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Consultation No. 02ETAU00-2014-F-0019

Dear Mr. Brooks:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion on the Georgetown salamander (GS) and conference opinion on the GS proposed critical habitat. It is based on our review of the proposed Shadow Canyon Project Fill Authorization[1] (Project) located in Williamson County, Texas, and its effects on the threatened Georgetown salamander (*Eurycea naufragia*) and proposed critical habitat in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)(Act). Your August 28, 2013, letter requesting a conference was received on September 4, 2013. This conference opinion is based on information provided in the biological assessment (BA) and other sources of information. A complete administrative record of this consultation is on file at this office.

Project Background and Consultation History

The U.S. Army Corps of Engineers (USACE) has received an application from the San Gabriel Harvard Limited Partnership (applicant) requesting authorization to place fill in regulated waters of the United States as required by section 404 of the Clean Water Act. The applicant needs the USACE authorization to proceed with the residential and commercial development of a 311-acre tract near Georgetown, Texas (Figure 1). The USACE has determined that the Project may affect the Georgetown salamander and its proposed critical habitat.

The Service previously issued an incidental take permit (ITP) to the applicant pursuant to section 10(a)(1)(B) of the Act. The ITP (TE-116313-0) authorizes the incidental take of the endangered golden-cheeked warbler (*Setophaga chrysoparia*). In addition, the applicant has "No Surprises" policy assurances (63 FR 8859) for the golden-cheeked warbler, Bone Cave harvestman (*Texella reyesi*), and Coffin Cave mold beetle (*Batrisodes texanus*). As required by the ITP, the applicant

[1] USACE Project No. SWF-2009-00458

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is implementing the Shadow Canyon Habitat Conservation Plan (SCHCP), which was submitted to the Service with its ITP application.

Consultation History

September 30, 2005	The Service receives the ITP Application for SCHCP.
July 23, 2007	The Service issues the Shadow Canyon ITP to the applicant.
June 28, 2011	USACE authorizes Shadow Canyon project by Nationwide Permit 29.
March 18, 2012	Nationwide Permit 29 expires.
June 25, 2012	The Service meets with the applicant, attorneys, and consultants to discuss project history, Shadow Canyon ITP, and type of permit amendment needed to include Georgetown salamander.
August 22, 2012	The Service publishes a proposed rule to list Georgetown salamander as endangered and proposes 14 critical habitat units within Williamson County.
August 24, 2012	Service provides a letter to the applicant on Georgetown salamander, describing issues that need to be addressed prior to amending ITP, including biological surveys and documents related to a major amendment of an HCP.
February 13, 2013	Applicant submits Nationwide Permit 29 application to USACE
April 30, 2013	The Service meets with the USACE, the applicant's attorneys and consultants regarding consultation and conference processes under section 7 and development plans.
September 4, 2013	USACE provides the Service with Shadow Canyon biological assessment, and requests conference.
January 30, 2014	The Service requests a 60-day extension to the consultation period.
February 24, 2014	The Services publishes final rule listing Georgetown salamander as threatened (effective March 26, 2014) and proposes a 4(d) rule for activities consistent with Georgetown ordinance for certain types of developments.
April 7, 2014	The Service provides the USACE with the draft biological opinion and draft conference opinion.
April 24, 2014	The USACE provides the Service with preliminary comments on the draft biological opinion.
August 21, 2014	The applicant provides comments to the USACE on the draft biological opinion.
October 8, 2014	The USACE provides the Service with final comments on the draft biological opinion.

Biological and Conference Opinion

I. Action Area and Description of the Proposed Action

Action Area

For the purposes of section 7 consultation, the Service defines the action area as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area affected by the project (50 CFR 402.02). The September 4, 2013, BA did not describe the action area. Therefore, based on the information contained in the BA, we have determined that the action area for this conference includes the 311-acre parcel of land owned by the applicant where future commercial and residential development is planned along with nearby areas and a downstream reach of the South Fork of the San Gabriel River. The regulated placement of fill into waters of the U.S. will occur on the parcel. Indirect effects of the action may occur in areas that are on- or off-site, and are nearby or downstream of the parcel.

The Shadow Canyon development (Project) is located south of State Highway 29 (SH 29) and west of Georgetown, Texas, and is partly in the Edwards Aquifer recharge zone and partly in Edwards Aquifer Contributing Zone as delineated by the Texas Commission on Environmental Quality (TCEQ 2005). The Shadow Canyon parcel is bounded on the north by SH 29, on the south by the South Fork of the San Gabriel River, and on the west and east by undeveloped private properties. The Service defines the action area for this consultation as the 311-acre Shadow Canyon parcel, all areas within 0.5 mile of the Shadow Canyon Tract, and about 6.7 river-miles of the South Fork of the San Gabriel River (Figure 2). The action area includes areas affected by direct and indirect effects, namely: (1) waters of the U.S. requiring section 404 authorization, (2) the Shadow Canyon Tract and areas adjacent to the Shadow Canyon Tract, (3) part of the Edwards Aquifer Recharge Zone, (4) the South Fork of the San Gabriel River at and downstream of Shadow Canyon to proposed subsurface critical habitat Unit 14 (San Gabriel Park), and (5) off-site areas adjacent to Shadow Canyon where roads, bridges, and developments are likely to occur. Given the uncertainty about the boundaries of the Shadow Canyon Spring springshed, it is possible that some of the recharge for Shadow Canyon Spring may come from areas outside the action area. However, the action area, inclusive of land and water within 0.5 mile of Shadow Canyon (and the nearby downstream reach of the South Fork of the San Gabriel River), is believed to capture the primary areas influenced by the Shadow Canyon development. The entire action area overlaps with either Edwards Aquifer recharge zone or contributing zone.

Proposed Action

The applicant has requested USACE authorization to place fill material into five jurisdictional waters of the U.S. in order to build roads, housing, and commercial development on the Shadow Canyon parcel. The Preconstruction Notification and January 2011 Nationwide Permit (NWP) 29 Authorization Request Submittal includes figures and tables providing the linear, areal, and volumetric aspects of fill to be placed in the creeks on the Shadow Canyon tract to accommodate the construction of a residential subdivision with roads. A summary of the regulated fill amounts is shown in Table 1. Waterways are numbered by the applicant and refer to the information provided by the applicant to the USACE.

The BA shows the original alignment of proposed roads in the Shadow Canyon tract. However, the applicant has agreed that no roads will be built within 80 meters of Shadow Canyon Spring.

Table 1. Water ID, Length of Impact, Area of Impact in Square Feet and Acres

Waterway ID	Linear Impact (Meters)	Areal Impact (Meters Square)	Total Impact (Acres)
1	705	83	0.02
2	no impact	no impact	no impact
3	722	26	0.01
4	640	19	0.00
5	7,477	646	0.16
Total	9,544	773	0.19

Interrelated and Interdependent Actions

The interrelated activities are activities that are part of the proposed action and depend on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation. The interrelated and interdependent actions include: development of a residential and commercial subdivision including roads, stormwater system, water supply system, wastewater system, power and telecommunication utilities, single family homes, multi-family apartments, and commercial business establishments.

Proposed Land Use Changes

The BA describes the proposed Project on the Shadow Canyon parcel. The major aspects of the proposed development are as follows:

- 658 to 674 lots of single family residential development
- 25 acres (400 units) of multi-family residential development
- more than 30 streets, estimated total length 6.5 miles and exceeding 45 acres
- 10.4 acres of retail development
- 1.8 acres of community amenities
- 70 acres of open space, including:
  - 25.65 acres of water quality easements, open space, and parkland
  - a pre-existing 43.84 acre karst preserve to be maintained in a natural condition

Impervious Cover

The drawings provided in the NWP 29 application show 658 single family lots on about 135.4 acres, excluding a 4-acre area labeled Phase 2 (revision) with 18 replacement lots. The average lot size for single family residential is estimated at 0.2 acre based on ACI Consulting Inc. figures (Figure 3). The average impervious cover for the single family residential land use (5 lots per acre) is estimated at 48% based on data presented in Cappiella and Brown (2001). USDA (1986) estimated multi-family residential development (townhouses) to have impervious cover of 65%. This is slightly higher than the maximum impervious cover for multi-family residential development stated in the Georgetown Unified Development Code (GUDC)(City of Georgetown

2012), which allows 50% impervious cover. The GUDC allows up to 60% impervious cover for multi-family residential development if a bonus is granted for designation as a Conservation Subdivision. The BA did not provide estimates of impervious cover by land use. The BA did not discuss designation as a Conservation Subdivision nor describe whether landscaped pervious medians would be part of the roads and streets of Shadow Canyon; therefore, the impervious cover associated with roadways (curb to curb) is assumed to be 100%. According to the GUDC, non-residential development, such as a retail center over the Edwards Aquifer recharge or contributing zone, is allowed 70% impervious cover for the first 5 acres and 55% impervious cover for the remain acreage. A retail development of 10.4 acres would be allowed about 62% impervious cover. The parts of Shadow Canyon designated karst preserves, bird preserve, park land, open space, and water quality easements have an unknown but likely small amount (near 0 or 1%) of impervious cover.

The wastewater system will convey sewage by gravity to a regional wastewater treatment plant. Notably, the proposed apartment and retail development as well as most of Phase 1 and 2 residential development will occur on the Edwards Aquifer recharge zone. The 43.84 acre karst preserve system is a required condition of the Service's ITP for the Shadow Canyon parcel.

Waterways and Stormwater Management

Shadow Canyon tract has two draws; waterway 5 (labeled WAT-5 in the BA) forms the western draw along the western property boundary and waterway 1 (with several short tributaries) forms the eastern draw. Figure 1 shows these waterways and the proposed development. The proposed stormwater system for Shadow Canyon will use conventional collection and pipeline conveyance methods and will treat stormwater with four water quality ponds prior to discharging flow into the South Fork of the San Gabriel River (South Fork). The following discusses these creeks (waterways) in order from west to east. Stormwater treatment on Shadow Canyon is relevant to Edwards Aquifer water quality since the South Fork crosses the Edwards Aquifer recharge zone upstream of San Gabriel Springs and the proposed critical habitat Unit 14.

Shadow Canyon Spring occurs in waterway 5 at an approximate elevation of 830 feet based on U.S. Geological Survey topographic maps. Waterway 5 meanders on and off of the parcel along the western boundary. According to a figure in the NWP 29 application titled "Proposed Preliminary Plan with WW Easement" waterway 5 will be altered during phase 4 of project development. The alteration includes 7,477 meters of channel covering 0.16 acres (Table 1). The placement of fill into waterway 5 will be located about 435 meters downstream of Shadow Canyon Spring.

The next waterway moving eastward is Waterway 2 which begins in a SCHCP karst preserve, runs about 323 meters southeast, and then joins waterway 1. No fill or alterations are proposed for waterway 2. Waterway 3 begins near the proposed cul-de-sac of Ridge Runner Drive and runs about 117 meters southeast and joins waterway 1. Part of the proposed action includes treatment of stormwater before reaching the South Fork of the San Gabriel River. Stormwater treatment pond 1-B is proposed to treat runoff from residential development in Phase 1. Waterway 1 begins near proposed Ridge Runner Drive just west of Channock Drive, and runs south through open space and parkland to its confluence with the South Fork of the San Gabriel River. Stormwater treatment pond 1-A is proposed to treat runoff from the residential and

commercial development in Phase 1. Waterway 4 is a 214 meter tributary of waterway 1. Stormwater treatment pond 1-C is proposed to treat residential runoff from the Mystic Canyon Lane area of Phase 1.

One factor to consider is the likelihood that part of Shadow Canyon's stormwater plans will need to be revised in order to maintain the natural integrity of the karst preserves established pursuant to the SCHCP. One of the proposed stormwater treatment ponds and part of another (shown in figures included in the NWP application) are in the SCHCP karst preserve. The Shadow Canyon subdivision phase plan figure shows Pond 1-B in the designated SCHCP karst preserve. Similarly, part of Pond 1-A appears to be located in the karst preserve.

Roads

There are four phases to the proposed development with an ultimate build out of more than 30 streets (curb and gutter) totaling about 6.6 miles and more than 14 acres in Shadow Canyon. The 2030 Comprehensive Plan (Georgetown Master Plan) identified planned roads to serve planned growth. Two of the proposed roads in Shadow Canyon appear to serve future developments adjacent to Shadow Canyon.

Recommended long term improvements by the City of Georgetown list nine new roadways including SW 3, which is proposed to run from SH 29 through the property to the west of Shadow Canyon and intersect Shadow Canyon Drive near Shadow Canyon Spring. SW 3 in Shadow Canyon is labeled Centre Drive on some figures. SW 3 crosses proposed subsurface critical habitat of the Georgetown salamander and at the southern end of the Shadow Canyon development would cross the South Fork of the San Gabriel River.

Shadow Canyon Drive begins at SH 29 and runs south and then west intersecting SW 3 near the proposed surface critical habitat. Significantly, this proposed street, west of SW 3 divides an area proposed for water quality easement and appears to be extended in the future to the west of Shadow Canyon.

Please refer to the BA and NWP 29 application for more details of the proposed action.

