another study by the U.S. Geological Survey detected insecticides (diazinon and malathion) and herbicides (atrazine, prometone, and simazine) in several Austin-area streams, most often at sites with urban and partly urban watersheds (Veenhuis and Slade 1990, pp. 45–47). Twenty-two of the 42 selected synthetic organic compounds analyzed in this study were detected more often and in larger concentrations at sites with more urban watersheds compared to undeveloped watersheds (Veenhuis and Slade 1990, p. 61). Other pesticides (dichlorodiphenyltrichloroethane, chlordane, hexachlorobenzene, and dieldrin) have been detected at multiple Jollyville Plateau salamander sites (COA 2001, p. 130).

The frequency and duration of exposure to harmful levels of pesticides have been largely unknown or undocumented for the four central Texas salamander species. Therefore, we do not know the extent to which pesticides and other waterborne contaminants have affected salamander survival, development, and reproduction, or their prey to date. However, pesticides are known to impact amphibian species in a number of ways. For example, Reylea (2009, p. 370) demonstrated that diazinon reduces growth and development in larval amphibians. Another pesticide, carbaryl, causes mortality and deformities in larval streamside salamanders (*Ambystoma barbouri*) (Rohr *et al.* 2003, p. 2,391). The Environmental Protection Agency (EPA) (2007a, p. 9) also found that carbaryl is likely to adversely affect the Barton Springs salamander both directly and indirectly through reduction of prey. Additionally, atrazine has been shown to impair sexual development in male amphibians at concentrations as low as 0.1 part per billion (Hayes 2002, p. 5,477). Atrazine levels were found to be greater than 0.44 part per billion after rainfall in Barton Springs Pool (Mahler and Van Mere 2000, pp. 4, 12).

In summary, even though we do not know the extent to which pesticides have affected the surface and subsurface habitat of the four central Texas salamander species at this time, pesticides do pose a significant, ongoing threat to the continued existence of all four salamanders throughout their ranges.

Hazardous Material Spills

The Edwards Aquifer is at risk from a variety of sources of pollutants (Ross 2011, p. 4), including hazardous materials that have the potential to be spilled, resulting in contamination of both surface and groundwater resources (Service 2005, pp. 1.6–14–1.6–15). Any activity that involves the extraction, storage, manufacture, or transport of potentially hazardous substances, such as fuels or chemicals, can contaminate water resources and cause harm to aquatic life. Spill events can involve a short release with immediate impacts, such as a collision that involves a tanker truck carrying gasoline, or the release can be long-term, involving the slow release of chemicals over time such as a leaking underground storage tank. As of 1996, more than 6,000 leaking underground storage tanks in Texas have resulted in contaminated groundwater (Mace *et al.* 1997, p. 2), including a large leak in the range of the Georgetown salamander (Mace *et al,* 1997, p. 32). The risk of this type of contamination is expected to increase with increasing urbanization.

The transport of hazardous materials is common on many highways, which are major transportation routes (Service 2005, p. 1.6–13). Interstate Highway 35 crosses the watersheds that contribute groundwater to spring sites known to be occupied by all four salamander species. A catastrophic spill could occur if a transport truck overturned and its contents entered the recharge zone of the Northern Segment of the Edwards Aquifer. Transportation accidents involving hazardous materials spills at bridge crossings are of particular concern because recharge areas in creek beds can transport contaminants directly into the aquifer (Service 2005, p. 1.6–14). Salado salamander sites located downstream of Interstate Highway 35 may be particularly vulnerable due to their proximity to this major transportation corridor. Interstate Highway 35 crosses Salado Creek just 760 to 1,100 ft (231 to 335 m) from three spring sites (Big Boiling Springs, Lil' Bubbly Springs, and Lazy Days Fish Farm) where the Salado salamander is known to occur. Should a hazardous materials spill occur at the Interstate Highway 35 bridge that crosses at Salado Creek, the Salado salamander could be at risk from contaminants entering the water flowing into its surface habitat downstream.

In addition, the Texas Department of Transportation (TxDOT) is planning to reconstruct a section of Interstate Highway 35 within the Village of Salado (Najvar, 2009, Service, pers. comm., p. 1). This work will include replacing four bridges that cross Salado Creek (two main lane bridges and two frontage road bridges) in an effort to widen the highway at this location. This project could affect the risk of hazardous materials spills and runoff into Salado Creek upstream of known Salado salamander locations. In August 2009, TxDOT began working with the Service to identify measures, such as the installation of permanent water quality control mechanisms to contain runoff, to protect the Salado salamander and its habitat from the effects of this project (Najvar 2009, pers. comm., p. 1).

Austin blind salamander habitat is similarly at risk from hazardous material spills that could contaminate groundwater. There is potential for a catastrophic gasoline spill in the Barton Springs Segment of the Edwards Aquifer, due to the presence of the Longhorn pipeline (Turner and O'Donnell 2004, pp. 2–3). Although a number of mitigation measures were employed to reduce the risk of a leak or spill from the Longhorn pipeline, such a spill could enter the aquifer and result in the contamination of salamander habitat at Barton Springs (EPA 2000, pp. 9–29–9–30).

Multiple water lines also run through the surrounding areas of Barton Springs. A water line break could potentially flow directly into Barton Springs, exposing salamanders to chlorine concentrations that are potentially toxic (Herrington and Turner 2009, pp. 5, 6). Sewage spills are the most common type of spill within the Barton Springs watershed and represent a potential catastrophic threat (Turner and O'Donnell 2004, p. 27). Sewage spills often include contaminants such as nutrients, PAHs, metals, pesticides, pharmaceuticals, and high levels of fecal coliform bacteria. Increased ammonia levels and reduced dissolved oxygen are the most likely impacts of a sewage spill that could cause rapid mortality of large numbers of salamanders (Turner and O'Donnell 2004, p. 27). Fecal coliform bacteria cause diseases in salamanders and their prey base (Turner and O'Donnell 2004, p. 27). Approximately 7,600 wastewater mains totaling 349 mi (561.6 km) are present in the Barton Springs Segment of the Edwards Aquifer (Herrington *et al.* 2010, p. 16). In addition, there are 9,470 known septic facilities in the Barton Springs Segment as of 2010 (Herrington *et al.* 2010, p. 5), up from 4,806 septic systems in 1995 (COA 1995, p. 3–13). In one City of Austin survey of these septic systems, over 7 percent were identified as failing (COA 1995, p. 3–18).

A contaminant spill could travel quickly through the aquifer to Barton Springs, where it could impact Austin blind salamander populations. Depending on water levels in the aquifer, groundwater flow rates through the Barton Springs Segment of the Edwards Aquifer can range from 0.6 mi (1 km) per day to over 4 mi (6 km) per day. The relatively rapid movement of groundwater under any flow conditions provides little time for mitigation efforts to reduce potential damage from a hazardous spill anywhere within the Barton Springs Segment of the Edwards Aquifer (Turner and O'Donnell 2004, pp. 11–13).

A number of point-sources of pollutants exist within the Jollyville Plateau salamander's range. Utility structures such as storage tanks or pipelines (particularly gas and sewer lines) can accidentally discharge. Leaking underground storage tanks have been documented as a problem within the Jollyville Plateau salamander's range (COA 2001, p. 16). Sewage spills from pipelines also have been documented in watersheds supporting Jollyville Plateau salamander populations (COA 2001, pp. 16, 21, 74). For example, in 2007, a sewage line overflowed an estimated 50,000 gallons (190,000 liters) of raw sewage into the Stillhouse Hollow drainage area of Bull Creek (COA 2007b, pp. 1–3). The location of the spill was a short distance downstream of currently known salamander locations, and no salamanders were thought to be affected.

The City of Austin also cites swimming pools as a potential threat to *Eurycea* salamanders if pools are drained into waterways or storm drains without dechlorination (COA 2001, p. 130). This is due to the concentrations of chlorine commonly used in residential swimming pools, which far exceed the lethal concentrations observed in experiments with the San Marcos salamander (*Eurycea nana*) (COA 2001, p. 130). Residential swimming pools can be found throughout the watersheds of several Jollyville Plateau salamander sites and may pose a risk to the salamanders if discharged into the storm drain system or waterways.

Data on chemical spills near the City of Georgetown are lacking, but the threat of groundwater contamination from accidental spills is still present. As recently as 2011, a fuel tanker overturned in Georgetown and spilled 3,500 gallons (13,249 liters) of gasoline (McHenry *et al.* 2011, p. 1). A large plume of hydrocarbons was detected within the Edwards Aquifer underneath Georgetown in 1997 (Mace *et al,* 1997, p. 32), probably the result of a leaking fuel storage tank. There are currently eight water treatment plants within the city limits, with wastewater and chlorinated drinking water lines running throughout Georgetown salamander stream drainages (City of Georgetown 2008, p. 3.37). A ''massive'' wastewater line is being constructed in the South San Gabriel River drainage (City of Georgetown 2008, p. 3.22), which is within the watershed of one known Georgetown salamander site. Almost 700 septic systems were permitted or inspected in Georgetown in 2006 (City of Georgetown 2008, p. 3.36). Even though data on chemical spills near the City of Georgetown are lacking, there is the potential for spills and contamination to occur from multiple sources.

Several groundwater contamination incidents have occurred within Salado salamander habitat (Price *et al.* 1999, p. 10). Big Boiling Springs is located on the south bank of Salado Creek, near locations of past contamination events (Chippindale *et al.* 2000, p. 43). Between 1989 and 1993, at least four incidents occurred within a quarter mile (0.4 km) from the spring site, including a 700-gallon (2,650-liter) and 400-gallon (1,514-liter) gasoline spill and petroleum leaks from two underground storage tanks (Price *et al.* 1999, p. 10). Because no follow-up studies were conducted, we have no information to indicate what effect these spills had on the species or its habitat. However, between 1991 and 1998, only a single salamander was observed at Big Boiling Springs (TPWD 2011a, p. 2).

In summary, catastrophic hazardous material spills pose a potential significant threat to the Austin blind, Georgetown, and Salado salamanders due to their restricted ranges. A significant hazardous materials spill within a stream drainage for any of these species could have the potential to threaten the long-term survival and sustainability of multiple populations or possibly an entire species. The threats from spills increase substantially under drought conditions due to lower dilution and buffering capability of impacted waterbodies. Spills under low flow conditions are predicted to have an impact at much smaller volumes (Turner and O'Donnell 2004, p. 26). For example, it is predicted that at low flows (10 cubic feet per second [cfs]) a spill of 360 gallons (1,362.7 liters) of gasoline 3 miles (4.8 km) from Barton Springs could be catastrophic for the Austin blind salamander population (Turner and O'Donnell 2004, p. 26). Because the Austin blind salamander resides in only one spring system, a catastrophic spill in its surface and subsurface habitat could cause the extinction of this species in the wild. However, because the Jollyville Plateau salamander occurs in more populations over a broader range, the potential for a catastrophic hazardous materials spill to affect the overall species' status is small.

A hazardous materials spill has the potential to cause localized populations to go extinct, but we do not consider this to be a threat to the Jollyville Plateau salamander's overall continued existence. But, in combination with the other threats identified in this five-factor analysis, we think a catastrophic hazardous materials spill could contribute to the species' risk of extinction by reducing its long-term viability. We, therefore, consider hazardous material spills to be a potential significant threat for the Austin blind and Salado salamander due to their limited distributions. Hazardous material spills are less of a threat for the more widespread Georgetown salamander. These spills pose a low risk to the Jollyville Plateau salamander due to its more widespread distribution.

Construction Activities

Short-term increases in pollutants, particularly sediments, can occur during construction in areas of new development. When vegetation is removed and rain falls on unprotected soils, large discharges of suspended sediments can erode from newly exposed areas, resulting in increased sedimentation in downstream drainage channels (Schueler 1987, pp. 1–4; Turner 2003, p. 24; O'Donnell *et al.* 2005, p. 15). This increased sedimentation from construction activities has been linked to declines in Jollyville Plateau salamander counts at multiple sites (Turner 2003, p. 24; O'Donnell *et al.* 2006, p. 34). Cave sites are also impacted by construction, as Testudo Tube Cave (Jollyville Plateau salamander habitat) showed an increase in nickel, calcium, and nitrate/nitrite after nearby road construction (Richter 2009, pp. 6–7). Barton Springs (Austin blind salamander habitat) is also under the threat of pollutant loading due to its proximity to construction activities and location at the downstream side of the watershed (COA 1997, p. 237). The City of Austin (1995, p. 3–11) estimated that construction-related sediment and in-channel erosion accounted for approximately 80 percent of the average annual sediment load in the Barton Springs watershed. In addition, the City of Austin (1995, p. 3–10) estimated that total suspended sediment loads have increased 270 percent over pre-development loadings within the Barton Springs Segment of the Edwards Aquifer. At this time, we are not aware of any studies that have examined sediment loading due to construction activities within the watersheds of Georgetown or Salado salamander habitats. However, because construction occurs in many of these watersheds, we believe that the threat of construction in areas of new development applies to these species as well. Construction is intermittent and temporary, but it affects both surface and subsurface habitats. Therefore, we have determined that this threat is ongoing and is and will continue to affect the Austin blind, Jollyville Plateau, and Georgetown salamanders and their habitats. However, we consider this threat to affect the Salado salamander to a lesser degree due to the relatively low levels of impervious cover in its range.

Also, the physical construction of pipelines has the potential to modify subsurface habitat for salamander species. It is known that these salamanders inhabit the subsurface environment. Tunneling for underground pipelines can destroy potential habitat by removing subsurface material. Additional material can become dislodged and result in increased sediment loading into the aquifer and associated spring systems. In addition, disruption of water flow to springs inhabited by salamanders can occur through the construction of tunnels and vertical shafts. Because detailed maps of the underground conduits that feed springs in the Edwards Aquifer are not available, tunnels and shafts have the possibility of intercepting and severing those conduits (COA 2010b, p. 28). Affected springs could rapidly become dry and would not support salamander populations. The closer a shaft or tunnel location is to a spring, the more likely that the construction will impact a spring (COA 2010b, p. 28). This has presumably occurred in the past at Moss Gulley Spring, where the drilling of a nearby test well in the mid-1980s led to the dewatering of the spring (Hillis *et al.* 2010, p. 2). Jollyville Plateau salamanders have not been observed at that site since the spring stopped flowing (Hillis *et al.* 2010, p. 2). Even small shafts pose a threat to nearby spring systems, and therefore, we consider construction of pipelines to be a future threat to the surface and subsurface habitat of all four salamander species. However, we consider this a low significance threat for the Jollyville Plateau salamander because tunnels or shafts are likely to only impact a few populations. Because there are currently no known projects that are likely to occur within the species' range, we consider this a threat of low significance for the Austin blind, Georgetown, and Salado salamanders.

Likewise, we consider tunnel and shaft construction to be a threat to the Jollyville Plateau salamander's surface and subsurface habitat due to its potential to intercept groundwater flow and dewatering. In 2011, construction began on the Jollyville Transmission Main (JTM), a tunnel designed to transport treated drinking water from Water Treatment Plant No. 4 to the Jollyville Reservoir. The project also includes four working shafts along the tunnel route (COA 2010b, p. 1). Because the tunnel is being constructed below the Edwards Aquifer and below the permeable portion of the Glen Rose formation (COA 2010b, p. 42; Toohey 2011, p. 1; COA 2011c, p. 36, 46), the threat to the salamander from this particular tunnel is considered low. The vertical shafts that are being drilled down through the Edwards Aquifer are a more significant concern.

Of the four shafts, only the one at the Four Points location appears to be a potential threat to any Jollyville Plateau salamanders. The Parks and Recreation Department (PARD) shaft is in the Glen Rose (not the Edwards) formation (Service 2010a; COA 2011c, p. 33) and therefore is not expected to affect Edwards Aquifer groundwater. The Jollyville Reservoir Shaft is on the other side of a groundwater divide from any springs within a mile of the site (Service 2010a). The shaft at the water treatment plant is going through a portion of the Edwards formation that is dry (COA 2011c, p. 33). There are 8 of 92 known Jollyville Plateau salamander sites within 1 mi (1.6 km) of the Four Points shaft location. The closest locations (Spring 21 and Spring 24) are about 2,000 ft (610 m) or greater from the shaft. Best management practices designed to protect groundwater resources have been implemented into the design and construction of the JTM shafts. These practices include, but are not limited to: Monitoring groundwater quality and spring flow, minimizing sediment discharges during construction, developing a groundwater impact contingency plan, locating working shafts in areas where the chance of encountering conduits to salamander springs is reduced, and re-routing conduit flow paths around the shaft if encountered (COA 2010b, pp. 51–55).

We believe that these best management practices have lowered the magnitude of the threat to the Jollyville Plateau salamander. However, a leak occurred at one shaft site (Four Points) in December 2011, and it was associated with an initial 1-foot (0.3 m) drop in the aquifer level (Toohey 2011, p. 2) as measured in a monitoring well 10 ft (3 m) away. A 1-foot (0.3-m) drop in water level was also seen in a monitoring well 100 ft (30 m) away, but not in monitoring wells farther out. The City did not see any drops in flow at the springs they were monitoring or in wells between those springs and the well 100 ft away; however, they do not have access to the closest springs (mentioned above). Since that time, grout has been injected into the shaft wall to stop the leak. Preliminary evidence indicates that the grout injection resulted in a tight seal at the site of the leak (Lesniak 2012, City of Austin, pers. comm.). Even so, we consider tunnel and shaft construction of the JTM to be a threat now to the Jollyville Plateau salamander's habitat due to its potential to intercept groundwater flow and to dewater; however, we consider this threat to be of low significance because the best management practices have been implemented into the design and construction of the JTM shafts to protect groundwater resources.

Lastly, limestone rock is an important raw material that is mined in quarries all over the world due to its popularity as a building material and its use in the manufacture of cement (Vermeulen and Whitten 1999, p. 1). The construction activities within rock quarries can permanently alter the geology and groundwater hydrology of the immediate area, and adversely affect springs that are hydrologically connected to impacted sites. The potential environmental impacts of quarries include outright destruction of springs or collapse of karst caverns, as well as impacts to water quality through siltation and sedimentation, and impacts to water quantity through water diversion, dewatering, and reduced flows (Ekmekci 1990, p. 4). Limestone is a common geologic feature of the Edwards Aquifer, and active quarries exist throughout the region. For example, at least three Georgetown salamander sites (Avant Spring, Knight (Crockett Gardens) Spring, and Cedar Breaks Hiking Trail Spring) occur adjacent to a limestone quarry that has been active since at least 1995. The population status of the Georgetown salamander is unknown at Knight Spring and Cedar Breaks Hiking Trail Spring, but salamanders are seen infrequently and in low abundance at the closest spring to the quarry (Avant Spring; Pierce 2011c, pers. comm.). Because quarries may only affect a small portion of the species' ranges, we consider the mining of limestock rock to be an ongoing threat with limited effect to the Georgetown, Jollyville Plateau, and Salado salamanders, but not the Austin blind salamander. The Austin blind salamander's range is located in downtown Austin, and there are no active limestone quarries within the species' range.

Water Quantity Reduction in Relation to Urbanization

The Northern Segment of the Edwards Aquifer is the primary supply of water for Jollyville Plateau, Georgetown, and Salado salamander habitat (Cole 1995, p. 33; TPWD 2011a, p. 3). In general, the aquifer has been described as localized, small, and highly susceptible to drying or draining (Chippindale *et al.* 2000, p. 36).

Urbanization and rapid population growth in the Northern Segment of the Edwards Aquifer may contribute to reduced spring flows due to increases in groundwater pumping. From 1980 to 2000, groundwater pumping in the Northern Segment of the Edwards Aquifer nearly doubled (TWDB 2003, pp. 32–33). The City of Georgetown predicts the average water demand to increase from 8.21 million gallons per day in 2003, to 10.9 million gallons per day by 2030 (City of Georgetown 2008, p. 3.36). Under peak flow demands (18 million gallons per day in 2003), the City of Georgetown uses seven groundwater wells in the Edwards Aquifer (City of Georgetown 2008, p. 3.36). Total water use for Williamson County was 73,532 ac ft in 2010, and is projected to increase to 98,268 ac ft by 2020, and to 211,854 ac ft by 2060, representing a 188 percent increase over the 50-year period (TWDB 2010, p. 46). Similarly, Bell County and Travis County expect a 59 percent and 91 percent increase in total water use over the same 50-year period, respectively (TWDB 2010, pp. 46, 64).

One prediction of future groundwater use in this area suggests a large drop in pumping as municipalities convert from groundwater to surface water supplies (TWDB 2003, p. 65). However, it is unknown if this reduction in groundwater use translates to adequate spring flows for salamanders. Increased urbanization in the watershed has been cited as one factor, in combination with drought, causing declines in spring flows (City of Austin 2006, pp. 46–47; TPWD 2011a, pp. 4–5). Urbanization removes the ability of the watershed to allow slow filtration of water through soils following rain events. Instead rainfall runs off impervious surfaces and into stream channels at higher rates, increasing downstream flows and decreasing groundwater recharge (Miller *et al.* 2007, p. 74).

The City of Austin found a negative correlation between urbanization and spring flows at Jollyville Plateau salamander sites (Turner 2003, p. 11). Field studies have also shown that a number of springs that support Jollyville Plateau salamanders have already gone dry periodically, and that spring waters resurface following rain events (O'Donnell *et al.* 2006, pp. 46–47). The San Gabriel Springs (Georgetown salamander habitat) are now intermittently flowing in the summer due to pumping from nearby water wells (TPWD 2011a, p. 9). Salamanders have not been seen on the surface there since 1991 (Chippindale *et al.* 2000, p. 40; Pierce 2011b, pers. comm.).

In combination with drought, groundwater pumping has a direct impact on spring flows. Groundwater availability models demonstrate that 1 cfs of pumping will diminish Barton Springs spring flow by 1 cfs under drought-of-record (1950s drought) conditions (Smith and Hunt 2004, pp. 24, 36). Under the same conditions, these models suggest that present-day pumping rates will temporarily cease Barton Springs flow on a daily basis (Smith and Hunt 2004, pp. 24, 36).

Groundwater pumping can lead to saline water encroachments in the aquifer. As groundwater levels decline, a decrease in hydrostatic pressure occurs and saline groundwater is able to penetrate up into the lower portion of the aquifer (Pavlicek *et al.* 1987, p. 2). This saline water encroachment would threaten the freshwater biota in the springs and the aquifer, including the four central Texas salamander species and their prey, by dramatically increasing the water salinity. Water quality in the Barton Springs Segment of the Edwards Aquifer has been degraded in the past due to saline encroachment (Slade *et al.* 1986, p. 62). This water quality degradation occurred when Barton Springs discharge was less than 30 cfs (Slade *et al.* 1986, p. 64). An analysis of more recent data found similar declines in water quality as the flow of Barton Springs dropped into the 20 to 30 cfs range (Johns 2006, pp. 6–7). As mentioned earlier, reduced groundwater levels would also increase the concentration of pollutants in the aquifer. Flows at Barton Springs dropped below 17 cfs as recently as mid-November 2011 (Barton Springs/Edwards Aquifer Conservation District 2011, p. 1).

Although water quantity decreases and spring flow declines are cited as a threat to *Eurycea* salamanders (Corn *et al.* 2003, p. 36; Bowles *et al.* 2006, p. 111), these species display some adaptive behavior to deal with periods of periodic surface flow losses. All four salamander species apparently spend some part of their life history in underground aquatic habitats and have the ability to retreat underground when surface flows decline. For example, one of the City of Austin monitoring sites where Jollyville Plateau salamanders are most abundant undergoes periods where there is no surface water habitat available for the salamander (O'Donnell *et al.* 2006, p. 47). Jollyville Plateau salamander juveniles were observed at Lanier Spring following 10 months of dry conditions on the surface, indicating that the salamanders are likely able to reproduce in the subsurface environment during a drought (Bendik 2011a, p. 32). Salado salamanders also reappeared in Robertson Springs after the springs went temporarily dry in 2009 (TPWD 2011a, p. 5). However, drying spring habitats can result in stranding salamanders, resulting in death of individuals (O'Donnell *et al.* 2006, p. 16). It is also known that prey availability for carnivores is low underground due to the lack of primary production (Hobbs and Culver 2009, p. 392). This is supported by recent evidence of ''shrinkage'' in Jollyville Plateau salamander body length following periods of no springflow (Bendik 2011b, pers. comm.). Length measurements taken during a COA mark-recapture study at Lanier Spring demonstrated that Jollyville Plateau salamanders had negative growth during a 10-month period of no springflow in 2008–2009 (Bendik 2011b, pers. comm.). Therefore, although central Texas salamanders can survive and reproduce underground, the best available scientific evidence shows that these animals need the energy-rich surface habitat for positive growth and development.

In summary, water quantity reduction in relation to urbanization is an ongoing threat to all four salamanders throughout their ranges, primarily due to increased groundwater pumping in the presence of drought conditions and potential increases in saline water encroachments in the aquifer. However, we believe this threat is having or likely to have only a moderate effect, because the salamanders have the ability to retreat underground when surface flows decline.

Physical Modification of Surface Habitat

All four salamanders are sensitive to direct physical modification of surface habitat from impoundments, feral hogs, livestock, and other human activities. Because these threats only impact the surface habitat of salamanders, and because each species has the ability to retreat to subsurface habitats for shelter, none of these threats is likely to result in a significant impact to the species or their habitat. However, in combination with other threats discussed above, these threats may contribute to the species' risk of extinction.

Impoundments

Impoundments disrupt the natural flow regime of streams, leading to a variety of stressors that impact the salamanders and their surface habitats. For example, a low water crossing on a tributary of Bull Creek, occupied by the Jollyville Plateau salamander, resulted in sediment build-up below the impoundment and a scour hole above the impoundment that supported predaceous fish (O'Donnell *et al.* 2008, p. 1). As a result, Jollyville Plateau salamanders were not found in this degraded habitat after the impoundment was constructed. When the crossing was removed in October 2008, the sediment build-up was removed, the scour hole was filled, and salamanders were later observed (Bendik 2011b, pers. comm.). Many low-water crossings are present near other Jollyville Plateau salamander sites (Bendik 2011b, pers. comm.). Impoundments only impact the surface habitat of salamanders. Because impoundments are likely to impact a small portion of the species' range, we consider impoundments caused by low-water crossings to be an ongoing threat of limited effect on the Jollyville Plateau salamander and its surface habitat, now and in the future.

Impoundments have also impacted surface habitat for the other salamander species. Most of the spring outlets in the Village of Salado, including the Salado salamander type locality at Big Boiling Springs, were modified by dam construction in the mid-1800s, to supply power to various mills (Brune 1981, p. 67). Two sites for the Georgetown salamander have spring openings that are confined to brick and mortar spring boxes (White 2011, SWCA, pers. comm.; Booker 2011, p. 1), presumably to collect the spring water for cattle. All spring sites for the Austin blind salamander (Main, Eliza, and Sunken Garden springs) have been impounded for recreational use. These sites were impounded in the early to mid-1900s. For example, Eliza Spring now discharges from 7 openings (each 1 ft (0.3 m) in diameter) in the concrete floor and 13 rectangular vents along the edges of the concrete. While the manmade structures help retain water in the spring pools during low flows, they have altered the salamander's natural environment. The impoundments have changed the Barton Springs ecosystem from a stream-like system to a more lentic (still water) environment, thereby reducing the water system's ability to flush sediments downstream and out of salamander habitat. Although a natural surface flow connection between Sunken Gardens Spring and Barton Creek has been restored recently (COA 2007c, p. 6), the Barton Springs system as a whole remains highly modified. Therefore, we consider impoundments to be an ongoing threat to the Salado, Georgetown, and Austin blind salamanders and their surface habitat, now and in the future. This threat has a limited effect on the Salado and Georgetown salamanders because it impacts a small portion of the species' ranges, but has a large effect on the Austin blind salamander because it affects this species' entire range.

Feral Hogs

There are between 1.8 and 3.4 million feral hogs (*Sus scrofa*) in Texas (TAMU 2011, p. 2). They prefer to live around moist areas, including riparian areas near streams, where they can dig into the soft ground for food and wallow in mud to keep cool (Mapson 2004, pp. 11, 14–15). Feral hogs disrupt these ecosystems by decreasing plant species diversity, increasing invasive species abundance, increasing soil nitrogen, and exposing bare ground (Texas A&M University (TAMU) 2012, p. 4). Feral hogs negatively impact surface salamander habitat by digging and wallowing in spring heads, which increases sedimentation downstream (O'Donnell *et al.* 2006, pp. 34, 46). They have been cited as a source of elevated bacteria, nitrates, and phosphorus to streams in the Austin area (Timmons *et al.* 2011, pp. 1–2).

Feral hogs have become abundant in some areas where the Jollyville Plateau, Georgetown, and Salado salamanders occur. O'Donnell *et al.* (2006, p. 34) noted that feral hog activity was increasing in the Bull and Cypress creek watersheds. Evidence of hogs has also been observed near one Georgetown salamander site (Cobbs Spring) (Booker 2011, p. 1). The landowner of Cobbs Spring is actively trapping feral hogs (Booker 2011, p. 1), but the effectiveness of this management has not been assessed. Feral hogs are also present in the area of several Salado salamander sites. Fortunately, feral hogs cannot access Austin blind salamander sites due to fencing and their location in downtown Austin.

In summary, because of their abundance and potential to negatively impact surface salamander habitat, we consider feral hogs to be an ongoing threat of low significance to the Jollyville Plateau, Georgetown, and Salado salamanders. As previously stated, we do not consider feral hogs to be a threat to the Austin blind salamander at this time.

Livestock

Similar to feral hogs, livestock can negatively impact surface salamander habitat by disturbing the substrate and increasing sedimentation in the spring run where salamanders are often found. Poorly managed livestock grazing results in changes in vegetation (from grass-dominated to brush-dominated), which leads to increased erosion of the soil profile (COA 1995, p. 3–59). Grazing near streams can negatively impact nutrients, bacteria, species diversity, and water temperature in stream systems (COA 1995, p. 3–62). Evidence of trampling and grazing in riparian areas from cattle can be found at one Georgetown salamander site (White 2011, SWCA, pers. comm.), and cattle are present on at least one other Georgetown salamander site. Cattle are also present on lands where four Salado salamander sites occur (Gluesenkamp 2011b, pers. comm.; Texas Section Society for Range Management 2011, p. 2). Austin blind salamander habitat is inside a City of Austin park, and livestock are not allowed in the spring areas. Much of the Jollyville Plateau salamander habitat is in suburban areas, and we are not aware of livestock damage in those areas.

There is some management of livestock occurring that reduces the magnitude of negative impacts. An 8,126-ac (3,288-ha) property in Bell County with at least three Salado salamander sites has limited its cattle rotation to a maximum of 450 head (Texas Section Society for Range Management 2011, p. 2), which is considered a moderate stocking rate. The landowners at four of the springs with Salado salamanders have been considering options for fencing off spring outlets to protect the salamander habitat from cattle damage (Harrell 2012, Service, pers. comm.). In addition, the landowner of Cobbs Spring (a Georgetown salamander site) is in the process of phasing out cattle on the property (Boyd 2011, Williamson County Conservation Foundation, pers. comm.).

In summary, even though livestock may be having impacts at four of the seven Salado salamander spring sites, we believe livestock to be an ongoing threat of low impact to this salamander's habitat because there is some management of the livestock that reduces the magnitude of negative impacts. Even though habitat degradation by livestock is a factor that seems to be impacting the habitat of the Georgetown salamander, we do not believe it is occurring at a scale that significantly contributes to the risk of extinction of the species on its own. However, in combination with the other threats identified in this five-factor analysis, we think livestock may be contributing to the species' risk of extinction by reducing its long-term viability. Livestock are not a threat to the continued existence of the Austin blind or Jollyville Plateau salamanders.

Other Human Activities

Some sites for the four central Texas salamanders have been directly modified by human-related activities. In the summer of 2008, a spring opening at a Salado salamander site was covered with gravel (Service 2010b, p. 6). Although we received anecdotal information that at least one salamander was observed at the site after the gravel was dumped at Big Boiling Springs, the Service has no detailed information on how the Salado salamander was affected by this action. Heavy machinery is continuously used in the riparian area of Big Boiling and Lil' Bubbly Springs to clear out vegetation and maintain a grassy lawn to the water's edge (Gluesenkamp 2011a,b, pers. comm.), which has led to erosion problems during flood events (TPWD 2011a, p. 6). The modification of springs for recreation or other purposes degrades natural riparian areas, which are important for controlling erosion and attenuating floodwaters in aquatic habitats. Other continuing human activities at Big Boiling Spring include pumping water from the spring opening, contouring the substrate of the spring environment, and covering spring openings with gravel (TPWD 2011a, p. 4). For example, in the fall of 2011, the outflow channels and edges of these two springs were reconstructed with large limestone blocks and mortar. In addition, in response to other activity in the area, the U.S. Army Corps of Engineers issued a cease and desist order to the Salado Chamber of Commerce in October 2011, for unauthorized discharge of dredged or fill material that occurred in this area (Brooks 2011, U.S. Corps of Engineers, pers. comm.). This order was issued in relation to the need for a section 404 permit under the Clean Water Act (33 U.S.C. 1251 et seq.). Also in October 2011, a TPWD game warden issued a citation to the Salado Chamber of Commerce due to the need for a sand and gravel permit from the TPWD for work being conducted within TPWD's jurisdiction (Heger 2012a, TPWD, pers. comm.). The citation was issued because the Salado Chamber of Commerce had been directed by the game warden to stop work within TPWD's jurisdiction, which Salado Chamber of Commerce did temporarily, but work started again in spite of the game warden's directive (Heger 2012a, pers. comm.). A sand and gravel permit was obtained on March 21, 2012. The spring run modifications were already completed by this date, but further modifications in the springs were prohibited by the permit. Additional work on the bank upstream of the springs was permitted and completed (Heger 2012b, pers. comm.).

Because the Salado salamander is only known from seven spring locations, any type of human-related activities, such as pumping water from a spring opening, contouring the substrate of a spring environment, and covering spring openings with gravel, may have significant detrimental effects on the salamander and its habitat. These activities only affect the surface salamander habitat. Therefore, we consider these types of human-related activities to be ongoing threats of low impact to the Salado salamander's continued existence.

Furthermore, frequent human visitation associated with easily accessed habitat of the four salamanders may negatively affect the species and their habitat. Documentation from the City of Austin of disturbed vegetation, vandalism, and the destruction of travertine deposits (fragile rock formations formed by deposit of calcium carbonate on stream bottoms) by foot traffic has been documented at one of their Jollyville Plateau salamander monitoring sites in the Bull Creek watershed (COA 2001, p. 21) and may result in direct destruction of small amounts of the salamander's habitat. Eliza Spring and Sunken Garden Spring, two of the three locations of the Austin blind salamander, also experience vandalism, despite the presence of fencing and signage (Dries 2011, City of Austin, pers. comm.). The deep water of the third location (Main Pool) likely protects the Austin blind salamander's surface habitat from damage from frequent human recreation. Therefore, we consider human visitation to be an ongoing threat of low impact to the Jollyville Plateau salamander, and a threat of moderate impact to the Austin blind salamander, now and in the future.

Lastly, at the complex of springs occupied by the Georgetown salamander within San Gabriel River Park, a thick bed of nonnative granite gravel has been placed in the spring runs (TPWD 2011a, p. 9). This pea gravel is too small to serve as cover habitat and does not form the interstitial spaces required for

Georgetown salamanders. Salamanders have not been observed here since 1991 (Chippindale *et al.* 2000, p. 40; Pierce 2011b, pers. comm.). Gravel dumping has not been documented at any other Georgetown salamander sites. Because this activity may have contributed to the decline of only this single population, we do not consider substrate modification in the form of gravel dumping to be a threat to the existence of the Georgetown salamander by itself. However, in combination with the other threats identified in this five-factor analysis, we think substrate modification may be contributing to the species' risk of extinction by reducing its long-term viability.

Drought and Flooding

Broad drought and flooding events have proven to have large impacts on the central Texas salamanders by drastically reducing or increasing the amount of water and affecting habitat quality.

Drought

The presence of water is an essential component to salamander habitat. Drought conditions alter the hydrologic conditions resulting in lowering groundwater tables and reduced spring flows. The impacts of drought are compounded by other consumptive uses of the aquifer such as groundwater pumping. The Northern Segment of the Edwards Aquifer, which supplies water to Jollyville Plateau, Georgetown, and Salado salamander habitat, is vulnerable to drought (Chippindale *et al.* 2000, p. 36). In particular, the portion of the Edwards Aquifer underlying the Jollyville Plateau is relatively shallow, with a high elevation, thus being unlikely to be able to sustain spring flows during periods of drought (Cole 1995, pp. 26–27). Drought in the watershed has been cited as one factor, in combination with urbanization, causing declines in spring flows (O'Donnell *et al.* 2006, pp. 46–47). A recent drought lasting from 2008 to 2009 was considered one of the worst droughts in central Texas history and caused numerous Jollyville Plateau salamander sites to go dry (Bendik 2011a, p. 31). An even more pronounced drought throughout Texas began in 2010, with the period from October 2010, through September 2011, being the driest 12-month period in Texas since rainfall records began (LCRA 2011, p. 1). Rainfall in early 2012 has lessened the intensity of the current drought, but below average rainfall and above average temperatures are forecasted for the summer of 2012 (LCRA 2012, p. 1).

Low flow conditions during drought also have negative impacts to the Austin blind salamander and its ecosystem in the Edwards Aquifer and at Barton Springs. The long-term average flow at the Barton Springs outlets is approximately 53 cfs (City of Austin 1998, p. 13; Smith and Hunt 2004, p. 10). The lowest flow recorded at Barton Springs was about 10 cfs during a record drought in the 1950s (COA 1998, p. 13). Discharge at Barton Springs decreases as water levels in the Barton Springs Segment of the Edwards Aquifer drop. Decreased discharge is associated with increases in water temperature, decreases in spring flow speed, and increases in sedimentation (COA 2011d, pp. 19, 24, 27). Large declines in aquifer levels have historically been due to a lack of adequate rainfall recharging the aquifer. In a 2004 groundwater flow modeling study, the Barton Springs Edwards Aquifer Conservation District predicted that under drought-of-record conditions and current pumping levels, the mean monthly springflow would be about 1 cfs. This study also indicated that under drought-of-record conditions, projected pumping rates for future years would cause Barton Springs to cease flowing for at least 4 months out of a year (Smith and Hunt 2004, pp. 1, 20, 24).

The specific effects of low flow on central Texas salamanders can be inferred by examining studies on the Barton Springs salamander. Drought decreases spring flow and dissolved oxygen levels and increases temperature in Barton Springs (Turner 2004, p. 2; Turner 2009, p. 14). Low dissolved oxygen levels decrease reproduction in Barton Springs salamanders (Turner 2004, p. 6; 2009, p. 14). Turner (2009, p. 14) also found that Barton Springs salamander counts decline with decreasing discharge (and thus declining dissolved oxygen levels). A prolonged drought from June 2008 through September 2009 caused decreases in Barton Springs salamander abundance (COA 2011d, pp. 19, 24, 27). The drought in 2011 resulted in dissolved oxygen concentrations so low that City of Austin used an aeration system to maintain oxygenated water in Eliza and Sunken Gardens Springs (Dries 2011, City of Austin, pers. comm.). Drought also lowers water quality in Barton Springs due to saline water encroachments in the Barton Springs Segment of the Edwards Aquifer (Slade *et al.* 1986, p. 62; Johns 2006, p. 8).

In summary, we consider drought to be an ongoing threat to all four salamanders, because it can cause direct mortality to salamanders by desiccation if they are unable to retreat underground, it increases competition for spaces and resources (Bendik 2011a, p. 31), and it negatively affects their habitat, as discussed above. However, we consider the threat of drought to have a limited impact to all four central Texas salamanders and their habitats because they may be evolutionarily adapted to drought conditions that are common to the region (Bendik 2011a, pp. 31–32). At the same time, climate change and groundwater pumping may exacerbate drought conditions to the point where salamanders cannot adapt (see ''Climate Change'', below, and ''Water Quantity Reduction in Relation to Urbanization'', above).

Flooding

Flooding as a result of rainfall events can dramatically alter the substrate and hydrology of salamander habitat. A flood event in September 2010 modified surface habitat for the Georgetown salamander at two sites (Pierce 2011a, p. 10). The stormwater runoff caused erosion, scouring of the streambed channel, the loss of large rocks, and the creation of several deep pools. Salamander densities dropped dramatically in the days following the flood, and at one site, remained at low levels until habitat restoration (returning large rocks to the spring run) took place in the spring of 2011 (Pierce 2011a, p. 11). Likewise, three storm events in 2009 and 2010 deposited sediment and other material on top of spring openings at Salado Spring, preventing salamanders from foraging (TPWD 2011a, p. 6). The increased flow rate from flooding causes unusually high dissolved oxygen concentrations, which may exert direct or indirect, sub-lethal effects (reduced reproduction or foraging success) on salamanders (Turner 2009, p. 11). In addition, Geismar (2005, p. 2) found that flooding increases contaminants and sediments in Barton Springs. In 2007, flooding resulted in repeated accumulation of sediment in the Main Pool of Barton Springs that was so rapid that cleaning by City of Austin staff was not frequent enough to keep the surface habitat from becoming embedded (COA 2007c, p. 4). Flooding likely has similar effects on contaminants and sediments in other salamander habitat, but we are not aware of other studies.

