NTESS Exhibit 15

Use Attainability Analysis for Tijeras Arroyo: Rio Grande to Four Hills Bridge Reach

(Assessment Unit NM-9000.A_070)

Sandia National Laboratories

U.S. Department of Energy
National Nuclear Security Administration
Sandia Field Office
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List of Acronyms

Acronym	Definition
AU	assessment unit
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
HUC	hydrologic unit code
KAFB	Kirtland Air Force Base
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
NPDES	National Pollution Discharge Elimination System
NTESS	National Technology & Engineering Solutions of Sandia, LLC
SFO	Sandia Field Office
SNL/NM	Sandia National Laboratories, New Mexico
SWQB	Surface Water Quality Bureau
UAA	use attainability analysis
USGS	United States Geologic Survey

Units of Measure

Term	Definition
°F	degrees Fahrenheit
AF	acre-foot
AF/yr	acre-feet per year
bgs	below ground surface
CF	cubic foot
cfs	cubic feet per second
CF/yr	cubic feet per year
ft	foot
mm	millimeter
mph	miles per hour

1.0 Introduction

This use attainability analysis (UAA) was conducted for the Rio Grande to Four Hills Bridge reach of the Tijeras Arroyo (AU NM-9000.A_070), located in Albuquerque, New Mexico (Figure 1). It was prepared by National Technology & Engineering Solutions of Sandia, LLC (NTESS) on behalf of the United States Department of Energy (DOE)/National Nuclear Security Administration (NNSA)/Sandia Field Office (SFO). NTESS is the management and operating contractor for Sandia National Laboratories, New Mexico (SNL/NM), and DOE/NNSA/SFO administers the SNL/NM contract. SNL/NM is located within the boundaries of Kirtland Air Force Base (KAFB), in Bernalillo County, New Mexico (Figure 1). The Tijeras Arroyo flows through property occupied by SNL/NM facilities.

The Tijeras Arroyo is located in the Tijeras Arroyo Watershed, which is identified by a 10-digit hydrologic unit code (HUC); the watershed boundary is shown in Figure 2. The study area for this UAA includes the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo (AU NM-9000.A_070) and adjacent portions of the Tijeras Arroyo Watershed having the potential to impact flows within the reach.

The Rio Grande to Four Hills Bridge reach of Tijeras Arroyo is currently classified as an intermittent stream with designated uses of marginal warmwater aquatic life, primary human contact, livestock watering, and wildlife habitat. This document provides the technical rationale for classification as an ephemeral stream, and as a result of limited ephemeral flows the highest attainable uses of limited aquatic life and secondary human contact along with livestock watering and wildlife habitat.

DOE and NTESS intend to petition for the amendment of the water quality standard based on the highest attainable use for Tijeras Arroyo through the standard rulemaking process for entities other than NMED in accordance with 20.6.4.15(E) NMAC.

1.1 History of Analysis

This UAA was conducted in accordance with a work plan, as revised, (Appendix A-1) that was approved by the New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) on February 9, 2018 (Appendix A-2). As described in that work plan, the NMED Hydrology Protocol (NMED 2011a) was used to evaluate whether the reach is ephemeral or intermittent in accordance with 20.6.4.15(B) NMAC (20.6.4 NMAC). SWQB provided formal comments to DOE and NTESS on the December 19, 2019 draft in a letter dated September 21, 2021.

In accordance with the NMED comments provided September 21, 2021 (Appendix A-4), the work plan has been revised to reflect the administrative changes associated with the procedures in 20.6.4.15(E) NMAC as opposed to those in 20.6.4.15(D) NMAC (Appendix A-5). Additionally, this UAA follows procedures and guidelines listed in the Federal Water Quality Standards (40 CFR 131.10). This UAA retains results of Hydrology Protocol surveys in accordance with 20.6.4.15(B).

2.0 Use Attainability Analysis

In accordance with 20.6.4.15(A) NMAC and 40 CFR 131.10(g), a UAA is required any time the criteria for a proposed designated use are less stringent than the criteria for the current designated use.

A UAA is a scientific study used to determine the factors affecting attainment of a designated use. There are three primary elements to a UAA. First, the proposed change in the designated use must be determined to have equal or more stringent criteria than the existing use. An existing use is defined under 20.6.4.7(E)(3) NMAC as those uses actually attained in a surface water of the state on or after November 28, 1975, whether or not it is a designated use. The designated use, whether current or proposed, shall not be less stringent than the existing use. Second, pending the findings from evaluating the existing use, a UAA must then demonstrate that a designated use is not attainable due to one of the factors identified under 40 CFR 131.10(g). Third, once it has been demonstrated that the designated use is not attainable, the highest attainable use must be determined. Defining the highest attainable use requires evaluation of existing uses, biotic and abiotic conditions, anthropogenic influences, and consideration of protected status delegations.