Conservation Measures

Conservation measures are actions to benefit or promote the recovery of listed species that are included by the Federal agency as an integral part of the proposed action. These actions will be taken by the Federal agency or the applicant, and serve to minimize or compensate for, project effects on the species. The applicant has proposed several measures as part of the project that are intended to reduce the effects of the project on the Georgetown salamander, in particular to reduce water quality impacts from the project. To reduce the amount of sediment that is transported to waterways during construction, the applicant will use the best management practices (BMPs) for construction (silt fences, etc.). Post-construction and for the long-term, a minimum of 80% of total dissolved solids (TSS) will be captured through four water quality retention ponds. Municipal approvals for the Shadow Canyon development predate the 2013 Georgetown Edwards Aquifer Recharge Zone water quality ordinance. The planned retention ponds filter stormwater before the flow discharges to the South Fork of the San Gabriel River. The applicant will construct and maintain water quality ponds to meet or exceed the TCEQ's

minimum requirement under its Edwards Rules for 80 percent removal of total suspended solids (TSS).

Regarding Shadow Canyon roads and streets, the curb and gutter design is listed by the BA as a conservation measure, diverting runoff from impervious cover away from Shadow Canyon Spring. Roadways may also be contributors of sediment and contaminants into waterways which reduce water quality, particularly when stormwater flow depth exceeds curb height. Overtopping of the curbs may happen when storm events involve high rainfall rates or when storm precipitation total approach the 1 to 5 year return interval (e.g., precipitation total exceeding 3 inches in 24 hours). The BA states:

> The design of this project would employ the use of concrete street curb and gutters to contain and convey the storm water run-off to the designated points of release. These points of release would be sedimentation and filtration basins that would be designed according to the TCEQ guidelines. This would ensure the capture of sediments and would treat the first flush run-off of storm water to remove total suspended solids by a minimum of 80 percent (as required by TCEQ). The land plan has locations designated to construct these basins. The basins would be maintained by the property owners association.

Shadow Canyon site plans identify areas labeled water quality easement (WQE). A WQE is an area designated to be permanently maintained in a natural state. The GUDC defines nonstructural stormwater management as "any natural or planted vegetation or other nonstructural components of the stormwater management plan that included no excavation and provides or enhances stormwater quantity and/or quality control or other stormwater management benefits, and includes, but is not limited to, riparian buffers, open and green space, overland flow filtration areas, natural depression, and vegetated channels". An easement is a dedication by a property owner for specific purposes, which in the case of WQE is to limit water quality degradation by maintaining natural vegetation to help improve stormwater runoff quality.

There are two WQEs at and near Shadow Canyon Spring. The larger of the two is about 6.8 acres and includes Shadow Canyon Spring. The smaller is 0.5 acre and is just north of Shadow Canyon Spring. Both are bordered by proposed road SW 3 and the western property boundary. The WQE areas are separated by an extension of Shadow Canyon Drive, which appears to have no utility except to connect to a future road west of Shadow Canyon.

Appendix D of the NWP 29 application shows the planting area and plant list for areas downstream of Shadow Canyon Spring. However, close coordination with the Service prior to any disturbance to aquatic habitats associated with Shadow Canyon Spring and Waterway 5 (downstream of Shadow Canyon Spring) is recommended to help avoid adverse effects to Georgetown salamanders. For example, substrates in occupied habitats should not be disturbed since the population size for Shadow Canyon Spring is unknown and potentially small.

As mentioned above, the Applicant has agreed the project will not locate any roads in Shadow Canyon within 80 meters of Shadow Canyon Spring consistent with the no disturbance zone measure in the proposed section 4(d) special rule for the Georgetown salamander (79 FR 10077). This represents both a revision to the project description and an additional conservation measure.

II. Status of Georgetown Salamander

On February 24, 2014, the Service published its final rule to list the Georgetown salamander as a threatened species, and we concurrently published a proposed 4(d) special rule containing measures that provide for the conservation of the species (79 FR 10077). Currently, both the special rule and critical habitat are proposed.

A. Description of Species and Proposed Critical Habitat

The GS is an aquatic and neotenic (retains juvenile characteristics at maturity) amphibian. Adults are about 2 inches long and have 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, while its 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 and cream-colored to translucent toward the outer margin. Unlike the Jollyville Plateau salamander, the GS has a distinct dark border along the lateral margins of the tail fin (Chippindale et al. 2000).

Proposed critical habitat consists of four components: (1) water from the Northern Segment of the Edwards Aquifer, (2) rocky substrate with interstitial spaces, (3) aquatic invertebrates for food, and (4) subterranean aquifer for shelter and protection during periods of drought or dewatering on the surface in and around spring sites. Proposed critical habitat includes both surface and subsurface habitats. The proposed surface critical habitat would include the spring outlets and the spring run extending 50 meters downstream. Generally, the proposed subsurface critical habitat would include the groundwater and water-filled conduits of the Edwards Aquifer within 300 meters of the spring (or water-filled) cave.

B. Life History

GS live underwater in springs, creeks, pools, and in the water-filled spaces in subterranean karst rock. Typically, GS are found where the gravel and cobble substrate is suitable to meet their life history requirements and prefer to use larger cobble and boulders as cover from predators (Pierce et al. 2010). Georgetown salamanders are usually within 164 feet of a spring outlet (Pierce et al. 2011a) but are more abundant within 16 feet of a spring (Pierce et al. 2010). In contrast, Jollyville Plateau salamanders, a closely related species, have been found farther from spring openings. During a recent mark-recapture study of Jollyville Plateau salamanders in a nearby watershed, researchers found marked individuals moved up to 262 feet both upstream and downstream from a spring outlet (Bendik 2013, pers. comm.) suggesting that *Eurycea* salamanders in central Texas can travel greater distances from a spring opening than was previously thought.

Feeding biology in GS has not been studied but if similar to other central Texas Eurycea, GS feed on amphipods, ostracods, chironomid larvae and pupae, and small snails (Tupa and Davis 1976).

Reproductive biology in GS has not been studied. Assuming reproduction in Georgetown salamanders is similar to the San Marcos salamander (*Eurycea nana*), males would become sexually mature the time that they grow to a snout-vent length of about 20 mm. Female *Eurycea nana* with a snout-vent length greater than 20 mm carry ova (Tupa and Davis 1976) and are considered gravid. *Eurycea* may become sexually mature in less than one year (Gluesenkamp, TPWD, pers. comm. 2014). Courtship and egg deposition by GS have not been observed. Pierce (2012) and Pierce and McEntire (2013) reported the percent gravid GS found in monthly surveys at Twin Springs and Swinbank Springs. It appears gravid GS peak in late fall and spring with few or no gravid GS reported in most summer months. The majority of gravid salamanders observed were found from November through April.

Predator recognition and avoidance by *Eurycea nana* was documented by Epp and Gabor (2008). The most likely predators of GS include sunfish, snakes, and birds, particularly waterbirds.

C. Population Dynamics

It is not known or estimated how many Georgetown salamanders there are range-wide. We know of only two locations where the GS population has been estimated. These estimates were made from data collected at Twin Springs and Swinbank Springs, both located in Williamson County, Texas. The information collected from these sites indicates that the populations change seasonally, increasing in the spring and decreasing in the fall with wide monthly variations (Pierce and McEntire 2013). Assuming the spring runs in their study (Pierce et al. 2014) averaged about 1 meter wide, the density of GS at Twin Springs and Swinbank Springs averages about 5 GS per meter^2.

The number of GS at a location can be estimated using different methods. Recent mark-recapture studies estimate a population size of 100 to 200 adult salamanders each at Twin Springs and Swinbank Spring (Pierce 2011a, Pierce et al. 2014). At other sites the number of GS is unknown. In some instances, researchers have counted salamanders that seen at the surface. This method is expected to undercount salamanders because it relies on only those that can be seen at the surface. In our review of survey data, we found that with the exception of Twin Springs and Swinbank Springs, all sites that had been surveyed in the last 10 years had less than 50 GS. In some cases, there were considerably fewer salamanders (as little as 4) and at some sites, GS could no longer be found.

There are other springs in Williamson County that may support Georgetown salamander populations, but access to the private lands where these springs are found has not been allowed, which has prevented surveys being done at these sites (Williamson County 2008).

D. Status and Distribution

The entire range of the Georgetown salamander is in within Williamson County, Texas. All of the known GS locations are either at spring outlets or in wet caves. The known surface spring locations are in the San Gabriel river basin, specifically in five of its tributaries (South Fork, Middle Fork, North Fork, Berry Creek, and Cowan Creek). A groundwater divide between the watershed of the South Fork of the San Gabriel River and Brushy Creek watershed to the south

likely creates the division between the ranges of the Jollyville Plateau salamanders and GS (Williamson County 2008). Table 2 and Figure 4 show the current and historical GS localities.

Table 2. Historic Georgetown Salamander Localities

Site No.	Site Name	Population Size
1	Avant Spring	Unknown
2	Bat Well Cave	Unknown, May Be Extirpated
3	Buford Hollow Spring	Unknown, May Be Extirpated
4	Cedar Breaks Hiking Trail Spring	Unknown, May Be Extirpated
5	Cedar Hollow Spring	Unknown
6	Cobb Spring	Unknown
7	Cobb Well	Unknown
8	Cowan Creek Spring	Unknown
9	Garey Ranch Spring	Unknown
10	Hog Hollow Spring	Unknown
11	Hog Hollow II Spring	Unknown
12	Knight Spring	Unknown
13	San Gabriel Spring	Unknown, May Be Extirpated
14	Shadow Canyon	Unknown, Estimated at 8•
15	Swinbank Spring	100 - 200
16	Twin Spring	100 - 200
17	Walnut Spring	Unknown
18	Water Tank Cave	Unknown

• Based on 1.6 meter^2 of suitable habitat and a density of 5 GS per meter^2.

Where it has been surveyed, observations of this species have been declining, and surveys have not been consistently conducted at all sites, confounding the difficulty of estimating population size and trends. For example, the GS has not been observed in more than 10 years at two spring sites (San Gabriel Spring and Buford Hollow Spring) despite several visual survey efforts (Pierce 2011, Southwestern University, pers. comm.). While we are unaware of any population surveys in the last 10 years from a number of sites, the Georgetown salamander continues to be present at the following sites: Avant Spring, Swinbank Spring, Knight Spring, Twin Springs, Cowan Creek Spring, Cedar Hollow Spring, Cobbs Spring, Walnut Spring, and Water Tank Cave (Pierce 2011c, pers. comm.; Gluesenkamp 2011a, TPWD, pers. comm.). For the most recent information on the distribution of this species, please see the final listing rule published in the Federal Register on February 24, 2014. To summarize, of the 18 known or historically occupied GS sites, only 12 sites have been recently surveyed and confirmed to have GS present. Of these 12 sites, only two sites (Swinbank Spring and Twin Spring) have been surveyed consistently (monthly) (Pierce and McEntire 2013).

The distribution of aquatic organisms is often described by the watersheds in which they occur. The United States is divided and sub-divided into successively smaller hydrologic units. The nested units represent watersheds that are uniquely identified using a system of hydrologic unit codes (HUCs). The number of digits in a HUC indicates the level of watershed where fewer

digits are larger watersheds and more digits are smaller sub-basins within the larger watersheds. Considering the full range of the GS, all known localities are found in one HUC8 watershed, four HUC10 watersheds, and six HUC12 watersheds. With the exception of a recently documented GS population at Garey Ranch Spring, the Shadow Canyon Spring population is the only other known GS population in the southern part of the GS's range.

There are 14 proposed critical habitat units distributed across the known range of the species at sites that have been monitored recently and others that have not been recently surveyed. The most southern subwatershed with a proposed critical habitat unit, the Lower South Fork of the San Gabriel River, has only one proposed critical habitat unit (unit 13). In contrast, the Lake Georgetown subwatershed, has seven proposed critical habitat units.

Reasons for Listing

1. Habitat Modification

Habitat modification is the primary threat to the Georgetown salamander. The Georgetown salamander faces habitat modification from degraded water quality, reduced water quantity, and physical habitat disturbance. Urbanization within the watershed is one of the activities resulting in pollution that may decrease water quality in stormwater, groundwater, and springflow. Urbanization of a watershed may modify the spatial distribution and rates of infiltration in the recharge zone. Urbanization results in an increase in impervious cover and typically an engineered stormwater system to convey runoff, resulting in decreased recharge.

Impervious Cover and Contaminants in Runoff

The Service has reviewed and analyzed the published effects of impervious cover in its February 24, 2014, final rule (final rule) to list GS as a threatened species (79 FR 10236). While the effects of an increase in impervious cover for a given site depend on local conditions, the observed trend is a degradation of aquatic habitats that increases with greater levels of impervious cover.

In the final rule, we also describe the contaminants expected to be found in urban runoff and as a result of land applications. Residential subdivisions in central Texas often include lawn irrigation systems that may overwater the turfgrass and ornamental gardens. Irrigation systems may leak creating a means of mobilizing chemicals used in lawn applications. In addition to suspended solids, nutrients (primarily nitrogen and phosphorous compounds), trace metals (e.g., lead, copper, and zinc), pesticides (includes herbicides), and coliform bacteria are transported by runoff. Runoff with these contaminants may result in a decrease in invertebrates including part of the salamander's preybase. Polluted runoff may also directly affect salamander health, growth, reproduction, and potentially survival. Apparently unregulated in Williamson County, coal tar based pavement sealants may result in high concentrations of polycyclic aromatic hydrocarbons (PAHs). PAHs at certain concentrations and exposures are known to adversely affect freshwater invertebrates and amphibians (Albers 2003, Sparling et al. 2009).