The four salamanders' surface habitat is characterized by shallow water depth (COA 2001, p. 128; Pierce 2011a, p. 3), but deep pools are sometimes formed within stream channels from the scouring of floods. Tumlison *et al.* (1990, p. 172) found that the abundance of one *Eurycea* species decreased as water depth increased. This relationship may be caused by an increase in predation pressure, as deeper water supports predaceous fish populations. However, several central Texas *Eurycea* species are able to thrive in deep water environments in the presence of many predators (for example, San Marcos salamander in Spring Lake, *Eurycea* sp. in Landa Lake, Barton Springs salamander in Barton Springs Pool). Anti-predator behaviors may allow these species to co-exist with predaceous fish, and the effectiveness of these behaviors may be species-specific (reviewed in Pierce and Wall 2011, pp. 18–19). The specific resistance to predation from fish for the four central Texas salamanders is unknown. In any case, flooding can alter the surface habitat by deepening stream channels, which may increase predaceous fish.

Also, salamanders may be flushed from the surface habitat by strong flows during flooding. Bowles *et al.* (2006, p. 117) observed no Jollyville Plateau salamanders in riffle habitat at one site during high water velocities and hypothesized that individual salamanders were either flushed downstream or retreated to the subsurface. This site had a relatively undeveloped watershed (Bowles *et al.* 2006, p. 112), indicating that the runoff was largely natural and not caused by impervious cover.

In conclusion, flooding is a naturally occurring event that all four salamander species have adapted to in the past. Further, even though flooding is a factor that seems to be impacting all four salamanders' surface habitats, we do not believe it is occurring at a scale that would cause the extinction of any of the salamanders on its own. Because of this, we consider flooding on its own to have a limited effect on the species and their habitats. However, in combination with the other threats identified in this five-factor analysis, we think flooding may be contributing to the species' risk of extinction by reducing its long-term viability. The intensity of flooding events has increased due to increases in impervious cover. As previously noted, once natural vegetation in a watershed is replaced with impervious cover, rainfall is converted to surface runoff instead of filtering through the ground (Schueler 1991, p. 114). Impervious cover in a stream's watershed causes streamflow to shift from predominately baseflow, which is derived from natural filtration processes and discharges from local groundwater supplies, to predominately stormwater runoff. With increasing stormwater runoff, the amount of baseflow available to sustain water supplies during drought cycles is diminished and the frequency and severity of flooding increases. Because of the detrimental effects previously discussed in association with increased stormwater runoff, we consider changes in flow regime due to impervious cover to be an ongoing threat to all four central Texas salamanders' surface habitats.

Climate Change

Future climate change could potentially affect water quantity and spring flow for the four salamander species. According to the Intergovernmental Panel on Climate Change (IPCC 2007, p. 1), ''warming of the climate system is unequivocal, as is now evident from observations of increases in global averages of air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.'' Localized projections suggest the southwest United States may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007, p. 8), with warming increases in southwestern States greatest in the summer. The IPCC also predicts hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007, p. 8).

Climate change could compound the threat of decreased water quantity at salamander spring sites. An increased risk of drought could occur if evaporation exceeds precipitation levels in a particular region due to increased greenhouse gases in the atmosphere (CH2M HILL 2007, p. 18). The Edwards Aquifer is also predicted to experience additional stress from climate change that could lead to decreased recharge and low or ceased springflows given increasing pumping demands (Loáiciga *et al.* 2000, pp. 192–193). CH2M HILL (2007, pp. 22–23) identified possible effects of climate change on water resources within the Lower Colorado River Watershed (which contributes recharge to Barton Springs). A reduction of recharge to aquifers and a greater likelihood for more extreme droughts were identified as potential impacts to water resources (CH2M HILL 2007, p. 23). The droughts of 2008 to 2009, and 2010 to 2011, were two of the worst in central Texas history, with the period from October 2010, through September 2011, being the driest 12-month period in Texas since rainfall records began (LCRA 2011, p. 1). Rainfall in early 2012 has lessened the intensity of the current drought, but below average rainfall and above average temperatures are forecasted for the summer of 2012 (LCRA 2012, p. 1).

In summary, the effects of climate change could potentially lead to detrimental impacts on aquifer-dependent species, especially coupled with other threats on water quality and quantity. However, there are little data available to correlate groundwater trends and climate change, and groundwater typically represents an integration of past climatic conditions over many years due to its time within an aquifer system (Mace and Wade 2008, p. 657). Recharge, pumping, natural discharge, and saline intrusion of groundwater systems could all be affected by climate change (Mace and Wade 2008, p. 657). Because climate change has the potential to negatively affect water quality and spring flow, we consider climate change to be a potential threat to all four central Texas salamanders and their habitats, now and in the future.

Land Conservation Programs and Plans

The Williamson County Conservation Foundation (Foundation), a nonprofit organization established by Williamson County in 2002, is currently working to find ways to conserve endangered species and other unlisted species of concern in Williamson County, Texas. This organization held a Georgetown salamander workshop in November 2003, in an effort to bring together landowners, ranchers, farmers, developers, local and State officials, Federal agencies, and biologists to discuss information currently known about the Georgetown salamander and to educate the public on the threats faced by this species.

With the help of a grant funded through section 6 of the Act, the Foundation developed the Williamson County Regional HCP to obtain a section 10(a)(1)(B) permit for incidental take of federally listed endangered species in Williamson County, Texas. This HCP became final in October 2008. Although the Georgetown salamander is not currently listed and is not a ''covered'' species, the Foundation has included considerations for the Georgetown salamander in the HCP. In particular, they plan to conduct a status review of the Georgetown salamander. The Foundation plans to fund at least $50,000 per year for 5 years for monitoring, surveying, and gathering baseline data on water quality and quantity at salamander spring sites. Information gathered during this status review will be used to develop a conservation strategy for this species. The Foundation began allocating funding for Georgetown salamander research and monitoring beginning in 2010. A portion of that funding supported mark-recapture studies of the Georgetown salamander at two of its known localities (Twin Springs and Swinbank Spring) in 2010 and 2011 (Pierce 2011a, p. 20). Additional funds have been directed at water quality assessments of at least two known localities and efforts to find previously undiscovered Georgetown salamander populations (Boyd 2011, pers. comm.). Although Jollyville Plateau salamanders are present in southwest Williamson County and Salado salamander spring sites are likely influenced by the Edwards Aquifer Recharge Zone in northern Williamson County, the regional HCP does not include considerations for these species. Also, Austin blind salamanders are not affected by this HCP.

Although the Service worked with the Foundation to develop the regional HCP for several listed karst invertebrates, it is also expected to benefit the Georgetown salamander by lessening the potential for water quality degradation within the spring systems it inhabits. As part of this HCP, the Foundation is looking to set aside land that is beneficial to karst invertebrate species. Some of these lands are in areas that will also provide water quality benefits for the Georgetown salamander. For example, the Foundation has purchased an easement on the 64.4-ac (26.1-ha) Lyda tract (Cobbs Cavern) in Williamson County through the section 6 grant program. This section 6 grant was awarded for the protection of listed karst invertebrate species; however, protecting this land also benefited the Georgetown salamander. Although the spring where salamanders are located was not included in the easement, a portion of the contributing watershed for this spring was included. For this reason, some water quality benefits to the salamander are expected. In January 2008, the Foundation also purchased the 145-ac (59-ha) Twin Springs preserve area. This tract is one of the sites known to be occupied by Georgetown salamanders.

Despite the conservation efforts of the Foundation, the Georgetown salamander faces ongoing threats due to the lack of habitat protection outside of these preserves. This species is limited to 16 known localities, of which only three (Cobbs Spring, Cobbs Well, and Twin Springs) have some amount of protection by the Foundation. The population size of Georgetown salamanders at Cobbs Spring is unknown, while the population size at Twin Springs is estimated to be only 100 to 200 individuals (Pierce 2011a, p. 18). Furthermore, the watershed of Cobbs Spring is currently only partially protected by the Foundation.

The Balcones Canyonlands Preserve offers some water quality benefits to the Jollyville Plateau salamander in portions of the Bull Creek, Brushy Creek, Cypress Creek, and Long Hollow Creek drainages through preservation of open space (Service 1996a, pp. 2–28, 2–29). However, eight of the nine City of Austin monitoring sites occupied by the Jollyville Plateau salamander within the Balcones Canyonlands Preserve have experienced water quality degradation occurring upstream and outside of the preserved tracts (O'Donnell *et al.* 2006, pp. 29, 34, 37, 49; COA 1999, pp. 6–11; Travis County 2007, p. 4). Additionally, Jollyville Plateau salamanders are not a covered species under the section 10(a)(1)(B) permit under which the preserves were established (Service 1996b, pp. 1–10). Therefore, they receive no specific protections under the Balcones Canyonlands Preserve permit, such as mitigation to offset impacts from development.

The landowners of one 8,126-ac (3,288-ha) property with at least three high-quality Salado salamander sites and the landowner of another property with one Salado salamander site have shown a commitment to natural resource conservation and land stewardship practices that benefit the Salado salamander. Neither ranch owner has immediate plans to develop their land, which means that the Salado salamander is currently not faced with threats from urbanization (see discussion above under Factor A) from these lands. However, only 21 percent of the watershed is contained within the property with three Salado salamander sites, and only 3 percent of the watershed is contained within the other property with the one Salado salamander site. The remaining area of the watersheds and the recharge zone for these springs is not contained within the properties and is not protected from future development. Considering the projected growth rates expected in Bell County (from 237,974 in 2000, to 397,741 in 2040, a 67 percent increase over the 40-year period; Texas State Data Center 2009, p. 19), these Salado salamander spring sites are still at threat from the detrimental effects of urbanization. The threat of development and urbanization continues into the foreseeable future because there are no long-term, binding conservation plans in place for these properties or adequate regulations in place for the watersheds or recharge zone.

The City of Austin is implementing an HCP to avoid, minimize, and mitigate incidental take of the Barton Springs salamander resulting from the continued operation and maintenance of Barton Springs Pool and adjacent springs (City of Austin 1998, pp. 1–53). Many of the provisions of the plan also benefit the Austin blind salamander. These provisions include: (1) Training lifeguard and maintenance staff to protect salamander habitat, (2) controlling erosion and preventing surface runoff from entering the springs, (3) ecological enhancement and restoration, (4) monthly monitoring of salamander numbers, (5) public outreach and education, and (6) establishment and maintenance of a captive breeding program, which includes the Austin blind salamander. As part of this HCP, the City of Austin completed habitat restoration of Eliza Spring and the main pool of Barton Springs in 2003 and 2004. A more natural flow regime was reconstructed in these habitats by removing large obstructions to flow.

Conclusion of Factor A

Degradation of habitat, in the form of reduced water quality and quantity and disturbance of spring sites (surface habitat), is the primary threat to the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders. Reductions in water quality occur primarily as a result of urbanization, which increases the amount of impervious cover in the watershed. Impervious cover increases storm flow velocities and increases erosion and sedimentation. Impervious cover also changes natural flow regimes within watersheds and increases the transport of contaminants common in urban environments, such as oils, metals, and pesticides.

After identifying 15 watersheds within the Watershed Boundary Dataset as being occupied by 1 of the 4 central Texas salamander species, and using the most recent National Land Cover Dataset impervious cover data available (from 2006), we could draw some generalizations about how each watershed might be affected by development. The watershed where the Austin blind salamander is known to occur has an average overall impervious cover estimate of 12 percent, but also includes some Balcones Canyonlands Preserve lands. Although this managed open space likely contributes some water quality benefits to surface flow, the habitat of this largely subterranean species can be influenced by land use throughout the recharge zone of the aquifer that supplies its spring flow.

The watersheds within the Jollyville Plateau salamander's range have average impervious cover estimates that range from approximately 6 percent to 34 percent. Although the Balcones

Canyonlands Preserve and other lands managed for open space within these watersheds likely provide some water quality benefits for this species, five out of the six watersheds that occur within its range have overall impervious cover estimates that can lead to sharp declines in water quality or cause permanent conditions of poor water quality (Schueler 1994, pp. 100–102).

The watersheds within the Georgetown salamander's range have average impervious cover estimates that range from approximately 0.59 percent to 10 percent. Five out of the six watersheds within this species' range are well below impervious cover levels that can lead to declines in water quality. With only two large tracts of land managed specifically as open space (64 ac (26 ha) and 145 ac (59 ha)) within the Georgetown salamander's range, it is likely that water quality for this species' habitat will decline into the future as impervious cover increases with development.

The two watersheds within the Salado salamander's range have average impervious cover estimates of 0.31 percent and 0.91 percent. Although four known Salado salamander sites are located on large, undeveloped ranches (8,126 ac (3,288 ha) and 827 ac (335 ha)), a significant portion of the recharge zone for the Northern Segment of the Edwards Aquifer that supplies water to this species' habitat extends to areas outside of these properties. Furthermore, we could not identify any large tracts managed specifically as open space within the Salado salamander's range. We also could identify no agreements in place to preserve or manage any properties for the benefit of this species or its habitat. Without these, it is likely that water quality within the Salado salamander's habitat will decrease as development and impervious cover increases in these watersheds in the future.

Expanding urbanization results in an increase of contaminants, such as fertilizers and pesticides, within the watershed, which degrades water quality at salamander spring sites. Additionally, urbanization increases nutrient loads at spring sites, which can lead to decreases in dissolved oxygen levels. Construction activities are a threat to both water quality and quantity because they can increase sedimentation and dewater springs by intercepting aquifer conduits.

Various other threats exist for these species, as well. Drought, which may be compounded by the effects of global climate change, also degrades water quality and reduces available habitat for the salamanders. Water quantity can also be reduced by groundwater pumping. Flood events contribute to the salamanders' risks of extinction by degrading water quality through increased sedimentation and contaminants levels, which may damage or alter substrates. Impoundments are also a threat for all four central Texas salamanders. Feral hogs are a threat to Georgetown, Salado, and Jollyville Plateau salamanders because they can physically alter their surface habitat. Likewise, livestock are a threat to Georgetown and Salado salamanders' surface habitat. Additionally, catastrophic spills and leaks remain a threat for many salamander locations. All of these threats are predicted to increase in the future, as the human population and development increases within watersheds that provide habitat for these salamanders. Overall, we consider the combined threats of Factor A to be ongoing and with a high degree of impact to all four central Texas salamanders and their habitats.

Factor B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

There is no available information regarding overutilization of any of the four salamander species for commercial, recreational, scientific, or educational purposes. We do not consider overutilization to be a threat to the four central Texas salamander species now or in the future.

Factor C. Disease or Predation

Chytridiomycosis (chytrid fungus) is a fungal disease that is responsible for killing amphibians worldwide (Daszak *et al.* 2000, p. 445). The chytrid fungus has been documented on the feet of Jollyville Plateau salamanders from 15 different sites and on Austin blind salamanders in the wild (O'Donnell *et al.* 2006, pp. 22–23; Chamberlain 2011, City of Austin, pers. comm.). However, the salamanders are not displaying signs of infection (O'Donnell *et al.* 2006, p. 23). We have no data to indicate whether impacts from this disease may increase or decrease in the future, and therefore, whether this disease is a significant factor affecting the species (a threat). Therefore, we do not consider chytridiomycosis to be a threat to any of the four central Texas salamanders at this time.

However, a condition affecting Barton Springs salamanders may also be a threat to the Austin blind salamander. In 2002, 19 Barton Springs salamanders, which co-occur with the Austin blind salamander, were found at Barton Springs with bubbles of gas occurring throughout their bodies (Chamberlain and O'Donnell 2003, p. 17). Three similarly affected Barton Springs salamanders also were found in 2003 (Chamberlain, unpublished data). Of the 19 salamanders affected in 2002, 12 were found dead or died shortly after they were found. Both adult and juvenile Barton Springs salamanders have been affected (Chamberlain and O'Donnell 2003, pp. 10, 17).

The incidence of gas bubbles in salamanders at Barton Springs is consistent with a disorder known as gas bubble disease, or gas bubble trauma, as described by Weitkamp and Katz (1980, pp. 664–671). In animals with gas bubble trauma, bubbles below the surface of the body and inside the cardiovascular system produce lesions and dead tissue that can lead to secondary infections (Weitkamp and Katz 1980, p. 670). Death from gas bubble trauma is apparently related to an accumulation of internal bubbles in the cardiovascular system (Weitkamp and Katz 1980, p. 668). Pathology reports on affected animals at Barton Springs found that the symptoms were consistent with gas bubble trauma (Chamberlain 2011, pers. comm.). The cause of gas bubble trauma is unknown, but its incidence has been correlated with water temperature. Gas bubble trauma has been observed in Austin blind salamanders in captivity when exposed to water temperatures approaching 80 °F (26.7 °C) (Chamberlain 2011, pers. comm.).

We consider gas bubble trauma to be a threat with a limited impact to the Austin blind salamander now and in the future. To our knowledge, gas bubble trauma has not been observed in Jollyville Plateau, Georgetown, or Salado salamanders. However, if an increase in water temperature is a causative factor, these three species may also be at risk during droughts or other environmental stressors that result in increases in water temperature. However, at this time, we do not consider gas bubble trauma to be a threat to the Jollyville Plateau, Georgetown, or Salado salamanders.

Regarding predation, City of Austin biologists found Jollyville Plateau salamander abundances were negatively correlated with the abundance of predatory centrarchid fish (carnivorous freshwater fish belonging to the sunfish family), such as black bass (*Micropterus* spp.) and sunfish (*Lepomis* spp.) (COA 2001, p. 102). Predation of a Jollyville Plateau salamander by a centrarchid fish was observed during a May 2006 field survey (O'Donnell *et al.* 2006, p. 38). However, Bowles *et al.* (2006, pp. 117–118) rarely observed these predators in Jollyville Plateau salamander habitat.

Centrarchid fish are currently present in two of three Austin blind salamander sites (Laurie Dries, City of Austin, unpublished data), and crayfish (another predator) occupy much of the same habitat as Georgetown, Salado, and Jollyville Plateau salamanders. All four salamanders have been observed retreating into gravel substrate after cover was moved, suggesting these salamanders display anti-predation behavior (Bowles *et al.* 2006, p. 117). However, we do not have enough data to indicate whether predation of the four salamander species may increase in the future or is a significant factor affecting the species and therefore a threat. Therefore, we do not consider predation to be a threat to any of the four central Texas salamanders at this time.

In summary, while predation and disease may be affecting individuals of these salamander species, we believe that these are not significant factors affecting the species' continued existence. Neither predation nor disease is occurring at a level that we consider to be a threat to the continued existence of any of the four central Texas salamander species now or in the future.

Factor D. The Inadequacy of Existing Regulatory Mechanisms

Water Quantity and Quality Protections

The main threats to the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders are from habitat degradation, specifically a lowering of water quality and quantity. Therefore, regulatory mechanisms that protect water from the Edwards Aquifer are crucial to the future survival of the species. These four salamander species are not listed on the Texas State List of Endangered or Threatened Species (TPWD 2011b, pp. 2–3). Therefore, these species are receiving no direct protection from the State.

Under authority of the Texas Administrative Code (Title 30, Chapter 213), the Texas Commission on Environmental Quality (TCEQ) regulates activities having the potential for polluting the Edwards Aquifer and hydrologically connected surface streams. Among other State statutes designed to protect water quality, the Edwards Rules require a number of water quality protection measures for new development occurring in the recharge and contributing zones of the Edwards Aquifer. These regulations provide incentives to developers in the form of exemptions and exceptions from permanent water quality control mechanisms for developments with less than 20 percent impervious cover. However, only the Georgetown salamander sites and about half of the known Jollyville Plateau salamander locations occur within those portions of the Edwards Aquifer regulated by TCEQ. Furthermore, the jurisdiction of the Edwards Rules does not extend into Bell County or the Barton Springs Segment (TCEQ 2001, p. 1). Therefore, many salamander populations do not directly benefit from these protections.

We recognize that implementation of the Edwards Rules in other areas of the Northern Segment of the Edwards Aquifer may have the potential to affect conditions at spring sites occupied by the Salado salamander. For those salamander locations that are covered by the TCEQ regulations, the regulations do not address land use, impervious cover limitations, non-point source pollution, or application of fertilizers and pesticides over the recharge zone (30 TAC 213.3). We are unaware of any water quality ordinances more restrictive than TCEQ's Edwards Rules in Bell, Williamson, or Travis Counties outside the City of Austin.

The City of Austin's water quality ordinances (City of Austin Code, Title 25, Chapter 8) provide some water quality regulatory protection to the Austin blind and Jollyville Plateau salamanders' habitat within Travis County. The ordinances range from relatively strict controls in its extraterritorial jurisdiction to lesser controls in outlying areas. Some of the protections provided in these ordinances include riparian buffers, permanent water quality control structures, wastewater system restrictions, and impervious cover limitations (Turner 2007, pp. 1–2). Some studies have demonstrated that these ordinances play a role in protecting Austin-area surface waters from urbanization-related contaminants. For example, in the period after the City of Austin passed water quality ordinances in 1986 and 1991, sedimentation and nutrients decreased in the five major Austin-area creeks (Turner 2007, p. 7). Peak storm flows were also lower after the enactment of the ordinances, which may explain the decrease in sedimentation (Turner 2007, p. 10). Likewise, a separate study on the water quality of Walnut Creek (Jollyville Plateau salamander habitat) from 1996 to 2008 found that water quality has either remained the same or improved (Scoggins 2010, p. 15). These trends in water quality occurred despite a drastic increase in construction and impervious cover during the same time period (Turner 2007, pp. 7–8; Scoggins 2010, p. 4), indicating that the ordinances are effective at mitigating some of the impacts of development on water quality. Another study in the Austin area compared 18 sites with stormwater controls (retention ponds) in their watersheds to 20 sites without stormwater controls (Maxted and Scoggins 2004, p. 8). In sites with more than 40 percent impervious cover, more contaminant-sensitive macroinvertebrate species were found at sites with stormwater controls than at sites without controls (Maxted and Scoggins 2004, p. 11).

However, based on long-term monitoring that shows an overall water quality decline at Jollyville Plateau and Austin blind salamander sites, these local ordinances are not effective at reducing contaminant levels to the extent that they no longer threaten salamander habitat (see discussion under Factor A). Furthermore, it is unclear how much surface water quality controls in developed areas benefit groundwater quality. A City of Austin study of four Jollyville Plateau salamander spring sites within two subdivisions found that stricter water quality controls (wet ponds instead of standard sedimentation/filtration ponds) did not translate into improved groundwater quality (Herrington *et al.* 2007, pp. 13–14).

In addition, Title 7, Chapter 245 of the Texas Local Government Code permits ''grandfathering'' of certain local regulations. Grandfathering allows developments to be exempted from new requirements for water quality controls and impervious cover limits if the developments were planned prior to the implementation of such regulations. However, these developments are still obligated to comply with regulations that were applicable at the time when project applications for development were first filed (Title 7, Chapter 245 of the Texas Local Government Code p. 1). Unpublished data provided by the City of Austin (2007) indicates that up to 26 percent of undeveloped areas within watersheds draining to Jollyville Plateau salamander habitat may be exempted from current water quality control requirements due to ''grandfathering'' legislation.

On January 1, 2006, the City of Austin banned the use of coal tar sealant (Scoggins *et al.* 2009, p. 4909), which has been shown to be the main source of PAHs in Austin-area streams (Mahler *et al.* 2005, p. 5565). However, historically applied coal tar sealant lasts for several years and can remain a source of PAHs to aquatic systems (DeMott *et al.* 2010, p. 372). A study that examined PAH concentrations in Austin streams before the ban and 2 years after the ban found no difference, indicating that either more time is needed to see the impact of the coal tar ban, or that other sources (e.g. airborne and automotive) are contributing more to PAH loadings (DeMott *et al.* 2010, pp. 375–377). Furthermore, coal tar sealant is still legal outside of the City of Austin's jurisdiction and may be contributing PAH loads to northern Jollyville Plateau, Georgetown, and Salado salamander habitat.

The TCEQ has required wastewater treatment systems within the Barton Springs Edwards Aquifer recharge and contributing zones to obtain a Texas Land Application Permit (TLAP) in order to discharge effluent onto the land (Ross 2011, p. 7). Although these permits are designed to protect the surface waters and underground aquifer, studies have demonstrated reduced water quality downstream of TLAP sites (Ross 2011, pp. 11–18). Ross (2011, pp. 18–21) attributes this regulatory inadequacy to TCEQ's failure to conduct regular soil monitoring for nutrient accumulation on TLAP sites, and the failure to conduct indepth reviews of TLAP applications.

The TCEQ has developed voluntary water quality protection measures for developers to minimize water quality effects to springs systems and other aquatic habitats within the Edwards Aquifer region of Texas (TCEQ 2005, p. i). In February 2005, the Service concurred that these measures, if implemented, would protect several aquatic species from take, including the Georgetown salamander, due to water quality degradation resulting from development in the Edwards Aquifer region (TCEQ 2007, p. 1). However, it should be noted that as non-listed species, ''take'' prohibitions do not apply. Thus, these water quality protection measures are not a regulatory mechanism.

The Barton Springs Edwards Aquifer Conservation District permits and regulates most wells on the Barton Springs segment of the Edwards Aquifer, subject to the limits of the State law. Bell County's groundwater resources are currently managed by the Clearwater Underground Water Conservation District. There are no groundwater conservation districts in Williamson or northern Travis Counties, so groundwater pumping is unregulated in these areas (TPWD 2011a, p. 7).

Conclusion of Factor D

Data indicate that water quality degradation in sites occupied by Austin blind and Jollyville Plateau salamanders continues to occur despite the existence of current regulatory mechanisms in place to protect water quality (Turner 2005a, pp. 8–17, O'Donnell *et al.* 2006, p. 29). Long-term water quality data are not available for Georgetown and Salado salamander sites, but rapid human population growth and urbanization in Williamson and Bell Counties continues. Existing regulations in these counties do not address many of the sources of groundwater pollution that are typically associated with urbanized areas. Therefore, we consider the inadequacy of existing regulatory mechanisms to be an ongoing, significant threat to all four salamander species now and in the foreseeable future.

Factor E. Other Natural or Manmade Factors Affecting Its Continued Existence

Ultraviolet Radiation

Increased levels of ultraviolet-B (UV–B) radiation, due to depletion of the stratospheric ozone layers, may lead to declines in amphibian populations (Blaustein and Kiesecker 2002, pp. 598–600). For example, research has demonstrated that UV–B radiation causes significant mortality and deformities in developing long-toed salamanders (*Ambystoma macrodactylum*) (Blaustein *et al.* 1997, p. 13,735). Exposure to UV–B radiation reduces growth in clawed frogs (*Xenopus laevis*) (Hatch and Burton, 1998, p. 1,783) and lowers hatching success in Cascades frogs (*Rana cascadae*) and western toads (*Bufo boreas*) (Kiesecker and Blaustein 1995, pp. 11,050–11,051). In lab experiments with spotted salamanders, UV–B radiation diminished their swimming ability (Bommarito *et al.* 2010, p. 1151). Additionally, UV–B radiation may act synergistically (the total effect is greater than the sum of the individual effects) with other factors (for example, contaminants, pH, pathogens) to cause declines in amphibians (Alford and Richards 1999, p. 141; see *Synergistic and Additive Interactions among Stressors*). Some researchers believe that future increases in UV–B radiation will have significant detrimental impacts on amphibians that are sensitive to this radiation (Blaustein and Belden 2003, p. 95).

The effect of increased UV–B radiation on the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders is unknown. These species may be protected from UV–B radiation through shading from trees at some spring sites. Removal of natural riparian vegetation may put these species at risk. Because eggs are believed to be deposited underground (Bendik 2011b, pers. comm.), UV–B radiation may have no impact on the hatching success of these species. In conclusion, the effect of increased UV–B radiation has the potential to cause deformities or developmental problems to individuals, but we do not consider this stressor to significantly contribute to the risk of extinction of any of the four central Texas salamander species at this time.

Deformities in Jollyville Plateau Salamanders

Jollyville Plateau salamanders observed at the Stillhouse Hollow monitoring sites have shown high incidences of deformities, such as curved spines, missing eyes, missing limbs or digits, and eye injuries (O'Donnell *et al.* 2006, p. 26). The Stillhouse Hollow location was also cited as having the highest observation of dead Jollyville Plateau salamanders (COA 2001, p. 88). Although water quality is relatively low in the Stillhouse Hollow drainage (O'Donnell *et al.* 2006, pp. 26, 37), no statistical correlations were found between the number of deformities and nitrate concentrations (O'Donnell *et al.* 2006, p. 26). Environmental toxins are the suspected cause of salamander deformities (O'Donnell *et al.* 2006, p. 25; COA 2001, pp. 70–74), but deformities in amphibians can also be the result of genetic mutations, parasitic infections, UV–B radiation, or the lack of an essential nutrient. More research is needed to elucidate the cause of these deformities. We consider deformities to be a stressor of low level impact to the Jollyville Plateau salamander because this stressor is only an issue at one site and it does not appear to be an issue for the other salamander species.

Small Population Size and Stochastic Events

All four central Texas salamanders may be more susceptible to threats and impacts from stochastic events because of their small population sizes. The risk of extinction for any species is known to be highly indirectly correlated with population size (Ogrady *et al.* 2004, pp. 516, 518; Pimm *et al.* 1988, pp. 774–775). In other words, the smaller the population, the greater the overall risk of extinction. True population size estimates have not been generated at most sites for these species, but mark-recapture studies at some of the highest quality sites for Georgetown and Jollyville Plateau salamanders estimated populations as low as 78 (O'Donnell *et al.* 2008, pp. 44–45). Populations are likely smaller at lower quality sites. Small population sizes can also act synergistically with other traits (such as being a habitat specialist and having limited distribution, as is the case with the four salamander species) to greatly increase risk of extinction (Davies *et al.* 2004, p. 270). Stochastic events from either environmental factors (random events such as severe weather) or demographic factors (random causes of births and deaths of individuals) may also heighten other threats to the salamanders because of the limited range and small population sizes (Melbourne and Hastings 2008, p. 100).

The highly restricted ranges of the salamanders and entirely aquatic environment make them extremely vulnerable to threats such as decreases in water quality and quantity. This is especially true for the Austin blind salamander, which is found in only one locality comprised of three hydrologically connected springs of Barton Springs, and the Salado salamander, which has only been found at seven spring sites. Due to their very limited distribution, the Austin blind and Salado salamanders are especially sensitive to incidences such as storm events, which can dramatically affect dissolved oxygen levels and increase contaminants, and cause catastrophic spills and leaks. One catastrophic spill event in Barton Springs could potentially cause the extinction of the Austin blind salamander in the wild.

The presence of several populations of Jollyville Plateau and Georgetown salamanders does provide some possibility for natural recolonization for these species if any of these factors resulted in a local extirpation event (Fagan *et al.* 2002, p. 3,255). In conclusion, we do not consider small population size to be a threat in and of itself to any of the four salamander species, but their small population sizes may make them more vulnerable to extinction from other existing or potential threats, such as a major stochastic event. Therefore, the magnitude of a stochastic event affecting the continued existence of the Jollyville Plateau and Georgetown salamanders is moderate because these species have more populations over a broader range. On the other hand, recolonization following a stochastic event is less likely for Austin blind and Salado salamanders due to a fewer number of known sites. Therefore, the impacts from a stochastic event for the Austin blind and Salado salamanders is a significant threat.

Synergistic and Additive Interactions Among Stressors

The interactions among multiple stressors (for example, contaminants, UV–B radiation, pathogens) may be contributing to amphibian population declines (Blaustein and Kiesecker 2002, p. 598). Multiple stressors may act additively or synergistically to have greater detrimental impacts on amphibians compared to a single stressor alone. Kiesecker and Blaustein (1995, p. 11,051) found a synergistic effect between UV–B radiation and a pathogen in Cascades frogs and western toads. Researchers demonstrated that reduced pH levels and increased levels of UV–B radiation independently had no effect on leopard frog (*Rana pipiens*) larvae; however, when combined, these two caused significant mortality (Long *et al.* 1995, p. 1,302). Additionally, researchers demonstrated that UV–B radiation increases the toxicity of PAHs, which can cause mortality and deformities on developing amphibians (Hatch and Burton 199, pp. 1,780–1,783). Beattie *et al.* (1992, p. 566) demonstrated that aluminum becomes toxic to amphibians at low pH levels. Also, disease outbreaks may occur only when there are contaminants or other stressors in the environment that reduce immunity (Alford and Richards 1999, p. 141). For example, Christin *et al.* (2003, pp. 1,129–1,130, 1,132) demonstrated that mixtures of pesticides reduced the immunity to parasitic infections in leopard frogs.

The effect of synergistic effects between stressors on the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders is not currently known. Furthermore, different species of amphibians differ in their reactions to stressors and combinations of stressors (Kiesecker and Blaustein 1995, p. 11,051; Relyea *et al.* 2009, pp. 367–368; Rohr *et al.* 2003, pp. 2,387–2,390). Studies that examine the effects of interactions among multiple stressors on the four central Texas salamanders are lacking. However, based on the number of examples in other amphibians, the possibility of synergistic effects on the four central Texas salamanders cannot be discounted.

Summary of Factor E

The effect of increased UV–B radiation is an unstudied stressor to the four central Texas salamanders that has the potential to cause deformities or development problems. The effect of this stressor is believed to be low at this time.

Deformities have been documented in one of the four salamander species (Jollyville Plateau salamander), and at only one location (Stillhouse Hollow). We do not know what causes these deformities, and there is no evidence that the incidence rate is increasing or spreading. Therefore, the effect of this stressor is believed to be low.

Small population sizes at most of the sites for the salamanders is not a threat in and of itself, but it may increase the risk of local extirpation events. However, the Georgetown and Jollyville Plateau salamanders may have some ability to recolonize sites because they occur in more populations over a broader range. Thus, we consider the level of impacts from a stochastic event to be moderate for these two species and high for the Austin blind and Salado salamanders due to their more limited distributions.

Finally, the significance of each threat discussed above (under Factors A through E) may be influenced by their interactions with other threats, and may subsequently increase under certain conditions.

Overall Threat Summary

The following table provides a general overview of the type, anticipated level of impact, and timing of threats facing the four salamanders proposed for listing. It is intended to assist the public in comparing the threats discussed above among the salamander species. The magnitude of threat is defined in terms of scope (the relative proportion or range of the species that is affected by the threat) and severity (impacts on the overall species' status), such that a high magnitude of threat indicates that the species is facing the greatest threats to their continued existence (48 FR 43098; September 21, 1983). We define imminence as the timing of when a threat begins. A threat is considered imminent if it is impacting the species now rather than in the foreseeable future. Some of the threats outlined within Tables 3 through 6 are difficult to fully quantify due to lack of available information. These threats were designated an unknown magnitude.

TABLE 3—SUMMARY OF THREATS TO THE AUSTIN BLIND SALAMANDER

Factor	Type of threat	Level of impact (low, medium, high)	Ongoing?
A	Contaminants from stormwater runoff	High	Yes.

TABLE 3—SUMMARY OF THREATS TO THE AUSTIN BLIND SALAMANDER—Continued

Factor	Type of threat	Level of impact (low, medium, high)	Ongoing?
	Sedimentation from stormwater runoff	High	Yes.
	Changes in flow regime from impervious cover	Med	Yes.
	Excess nutrient input	Low	Yes.
	Pesticides	Low	Yes.
	Catastrophic hazardous material spills	High	Yes.
	Pollution from construction activities	Med	Yes.
	Construction of pipelines	Low	No.
	Groundwater pumping	Med	Yes.
	Impoundments	High	Yes.
	Physical modification of surface habitat for human-related activities	Med	Yes.
	Drought	Low	Yes.
	Flooding	Low	Yes.
	Climate change	Unknown	Yes.
C	Gas bubble trauma	Low	No.
D	Inadequacy of existing regulatory mechanisms	High	Yes.
E	Small population size and stochastic events	High	Yes.
	Synergistic and additive interactions among stressors	Unknown	Unknown.
	UV–B radiation	Unknown	Unknown.

TABLE 4—SUMMARY OF THREATS TO THE JOLLYVILLE PLATEAU SALAMANDER

Factor	Type of threat	Level of impact (low, medium, high)	Ongoing?
A	Contaminants from stormwater runoff	High	Yes.
	Sedimentation from stormwater runoff	High	Yes.
	Changes in flow regime from impervious cover	Med	Yes.
	Excess nutrient input	MedLow	Yes.
	Pesticides	Low	Yes.
	Catastrophic hazardous material spills	Low	Yes.
	Pollution from construction activities	HighMed	Yes.
	Construction of pipelines	Low	No.
	Construction of the Jollyville Transmission Main	Low	Yes.
	Rock quarries	Low	Yes.
	Groundwater pumping	Med	Yes.
	Impoundments	Low	Yes.
	Feral hogs	Low	Yes.
	Physical modification of surface habitat for human-related activities	Low	Yes.
	Drought	MedLow	Yes.
	Flooding	Low	Yes.
	Climate change	Unknown	Yes.
D	Inadequacy of existing regulatory mechanisms	High	Yes.
E	Small population size and stochastic events	Med	Yes.
	Synergistic and additive interactions among stressors	Unknown	Unknown.
	UV–B radiation	Unknown	Unknown.

TABLE 5—SUMMARY OF THREATS TO THE GEORGETOWN SALAMANDER

Factor	Type of threat	Level of impact (low, medium, high)	Ongoing?
A	Contaminants from stormwater runoff	High	Yes.
	Sedimentation from stormwater runoff	High	Yes.
	Changes in flow regime from impervious cover	Med	Yes.
	Excess nutrient input	Low	Yes.
	Pesticides	Low	Yes.
	Catastrophic hazardous material spills	Med	Yes.
	Pollution from construction activities	Med	Yes.
	Construction of pipelines	Low	No.
	Rock quarries	Low	Yes.
	Groundwater pumping	Med	Yes.
	Impoundments	Low	Yes.
	Feral hogs	Low	Yes.
	Livestock	Low	Yes.
	Physical modification of surface habitat for human-related activities	Low	Yes.
	Drought	MedLow	Yes.
	Flooding	Low	Yes.
	Climate change	Unknown	Yes.
D	Inadequacy of existing regulatory mechanisms	High	Yes.

TABLE 5—SUMMARY OF THREATS TO THE GEORGETOWN SALAMANDER—Continued

Factor	Type of threat	Level of impact (low, medium, high)	Ongoing?
E	Small population size and stochastic events	Med	Yes.
	Synergistic and additive interactions among stressors	Unknown	Unknown.
	UV–B radiation	Unknown	Unknown.

TABLE 6—SUMMARY OF THREATS TO THE SALADO SALAMANDER

Factor	Type of threat	Level of impact (low, medium, high)	Ongoing?
A	Contaminants from stormwater runoff	Med	Yes.
	Sedimentation from stormwater runoff	Med	Yes.
	Changes in flow regime from impervious cover	Low	Yes.
	Excess nutrient input	Low	Yes.
	Pesticides	Low	Yes.
	Catastrophic hazardous material spills	High	Yes.
	Pollution from construction activities	Low	Yes.
	Construction of pipelines	Low	No.
	Rock quarries	Low	Yes.
	Groundwater pumping	Med	Yes.
	Impoundments	Low	Yes.
	Feral hogs	Low	Yes.
	Livestock	Low	Yes.
	Physical modification of surface habitat for human-related activities	Low	Yes.
	Drought	Low	Yes.
	Flooding	Low	Yes.
	Climate change	Unknown	Yes.
D	Inadequacy of existing regulatory mechanisms	High	Yes.
E	Small population size and stochastic events	High	Yes.
	Synergistic and additive interactions among stressors	High	Yes.
	UV–B radiation	Unknown	Unknown.

Proposed Listing Determination

As previously noted, the magnitude of a threat is defined in terms of scope (the relative proportion or range of the species that is affected by the threat) and severity (impacts on the overall species' status), such that a high magnitude of threat indicates that the species is facing the greatest threats to their continued existence (48 FR 43098; September 21, 1983). We define imminence as the timing of when a threat begins. A threat is considered imminent if it is impacting the species now rather than in the foreseeable future.

Austin Blind Salamander

The primary threat to this species is habitat modification (Factor A) in the form of reduced flows and degradation of water quality of spring habitats as a result of urbanization within the watersheds and recharge and contributing zones of the Edwards Aquifer. Substantial human population growth (a projected increase of 84 percent from 2000 to 2040) is ongoing within Travis County, Texas (Texas State Data Center 2008, p. 1), the only location where the Austin blind salamander is known to occur. This human population growth is likely to result in considerable urbanization within the watershed, which would influence spring flow and water quality within the salamander's three known sites at Barton Springs. Urbanization leads to increases in sedimentation, contaminants, and nutrient loads as well as decreases in aquatic invertebrates (the salamander's prey base). Significant changes in water quality constituents have been reported from analyses conducted from within the Austin blind salamander's habitat at Barton Springs Pool (COA 1997, pp. 229, 231–232; Mahler and Van Metre 2000, p. 1); these changes have been attributed to urbanization within the recharge and contributing zones of the Edwards Aquifer (Turner 2005a, p. 6).

We analyzed the impervious cover estimates of the watershed within the Austin blind salamander's range, along with the amount of land currently managed as open space that could possibly contribute water quality benefits to the salamander's habitats. The watershed where the Austin blind salamander is known to occur has an average overall impervious cover estimate of 11.58 percent, which is within the range in which sharp declines of water quality in aquatic habitats have been observed (Schueler 1994, pp. 100–102). Although this watershed has some managed open space that likely contributes water quality benefits to surface flow, the habitat of this largely subterranean species can be influenced by land use throughout the recharge zone of the aquifer that supplies its spring flow. In consideration of this information and analysis, we believe the threat of habitat modification in the form of reduced water quality is ongoing and has a high level of impact throughout the Austin blind salamander's range.

Data indicate that water quality degradation in sites occupied by Austin blind salamanders continues to occur despite the existence of current regulatory mechanisms in place designed to protect water quality (Turner 2005a, pp. 8–17, O'Donnell *et al.* 2006, p. 29). Therefore, we consider the inadequacy of existing regulatory mechanisms to protect against water quality degradation (Factor D) to be a significant threat.