A UAA must demonstrate that attainment of a designated use is not feasible based on at least one of the factors identified in 40 CFR 131.10(g):

(1) Naturally occurring pollutant concentrations prevent the attainment of the use; or
(2) Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or
(3) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
(4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use; or
(5) Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
(6) Controls more stringent than those required by sections 301(b) and 306 [technology-based effluent limitations] of the Act would result in substantial and widespread economic and social impact.

The second factor is of particular relevance to this UAA. Flow in the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo (AU NM-9000.A_070) occurs infrequently, briefly, and only in direct response to precipitation (stormwater runoff).

3.0 Reason for this Use Attainability Analysis

The purpose of this UAA is to assess the highest attainable use associated with the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo (AU NM-9000.A_070), depicted in Figure 1, Figure 2, and Figure 3.

3.1 Reason for Designated Use Evaluation

The Rio Grande to Four Hills Bridge reach of Tijeras Arroyo is currently classified as intermittent (NMED, 2022), however, it has been observed over a period of many years to flow exclusively in direct response to precipitation. The data presented below demonstrate that the reach is ephemeral (20.6.4.97 NMAC) and cannot support the designated uses associated with intermittent waters.

3.2 Designated Uses Being Evaluated

This UAA evaluates the aquatic life and human contact designated uses of the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo. The designated uses associated with intermittent (20.6.4.98 NMAC) and ephemeral (20.6.4.97 NMAC) waters provided in 20.6.4.900 NMAC are listed in Table 1. As can be seen in Table 1, the difference in designated uses between intermittent and ephemeral waters are the aquatic life and human contact uses. This UAA demonstrates that the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo cannot support the current designated uses of marginal warmwater aquatic life and primary contact associated with intermittent waters, and should be classified as ephemeral.

4.0 Antidegradation and Existing Uses

New Mexico's antidegradation policy, codified under 20.6.4.8 NMAC, defines three tiers of protection against degradation. These include protections for existing uses (Tier 1); protections for high-quality waters that exceed levels necessary to support aquatic life, wildlife, and recreational uses (Tier 2); and protections for waters designated as Outstanding National Resource Waters (Tier 3). The antidegradation policy also requires an evaluation of downstream waters to ensure that their protections are also sustained, should a designated use amendment be supported.

The Rio Grande to Four Hills Bridge reach of Tijeras Arroyo is a Tier 1 water, and it discharges into the Rio Grande, which is also a Tier 1 water.

4.1 Determination of Existing Uses

According to 40 CFR 131.3(e), the definition of existing uses "are those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." In accordance with 40 CFR 131.10, a designated use must be at least as stringent as the existing use and be in accordance with 40 CFR 131.20. Additionally, in accordance with 20.6.4.15(A)(2) NMAC, a designated use cannot be removed if it is an existing use. Therefore, as part of this UAA, the existing uses were established to determine whether a designated use may be removed and to provide a baseline for establishing the highest attainable use.

Human contact is extremely limited. There are no opportunities for swimming, boating, or fishing is possible. The existing human contact use is "secondary contact" (can support activities involving human contact where risk of ingestion is minimal), only because that is the lowest available existing use that can be assigned.

There is no presence of aquatic life. The existing aquatic life use is "limited aquatic life" (can support limited aquatic life specifically adapted to rapidly changing environmental conditions). This is the lowest exiting use that can be assigned.

Wildlife habitat is limited but considered an existing use. Wildlife habitat is likely associated with the vegetation that grows along the edges of the arroyo.

There are no agricultural, livestock watering, or potable diversions of surface water from the reach; no surface diversion rights exist in the New Mexico Office of the State Engineer database (See Section 6.8).

As part of the evaluation to determine the existing uses for AU NM-9000.A_070, a data search was conducted through the EPA Water Quality Portal via the Water Quality Exchange. There were no applicable data for AU NM-9000.A_070. As discussed in detail in Section 6.8, this reach of the Tijeras Arroyo is completely dry more than 90% of the time. The only flows occur for short duration (hours) in response to stormwater runoff, so the only water quality data is stormwater discharge data. Data for samples collected within Tijeras Arroyo are limited, however, water quality holds little relevance to this UAA because the limited flows do not and cannot support the designated uses, regardless of the water quality.

5.0 Endangered and Threatened Species Review

In accordance with Section 7(a)(2) of the Endangered Species Act, this action must not be likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat of such species. In order to assist with that evaluation, the UAA includes a preliminary screening of listed threatened and endangered species within the geographical areas being analyzed for potential designated use changes. Since the highest attainable uses support the existing water quality, there will be no impacts to endangered or threatened species.

5.1 Evaluation of Endangered and Threatened Species

This UAA includes a review of the U.S. Fish and Wildlife Service's Information for Planning and Consultation (IPaC) project planning tool to determine whether the geographical location of the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo overlaps with listed species or critical habitat. The Rio Grande in the vicinity where it joins the reach was included in the evaluation.