Vulnerability of Groundwater to Pollution

Alley et al. (1999) stated "in principle, virtually any human activity at and near the land surface can be a source of contaminants to ground water as long as water and possibly other fluids move from the land surface to the water table". The first step and challenge to protecting ground water quality and quantity in Williamson County (that Georgetown salamanders rely on) is to know which areas contribute recharge to the subject springs and caves. Unfortunately, in springs and caves with karst aquifers as a source, a signficant difficulty is identifying the recharge zone, which may or may not coincide with the surface watershed. The recharge zone for a subject spring, referred to here as the springshed, may conform or overlap with the surface watershed in part or in whole. However, while karst groundwater flows downgradient, the flow paths do not necessarily conform to surface topography and groundwater may flow under topographic highs (B. Mahler, USGS, pers. comm., 2013). Groundwater dye tracing is considered the primary means of delineating the springshed and recharge features.

The U.S. Geological Survey (USGS) considered multiple methods of assessing the vulnerability of groundwater to contamination in the San Antonio, Texas area (Clark 2000, Clark 2003). These reports analyzed natural aspects related to soils, hydraulic properties of outcropping hydrogeologic units, presence or absence of caves, sinkholes and closed depressions, and slope of land surface. While depth to water was not used in the USGS vulnerability rating, depth to water is part of the U.S. Environmental Protection Agency's DRASTIC method (Aller et al. 1987) to evaluate groundwater pollution potential. In short, areas of the Edwards aquifer recharge zone with caves are rated relatively high for vulnerability to contamination. Additionally, abandoned wells may become conduits for groundwater pollution. Musgrove et al. (2011) identified the following anthropogenic sources that may affect groundwater quality: (1) septic systems, (2) leakage from municipal water and wastewater systems, (3) industrial, commercial, or residential use of fertilizers, pesticides, and volatile organic compounds (VOCs).

The Edwards Aquifer recharge zone in Williamson County is at risk from hazardous material that may be spilled or leaked potentially contaminating surface water, groundwater, or both. Spills may be the result of vehicle, pipeline, or industrial accidents. Quarry operations may also result in groundwater pollution. In January 2000, aboveground storage tanks at a quarry in Comal County spilled more than 2,600 gallons of diesel fuel. Markers diagnostic of diesel (naphthalenes and xylenes) surfaced at Comal Springs (Spring Run 1) about 4 miles away in 9 days (indicating a groundwater velocity of 0.47 miles per day).

Since these salamanders and their prey are strictly aquatic, water quality has been considered a main concern. All known GS localities are in Williamson County. Williamson County is experiencing rapid population growth and urbanization. Urbanization degrades water quality in stormwater runoff by increasing pollutant loads of sediment; oil, grease, and toxic chemicals from motor vehicles; pesticides and excess nutrients from lawns and gardens; viruses, bacteria and nutrients from pet waste and sewage systems; heavy metals from roof materials and motor vehicles; and thermal pollution from impervious surfaces such as streets and rooftops (USEPA 2003).

Water Quantity Reduction in Relation to Urbanization or Industry Effects

Adequate springflows and groundwater levels are essential to maintaining the known populations of GS. GS populations in water-filled caves may also need groundwater movement through their habitat. A risk to GS populations is groundwater development (pumping). Pumping during severe drought may result in loss of springflow and loss of all accessible salamander habitat. Limestone rock quarries are near several GS sites. Quarries may use groundwater. Quarrying physically modifies the surface - subsurface and may alter groundwater levels and flowpaths by lowering the land surface, potentially dewatering hydrologically connected areas.

The reduction or cessation of springflow at springs supporting Georgetown salamanders may result in extirpation of that population. Boghici (2011), referring in part to Williamson County, noted that the northern section of the Edwards Aquifer lacks a contributing zone and recharge is mostly from diffuse infiltration of rainfall on the Edwards Limestone outcrop. Williamson County is in the State of Texas' Groundwater Management Area 8. However, there are no groundwater conservation districts in Williamson County. The future aquifer levels of the Edwards Aquifer in Williamson County will depend on precipitation, the recharge rate, springflow rates, and groundwater demand.

2. Physical Modification of Surface Habitat

Physical modification of surface habitat may occur through impoundments, feral hogs, and livestock. Cattle and horses may trample spring runs. In addition to habitat modification, other factors are contributing to the decline of the species, such as disease, predation, inadequacy of existing regulatory mechanisms, and other natural or manmade factors. The species is at further risk because of its highly restricted range, small habitat patch sizes, and small population sizes.

Feral hogs, livestock, and human activities are among the most likely ways that spring sites may be disturbed. Feral hogs are becoming more abundant at spring sites with salamanders in Bell, Travis, and Williamson counties (O'Donnell 2006). The February 22, 2013, Austin American Statesman (Claire Osborn) reported on a local forum with Georgetown Police and others on feral hog problems in the Georgetown area. White (2011) reported cattle are present at two of the Georgetown salamander localities. Cattle and other livestock may trample and disturb wetland and riparian areas. It appears there are multiple instances humans have deposited gravel in spring habitat supporting *Eurycea*, potentially resulting in loss or severe reduction in suitable salamander habitat. This may be the case at the spring complex in San Gabriel River Park, where GS may be extirpated.

3. Small Population Size, Drought, Flooding, and Climate Change

As detailed in the final rule, there are other factors that may affect the continued occupation of a site by GS and the viability of the taxon. Available evidence, with the exception of a few sites, indicates that most local populations appear to be less than 200 individuals. The census size drives demographic and ecological processes while the effective population size determines the population response to evolutionary forces (Waples 2010). If sex ratios are skewed and/or non-random mating occurs, the effective population size of these sites will be significantly less than 200. These small population sizes make the populations vulnerable to local extinction due to

demographic and environmental factors. As Morris and Doak (2002) put it, given a small populations size, " a string of bad years will cause it to actually hit the (extinction) threshold".

Drought, particularly a multiyear drought, may reduce or eliminate habitats range-wide. Severe drought would lower surface water supplies and ground water levels. Lower groundwater levels means some springs will have decreased springflow or will cease to flow altogether. Flooding may result in geomorphic changes to the river channel, potentially scouring springs along the river margin. Lastly, according to Alley et al. 1999, climate change could affect groundwater sustainability in several ways: "(1) changes in ground-water recharge resulting from changes in average precipitation and temperature or in the seasonal distribution of precipitation, (2) more severe and longer lasting droughts, (3) changes in evapotranspiration resulting from changes in vegetation, and (4) possible increased demands for ground water as a backup source of water supply". While climate models are being downscaled to address regions like central Texas, there are indications that the southwest part of the U.S. will experience temperature increases along with more frequent hot extremes, heat waves, and heavy precipitation (IPCC 2007).

E. Analysis of Species and Proposed Critical Habitat Likely to be Affected

Many of the stressors discussed above are related to habitat modification and likewise are pertinent to proposed critical habitat effects analysis. The proposed action is likely to adversely affect Georgetown salamanders and their habitat that occur on or near the Shadow Canyon development site. We have listed the GS as threatened and proposed to designate critical habitat for this species in 14 units, including a unit 13. Unit 13 is located on Shadow Canyon Spring on the western side of the Shadow Canyon tract. The action area includes the entire proposed surface and subsurface critical habitat of Unit 13. The species and this unit are likely to be affected by the proposed action.

Summary of Threats to the Georgetown Salamander

The primary threat to the GS is habitat modification in the form of reduced springflows and degraded water quality in spring habitats as result of urbanization of the watersheds and recharge zones in Williamson County. The following table assigns known threats to the five factors used for listing decisions. The five factors are: (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; or (E) other natural or manmade factors affecting its continued existence. The rule provides a qualitative value of the expected level of the impact of the threat on the GS, which may change based on new information.

Table 3. Threats to the Georgetown Salamander

Factor	Type of Threat
A	Contaminants from stormwater runoff
A	Sedimentation from stormwater runoff
A	Changes in flow regime from impervious cover
A	Excess nutrient input
A	Pesticides
A	Catastrophic hazardous material spills
A	Pollution from construction activities
A	Construction of pipelines
A	Rock quarries
A	Groundwater pumping
A	Impoundments
A	Feral hogs
A	Livestock
A	Physical modification of surface habitat for human-related activities
A	Drought
A	Flooding
D	Climate change
E	Inadequacy of existing regulatory mechanisms
E	Synergistic and additive interactions among stressors
E	Ultraviolet-B radiation

III. Environmental Baseline

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and ecosystem within the action area.

A. Status of the Georgetown Salamander and Proposed Critical Habitat within the Action Area

Georgetown Salamanders in the Action Area

Known and Potential Sites

In the action area, the only documented population of GS occurs at Shadow Canyon Spring. Little is known about the population of Georgetown salamanders in Shadow Canyon Spring. Shadow Canyon Spring was surveyed on March 4 and May 27, 2004, but the September 19, 2005, ACI Consulting memorandum mentioning these two surveys does not qualify or quantify the survey effort nor report the number of GS seen. Kemble White reported observing a single salamander in a small pool of water in Shadow Canyon Spring within the stone "masonry spring box" on July 20, 2009 (K. White, pers. comm, 2014). He described the box as circular, about 3 feet in diameter, and about one foot high. In summary, we do not have any historic or recent information on the local population size, area of suitable habitat available, or the condition of Georgetown salamanders in Shadow Canyon Spring. The population of the Georgetown salamanders in Shadow Canyon Spring is inferred to be small (less than 10 individuals) based on the limited amount of spring dominated aquatic habitat and abundance estimates of Georgetown salamanders at other small springs.

A water well (F-36 from the Geologic Assessment prepared by ACI Consulting, 2002) on the Shadow Canyon tract also represents an additional site that may be occupied by Georgetown salamanders. This well is 8 feet in diameter, 208 feet deep with a 30 feet catch basin. The water level in the well on July 15, 2002 was reported as 35 feet below land surface. Given an estimated elevation of 865 to 870 feet, the water level in the well is similar to the elevation of Shadow Canyon Spring. If well F-36 is hydologically connected to Shadow Canyon Spring, it represents: (a) potential GS habitat and (b) potential means of (conduit for) groundwater contamination and pollution of Shadow Canyon Spring. However, we are unaware of any biological surveys or inventories of this nearby well. Like other wells in the recharge zone near GS occupied springs, this well represents potential GS habitat given the network of groundwater may have water-filled conduits connecting the well to Shadow Canyon Spring.

There are at least two other small springs (F-14 and F-15) on the Shadow Canyon tract, which during wetter times may have been hydrologically connected to the spring run associated with Shadow Canyon Spring. Based on the availability of spring habitat in proximity to Shadow Canyon Spring, it is a clear possibility that Georgetown salamanders occupied and may continue to occupy one or both of the small springs (F-14 and F-15) associated with waterway 1 (WAT-1).

The Service has developed Scientific Permit Requirements for conducting Georgetown salamander surveys (revised June 26, 2014 and available online) to produce sound scientific

information upon which to base decisions and conservation actions. A minimum of 15 sequential surveys are needed to better determine whether Georgetown salamanders occupy a site. The Service believes the proximity of these spring-seep habitats (F-14 and F-15) and groundwater habitat (F-36) to Shadow Canyon Spring signifies the potential for Georgetown salamanders to be present. The surveys conducted by ACI Consulting on March 4 and May 27, 2004 do not satisfy our current standards to determine absence of this species at a site.

Proposed Critical Habitat in the Action Area

Proposed critical habitat unit 13 is centered on Shadow Canyon Spring. Shadow Canyon Spring is the only documented GS locality in the action area. According to the BA's Appendix B, the site has indicators of fairly perennial flow such as wetland vegetation and sustained spring fauna. The author of Appendix B, Mark Adams, states that rainfall is captured in upland karst features (caves, sinkholes, and solution cavities) and as groundwater follows conduits developed in Edwards Limestone, springflow emerges at the spring orifice. The spring run associated with Shadow Canyon Spring, in the summer of 2010, ended about 600 feet downstream of the spring where surface flow is lost to alluvium.

The vital needs provided by proposed critical habitat unit 13 to the Georgetown salamanders on the individual scale include: (1) space to feed on their invertebrate preybase, (2) an aquatic environment with water quality within the physiological tolerances of the Georgetown salamander and its preybase, and (3) areas to shelter, grow, and reproduce. Table 4 provides the primary constituent elements (PCE) for proposed critical habitat of the GS (77 FR 50768).

On a population scale, proposed critical habitat unit 13 provides vital needs in the form of perennial springflow supporting aquatic habitats near the spring and downstream. On the rangewide scale, proposed critical habitat unit 13 is only one of two critical habitat units from the South Fork of the San Gabriel River hydrologic unit. While it is too distant and isolated from other known GS populations to realistically be involved in intersite movement, unit 13 represents one of only 14 critical habitat units for the species and thus is important in the species conservation.