The Edwards Aquifer is at risk from a variety of sources of pollutants (Ross 2011, p. 4), including hazardous materials that could be spilled or leaked, potentially resulting in the contamination of both surface and groundwater resources (Service 2005, pp. 1.6–14–1.6–15). A catastrophic spill could occur if a truck transporting hazardous materials overturned and spilled its contents over the recharge zone of the aquifer. The Austin blind salamander is at considerable risk from hazardous materials spills given that it only occurs at three spring sites in one locality (Barton Springs). Among other sources, there is the potential for a catastrophic gasoline spill in the Barton Springs Segment of the Edwards Aquifer from the Longhorn pipeline (EPA 2000, pp. 9–29–9–30). There is also potential for hazardous material spills from the multiple drinking water lines and sewage pipelines surrounding Barton Springs. For these reasons, we believe the threat of habitat modification in the form of water quality degradation and contamination from hazardous materials spills to be an ongoing threat of high impact to this species.

Construction activities resulting from urban development are a threat to both water quality and quantity because they can increase sedimentation and dewater springs by intercepting aquifer conduits. Austin blind salamander habitat at Barton Springs is under the threat of pollutant loading due to its proximity to construction activities and its location at the downstream side of the watershed (COA 1997, p. 237). Given that construction-related sediment loading is already occurring within the Austin blind salamander's narrowly restricted range, we believe the threat of habitat modification in the form of water quality degradation and changes to water flows caused by construction activities from urban development to be an ongoing threat of medium impact to this species.

Another potential threat to the Austin blind salamander and its habitat is low flow conditions in the aquifer and at Barton Springs. Groundwater pumping can cause such conditions and lead to saline water encroachments in the aquifer. Water quality in the Barton Springs Segment of the Edwards Aquifer has been degraded in the past due to saline encroachment (Slade *et al.* 1986, p. 62). This water quality degradation occurred when Barton Springs discharge was less than 30 cfs (Slade *et al.* 1986, p. 64). Reduced groundwater levels could also increase the concentration of some pollutants in the aquifer. Average flows at Barton Springs have dropped below 17 cfs as recently as mid-November 2011 (Barton Springs/Edwards Aquifer Conservation District 2011, p. 1). This saline water encroachment would threaten the freshwater biota in the springs and the aquifer, including the Austin blind salamander, by dramatically changing the water chemistry (such as increasing conductivity).

In addition to groundwater pumping, low flows in Barton Springs may be attributed to ongoing urbanization and recent drought conditions. Future climate change could also affect water quantity and spring flow for the Austin blind salamander. Climate change could compound the threat of decreased water quantity at salamander spring sites. The effects of climate change on aquifer-dependant species is difficult to assess; however, the Edwards Aquifer is predicted to experience additional stress from climate change that could lead to decreased recharge and low or ceased spring flows given increasing pumping demands (Loáiciga *et al.* 2000, pp. 192–193). In any case, we believe habitat modification in the form of water quantity reduction, whether reduced spring flows are caused by climate change or are in combination with other stressors, to be an ongoing threat of high impact to this species.

The Austin blind salamander is sensitive to direct physical habitat modification, such as modification resulting from human recreational activities and impoundments. Eliza Spring and Sunken Garden Spring, two of the three locations of the Austin blind salamander, also experience vandalism, despite the presence of fencing and signage (Dries 2011, pers. comm.). The deep water of Barton Springs likely protects the Austin blind salamander's surface habitat from damage from frequent human recreation.

All spring sites for the Austin blind salamander (Main, Eliza, and Sunken Garden springs) have been impounded for recreational use. While the manmade structures help retain water in the spring pools during low flows, they have altered the salamander's natural environment. The impoundments have changed the Barton Springs ecosystem from a stream-like system to a more lentic (still water) environment, thereby reducing the water system's ability to flush sediments downstream and out of salamander habitat. Because of the physical habitat modifications that have permanently impacted the Austin blind salamander's habitat or are currently ongoing, we consider this threat to be ongoing and of high impact to this species.

Gas bubble trauma has been observed in Austin blind salamanders in captivity (Chamberlain 2011, pers. comm.), and has been known to affect another salamander species (the Barton Springs salamander) at Barton Springs (Chamberlain 2011, pers. comm.). Chytrid fungus has also been documented on the feet of Austin blind salamanders in the wild (O'Donnell *et al.* 2006, pp. 22–23). However, we have no data to indicate whether disease or predation (Factor C) of any of the salamander species proposed for listing is a significant threat facing the species. Predation and disease may be affecting these salamander species, but there is not enough evidence to consider these factors threats. Neither factor is at a level that we consider to be threatening the continued existence of the salamander species now or in the foreseeable future.

Other natural or manmade factors (Factor E) affecting the Austin blind salamander include UV–B radiation, small population sizes, stochastic events, and synergistic and additive interactions among stressors. Increased levels of UV–B radiation, due to the depletion of stratospheric ozone layers has been shown to cause significant mortality and deformities in amphibian species (Blaustein *et al.* 1997, p. 13,735), although the effects of UV–B radiation on this species are unknown. Small population sizes may act synergistically with other traits of the species (such as its limited distribution) to increase its overall risk of extinction (Davies *et al.* 2004, p. 270). Stochastic events, such as severe weather or demographic changes to the population, are also heightened threats because of its restricted range and small population sizes (Melbourne and Hastings 2008, p. 100). We therefore consider this to be an ongoing threat of high impact.

The population status of Austin blind salamanders is unknown, largely because it is rarely seen at the water's surface (Hillis *et al.* 2001, p. 267). However, observations of Austin blind salamanders have been decreasing in recent years (2009–2010) (COA 2011a, pp. 51–52). From January 1998 to December 2000, there were only 17 documented observations of the Austin blind salamander (Hillis *et al.* 2001, p. 273). The abundance of Austin blind salamanders increased slightly from 2002 to 2006, but fewer observations have been made in more recent years (2009 to 2010) (COA 2011a, pp. 51–52). Because fewer observations coincide with habitat degradation throughout the species' entire range, we expect the downward trend to continue into the future as human population growth and urbanization drive further declines in habitat quality and quantity. Due to its small range and probable small population size, we believe the species resiliency to the threats outlined above is low.

The Act defines an endangered species as any species that is ''in danger of extinction throughout all or a significant portion of its range'' and a threatened species as any species ''that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.'' Due to small population size, limited range, and susceptibility to ongoing threats, we determine that the Austin blind salamander is currently on the brink of extinction and therefore meets the definition of endangered. We find that the Austin blind salamander is presently in danger of extinction throughout its entire range based on the immediacy, severity, and scope of the threats described above. The Austin blind salamander species is proposed as endangered, rather than threatened, because the threats are occurring now, and their impacts to the species and its habitat would be catastrophic given the very limited range of the species, making the salamander at risk of extinction at the present time. Therefore, on the basis of the best available scientific and commercial information, we propose listing the Austin blind salamander as endangered in accordance with sections 3(6) and 4(a)(1) of the Act.

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. The Austin blind salamander proposed for listing in this rule is highly restricted in its range, and the threats occur throughout its entire range. Therefore, the threats to the survival of this species are not restricted to any particular significant portion of that range. Accordingly, our assessment and proposed determination applies to the species throughout its entire range.

Jollyville Plateau Salamander

The primary threat to this species is habitat modification (Factor A) in the form of reduced flows and degradation of water quality of spring habitats as a result of human population growth and subsequent urbanization within the watersheds and recharge and contributing zones of the Edwards Aquifer. Substantial human population growth is ongoing within this species' range. The Texas State Data Center (2008, p. 1) has reported a population increase of 84 percent and 597 percent for Travis and Williamson Counties, Texas, respectively. This population growth is likely to result in considerable urbanization within the watersheds that contribute to spring flow and thereby influence water quality within the salamander's habitat. Urbanization leads to increases in water demand and reduced water quality from erosion, sedimentation, contaminants, and nutrient loads as well as decreases in aquatic invertebrates (the salamanders' prey base). Specifically, elevated PAH and conductivity levels as well as excessive sedimentation have been documented within Jollyville Plateau salamander habitat and have been associated with population declines observed during monitoring (COA 2001, pp. 101, 126; O'Donnell *et al.* 2006, pp. 37, 47). Poor water quality, particularly elevated nitrates, is also believed to be a cause of morphological deformities observed in individual Jollyville Plateau salamanders (O'Donnell *et al.* 2006, pp. 26, 37).

We analyzed the impervious cover estimates of each watershed within the Jollyville Plateau salamander's range, along with the amount of land currently managed as open space that could possible contribute water quality benefits to the salamander's habitats. The watersheds within the Jollyville Plateau salamander's range have average impervious cover estimates that range from 5.72 percent to 34.32 percent. Although the Balcones Canyonlands Preserve and other lands managed for open space within these watersheds likely provide some water quality benefits for this species, five out of the six watersheds that occur within its range have overall impervious cover estimates that can lead to sharp declines in water quality or cause permanent conditions of poor water quality (Schueler 1994, pp. 100–102). In consideration of this information and analysis, we believe the threat of habitat modification in the form of reduced water quality is ongoing and of high impact throughout the Jollyville Plateau salamander's range.

Data indicate that water quality degradation in sites occupied by Jollyville Plateau salamanders continues to occur despite the existence of current regulatory mechanisms in place to protect water quality (Turner 2005a, pp. 8–17, O'Donnell *et al.* 2006, p. 29); therefore, these mechanisms are not adequate to protect this species and its habitat. Therefore, we consider the inadequacy of existing regulatory mechanisms (Factor D) to be an ongoing threat of high impact.

The Edwards Aquifer is at risk from a variety of sources of pollutants (Ross 2011, p. 4), including hazardous materials that could be spilled or leaked, potentially resulting in the contamination of both surface and groundwater resources (Service 2005, pp. 1.6–14–1.6–15). A catastrophic spill could occur if a truck transporting hazardous materials overturned and spilled its contents over the recharge zone of the aquifer. The transport of hazardous materials is common on many highways that serve as major transportation routes (Service 2005, p. 1.6–13).

A number of point-sources of pollutants exist within the Jollyville Plateau salamander's range, including leaking underground storage tanks and sewage spills from pipelines (COA 2001, pp. 16, 21, 74). A significant hazardous materials spill within a stream drainage for the Jollyville Plateau salamander could have the potential to threaten the long-term survival and sustainability of multiple populations. Because of these reasons, we believe the threat of habitat modification in the form of water quality degradation and contamination from hazardous materials spills to be an ongoing threat of low impact to this species.

Construction activities resulting from urban development are a threat to both water quality and quantity because they can increase sedimentation and dewater springs by intercepting aquifer conduits. Increased sedimentation from construction activities has been linked to declines in Jollyville Plateau salamander counts at multiple sites (Turner 2003, p. 24; O'Donnell *et al.* 2006, p. 34). Given that construction-related sediment loading is likely to occur from ongoing urbanization within the Jollyville Plateau salamander's range, we believe the threat of habitat modification in the form of water quality degradation and water reduction caused by construction activities from urban development to be an ongoing threat of high impact to this species.

Another potential threat to the Jollyville Plateau salamander and its habitat is low flow conditions in the aquifer and within this species' surface habitat due to urbanization and recent drought conditions. The City of Austin found a negative correlation between urbanization and spring flows at Jollyville Plateau salamander sites (Turner 2003, p. 11). Field studies have also shown that a number of springs that support Jollyville Plateau salamanders have already gone dry periodically, and that spring waters resurface following rain events (O'Donnell *et al.* 2006, pp. 46–47).

Future climate change could also affect water quantity and spring flow for the Jollyville Plateau salamander. Climate change could compound the threat of decreased water quantity at salamander spring sites. The effects of climate change on aquifer-dependant species is difficult to assess; however, the Edwards Aquifer is predicted to experience additional stress from climate change that could lead to decreased recharge and low or ceased spring flows given increasing pumping demands (Loáiciga *et al.* 2000, pp. 192–193). Therefore, we believe habitat modification in the form of water quantity reduction, whether reduced spring flows is caused by climate change or in combination with other stressors, to be an ongoing threat of unknown impact to this species.

All four salamanders are sensitive to direct physical habitat modification, such as those resulting from human recreational activities, impoundments, feral hogs, and livestock. Destruction of Jollyville Plateau salamander habitat has been attributed to vandalism (COA 2001, p. 21), human recreational use (COA 2001, p. 21), impoundments (O'Donnell *et al.* 2008, p.1; Bendik 2011b, pers. comm.), and feral hog activity (O'Donnell *et al.* 2006, pp. 34, 46). Because there is ongoing physical habitat modification occurring to known Jollyville Plateau salamander sites, we consider this threat to be ongoing and of low impact to this species.

Chytrid fungus has also been documented on the feet of Jollyville Plateau salamanders in the wild, but with no visible symptoms of the disease (O'Donnell *et al.* 2006, pp. 22–23). Furthermore, there are no data to indicate whether disease or predation of any of the salamander species proposed for listing is a significant threat facing these species. Predation and disease (Factor C) may be affecting the Jollyville Plateau salamander species, but there is not enough evidence to consider these factors threats. Neither factor is at a level that we consider to be threatening the continued existence of the Jollyville Plateau salamander now or in the foreseeable future.

Other natural or manmade factors (Factor E) affecting the Jollyville Plateau salamander include UV–B radiation, small population sizes, stochastic events, and synergistic and additive interactions among stressors. Increased levels of UV–B radiation, due to the depletion of stratospheric ozone layers has been shown to cause significant mortality and deformities that affect reproduction in amphibian species (Blaustein *et al.* 1997, p. 13,735), although the effects of UV–B radiation on this species are unknown. Small population sizes may act synergistically with other traits of the species (such as its limited distribution) to increase its overall risk of extinction (Davies *et al.* 2004, p. 270). Stochastic events, such as severe weather or demographic changes to the population, are also heightened threats because of the species' restricted range and small population sizes (Melbourne and Hastings 2008, p. 100). We therefore consider this to be an ongoing threat of medium impact.

The population status of Jollyville Plateau salamanders is unknown at most of their sites. However, observations of Jollyville Plateau salamanders at several long-term monitoring sites have been decreasing in correspondence with habitat degradation (O'Donnell *et al.* 2006, pp. 4, 48). We expect the downward trend to continue into the future as human population growth and urbanization drive further declines in habitat quality and quantity.

The Act defines an endangered species as any species that is ''in danger of extinction throughout all or a significant portion of its range'' and a threatened species as any species ''that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.'' Due to its susceptibility to threats that are ongoing throughout its entire range, we determine that the Jollyville Plateau salamander is currently on the brink of extinction and therefore meets the definition of endangered. We find that the Jollyville Plateau salamander is presently in danger of extinction throughout its entire range based on the immediacy, severity, and scope of the threats described above. The Jollyville Plateau salamander species is proposed as endangered, rather than threatened, because the threats are occurring now or are imminent, and their potential impacts to the species would be catastrophic given the very limited range of the species, making the salamander at risk of extinction at the present time. Therefore, on the basis of the best available scientific and commercial information, we propose listing the Jollyville Plateau salamander as endangered in accordance with sections 3(6) and 4(a)(1) of the Act.

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. The Jollyville Plateau salamander proposed for listing in this rule is highly restricted in its range, and the threats occur throughout its entire range. Therefore, the threats to the survival of this species are not restricted to any particular significant portion of that range. Accordingly, our assessment and proposed determination applies to the species throughout its entire range.

Georgetown Salamander

The primary threat to this species is habitat modification (Factor A) in the form of reduced flows and degradation of water quality of spring habitats as a result of urbanization within the watersheds and recharge and contributing zones of the Edwards Aquifer. Williamson County, Texas, is experiencing tremendous human population growth. An increase of 597 percent from 2000 to 2040 is currently projected (Texas State Data Center 2008, p.1). Along with human population growth, we expect more urbanization, which leads to increases in sedimentation, contaminants, and nutrient loads as well as decreases in aquatic invertebrates (the salamanders' prey base).

We analyzed the impervious cover estimates of each watershed within the Georgetown salamander's range, along with the amount of land currently managed as open space that could possibly contribute water quality benefits to the salamander's habitat. The watersheds within the Georgetown salamander's range have average impervious cover estimates that range from 0.59 percent to 9.60 percent. Five out of the six watersheds within this species' range are well below impervious cover levels that can lead to declines in water quality.

Although our analyses indicated relatively low levels of impervious cover throughout the watersheds within the Georgetown salamander's range, there are developed areas that could be affecting the water quality at sites known to be occupied by the Georgetown salamander. Moreover, existing regulations in Williamson County do not address many of the sources of groundwater pollution that are typically associated with urbanized areas; therefore, these regulations are not adequate to protect this species and its habitat. With only two large tracts (64 ac [25.9 ha] and 145 ac [58.7 ha]) protected as open space within the Georgetown salamander's range, it is unlikely the water quality for this species' habitat will be protected as development continues into the foreseeable future. In consideration of this information and analysis, we believe the threat of habitat modification in the form of reduced water quality is ongoing and of high impact throughout the Georgetown salamander's range.

In regards to regulatory mechanisms to protect water quality, it is unlikely that water quality within the Georgetown salamander's habitat will be maintained or protected as urbanization occurs in these watersheds into the foreseeable future. Therefore, we consider the inadequacy of existing regulatory mechanisms (Factor D) to be an ongoing threat of high impact.

The Edwards Aquifer is at risk from a variety of sources of pollutants (Ross

2011, p. 4), including hazardous materials that could be spilled or leaked, potentially resulting in the contamination of both surface and groundwater resources (Service 2005, pp. 1.6–14–1.6–15). A catastrophic spill could occur if a truck transporting hazardous materials overturned and spilled its contents over the recharge zone of the aquifer. Interstate Highway 35 crosses watersheds that contribute groundwater to spring sites known to be occupied by the Georgetown salamander.

The Georgetown salamander is also at risk from several other point sources of pollutants, including wastewater pipelines, chlorinated drinking water lines, and septic systems. A significant hazardous materials spill within a stream drainage for the Georgetown salamander could have the potential to threaten the long-term survival and sustainability of multiple populations. For these reasons, we believe the threat of habitat modification in the form of water quality degradation and contamination from hazardous materials spills to be an ongoing threat of medium impact to this species.

Construction activities resulting from urban development are a threat to both water quality and quantity because they can increase sedimentation and dewater springs by intercepting aquifer conduits. There are currently three active rock quarries located near Georgetown salamander sites within Williamson County, Texas, which may impact the species and its habitat, which could result in the destruction of spring sites, collapse of karst caverns, degradation of water quality, and reduction of water quantity (Ekmekci 1990, p. 4). Given that construction-related sediment loading is likely to occur within the rapidly developing range of the Georgetown salamander, we believe the threat of habitat modification in the form of water quality degradation and water reduction caused by construction activities from urban development to be an ongoing threat of medium impact to this species.

Another potential threat to the Georgetown salamander and its habitat is low flow conditions in the aquifer and within this species' surface habitat due to urbanization and recent drought conditions. The San Gabriel Springs (Georgetown salamander habitat) are now only intermittently flowing in the summer due to pumping from nearby water wells (TPWD 2011a, p. 9). Salamanders have not been seen on the surface there since 1991 (Chippindale *et al.* 2000, p. 40; Pierce 2011b, pers. comm.). Although *Eurycea* salamanders may spend some time below the surface in underground aquatic habitat areas to adapt to periodic flow losses (O'Donnell *et al.* 2006, p. 47), drying spring habitats can result in stranding salamanders (TPWD 2011a, p. 5). Also, prey availability is likely low underground due to the lack of primary production (Hobbs and Culver 2009, p. 392).

Future climate change could also affect water quantity and spring flow for the Georgetown salamander. Climate change could compound the threat of decreased water quantity at salamander spring sites. The effects of climate change on aquifer-dependant species is difficult to assess; however, the Edwards Aquifer is predicted to experience additional stress from climate change that could lead to decreased recharge and low or ceased spring flows given increasing pumping demands (Loáiciga *et al.* 2000, pp. 192–193). In consideration of the information presented above, we believe habitat modification in the form of water quantity reduction to be an ongoing threat of high impact to this species.

All four salamanders are sensitive to direct physical habitat modification, such as those resulting from human recreational activities, impoundments, feral hogs, and livestock. Destruction of Georgetown salamander habitat has been attributed to direct human modification (TPWD 2011a, p. 9), feral hog activity (O'Donnell *et al.* 2006, pp. 34, 46; Booker 2011, p. 1), and livestock activity (White 2011, SWCA, pers. comm.). Because there is ongoing physical habitat modification occurring to known Georgetown salamander sites within a restricted range, we consider this to be an ongoing threat of low impact for this species.

Predation and disease (Factor C) may be affecting the Georgetown salamander, but there is not enough evidence to consider these factors threats . Neither factor is at a level that we consider to be threatening the continued existence of the Georgetown salamander species now or in the foreseeable future.

Other natural or manmade factors (Factor E) potentially affecting the Georgetown salamander include UV–B radiation, small population sizes, stochastic events, and synergistic and additive interactions among stressors. Increased levels of UV–B radiation, due to the depletion of stratospheric ozone layers has been shown to cause significant mortality and deformities in amphibian species (Blaustein *et al.* 1997, p. 13,735), although the effects of UV–B radiation on this species are unknown. Small population sizes may act synergistically with other traits of the species (such as its limited distribution) to increase its overall risk of extinction (Davies *et al.* 2004, p. 270). Stochastic events, such as severe weather or demographic changes to the population, are also heightened threats because of its restricted range and small population sizes (Melbourne and Hastings 2008, p. 100). We therefore consider this to be an ongoing threat of medium impact.

The population status of Georgetown salamanders is unknown at all but two of their sites. A lack of long-term data prevents us from drawing conclusions on how Georgetown salamander populations may be changing over time. However, similar to Austin blind and Jollyville plateau salamander populations, we expect Georgetown salamander populations to trend downwards in the future as human population growth and urbanization in the area drive declines in habitat quality and quantity.

The Act defines an endangered species as any species that is ''in danger of extinction throughout all or a significant portion of its range'' and a threatened species as any species ''that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.'' Due to its susceptibility to threats that are ongoing throughout its entire range, we determine that the Georgetown salamander is currently on the brink of extinction and therefore meets the definition of endangered. We find that the Georgetown salamander is presently in danger of extinction throughout its entire range based on the immediacy, severity, and scope of the threats described above. The Georgetown salamander species is proposed as endangered, rather than threatened, because the threats are occurring now or are imminent, and their potential impacts to the species would be catastrophic given the very limited range of the species, making the salamander at risk of extinction at the present time. Therefore, on the basis of the best available scientific and commercial information, we propose listing the Georgetown salamander as endangered in accordance with sections 3(6) and 4(a)(1) of the Act.

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. The Georgetown salamander proposed for listing in this rule is highly restricted in its range, and the threats occur throughout its entire range. Therefore, the threats to the survival of this species are not restricted to any particular significant portion of that range. Accordingly, our assessment and proposed determination applies to the species throughout its entire range.

Salado Salamander

The primary threat to this species is habitat modification (Factor A) in the form of reduced flows and degradation of water quality of spring habitats as a result of urbanization within the watersheds and recharge and contributing zones of the Edwards Aquifer. Urbanization leads to increases in sedimentation, contaminants, and nutrient loads as well as decreases in aquatic invertebrates (the Salado salamander's prey base).

We analyzed the impervious cover estimates of each watershed within the Salado salamander's range along with the amount of land currently managed as open space that could possibly contribute water quality benefits to the salamander's habitat. The two watersheds within the Salado salamander's range have 0.31 percent and 0.91 percent impervious cover. Although four known Salado salamander sites are located on large, undeveloped ranches (8,126 ac [3,288 ha] and 827 ac [335 ha]), a significant portion of the recharge zone for the Northern Segment of the Edwards Aquifer that supplies water to this species' habitat extends to areas outside of these properties. We could not identify any large tracts managed specifically as open space within the Salado salamander's range. We also could not identify any agreements in place to preserve or manage any properties for the benefit of this species or its habitat. Furthermore, population projections from the Texas State Data Center (2009, p. 19) estimate that Bell County will increase in population from 237,974 in 2000, to 397,741 in 2040, a 67 percent increase over the 40-year period. In consideration of this information and analysis, we believe the threat of habitat modification in the form of water quality degradation is ongoing and of medium impact throughout the Salado salamander's range.

In regards to adequate regulatory mechanisms to protect water quality, it is unlikely that water quality within the Salado salamander's habitat will be protected if development occurs in these watersheds into the foreseeable future. We therefore consider the inadequacy of existing regulatory mechanisms (Factor D) to be an ongoing threat of high impact.

The Edwards Aquifer is at risk from a variety of sources of pollutants (Ross 2011, p. 4), including hazardous materials that could be spilled or leaked, potentially resulting in the contamination of both surface and groundwater resources (Service 2005, pp. 1.6–14–1.6–15). A catastrophic spill could occur if a truck transporting hazardous materials overturned and spilled its contents over the recharge zone of the aquifer. Salado salamander sites located downstream of Interstate Highway 35 may be particularly vulnerable due to their proximity to this major transportation corridor. Should a hazardous materials spill occur at the Interstate Highway 35 bridge that crosses at Salado Creek, this species could be at risk from contaminants entering the water flowing into its surface habitat downstream.

Several groundwater contamination incidents have occurred within Salado salamander habitat (Price *et al.* 1999, p. 10). Because these groundwater contamination events are already occurring and because the Salado salamander's range is restricted to only a few known spring sites, we consider the threat of hazardous materials spills to be ongoing and of high impact to this species.

Construction activities resulting from urban development are a threat to both water quality and quantity because they can increase sedimentation and dewater springs by intercepting aquifer conduits. The Service is not aware of any specific, large-scale construction activities currently ongoing within the Salado salamander's range. However, because the human population is increasing rapidly in this area, urbanization and subsequent construction activities are likely to impact the few known Salado salamander populations within the foreseeable future. Thus, we believe construction activities are an ongoing threat of low impact to this species.

Another potential threat to the Salado salamander and its habitat is low flow conditions in the aquifer and within this species' surface habitat due to urbanization and recent drought conditions. Robertson Springs (Salado salamander habitat) reportedly went temporarily dry in 2009 (TPWD 2011a, p. 5). Although *Eurycea* salamanders may spend some time below the surface in underground aquatic habitat areas to adapt to periodic flow losses (O'Donnell *et al.* 2006, p. 47), drying spring habitats can result in stranding salamanders (TPWD 2011a, p. 5). Also, prey availability is likely low underground due to the lack of primary production (Hobbs and Culver 2009, p. 392).

Future climate change could also affect water quantity and spring flow for the Salado salamander. Climate change could compound the threat of decreased water quantity at salamander spring sites. The effects of climate change on aquifer-dependant species is difficult to assess; however, the Edwards Aquifer is predicted to experience additional stress from climate change that could lead to decreased recharge and low or ceased spring flows given increasing pumping demands (Loáiciga *et al.* 2000, pp. 192–193). In consideration of the information presented above, we believe that habitat modification in the form of water quantity reduction to be an ongoing threat of medium magnitude to this species.

All four salamanders are sensitive to direct physical habitat modification, such as those resulting from human recreational activities, impoundments, feral hogs, and livestock. Destruction of Salado salamander habitat has been attributed to direct human modification (including heavy machinery use, outflow channel reconstruction, and substrate alteration at Big Boiling Springs) and feral hog activity (Service 2010b, p. 6; Gluesenkamp 2011a, b, pers. comm.). Because there is ongoing physical habitat modification occurring to known Salado salamander sites within a very restricted range, we consider this threat resulting from human recreational activities to be ongoing and of low impact to this species. Furthermore, we consider the threats of impoundments, feral hogs, and livestock to be ongoing, but of low impact.

Predation and disease (Factor C) may be affecting the Salado salamander, but there is not enough evidence to consider these factors threats. Neither factor is at a level that we consider to be threatening the continued existence of the Salado salamander species now or in the foreseeable future.

Other natural or manmade factors (Factor E) affecting the Salado salamander include UV–B radiation, small population sizes, stochastic events, and synergistic and additive interactions among stressors. Increased levels of UV–B radiation, due to the depletion of stratospheric ozone layers has been shown to cause significant mortality and deformities in amphibian species (Blaustein *et al.* 1997, p. 13,735), although the effects of UV–B radiation on this species are unknown. Small population sizes may act synergistically with other traits of the species (such as its limited distribution) to increase its overall risk of extinction (Davies *et al.* 2004, p. 270). Stochastic events, such as severe weather or demographic changes to the population, are also heightened threats because of its restricted range and small population sizes (Melbourne and Hastings 2008, p. 100). We therefore consider this to be an ongoing threat of high impact.

The population status of Salado salamanders is unknown. A lack of long-term data prevents us from drawing conclusions on how Salado salamander populations may be changing over time. However, similar to Austin blind and Jollyville plateau salamander populations, we expect Salado salamander populations to trend downwards in the future as human population growth and urbanization in the area drive declines in habitat quality and quantity. Due to its relatively small range and small number of populations, we believe the species' resiliency to the threats outlined above is low.

The Act defines an endangered species as any species that is ''in danger of extinction throughout all or a significant portion of its range'' and a threatened species as any species ''that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.'' Due to its susceptibility to threats that are ongoing throughout its entire range, we determine that the Salado salamander is currently on the brink of extinction and therefore meets the definition of endangered. We find that the Salado salamander is presently in danger of extinction throughout its entire range, based on the immediacy, severity, and scope of the threats described above. This salamander species is proposed as endangered, rather than threatened, because the threats are occurring now or are imminent, and their potential impacts to the species would be catastrophic given the very limited range of the species, making the salamander at risk of extinction at the present time. Therefore, on the basis of the best available scientific and commercial information, we propose listing the Salado salamander as endangered in accordance with sections 3(6) and 4(a)(1) of the Act.

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. The Salado salamander proposed for listing in this rule is highly restricted in its range, and the threats occur throughout its entire range. Therefore, the threats to the survival of this species are not restricted to any particular significant portion of that range. Accordingly, our assessment and proposed determination applies to the species throughout its entire range.

Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened under the Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing can result in public awareness and conservation by Federal, State, Tribal, and local agencies, private organizations, and individuals. The Act encourages cooperation with the States and requires that recovery actions be carried out for all listed species. The protection required by Federal agencies and the prohibitions against certain activities are discussed, in part, below.

The primary purpose of the Act is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of such conservation efforts is the recovery of these listed species, so that they no longer need the protective measures of the Act. Subsection 4(f) of the Act requires the Service to develop and implement recovery plans for the conservation of endangered and threatened species. The recovery planning process involves the identification of actions that are necessary to halt or reverse the species' decline by addressing the threats to its survival and recovery. The goal of this process is to restore listed species to a point where they are secure, self-sustaining, and functioning components of their ecosystems.

Recovery planning includes the development of a recovery outline shortly after a species is listed, preparation of a draft and final recovery plan, and revisions to the plan as significant new information becomes available. The recovery outline guides the immediate implementation of urgent recovery actions and describes the process to be used to develop a recovery plan. The recovery plan identifies site-specific management actions that will achieve recovery of the species, measurable criteria that determine when a species may be downlisted or delisted, and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (comprised of species experts, Federal and State agencies, non-government organizations, and stakeholders) are often established to develop recovery plans. If we list these four central Texas salamanders, when completed, the recovery outline, draft recovery plan, and the final recovery plan will be available on our Web site (*http://www.fws.gov/endangered*), or from our Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Implementation of recovery actions generally requires the participation of a broad range of partners, including other Federal agencies, States, Tribal, non-governmental organizations, businesses, and private landowners. Examples of recovery actions include habitat restoration (for example, restoration of native vegetation), research, captive propagation and reintroduction, and outreach and education. The recovery of many listed species cannot be accomplished solely on Federal lands because their range may occur primarily or solely on non-Federal lands. To achieve recovery of these four species requires cooperative conservation efforts on private, local government, and other lands.

If these species are listed, funding for recovery actions will be available from a variety of sources, including Federal budgets, State programs, and cost share grants for non-Federal landowners, the academic community, and non-governmental organizations. In addition, pursuant to section 6 of the Act, the State of Texas would be eligible for Federal funds to implement management actions that promote the protection and recovery of the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders. Information on our grant programs that are available to aid species recovery can be found at: *http://www.fws.gov/grants.*

Although the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders are only proposed for listing under the Act at this time, please let us know if you are interested in participating in recovery efforts for this species. Additionally, we invite you to submit any new information on this species whenever it becomes available and any information you may have for recovery planning purposes (see **FOR FURTHER INFORMATION CONTACT**).

Section 7(a) of the Act requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if any is designated. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR part 402. Section 7(a)(4) of the Act requires Federal agencies to confer with the Service on any action that is likely to jeopardize the continued existence of a species proposed for listing or result in destruction or adverse modification of proposed critical habitat. If a species is listed subsequently, section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species or destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into consultation with the Service.

Federal agency actions within the species habitat that may require conference or consultation or both as described in the preceding paragraph include, but are not limited to, issuance of section 404 Clean Water Act permits by the U.S. Army Corps of Engineers; construction and management of gas pipeline and power line rights-of-way by the Federal Energy Regulatory Commission; Federal Emergency Management Agency for floodplain map revisions; U.S. Department of Agriculture Rural Development grants; Housing and Urban Development grants; Service for Partners projects; Service issuance of section 10 permits under the Act; construction and maintenance of roads or highways by the Federal Highway Administration; Natural Resources Conservation Service funded projects; and Environmental Protection Agency pesticide registration.

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to all endangered wildlife. The prohibitions of section 9(a)(2) of the Act, codified at 50 CFR 17.21 for endangered wildlife, in part, make it illegal for any person subject to the jurisdiction of the United States to take (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import, export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any listed species. Under the Lacey Act (18 U.S.C. 42–43; 16 U.S.C. 3371–3378), it is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. Certain exceptions apply to agents of the Service and State conservation agencies.

We may issue permits to carry out otherwise prohibited activities involving endangered and threatened wildlife species under certain circumstances. Regulations governing permits are codified at 50 CFR 17.22 for endangered species, and at 17.32 for threatened species. With regard to endangered wildlife, a permit must be issued for the following purposes: For scientific purposes, to enhance the propagation or survival of the species, and for incidental take in connection with otherwise lawful activities.

It is our policy, as published in the **Federal Register** on July 1, 1994 (59 FR 34272), to identify to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the Act. The intent of this policy is to increase public awareness of the effect of a proposed listing on proposed and ongoing activities within the range of the species proposed for listing. The following activities could potentially result in a violation of section 9 of the Act; this list is not comprehensive:

(1) Unauthorized collecting, handling, possessing, selling, delivering, carrying, or transporting of the species, including import or export across State lines and international boundaries, except for properly documented antique specimens of these taxa at least 100 years old, as defined by section 10(h)(1) of the Act.

(2) Introduction of nonnative species that compete with or prey upon any of the four salamanders, such as the introduction of competing, nonnative aquatic animals to the State of Texas.

(3) The unauthorized release of biological control agents that attack any life stage of these four species.

(4) Unauthorized modification of the spring opening, stream channel, or water flow of any spring or stream or removal or destruction of substrate in any body of water in which any of the four salamanders are known to occur.

(5) The interception of groundwater such that it reduces water flow into any waters where any of the four salamanders are known to occur.

(6) Unauthorized discharge of chemicals or fill material into any waters in which any of the four salamanders are known to occur.

If the four central Texas salamanders are listed under the Act, the State of Texas' endangered species law is automatically invoked, which would also prohibit take of these species and encourage conservation by State government agencies. Chapter 68, section 68.002 of the TPWD's Code defines State-level endangered species as those species of fish or wildlife indigenous to Texas that are listed on: (1) The United States List of Endangered and Threatened Wildlife; or (2) the list of fish or wildlife threatened with Statewide extinction as filed by the director of the department. Further, the State of Texas may enter into agreements with Federal agencies to administer and manage any area required for the conservation, management, enhancement, or protection of endangered species. Funds for these activities could be made available under section 6 of the Act (Cooperation with the States). Thus, the Federal protection afforded to these species by listing them as endangered species will be reinforced and supplemented by protection under State law.

Questions regarding whether specific activities would constitute a violation of section 9 of the Act should be directed to the Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**). Requests for copies of the regulations concerning listed animals and general inquiries regarding prohibitions and permits may be addressed to the U.S. Fish and Wildlife Service, Endangered Species Permits, 10711 Burnet Road, Suite 200, Austin, TX 78758; telephone 512–490–0057; facsimile 512–490–0974.

Prudency Determination

Section 4 of the Act, as amended, and implementing regulations (50 CFR 424.12), require that, to the maximum extent prudent and determinable, the Secretary designate critical habitat at the time the species is determined to be endangered or threatened. Our regulations at 50 CFR 424.12(a)(1) state that the designation of critical habitat is not prudent when one or both of the following situations exist: (1) The species is threatened by taking or other activity and the identification of critical habitat can be expected to increase the degree of threat to the species; or (2) the designation of critical habitat would not be beneficial to the species.

There is no documentation that the four Texas salamanders are significantly threatened by collection. Although human visitation to four Texas salamanders' habitat carries with it the possibility of introducing infectious disease and potentially increasing other threats where the salamanders occur, the locations of important recovery areas are already accessible to the public through Web sites, reports, online databases, and other easily accessible venues. Therefore, identifying and mapping critical habitat is unlikely to increase threats to the four Texas salamander species or their habitats. In the absence of finding that the designation of critical habitat would increase threats to a species, if there are any benefits to a critical habitat designation, then a prudent finding is warranted. The potential benefits of critical habitat to the four Texas salamanders include: (1) Triggering consultation under section 7 of the Act where a Federal nexus may not otherwise occur (for example, a critical habitat unit may become unoccupied, and without critical habitat designation, a consultation would not occur on a project that may affect an unoccupied area); (2) focusing conservation activities on the most essential features and areas; (3) providing educational benefits to State or county governments, or private entities; and (4) preventing people from causing inadvertent harm to the species. Therefore, because we have determined that the designation of critical habitat will not likely increase the degree of threat to any of the four salamander species and may provide some measure of benefit, we find that designation of critical habitat is prudent for the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders.

Proposed Critical Habitat Designation for the Four Central Texas Salamanders

Background

It is our intent to discuss below only those topics directly relevant to the designation of critical habitat for the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders in this section of the proposed rule.

Critical habitat is defined in section 3 of the Act as:

(1) The specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the Act, on which are found those physical or biological features

(a) Essential to the conservation of the species and

(b) Which may require special management considerations or protection; and

(2) Specific areas outside the geographical area occupied by the species at the time it is listed, upon a determination that such areas are essential for the conservation of the species.

Conservation, as defined under section 3 of the Act, means to use and the use of all methods and procedures that are necessary to bring an endangered or threatened species to the point at which the measures provided pursuant to the Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management such as research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation, and, in the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, may include regulated taking.

Critical habitat receives protection under section 7 of the Act through the requirement that Federal agencies ensure, in consultation with the Service, that any action they authorize, fund, or carry out is not likely to result in the destruction or adverse modification of critical habitat. The designation of critical habitat does not affect land ownership or establish a refuge, wilderness, reserve, preserve, or other conservation area. Such designation does not allow the government or public to access private lands. Such designation does not require implementation of restoration, recovery, or enhancement measures by non-Federal landowners. Where a landowner requests Federal agency funding or authorization for an action that may affect a listed species or critical habitat, the consultation requirements of section 7(a)(2) of the Act would apply, but even in the event of a destruction or adverse modification finding, the obligation of the Federal action agency and the landowner is not to restore or recover the species, but to implement reasonable and prudent alternatives to avoid destruction or adverse modification of critical habitat.

Under the first prong of the Act's definition of critical habitat, areas within the geographical area occupied by the species at the time it was listed are included in a critical habitat designation if they contain physical or biological features (1) which are essential to the conservation of the species and (2) which may require special management considerations or protection. For these areas, critical habitat designations identify, to the extent known using the best scientific data available, those physical or biological features that are essential to the conservation of the species (such as space, food, cover, and protected habitat). In identifying those physical or biological features within an area, we focus on the principal constituent elements (primary constituent elements such as roost sites, nesting grounds, seasonal wetlands, water quality, tide, soil type) that are essential to the conservation of the species. Primary constituent elements are the elements or components of physical or biological features that are essential to the conservation of the species.

Under the second prong of the Act's definition of critical habitat, we can designate critical habitat in areas outside the geographical area occupied by the species at the time it is listed, upon a determination that such areas are essential for the conservation of the species. For example, an area currently occupied by the species but that was not occupied at the time of listing may be essential to the conservation of the species and may be included in the critical habitat designation. We designate critical habitat in areas outside the geographical area occupied by a species only when a designation limited to its range would be inadequate to ensure the conservation of the species.

Section 4 of the Act requires that we designate critical habitat on the basis of the best scientific data available. Further, our Policy on Information Standards Under the Endangered Species Act (published in the **Federal Register** on July 1, 1994 (59 FR 34271)), the Information Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Pub. L. 106–554; H.R. 5658)), and our associated Information Quality Guidelines, provide criteria, establish procedures, and provide guidance to ensure that our decisions are based on the best scientific data available. They require our biologists, to the extent consistent with the Act and with the use of the best scientific data available, to use primary and original sources of information as the basis for recommendations to designate critical habitat.

When we are determining which areas should be designated as critical habitat, our primary source of information is generally the information developed during the listing process for the species. Additional information sources may include the recovery plan for the species, articles in peer-reviewed journals, conservation plans developed by States and counties, scientific status surveys and studies, biological assessments, other unpublished materials, or experts' opinions or personal knowledge.