Appendix B contains the IPaC geographical area delineations, their descriptions, and their associated assessed IPaC map image. Based on the results from the assessed IPaC delineations, there are five species of threatened or endangered species within the Lower Tijeras Arroyo Watershed and in the receiving waters of the Rio Grande:

Mammals:

- New Mexico meadow jumping mouse (*Zapus hudsonius luteus*)
  - There is final critical habitat for this species. The location of the critical habitat is not available.
  - Species profile: U.S. Fish and Wildlife Service-7965
  - Status: Endangered

Birds:

- Mexican spotted owl (*Strix occidentalis lucida*)
  - There is final critical habitat for this species. The location of the critical habitat is not available.
  - Species profile: U.S. Fish and Wildlife Service-8196
  - Status: Threatened
- Southwestern willow flycatcher (*Empidonax traillii extimus*)
  - There is final critical habitat for this species. The location of the critical habitat is not available.
  - Species profile: U.S. Fish and Wildlife Service-6749
  - Status: Endangered
- Yellow-billed cuckoo (*Coccyzus americanus*)
  - There is proposed critical habitat for this species. The location overlaps the critical habitat.
  - Species profile: U.S. Fish and Wildlife Service-3911
  - Status: Threatened

Fishes:

- Rio Grande silvery minnow (*Hybognathus amarus*)
  - There is final critical habitat for this species. The location overlaps the critical habitat.
  - Population: Wherever found, except where listed as an experimental population
  - Species profile: U.S. Fish and Wildlife Service-1391
  - Status: Endangered

Changing the classification of the Tijeras Arroyo from intermittent to ephemeral will not jeopardize the continued existence of any threatened or endangered species nor result in the destruction or adverse modification of critical habitat. The change would not jeopardize natural communities of conservation concern (e.g., emergent wetland, riverine wetland, prairie, and glade) because the Tijeras Arroyo does not currently support those community types, and existing habitat outside the arroyo will not be impacted.

Of particular concern may be potential impacts to Rio Grande silvery minnow habitat in the Rio Grande downstream of Tijeras Arroyo. Changing the designated uses in Tijeras Arroyo to reflect existing and attainable uses will not impact the silvery minnow. The current designated use is not attainable; this UAA would not result in a change to existing or attainable uses, only designated uses. Therefore, since the silvery minnow currently inhabits the Rio Grande under existing conditions, and no degradation would result from a change in designated uses, there would be no impact to silvery minnow habitat.

6.0 General Site Conditions

There has been substantial environmental characterization conducted at SNL/NM and in surrounding areas close to Tijeras Arroyo over the last 40 or more years. Much of the information presented in this section was obtained from the following documents:

- *SNL/NM Site-Wide Hydrogeologic Characterization Project* (SNL/NM 1994)
- *Annual Groundwater Monitoring Report, Calendar Year 2018* (SNL/NM 2019)
- *2020 Annual Site Environmental Report for Sandia National Laboratories, New Mexico* (SNL/NM 2020)

6.1 Watershed Boundaries

Tijeras Arroyo is the main surface drainage feature of the Tijeras Arroyo Watershed. The watershed comprises an area of roughly 132 square miles in Bernalillo County in central New Mexico. It is approximately 24 miles long, drains portions of the west slopes of the Sandia and Manzano mountains, and discharges into the Rio Grande (Figure 2).

The Tijeras Arroyo Watershed (HUC 1302020302) (Figure 2) is divided into three sub-watersheds as depicted in Figure 3:

- Upper Tijeras Arroyo Sub-watershed (HUC 130202030201)
- Middle Tijeras Arroyo Sub-watershed (HUC 130202030202)
- Lower Tijeras Arroyo Sub-watershed (HUC 130202030203)

The upper sub-watershed is located within the western slopes of the Sandia and Manzano mountains, to the east and north of KAFB. The middle sub-watershed is located primarily within Tijeras Canyon but extends a short distance into the Albuquerque Basin (see Section 6.2). The lower sub-watershed is completely within the Albuquerque Basin.

The Tijeras Arroyo channel is relatively steep and narrow in the upper watershed, but in the middle and lower watersheds the gradient decreases and the channel becomes wider as it leaves the mountainous terrain and enters the Albuquerque Basin. In parts of the upper and middle sub-watersheds, perennial conditions exist; however, nothing close to perennial conditions are found in the lower sub-watershed. Significant geologic differences exist between the three sub-watersheds, which largely accounts for the differences in flow regime (see Section 6.2 and Section 6.7).

The Rio Grande to Four Hills Bridge reach exists primarily in the Lower Tijeras Arroyo Sub-watershed but extends a short distance into the lower part of the middle watershed (Figure 3). The only significant tributary to the Rio Grande to Four Hills Bridge reach is the Arroyo del Coyote, which drains a portion of the Manzano Mountains, including Madera Canyon, Lurance Canyon, and Sol se Mete Canyon. The Arroyo del Coyote joins Tijeras Arroyo at the upstream extent of the lower sub-watershed (Figure 3).