Table 4. Primary Constituent Elements (PCE) of Proposed Critical Habitat for Georgetown Salamanders

PCE NUMBER	Georgetown Salamander Proposed Critical Habitat Primary Constituent Elements from Proposed Rule, August 22, 2012
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.

B. Factors Affecting Species Environment within the Action Area

Water Quality

The water quality of Shadow Canyon Spring and proposed critical habitat unit 13 has not been characterized but are inferred to be supportive of the Georgetown salamander and its preybase based on the mostly natural conditions of the area above the spring. A large (8-ft diameter, 208 ft deep) abandoned well on the Shadow Canyon tract (F-36) was reported by ACI Consulting (2002) but not mentioned in the BA. Wells may be vandalized and become conduits for groundwater contamination. The Texas Water Development Board well database includes several wells in the action area along SH 29. Dye trace research, which would identify recharge features and inform us of the general groundwater pathways, has not been done in this part of the Edwards Aquifer. Precipitation in the recharge zone in areas near the spring is likely to contribute to springflow. While we are currently unable to identify specific areas where human activities are most likely to degrade groundwater and affect the water quality of Shadow Canyon Spring, continuous adequate water quality and springflow will depend on maintenance of natural areas near and upgradient from the spring.

Water Quantity

There are only a few recorded observations of the springflow discharge rate from Shadow Canyon Spring. Appendix B of the BA states that the spring is located just above the lithologic contact of the Edwards Limestone and the underlying Comanche Peak Limestone. Above the spring, the Edwards Limestone is karstified and part of the Edwards Aquifer Recharge Zone as delineated by the TCEQ. The Shadow Canyon Spring was visited on July 26, 2010, by ACI Consulting staff who reported springflow discharge of 3 to 5 gallons per minute (0.007 to 0.011 cubic feet per second). Shadow Canyon Spring was visited by Kemble White in July, 2009, and he reported the springflow as a trickle. We are unaware of any other spring discharge estimations. Shadow Canyon Spring is a small spring and the surface area of aquatic habitat (including the bed of spring and the vertical surfaces of the spring box) is likely to be smaller than better studied GS localities like Swinbank Spring. We have no reports of springflow failing at Shadow Canyon Spring and we infer flow there is perennial at least in recent years. The current quantity of Georgetown salamander habitat in the action area is likely to support a small salamander population. However, because it is a small magnitude spring, it may be adversely affected by: (1) alterations in its recharge area that prevent or reduce recharge and infiltration, (2) pumping or inadvertent interception of groundwater in the area, and (3) reduced rainfall during a drought. Potentially even a slight decrease in groundwater levels may result in loss of flow at Shadow Canyon Spring.

Currently, there is no comprehensive groundwater permitting authority in Williamson County. While Jones (2003) reported that total annual pumpage from the Northern Segment of the Edwards Aquifer is predicted to fall in the range of 5,000 to 10,000 acre-feet per year, no pumping data relevant to the Edwards Aquifer and its springs in Williamson County have been provided.

Physical Disturbance of Habitat

The BA included photographs of Shadow Canyon Spring surrounded by a short limestone masonry wall. The pool formed by a circular stone masonry wall reported to be about 3 feet in

diameter and 1 foot high. To the best of our knowledge, the condition of this small spring is the same as when it was surveyed in 2004.

IV. Effects of the Action

This section includes an analysis of the direct and indirect effects of the proposed action and its interrelated and interdependent activities on the species and/or proposed critical habitat.

A. Factors to be considered

This analysis will look at the effects in four focal areas, beginning with Shadow Canyon Spring and extending outward: (A) Shadow Canyon Spring and associated aquatic habitat, (B) the proposed surface critical habitat found within 50 meters of Shadow Canyon Spring, (C) the proposed subsurface critical habitat consisting of the Edwards Aquifer within 300 meters of Shadow Canyon Spring, and (D) the surface watershed above Shadow Canyon Spring and the potential recharge zone of Shadow Canyon Spring (herein, Shadow Canyon Spring Springshed) (Figure 5).

The effects of the action depend on understanding how a wide variety of activities and land use changes affect: (1) groundwater-springwater water quality and (2) the areal extent and rate of recharge and infiltration to the part of the Edwards Aquifer contributing to flow to Shadow Canyon Spring. A primary factor of our uncertainty arises from not knowing the boundaries of the Shadow Canyon Spring Springshed (focal area D). The recharge area to karst spring systems is not necessarily obvious and cannot be strictly determined from a topographic map (Barbara Mahler, USGS, pers. comm. 2013). Notwithstanding the difficulties in determining the recharge area for Shadow Canyon Spring, our assumption in this opinion is that the upland area of the Shadow Canyon tract (land above the elevation contour 830 feet) provides a non-trivial amount of the recharge for Shadow Canyon Spring. Due to the relatively low springflow rate at Shadow Canyon Spring, pollution of groundwater flowing through the conduits to Shadow Canyon Spring would be expected to have a significant effect to the spring fauna. The primary effects of the action are related to the land use changes proposed after the section 404 work is done. Therefore, land activities that generate polluted stormwater, which may infiltrate and percolate to the Edwards Aquifer (the source of Shadow Canyon Spring), represent the most likely contributor to spring water quality degradation and adverse effects to the GS.

Proximity to the Action

The activities proposed to be authorized by the USACE occur downstream of Shadow Canyon Spring or in an adjacent draw. The Shadow Canyon development involves land use changes from oak-juniper woodlands to roads, apartments, homes, and businesses. The roads, stormwater system, and sewage pipeline system necessary for the development will cross majority of the 311 acre tract. A significant portion of these land use changes are in the Edwards Aquifer Recharge Zone and at elevations above Shadow Canyon Spring.

Distribution and Timing

The activities authorized by the proposed section 404 permit are expected to be done within a year of this opinion. The development of Shadow Canyon is proposed in four phases. Several

aspects including the apartment complex and commercial development are not identified with a particular phase.

Nature of the Effect and Duration

The activities authorized by the proposed section 404 permit are not expected to disturb or alter Shadow Canyon Spring. A water quality pond (1-C) is proposed just upstream of Spring F-14. The land use changes above Shadow Canyon Spring are expected to alter the quantity of water recharged to the Edwards Aquifer. The baseflow of area springs may decrease as there will be an increase in imperviousness of the Edwards Aquifer Recharge Zone in the Shadow Canyon tract. The proposed apartment complex is expected to have a large roof and parking lot. Concentrated runoff may form channelized paths through the thin soils to undiscovered solution openings in the Edwards Limestone. When rainfall reaches certain thresholds, infiltration and percolation of development runoff is expected to reach groundwater conduits leading to Shadow Canyon Spring. We expect there will be extended periods where springflow and spring water quality will be normal, but post-development there will be intermittent periods where rainfall overtops curbs and stormwater inlets potentially carrying heavy metals and pesticides to Shadow Canyon Spring.

B. Analyses for the Effects of the Action

Direct Effects

No direct effects to GS salamanders are expected due to the location of the activities authorized by the proposed section 404 permit away from and downgradient of Shadow Canyon Spring.

Indirect Effects

The proposed development of roads, single family homes, and apartments in proximity to Shadow Canyon Spring is a primary factor to be considered in the effects of the action. The BA identifies the preservation of open space at and near Shadow Canyon Spring as a conservation measure but the narrow configuration of the open space and adjacent roads present a scenario where an above average rainfall event episodically will likely result in stormwater spilling over conventional curbs and flowing to Shadow Canyon Spring. The presence of roads near the springs means the increased risk of vehicular accidents and hazardous material spills on what likely constitutes part of the recharge zone for the spring.

The proposed action involves land-clearing and construction of more than one hundred single family homes within 300 meters of Shadow Canyon Spring. The area associated with the distance of 300 meters of Shadow Canyon Spring is mentioned since it is represents the proposed subsurface critical habitat. The following is a summary of the main anticipated effects by focal area.

(A) Shadow Canyon Spring

Water Quality

The spring is located in a designated water quality easement and no planned land disturbance is expected in the immediate vicinity of the spring. The spring itself may be subject to an increased risk of vandalism and dumping due to an increase in the nearby human population. The

springbox, if intact, would generally prevent surface runoff in the WAT-5 draw from entering the spring. The exception would be during runoff events that overtop the springbox. The nearest weather station at Lake Georgetown provides daily precipitation totals since January 1982. In the 32-year period of record from 1982 through 2013, daily precipitation totals have met or exceeded 4 inches on 6 occasions or on the average, about once every five years (Table 5). According to the U.S. Department of Agriculture (1986), the 5-year 24-hour rainfall event for central Williamson County is 5.5 inches. Additionally, Williamson County is in the area designated as a Type III rainfall pattern. Type III represents Gulf of Mexico and Atlantic coastal areas where tropical storms bring large 24-hour rainfall amounts. Assuming future rainfall rates (on an hourly scale) and rainfall totals are similar, we expect stormwater runoff to intermittently overtop the springbox whenever flow in the WAT-5 draw exceeds the stone masonry wall. Additionally, infiltration may occur in the draw immediately upstream from the spring. If the runoff water quality is harmful to insects and other invertebrate prey, GS feeding will be adversely affected.

Table 5. Daily Rainfall Totals from Lake Georgetown Weather Station: 1982 through 2013

Daily (24 Hour) Total Precipitation in Inches, Met or Exceeded	Number of Events in Period of Record at Lake Georgetown Weather Station	Average Number of Events Per Year for Period of Record
1.5	176	5.50
2.0	91	2.84
3.0	29	0.91
4.0	6	0.19
5.0	2	0.06
14.0	1	0.03

Water Quantity – Effects to Potential Recharge

The Shadow Canyon Spring occurs on an area proposed to be maintained as a water quality easement. Left in a semi-natural state, we expect no changes to recharge potential in this area.

(B) Proposed surface critical habitat

Water Quality

Runoff from the Shadow Canyon development is expected to occasionally overtop the curb and gutter system associated with roads aligned close to the proposed surface critical habitat boundary. Additionally, two roadways nearly intersect the proposed surface critical habitat on the east and north. A spill or vehicle accident on these roads may lead to a pollution event reaching the proposed surface critical habitat.

Water Quantity – Effects to Potential Recharge

The subset of the proposed surface critical habitat in the Shadow Canyon tract is proposed to be maintained as a water quality easement. Left in a semi-natural state, we expect no changes to recharge potential in this area. The subset outside of the Shadow Canyon tract (immediately to

the west) is currently in the same semi-natural state. However, the two proposed roads (SW 3 and Shadow Canyon Drive) will alter the current surface topography and normally divert water that would have flowed across the recharge zone near (including upgradient from) Shadow Canyon Spring. In short, the proposed roads and other developments will likely decrease local recharge in the proposed surface critical habitat due to altered runoff patterns.

Anticipated effects in the proposed surface critical habitat include episodic high flow events that will likely scour the aquatic habitat downstream of Shadow Canyon Spring. When impervious cover in the watershed increases, the flows through the draw will become more flashy. Higher water velocities may potentially remove gravels, cobbles, and rubble substrate used by GS.

(C) Proposed subsurface critical habitat

Water Quality

The proposed land use changes in the area above proposed subsurface critical habitat represent a potential source of pollution. The BA provides minimal information on the Edwards Aquifer recharge zone land-surface water-table connection. Chemical applications within the Shadow Canyon tract are likely to include herbicides, fertilizers, termiticides, and other insecticides. These chemicals may dissolve in runoff or sorb to suspended sediments in runoff. The hazards to wildlife posed by these chemicals on residential single family lots, roads, and residential multi-family development are more likely when karst landscapes and thin soils are present since little filtration is likely to occur. In brief, springs in karst watershed setting are vulnerable to degradation from these anthropogenic chemicals and fecal group bacteria (from pets and leakage from sanitary sewer systems). A sewage leak that flowed through the subsurface to Shadow Canyon Spring would potentially harm most or all of the insects, crustaceans, and salamanders present if the high biological oxygen demand of sewage drove dissolved oxygen to an unsuitable level.

The application of chemicals on lawns and landscapes will result in runoff that will transport a wide variety of pollutants presently absent from the springshed. The introduction of contaminants by human activities is expected to take place in the residential single family lots above the proposed subsurface critical habitat. Since this area is the Edwards Aquifer recharge zone and generally overlaid by thin soils, precipitation falling directly on lawns may infiltrate the subsurface and flow to groundwater pathways leading to Shadow Canyon Spring. Runoff not conveyed by the stormwater system will pond, flow overland, evaporate, be taken up by plants, or infiltrate.

Water Quantity – Effects to Potential Recharge

Focusing on the area within the Shadow Canyon tract over the proposed subsurface critical habitat, the proposed land use changes will result in an increase in impervious cover from the current level near zero to the expected ultimate developed state of about 48 percent. The assumed impervious cover value for single family residential development with 0.2-acre lots is interpolated from data presented in Cappiella and Brown (2001). The assumed impervious cover value for multi-family residential development is based on impervious cover allowed under the Georgetown Unified Development Code for properties over the Edwards Aquifer.

Table 6 shows the breakdown of acreages and assumed impervious cover for proposed land use in Shadow Canyon above the 830 ft contour. This shows that for the subset of Shadow Canyon above Shadow Canyon Spring (830 ft elevation), impervious cover will reach about 48 percent, based on full build out.