Habitat is dynamic, and species may move from one area to another over time. We recognize that critical habitat designated at a particular point in time may not include all of the habitat areas that we may later determine are necessary for the recovery of the species. For these reasons, a critical habitat designation does not signal that habitat outside the designated area is unimportant or may not be needed for recovery of the species. Areas that are important to the conservation of the species, both inside and outside the critical habitat designation, will continue to be subject to: (1) Conservation actions implemented under section 7(a)(1) of the Act, (2) regulatory protections afforded by the requirement in section 7(a)(2) of the Act for Federal agencies to ensure their actions are not likely to jeopardize the continued existence of any endangered or threatened species, and (3) the prohibitions of section 9 of the Act if actions occurring in these areas may affect the species. Federally funded or permitted projects affecting listed species outside their designated critical habitat areas may still result in jeopardy findings in some cases. These protections and conservation tools will continue to contribute to recovery of this species. Similarly, critical habitat designations made on the basis of the best available information at the time of designation will not control the direction and substance of future recovery plans, habitat conservation plans (HCPs), or other species conservation planning efforts if new information available at the time of these planning efforts calls for a different outcome.

Physical or Biological Features

In accordance with section 3(5)(A)(i) and 4(b)(1)(A) of the Act and regulations at 50 CFR 424.12, in determining which areas within the geographic area occupied by the species at the time of listing to designate as critical habitat, we consider the physical or biological features that are essential to the conservation of the species and which may require special management considerations or protection. These include, but are not limited to:

(1) Space for individual and population growth and for normal behavior;

(2) Food, water, air, light, minerals, or other nutritional or physiological requirements;

(3) Cover or shelter;

(4) Sites for breeding, reproduction, or rearing (or development) of offspring; and

(5) Habitats that are protected from disturbance or are representative of the historical, geographic, and ecological distributions of a species.

We derive the specific physical or biological features required for the four central Texas salamander species from studies of these species' habitat, ecology, and life history as described below. Additional information can be found in the listing portion of this proposed rule. We have determined that the aquatic ecosystem of the Barton Springs Segment of the Edwards Aquifer is the physical or biological feature essential for the Austin blind salamander. We have determined that the aquatic ecosystem of the Northern Segment of the Edwards Aquifer is the physical or biological feature essential for the Jollyville Plateau salamander, the Georgetown salamander, and the Salado salamander.

Space for Individual and Population Growth and for Normal Behavior

Austin Blind Salamander

The Austin blind salamander has been found where water emerges from the ground as a free-flowing spring. However, this species is rarely seen at the surface of the spring, so it is assumed that it is subterranean for most of its life (Hillis *et al.* 2001, p. 267). Supporting this assumption is the fact that the species' physiology is cave-adapted, with reduced eyes and pale coloration (Hillis *et al.* 2001, p. 267). Most individuals found on the surface near spring openings are juveniles (Hillis *et al.* 2001, p. 273). Austin blind salamanders have been found in the streambed a short distance (about 33 ft (10 m)) downstream of Sunken Gardens Spring (Dries, 2011, pers. comm.). Therefore, based on the information above, we identify springs, associated streams, and underground spaces within the aquifer to be the primary components of the physical or biological features essential to the conservation of this species.

Jollyville Plateau Salamander

The Jollyville Plateau salamander occurs where water emerges from the ground as a free-flowing spring and stream. Within the spring ecosystem, proximity to the springhead is important because of the appropriate stable water chemistry and temperature, substrate, and flow regime. Jollyville Plateau salamanders are known to use the underground aquifer for habitat when surface habitats go dry (Bendik 2011a, p. 31). Georgetown salamanders, a closely related species, are found up to 164 ft (50 m) from a spring opening (Pierce *et al.* 2011a, p. 4), but they are most abundant within the first 16 ft (5 m) (Pierce *et al.* 2010, p. 294). Forms of Jollyville Plateau salamander with cave morphology have been found in several underground streams (Chippindale *et al.* 2000, pp. 36–37; TPWD 2011a, pp. 9–10). Therefore, based on the information above, we identify springs, associated streams, and underground spaces within the aquifer to be the primary components of the physical or biological features essential to the conservation of this species.

Georgetown Salamander

The Georgetown salamander occurs where water emerges from the ground as a free-flowing spring and stream. Within the spring ecosystem, proximity to the springhead is important because of the appropriate stable water chemistry and temperature, substrate, and flow regime. Georgetown salamanders are found within 164 ft (50 m) of a spring opening (Pierce *et al.* 2011a, p. 4), but they are most abundant within the first 16 ft (5 m) (Pierce *et al.* 2010, p. 294). Georgetown salamanders are also thought to use the underground aquifer for habitat, similar to other closely related *Eurycea* species. Forms of Georgetown salamander with cave morphology have been found at two locations (TPWD 2011a, p. 8), indicating that they spend most of their lives underground at these locations. Therefore, based on the information above, we identify springs, associated streams, and underground spaces within the aquifer to be the primary components of the physical or biological features essential to the conservation of this species.

Salado Salamander

The Salado salamander occurs where water emerges from the ground as a free-flowing spring and stream. Within the spring ecosystem, proximity to the springhead is important because of the appropriate stable water chemistry and temperature, substrate, and flow regime. *Eurycea* salamanders are rarely found more than 66 ft (20 m) from a spring source (TPWD 2011, p. 3). However, Georgetown salamanders, a similar species, are found up to 164 ft (50 m) downstream of a spring opening. Salado salamanders are also thought to use the underground aquifer for habitat in times of drought when surface habitat is no longer available or suitable (TPWD 2011, p. 3), similar to other closely related *Eurycea* species (Bendik 2011a, p. 31). Therefore, based on the information above, we identify springs, associated streams, and underground spaces within the aquifer to be the primary components of the physical or biological features essential to the conservation of this species.

Food, Water, Air, Light, Minerals, or Other Nutritional or Physiological Requirements

Austin Blind Salamander

No species-specific dietary study has been completed, but the diet of the Austin blind salamander is presumed to be similar to other *Eurycea* species, consisting of small aquatic invertebrates such as amphipods, copepods, isopods, and insect larvae (reviewed in COA 2001, pp. 5–6). The feces of one wild-caught Austin blind salamander contained amphipods, ostracods, copepods, and plant material (Hillis *et al.* 2001, p. 273).

Austin blind salamanders are strictly aquatic and spend their entire lives submersed in water from the Barton Springs Segment of the Edwards Aquifer (Hillis *et al.* 2001, p. 273). These salamanders, and the prey that they feed on, require water sourced from the Edwards Aquifer at sufficient flows (quantity) to meet all of their physiological requirements. This water should be flowing and unchanged in chemistry, temperature, and volume from natural conditions. The average water temperature at Austin blind salamander sites in Barton Springs is between 67.8 and 72.3 °F (19.9 and 22.4 °C) (COA 2011b, unpublished data).

Edwards Aquifer *Eurycea* are adapted to a lower ideal range of oxygen saturations compared to other salamanders (Turner 2009, p. 11). However, *Eurycea* salamanders need dissolved oxygen concentrations to be above a certain concentration, as the co-occurring Barton Springs salamander demonstrates declining abundance with declining dissolved oxygen levels (Turner 2009, p. 14). Woods *et al.* (2010, p. 544) observed a number of physiological effects to low dissolved oxygen concentrations (below 4.5 milligrams of oxygen per liter (mg L^{-1})) in the related San Marcos salamander, including decreased metabolic rates and decreased juvenile growth rates. Barton Springs salamander abundance is highest when dissolved oxygen is between 5 to 7 mg L^{-1} (Turner 2009, p. 12). Therefore, we assume that the dissolved oxygen level of water is important to the Austin blind salamander as well. The mean annual dissolved oxygen (from 2003 through 2011) at Main Spring, Eliza Spring, and Sunken Garden Spring is 6.36, 5.89, and 5.95 mg L^{-1}, respectively (COA 2011b, unpublished data).

The conductivity of water is also important to salamander physiology because it is related to the concentration of ions in the water. Increased conductivity is associated with increased water contamination and decreased *Eurycea* abundance (Willson and Dorcas 2003, pp. 766–768; Bowles *et al.* 2006, pp. 117–118). The lower limit of observed conductivity in developed Jollyville Plateau salamander sites where salamander densities were lower was 800 microsiemens per centimeter (μS cm^{-1}) (Bowles *et al.* 2006, p. 117). Salamanders were significantly more abundant at undeveloped sites where water conductivity averaged 600 μS cm^{-1} (Bowles *et al.* 2006, p. 117). Because of its similar physiology to the Jollyville Plateau salamander, we assume that the Austin blind salamander will have a similar response to elevated water conductance. Although one laboratory study on the related San Marcos salamander demonstrated that conductivities up to 2738 μS cm^{-1} had no measurable effect on adult activity (Woods and Poteet 2006, p. 5), it remains unclear how elevated water conductance might affect juveniles or the long-term health of salamanders in the wild. In the absence of better information on the sensitivity of salamanders to changes in conductivity (or other contaminants), it is reasonable to assume that salamander survival, growth, and reproduction will be most successful when water quality is unaltered from natural aquifer conditions. The average water conductance at Main Spring, Eliza Spring, and Sunken Garden Spring is between 605 and 740 μS cm^{-1}, respectively (COA 2011b, unpublished data).

Therefore, based on the information above, we identify aquatic invertebrates and water from the Barton Springs Segment of the Edwards Aquifer with adequate dissolved oxygen concentration, water conductance, and water temperature to be the essential components of the physical or biological features essential to the conservation of this species.

Jollyville Plateau Salamander

As in other *Eurycea* species, the Jollyville Plateau salamander feeds on aquatic invertebrates that commonly occur in spring environments (reviewed in COA 2001, pp. 5–6). A gut content analysis by the City of Austin demonstrated that this salamander preys on varying proportions of ostracods, copepods, mayfly larvae, fly larvae, snails, water mites, aquatic beetles, and stone fly larvae depending on the location of the site (Bendik 2011b, p. 55).

Jollyville Plateau salamanders are strictly aquatic and spend their entire lives submersed in water from the Northern Segment of the Edwards Aquifer (COA 2001, pp. 3–4; Bowles *et al.* 2006, p. 112). These salamanders, and the prey that they feed on, require water sourced from the Edwards Aquifer at sufficient flows (quantity) to meet all of their physiological requirements. This water should be flowing and unchanged in chemistry, temperature, and volume from natural conditions. The average water temperature at Jollyville Plateau salamander sites with undeveloped watersheds ranges from 65.3 to 67.3 °F (18.5 to 19.6 °C) (Bowles *et al.* 2006, p. 115).

Edwards Aquifer *Eurycea* are adapted to a lower ideal range of oxygen saturations compared to other salamanders (Turner 2009, p. 11). However, *Eurycea* salamanders need dissolved oxygen concentrations to be above a certain concentration, as the related Barton Springs salamander demonstrates declining abundance with declining dissolved oxygen levels (Turner 2009, p. 14). In addition, Woods *et al.* (2010, p. 544) observed a number of physiological effects to low dissolved oxygen concentrations (below 4.5 mg L^{-1}) in the related San Marcos salamander, including decreased metabolic rates and decreased juvenile growth rates. The average dissolved oxygen level of Jollyville Plateau salamander sites with little or no development in the watershed ranges from 5.6 to 7.1 mg L^{-1} (Bendik 2011a, p. 10). Based on this information, we conclude that the dissolved oxygen level of water is important to the Jollyville Plateau salamander for respiratory function.

The conductivity of water is also important to salamander physiology because it is related to the concentration of ions in the water. Increased conductivity is associated with increased water contamination and decreased *Eurycea* abundance (Willson and Dorcas 2003, pp. 766–768; Bowles *et al.* 2006, pp. 117–118). The lower limit of conductivity in developed Jollyville Plateau salamander sites where salamander densities were lower was 800 μS cm^{-1} (Bowles *et al.* 2006, p. 117). Salamanders were significantly more abundant at undeveloped sites where water conductivity averaged 600 μS cm^{-1} (Bowles *et al.* 2006, p. 117). The average water conductance of Jollyville Plateau salamander sites with little or no development in the watershed ranges from 550 to 625 μS cm^{-1} (Bendik 2011a, p. 10, Bowles *et al.* 2006, p.115). Although one laboratory study on the related San Marcos salamander demonstrated that conductivities up to 2738 μS cm^{-1} had no measurable effect on adult activity (Woods and Poteet 2006, p. 5), it remains unclear how elevated water conductance might affect juveniles or the long-term health of salamanders in the wild. In the absence of better information on the sensitivity of salamanders to changes in conductivity (or other contaminants), it is reasonable to assume that salamander survival, growth, and reproduction will be most successful when water quality is unaltered from natural aquifer conditions.

Therefore, based on the information above, we identify aquatic invertebrates and water from the Northern Segment of the Edwards Aquifer, including adequate dissolved oxygen concentration, water conductance, and water temperature, to be the essential components of the physical or biological features essential for the conservation of this species.

Georgetown Salamander

No species-specific dietary study has been completed, but the diet of the Georgetown salamander is presumed to be similar to other *Eurycea* species, consisting of small aquatic invertebrates such as amphipods, copepods, isopods, and insect larvae (reviewed in COA 2001, pp. 5–6).

Georgetown salamanders are strictly aquatic and spend their entire lives submersed in water from the Northern Segment of the Edwards Aquifer (Pierce *et al.* 2010, p. 296). These salamanders, and the prey that they feed on, require water sourced from the Edwards Aquifer at sufficient flows (quantity) to meet all of their physiological requirements (TPWD 2011a, p. 8). This water should be flowing and unchanged in chemistry, temperature, and volume from natural conditions. Normal water temperature at a relatively undisturbed Georgetown salamander site ranges from 68.4 to 69.8 °F (20.2 to 21.0 °C) throughout the year (Pierce *et al.* 2010, p. 294).

Edwards Aquifer *Eurycea* are adapted to a lower ideal range of oxygen saturations compared to other salamanders (Turner 2009, p. 11). However, *Eurycea* salamanders need dissolved oxygen concentrations to be above a certain threshold, as the related Barton Springs salamander demonstrates declining abundance with declining dissolved oxygen levels (Turner 2009, p. 14). In addition, Woods *et al.* (2010, p. 544) observed a number of physiological effects to low dissolved oxygen concentrations (below 4.5 mg L^{-1}) in the related San Marcos salamander, including decreased metabolic rates and decreased juvenile growth rates. Georgetown salamander sites are characterized by high levels of dissolved oxygen, typically 6 to 8 mg L^{-1} (Pierce and Wall 2011, p. 33). Therefore, we assume that the dissolved oxygen level of water is important to the Georgetown salamander for respiratory function.

The conductivity of water is also important to salamander physiology because it is related to the concentration of ions in the water. Increased conductivity is associated with increased water contamination and decreased *Eurycea* abundance (Willson and Dorcas 2003, pp. 766–768; Bowles *et al.* 2006, pp. 117–118). The lower limit of observed conductivity in developed Jollyville Plateau salamander sites where salamander densities were lower was 800 μS cm^{-1} (Bowles *et al.* 2006, p. 117). Salamanders were significantly more abundant at undeveloped sites where water conductivity averaged 600 μS cm^{-1} (Bowles *et al.* 2006, p. 117). Because of its similar physiology to the Jollyville Plateau salamander, we assume that the Georgetown salamander will have a similar response to elevated water conductance. Normal water conductance at a relatively undisturbed Georgetown salamander site ranges from 604 to 721 μS cm^{-1} throughout the year (Pierce *et al.* 2010, p. 294). Although one laboratory study on the related San Marcos salamander demonstrated that conductivities up to 2738 μS cm^{-1} had no measurable effect on adult activity (Woods and Poteet 2006, p. 5), it remains unclear how elevated water conductance might affect juveniles or the long-term health of salamanders in the wild. In the absence of better information on the sensitivity of salamanders to changes in conductivity (or other contaminants), it is reasonable to assume that salamander survival, growth, and reproduction will be most successful when water quality is unaltered from natural aquifer conditions.

Therefore, based on the information above, we identify aquatic invertebrates and water from the Northern Segment of the Edwards Aquifer, including adequate dissolved oxygen concentration, water conductance, and water temperature, to be essential components of the physical or biological features essential for the conservation of this species.

Salado Salamander

No species-specific dietary study has been completed, but the diet of the Salado salamander is presumed to be similar to other *Eurycea* species, consisting of small aquatic invertebrates such as amphipods, copepods, isopods, and insect larvae (reviewed in COA 2001, pp. 5–6).

As with other central Texas *Eurycea* species, Salado salamanders are strictly aquatic. Individuals spend their entire lives submersed in water from the Northern Segment of the Edwards Aquifer (TPWD 2011a, p. 3). These salamanders, and the prey that they feed on, require water sourced from the Edwards Aquifer at sufficient flows (quantity) to meet all of their physiological requirements. This water should be flowing and unchanged in chemistry, temperature, and volume from natural conditions.

Edwards Aquifer *Eurycea* are adapted to a lower ideal range of oxygen saturations compared to other salamanders (Turner 2009, p. 11). However, *Eurycea* salamanders need dissolved oxygen concentrations to be above a certain threshold, as the related Barton Springs salamander demonstrates declining abundance with declining dissolved oxygen levels (Turner 2009, p. 14). In addition, Woods *et al.* (2010, p. 544) observed a number of physiological effects to low dissolved oxygen concentrations (below 4.5 mg L^{-1}) in the related San Marcos salamander, including decreased metabolic rates and decreased juvenile growth rates. Therefore, we assume that the dissolved oxygen level of water is important to the Salado salamander for respiratory function.

We also assume that the conductivity of water is important to salamander physiology because it is related to the concentration of ions in the water. Increased conductivity is associated with increased water contamination and decreased *Eurycea* abundance (Willson and Dorcas 2003, pp. 766–768; Bowles *et al.* 2006, pp. 117–118). The lower limit of conductivity in developed Jollyville Plateau salamander sites where salamander densities were lower was 800 μS cm^{-1} (Bowles *et al.* 2006, p. 117). Salamanders were significantly more abundant at undeveloped sites where water conductivity averaged 600 μS cm^{-1} (Bowles *et al.* 2006, p. 117). Although one laboratory study on the related San Marcos salamander demonstrated that conductivities up to 2738 μS cm^{-1} had no measurable effect on adult activity (Woods and Poteet 2006, p. 5), it remains unclear how elevated water conductance might affect juveniles or the long-term health of salamanders in the wild. In the absence of better information on the sensitivity of salamanders to changes in conductivity (or other contaminants), it is reasonable to assume that salamander survival, growth, and reproduction will be most successful when water quality is unaltered from natural aquifer conditions.

Therefore, based on the information above, we identify aquatic invertebrates and water from the Northern Segment of the Edwards Aquifer, including adequate dissolved oxygen concentration, water conductance, and water temperature, to be essential components of the physical or biological features essential for the conservation of this species.

Cover or Shelter

Austin Blind Salamander

The Austin blind salamander likely spends most of its life below the surface in the aquifer, and may only be flushed to the surface accidentally (Hillis *et al.* 2001, p. 273). While on the surface near spring outlets, they move into interstitial spaces (empty voids between rocks) within the substrate, using these spaces for foraging habitat and cover from predators similar to other *Eurycea* salamanders in central Texas (Cole 1995, p. 24; Pierce and Wall 2011, pp. 16–17). The surface is believed to be important as a source of food for this primarily subterranean species. These spaces should be free from sediment, as sediment fills interstitial spaces, eliminating resting places and also reducing habitat of the prey base (small aquatic invertebrates) (O'Donnell *et al.* 2006, p. 34). Austin blind salamanders have been observed under rocks and vegetation (Dries 2011, pers. comm.).

Therefore, based on the information above, we identify rocky substrate, consisting of boulder, cobble, and gravel, with interstitial space that is free from sediment, to be an essential component of the physical or biological features essential for the conservation of this species.

Jollyville Plateau Salamander

Similar to other *Eurycea* salamanders in central Texas, Jollyville Plateau salamanders move an unknown depth into the interstitial spaces (empty voids between rocks) within the substrate, using these spaces for foraging habitat and cover from predators (Cole 1995, p. 24; Pierce and Wall 2011, pp. 16–17). These spaces should be free from sediment, as sediment fills interstitial spaces, eliminating resting places and also reducing habitat of the prey base (small aquatic invertebrates) (O'Donnell *et al.* 2006, p. 34).

Jollyville Plateau salamanders have been observed under rocks, leaf litter, and other vegetation (Bowles *et al.* 2006, pp. 114–116). There was a strong positive relationship between salamander abundance and the amount of available rocky substrate (Bowles *et al.* 2006, p. 114).

Therefore, based on the information above, we identify rocky substrate, consisting of boulder, cobble, and gravel, with interstitial space that is free from sediment, to be an essential component of the physical or biological features essential for the conservation of this species.

Georgetown Salamander

Similar to other *Eurycea* salamanders in central Texas, Georgetown salamanders move an unknown depth into the interstitial spaces (empty voids between rocks) within the substrate, using these spaces for foraging habitat and cover from predators (Cole 1995, p. 24; Pierce and Wall 2011, pp. 16–17). These spaces should be free from sediment, as sediment fills interstitial spaces, eliminating resting places and also reducing habitat of the prey base (small aquatic invertebrates) (O'Donnell *et al.* 2006, p. 34).

Georgetown salamanders have been observed under rocks, leaf litter, woody debris, and other cover objects (Pierce *et al.* 2010, p. 295). There is evidence that these salamanders prefer large rocks over other cover objects (Pierce *et al.* 2010, p. 295), which is consistent with other studies on *Eurycea* habitat (Bowles *et al.* 2006, p. 114).

Therefore, based on the information above, we identify rocky substrate, consisting of boulder, cobble, and gravel, with interstitial space that is free from sediment, to be an essential component of the physical or biological features essential for the conservation of this species.

Salado Salamander

Because of its similarity to other *Eurycea* salamanders in central Texas, we assume that the Salado salamander spends some proportion of its life below the surface between rocks. *Eurycea* salamanders move an unknown depth into the interstitial spaces (empty voids between rocks) within the substrate, using these spaces for foraging habitat and cover from predators (Cole 1995, p. 24; Pierce and Wall 2011, pp. 16–17). These spaces should be free from sediment, as sediment fills interstitial spaces, eliminating resting places and also reducing habitat of the prey base (small aquatic invertebrates) (O'Donnell *et al.* 2006, p. 34).

Salado salamanders have been observed under cover objects, such as rocks (Gluesenkamp 2011a, pers. comm.). Although no study has demonstrated the substrate preference of the Salado salamander, we assume that this species prefers large rocks over other cover objects, similar to other closely related *Eurycea* salamanders. Larger rocks provide more suitable interstitial spaces for foraging and cover.

Therefore, based on the information above, we identify rocky substrate, consisting of boulder, cobble, and gravel, with interstitial space that is free from sediment, to be an essential component of the physical or biological features essential for the conservation of this species.

Sites for Breeding, Reproduction, or Rearing (or Development) of Offspring

Austin Blind Salamander

Little is known about the reproductive habits of this species. However, the Austin blind salamander is fully aquatic, and therefore spends all of its life cycles in aquifer and spring waters. Eggs of central Texas *Eurycea* are rarely seen on the surface, so it is widely assumed that eggs are laid underground (Gluesenkamp 2011a, pers. comm.; Bendik 2011b, pers. comm.). Most Austin blind salamanders found on the surface are juveniles (Hillis *et al.* 2001, p. 267).

Jollyville Plateau Salamander

Little is known about the reproductive habits of this species. However, the Jollyville Plateau salamander is fully aquatic, and therefore spends all of its life cycles in aquifer and spring waters. Eggs of central Texas *Eurycea* are rarely seen on the surface, so it is widely assumed that eggs are laid underground (Gluesenkamp 2011a, pers. comm.; Bendik 2011b, pers. comm.).

Georgetown Salamander

Little is known about the reproductive habits of this species. However, the Georgetown salamander is fully aquatic, and therefore spends all of its life cycles in aquifer and spring waters. Eggs of central Texas *Eurycea* are rarely seen on the surface, so it is widely assumed that eggs are laid underground (Gluesenkamp 2011a, pers. comm.; Bendik 2011b, pers. comm.).

Salado Salamander

Little is known about the reproductive habits of this species. However, the Salado salamander is fully aquatic, and therefore spends all of its life cycles in aquifer and spring waters. Eggs of central Texas *Eurycea* are rarely seen on the surface, so it is widely assumed that eggs are laid underground (Gluesenkamp 2011a, pers. comm.; Bendik 2011b, pers. comm.).

Primary Constituent Elements for the Four Central Texas Salamanders

Under the Act and its implementing regulations, we are required to identify the physical or biological features essential to the conservation of the salamander species in areas occupied at the time of listing, focusing on the features' primary constituent elements. We consider primary constituent elements to be the elements of physical or biological features that are essential to the conservation of the species.

Based on our current knowledge of the physical or biological features and habitat characteristics required to sustain the species' life-history processes, we determine that the primary constituent elements specific to these salamander species are surface springs, underground streams, and wet caves containing:

Austin Blind Salamander

1. *Water from the Barton Springs Segment of the Edwards Aquifer.* The

groundwater must be similar to natural aquifer conditions both underground and as it discharges from natural spring outlets. Concentrations of water quality constituents that could have a negative impact on the salamander should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Austin blind salamander's prey base). Hydrologic regimes similar to the historical pattern of the specific sites must be present, with at least temporal surface flow from the spring sites and continuous flow in the subterranean habitat. The water chemistry must be similar to natural aquifer conditions, with temperatures between 67.8 and 72.3 °F (19.9 and 22.4 °C), dissolved oxygen concentrations between 5 and 7 mg L^{-1}, and specific water conductance between 605 and 740 µS cm^{-1}.

2. *Rocky substrate with interstitial spaces.* Rocks (boulders, cobble, or gravel) in the substrate of the salamander's surface aquatic habitat should be large enough to provide salamanders with cover, shelter, and foraging habitat. The substrate and interstitial spaces should have minimal sedimentation.

3. *Aquatic invertebrates for food.* The spring and cave environments should be capable of supporting a diverse aquatic invertebrate community that includes crustaceans and insects.

4. *Subterranean aquifer.* During periods of drought or dewatering on the surface in and around spring sites, access to the subsurface water table must exist to provide shelter and protection.

Jollyville Plateau Salamander

1. *Water from the Northern Segment of the Edwards Aquifer.* The groundwater must be similar to natural aquifer conditions both underground and as it discharges from natural spring outlets. Concentrations of water quality constituents that could have a negative impact on the salamander should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Jollyville Plateau salamander's prey base). Hydrologic regimes similar to the historical pattern of the specific sites must be present, with at least temporal surface flow for spring sites and continuous flow in subterranean habitats. The water chemistry must be similar to natural aquifer conditions, with temperatures between 65.3 and 67.3 °F (18.5 and 19.6 °C), dissolved oxygen concentrations between 5.6 and 7.1 mg L^{-1}, and specific water conductance between 550 and 625 µS cm^{-1}.

2. *Rocky substrate with interstitial spaces.* Rocks (boulders, cobble, or gravel) in the substrate of the salamander's surface aquatic habitat should be large enough to provide salamanders with cover, shelter, and foraging habitat. The substrate and interstitial spaces should have minimal sedimentation.

3. *Aquatic invertebrates for food.* The spring and cave environments should be capable of supporting a diverse aquatic invertebrate community that includes crustaceans and insects.

4. *Subterranean aquifer.* During periods of drought or dewatering on the surface in and around spring sites, access to the subsurface water table must exist to provide shelter and protection.

Georgetown Salamander

1. *Water from the Northern Segment of the Edwards Aquifer.* The groundwater must be similar to natural aquifer conditions both underground and as it discharges from natural spring outlets. Concentrations of water quality constituents that could have a negative impact on the salamander should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Georgetown salamander's prey base). Hydrologic regimes similar to the historical pattern of the specific sites must be present, with at least temporal surface flow for spring sites and continuous flow for subterranean sites. The water chemistry must be similar to natural aquifer conditions, with temperatures between 68.4 and 69.8 °F (20.2 and 21.0 °C), dissolved oxygen concentrations between 6 and 8 mg L^{-1}, and specific water conductivity between 604 and 721 µS cm^{-1}.

2. *Rocky substrate with interstitial spaces.* Rocks (boulders, cobble, or gravel) in the substrate of the salamander's surface aquatic habitat should be large enough to provide salamanders with cover, shelter, and foraging habitat. The substrate and interstitial spaces should have minimal sedimentation.

3. *Aquatic invertebrates for food.* The spring and cave environments should be capable of supporting a diverse aquatic invertebrate community that includes crustaceans and insects.

4. *Subterranean aquifer.* During periods of drought or dewatering on the surface in and around spring sites, access to the subsurface water table must exist to provide shelter and protection.

Salado Salamander

1. *Water from the Northern Segment of the Edwards Aquifer.* The groundwater must be similar to natural aquifer conditions both underground and as it discharges from natural spring outlets. Concentrations of water quality constituents that could have a negative impact on the salamander should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Salado salamander's prey base). Hydrologic regimes similar to the historical pattern of the specific sites must be present, with at least temporal surface flow for spring sites and continuous flow for subterranean sites. The water chemistry must be similar to natural aquifer conditions, with temperatures between 65.3 and 69.8 °F (18.5 and 21.0 °C), dissolved oxygen concentrations between 5.6 and 8 mg L^{-1}, and conductivity between 550 and 721 µS cm^{-1}. The best scientific evidence available suggests that the groundwater of Salado salamander habitat is the same as Georgetown and Jollyville Plateau salamander habitat in terms of chemistry. Therefore, we include here for the Salado salamander the range of water chemistry parameters that encompass the ranges found in Jollyville and Georgetown salamander habitats.

2. *Rocky substrate with interstitial spaces.* Rocks (boulders, cobble, or gravel) in the substrate of the salamander's surface aquatic habitat should be large enough to provide salamanders with cover, shelter, and foraging habitat. The substrate and interstitial spaces should have minimal sedimentation.

3. *Aquatic invertebrates for food.* The spring and cave environments should be capable of supporting a diverse aquatic invertebrate community that includes crustaceans and insects.

4. *Subterranean aquifer.* During periods of drought or dewatering on the surface in and around spring sites, access to the subsurface water table should be provided for shelter and protection.

With this proposed designation of critical habitat, we intend to identify the physical or biological features essential to the conservation of the species, through the identification of the primary constituent elements sufficient to support the life-history processes of the species. All units and subunits proposed to be designated as critical habitat are currently occupied by one of the four salamander species and contain the primary constituent elements sufficient to support the life-history needs of the species.

Special Management Considerations or Protection

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of this species may require special management considerations or protection to reduce the following threats: Water quality degradation from contaminants, alteration to natural flow regimes, and physical habitat modification.

For these salamanders, special management considerations or protection are needed to address threats. Management activities that could ameliorate threats include (but are not limited to): (1) Protecting the quality of cave and spring water by implementing comprehensive programs to control and reduce point sources and non-point sources of pollution throughout the Barton Springs and Northern Segments of the Edwards Aquifer, (2) minimizing the likelihood of pollution events that would affect groundwater quality, (3) protecting groundwater and spring flow quantity (for example, by implementing water conservation and drought contingency plans throughout the Barton Springs and Northern Segments), and (4) excluding cattle and feral hogs through fencing to protect spring habitats from damage.

Criteria Used To Identify Critical Habitat

As required by section 4(b)(1)(A) of the Act, we use the best scientific data available in determining areas that contain the features that are essential to the conservation of the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders. During our preparation for proposing critical habitat for the four salamander species, we have reviewed: (1) Data for historical and current occurrence, (2) information pertaining to habitat features essential for the conservation of these species, and (3) scientific information on the biology and ecology of the four species. We have also reviewed a number of studies and surveys of the four salamander species that confirm historical and current occurrence of the four species including, but not limited to, Sweet (1978; 1982), COA (2001), Chippindale *et al.* (2000), and Hillis *et al.* (2001). Finally, salamander site locations and observations were verified with the aid of salamander biologists, museum collection records, and site visits.

In accordance with the Act and its implementing regulation at 50 CFR 424.12(e), we consider whether designating additional areas—outside those currently occupied as well as those occupied at the time of listing—are necessary to ensure the conservation of the species. We are not currently proposing to designate any additional areas outside the geographical area occupied by the species, because the occupied habitats proposed for critical habitat are sufficient for the conservation of the species. For the purpose of designating critical habitat for the four central Texas salamander species, we define an area as occupied based upon the reliable observation of a salamander species by a knowledgeable scientist. It is very difficult to prove unquestionably that a salamander population has been extirpated from a spring site due to these species' ability to occupy the inaccessible subsurface habitat. We therefore considered any site that had a salamander observation at any point in time currently occupied, unless that spring or cave site had been destroyed.

Based on our review, the proposed critical habitat areas described below constitute our best assessment at this time of areas that are within the geographical range occupied by at least one of the four salamander species, and are considered to contain features essential to the conservation of these species. The extent to which the subterranean populations of these species exist belowground away from outlets of the spring system is unknown. Because the hydrology of central Texas is very complex and information on the hydrology of specific spring sites are largely unknown, we will be seeking information on spring hydrology and salamander underground distribution during our public comment period (see **DATES**). However, at the time of this proposed listing rule, the best scientific evidence available suggests that the population of these salamanders can extend at least 984 ft (300 m) from the spring opening through underground conduits.

We are proposing for designation of critical habitat lands that we have determined are occupied by at least one of the four salamanders and contain sufficient elements of physical or biological features to support life-history processes essential for the conservation of the species. We delineated both surface and subsurface critical habitat components. The surface critical habitat component was delineated by starting with the cave or spring point locations that are occupied by the salamanders and extending a line downstream 164 ft (50 m) because this is the farthest a salamander has been observed from a spring outlet. The surface critical habitat includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat, but does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas); however, the subterranean aquifer may extend below such structures. We delineated the subsurface critical habitat unit boundaries by starting with the cave or spring point locations that are occupied by the salamanders. From these cave or springs points, we delineated a 984-ft (300-m) buffer to create the polygons that capture the extent to which we believe the salamander populations exist through underground conduits. The polygons were then simplified to reduce the number of vertices, but still retain the overall shape and extent. Once that was done, polygons that were within 98 ft (30 m) of each other were merged together because these areas are likely connected underground. Each new merged polygon was then revised by removing extraneous divits or protrusions that resulted from the merge process.

When determining proposed critical habitat boundaries, we made every effort to avoid including developed areas, such as lands covered by buildings, pavement, and other structures, because such lands lack physical or biological features essential for the conservation of the four central Texas salamanders. The scale of the maps we prepared under the parameters for publication within the Code of Federal Regulations may not reflect the exclusion of such developed lands. Any such lands inadvertently left inside critical habitat boundaries shown on the maps of this proposed rule have been excluded by text in the proposed rule, and are not proposed for designation as critical habitat. Therefore, if the critical habitat is finalized as proposed, a Federal action involving these lands would not trigger section 7 consultation with respect to critical habitat and the requirement of no adverse modification unless the specific action would affect the physical or biological features in the underground or adjacent critical habitat.

The critical habitat designation is defined by the map or maps, as modified by any accompanying regulatory text, presented at the end of this document in the rule portion. We include more detailed information on the boundaries of the critical habitat designation in the preamble of this document. We will make the coordinates or plot points or both on which each map is based available to the public on *http://regulations.gov* at Docket No. FWS–R2–ES–2012–0035, on our Internet site at *http://www.fws.gov/southwest/es/AustinTexas/,* and at the field office responsible for the designation (see **FOR FURTHER INFORMATION CONTACT** above).

Proposed Critical Habitat Designation

We are proposing a total of 52 units for designation for the 4 central Texas salamanders based on sufficient elements of physical or biological features being present to support the Austin blind, Jollyville Plateau, Georgetown, and Salado salamanders' life-history processes. Some units contain all of the identified elements of physical or biological features and support multiple life-history processes. Some units contain only some elements of the physical or biological features necessary to support the four central Texas salamanders' particular use of that habitat. In some units, the physical or biological features essential for the conservation of these salamanders have been impacted at times, and in some cases these impacts have had negative effects on the salamander populations there. We recognize that some units have experienced impacts and may have physical or biological features of lesser quality than others. Special management or protection is needed at these sites to restore the physical or biological features to provide for long-term sustainability of the species at these sites. In addition, high-quality sites need special protection, and in some cases management, to maintain their quality and ability to sustain the salamander populations over the long term.

We are proposing 1 unit as critical habitat for the Austin blind salamander, 33 units as critical habitat for the Jollyville Plateau salamander, 14 units as critical habitat for the Georgetown salamander, and 4 units as critical habitat for the Salado salamander (52 units total). The critical habitat areas we describe below constitute our current best assessment of areas that meet the definition of critical habitat for the four salamander species. As previously noted, we are proposing both surface and subsurface critical habitat components. The surface critical habitat includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat, but does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas); however, the subterranean aquifer may extend below such structures. The subsurface critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs. The 52 units we propose as critical habitat are listed and described below, and acreages are based on the size of the subsurface critical habitat component. All units described below are occupied by one of the four salamander species.

TABLE 7—PROPOSED CRITICAL HABITAT UNIT FOR THE AUSTIN BLIND SALAMANDER

Critical habitat unit	Land ownership by type	Size of unit in acres (hectares)
1. Barton Springs Unit	City, Private	120 (49).
Total		120 ac (49 ha).

Note: Area sizes may not sum due to rounding. Area estimates reflect all land within critical habitat unit boundaries.

TABLE 8—PROPOSED CRITICAL HABITAT UNITS FOR THE JOLLYVILLE PLATEAU SALAMANDER

Critical habitat unit	Land ownership by type	Size of unit in acres (hectares)
1. Krienke Spring Unit	Private	68 (28).
2. Brushy Creek Spring Unit	Private	68 (28).
3. Testudo Tube Cave Unit	Private, City	68 (28).
4. Buttercup Creek Cave Unit	Private	227 (92).
5. Treehouse Cave Unit	Private	68 (28).
6. Avery Spring Unit	Private	237 (96).
7. PC Spring Unit	Private	68 (28).
8. Baker and Audubon Spring Unit	Private	110 (45).
9. Wheless Spring Unit	Private, County	135 (55).
10. Blizzard R-Bar-B Spring Unit	Private	68 (28).
11. House Spring Unit	Private	68 (28).
12. Kelly Hollow Spring Unit	Private	68 (28).
13. MacDonald Well Unit	Private, County	68 (28).
14. Kretschmarr Unit	Private, County	112 (45).
15. Pope and Hiers (Canyon Creek) Spring Unit	Private	68 (28).
16. Fern Gully Spring Unit	Private, City	68 (28).
17. Bull Creek 1 Unit	Private, City, County	1,157 (468).
18. Bull Creek 2 Unit	Private, City, County	237 (96).
19. Bull Creek 3 Unit	Private, City	254 (103).
20. Moss Gulley Spring Unit	City, County	68 (28).
21. Ivanhoe Spring Unit	City	68 (28).
22. Sylvia Spring Unit	Private, City, County	103 (42).
23. Tanglewood Spring Unit	Private	68 (28).
24. Long Hog Hollow Unit	Private	68 (28).
25. Tributary 3 Unit	Private	68 (28).
26. Sierra Spring Unit	Private	68 (28).
27. Troll Spring Unit	Private	98 (40).
28. Stillhouse Unit	Private	203 (82).

TABLE 8—PROPOSED CRITICAL HABITAT UNITS FOR THE JOLLYVILLE PLATEAU SALAMANDER—Continued

Critical habitat unit	Land ownership by type	Size of unit in acres (hectares)
29. Salamander Cave Unit	Private	68 (28).
30. Indian Spring Unit	Private	68 (28).
31. Spicewood Spring Unit	Private	68 (28).
32. Balcones District Park Spring Unit	Private, City	68 (28).
33. Tributary 4 Unit	Private, City	159 (64).
Total		4,460 ac (1,816 ha).

Note: Area sizes may not sum due to rounding. Area estimates reflect all land within critical habitat unit boundaries.

TABLE 9—PROPOSED CRITICAL HABITAT UNITS FOR THE GEORGETOWN SALAMANDER

Critical habitat unit	Land ownership by type	Size of unit in acres (hectares)
1. Cobb Unit	Private	83 (34)
2. Cowen Creek Spring Unit	Private	68 (28).
3. Bat Well Unit	Private	68 (28).
4. Walnut Spring Unit	Private, County	68 (28).
5. Twin Springs Unit	Private, County	68 (28).
6. Hogg Hollow Spring Unit	Private, Federal	68 (28).
7. Cedar Hollow Spring Unit	Private	68 (28).
8. Lake Georgetown Unit	Federal, Private	132 (53).
9. Water Tank Cave Unit	Private	68 (28).
10. Avant Spring Unit	Private	68 (28).
11. Buford Hollow Spring Unit	Federal, Private	68 (28).
12. Swinbank Spring Unit	City, Private	68 (28).
13. Shadow Canyon Unit	City, Private	68 (28).
14. San Gabriel Springs Unit	City	68 (28).
Total		1,031 ac (423 ha).

Note: Area sizes may not sum due to rounding. Area estimates reflect all land within critical habitat unit boundaries.

TABLE 10—PROPOSED CRITICAL HABITAT UNITS FOR THE SALADO SALAMANDER

Critical habitat unit	Land ownership by type	Size of unit in acres (hectares)
1. Hog Hollow Spring Unit	Private	68 (28)
2. Solana Spring #1 Unit	Private	68 (28).
3. Cistern Spring Unit	Private	68 (28).
4. IH–35 Unit	Private, State, City	168 (68).
Total		372 ac (152 ha).

Note: Area sizes may not sum due to rounding. Area estimates reflect all land within critical habitat unit boundaries.

We present brief descriptions of all units, and reasons why they meet the definition of critical habitat for the four central Texas salamanders, below.