6.2 Geologic Setting

Tijeras Arroyo is located within a geologic setting that has been subjected to relatively recent episodes of basaltic volcanism and ongoing regional rifting (crustal extension). The Rio Grande Rift has formed a series of connected down-dropped basins filled with sedimentary deposits that are coincident with the path of the Rio Grande. The Rio Grande Rift extends from north to south for about 450 miles from Leadville, Colorado, through New Mexico and into Chihuahua, Mexico.

The Albuquerque Basin (Figure 4) is one of several north–south-trending sediment-filled basins formed by the Rio Grande Rift. The Rio Grande has been an aggrading stream for much of its history and has filled the Albuquerque Basin with up to 10,000 feet of alluvial sediments. Sediments are divided into two separate geologic units: the Santa Fe Group and Quaternary alluvium. Santa Fe Group sediments are characterized by poorly to moderately consolidated alluvial and colluvial deposits ranging in size from boulders to clays. Quaternary alluvium overlying deposits of the Santa Fe Group were deposited as a series of coalescing alluvial fans extending westward from the base of the mountains. These sediments range from poorly sorted mudflow material to well-sorted stream gravel.

There are three distinct hydrologic zones underlying the Tijeras Arroyo Watershed: (1) the fractured bedrock system of the foothills and mountains, (2) the Tijeras Fault Complex, and (3) the Albuquerque Basin (Figure 5). The headwaters of Tijeras Arroyo are located in the bedrock zone; from there the arroyo flows through the Tijeras Fault Complex and into the Albuquerque Basin.

The Rio Grande to Four Hills Bridge reach of Tijeras Arroyo is located entirely within the Albuquerque Basin hydrologic zone. Within the Albuquerque Basin is a large regional aquifer that lies approximately 500 ft below ground surface (bgs). A small localized perched aquifer lies approximately 200 ft above the regional aquifer below portions of KAFB and SNL/NM. Figure 6 provides a generalized three-dimensional representation of geologic conditions under the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo.

Geology is the primary control on how much surface flow occurs in Tijeras Arroyo. In the bedrock hydrologic zone, downward migration of surface flow is slow due to the bedrock's relatively low permeability; flows are largely sustained through this reach. In the Albuquerque Basin hydrologic zone, downward migration of surface flow is rapid due to the relatively high permeability of the basin fill sediments; flows are largely depleted through this reach. Additional discussion of the local hydrogeology is provided in Section 6.7.

6.3 Topography

Tijeras Arroyo is set in the high desert region of central New Mexico. The most prominent local topographic features are the Sandia and Manzano mountains. The Sandia Mountains form a 13-mile-long escarpment distinguished by steep cliffs, pinnacles, and narrow canyons; the tallest point is Sandia Crest at 10,678 ft. The Sandia Mountains are separated from the Manzano Mountains (to the south) by Tijeras Canyon, through which Tijeras Arroyo flows. West of the mountains lies a broad upland bench called the Llano de Sandia. The Rio Grande lies approximately 10 miles west of the mountain front. The mountains in the east and the plains to the west create a diverse range of geological, hydrological, ecological, and climatic settings.

The Rio Grande to Four Hills Bridge reach of Tijeras Arroyo is located west of the mountains on Llano de Sandia high desert grasslands. The topography of the Llano de Sandia is gently sloping to level. Elevations range from approximately 5,800 ft above mean sea level along its eastern extent to approximately 5,300 ft above mean sea level along its western extent (Figure 7). The predominant direction of surface drainage is from the east to the west with an average slope of about 2.5%; however, localized drainage directions vary. The average slope of the Rio Grande to Four Hills Bridge reach channel was estimated using a geographic information system to be approximately 1.5%. The channel gradient is fairly consistent along the entire reach; however, it is slightly higher at the top of the reach (approximately 1.7%) than it is at the bottom of the reach (approximately 1.3%).

6.4 Climate

Large diurnal temperature ranges, summer monsoons, and frequent drying winds are characteristic of the Albuquerque Basin. Temperatures are typical of mid-latitude dry continental climates with summer high temperatures in the basin of approximately 90°F and winter high temperatures around 50°F. Daily low temperatures range from approximately 60°F in the summer to approximately 20°F in the winter. The dry continental climate also produces low average humidity in the late spring and summer prior to the onset of the monsoon season. Daytime relative humidity can be between 10% and 20% in the spring and early summer, with an average humidity near 30%. Winter relative humidity averages near 50%.

Site-specific meteorology is influenced by proximity to topographic features, such as mountains, canyons, and arroyos. These features influence local wind patterns across the site. Canyons and arroyos tend to channel or funnel wind, whereas mountains create an upslope–downslope diurnal pattern to wind flows. Winds tend to blow toward the mountains or up the Rio Grande Valley during the day, and nocturnal winds tend to blow down the mountains toward the Rio Grande Valley. These topographically induced wind flows can be enhanced or negated by weather systems that move across the southwestern United States. The strongest winds occur in the spring when monthly wind speeds average 10.3 mph. Wind gusts commonly reach 50 mph.