Table 6. Land Use and Assumed Impervious Cover for Areas in Shadow Canyon above the Elevation of 830 ft.

Shadow Canyon Land Use above 830 ft Contour	Assumed Impervious Cover, in Percent	Area of Land Use Type above 830 ft Contour, in Acres	Percent of Total Area above 830 ft Contour	Incremental Contribution of Impervious Cover above 830 ft Contour, in Percent
Single Family Residential (mean 0.2-acre lot)	48 □	60.9	39	18.9
Multi-Family Residential	60 ♦	27.6	18	10.7
Commercial	62 ♦	10.4	7	4.2
Open Space	0 ●	33.1	21	0.0
Streets	100 ●	22.7	15	14.7
		154.7 Total Area, in Acres	100	**48.4% Impervious Cover for Area above 830 ft Contour**

□ Based on Cappiella and Brown 2001
♦ Based on Georgetown Unified Development Code (2012) and Conservation Subdivision Designation
● Based on the assumptions of no impervious cover in water quality easements and no pervious medians for streets

A concurrent decrease in recharge would be expected if the development occurs over the actual recharge zone for Shadow Canyon Spring. Herein, we focus on the subset of Shadow Canyon above the 830 ft contour because it is this area that has relevance to Shadow Canyon Spring and future springshed conditions. Even if the springshed occurs on properties external to Shadow Canyon, the ultimate development is expected to result in about 50 percent impervious cover upgradient from Shadow Canyon Spring. Given that Shadow Canyon Spring has a small discharge, it is likely that covering recharge features in its springshed will make it more likely that spring will cease flowing during an extended drought.

(D) Springshed for Shadow Canyon Spring

Water Quality

The effects in this focal area are expected to be similar to those described above for proposed subsurface habitat. The springshed may include State Highway 29 and its right-of-way. The Georgetown Development tracking system shows multiple developments under construction or planned in the potential recharge zone for Shadow Canyon Spring. All of the negative effects of urban land use discussed above are likely to occur throughout the developable parts of this focal area.

Water Quantity – Effects to Potential Recharge

To the extent that impervious cover increases in the springshed, recharge is expected to decrease. In this case, due to the broad and increasing pace of development along SH 29, a decrease in natural recharge is likely. An exception would be if ditches (or some inadvertent runoff pathway) hit a recharge feature, recharge would be artificially enhanced. Another exception may occur when water mains with chlorinated water break or leak, potentially recharging millions of gallons of water to a groundwater network leading in part to Shadow Canyon Spring. If chlorinated water dominated the spring area for a long enough duration, few if any salamanders would be expected to survive.

C. Georgetown Salamander Response to Proposed Action

Numbers of Individuals Affected

Water quality degradation may adversely affect some or all of the salamanders present in Shadow Canyon Spring. The potential decrease in recharge to the aquifer supplying flow to Shadow Canyon Spring may cause the spring to shift from being perennial to ephemeral. In the event springflow fails, most or all of the observable salamanders would die. There is no site specific information that a subsurface population exists at Shadow Canyon Spring although some individuals may succeed in remaining in wetted habitat by descending into groundwater conduits or the interstices of submerged substrates.

A subset of the threats and stressors discussed above in the status of the species and environmental baseline are expected to result in the degradation of water quality at Shadow Canyon Spring. The decrease in water quality would result from the conventional and expected land application of insecticides, herbicides, and fertilizer in the area immediately upgradient from Shadow Canyon Spring. Given the geologic units present and thin soils, little filtration of stormwater is expected, and degraded water that is not captured by the stormwater system is expected to infiltrate the soils, moving down through fractures, dissolved conduits, and rock facies to mix with groundwater. If contaminants in groundwater persist at levels with biological activity, we would expect decreased growth and reproduction of salamanders. In addition, pollution would reduce the numbers and biomass of susceptible invertebrates. A decrease in the invertebrate preybase would adversely affect the GS population. There are no easily available models to address multiple contaminants resulting from human activities to evaluate effects on spring dependent fauna.

Sensitivity to Change

Like its sister species in central Texas (Barton Springs salamander, Jollyville Plateau salamander, and Salado salamander), the Georgetown salamander is considered a sensitive

species. As discussed in the final listing rule, salamander populations associated with more urbanized areas appear to be a greater risk of extirpation.

V. Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The City of Georgetown has ordinances to maintain water quality in the Edwards Aquifer recharge zone while allowing development to occur. The ordinances require buffers around springs and streams in the Edwards Aquifer recharge zone. The stream buffers are scaled to the drainage area of the waterway and consider the Federal Emergency Management Agency (FEMA) designated floodplains. Georgetown water quality protection measures on the Edwards Aquifer recharge zone include permanent structural best management practices designed to remove 80 (potentially requiring 85) percent removal of total suspended solids in project runoff. New projects will be required to achieve 85% removal of total suspended solids.

Groundwater Quality and Quantity

The primary cumulative effects expected will result from land use changes in the springshed of Shadow Canyon Spring as Georgetown grows and urbanizes along State Highway 29. Groundwater in this area is particularly vulnerable to pollution because in karst terrains, aquifers have low self-purification capabilities (Kresic et al. 1992). Additionally, there may be rapid infiltration of surface waters into the underground. The development of land to the west of Shadow Canyon is relevant since it is likely to include part of the recharge zone for Shadow Canyon Spring. All of the adverse effects resulting from development discussed above apply to adjacent tracts, should they be developed. The main effect expected is a reduction in water quality. The focus of TCEQ and local regulations is to limit total suspended solids (TSS) from reaching a receiving stream. However, there are other contaminants besides TSS (e.g., neonicotinoid systemic insecticides, dissolved metals or organics) that: (1) may be present in runoff, (2) are extremely toxic to fish and other aquatic organisms, and (3) may cause morbidity and mortality of salamanders and their prey. Another potential stressor to groundwater quality is leakage or overflow from the sanitary sewer systems in the springshed, which would potentially result in harmful levels of ammonia and lower dissolved oxygen.

The future non-Federal actions that present risks to the Shadow Canyon Spring population of Georgetown salamanders are the land use changes proposed or likely in the recharge area for the spring. The land use changes will result in human activities transporting, applying, and occasionally spilling materials on the recharge zone. Given precipitation and lawn-landscape irrigation, some of these contaminants are likely to be transported by water to the groundwater network supplying flow at Shadow Canyon Spring. The biological activity of these contaminants will depend on the duration of elevated environmental concentrations and we expect the Georgetown salamander will be adversely affected in terms of its food supply, growth, health, and reproduction. The primary and secondary productivity of the Shadow Canyon Spring is likely small compared to other aquatic habitats like the San Gabriel River. Prey availability may be a main factor in the carrying capacity of the Shadow Canyon Spring habitat and pollution

of the springwater with chemicals toxic to aquatic invertebrates would likely result in a decrease in the condition and number of Georgetown salamanders present.

There is uncertainty about the boundary for the recharge zone for Shadow Canyon Spring, which may extend beyond the action area. Williamson County quarry operations may intersect groundwater and alter groundwater levels and flowpaths. Additionally, an increase in impervious cover in the Shadow Canyon Spring recharge zone may result in decreased recharge. This would increase the likelihood that Shadow Canyon Spring may cease to flow during a severe drought.

The proposed action is likely to degrade water quality and reduce recharge for Shadow Canyon Springs. Considering the long-term (next 100 years), multiple events are likely to occur that would result in the extirpation of the Georgetown salamander from Shadow Canyon Spring. Within the area potentially recharging Shadow Canyon Spring (upper Shadow Canyon tract and areas the west of Shadow Canyon (presumed likely to be developed), chemical applications are likely to include herbicides, fertilizers, termiticides, and other insecticides. After precipitation events, the runoff and recharge in this area are expected to have concentrations of these chemicals that exert adverse biological effects on aquatic organisms. With expected chemical use nearby over the coming years and decades, contaminants carried in recharge are expected to periodically break through to Shadow Canyon Spring. Cumulative development will increase impervious cover and concurrently decrease recharge for Shadow Canyon Spring as the areal extent available for infiltration is reduced.

The entire population of Georgetown salamanders consists of more than 14 sites distributed among multiple watersheds (equivalent to HUC12 subwatersheds). To the best of our knowledge, there is not likely to be any intersite movement with the exception of the few sites close to another site. Our expectation is by the time the expected ultimate developed state of its springshed is reached, the presumably small population of Georgetown salamanders at Shadow Canyon Spring will have mortality rates that exceed fecundity rates and become extirpated (locally extinct). It is unlikely to be recolonized from the other Georgetown salamander population in the subwatershed due to the distance involved.

A species viability is determined in part by the number and distribution of populations (redundancy). There are 18 known historic sites for Georgetown salamander. As stated in the final listing rule, four of the 18 sites may already be extirpated. Only two of the 18 sites are known to have a population size that exceeds 100. The status of current populations is detailed in the final rule listing GS as threatened. While the population size of 14 sites (including Shadow Canyon Spring) is unknown, the existence of multiple GS populations means the species is more likely to survive in the wild, retaining the potential for recovery. The potential extirpation of one population (Shadow Canyon Spring) reduces redundancy for Georgetown salamanders. The most southern HUC12 hydrounit (Lower South Fork San Gabriel River) in the Georgetown salamander range presently has GS populations in Shadow Canyon Spring and Garey Ranch Spring The potential extirpation of the Shadow Canyon Spring population of GS would effectively reduce representation in this hydrounit by half. However, the continued presence of 13 or more remaining populations will help ensure the species status remains at threatened as local efforts progress to conserve water quality over the Northern Segment of the

Edwards Aquifer. Thus, the proposed action is not likely to jeopardize the continued existence of the Georgetown salamander.

VI. Conclusion

Our biological opinion is based primarily on the current 14 Georgetown salamander populations, which provide redundancy. In addition, all currently known sites are protected by Georgetown ordinances and two of the sites are protected as preserves. After reviewing the current status of Georgetown salamander, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the USACE section 404 authorization of fill in waterways of Shadow Canyon, as proposed, is not likely to jeopardize the continued existence of the Georgetown salamander.

VII. Incidental Take Statement

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The Service expects that USACE section 404 authorization of fill into the jurisdictional waterways of the Shadow Canyon development will not result in the incidental take of individuals of Georgetown salamanders. However, the land development activities that are interdependent to the USACE authorization will ultimately result in some groundwater pollution. The pollutants associated with an urbanized watershed are likely to be transported to groundwater upgradient from Shadow Canyon Spring over subsequent years and decades. These pollutants will vary in terms of their fate and toxicity. Eventually, given more human activities in the recharge zone, we expect peak springflows (following a rain event the springshed) will have higher concentrations of pollutants such as biogenic nitrogen (similar to the variability seen at Barton Springs) (Mahler et al. 2012). Biogenic nitrogen results from human or animal waste, or both and has been implicated as a likely source of nitrate in Barton Springs. Using nitrate as an example of an urban pollutant, we would be concerned if nitrate levels exceeded the 2 mg nitrate (NO_3-N/l) level recommended by Camargo et al. 2005 to protect sensitive freshwater species. Incidental take of GS may be the result of a decrease in the availability of food, if water quality in Shadow Canyon Spring is not supportive of sensitive microcrustaceans, aquatic insects, and other invertebrate prey. A reduction in food availability may lead to a decrease in the health of individuals and growth.

We anticipate occasional storm-related recharge events causing adverse effects to 50 percent of the Georgetown salamander population at Shadow Canyon Spring as groundwater with anthropogenic compounds arrive at the spring. The return interval for this type of event (5.5 inch rain over 24 hours) is five years. Take will be in the form of death of individuals from pollution events where the mixture of urban contaminants reaches acute LC_{50} levels (generally in less than 48 hours). Other more frequent pollution events may inhibit Georgetown salamander growth and reproduction. Groundwater pollution may also result in chronic adverse effects to Georgetown salamanders and their invertebrate prey, the most likely of these is to reduce or inhibit growth and reproductive rates. The GS habitat available at Shadow Canyon Spring is estimated at 1.6 meter^2. This is based on an estimated 0.6 meter^2 of surface habitat and an inference that additional subsurface habitat is available. We estimate nearby subsurface GS habitat totals 1.0 meter^2 (consisting of nearby groundwater conduits and interstitial space). The density of GS is estimated at an average of 5 individuals per meters^2, based on Pierce et al. 2014 reported population sizes for two spring runs (Twin Springs and Swinbank Springs spring runs are assumed to be 1 meter wide). The Shadow Canyon Spring GS population is estimated to average 8 individuals (based on 1.6 meter^2 GS habitat and 5 GS per meter^2).

In the foreseeable future with the proposed development, the Shadow Canyon springs recharge zone will by dominated by urban land use. Storm-related recharge is expected to transport anthropogenic compounds persistently at low levels. Intermittently (5 year return interval), we expect storm-related recharge to present higher levels of pollutants that have concentrations directly affecting GS. A 5-year storm is anticipated to transport pollutants such as nitrate that will be detectable, elevated for more than 48 hours, and detrimental to the health of GS. The incidental take is expected to be 4 individuals over a period of five years. If the Georgetown salamander population size estimate for all Shadow Canyon Spring associated habitat is less than 4 individuals, the incidental take for this action will be considered to be depleted and no further incidental take is authorized.