Austin Blind Salamander

Unit 1: Barton Springs Unit

The Barton Springs Unit consists of 120 ac (49 ha) of City and private land in the City of Austin, central Travis County, Texas. Most of the unit is located in Zilker Park, which is owned by the City of Austin. Most of the unit consists of landscaped areas managed as a public park. The southwestern portion of the unit is dense commercial development, and part of the southern portion contains residential development. Barton Springs Road, a major roadway, crosses the northeastern portion of the unit. This unit contains Parthenia Spring, Sunken Gardens Spring, and Eliza Spring, which are occupied by Austin blind salamander. The springs are located in the Barton Creek watershed. Parthenia Spring is located in the backwater of Barton Springs Pool, which is formed by a dam on Barton Creek; Eliza Spring is on an unnamed tributary to the bypass channel of the pool; and Sunken Gardens Spring is located on a tributary that enters Barton Creek downstream of the dam for Barton Springs Pool. The unit contains all of the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the contributing and recharge zone for the Barton Springs segment of the Edwards Aquifer and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the underground aquifer in this area and the springs and fissure outlets. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Because we did not have specific points for species locations, we used the center of Eliza and Sunken Gardens springs and the southwestern point of a fissure in Parthenia Springs.

Jollyville Plateau Salamander

Unit 1: Krienke Spring Unit

Unit 1 consists of 68 ac (28 ha) of private land in southern Williamson County, Texas. The unit is located just south of State Highway 29. The northern part of the unit is in dense residential development, while the southern part of the unit is less densely developed. County Road 175 (Sam Bass Road) crosses the northern half of the unit. This unit contains Krienke Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary of Dry Fork, a tributary to Brushy Creek. The unit contains all the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 2: Brushy Creek Spring Unit

Unit 2 consists of 68 ac (28 ha) of private land in southern Williamson County, Texas. The unit is centered just south of Palm Valley Boulevard and west of Grimes Boulevard. The northern part of the unit is covered with commercial and residential development, while the southern part is less densely developed. Some areas along the stream are undeveloped. This unit contains Brushy Creek Spring, which is occupied by the Jollyville Plateau salamander. The spring is near Brushy Creek. The unit contains all the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 3: Testudo Tube Cave Unit

Unit 3 consists of 68 ac (28 ha) of City of Austin and private land in southern Williamson County and northern Travis County, Texas. The unit is located just east of Lime Creek Road. The unit is mostly undeveloped but several unpaved roads cross it. This unit contains Testudo Tube Cave, which is occupied by the Jollyville Plateau salamander. The cave and the surrounding area are owned by the City of Austin as water quality protection land. The cave contains the Tooth Cave ground beetle (*Rhadine persephone*), an endangered karst invertebrate. As part of the mitigation for the Lakeline Mall HCP, the cave must be protected and managed in perpetuity. These actions will provide some benefit to the Jollyville Plateau salamander. The unit contains all the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the cave. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the cave, representing the extent of the subterranean critical habitat.

Unit 4: Buttercup Creek Cave Unit

Unit 4 consists of 227 ac (92 ha) of private land in southern Williamson County, Texas. The unit is located east and south of the intersection of Lakeline Boulevard and Buttercup Creek Boulevard. The unit is mostly covered with residential property. Lakeline Boulevard, a major thoroughfare, crosses the northeast area of the unit. An undeveloped area of parks and setbacks is in the south central part of the unit. This unit contains four caves: TWASA Cave, Illex Cave, Buttercup Creek Cave, and Flea Cave, which are occupied by the Jollyville Plateau salamander. The three latter caves are located in a preserve set up as mitigation property under the Buttercup HCP. The HCP covers adverse impacts to the Tooth Cave ground beetle. Although the salamander is not covered under the Buttercup HCP, the protection afforded these caves by the HCP provides some benefit for the species. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section). The unit is within the Buttercup HCP, and impacts to the Tooth Cave ground beetle are permitted (Service 1999, p. 1). However, impacts to the Jollyville Plateau salamander are not covered under this HCP.

The proposed designation includes the caves. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the caves, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 5: Treehouse Cave Unit

Unit 5 consists of 68 ac (28 ha) of private land in southern Williamson County, Texas. The unit is located east of the intersection of Buttercup Creek Boulevard and Sycamore Drive. Most of the unit is covered with moderately dense residential development. A small park is close to the center of the unit, and a greenbelt crosses the unit from east to west. This unit contains Treehouse Cave, which is occupied by the Jollyville Plateau salamander. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the cave. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the cave, representing the extent of the subterranean critical habitat.

Unit 6: Avery Spring Unit

Unit 6 consists of 237 ac (96 ha) of private land in southern Williamson County, Texas. The unit is located north of Avery Ranch Boulevard and west of Parmer Lane. The unit has large areas covered by residential development. The developed areas are separated by fairways and greens of a golf course. This unit contains three springs: Avery Springhouse Spring, Hill Marsh Spring, and Avery Deer Spring, which are occupied by the Jollyville Plateau salamander. The springs are located on an unnamed tributary to South Brushy Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the three springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 7: PC Spring Unit

Unit 7 consists of 68 ac (28 ha) of private and public land in southern Williamson County, Texas. State Highway 45, a major toll road, crosses the north central part of the unit from east to west, and Ranch to Market Road 620 goes under it midway between the center and the western edge. Except for roadways, the unit is undeveloped. This unit contains PC Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Davis Spring Branch. The unit contains the primary constituent elements essential for the conservation of species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 8: Baker and Audubon Spring Unit

Unit 8 consists of 110 ac (45 ha) of private and Lower Colorado River Authority (LCRA) land in northern Travis County, Texas. The unit is located south of Lime Creek Road and southwest of the intersection of Canyon Creek Drive and Lime Springs Road. The unit is wooded, undeveloped, and owned by Travis Audubon Society and LCRA. The entire unit is managed as part of the Balcones Canyonlands HCP. This unit contains two springs, Baker Spring and Audubon Spring, which are occupied by the Jollyville Plateau salamander. The springs are in the drainage of an unnamed tributary to Cypress Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section). The unit is within the Balcones Canyonlands Preserve HCP, and impacts to 35 species are permitted (Service 1996b, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP.

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 9: Wheless Spring Unit

Unit 9 consists of 135 ac (55 ha) of private LCRA and Travis County land in northern Travis County, Texas. The unit is located about 0.8 mi (1.3 km) west of Grand Oaks Loop. The unit is wooded and consists of totally undeveloped land owned by LCRA and The Nature Conservancy. The unit is managed as part of the Balcones Canyonlands Preserve HCP. An unpaved road crosses the unit from north to south. This unit contains two springs, Wheless Spring and Spring 25, which are occupied by the Jollyville Plateau salamander. The springs are in the Long Hollow Creek drainage. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, habitat disturbance by feral hogs, and depletion of groundwater (see *Special Management Considerations or Protection* section). The unit is within the Balcones Canyonlands Preserve HCP, and impacts to 35 species are permitted (Service 1996b, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP.

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 10: Blizzard R-Bar-B Spring Unit

Unit 10 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located west of Grand Oaks Loop. The extreme eastern portion of the unit is on the edge of residential development; a golf course (Twin Springs) crosses the central portion; and the remainder is wooded and undeveloped. This unit contains Blizzard R-Bar-B Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Cypress Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 11: House Spring Unit

Unit 11 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located just north of Benevento Way Road. Dies Ranch Road crosses the extreme eastern part of the unit. The entire unit is covered with dense residential development except for a narrow corridor along the stream, which crosses the unit from north to south. Several streets are located in the unit. This unit contains House Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Lake Marble Falls. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 12: Kelly Hollow Spring Unit

Unit 12 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located southeast of the intersection of Anderson Mill Road and Farm to Market Road 2769. With the exception of a portion of Anderson Mill Road along the northern edge of the unit, this unit is primarily undeveloped woodland. This unit contains Kelly Hollow Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Lake Marble Falls. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 13: MacDonald Well Unit

Unit 13 consists of 68 ac (28 ha) of private and Travis County land in northern Travis County, Texas. The unit is centered near the intersection of Grand Oaks Loop and Farm to Market Road 2769. Farm to Market Road 2769 crosses the unit slightly north of its center. The northern portion of the unit contains residential development and part of Twin Creeks Golf Course. This unit contains MacDonald Well, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Lake Marble Falls. The unit contains the primary constituent elements essential for the conservation of the species. The spring and adjacent land are protected and monitored as part of the Balcones Canyonlands Preserve HCP.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section). The unit is within the Balcones Canyonlands Preserve HCP, and impacts to 35 species are permitted (Service 1996b, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP.

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 14: Kretschmarr Unit

Unit 14 consists of 112 ac (45 ha) of private and Travis County land in northern Travis County, Texas. The unit is located west of Ranch to Market Road 620. Wilson Parke Avenue crosses the unit along its southern border. Most of the unit is undeveloped, with one commercial development near the west central portion. Some of the unit is owned and managed by Travis County as part of the Balcones Canyonlands Preserve. This unit contains three springs: Kretschmarr Salamander Cave, Unnamed Tributary Downstream of Grandview, and SAS Canyon, which are occupied by the Jollyville Plateau salamander. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We connected the edges of the resulting circles.

Unit 15: Pope and Hiers (Canyon Creek) Spring Unit

Unit 15 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located between Bramblecrest Drive and Winchelsea Drive. The unit contains dense residential development on its northern, eastern, and western portions. The central portion of the unit is an undeveloped canyon and is preserved in perpetuity as part of a private preserve. This unit contains Canyon Creek Pope and Hiers Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek Tributary 6. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 16: Fern Gully Spring Unit

Unit 16 consists of 68 ac (28 ha) of private and City of Austin land in northern Travis County, Texas. The unit is centered just south of the intersection of Jenaro Court and Boulder Lane. The unit contains dense residential development on much of its northern half. Most of the southern half of the unit is undeveloped land managed by the City of Austin as part of the Balcones Canyonlands Preserve HCP, and a portion is part of the Canyon Creek preserve, a privately managed conservation area. This unit contains Fern Gully Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek Tributary 5. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section). The unit is within the Balcones Canyonlands Preserve HCP, and impacts to 35 species are permitted (Service 1996b, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP.

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 17: Bull Creek 1 Unit

Unit 17 consists of 1,157 ac (468 ha) of private, City of Austin, and Travis County land in northern Travis County, Texas. The unit extends from the southeastern portion of Chestnut Ridge Road to 3M Center, just north of Ranch to Market Road 2222. The unit contains some residential development on the extreme edge of its northern portion and part of Vandegrift High School near its southeastern corner. Most of the remainder of the unit is undeveloped land managed by the City of Austin and Travis County as part of the Balcones Canyonlands Preserve HCP. This unit contains the following 34 springs: Tubb Spring, Broken Bridge Spring, Spring 17, Tributary No. 5, Tributary 6 at Sewage Line, Canyon Creek, Tributary No. 6, Gardens of Bull Creek, Canyon

Creek Hog Wallow Spring, Spring 5, Franklin, Pit Spring, Bull Creek Spring Pool, Spring 1, Spring 4, Spring 2, Lanier Spring, Cistern (Pipe) Spring, Spring 3, Lanier 90-foot Riffle, Bull Creek at Lanier Tract, Ribelin/Lanier, Spring 18, Horsethief, Ribelin, Spring 15, Spring 16, Spring 14, Lower Ribelin, Spring 13, Spring 12, Upper Ribelin, Spring 10, and Spring 9. These springs are occupied by the Jollyville Plateau salamander and are located on Bull Creek and its tributaries. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, habitat destruction by feral hogs, and depletion of groundwater (see *Special Management Considerations or Protection* section). The unit is within the Balcones Canyonlands Preserve HCP, and impacts to 35 species are permitted (Service 1996b, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP.

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 18: Bull Creek 2 Unit

Unit 18 consists of 237 ac (96 ha) of private, City of Austin, and Travis County land in northern Travis County, Texas. The center of the unit is near the eastern end of Concordia University Drive. Concordia University is in the central and eastern parts of the unit. Much of the rest of the unit is undeveloped land managed by the City of Austin and Travis County as part of the Balcones Canyonlands Preserve HCP. This unit contains six springs: Schlumberger Spring No. 1, Schlumberger Spring No. 2, Schlumberger Spring No. 6, Schlumberger Spring No. 19, Concordia Spring X, and Concordia Spring Y, which are occupied by the Jollyville Plateau salamander. The springs are located on Bull Creek Tributary 7. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section). The unit is within the Balcones Canyonlands Preserve HCP, and impacts to 35 species are permitted (Service 1996b, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP.

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 19: Bull Creek 3 Unit

Unit 19 consists of 254 ac (103 ha) of private and City of Austin land in northern Travis County, Texas. The unit is just southeast of the intersection of Ranch to Market Road 620 and Vista Parke Drive. The unit contains dense residential development on much of its northern half. Most of the rest of the unit (about 134 ac (54.2 ha)) is undeveloped land managed by as part of the Four Points HCP. Much of the remainder of the unit is managed by the City of Austin as part of the Balcones Canyonlands Preserve HCP. This unit contains five springs: Spring No. 21, Spring No. 22, Spring No. 24, Hamilton Reserve West, and Gaas Spring, which are occupied by the Jollyville Plateau salamander. The springs are located on Bull Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles. Under section 4(b)(2) of the Act, certain lands in this unit are being considered for exclusion from the final rule for critical habitat (see *Application of Section 4(b)(2) of the Act* section below).

Unit 20: Moss Gulley Spring Unit

Unit 20 consists of 68 ac (28 ha) of City of Austin and Travis County land in northern Travis County, Texas. The unit is just east of the eastern end of Unit 19. The unit is all undeveloped woodland, and all is managed by the City of Austin or Travis County as part of the Balcones Canyonlands Preserve HCP. This unit contains Moss Gulley Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section). The unit is within the Balcones Canyonlands Preserve HCP, and impacts to 35 species are permitted (Service 1996b, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP.

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 21: Ivanhoe Spring Unit

Unit 21 consists of 68 ac (28 ha) of City of Austin land in northern Travis County, Texas. The unit is east of the northwest extent of High Hollow Drive. The unit is all undeveloped woodland, and is managed by the City of Austin as part of the Balcones Canyonlands Preserve HCP. This unit contains Ivanhoe Spring 2, which is occupied by the Jollyville Plateau salamander. The spring is located on West Bull Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, destruction of habitat by feral hogs, and depletion of groundwater (see *Special Management Considerations or Protection* section). The unit is within the Balcones Canyonlands Preserve HCP, and impacts to 35 species are permitted (Service 1996b, p. 3). However, impacts to the Jollyville Plateau salamander are not covered under this HCP.

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 22: Sylvia Spring Unit

Unit 22 consists of 103 ac (42 ha) of private, City, and Williamson County land in northern Travis County and southwestern Williamson County, Texas. The unit is centered just east of the intersection Callanish Park Drive and Westerkirk Drive. The western, extreme northeastern, and extreme southern portions of the unit are residential development. An undeveloped stream corridor crosses the unit from north to south. This unit contains two springs: Small Sylvia Spring and Spicewood Valley Park Spring, which are occupied by the Jollyville Plateau salamander. The springs are located on an unnamed tributary to Tanglewood Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 23: Tanglewood Spring Unit

Unit 23 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered north of the intersection of Spicewood Springs Road and Yaupon Drive. Spicewood Springs Road crosses the unit from southwest to east. Residential and commercial development is found in most of the unit except in a stream corridor in the central part of the unit. An undeveloped stream corridor crosses the unit from east to west. This unit contains Tanglewood Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Tanglewood Creek, a tributary to Bull Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 24: Long Hog Hollow Unit

Unit 24 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered east of the intersection of Cassia Drive and Fireoak Drive. Most of the unit is in residential development. There are wooded corridors in the central and eastern portion of the unit. This unit contains Long Hog Hollow Tributary, which is occupied by the Jollyville Plateau salamander. The spring is located on Long Hog Hollow Tributary. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 25: Tributary 3 Unit

Unit 25 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered between Bluegrass Drive and Spicebush Drive. The eastern and western part of the unit is in residential development. There are wooded corridors in the central part of the unit, and scattered woodland in the eastern and western part. There is a golf course in the north-central part of the unit. This unit contains Tributary No. 3, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek Tributary 3. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 26: Sierra Spring Unit

Unit 26 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is located west of the intersection of Tahoma Place and Ladera Vista Drive. The eastern and western part of the unit is in residential development. A wooded corridor crosses the central part of the unit from north to south. This unit contains Sierra Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on Bull Creek Tributary 3. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 27: Troll Spring Unit

Unit 27 consists of 98 ac (40 ha) of private land in northern Travis County, Texas. The unit is located west of the intersection of Jollyville Road and Taylor Draper Lane. The eastern and western part of the unit is in residential development. A wooded corridor crosses the central part of the unit from north to south. This unit contains two springs, Hearth Spring and Troll Spring, which are occupied by the Jollyville Plateau salamander. The springs are located on Bull Creek Tributary 3. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We connected the edges of the resulting circles.

Unit 28: Stillhouse Unit

Unit 28 consists of 203 ac (82 ha) of private land in northern Travis County, Texas. The unit is centered due north of the intersection of West Rim Drive and Burney Drive. The northern and southern part of the unit is in residential development. A wooded corridor crosses the central part of the unit from east to west. This unit contains seven springs: Barrow Hollow Spring, Spring 20, Stillhouse Hollow Tributary, Stillhouse Tributary, Little Stillhouse Hollow Spring, Stillhouse Hollow Spring, and Barrow Preserve Tributary. All are occupied by the Jollyville Plateau salamander. The springs are located on an unnamed tributary to Bull Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflows up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We connected the edges of the resulting circles.

Unit 29: Salamander Cave Unit

Unit 29 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered near the southern end of Raintree Place, just north of Spicewood Springs Road. Most of the unit is covered with commercial and residential development, except for a small portion of wooded area near the center. A wooded corridor crosses the central part of the unit from east to west. This unit contains Salamander Cave, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Shoal Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 30: Indian Spring Unit

Unit 30 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered just south of Greystone Drive about half way between its intersection with Edgerock Drive and Chimney Corners Drive. Most of the unit is covered with residential development except for a small wooded corridor that crosses the central part of the unit from east to west. This unit contains Indian Spring, which is occupied by the Jollyville Plateau salamander. The spring is located on an unnamed tributary to Shoal Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 31: Spicewood Spring Unit

Unit 31 consists of 68 ac (28 ha) of private land in northern Travis County, Texas. The unit is centered just northeast of the intersection of Ceberry Drive and Spicewood Springs Road, just downstream of the bridge on Ceberry Drive. Most of the unit is covered with commercial and residential development except for a small wooded corridor along the stream, which crosses the unit from north to east. This unit contains two springs, Spicewood Spring and Spicewood Tributary, which are occupied by the Jollyville Plateau salamander. The springs are located in an unnamed tributary to Shoal Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 32: Balcones District Park Spring Unit

Unit 32 consists of 68 ac (28 ha) of City of Austin and private land in northern Travis County, Texas. The unit is centered about 470 yards (430 m) northeast of the intersection of Duval Road and Amherst Drive. Most of the unit is in a city park (Balcones Community Park) with a swimming pool. A substantial amount of the park is wooded and undeveloped. There is dense commercial development in the southern and southeastern portions of the unit. This unit contains Balcones District Park Spring, which is occupied by the Jollyville Plateau salamander. The spring is located in the streambed of an unnamed tributary to Walnut Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat.

Unit 33: Tributary 4 Unit

Unit 33 consists of 159 ac (64 ha) of private and City of Austin land in northern Travis County, Texas. The unit is located west of the intersection of Spicewood Springs Road and Old Lampasas Trail in the Bull Creek Ranch community. The extreme western, northern, and eastern portions of the unit are residential development. Undeveloped stream corridors cross the unit from west to east. This unit contains three spring sites: Tributary 4 upstream, Tributary 4 downstream, and Spicewood Park Dam, which are occupied by the Jollyville Plateau salamander. The springs are located on Tributary 4 and an unnamed tributary to Bull Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed, potential for vandalism, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Georgetown Salamander

Unit 1: Cobb Unit

Unit 1 consists of 83 ac (34 ha) of private land located in northwestern Williamson County, Texas. The unit is undeveloped land. This unit contains two springs, Cobb Springs and Cobb Well, both known to be occupied by the Georgetown salamander. Cobb Springs is located on Cobb Springs Branch, and Cobb Well is located on a tributary to the stream. The unit contains the primary constituent elements essential for the conservation of the species. Cobb Springs is a surface location, and Cobb Well is a subterranean location for the species.

The unit requires special management because of the potential for groundwater pollution from future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat for Cobb Springs. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring and well, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 2: Cowen Creek Spring Unit

Unit 2 consists of 68 ac (28 ha) of private land located in west-central Williamson County, Texas. The northern portion of the unit is residential development; the remainder is undeveloped. This unit contains Cowan Creek Spring, which is occupied by the Georgetown salamander. The spring is located on Cowan Creek. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 3: Bat Well Unit

Unit 3 consists of 68 ac (28 ha) of private land located in west-central Williamson County, Texas. The western, northern, and southern portion of the unit contains residential development. This unit contains Bat Well, located in a cave and known to be occupied by the Georgetown salamander. The cave is located in the Cowan Creek watershed. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the cave. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the cave, representing the extent of the subterranean critical habitat.

Unit 4: Walnut Spring Unit

Unit 4 consists of 68 ac (28 ha) of private and Williamson County land located in west-central Williamson County, Texas. The western, eastern, and northeastern portions of the unit contain low-density residential development; the southern and north-central portions are undeveloped. The extreme southeastern corner of the unit is part of Williamson County Conservation Foundation's Twin Springs Preserve. This unit contains Walnut Spring, which is occupied by the Georgetown salamander. The spring is located on Walnut Spring Hollow. The unit contains the primary constituent elements for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 5: Twin Springs Unit

Unit 5 consists of 68 ac (28 ha) of private and Williamson County land located in west-central Williamson County, Texas. The northern portion of the unit contains low-density residential development; the remainder of the unit is undeveloped. The majority of the unit is part of Williamson County Conservation Foundation's Twin Springs Preserve. The preserve is managed by Williamson Conservation Foundation as a mitigation property for the take of golden-cheeked warbler and Bone Cave under the Williamson County Regional Habitat Conservation Plan. The preserve habitat will be undeveloped in perpetuity. Salamander populations are monitored, and there is some control of public access. This unit contains Twin Springs, which is occupied by the Georgetown salamander. The spring is located on Taylor Ray Hollow, a tributary of Lake Georgetown. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 6: Hogg Hollow Spring Unit

Unit 6 consists of 68 ac (28 ha) of private and Federal undeveloped land located in west-central Williamson County, Texas. Part of this unit is on the U.S. Army Corps of Engineers Lake Georgetown's property. There are currently no plans to develop the property. There is some control of public access. This unit contains Hogg Hollow Spring, which is occupied by the Georgetown salamander. The spring is located on Hogg Hollow, a tributary to Lake Georgetown. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 7: Cedar Hollow Spring Unit

Unit 7 consists of 68 ac (28 ha) of private land in west-central Williamson County, Texas. A secondary road crossed the extreme southern portion of the unit, and there are residences in the northwestern, southwestern, and west central portions of the unit. This unit contains Cedar Hollow Spring, which is occupied by the Georgetown salamander. The spring is located on Cedar Hollow, a tributary to Lake Georgetown. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 8: Lake Georgetown Unit

Unit 8 consists of 132 ac (53 ha) of Federal and private land in west-central Williamson County, Texas. Part of the unit is U.S. Army Corps of Engineers Lake Georgetown property. There are currently no plans to develop the property. There is some control of public access. Unpaved roads are found in the western portion of the unit, and a trail begins in the central part of the unit and leaves the northeast corner. A secondary road crosses the extreme southern portion of the unit, and there are residences in the northwestern, southwestern, and west central portions of the unit. A large quarry is located a short distance southeast of the unit. This unit two springs, Knight (Crockett Gardens) Spring and Cedar Breaks Hiking Trail Spring, which are occupied by the Georgetown salamander. The springs are located on an unnamed tributary to Lake Georgetown. A portion of the northern part of the unit extends under Lake Georgetown. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed present operations and future expansion of the quarry, and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflows up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around each of the two springs, representing the extent of the subterranean critical habitat. We joined the edges of the resulting circles.

Unit 9: Water Tank Cave Unit

Unit 9 consists of 68 ac (28 ha) of private land in west-central Williamson County, Texas. A golf course crosses the unit from northwest to southeast, and there are several roads in the eastern part of the unit. A secondary road crosses the extreme southern portion of the unit, and there are residences in the northwestern, southwestern, and west central portions of the unit. This unit contains Water Tank Cave, a subterranean location, which is occupied by the Georgetown salamander. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the subterranean cave. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the cave, representing the extent of the subterranean critical habitat.

Unit 10: Avant Spring Unit

Unit 10 consists of 68 ac (28 ha) of private land in west-central Williamson County, Texas. The northern part of a large quarry is along the southwestern edge of the unit. The rest of the unit is undeveloped. This unit contains Avant's (Capitol Aggregates) Spring, which is occupied by the Georgetown salamander. The spring is close to the streambed of the Middle Fork of the San Gabriel River. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlet and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 11: Buford Hollow Spring Unit

Unit 11 consists of 68 ac (28 ha) of Federal and private land in west-central Williamson County, Texas. The unit is located just below the spillway for Lake Georgetown. The U.S. Army Corps of Engineers owns most of this unit as part of Lake Georgetown. The D.B. Wood Road, a major thoroughfare, crosses the eastern part of the unit. The rest of the unit is undeveloped. This unit contains Buford Hollow Springs, which is occupied by the Georgetown salamander. The spring is located on Buford Hollow, a tributary to the North Fork San Gabriel River. The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 12: Swinbank Spring Unit

Unit 12 consists of 68 ac (28 ha) of City and private land in west-central Williamson County, Texas. The unit is located near River Road south of Melanie Lane. The northern part of the unit is primarily in residential development, while the southern part of this unit is primarily undeveloped. This unit contains Swinbank Spring, which is occupied by the Georgetown salamander. The spring is located just off the main channel of North Fork San Gabriel River. The unit contains the primary constituent elements essential for the conservation of the species. The population of Georgetown salamanders in the spring is being monitored monthly as part of the Williamson

County Regional HCP's efforts to conserve the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section). Although the Georgetown salamander has been given special consideration under the Williamson County Regional HCP, take is not covered for this species (Williamson County Conservation Foundation 2008, pp. 4–19). Actions authorized under the HCP for the covered species may impact the Georgetown salamander through habitat degradation (Williamson County Conservation Foundation 2008, pp. 4–19). This includes increased impervious cover and the associated decline in water quality.

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 13: Shadow Canyon Unit

Unit 13 consists of 68 ac (28 ha) of City and private land in west-central Williamson County, Texas. The unit is located just south of State Highway 29. This unit contains Shadow Canyon Spring, which is occupied by the Georgetown salamander. The spring is located on an unnamed tributary of South Fork San Gabriel River. The unit contains the essential primary constituent elements for the conservation of the species. The unit is authorized for development under the Shadow Canyon HCP. Impacts to the endangered golden-cheeked warbler (*Dendroica chrysoparia*) and Bone Cave harvestman (*Texella reyesi)* are permitted; however, impacts to Georgetown salamander are not covered under the HCP.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 14: San Gabriel Springs Unit

Unit 14 consists of 68 ac (28 ha) of City of Georgetown land in west-central Williamson County, Texas. The unit is located between North College Street and East Morrow Street, just north of the San Gabriel River in San Gabriel Park. The northern part of the unit contains some park buildings, parking lots, and other impervious surfaces, but only the subterranean aquifer that extends below these structures is included in the critical habitat unit. The southern part of the unit is primarily undeveloped. This unit contains San Gabriel Springs, which is occupied by the Georgetown salamander. Even though the species has not been collected on the surface there since 1991 (Chippindale *et al.* 2000, p. 40; Pierce 2011b, pers. comm.), it may occur on the subsurface. Therefore, we consider this unit to be currently occupied. The spring is located just off the main channel of the San Gabriel River, downstream of the confluence of the North San Gabriel and South San Gabriel rivers. A city well is located approximately 82 ft (25 m) from one of the spring outlets, and causes the spring to go dry when it is active during the summer (TPWD 2011a, p. 9). The unit contains the primary constituent elements essential for the conservation of the species.

The unit requires special management because of the potential for groundwater pollution from current and future development in the watershed and depletion of groundwater from pumping (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Salado Salamander

Unit 1: Hog Hollow Spring Unit

Unit 1 consists of 68 ac (28 ha) of private land located in southwestern Bell County, Texas. The unit is primarily undeveloped ranch land. This unit contains Hog Hollow Spring, which is occupied by the Salado salamander. The unit is located on a tributary to Rumsey Creek in the Salado Creek drainage and contains the primary constituent elements essential for the conservation of the species. The owners of the spring are interested in conserving the species, but there are currently no long-term commitments to conservation in place.

The unit requires special management because of the potential for groundwater pollution from future development in the watershed, destruction of habitat by feral hogs, future depletion of groundwater, and disturbance of habitat by livestock (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 2: Solana Spring #1 Unit

Unit 2 consists of 68 ac (28 ha) of private land located in southwestern Bell County, Texas. The unit is primarily undeveloped ranch land. This unit contains Solana Spring #1, which is occupied by the Salado salamander. The unit is located on a tributary to Rumsey Creek in the Salado Creek drainage and contains the primary constituent elements essential for the conservation of the species. The owners of the spring are interested in conserving the species, but there are currently no long-term commitments to conservation in place.

The unit requires special management because of the potential for groundwater pollution from future development in the watershed, destruction of habitat by feral hogs, future depletion of groundwater, and disturbance of habitat by livestock (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 3: Cistern Spring Unit

Unit 3 consists of 68 ac (28 ha) of private land located in southwestern Bell County, Texas, on the same private ranch as Units 1 and 2 for the Salado salamander. The unit is primarily undeveloped ranch land. This unit contains Cistern Spring, which is occupied by the Salado salamander. The unit is located on a tributary to Rumsey Creek in the Salado Creek drainage and contains the primary constituent elements essential for the conservation of the species. The owners of the spring are interested in conserving the species, but there are currently no long-term commitments to conservation in place.

The unit requires special management because of the potential for groundwater pollution from future development in the watershed, destruction of habitat by feral hogs, future depletion of groundwater, and disturbance of habitat by livestock (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around the spring, representing the extent of the subterranean critical habitat.

Unit 4: IH–35 Unit

Unit 4 consists of 168 ac (68 ha) of private, State, and City of Salado land located in southwestern Bell County, Texas, in the southern part of the Village of Salado. The unit extends along Salado Creek on both sides of Interstate Highway 35 (IH 35). The IH 35 right of way crosses Salado Creek and is owned by the Texas Department of Transportation. The unit is a mixture of residential and commercial properties on its eastern portion, with some undeveloped ranch land in the western part west of IH 35. This unit contains four springs, all located on private property: Robertson Spring, Big Boiling Spring, Lil' Bubbly Spring, and Lazy Days Fish Farm, all known to be occupied by the Salado salamander.

There has been some recent modification to the spring habitat within this unit. In the fall of 2011, the outflow channels and edges of Big Boiling and Lil' Bubbly Spring were reconstructed with large limestone blocks and mortar. In addition, in response to other activity in the area, the U.S. Army Corps of Engineers issued a cease and desist order to the Salado Chamber of Commerce in October 2011, for unauthorized discharge of dredged or fill material that occurred in this area (Brooks 2011, U.S. Corps of Engineers, pers. comm.). This order was issued in relation to the need for a section 404 permit under the Clean Water Act. A citation from a TPWD game warden was also issued in October 2011, due to the need for a sand and gravel permit from the TPWD for work being conducted within TPWD jurisdiction (Heger 2012a, pers. comm.). The citation was issued because the Salado Chamber of Commerce had been directed by the game warden to stop work within TPWD's jurisdiction, which the Salado Chamber of Commerce did temporarily, but work started again in spite of the game warden's directive (Heger 2012a, pers. comm.). A sand and gravel permit was obtained on March 21, 2012. The spring run modifications were already completed by this date, but further modifications in the springs were prohibited by the permit. Additional work on the bank upstream of the springs was permitted and completed (Heger 2012b, pers. comm.).

The unit requires special management to protect it from illegal dumping within the stream channel, surface runoff from nearby roads and other development, the potential for groundwater pollution from future development in the watershed, future depletion of groundwater, and habitat disturbance from livestock and feral hogs (see *Special Management Considerations or Protection* section).

The proposed designation includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat. The unit was further delineated by drawing a circle with a radius of 984 ft (300 m) around each of the four springs, representing the extent of the subterranean critical habitat. We then joined the edges of the resulting circles.

Effects of Critical Habitat Designation

Section 7 Consultation

Section 7(a)(2) of the Act requires Federal agencies, including the Service, to ensure that any action they fund, authorize, or carry out is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of designated critical habitat of such species. In addition, section 7(a)(4) of the Act requires Federal agencies to confer with the Service on any agency action which is likely to jeopardize the continued existence of any species proposed to be listed under the Act or result in the destruction or adverse modification of proposed critical habitat.

Decisions by the 5th and 9th Circuit Courts of Appeals have invalidated our regulatory definition of ''destruction or adverse modification'' (50 CFR 402.02) (see *Gifford Pinchot Task Force* v. *U.S. Fish and Wildlife Service,* 378 F. 3d 1059 (9th Cir. 2004) and *Sierra Club* v. *U.S. Fish and Wildlife Service et al.,* 245 F.3d 434, 442 (5th Cir. 2001)), and we do not rely on this regulatory definition when analyzing whether an action is likely to destroy or adversely modify critical habitat. Under the statutory provisions of the Act, we determine destruction or adverse modification on the basis of whether, with implementation of the proposed Federal action, the affected critical habitat would continue to serve its intended conservation role for the species.

If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency (action agency) must enter into consultation with us. Examples of actions that are subject to the section 7 consultation process are actions on State, tribal, local, or private lands that require a Federal permit (such as a permit from the U.S. Army Corps of Engineers under section 404 of the Clean Water Act (33 U.S.C. 1251 *et seq.*) or a permit from the Service under section 10 of the Act) or that involve some other Federal action (such as funding from the Federal Highway Administration, Federal Aviation Administration, or the Federal Emergency Management Agency). Federal actions not affecting listed species or critical habitat, and actions on State, tribal, local, or private lands that are not federally funded or authorized, do not require section 7 consultation.

As a result of section 7 consultation, we document compliance with the requirements of section 7(a)(2) through our issuance of:

(1) A concurrence letter for Federal actions that may affect, but are not likely to adversely affect, listed species or critical habitat; or

(2) A biological opinion for Federal actions that may affect, or are likely to adversely affect, listed species or critical habitat.

When we issue a biological opinion concluding that a project is likely to jeopardize the continued existence of a listed species and destroy or adversely modify critical habitat, we provide reasonable and prudent alternatives to the project, if any are identifiable, that would avoid the likelihood of jeopardy and destruction or adverse modification of critical habitat. We define ''reasonable and prudent alternatives'' (at 50 CFR 402.02) as alternative actions identified during consultation that:

(1) Can be implemented in a manner consistent with the intended purpose of the action,

(2) Can be implemented consistent with the scope of the Federal agency's legal authority and jurisdiction,

(3) Are economically and technologically feasible, and

(4) Would, in the Director's opinion, avoid the likelihood of jeopardizing the continued existence of the listed species and avoid the likelihood of destroying or adversely modifying critical habitat.

Reasonable and prudent alternatives can vary from slight project modifications to extensive redesign or relocation of the project. Costs associated with implementing a reasonable and prudent alternative are similarly variable.

Regulations at 50 CFR 402.16 require Federal agencies to reinitiate consultation on previously reviewed actions in instances where we have listed a new species or subsequently designated critical habitat that may be affected and the Federal agency has retained discretionary involvement or control over the action (or the agency's discretionary involvement or control is authorized by law). Consequently, Federal agencies sometimes may need to request reinitiation of consultation with us on actions for which formal consultation has been completed, if those actions with discretionary involvement or control may affect subsequently listed species or designated critical habitat.

Application of the ''Adverse Modification'' Standard

The key factor related to the adverse modification determination is whether, with implementation of the proposed Federal action, the affected critical habitat would continue to serve its intended conservation role for the species. Activities that may destroy or adversely modify critical habitat are those that alter the physical or biological features to an extent that appreciably reduces the conservation value of critical habitat for the four salamander species. As discussed above, the role of critical habitat is to support life-history needs of the species and provide for the conservation of the species.

Section 4(b)(8) of the Act requires us to briefly evaluate and describe, in any proposed or final regulation that designates critical habitat, activities involving a Federal action that may destroy or adversely modify such habitat, or that may be affected by such designation.

Activities that may affect critical habitat, when carried out, funded, or authorized by a Federal agency, should result in consultation for the four salamander species. These activities include, but are not limited to:

(1) Actions that would physically disturb the spring habitat upon which these four Texas salamander species depend. Such activities could include, but are not limited to, channelization and other activities that result in the physical destruction of habitat or the modification of habitat so that it is not suitable for the species.

(2) Actions that would increase the concentration of silt in the surface or subsurface habitat. Such activities could include, but are not limited to, increases in impervious cover in the surface watershed, improper erosion controls on the surface and subsurface watersheds, release of pollutants into the surface water or connected groundwater at a point source or by dispersed release (non-point source). These activities could alter water conditions to levels that are beyond the tolerances of the four Texas salamander species and result in direct or cumulative adverse effects to these individuals and their life cycles.

(3) Actions that would deplete the aquifer to an extent that decreases or stops the flow of occupied springs or that reduce the quantity of subterranean habitat used by the species. Such activities could include, but are not limited to, excessive water withdrawals from aquifers and channelization or other modification of recharge features that would decrease recharge. These activities could dewater habitat or cause reduced water quality to levels that are beyond the tolerances of the four Texas salamanders and result in direct or cumulative adverse effects to these individuals and their life cycles.

Exemptions

Application of Section 4(a)(3) of the Act

The Sikes Act Improvement Act of 1997 (Sikes Act) (16 U.S.C. 670a) required each military installation that includes land and water suitable for the conservation and management of natural resources to complete an integrated natural resources management plan (INRMP) by November 17, 2001. An INRMP integrates implementation of the military mission of the installation with stewardship of the natural resources found on the base. Each INRMP includes:

(1) An assessment of the ecological needs on the installation, including the need to provide for the conservation of listed species;

(2) A statement of goals and priorities;

(3) A detailed description of management actions to be implemented to provide for these ecological needs; and

(4) A monitoring and adaptive management plan.

Among other things, each INRMP must, to the extent appropriate and applicable, provide for fish and wildlife management; fish and wildlife habitat enhancement or modification; wetland protection, enhancement, and restoration where necessary to support fish and wildlife; and enforcement of applicable natural resource laws.

The National Defense Authorization Act for Fiscal Year 2004 (Pub. L. 108–136) amended the Act to limit areas eligible for designation as critical habitat. Specifically, section 4(a)(3)(B)(i) of the Act (16 U.S.C. 1533(a)(3)(B)(i)) now provides: ''The Secretary shall not designate as critical habitat any lands or other geographic areas owned or controlled by the Department of Defense, or designated for its use, that are subject to an integrated natural resources management plan prepared under section 101 of the Sikes Act (16 U.S.C. 670a), if the Secretary determines in writing that such plan provides a benefit to the species for which critical habitat is proposed for designation.''

There are no Department of Defense lands within the proposed critical habitat designation.

Exclusions

Application of Section 4(b)(2) of the Act

Section 4(b)(2) of the Act states that the Secretary shall designate and make revisions to critical habitat on the basis of the best available scientific data after taking into consideration the economic impact, national security impact, and any other relevant impact of specifying any particular area as critical habitat. The Secretary may exclude an area from critical habitat if he determines that the benefits of such exclusion outweigh the benefits of specifying such area as part of the critical habitat, unless he determines, based on the best scientific data available, that the failure to designate such area as critical habitat will result in the extinction of the species. In making that determination, the statute on its face, as well as the legislative history are clear that the Secretary has broad discretion regarding which factor(s) to use and how much weight to give to any factor.

In considering whether to exclude a particular area from the designation, we identify the benefits of including the area in the designation, identify the benefits of excluding the area from the designation, and evaluate whether the benefits of exclusion outweigh the benefits of inclusion. If the analysis indicates that the benefits of exclusion outweigh the benefits of inclusion, the Secretary may exercise his discretion to exclude the area only if such exclusion would not result in the extinction of the species.

When identifying the benefits of inclusion for an area, we consider the additional regulatory benefits that area would receive from the protection from adverse modification or destruction as a result of actions with a Federal nexus; the educational benefits of mapping essential habitat for recovery of the listed species; and any benefits that may result from a designation due to State or Federal laws that may apply to critical habitat.

When identifying the benefits of exclusion, we consider, among other things, whether exclusion of a specific area is likely to result in conservation; the continuation, strengthening, or encouragement of partnerships; or implementation of a management plan that provides equal to or more conservation than a critical habitat designation would provide.

In the case of the four central Texas salamanders, the benefits of critical habitat include public awareness of Austin blind salamander, Georgetown salamander, Jollyville Plateau salamander, and Salado salamander presence and the importance of habitat protection, and in cases where a Federal nexus exists, increased habitat protection for Austin blind salamander, Georgetown salamander, Jollyville Plateau salamander, and Salado salamander due to the protection from adverse modification or destruction of critical habitat.

When we evaluate the existence of a conservation plan when considering the benefits of exclusion, we consider a variety of factors, including but not limited to, whether the plan is finalized; how it provides for the conservation of the essential physical or biological features; whether there is a reasonable expectation that the conservation management strategies and actions contained in a management plan will be implemented into the future; whether the conservation strategies in the plan are likely to be effective; and whether the plan contains a monitoring program or adaptive management to ensure that the conservation measures are effective and can be adapted in the future in response to new information.