Precipitation varies across the area with many locations in the higher elevations of the mountains receiving annual rainfall twice that of locations in the Albuquerque Basin. Nearly all of SNL/NM west of the foothills is considered to be arid, receiving less than 10 inches of rain annually. Some remote test areas in the mountains and foothills may have annual rainfall in excess of 10 inches. Data collected at SNL/NM meteorological Tower A21 (located one-half mile from Tijeras Arroyo; see Figure 8) from 1994 to 2018 indicate an average annual rainfall of 8.61 inches. Approximately 61% (approximately 5.3 inches) of the average annual rainfall occurs during four months of the year: July, August, September, and October (Figure 8; also see Appendix C). Precipitation during these months is mainly in the form of brief, heavy monsoonal storm events. The winter season in the Albuquerque Basin is generally dry, with an average of less than two inches of precipitation falling between December and February.

Summer monsoonal storm cells generally develop over relatively small, localized areas. It is common to receive substantial rainfall in part of the Tijeras Arroyo Watershed and none at all in other parts of the watershed. Significant differences in rainfall can be observed in weather stations located less than one mile apart.

6.5 Ecoregions

Ecoregion data were obtained from the United States Forest Service (Griffith et al. 2006).

The mountainous eastern portion of the Tijeras Arroyo Watershed (Four Hills Bridge to headwaters reach) is located primarily within Level III Ecoregion 23, Arizona/New Mexico Mountains. Two Level IV ecoregions exist within the Arizona/New Mexico Mountains ecoregion: 23e, Conifer Woodlands and Savannas, and 23f, Rocky Mountain Conifer Forests.

The western portion of the Tijeras Arroyo Watershed, which includes the Rio Grande to Four Hills Bridge reach, is located primarily within Level III Ecoregion 22 (Arizona/New Mexico Plateau). The Arizona/New Mexico Plateau is comprised of two Level IV ecoregions: 22m, Albuquerque Basin, and 22g, Rio Grande Floodplain. The boundaries of these ecoregions are depicted in Figure 9, and additional detail is provided in Appendix D.

The Arizona/New Mexico Plateau Ecoregion (22) represents a large transitional region between the drier shrublands and wooded higher-relief tablelands of the Colorado Plateaus (20) in the north; the lower, hotter, less-vegetated Mojave Basin and Range (14) in the west; and forested mountain ecoregions that border the region on the northeast (21) and south (23). Local relief in the region varies from a few feet on plains and mesa tops to well over 1,000 ft along tableland side slopes. The Continental Divide splits the region, but it is not a prominent topographic feature. The region extends across northern Arizona, northwestern New Mexico, and into Colorado in the San Luis Valley. Gunnison prairie dogs are a keystone species in many of the sagebrush ecosystems, and their burrows provide habitat for other wildlife, including burrowing owls, weasels, badgers, and a variety of snakes.

The Albuquerque Basin (22m) is lower in elevation, drier, and warmer than surrounding Level IV ecoregions to the north, east, and west. The basin is filled with thick sediments of mostly Quaternary and some Tertiary age, with a few areas of volcanic rocks and lava-capped mesas. Extending from the La Bajada Escarpment on the north to near Socorro in the south, the region contains some diverse features and transitional characteristics. Unlike most of Ecoregion 22, which has mesic soils, 22m has a largely thermic soil temperature regime with a mix of sand scrub and desert grassland vegetation. Native vegetation includes black grama, sand dropseed, mesa dropseed, blue grama, galleta, sand sage, alkali sacaton, threeawns, and scattered yucca. Juniper occurs primarily in the north. Urban and suburban land uses are spreading.

The portion of Tijeras Arroyo that is within the Rio Grande Floodplain ecoregion (22g) has been channelized and lined with concrete for flood control and stabilization.

6.6 Soils

Soil maps were obtained from the National Resources Conservation Service National Cooperative Soil Survey Web Soil Survey (USDA 1977) (Figure 10). Detailed descriptions of the most prominent units are provided in Appendix E. Essentially all the active channel in the Rio Grande to Four Hills Bridge reach and much of the floodplain are comprised of Gila fine sandy loam. Gila fine sandy loam is classified under the hydrologic soil group B, which is sandy loam soils with moderately fine to moderately coarse textures. The National Cooperative Soil Survey describes Gila fine sandy loam as being derived from igneous and sedimentary rock, occurring in alluvial fans and floodplains (Appendix E). The typical profile consists of 0–7 inches of fine sandy loam, underlain by stratified gravelly loam to silt loam from 7–60 inches bgs. It is well drained, has a runoff classification of low, and the available water storage within its profile is about 10.5 inches. The most restrictive (slowest) transmitting layer is classified as moderately high to highly permeable with a hydraulic conductivity of 0.60 to 2.00 inches per hour. The physical characteristics of Gila fine sandy loam promote rapid downward infiltration of surface water.

A number of additional soil series are present in upland areas immediately surrounding the Tijeras Arroyo floodplain; some of the more prevalent are the Bluepoint, Embudo, Latene, Madurez, Tijeras, and Wink (Figure 10). These soils are similar in composition and structure to Gila fine sandy loam; all are classified as group B soils under the hydrologic soil grouping scheme. With little exception, the soils in and around Tijeras Arroyo promote rapid infiltration, which decreases runoff and thus flow to and within the stream channel.