Periodic groundwater pollution events are anticipated. They are expected to be temporary in nature unless a persistent contaminant is spilled in the springshed. The return interval of these events is considered to be on par with larger storm events that may not occur annually but would be expected on the average every five years. While a large storm would have presumably more recharge, increase springflow, and result in some dilution of pollutants, the concern is a large storm event will mobilize pollutants on the surface in the springshed. We expect the environmental concentration of insecticides and other chemicals to remain elevated over a period of hours and perhaps days resulting in unsuitable habitat for salamanders and their prey.

a. Reasonable and Prudent Measures

The measures described below are non-discretionary, and must be undertaken by the USACE so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The USACE has a continuing duty to regulate the activity covered by this incidental take statement. If the USACE: (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to

monitor the impact of incidental take, the USACE must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

The following reasonable and prudent measures presented below are necessary and appropriate to minimize the incidental taking authorized by this biological opinion.

1. The USACE shall: (a) ensure the applicant (San Gabriel Harvard Limited) avoids and minimizes adverse effects to Georgetown salamanders, to the maximum practicable extent and (b) condition their section 404 authorization to the applicant in order to reduce potential risks to the Shadow Canyon Spring population of Georgetown salamanders.

2. The USACE shall condition their authorization to the applicant to ensure the water quality of runoff and stormwater in the Edwards Aquifer recharge zone within 80 meters of Shadow Canyon Spring is maintained in a natural state.

3. The USACE shall ensure the applicant minimizes potential pollution of groundwater near Shadow Canyon Spring by permanently protecting in a natural condition all identifiable recharge features of the Edwards Aquifer Recharge Zone supplying Shadow Canyon Spring.

b. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the USACE must comply with the following terms and conditions that implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. The Service does not consider these Terms and Conditions to be a major change to proposed action. These terms are non-discretionary.

1. The USACE will work with the applicant to ensure that the area within 80 meters of Shadow Canyon Spring is permanently maintained in a natural condition that is additionally free of roads, development, and sanitary sewer infrastructure (Figures 6a and 6b). In order to prevent the pollution of surface water, groundwater, and springflow associated with Shadow Canyon Spring and reducing the effective recharge area for Shadow Canyon Spring, the proposed roads (SW 3 and Shadow Canyon Drive) will be built outside an area defined by a distance of 80 meters from Shadow Canyon Spring. All protected areas (e.g., water quality easements) will be surveyed by a registered professional land surveyor and the survey will be submitted to the USACE and Service. All protected areas will be protected in perpetuity with a third party conservation easement holder.

2. The USACE will work with the applicant to ensure that no coal-tar based sealcoat materials are applied to pavement, parking lots, playgrounds, or driveways in the Shadow Canyon tract. This will reduce a known source of the pollutant class polycyclic aromatic hydrocarbon compounds (PAHs), which are persistent and toxic to fish and other aquatic life.

3. The USACE will ensure that annual biological surveys of Shadow Canyon Spring are made and reported to USFWS. Surveys shall be made annually from the issuance of USACE authorization and continue at least five years after the completion of residential subdivision

Phase One or the multi-family development, whichever occurs last. The Service encourages the coordination of monitoring efforts at Shadow Canyon with the broader Adaptive Management working group established by the City of Georgetown and Williamson County. In the event that no surveys are done, the USACE will ensure the Service is allowed access to Georgetown salamander habitat in Shadow Canyon, including Shadow Canyon Spring, springs labeled F-14 and F-15, and the water well labeled Weisberg F-36 in the ACI Consulting report (2002).

VIII. Conference Opinion Adverse Modification of Proposed Critical Habitat Analysis

Effects of Action on Proposed Critical Habitat Analysis

The proposed action is likely to degrade water quality and reduce recharge for Shadow Canyon Springs. These are two of the primary constituent elements described in our proposed rule for critical habitat. The Shadow Canyon tract land use changes are inextricably linked to the USACE section 404 authorization. The development of retail, residential single family, and residential multi-family are interrelated activities that depend on the proposed action for its justification. It is the effects of these activities that may compromise the PCEs of the proposed surface and subsurface critical habitats.

Citing our Endangered Species Consultation Handbook (Service and NMFS 1998), "if an action affects critical habitat, but does not appreciably diminish the value of constituent elements essential to the species' conservation, the adverse modification threshold is not exceeded. On the other hand, the adverse modification threshold is exceeded when the proposed action will adversely affect the critical habitat's constituent elements or their management in a manner likely to appreciably diminish or preclude the role of that habitat in both the survival and recovery of the species". If the PCEs are temporarily degraded, proposed critical habitat unit 13 may still contribute to survival and recovery of GS. However, if proposed Critical Habitat Unit 13 becomes unoccupied due to extirpation, it will be difficult if not impossible to re-establish a GS population. If the PCEs are permanently degraded due to persistent presence of contaminants that preclude Georgetown salamanders and prey, then Unit 13 will no longer contribute to the group of 14 proposed critical habitat units deemed necessary for the viability of the GS. The loss of one of 14 proposed critical habitat units due to action related decreases in water quality and springflow will diminish recovery potential particularly if the temporary reduction in the values of PCEs results in extirpation of GS from proposed critical habitat unit 13. Being one of 14 units, the loss would not reach the adverse modification threshold of appreciably reducing the proposed critical habitat PCEs essential to the species conservation.

Conference Opinion Conclusion

After reviewing the current status, the environmental baseline, the effects of the action and the cumulative effects, it is the Service's Conference Opinion that the action, as proposed, is not likely to destroy or adversely modify proposed critical habitat for the Georgetown salamander. The effects of the action may result in episodic reduction in primary constituent elements at proposed critical habitat unit 13.

You may ask the Service to confirm the conference opinion as a biological opinion issued through formal consultation when critical habitat is finalized. The request must be in writing. If

the Service reviews the proposed action and finds that there have been no significant changes in the action as planned or in the information used during the conference, the Service will confirm the conference opinion as the biological opinion on the action and no further section 7 consultation will be necessary.

IX. Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or proposed critical habitat, to help implement recovery plans, or to develop information.

The Service makes these conservation recommendations:

(1) Develop, implement, and report on hydrogeologic research that delineates the springshed for Shadow Canyon Spring. This would likely include a network of groundwater wells with monitoring equipment to track groundwater levels and groundwater quality. Develop and implement land use plans that will help ensure non-degradation of proposed critical habitat PCEs due to the Shadow Canyon development.

(2) Building on Conservation Recommendation 1, prepare and implement a low impact development strategy for the entire Shadow Canyon tract. Establish agreements with the Shadow Canyon landowners to have long-term commitments to the low impact development strategies and practices.

(3) The Applicant should coordinate with the City of Georgetown and Williamson County to explore alternative regional roads to avoid and minimize adverse effects to proposed surface and subsurface critical habitat of the Georgetown salamander. For example, proposed road SW3 should be aligned or removed from the Shadow Canyon Project in order to avoid crossing the proposed subsurface critical habitat proposed for Unit 13 and other proposed critical habitat units. Similarly, the Applicant should end Shadow Canyon Drive at Malabar Drive or Bear Paw Lane and not build the western part of Shadow Canyon Drive.

(4) The area around Shadow Canyon Spring should be adequately fenced to prevent access by livestock and people. This will help reduce the likelihood of dumping, pollution, and vandalism to the spring area. Similarly, the area around the water well F-36 should be fenced and protected from unauthorized human access.

(5) With the exception of wells dedicated to geohydrologic research, no new water wells should be drilled on the Shadow Canyon tract. No groundwater should be pumped (or in the case

of a flowing artesian well, allowed to discharge) within the Shadow Canyon tract or areas potentially associated with Shadow Canyon Spring.

X. Re-initiation Requirements

The USACE shall request reinitiation of consultation if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect species or critical habitat in a manner or to an extent not considered in this biological and conference opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the species or critical habitat that was not considered in this biological and conference opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

We appreciate the opportunity to work with the U.S. Army Corps of Engineers. If you have any needs or questions on the Shadow Canyon consultation-conference, please contact Tanya Sommer at 512 490-0057, extension 222.

Sincerely,

/ S /

Adam Zerrenner
Field Supervisor

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3. List of Threats to Georgetown Salamander by Factor
4. Primary Constituent Elements of Proposed Critical Habitat
5. Rainfall Statistics for Lake Georgetown Station
6. Land Use and Assumed Impervious Cover for Areas in Shadow Canyon above the Elevation of 830 ft

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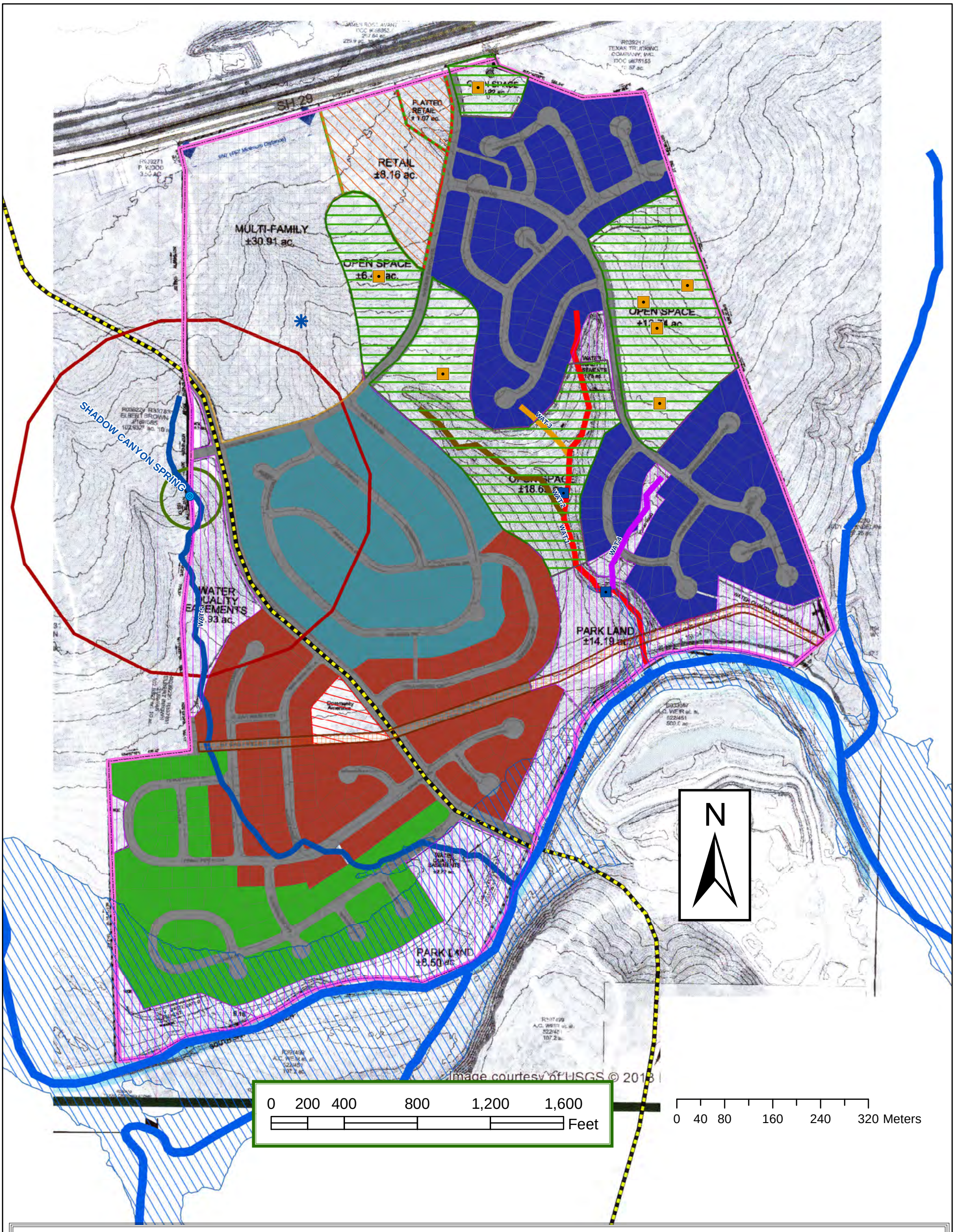
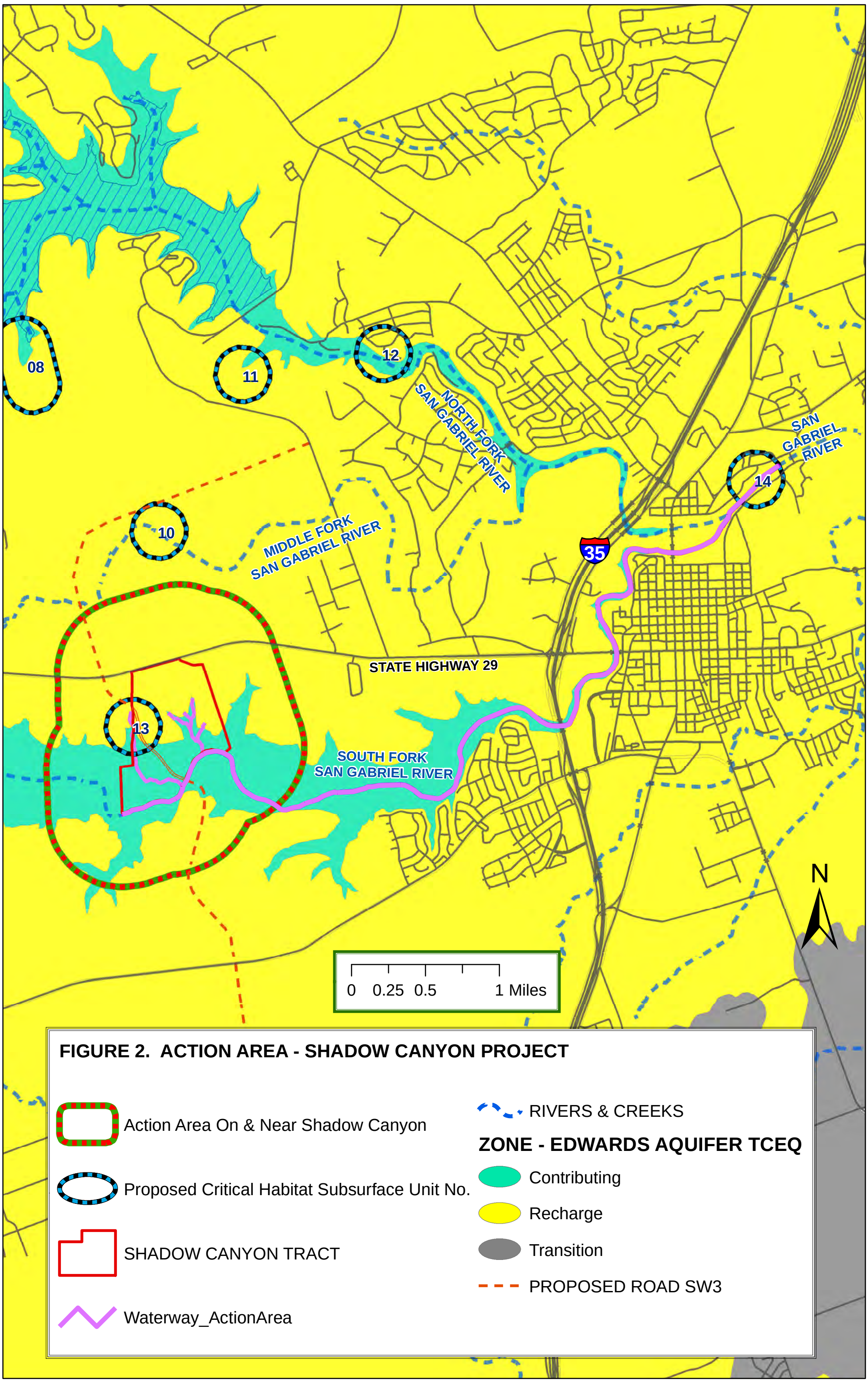