After identifying the benefits of inclusion and the benefits of exclusion, we carefully weigh the two sides to evaluate whether the benefits of exclusion outweigh those of inclusion. If our analysis indicates that the benefits of exclusion outweigh the benefits of inclusion, we then determine whether exclusion would result in extinction. If exclusion of an area from critical habitat will result in extinction, we will not exclude it from the designation.

Based on the information that will be provided by entities seeking exclusion, as well as any additional public comments we receive during the open public comment period (see **DATES**), we will evaluate whether certain lands in the proposed critical habitat for Jollyville Plateau salamander in the Bull Creek 3 Unit (Unit 19 for the Jollyville Plateau salamander) are appropriate for exclusion from the final designation under section 4(b)(2) of the Act. If the analysis indicates that the benefits of excluding lands from the final designation outweigh the benefits of designating those lands as critical habitat, then the Secretary may exercise his discretion to exclude the lands from the final designation.

After considering the following areas under section 4(b)(2) of the Act, we are proposing to exclude them from the critical habitat designation for Jollyville Plateau salamander.

TABLE 11—AREAS CONSIDERED FOR EXCLUSION BY CRITICAL HABITAT UNIT FOR THE JOLLYVILLE PLATEAU SALAMANDER

Unit	Specific area	Areas meeting the definition of critical habitat, in acres (hectares)	Areas considered for possible exclusion, in acres (hectares)
Unit 19: Bull Creek 3 Unit	Four Points HCP	254 ac (103 ha)	152 ac (62 ha).

We are considering these areas for exclusion, because we believe that:

(1) Their value for conservation will be preserved for the foreseeable future by existing protective actions, or

(2) They are appropriate for exclusion under the ''other relevant factor'' provisions of section 4(b)(2) of the Act.

However, we specifically solicit comments on the inclusion or exclusion of such areas. In the paragraphs below, we provide a detailed analysis of our exclusion of these lands under section 4(b)(2) of the Act.

Exclusions Based on Economic Impacts

Under section 4(b)(2) of the Act, we consider the economic impacts of specifying any particular area as critical habitat. In order to consider economic impacts, we are preparing an analysis of the economic impacts of the proposed critical habitat designation and related factors.

Sectors that may be affected by the proposed designation include private developers of residential and commercial property; city, county, and State governments that construct and maintain roads and other infrastructure; and entities that pump water from the aquifers.

We will announce the availability of the draft economic analysis as soon as it is completed, at which time we will seek public review and comment. At that time, copies of the draft economic analysis will be available for downloading from the Internet at *http://www.regulations.gov,* or by contacting the Austin Ecological Services Field Office directly (see **FOR FURTHER INFORMATION CONTACT**). During the development of a final designation, we will consider economic impacts, public comments, and other new information, and areas may be excluded from the final critical habitat designation under section 4(b)(2) of the Act and our implementing regulations at 50 CFR 424.19.

Exclusions Based on National Security Impacts

Under section 4(b)(2) of the Act, we consider whether there are lands owned or managed by the Department of Defense (DOD) where a national security impact might exist. In preparing this proposal, we have determined that the lands within the proposed designation of critical habitat for Austin blind salamander, Georgetown salamander, Jollyville Plateau salamander, and Salado salamander are not owned or managed by the Department of Defense, and, therefore, we anticipate no impact on national security. Consequently, the Secretary does not propose to exercise his discretion to exclude any areas from the final designation based on impacts on national security.

Exclusions Based on Other Relevant Impacts

Under section 4(b)(2) of the Act, we consider any other relevant impacts, in addition to economic impacts and impacts on national security. We consider a number of factors including whether the landowners have developed any HCPs or other management plans for the area, or whether there are conservation partnerships that would be encouraged by designation of, or exclusion from, critical habitat. In addition, we look at any tribal issues, and consider the government-to-government relationship of the United States with tribal entities. We also consider any social impacts that might occur because of the designation.

Land and Resource Management Plans, Conservation Plans, or Agreements Based on Conservation Partnerships

We consider a current land management or conservation plan (HCPs as well as other types) to provide adequate management or protection if it meets the following criteria:

(1) The plan is complete and provides the same or better level of protection from adverse modification or destruction than that provided through a consultation under section 7 of the Act;

(2) There is a reasonable expectation that the conservation management strategies and actions will be implemented for the foreseeable future, based on past practices, written guidance, or regulations; and

(3) The plan provides conservation strategies and measures consistent with currently accepted principles of conservation biology.

We believe that the Four Points HCP fulfills the above criteria, and are considering the exclusion of non-Federal lands covered by this plan that provide for the conservation of Jollyville Plateau salamander. We are requesting comments on the benefit to Jollyville Plateau salamander from this HCP.

Four Points Habitat Conservation Plan

The Permittee (TPG Four Points Land, L.P.) is authorized to ''take'' (kill, harm, or harass) the golden-cheeked warbler, black-capped vireo, Tooth Cave ground beetle, Bone Cave harvestman, Bee Creek Cave harvestman, Tooth Cave pseudoscorpion (*Tartarocreagris texana*), Tooth Cave spider (*Tayshaneta myopica*), Kretschmarr Cave mold beetle (*Texamaurops reddelli*), and the Coffin Cave mold beetle (*Batrisodes texanus*) at a known location (the 333-ac (135-ha) Four Points Property, located approximately 11 mi (18 km) northwest of Austin near the intersection of RM 2222 and RM 620, Travis County, Texas), of habitat for these species, incidental to activities necessary for the construction of mixed use real estate development projects and attendant utilities as described in the original Permittee's (P–WB Joint Venture) application and habitat conservation plan. The HCP also covers the Jollyville Plateau salamander as if it were a listed species, meaning that impacts to this salamander species from construction activites described in the permit are permitted.

The HCP requires avoidance of direct impacts to warblers by not conducting clearing or construction in occupied golden-cheeked warbler habitat and by initiating clearing and construction only during times of year when birds are not present. Approximately 52 ac (21 ha) that contains six caves (Owl Eyes, Japygid, Eluvial, Fernpit, M.W.A., and Jollyville) known to be inhabited by Tooth Cave ground beetle and the Bone Cave harvestman have been permanently preserved.

Protection of this area is also expected to contribute to the maintenance of water quality, and, therefore, the quality of salamander habitat at resurgence springs (Spring No. 12, Spring No. 22, and Spring No. 24) down-gradient of the preserve area. In addition, runoff from multi-family residential areas and the hotel will be routed to avoid drainages which contain springs known to support Jollyville Plateau salamanders.

In addition to the karst preserve, another approximately 135 ac (54 ha) of the property was permanently set aside and maintained as a golden-cheeked warbler preserve.

All preserve areas will be permanently fenced and posted to preclude public access, and red imported fire ants (*Solenopsis invicta*) will be controlled in the karst preserves. Fire ants are a pervasive, nonnative ant species originally introduced to the United States from South America over 50 years ago and are an aggressive predator and competitor that has spread across the southern United States. They often replace native species, and evidence shows that overall arthropod diversity, as well as species richness and abundance, decreases in infested areas. Fire ants are spread by activities that accompany urbanization and that result in soil disturbance and disruption to native ant communities. As such, fire ants will be controlled by limiting these types of activities. No pesticides or herbicides will be used within preserve areas, and any pesticides or herbicides used within developed areas will be used according to the EPA label instructions.

Peer Review

In accordance with our joint policy on peer review published in the **Federal Register** on July 1, 1994 (59 FR 34270), we will seek the expert opinions of at least three appropriate and independent specialists regarding this proposed rule. The purpose of peer review is to ensure that our listing determination and critical habitat designation are based on scientifically sound data, assumptions, and analyses. We have invited these peer reviewers to comment during this public comment period on our specific assumptions and conclusions in this proposed listing and designation of critical habitat.

We will consider all comments and information we receive during this comment period on this proposed rule during our preparation of a final determination. Accordingly, the final decision may differ from this proposal.

Public Hearings

Section 4(b)(5) of the Act provides for one or more public hearings on this proposal, if requested. Requests must be received within 45 days after the date of publication of this proposed rule in the **Federal Register**. Such requests must be sent to the address shown in the **FOR FURTHER INFORMATION CONTACT** section. We will schedule public hearings on this proposal, if any are requested, and announce the dates, times, and places of those hearings, as well as how to obtain reasonable accommodations, in the **Federal Register** and local newspapers at least 15 days before the hearing.

Required Determinations

Regulatory Planning and Review—Executive Order 12866

Executive Order 12866 provides that the Office of Information and Regulatory Affairs (OIRA) will review all significant rules. The Office of Information and Regulatory Affairs has determined that this rule is not significant.

Executive Order 13563 reaffirms the principles of E.O. 12866 while calling for inprovements in the nation's regulatory system to promote predictability, to reduce uncertainty, and to use the best, most innovative, and least burdensome tools for achieving regulatory ends. The executive order directs agencies to consider regulatory approaches that reduce burdens and maintain flexibility and freedom of choice for the public where these approaches are relevant, feasible, and consistent with regulatory objectives. E.O. 13563 emphasizes further that regulations must be based on the best available science and that the rulemaking process must allow for public participation and an open exchange of ideas. We have developed this rule in a manner consistent with these requirements.

Regulatory Flexibility Act (5 U.S.C. 601 et seq.)

Under the Regulatory Flexibility Act (RFA; 5 U.S.C. 601 *et seq.*) as amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA; 5 U.S.C. 801 *et seq.*), whenever an agency is required to publish a notice of rulemaking for any proposed or final rule, it must prepare and make available for public comment a regulatory flexibility analysis that describes the effects of the rule on small entities (small businesses, small organizations, and small government jurisdictions). However, no regulatory flexibility analysis is required if the head of the agency certifies the rule will not have a significant economic impact on a substantial number of small entities. The SBREFA amended the RFA to require Federal agencies to provide a certification statement of the factual basis for certifying that the rule will not have a significant economic impact on a substantial number of small entities.

According to the Small Business Administration, small entities include small organizations such as independent nonprofit organizations; small governmental jurisdictions, including school boards and city and town governments that serve fewer than 50,000 residents; and small businesses (13 CFR 121.201). Small businesses include such businesses as manufacturing and mining concerns with fewer than 500 employees, wholesale trade entities with fewer than 100 employees, retail and service businesses with less than $5 million in annual sales, general and heavy construction businesses with less than $27.5 million in annual business, special trade contractors doing less than $11.5 million in annual business, and forestry and logging operations with fewer than 500 employees and annual business less than $7 million. To determine whether small entities may be affected, we will consider the types of activities that might trigger regulatory impacts under this designation as well as types of project modifications that may result. In general, the term ''significant economic impact'' is meant to apply to a typical small business firm's business operations.

Importantly, the incremental impacts of a rule must be both significant and substantial to prevent certification of the rule under the RFA and to require the preparation of an initial regulatory flexibility analysis. If a substantial number of small entities are affected by the proposed critical habitat designation, but the per-entity economic impact is not significant, the Service may certify. Likewise, if the per-entity economic impact is likely to be significant, but the number of affected entities is not substantial, the Service may also certify.

Under the RFA, as amended, and following recent court decisions, Federal agencies are only required to evaluate the potential incremental impacts of rulemaking on those entities directly regulated by the rulemaking itself, and not the potential impacts to indirectly affected entities. The regulatory mechanism through which critical habitat protections are realized is section 7 of the Act, which requires Federal agencies, in consultation with the Service, to ensure that any action authorized, funded, or carried by the Agency is not likely to adversely modify critical habitat. Therefore, only Federal action agencies are directly subject to the specific regulatory requirement (avoiding destruction and adverse modification) imposed by critical habitat designation. Under these circumstances, it is our position that only Federal action agencies will be directly regulated by this designation. Therefore, because Federal agencies are not small entities, the Service may certify that the proposed critical habitat rule will not have a significant economic impact on a substantial number of small entities.

We acknowledge, however, that in some cases, third-party proponents of the action subject to permitting or funding may participate in a section 7 consultation, and thus may be indirectly affected. We believe it is good policy to assess these impacts if we have sufficient data before us to complete the necessary analysis, whether or not this analysis is strictly required by the RFA. While this regulation does not directly regulate these entities, in our draft economic analysis we will conduct a brief evaluation of the potential number of third parties participating in consultations on an annual basis in order to ensure a more complete examination of the incremental effects of this proposed rule in the context of the RFA.

In conclusion, we believe that, based on our interpretation of directly regulated entities under the RFA and relevant case law, this designation of critical habitat will only directly regulate Federal agencies which are not by definition small business entities. And as such, certify that, if promulgated, this designation of critical habitat would not have a significant economic impact on a substantial number of small business entities. Therefore, an initial regulatory flexibility analysis is not required. However, though not necessarily required by the RFA, in our draft economic analysis for this proposal we will consider and evaluate the potential effects to third parties that may be involved with consultations with Federal action agencies related to this action.

Energy Supply, Distribution, or Use—Executive Order 13211

Executive Order 13211 (Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use) requires agencies to prepare Statements of Energy Effects when undertaking certain actions.

We do not expect the designation of this proposed critical habitat to significantly affect energy supplies, distribution, or use, because the majority of the lands we are proposing as critical habitat are privately owned, and do not have energy production or distribution. Therefore, this action is not a significant energy action, and no Statement of Energy Effects is required. However, we will further evaluate this issue as we conduct our economic analysis, and review and revise this assessment as warranted.

Unfunded Mandates Reform Act (2 U.S.C. 1501 et seq.)

In accordance with the Unfunded Mandates Reform Act (2 U.S.C. 1501 *et seq.*), we make the following findings:

(1) This rule would not produce a Federal mandate. In general, a Federal mandate is a provision in legislation, statute, or regulation that would impose an enforceable duty upon State, local, or tribal governments, or the private sector, and includes both ''Federal intergovernmental mandates'' and ''Federal private sector mandates.'' These terms are defined in 2 U.S.C. 658(5)–(7). ''Federal intergovernmental mandate'' includes a regulation that ''would impose an enforceable duty upon State, local, or tribal governments'' with two exceptions. It excludes ''a condition of Federal assistance.'' It also excludes ''a duty arising from participation in a voluntary Federal program,'' unless the regulation ''relates to a then-existing Federal program under which $500,000,000 or more is provided annually to State, local, and tribal governments under entitlement authority,'' if the provision would ''increase the stringency of conditions of assistance'' or ''place caps upon, or otherwise decrease, the Federal Government's responsibility to provide funding,'' and the State, local, or tribal governments ''lack authority'' to adjust accordingly. At the time of enactment, these entitlement programs were: Medicaid; Aid to Families with Dependent Children work programs; Child Nutrition; Food Stamps; Social Services Block Grants; Vocational Rehabilitation State Grants; Foster Care, Adoption Assistance, and Independent Living; Family Support Welfare Services; and Child Support

Enforcement. ''Federal private sector mandate'' includes a regulation that ''would impose an enforceable duty upon the private sector, except (i) a condition of Federal assistance or (ii) a duty arising from participation in a voluntary Federal program.''

The designation of critical habitat does not impose a legally binding duty on non-Federal Government entities or private parties. Under the Act, the only regulatory effect is that Federal agencies must ensure that their actions do not destroy or adversely modify critical habitat under section 7. While non-Federal entities that receive Federal funding, assistance, or permits, or that otherwise require approval or authorization from a Federal agency for an action, may be indirectly impacted by the designation of critical habitat, the legally binding duty to avoid destruction or adverse modification of critical habitat rests squarely on the Federal agency. Furthermore, to the extent that non-Federal entities are indirectly impacted because they receive Federal assistance or participate in a voluntary Federal aid program, the Unfunded Mandates Reform Act would not apply, nor would critical habitat shift the costs of the large entitlement programs listed above onto State governments.

(2) We do not believe that this rule would significantly or uniquely affect small governments because the proposed areas that cover small government jurisdictions are small, and there is little potential that the proposal would impose significant additional costs above those associated with the proposed listing of the species. Therefore, a Small Government Agency Plan is not required. However, we will further evaluate this issue as we conduct our economic analysis, and review and revise this assessment if appropriate.

Takings—Executive Order 12630

In accordance with Executive Order 12630 (Government Actions and Interference with Constitutionally Protected Private Property Rights), we will analyze the potential takings implications of designating critical habitat for the Austin blind salamander, Georgetown salamander, Jollyville Plateau salamander, and Salado salamander in a takings implications assessment. Following publication of this proposed rule, a draft economic analysis will be completed for the proposed designation. The draft economic analysis will provide the foundation for us to use in preparing a takings implications assessment.

Federalism—Executive Order 13132

In accordance with Executive Order 13132 (Federalism), this proposed rule does not have significant Federalism effects. A Federalism assessment is not required. In keeping with Department of the Interior and Department of Commerce policy, we requested information from, and coordinated development of, this proposed critical habitat designation with appropriate State resource agencies in Texas. The designation of critical habitat in areas currently occupied by the Austin blind salamander, Georgetown salamander, Jollyville Plateau salamander, and Salado salamander may impose nominal additional regulatory restrictions to those currently in place and, therefore, may have little incremental impact on State and local governments and their activities. The designation may have some benefit to these governments because the areas that contain the physical or biological features essential to the conservation of the species are more clearly defined, and the elements of the features of the habitat necessary to the conservation of the species are specifically identified. This information does not alter where and what federally sponsored activities may occur. However, it may assist local governments in long-range planning (rather than having them wait for case-by-case section 7 consultations to occur).

Where State and local governments require approval or authorization from a Federal agency for actions that may affect critical habitat, consultation under section 7(a)(2) would be required. While non-Federal entities that receive Federal funding, assistance, or permits, or that otherwise require approval or authorization from a Federal agency for an action may be indirectly impacted by the designation of critical habitat, the legally binding duty to avoid destruction or adverse modification of critical habitat rests squarely on the Federal agency.

Civil Justice Reform—Executive Order 12988

In accordance with Executive Order 12988 (Civil Justice Reform), the Office of the Solicitor has determined that the rule does not unduly burden the judicial system and that it meets the requirements of sections 3(a) and 3(b)(2) of the Order. We have proposed designating critical habitat in accordance with the provisions of the Act. This proposed rule uses standard property descriptions and identifies the elements of physical or biological features essential to the conservation of the Austin blind salamander, Georgetown salamander, Jollyville Plateau salamander, and Salado salamander within the designated areas to assist the public in understanding the habitat needs of the species.

Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.)

This rule does not contain any new collections of information that require approval by the Office of Management and Budget under the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*). This rule will not impose recordkeeping or reporting requirements on State or local governments, individuals, businesses, or organizations. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

National Environmental Policy Act (42 U.S.C. 4321 et seq.)

It is our position that, outside the jurisdiction of the U.S. Court of Appeals for the Tenth Circuit, we do not need to prepare environmental analyses pursuant to the National Environmental Policy Act (NEPA; 42 U.S.C. 4321 *et seq.*) in connection with designating critical habitat under the Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244). This position was upheld by the U.S. Court of Appeals for the Ninth Circuit (*Douglas County* v. *Babbitt,* 48 F.3d 1495 (9th Cir. 1995), cert. denied 516 U.S. 1042 (1996)). The proposed designation of critical habitat for the four Texas salamanders is entirely within the 5th Circuit jurisdiction; therefore, we do not intend to prepare an environmental analysis in connection with this proposed critical habitat designation.

Clarity of the Rule

We are required by Executive Orders 12866 and 12988 and by the Presidential Memorandum of June 1, 1998, to write all rules in plain language. This means that each rule we publish must:

(1) Be logically organized;

(2) Use the active voice to address readers directly;

(3) Use clear language rather than jargon;

(4) Be divided into short sections and sentences; and

(5) Use lists and tables wherever possible.

If you feel that we have not met these requirements, send us comments by one of the methods listed in the **ADDRESSES** section. To better help us revise the rule, your comments should be as specific as possible. For example, you should tell us the numbers of the sections or paragraphs that are unclearly written, which sections or sentences are too long, the sections where you feel lists or tables would be useful, etc.

Government-to-Government Relationship With Tribes

In accordance with the President's memorandum of April 29, 1994 (Government-to-Government Relations with Native American Tribal Governments; 59 FR 22951), Executive Order 13175 (Consultation and Coordination With Indian Tribal Governments), and the Department of the Interior's manual at 512 DM 2, we readily acknowledge our responsibility to communicate meaningfully with recognized Federal Tribes on a government-to-government basis. In accordance with Secretarial Order 3206 of June 5, 1997 (American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act), we readily acknowledge our responsibilities to work directly with tribes in developing programs for healthy ecosystems, to acknowledge that tribal lands are not subject to the same controls as Federal public lands, to remain sensitive to Indian culture, and to make information available to tribes.

We determined that there are no Tribal lands that are occupied by the four central Texas salamanders. Therefore, we are not proposing to designate critical habitat for the salamander species on Tribal lands.

References Cited

A complete list of references cited in this rulemaking is available on the Internet at *http://www.regulations.gov* and upon request from the Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Authors

The primary authors of this package are the staff members of the Austin Ecological Services Field Office, Arlington Ecological Services Field Office, and the Texas Fish and Wildlife Conservation Office.

List of Subjects in 50 CFR Part 17

Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, Transportation.

Proposed Regulation Promulgation

Accordingly, we propose to amend part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, as set forth below:

PART 17—[AMENDED]

1. The authority citation for part 17 continues to read as follows:

Authority: 16 U.S.C. 1361–1407; 16 U.S.C. 1531–1544; 16 U.S.C. 4201–4245; Pub. L. 99–625, 100 Stat. 3500; unless otherwise noted.

2. Amend § 17.11(h) by adding entries for ''Salamander, Austin blind'', ''Salamander, Georgetown'', ''Salamander, Jollyville Plateau'', and ''Salamander, Salado'' in alphabetical order under AMPHIBIANS to the List of Endangered and Threatened Wildlife to read as follows:

§ 17.11 Endangered and threatened wildlife.

* * * * *

(h) * * *

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
*	*	*	*	*	*		*
AMPHIBIANS							
*	*	*	*	*	*		*
Salamander, Austin blind.	*Eurycea waterlooensis*.	U.S.A. (TX)	Entire	E	....	17.95(d)	NA
*	*	*	*	*	*		*
Salamander, Georgetown.	*Eurycea naufragia*	U.S.A. (TX)	Entire	E	....	17.95(d)	NA
Salamander, Jollyville Plateau.	*Eurycea tonkawae*	U.S.A. (TX)	Entire	E	....	17.95(d)	NA
*	*	*	*	*	*		*
Salamander, Salado.	*Eurycea chisholmensis*.	U.S.A. (TX)	Entire	E	....	17.95(d)	NA
*	*	*	*	*	*		*

3. Amend § 17.95(d) by adding entries for ''Austin Blind Salamander (*Eurycea waterlooensis*),'' ''Georgetown Salamander (*Eurycea naufragia*)'', ''Jollyville Plateau Salamander (*Eurycea* tonkawae)'', and ''Salado Salamander (*Eurycea chisholmensis*)'', in the same alphabetical order in which the species appear in the table at § 17.11(h), to read as follows:

§ 17.95 Critical habitat—fish and wildlife.

* * * * *

(d) *Amphibians.*

* * * * *

Austin Blind Salamander (*Eurycea waterlooensis*)

(1) The critical habitat unit is depicted for Travis County, Texas, on the map below.

(2) Within this area, the primary constituent elements of the physical or biological features essential to the conservation of Austin blind salamander consist of four components:

(i) *Water from the Barton Springs Segment of the Edwards Aquifer.* The groundwater must be similar to natural aquifer conditions both underground and as it discharges from natural spring outlets. Concentrations of water quality constituents that could have a negative impact on the salamander are below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Austin blind salamander prey base). Hydrologic regimes similar to the historical pattern of the specific sites are present, with at least temporal surface flow for spring sites and continuous flow for subterranean sites. The water chemistry must be similar to natural aquifer conditions, with temperatures between 67.8 and 72.3 °F (19.9 and 22.4 °C), dissolved oxygen concentrations between 5 and 7 milligrams per liter, and specific water conductance between 605 and 740 microsiemens per centimeter.

(ii) *Rocky substrate with interstitial spaces.* Rocks (boulders, cobble, or gravel) in the substrate of the salamander's surface aquatic habitat must be large enough to provide salamanders with cover, shelter, and foraging habitat. The substrate and interstitial spaces should have minimal sedimentation.

(iii) *Aquatic invertebrates for food.* The spring and cave environments must be capable of supporting a diverse aquatic invertebrate community that includes crustaceans and insects.

(iv) *Subterranean aquifer.* During periods of drought or dewatering on the surface in and around spring sites, access to the subsurface water table must be provided for shelter and protection.

(3) Surface critical habitat includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat, but does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule; however, the subterranean aquifer may extend below such structures. The subterranean critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs.

(4) *Critical habitat map units.* Data layers defining map units were created using a geographic information system (GIS), which included species locations, roads, property boundaries, 2011 aerial photography, and USGS 7.5′ quadrangles. Points were placed on the GIS. We delineated critical habitat unit boundaries by starting with the cave or spring point locations that are occupied by the salamanders. From these cave or springs points, we delineated a 984-ft (300-m) buffer to create the polygons that capture the extent to which we believe the salamander populations exist through underground conduits. The polygons were then simplified to reduce the number of vertices, but still retain the overall shape and extent. Subsequently, polygons that were within 98 ft (30 m) of each other were merged together. Each new merged polygon was then revised to remove extraneous divits or protrusions that resulted from the merge process. The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which each map is based are available to the public at the field office Internet site (*http://www.fws.gov/southwest/es/AustinTexas/*), *http://www.regulations.gov* at Docket No. FWS–R2–ES–2012–0035 and at the Service's Austin Ecological Services Field Office. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2.

(5) Unit 1: Barton Springs Unit, Travis County, Texas. Map of Unit 1 follows:

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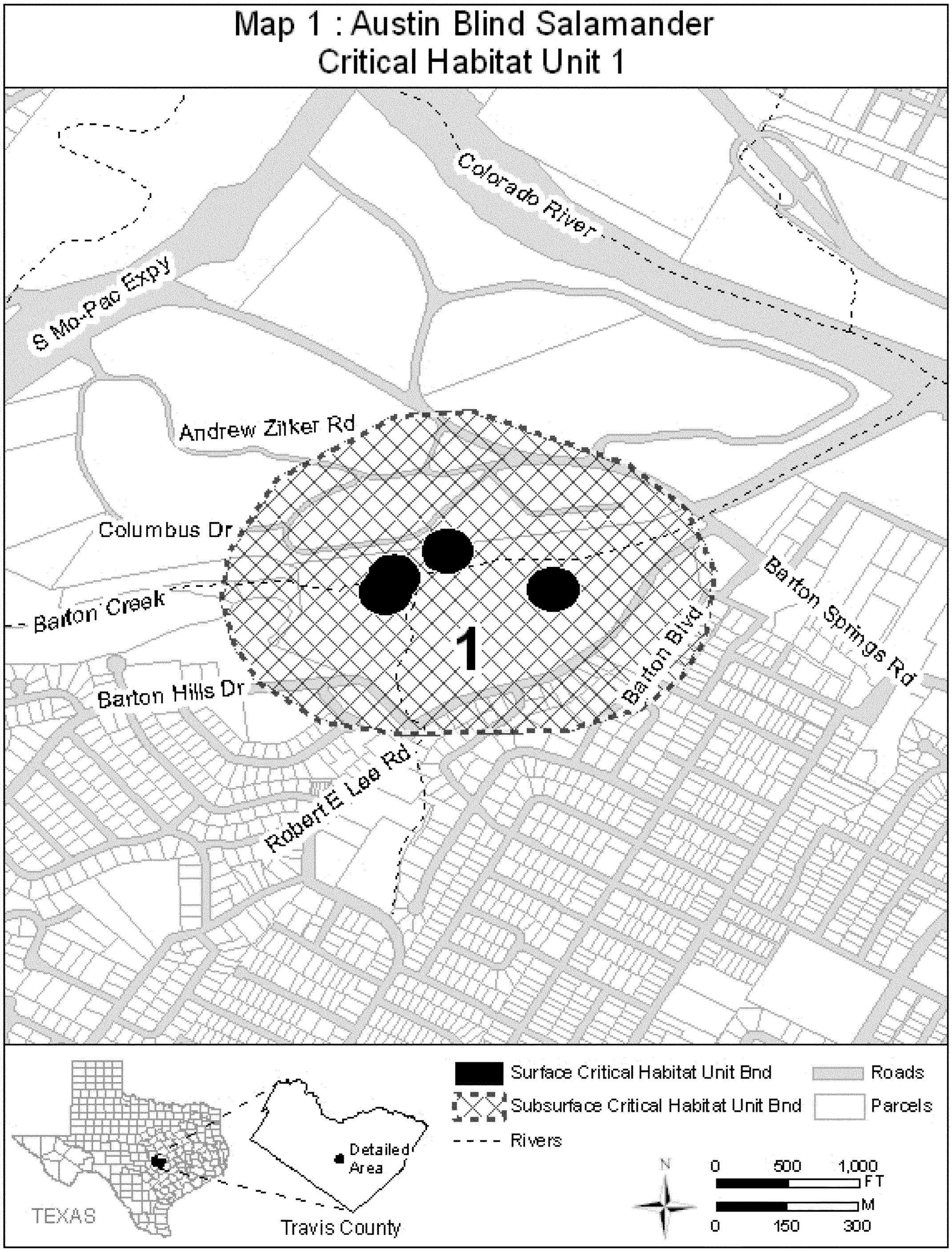


* * * * *

Georgetown Salamander (*Eurycea naufragia*)

(1) Critical habitat units are depicted for Williamson County, Texas, on the maps below.

(2) Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of Georgetown salamander consist of four components:

(i) *Water from the Northern Segment of the Edwards Aquifer.* The groundwater must be similar to natural aquifer conditions both underground and as it discharges from natural spring outlets. Concentrations of water quality constituents that could have a negative impact on the salamander should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Georgetown salamander prey base). Hydrologic regimes similar to the historical pattern of the specific sites must be present, with at least temporal surface flow for spring sites and continuous flow for subterranean sites. The water chemistry must be similar to natural aquifer conditions, with temperatures between 68.4 and 69.8 °F (20.2 and 21.0 °C), dissolved oxygen concentrations between 6 and 8 milligrams per liter, and specific water conductivity between 604 and 721 microsiemens per centimeter.

(ii) *Rocky substrate with interstitial spaces.* Rocks (boulders, cobble, or gravel) in the substrate of the salamander's surface aquatic habitat must be large enough to provide salamanders with cover, shelter, and foraging habitat. The substrate and interstitial spaces must have minimal sedimentation.

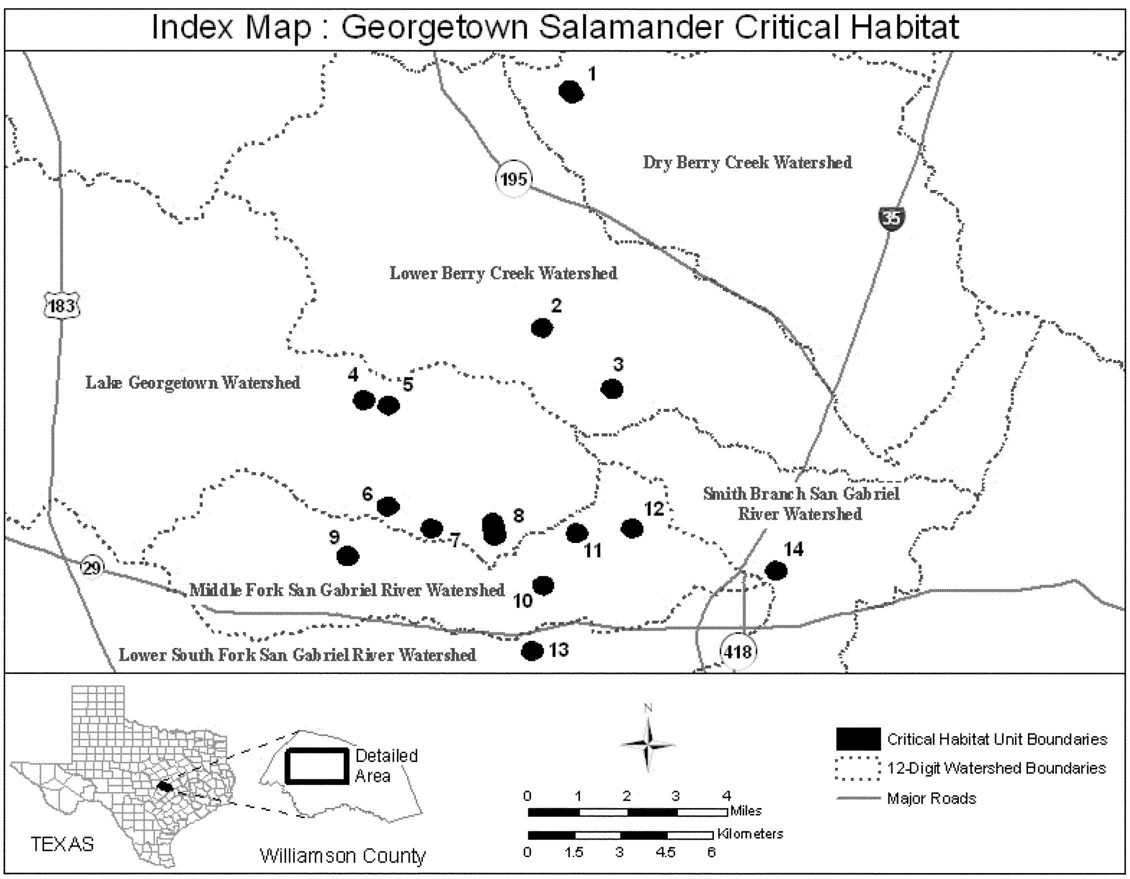
(iii) *Aquatic invertebrates for food.* The spring and cave environments must be capable of supporting a diverse aquatic invertebrate community that includes crustaceans and insects.

(iv) *Subterranean aquifer.* During periods of drought or dewatering on the surface in and around spring sites, access to the subsurface water table must be provided for shelter and protection.

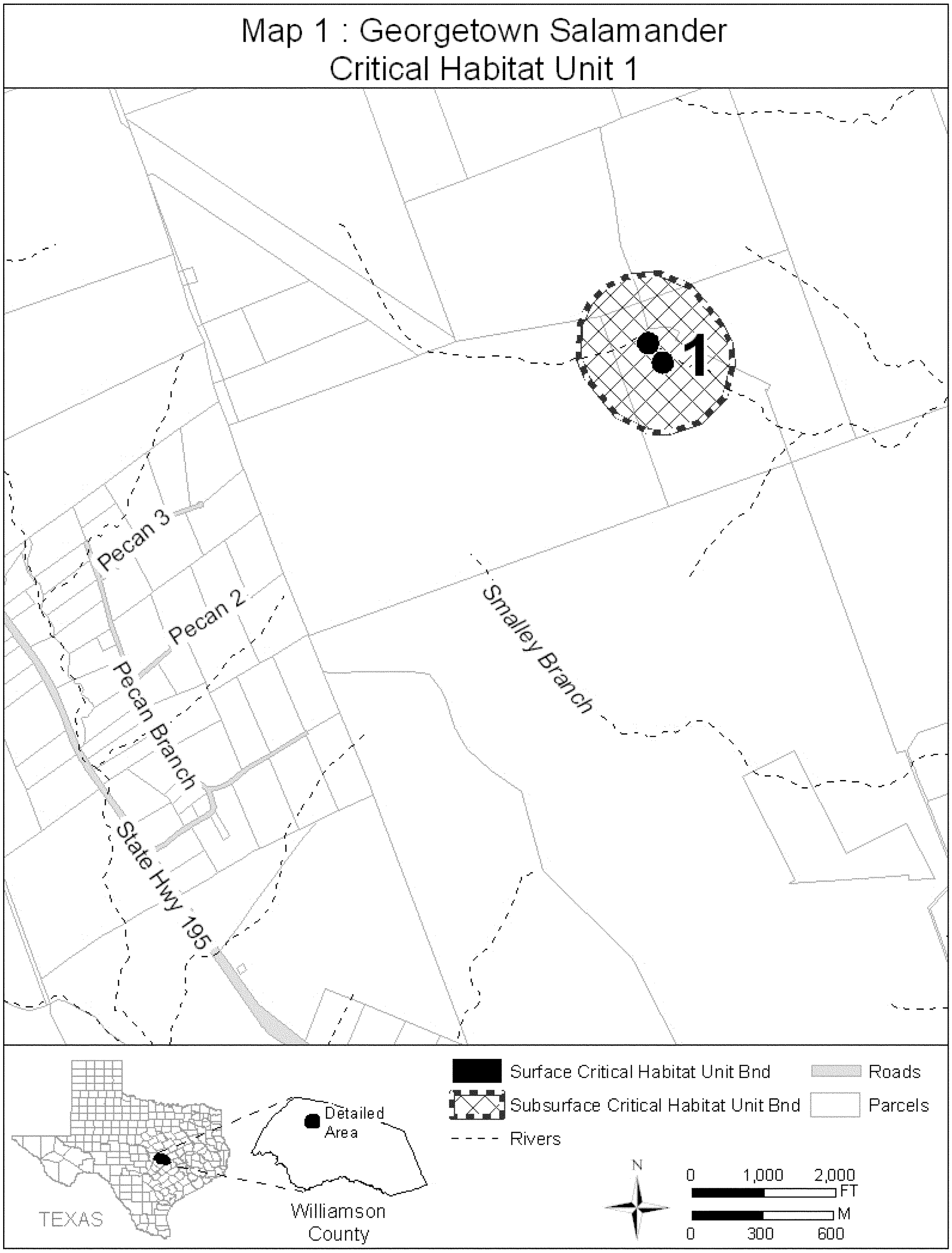
(3) Surface critical habitat includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat, but does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule; however, the subterranean aquifer may extend below such structures. The subterranean critical habitat includes underground features in a circle with a radius of 984-ft (300-m) around the springs.

(4) *Critical habitat map units.* Data layers defining map units were created using a geographic information system (GIS), which included species locations, roads, property boundaries, 2011 aerial photography, and USGS 7.5′ quadrangles. Points were placed on the GIS. We delineated critical habitat unit boundaries by starting with the cave or spring point locations that are occupied by the salamanders. From these cave or springs points, we delineated a 984 ft (300 m) buffer to create the polygons that capture the extent to which we believe the salamander populations exist through underground conduits. The polygons were then simplified to reduce the number of vertices, but still retain the overall shape and extent. Subsequently, polygons that were within 98 ft (30 m) of each other were merged together. Each new merged polygon was then revised to remove extraneous divits or protrusions that resulted from the merge process. The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which each map is based are available to the public at the field office Internet site (at Docket No. FWS–R2–ES–2012–0035 and at the Service's Austin Ecological Services Field Office. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2.