6.7 Groundwater Conditions

There are three distinct hydrogeologic zones within the Tijeras Arroyo Watershed: (1) the fractured bedrock system of the foothills and mountains, (2) the Tijeras Fault Complex, and (3) the Albuquerque Basin (Figure 5).

The predominant direction of groundwater flow is from east to west. The Tijeras Fault Complex is a transition zone that separates the fractured bedrock system on the east from the Albuquerque Basin on the west (Figure 5). East of the Tijeras Fault Complex, the hydrogeology is characterized by fractured and faulted bedrock with depths to groundwater ranging from 45 to 325 ft bgs. On the west side of the Tijeras Fault Complex, the hydrogeology is characterized by unconsolidated sediments of the Santa Fe Group with depths to groundwater ranging from approximately 200 to 570 ft bgs (Figure 11 and Figure 12; Appendix F). The Albuquerque Basin contains a substantial regional aquifer that provides potable water to the Albuquerque metropolitan area. A small, perched aquifer related to anthropogenic activity has also been identified, but it has been declining steadily over the past several decades and is expected to be dewatered completely within 20 years.

6.7.1 Fractured Bedrock Aquifer

Groundwater in the fractured bedrock system generally flows west out of the canyons toward the Tijeras Fault Complex. The groundwater gradient is relatively steep, 0.03 feet per foot (feet of vertical change per foot of horizontal distance). Across the Tijeras Fault Complex the change in the groundwater elevation is 350 feet; the steep gradient suggests that westward groundwater flow is retarded by the Tijeras Fault Complex. The hydrogeology in this area is poorly understood due to the complex geology created by the fault systems. On the east side of the Tijeras Fault Complex, depth to groundwater ranges from about 45 to 325 ft bgs. Most non-potable water supply and monitoring wells east of the faults are completed in fractured bedrock at relatively shallow depths and produce modest yields of groundwater.

6.7.2 Albuquerque Basin Aquifer

West of the Tijeras Fault Complex, within the sediments of the Albuquerque Basin, the Regional Aquifer lies at approximately 500 ft bgs. Within the Regional Aquifer, the gradient is relatively low, averaging about 0.005 feet per foot. The historic direction of regional groundwater flow within the basin was westward from the mountains toward the Rio Grande. Due to groundwater pumping by KAFB, the Veterans Administration Hospital, and Albuquerque Bernalillo County Water Utility Authority production wells, a depression in the Regional Aquifer has been created originating at the well fields near the northwest corner of KAFB. The impact of the seasonal variation in water production by both KAFB and Albuquerque Bernalillo County Water Utility Authority wells can be observed as minor fluctuations in the groundwater elevations of some SNL/NM and KAFB monitoring wells as far to the southeast as Technical Area III. Pumping and associated decreased groundwater levels have had no effect on surface flows in the Tijeras Arroyo, as there are hundreds of feet separating the stream channel from the shallowest groundwater.

6.7.3 Perched Aquifer

A diminishing Perched Groundwater System lies above the Regional Aquifer in a portion of northern KAFB (Figure 6). The Perched Groundwater System flows from west to east (opposite of the regional groundwater flow direction), from roughly the eastern extent of the KAFB airfield to the KAFB golf course. It extends north to approximately Southern Boulevard and south to Tijeras Arroyo. The perching layer is discontinuous in the vicinity of the golf course, where perched water drains to the regional aquifer. Depth to water in the perched zone averages 300 ft bgs. Possible recharge sources for the Perched Groundwater System are Tijeras Arroyo, golf course irrigation, landscape watering, water leakage from utility distribution lines, former septic system discharges, and infiltration from a former unlined KAFB wastewater treatment lagoon system (SNL/NM 1998). Water table elevations in the perched zone have been decreasing over the past 20 years, with trends suggesting that complete dewatering of the perched zone may occur sometime near 2040.

6.7.4 Groundwater-Surface Water Interaction

The depth to first groundwater (perched zone) beneath the Tijeras Arroyo channel is approximately 200 ft bgs. Where the perched aquifer is not present, the depth to first groundwater is as much as 500 feet bgs. Due to the substantial distance from ground surface to the water table, groundwater does not contribute to flow in the Rio Grande to Four Hills Bridge reach.

Groundwater recharge to the Albuquerque Basin occurs primarily along the eastern mountain front and along the major arroyos (SNL/NM 1998). The amount of recharge occurring in the foothills and canyons is not well characterized. Recharge for the portion of Tijeras Arroyo on KAFB was estimated to be approximately 2.2 million CF/yr (50 AF/yr) (SNL/NM 1998). The same study estimated the groundwater recharge associated with Arroyo del Coyote to be about 0.4 million CF/yr (9.2 AF/yr). This recharge occurs exclusively during storm (precipitation) runoff events.