FIGURE 1 OVERVIEW SHADOW CANYON DEVELOPMENT

DEVELOPMENT PHASE

- 1
- 2
- 3
- 4
- SHADOW CANYON TRACT
- RETAIL_COMMERCIAL
- APARTMENTS
- COMMUNITY
- HCP KARST PRESERVE
- PIPELINE_SEMINOLE
- WQ EASEMENTS
- Prop. Critical Habitat Surface
- Prop. Critical Habitat Subsurface
- FEMA 100 Year Floodplain
- Water Well F-36, 208 ft deep
- KARST FEATURE
- SPRINGS F14 & F15
- SHADOW CANYON SPRING


08
11
12
10
13
14
NORTH FORK
SAN GABRIEL RIVER
MIDDLE FORK
SAN GABRIEL RIVER
SAN
GABRIEL
RIVER
35
STATE HIGHWAY 29
SOUTH FORK
SAN GABRIEL RIVER
N
0 0.25 0.5 1 Miles
FIGURE 2. ACTION AREA - SHADOW CANYON PROJECT
Action Area On & Near Shadow Canyon
Proposed Critical Habitat Subsurface Unit No.
SHADOW CANYON TRACT
Waterway_ActionArea
RIVERS & CREEKS
ZONE - EDWARDS AQUIFER TCEQ
Contributing
Recharge
Transition
PROPOSED ROAD SW3

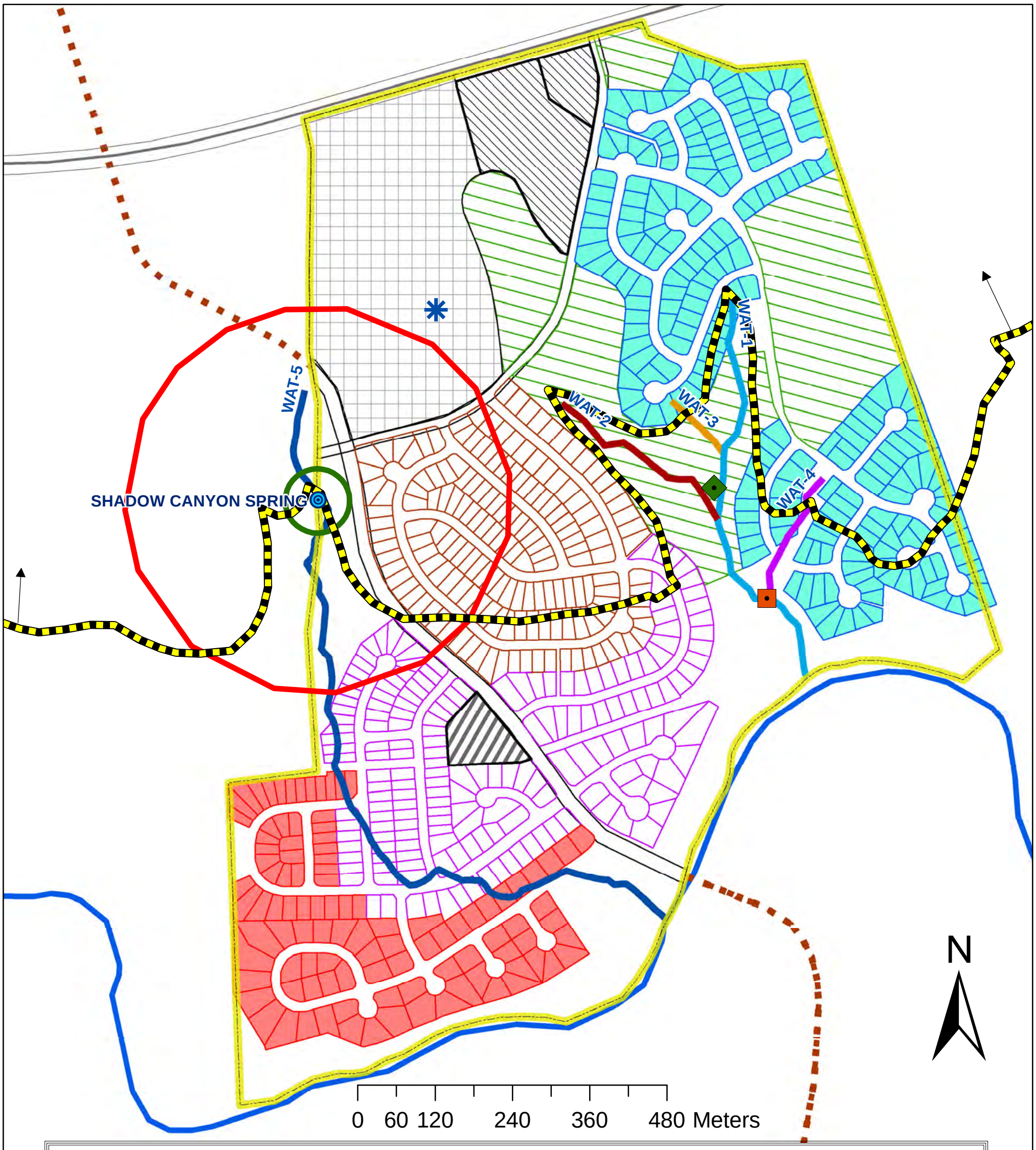


FIGURE 3. SHADOW CANYON TRACT - SECTION 404 WATERWAYS AND DEVELOPMENT PHASES

SHADOW CANYON TRACT

Proposed Critical Habitat Surface

Proposed Critical Habitat Subsurface

RESIDENTIAL_MULTIFAMILY_LAND_USE

RETAIL_COMMERCIAL

PROPOSED ROAD SW3

RESIDENTIAL LOTS CREEK PHASE

1

2

3

4

Recharge Zone

WAT-1

WAT-2

WAT-3

WAT-4

WAT-5

SHADOW CANYON SPRING

2_SPRINGS_AND_A_WELL
Descr

F-14 SPRING

F-15 SPRING

F-36 WELL

Number	Site Name	HYDROUNIT HUC12
1a	Cobb Springs	Dry Berry Ck
1b	Cobb Well	Dry Berry Ck
2	Cowan Creek Spring	Low Berry Ck
3	Bat Well Cave	Low Berry Ck
4	Walnut Spring	Lk G'town
5	Twin Spring	Lk G'town
6	Hogg Hollow Spring	Lk G'town
7	Cedar Hollow Spring	Lk G'town
8a	Knight Spring	Lk G'town
8b	Cedar Breaks Hiking Trail	Lk G'town
9	Water Tank Cave	N&M Fork San Gabriel
10	Avant Spring	N&M Fork San Gabriel
11	Buford Hollow Springs	N&M Fork San Gabriel
12	Swinbank Spring	N&M Fork San Gabriel
13	Shadow Canyon Spring	L S Fork San Gabriel
14	San Gabriel Spring	Smith Brnch & San Gabriel
15	Garey Ranch Spring	L S Fork San Gabriel
16	Hogg Hollow II Spring	Lk G'town