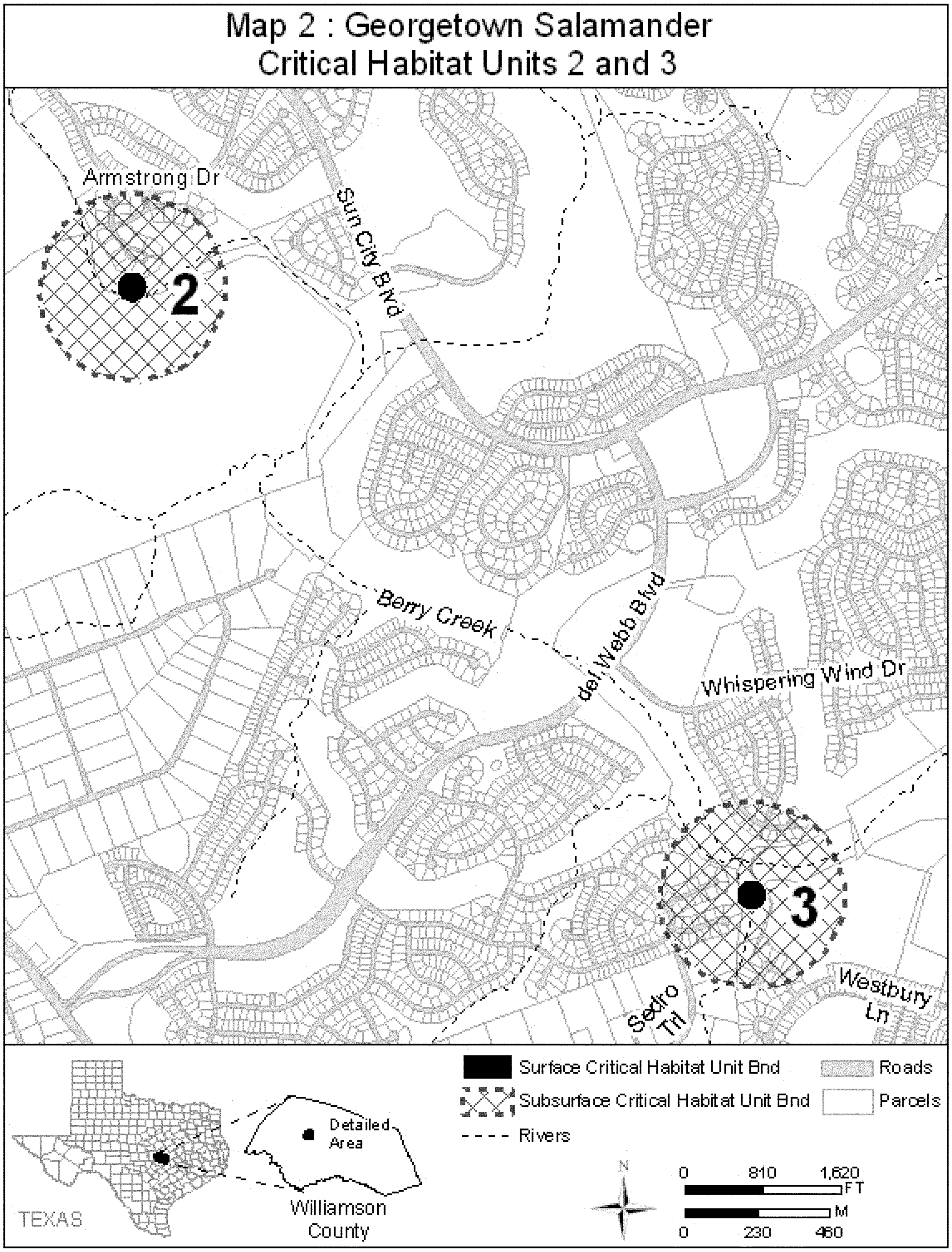
(5) Index map follows:



(6) Unit 1: Cobb Unit, Williamson County, Texas. Map of Unit 1 follows:



(7) Unit 2: Cowen Creek Spring Unit, Williamson County, Texas. Map of Units 2 and 3 follows:

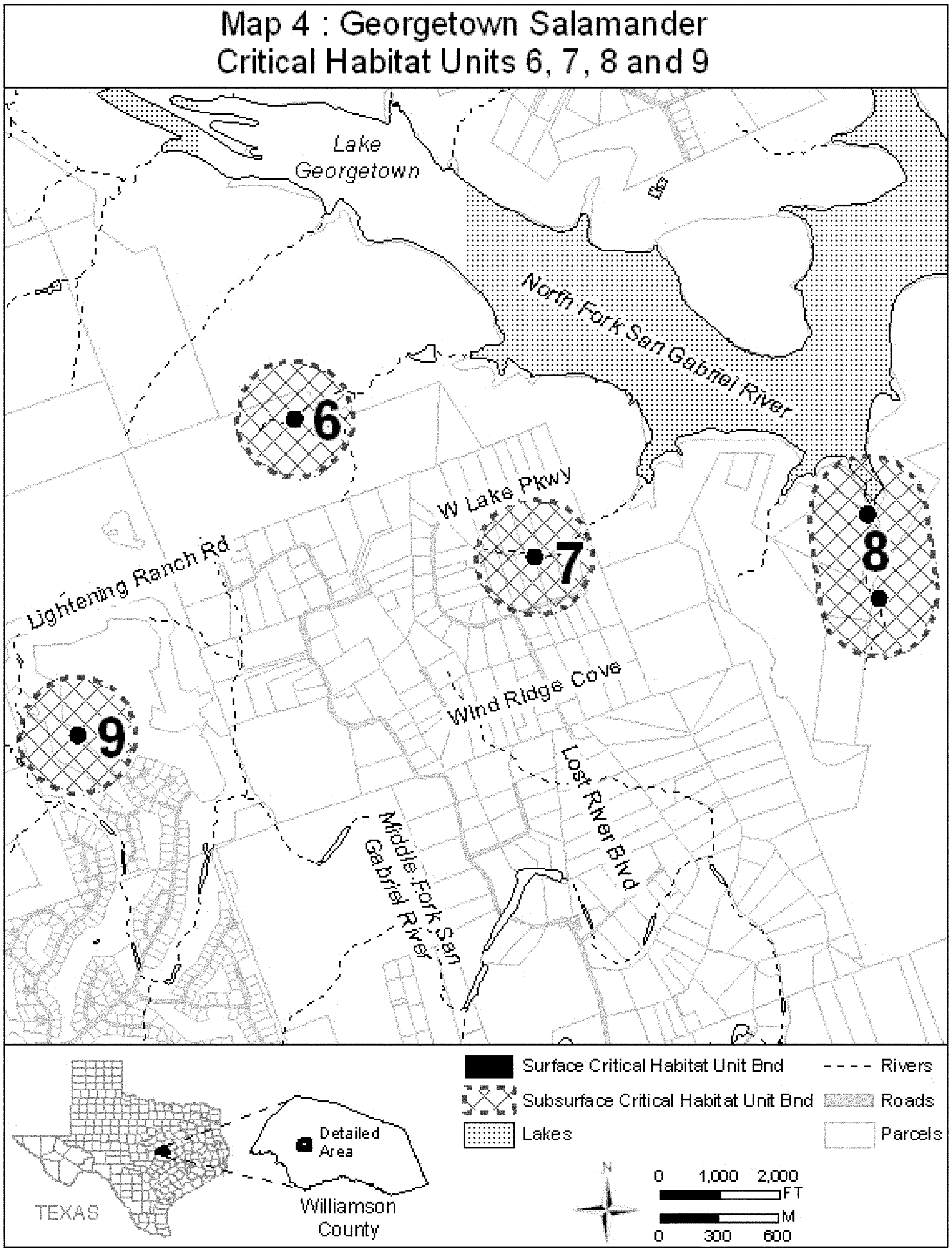


(8) Unit 3: Bat Well Unit, Williamson County, Texas. Map of Units 2 and 3 is provided at paragraph (7) of this entry.

(9) Unit 4: Walnut Spring Unit,Williamson County, Texas. Map of Units 4 and 5 follows:

(10) Unit 5: Twin Springs Unit, Williamson County, Texas. Map of Units 4 and 5 is provided at paragraph (9) of this entry.

(11) Unit 6: Hogg Hollow Spring Unit, Williamson County, Texas. Map of Units 6, 7, 8, and 9 follows:

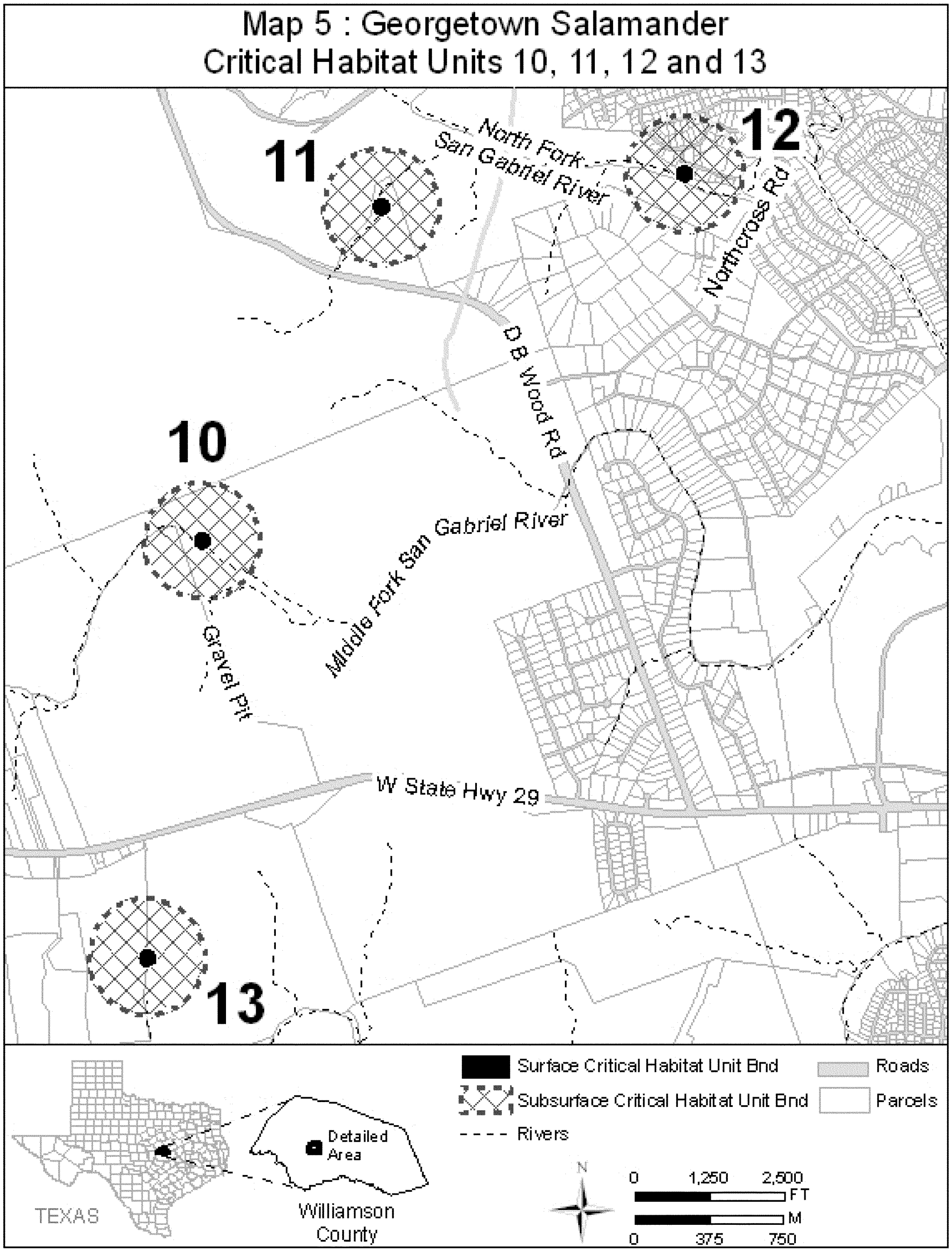


(12) Unit 7: Cedar Hollow Spring Unit, Williamson County, Texas. Map of Units 6, 7, 8, and 9 is provided at paragraph (11) of this entry.

(13) Unit 8: Lake Georgetown Unit, Williamson County, Texas. Map of Units 6, 7, 8, and 9 is provided at paragraph (11) of this entry.

(14) Unit 9: Water Tank Cave Unit, Williamson County, Texas. Map of Units 6, 7, 8, and 9 is provided at paragraph (11) of this entry.

(15) Unit 10: Avant Spring Unit, Williamson County, Texas. Map of Units 10, 11, 12, and 13 follows:

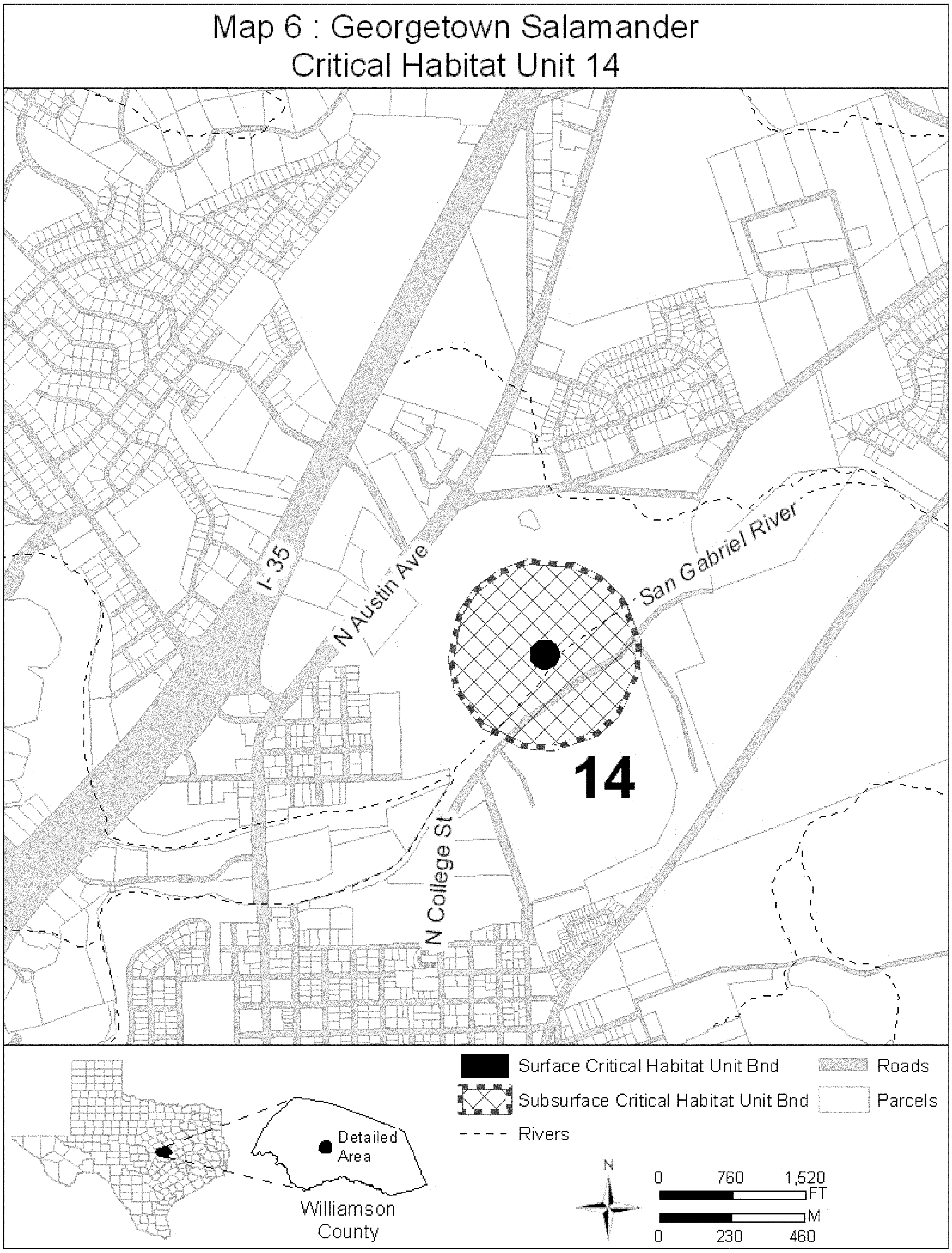


(16) Unit 11: Buford Hollow Spring Unit, Williamson County, Texas. Map of Units 10, 11, 12, 13 is provided at paragraph (15) of this entry.

(17) Unit 12: Swinbank Spring Unit, Williamson County, Texas. Map of Units 10, 11, 12, and 13 is provided at paragraph (15) of this entry.

(18) Unit 13: Shadow Canyon Unit, Williamson County, Texas. Map of Units 10, 11, 12, and 13 is provided at paragraph (15) of this entry.

(19) Unit 14: San Gabriel Springs Unit, Williamson County, Texas. Map of Unit 14 follows:



Jollyville Plateau Salamander (*Eurycea tonkawae*)

(1) Critical habitat units are depicted for Travis and Williamson Counties, Texas, on the maps below.

(2) Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of Jollyville Plateau salamander consist of four components:

(i) *Water from the Northern Segment of the Edwards Aquifer.* The groundwater must be similar to natural aquifer conditions both underground and as it discharges from natural spring outlets. Concentrations of water quality constituents that could have a negative impact on the salamander should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Jollyville Plateau salamander's prey base). Hydrologic regimes similar to the historical pattern of the specific sites must be present, with at least temporal surface flow for spring sites and continuous flow in subterranean habitats. The water chemistry must be similar to natural aquifer conditions, with temperatures between 65.3 and 67.3 °F (18.5 and 19.6 °C), dissolved oxygen concentrations between 5.6 and 7.1 milligrams per liter, and specific water conductance between 550 and 625 microsiemens per centimeter.

(ii) *Rocky substrate with interstitial space*s. Rocks (boulders, cobble, or gravel) in the substrate of the salamander's surface aquatic habitat must be large enough to provide salamanders with cover, shelter, and foraging habitat. The substrate and interstitial spaces must have minimal sedimentation.

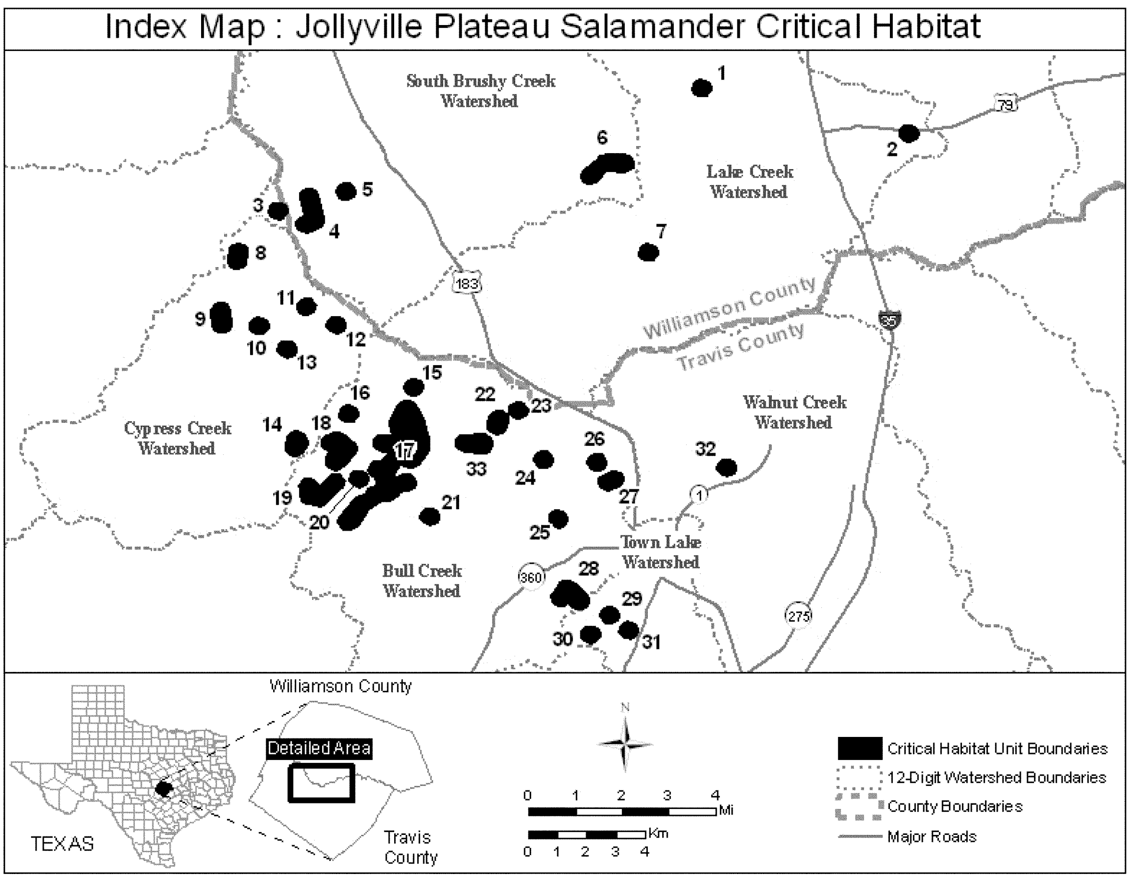
(iii) *Aquatic invertebrates for food.* The spring and cave environments must be capable of supporting a diverse aquatic invertebrate community that includes crustaceans and insects.

(iv) *Subterranean aquifer.* During periods of drought or dewatering on the surface in and around spring sites, access to the subsurface water table must be provided for shelter and protection.

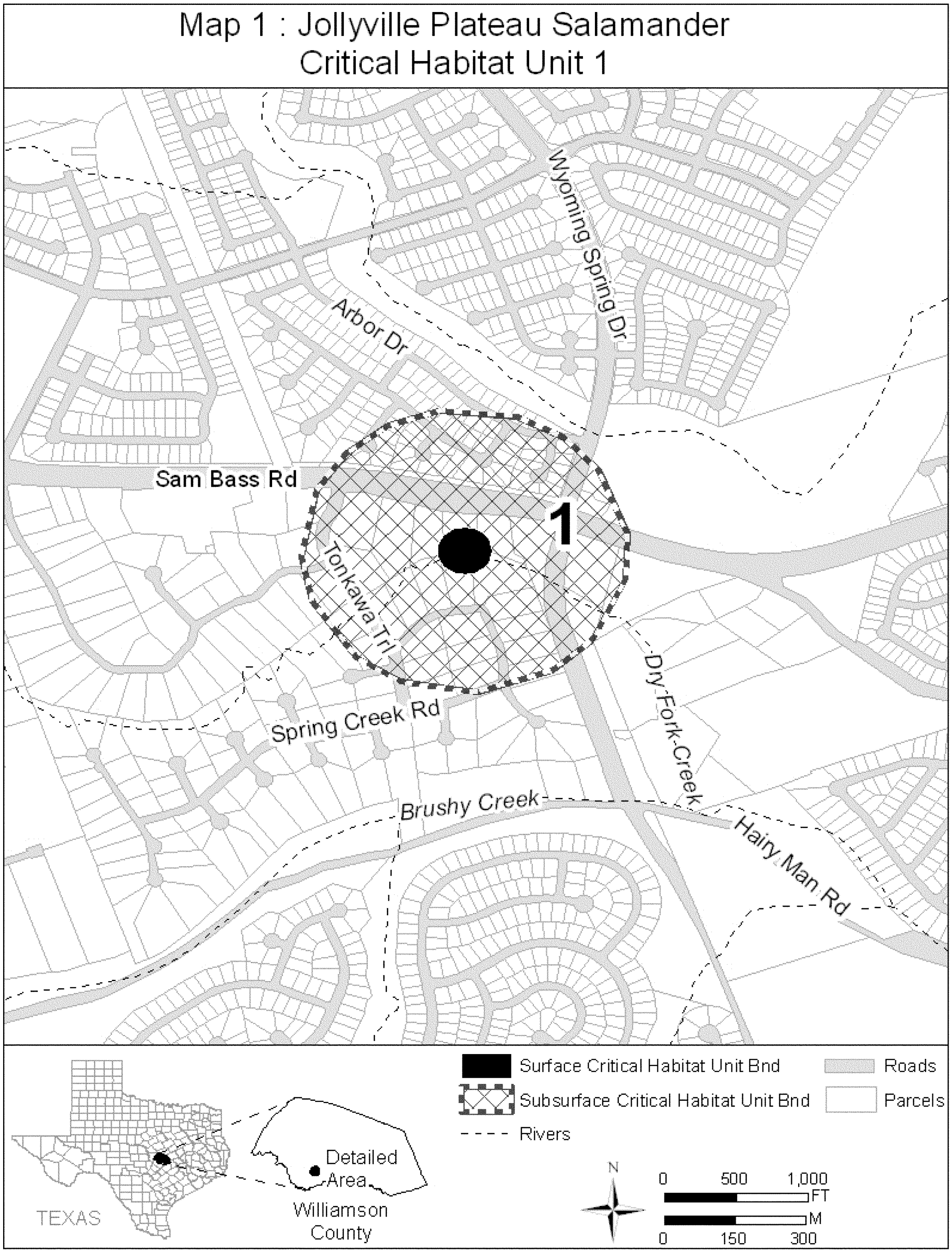
(3) Surface critical habitat includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat, but does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule; however, the subterranean aquifer may extend below such structures. The subterranean critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs.

(4) *Critical habitat map units.* Data layers defining map units were created using a geographic information system (GIS), which included species locations, roads, property boundaries, 2011 aerial photography, and USGS 7.5′ quadrangles. Points were placed on the GIS. We delineated critical habitat unit boundaries by starting with the cave or spring point locations that are occupied by the salamanders. From these cave or springs points, we delineated a 984-ft (300-m) buffer to create the polygons that capture the extent to which we believe the salamander populations exist through underground conduits. The polygons were then simplified to reduce the number of vertices, but still retain the overall shape and extent. Subsequently, polygons that were within 98 ft (30 m) of each other where merged together. Each new merged polygon was then revised to remove extraneous divits or protrusions that resulted from the merge process. The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which each map is based are available to the public at the field office Internet site (*http://www.fws.gov/southwest/es/AustinTexas/*), *http://www.regulations.gov* at Docket No. FWS–R2–ES–2012–0035 and at the Service's Austin Ecological Services Field Office. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2.

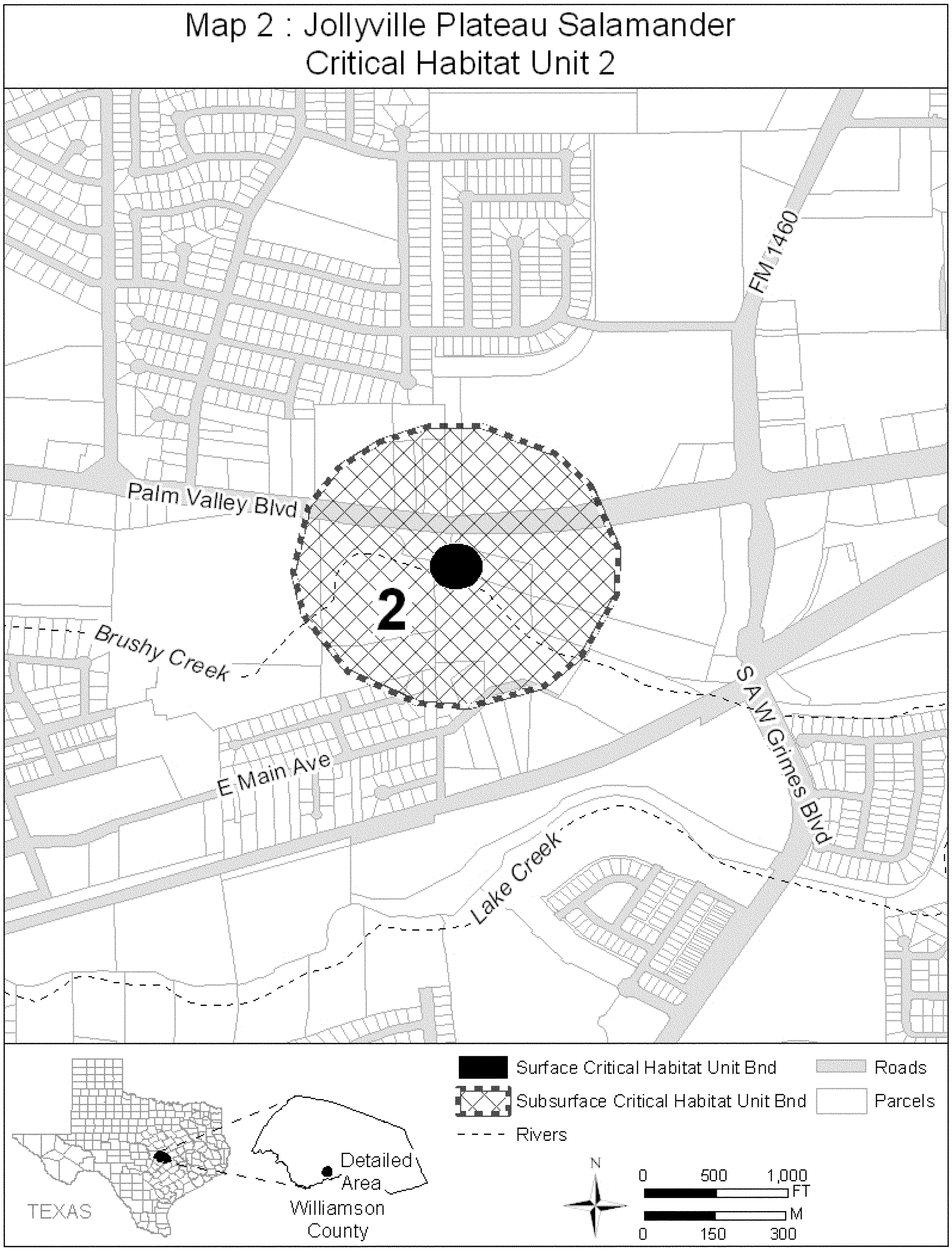
(5) Index map follows:



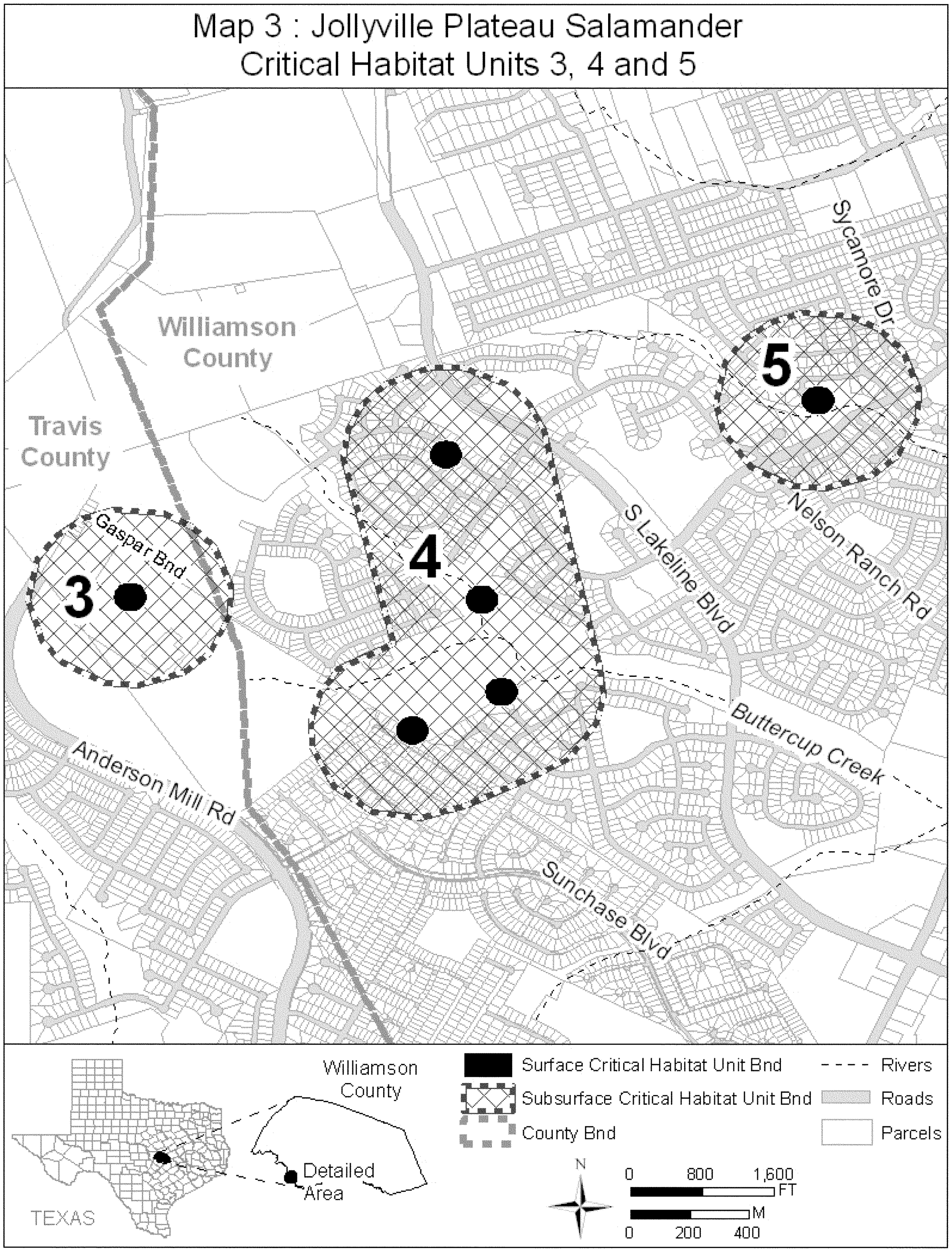
(6) Unit 1: Krienke Spring Unit, Williamson County, Texas. Map of Unit 1 follows:



(7) Unit 2: Brushy Creek Spring Unit, Williamson County, Texas. Map of Unit 2 follows:



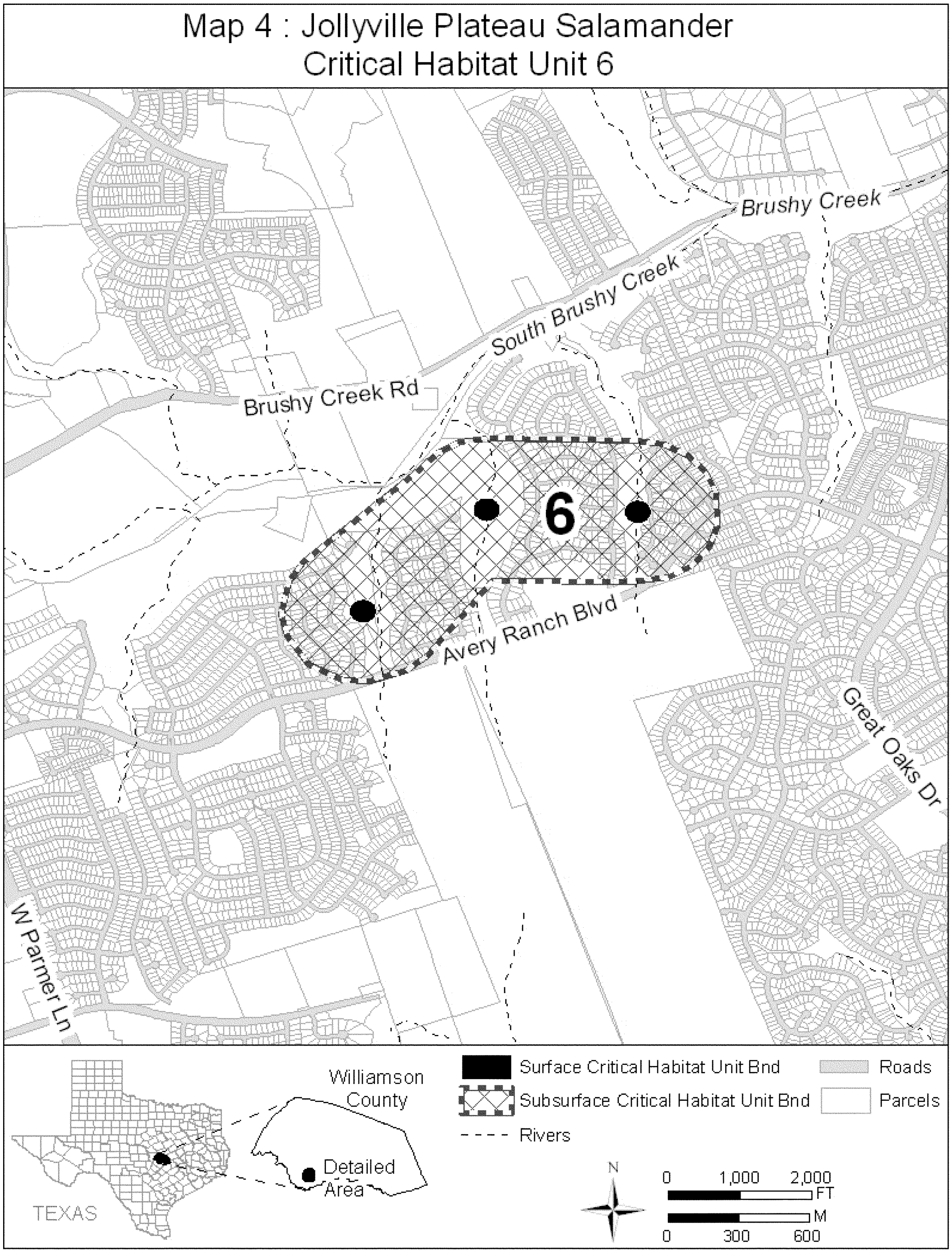
(8) Unit 3: Testudo Tube Cave Unit, Williamson and Travis Counties, Texas. Map of Units 3, 4, and 5 follows:



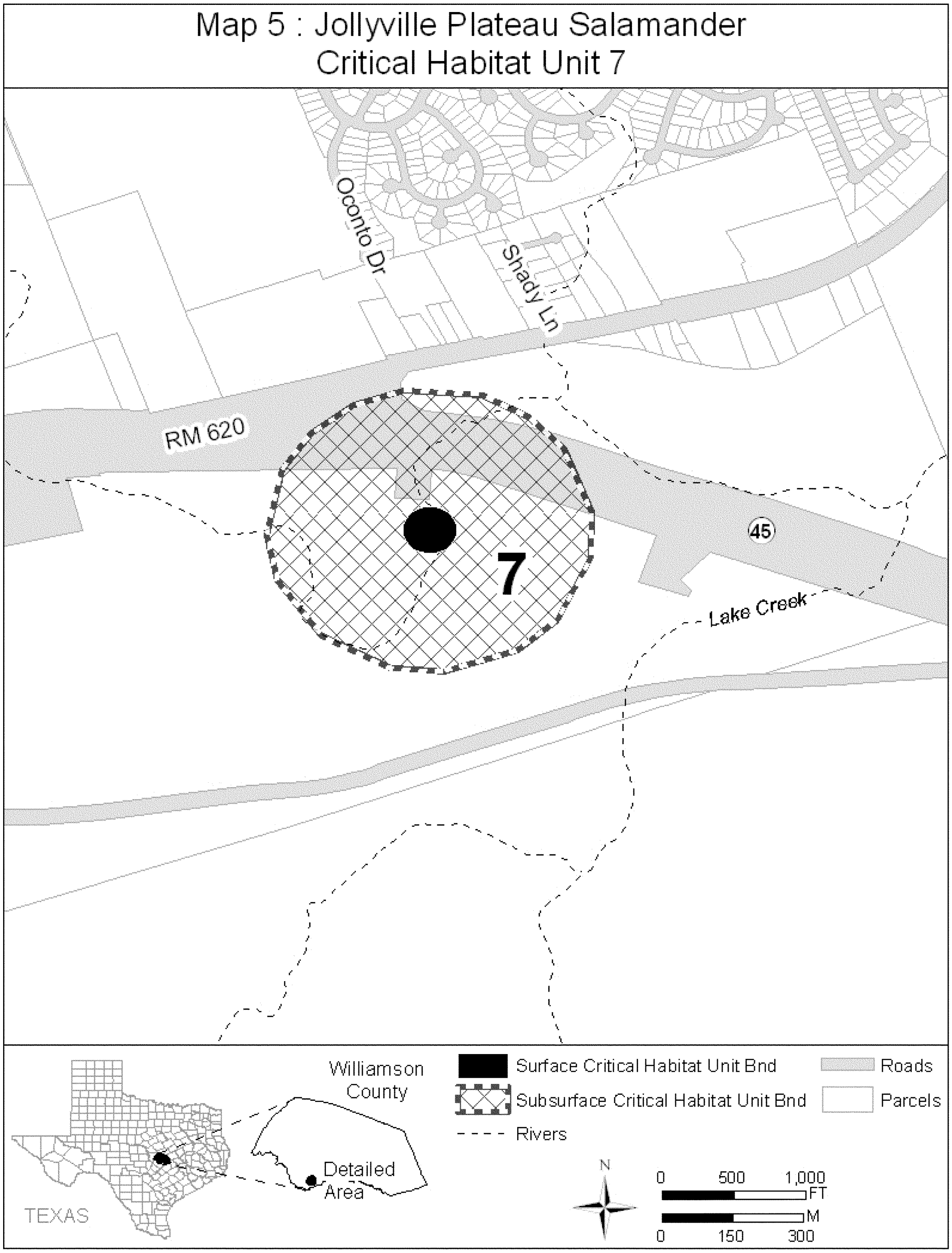
(9) Unit 4: Buttercup Creek Cave Unit, Travis and Williamson County, Texas. Map of Units 3, 4, and 5 is provided at paragraph (8) of this entry.

(10) Unit 5: Treehouse Cave Unit, Williamson County, Texas. Map of Units 3, 4, and 5 is provided at paragraph (8) of this entry.