The Rio Grande to Four Hills Bridge reach is a losing stream; surface water infiltrates through the channel bottom and percolates downward to the water table. There is no evidence to suggest that the water table historically intersected ground surface or otherwise promoted flow within the Arroyo. To illustrate the historically deep water table, representative hydrographs from along the Rio Grande to Four Hills Bridge reach are provided in Appendix F.

6.8 Surface Water Conditions

The Rio Grande is the major surface hydrologic feature in central New Mexico. The Rio Grande originates in the San Juan Mountains of Colorado and terminates at the Gulf of Mexico, near Brownsville, Texas. The Rio Grande has a total length of 1,760 miles and is the third-longest river system in North America.

Tijeras Arroyo discharges to the Rio Grande (Figure 2) and drains the Tijeras Arroyo Watershed (Section 6.1). The only significant tributary to the Tijeras Arroyo is the Arroyo del Coyote, which intersects Tijeras Arroyo at the top of the Lower Tijeras Arroyo Sub-watershed (Figure 3). Both Tijeras Arroyo and Arroyo del Coyote carry significant runoff after heavy thunderstorms that usually occur from June through August. Tijeras Arroyo, above the confluence with Arroyo del Coyote, drains about 80 square miles, while Arroyo del Coyote drains about 39 square miles (USACE 1979). The total watershed for Tijeras Arroyo is approximately 132 square miles.

The Tijeras Arroyo channel is relatively narrow and steep in the upper and middle watersheds, but it flattens and widens as it leaves the igneous and metamorphic terrain and enters the poorly consolidated sediments that comprise the Albuquerque Basin. This change in channel morphology and bed material results in a significant increase in infiltration potential. While portions of the upper and middle Tijeras Arroyo have been observed to support flow throughout the year, flow within the lower watershed occurs only for brief periods in response to rainfall and snowmelt.

Several springs on KAFB are associated with the uplifts in the Tijeras Fault Complex and in the Foothills and Canyons hydrogeologic areas (Figure 13): (1) Coyote Springs, Cattail Springs, and G Spring within Arroyo del Coyote, (2) Burn Site Spring in Lurance Canyon, and (3) Sol se Mete Spring within the Manzanita Mountains. Hubbell Spring (a perennial spring) is located just south of KAFB on Isleta Pueblo. Coyote Springs and Sol se Mete are perennial springs (continuously flowing), while the others are ephemeral springs. When flowing, the springs produce surface flows that only last for a short distance, on the order of tens or perhaps hundreds of feet. The springs do not contribute flow to the Tijeras Arroyo.

6.8.1 Flow Gauging

Flow data are available from only one flow gauge within the reach—the United States Geologic Survey (USGS) Station 08330600 in Tijeras Arroyo near Albuquerque (Figure 13). The station has a nearly 37-year period of record spanning from September 1982 to the present (May 1, 2019, for this report). Data since October 1, 2017, are provisional, and there are a number of periods prior to that where data does not exist or has not been approved for publication. Most of the days with missing data occurred during the winter months when flow is less likely to occur. Out of the 13,353 days since the period of record began, there are 9,933 days of flow data approved for publication. The following description of flow frequency is based on those 9,933 days. The complete data set used for the analysis in this report is provided in Appendix G.

Over the period of record, the average number of days per year in which flow at the gage was measured above zero is 37.7 (10.3% of days). The breakdown by month is provided in Table 2. The number of days in each month with measurable flow is depicted graphically in Figure 14.

As can be seen, the months with the highest flow frequency are the summer monsoonal months of July and August. During these months, flow occurs approximately six days per month. During the reminder of the year, flows occur during roughly two to three days of each month. Occasional large releases from broken water mains, well development, hydrant flushing, or other anthropogenic activities may occur; however, runoff from precipitation is by far the largest contributor of flow to the arroyo. Due to the spatial and temporal variability in rainfall that occurs in Albuquerque, correlations between individual flow and precipitation events for specific days and monitoring stations are difficult to establish. However, comparison of monthly averages, which help smooth out the random spatial distribution of monsoonal storm cells, shows a strong correlation between the number of monthly precipitation events and the number of flow events (Figure 15). Figure 15 illustrates that flow frequency increases linearly with precipitation frequency, indicating that flow is closely tied to precipitation.

The frequency of flow measured at the USGS gage is higher than expected by NTESS staff who work near and see the Tijeras Arroyo daily. It is possible that flows occur more frequently at the gage than it does in the vicinity of SNL/NM; there are considerable urbanized areas downstream that could be contributing flow to the arroyo. However, there are no data available to support this observation.

6.9 Land Use History

There are numerous human-related disturbances throughout the Lower Tijeras Arroyo Watershed, including but not limited to land clearing, mining, urbanization, roads and road construction, livestock grazing, off-road vehicle use, and vegetation conversion. There are signs of historic small-scale irrigation for agriculture, but irrigated agriculture has not occurred in recent history. Due to the increase in impervious surfaces associated with urbanization, it is likely that more runoff occurs in Tijeras Arroyo under current conditions than occurred under predevelopment conditions.