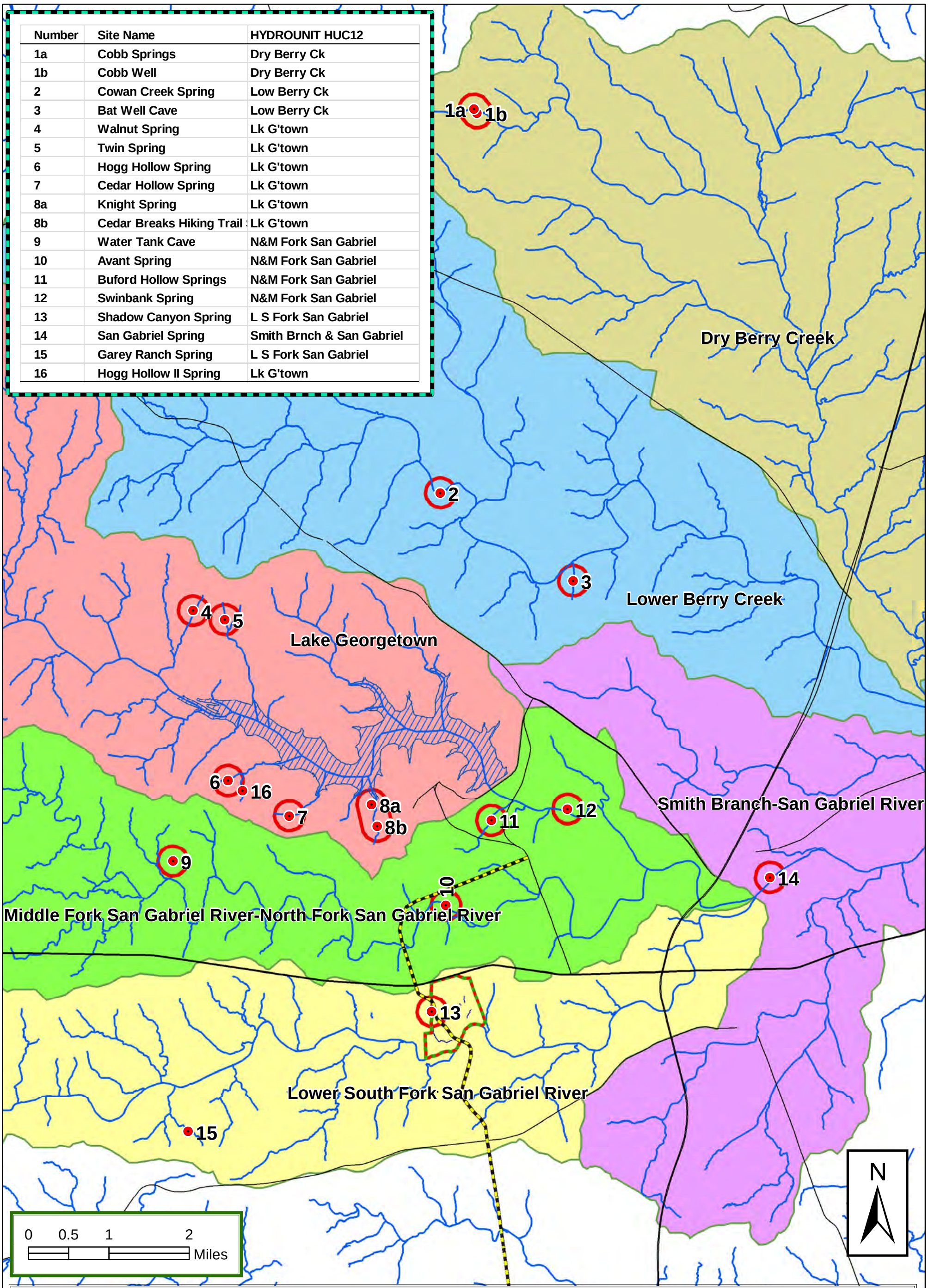


FIGURE 4 OVERVIEW GEORGETOWN SALAMANDER SITES

Proposed Critical Habitat Subsurface <= 300 m

PROPOSED ROAD SW3

SHADOW CANYON BOUNDARY

GEORGETOWN SALAMANDER SITE

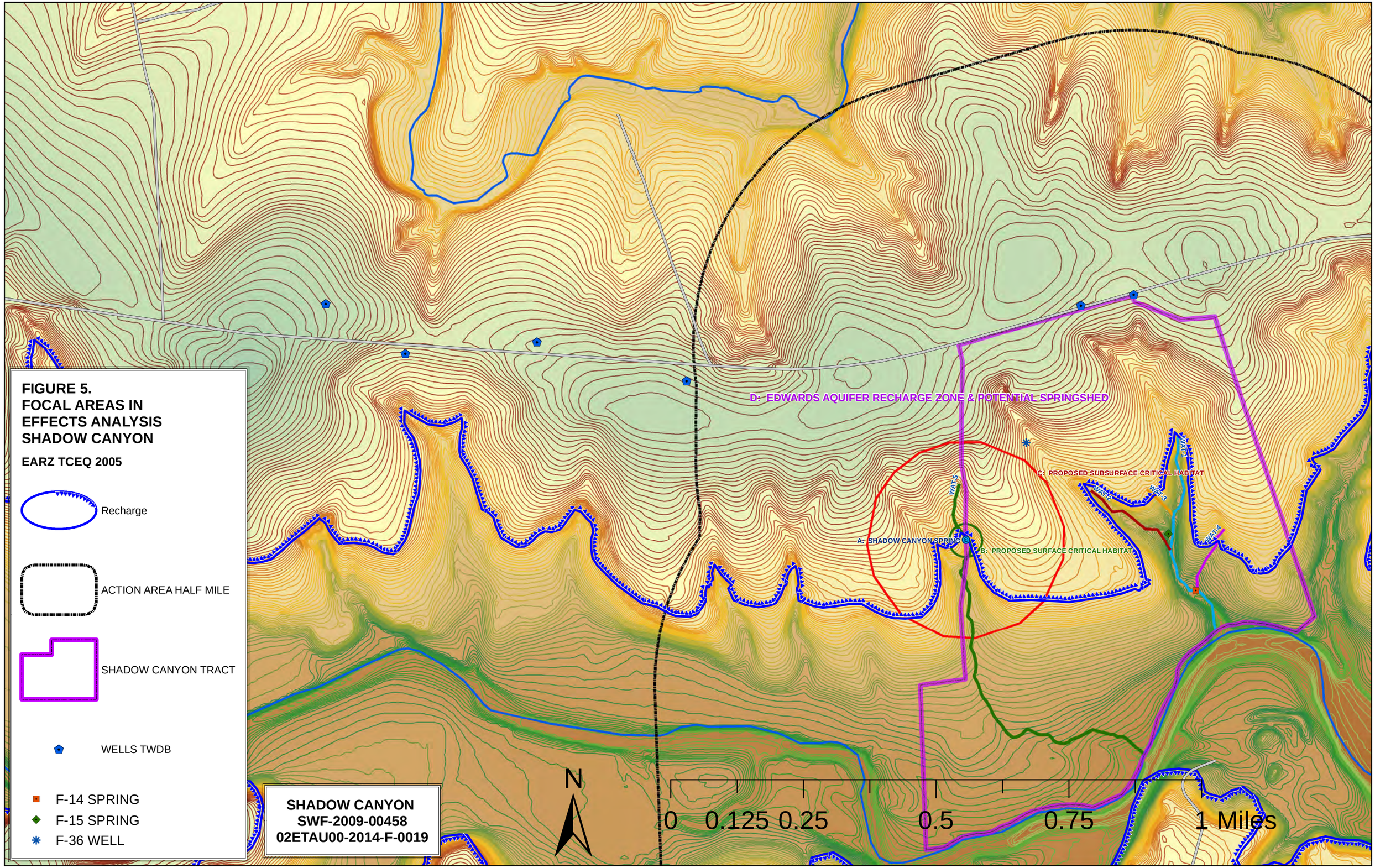


FIGURE 5.
FOCAL AREAS IN
EFFECTS ANALYSIS
SHADOW CANYON
EARZ TCEQ 2005
Recharge
ACTION AREA HALF MILE
SHADOW CANYON TRACT
WELLS TWDB
F-14 SPRING
F-15 SPRING
F-36 WELL
D: EDWARDS AQUIFER RECHARGE ZONE & POTENTIAL SPRINGSHED
C: PROPOSED SUBSURFACE CRITICAL HABITAT
A: SHADOW CANYON SPRING
B: PROPOSED SURFACE CRITICAL HABITAT
WAT-5
WAT-2
WAT-3
WAT-4
WAT-1
SHADOW CANYON
SWF-2009-00458
02ETAU00-2014-F-0019
N
0 0.125 0.25 0.5 0.75 1 Miles

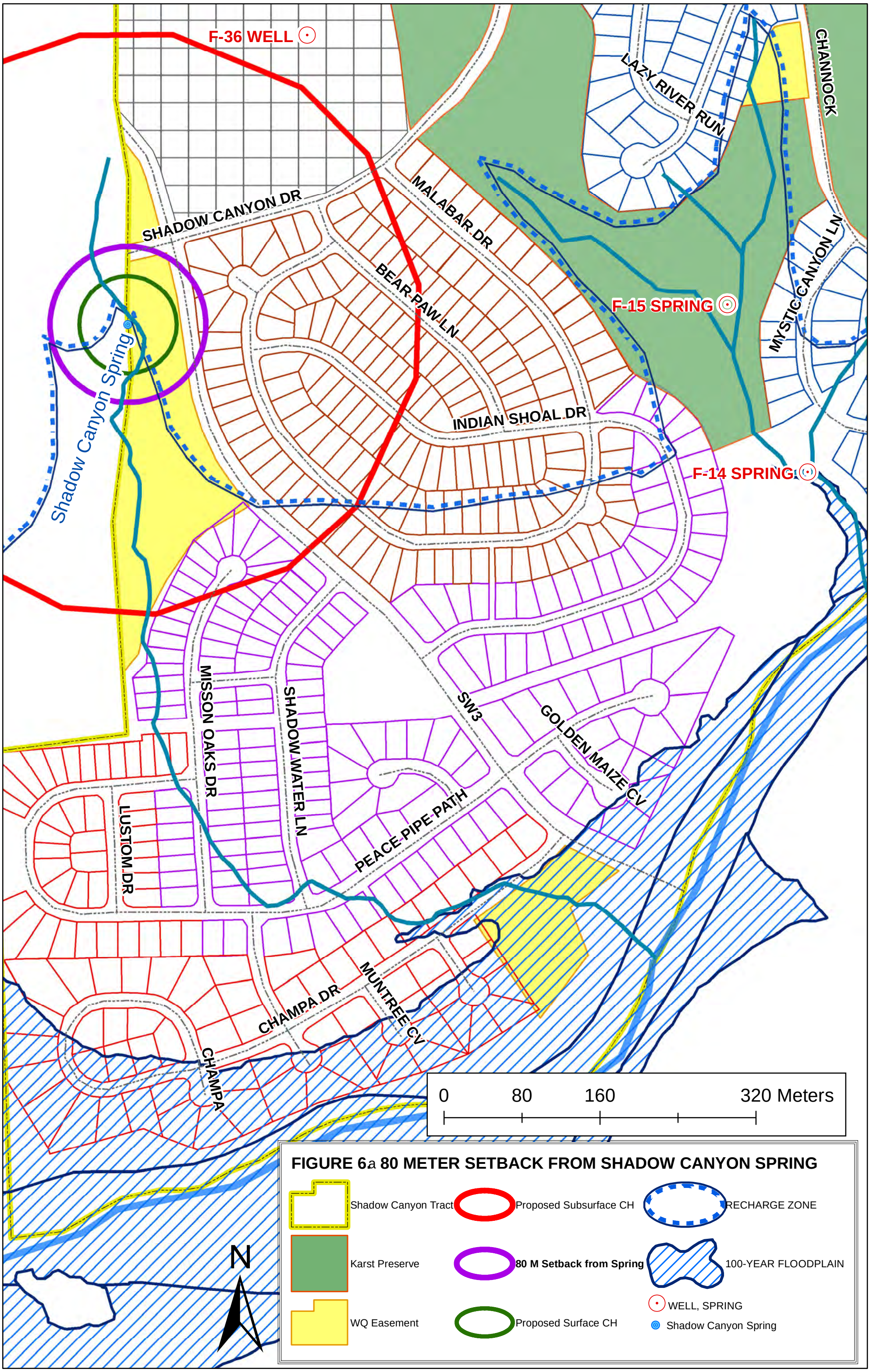


FIGURE 6a 80 METER SETBACK FROM SHADOW CANYON SPRING

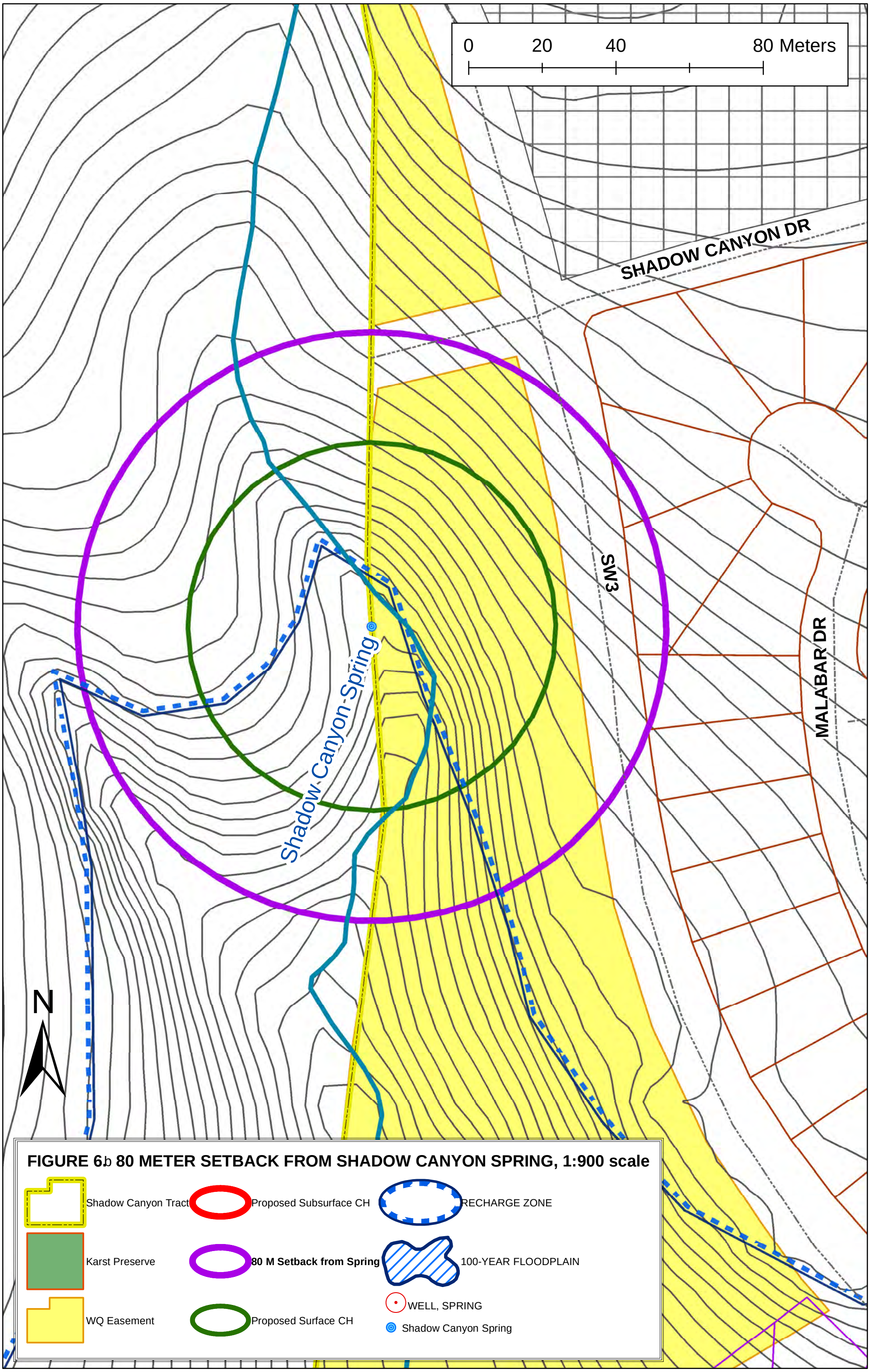


FIGURE 6b 80 METER SETBACK FROM SHADOW CANYON SPRING, 1:900 scale