(11) Unit 6: Avery Spring Unit, Williamson County, Texas. Map of Unit 6 follows:

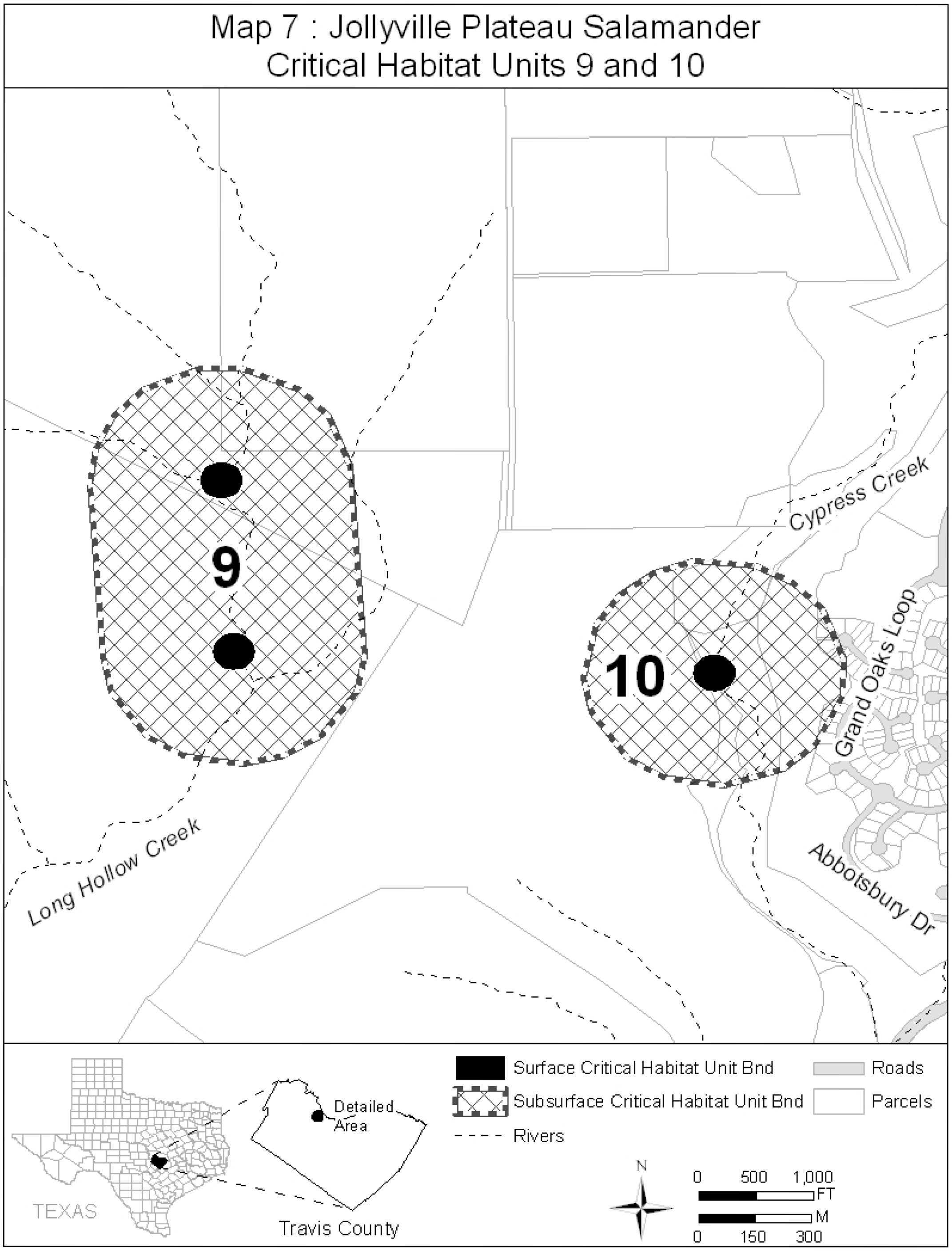


(12) Unit 7: PC Spring Unit, Williamson County, Texas. Map of Unit 7 follows:



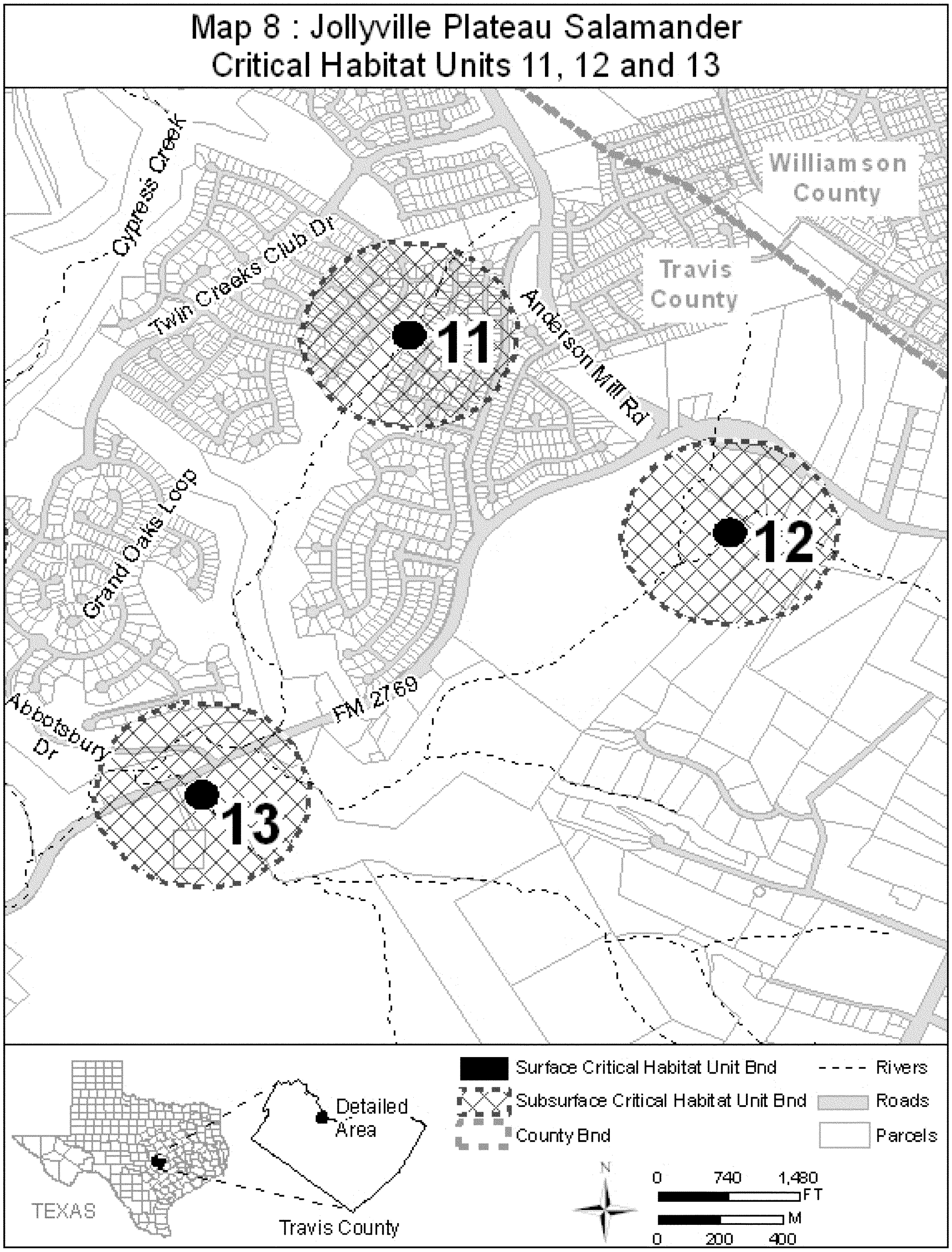
(13) Unit 8: Baker and Audubon Spring Unit, Travis County, Texas, Map of Unit 8 follows:

(14) Unit 9: Wheless Spring Unit, Travis County, Texas. Map of Units 9 and 10 follows:



(15) Unit 10: Blizzard R-Bar-B Spring Unit, Travis County, Texas. Map of Units 9 and 10 in provided at paragraph (14) of this entry.

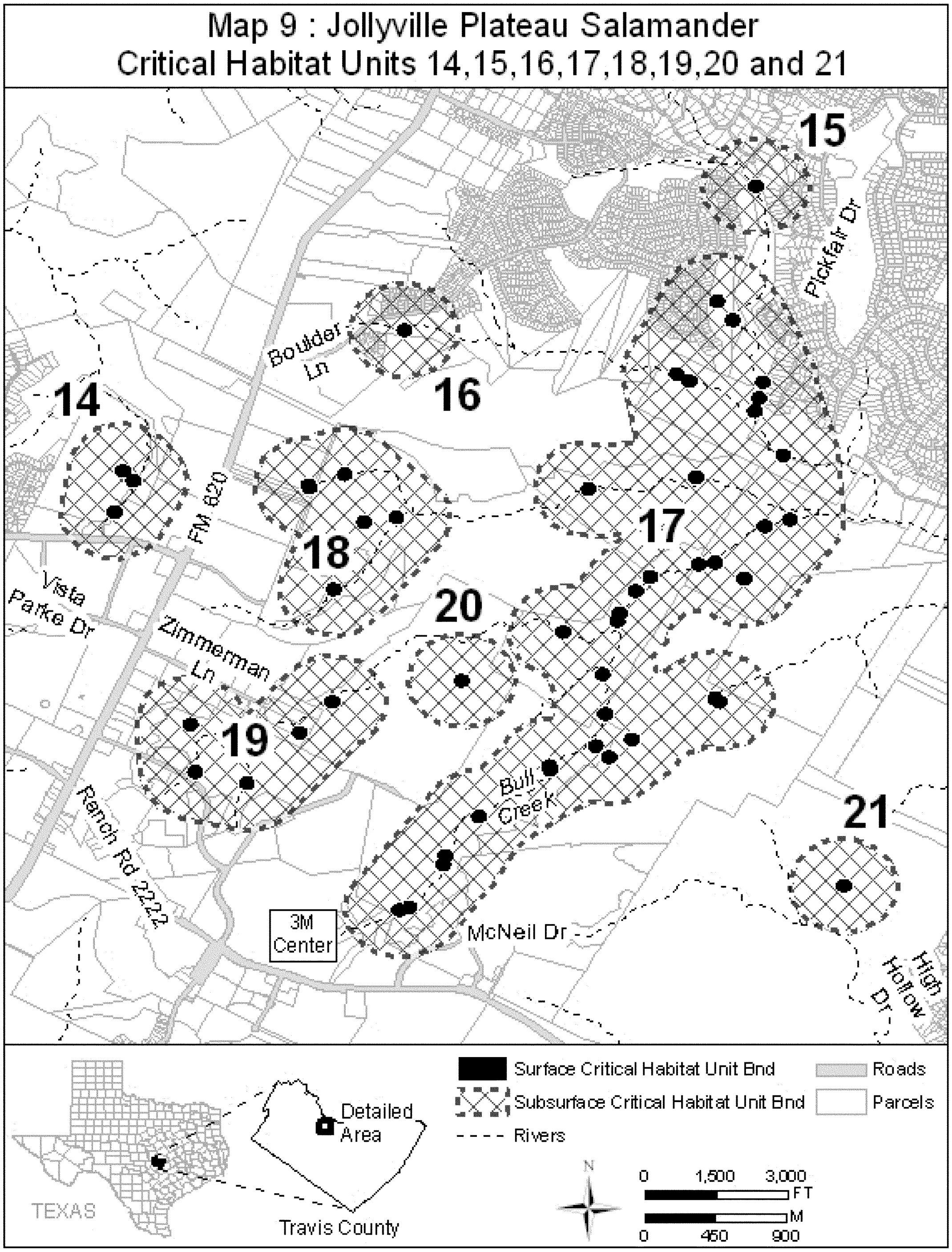
(16) Unit 11: House Spring Unit, Travis County, Texas. Map of Units 11, 12, and 13 follows:



(17) Unit 12: Kelly Hollow Spring Unit, Travis County, Texas. Map of Units 11, 12, and 13 is provided at paragraph (16) of this entry.

(18) Unit 13: MacDonald Well Unit, Travis County, Texas. Map of Units 11, 12, and 13 is provided at paragraph (16) of this entry.

(19) Unit 14: Kretschmarr Unit, Travis County, Texas. Map of Units 14, 15, 16, 17, 18, 19, 20, and 21 follows:



(20) Unit 15: Pope and Hiers Spring Unit, Travis County, Texas. Map of Units 14, 15, 16, 17, 18, 19, 20, and 21 is provided at paragraph (19) of this entry.

(21) Unit 16: Fern Gully Spring Unit, Travis County, Texas. Map of Units 14, 15, 16, 17, 18, 19, 20, and 21 is provided at paragraph (19) of this entry.

(22) Unit 17: Bull Creek 1 Unit, Travis County, Texas. Map of Units 14, 15, 16, 17, 18, 19, 20, and 21 is provided at paragraph (19) of this entry.

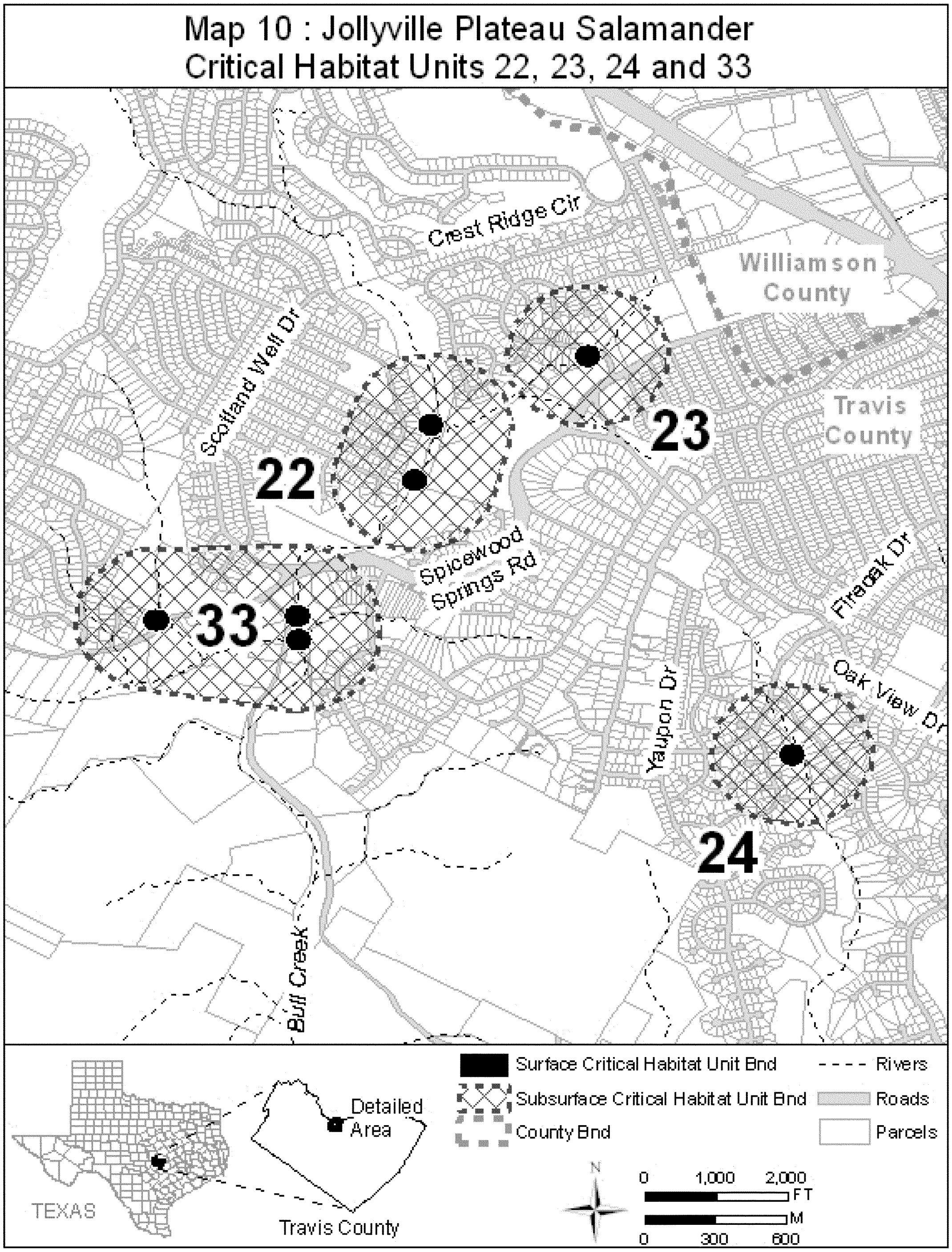
(23) Unit 18: Bull Creek 2 Unit, Travis County, Texas. Map of Units 14, 15, 16, 17, 18, 19, 20, and 21 is provided at paragraph (19) of this entry.

(24) Unit 19: Bull Creek 3 Unit, Travis County, Texas. Map of Units 14, 15, 16, 17, 18, 19, 20, and 21 is provided at paragraph (19) of this entry.

(25) Unit 20: Moss Gulley Spring Unit, Travis County, Texas. Map of Units 14, 15, 16, 17, 18, 19, 20, and 21 is provided at paragraph (19) of this entry.

(26) Unit 21: Ivanhoe Spring Unit, Travis County, Texas. Map of Units 14, 15, 16, 17, 18, 19, 20, and 21 is provided at paragraph (19) of this entry.

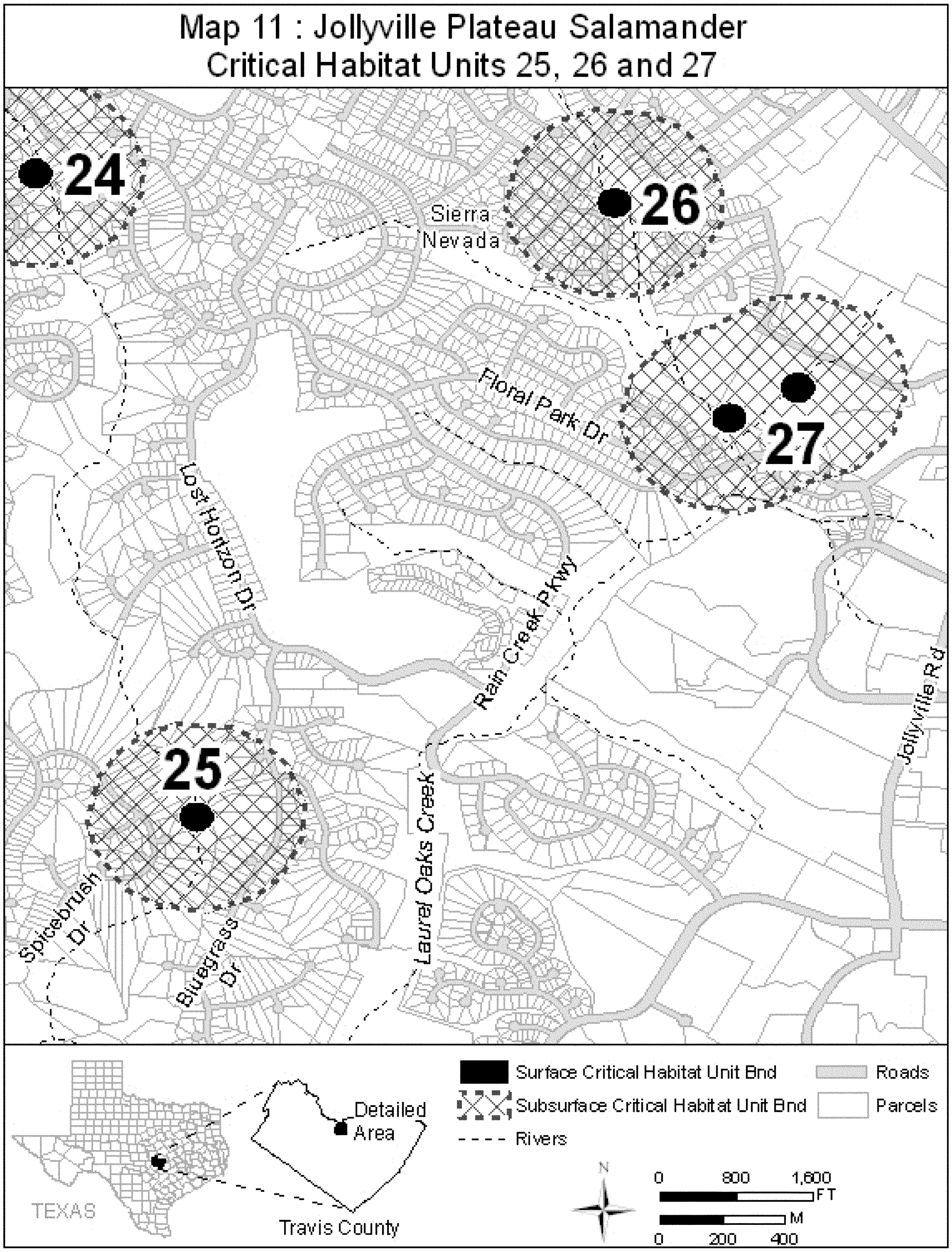
(27) Unit 22: Sylvia Spring Unit, Travis County, Texas. Map of Units 22, 23, 24, and 33 follows:



(28) Unit 23: Tanglewood Spring Unit, Travis County, Texas. Map of Units 22, 23, 24, and 33 is provided at paragraph (27) of this entry.

(29) Unit 24: Long Hog Hollow Unit, Travis County, Texas. Map of Units 22, 23, 24, and 33 is provided at paragraph (27) of this entry.

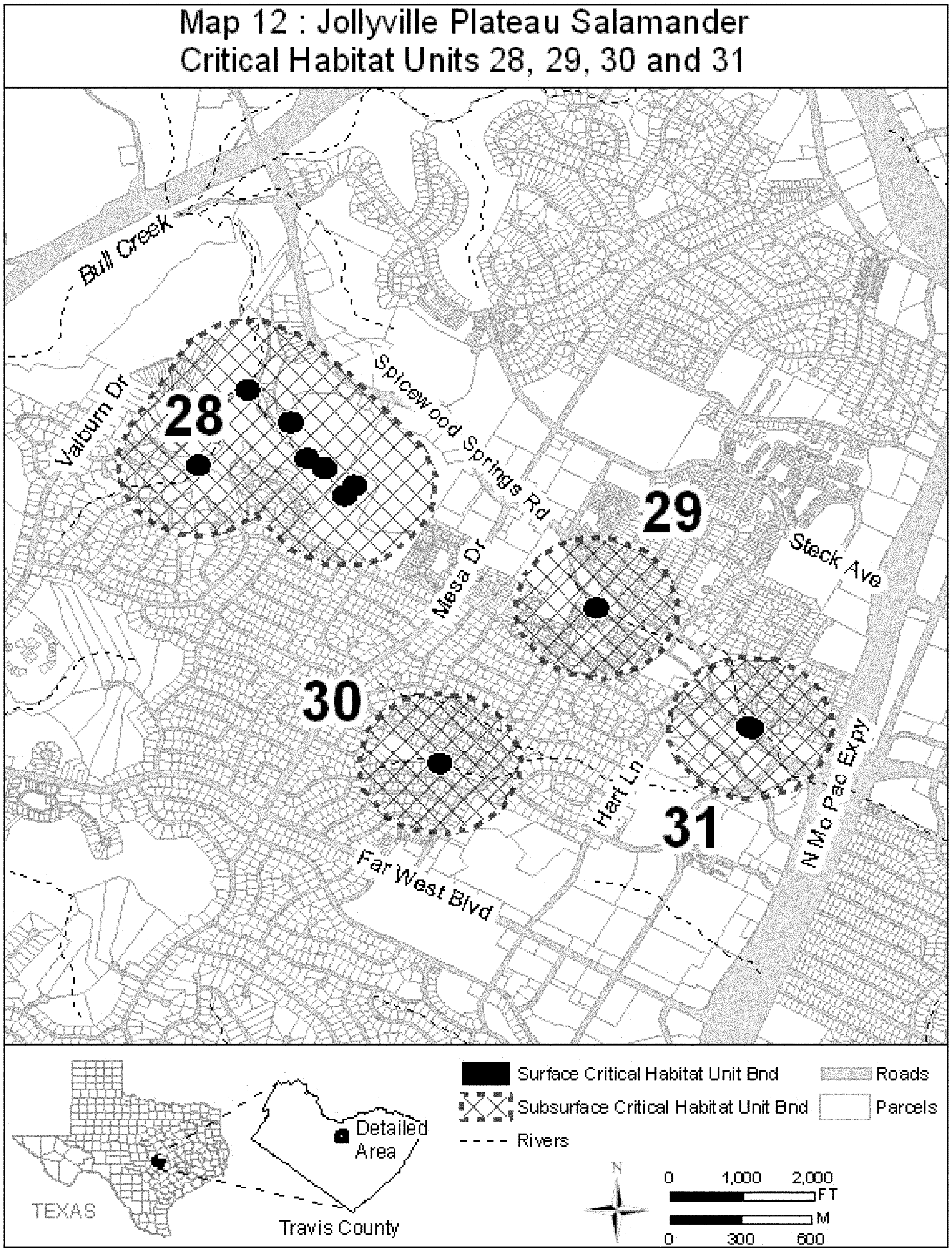
(30) Unit 25: Tributary 3 Unit, Travis County, Texas. Map of Units 25, 26, and 27 follows:



(31) Unit 26: Sierra Spring Unit, Travis County, Texas. Map of Units 25, 26, and 27 is provided at paragraph (30) of this entry.

(32) Unit 27: Troll Spring Unit, Travis County, Texas. Map of Units 25, 26, and 27 is provided at paragraph (30) of this entry.

(33) Unit 28: Stillhouse Unit, Travis County, Texas. Map of Units 28, 29, 30, and 31 follows:

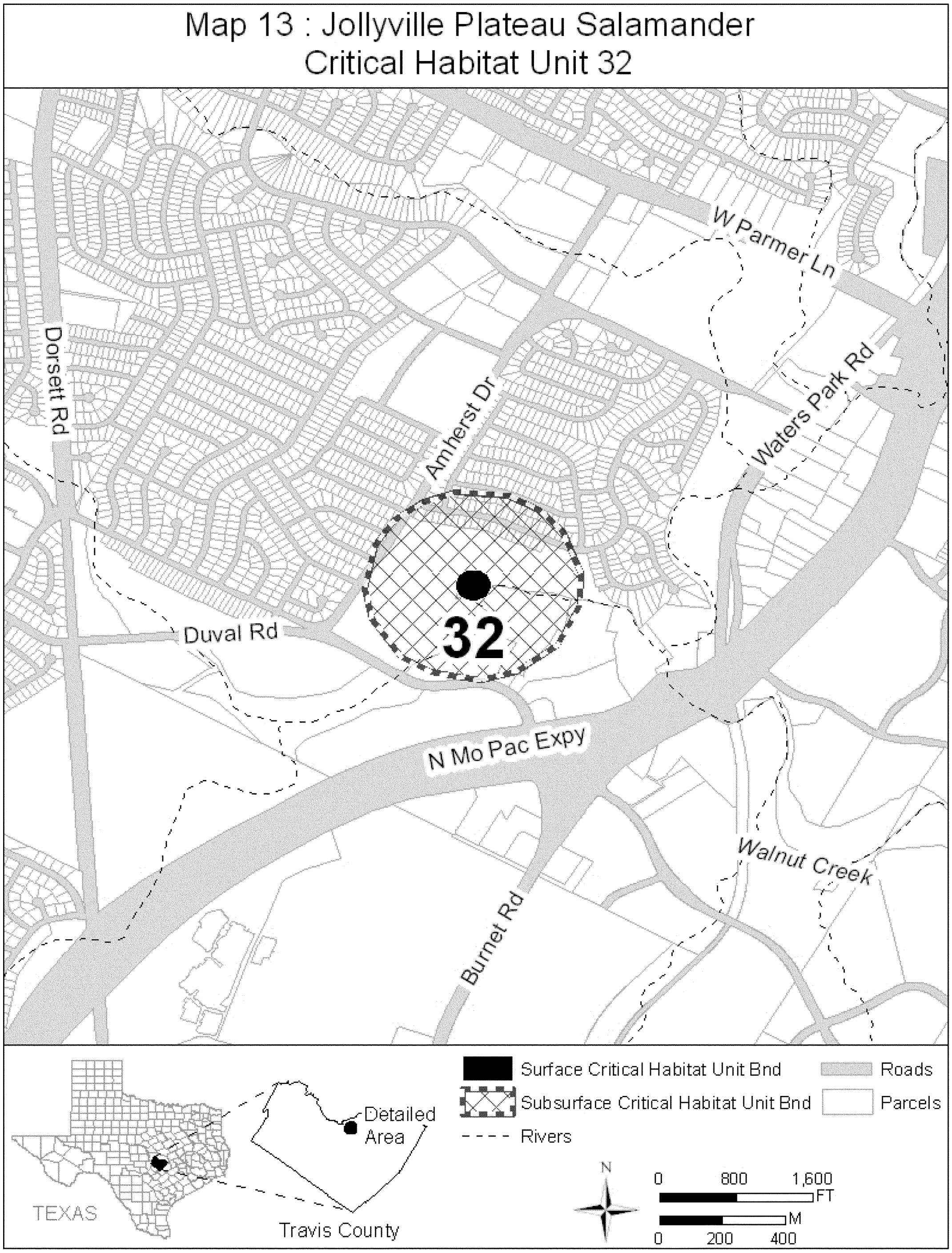


(34) Unit 29: Salamander Cave Unit, Travis County, Texas. Map of Units 28, 29, 30, 31 is provided at paragraph (33) of this entry.

(35) Unit 30: Indian Spring Unit, Travis County, Texas. Map of Units 28, 29, 30, and 31 is provided at paragraph (33) of this entry.

(36) Unit 31: Spicewood Spring Unit, Travis County, Texas. Map of Units 28, 29, 30, and 31 is provided at paragraph (33) of this entry.

(37) Unit 32: Balcones District Park Spring Unit, Travis County, Texas. Map of Unit 32 follows:



(38) Unit 33: Tributary 4 Unit, Travis County, Texas. Map of Units 22, 23, 24, and 33 is provided at paragraph (27) of this entry.

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Salado Salamander (*Eurycea chisholmensis*)

(1) Critical habitat units are depicted for Bell County, Texas, on the maps below.

(2) Within these areas, the primary constituent elements of the physical or biological features essential to the conservation of Salado salamander consist of four components:

(i) *Water from the Northern Segment of the Edwards Aquifer.* The groundwater must be similar to natural aquifer conditions both underground and as it discharges from natural spring outlets. Concentrations of water quality constituents that could have a negative impact on the salamander should be below levels that could exert direct lethal or sublethal effects (such as effects to reproduction, growth, development, or metabolic processes), or indirect effects (such as effects to the Salado salamander's prey base). Hydrologic regimes similar to the historical pattern of the specific sites must be present, with at least temporal surface flow for spring sites and continuous flow for subterranean sites. The water chemistry must be similar to natural aquifer conditions, with temperatures between 65.3 and 69.8 °F (18.5 and 21.0 °C), dissolved oxygen concentrations between 5.6 and 8 milligrams per liter, and conductivity between 550 and 721 microsiemens per centimeter.

(ii) *Rocky substrate with interstitial spaces.* Rocks (boulders, cobble, or gravel) in the substrate of the salamander's surface aquatic habitat must be large enough to provide salamanders with cover, shelter, and foraging habitat. The substrate and interstitial spaces must have minimal sedimentation.

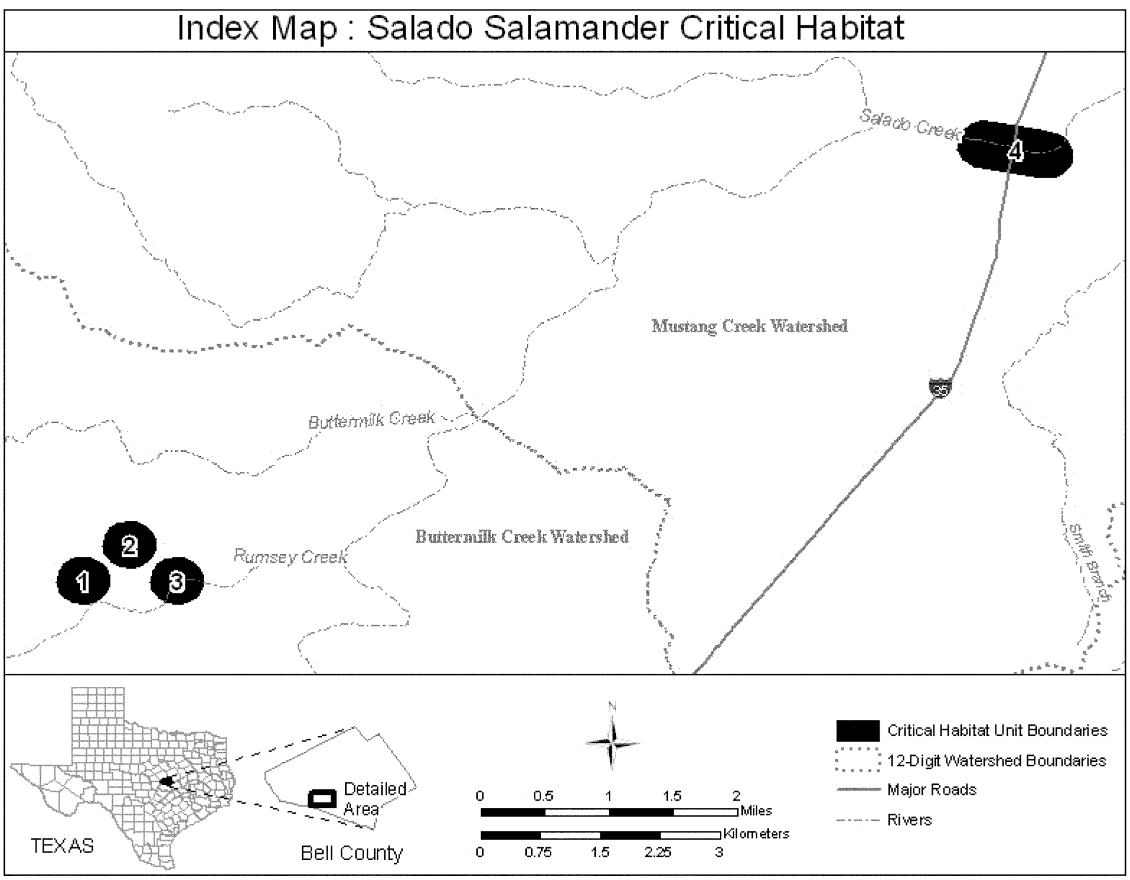
(iii) *Aquatic invertebrates for food.* The spring and cave environments must be capable of supporting a diverse aquatic invertebrate community that includes crustaceans and insects.

(iv) *Subterranean aquifer.* During periods of drought or dewatering on the surface in and around spring sites, access to the subsurface water table must be provided for shelter and protection.

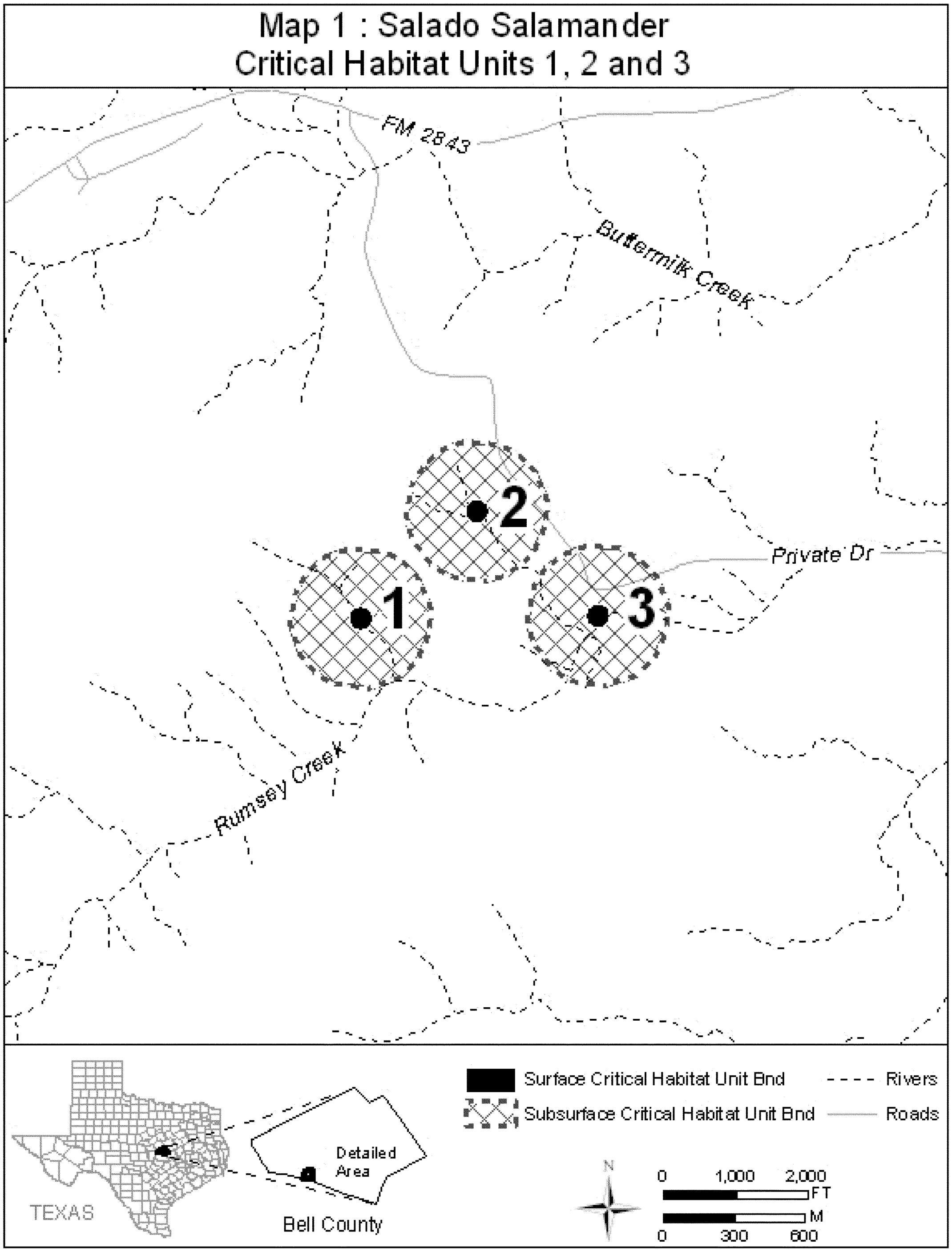
(3) Surface critical habitat includes the spring outlets and outflow up to the high water line and 164 ft (50 m) of downstream habitat, but does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on the effective date of this rule; however, the subterranean aquifer may extend below such structures. The subterranean critical habitat includes underground features in a circle with a radius of 984 ft (300 m) around the springs.

(4) *Critical habitat map units.* Data layers defining map units were created using a geographic information system (GIS), which included species locations, roads, property boundaries, 2011 aerial photography, and USGS 7.5′ quadrangles. Points were placed on the GIS. We delineated critical habitat unit boundaries by starting with the cave or spring point locations that are occupied by the salamanders. From these cave or springs points, we delineated a 984-ft (300-m) buffer to create the polygons that capture the extent to which we believe the salamander populations exist through underground conduits. The polygons were then simplified to reduce the number of vertices, but still retain the overall shape and extent. Subsequently, polygons that were within 98 ft (30 m) of each other where merged together. Each new merged polygon was then revised to remove extraneous divits or protrusions that resulted from the merge process. The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which each map is based are available to the public at the field office Internet site (*http://www.fws.gov/southwest/es/AustinTexas/*), *http://www.regulations.gov* at Docket No. FWS–R2–ES–2012–0035 and at the Service's Austin Ecological Services Field Office. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2.

(5) Index map follows:



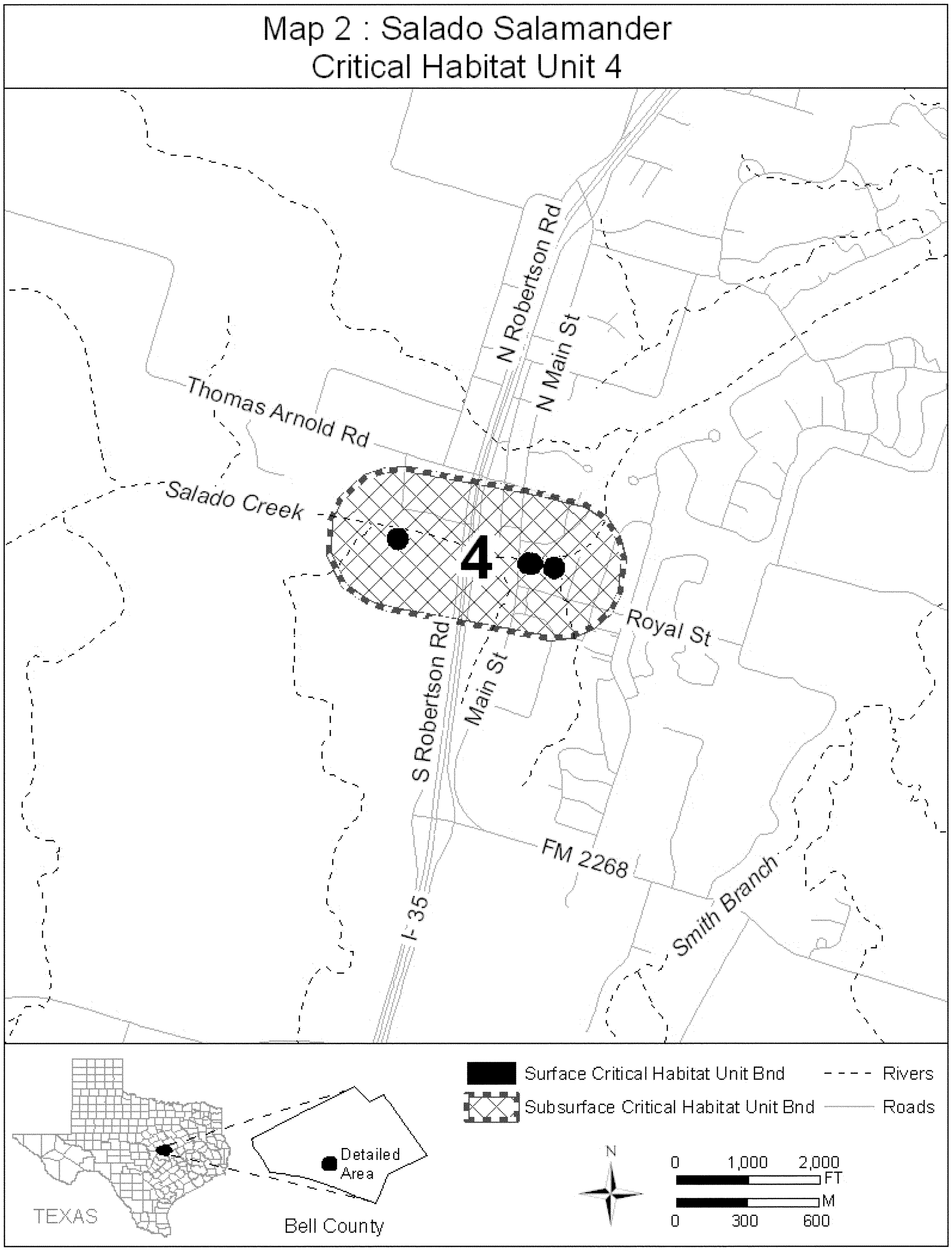
(6) Unit 1: Hog Hollow Spring Unit, Bell County, Texas. Map of Units 1, 2, and 3 follows:



(7) Unit 2: Solana Spring #1 Unit, Bell County, Texas. Map of Units 1, 2, and 3 is provided at paragraph (6) of this entry.

(8) Unit 3: Cistern Spring Unit, Bell County, Texas. Map of Units 1, 2, and 3 is provided at paragraph (6) of this entry.

(9) Unit 4: IH–35 Unit, Bell County, Texas. Map of Unit 4 follows:



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Dated: July 31, 2012.

Rachel Jacobson,

Principal Deputy Assistant Secretary for Fish and Wildlife and Parks.

[FR Doc. 2012–19659 Filed 8–21–12; 8:45 am]

BILLING CODE 4310–55–C