Even though anthropogenic disturbances can affect water quality, current land use and history do not provide direct evidence to support or refute changing the established designated uses. The Lower Tijeras Arroyo Watershed, regardless of anthropogenic influences, is not able to attain the established designated uses for primary contact and limited warmwater aquatic life. Therefore, the potential anthropogenic impacts on water quality are not a factor in this UAA, which is basing the replacement of designated uses on natural, low-flow conditions.

6.9.1 Urbanized Areas

There are significant urbanized areas adjacent to and within the stream channel of the Rio Grande to Four Hills reach of Tijeras Arroyo. These are documented in additional detail in Section 7.0 and Section 8.0.

Anthropogenic disturbances can affect water quality due to impervious surfaces and pollution of stormwater runoff. However, water quality is not the basis for questioning the ability of this reach to support the designated uses. Urbanization likely increases the amount of flow that occurs in Tijeras Arroyo due to the increase in impervious surfaces draining to the arroyo; however, these additional flows are insufficient to support the designated uses associated with intermittent waters (primary contact limited warmwater aquatic life). Discharges from urban areas are irregular and do not provide a consistent source of water to offset the non-perennial nature of the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo.

6.9.2 Surface Declarations and Permits

The New Mexico Office of the State Engineer (OSE) is the agency responsible for issuing surface water declarations and permits, also known as "water rights." A water right is a legal right, issued as a permit or declaration to utilize water (19.26.2 NMAC). Some permits may involve hydrologic modifications, such as diversions. The flow regime of a stream, which is necessary for attaining the water quality associated with designated uses, is impacted by surface water diversions.

A stream with a diversion may signify that low flow is due to hydrological modifications and not due to natural causes. Therefore, if a non-perennial water contains a surface declaration or a permit with an associated existing designated use, then that water will retain its current designated use, at this time, because low flow could be due to anthropogenic hydrologic modifications and not natural causes.

DOE and NTESS conducted an Office of the State Engineer surface declaration and permit review to identify whether any permits exist within the reach. Permit data were obtained from the New Mexico Office of the State Engineer's Point of Diversions Open Data Site. No surface declarations or Office of the State Engineer permits for the diversion of surface water from the Rio Grande to Four Hills Bridge reach of the Tijeras Arroyo were identified.

6.9.3 NPDES Permits

A review of the EPA NPDES Individual and Stormwater General Permits associated with the non-perennial sections was conducted to determine whether flows from permitted discharges could compensate the low-flow conditions.

The only NPDES-permitted discharges to the Tijeras Arroyo within the Rio Grande to Four Hills Bridge reach are stormwater discharges from SNL/NM, KAFB, the City of Albuquerque, and Bernalillo County. Coverage under the NPDES Municipal Separate Storm Sewer System Permit allows these entities to divert stormwater to Tijeras Arroyo. Stormwater discharges occur in direct response to rainfall and snowmelt; storm drains do not sustain flows beyond a brief period following a storm event. Stormwater outfalls to Tijeras Arroyo that were identified during this investigation are shown in Figure 13; there may be some relatively small outfalls that were not identified.

There are no other NPDES discharges to the reach, including from industrial sites or wastewater reclamation facilities. Based on this review, existing NPDES permits contribute runoff to Tijeras Arroyo for brief periods, but this runoff cannot generate consistent discharge to compensate for the ephemeral nature of flows in the reach.

6.9.4 Dams and Other Stream Modifications

Appendix H contains aerial photographs of the Rio Grande to Four Hills Bridge reach from six different years: 1935, 1951, 1959, 1982, 2002, and 2018. The 1935 photos are not used for close-up views of individual sub-reaches because the resolution was too low; however, the 1935 photo for the entire reach is useful for general comparison.

There has been substantial development adjacent to Tijeras Arroyo since 1935; the largest impacts have been residential housing construction in sub-reaches 7 and 8 and the expansion of facilities within KAFB and the Albuquerque International Sunport (airport) near reaches 5 and 6. Numerous stream channel and bank modifications have been implemented or been caused indirectly over the last approximately 75 years. Most of these changes have been erosion control projects, primarily for stabilizing the banks and channel. The following list describes the more notable modifications. The locations of each modification is shown in Figure 16, with numbers in the figure corresponding to numbers in the list:

Reach 8:

1. Four Hills Road bridge crossing
2. concrete drop structure immediately downstream of Four Hills Bridge
3. loose concrete rip-rap bank on both sides of the channel for most of the sub-reach
4. concrete bank on the south side of the channel

Reach 7:

5. bridge/road crossing and associated channel
6. encroachment on the north side of the channel from landfill
7. concrete bank on the south side of the channel

Reach 6:

8. concrete road crossing and low-flow diversion beneath the road
9. dirt road crossing

Reach 5:

10. bridge and associated channel
11. encroachment on the north side of the channel from landfill
12. concrete drop structure

Reach 4:

13. bridge
14. stabilized channel for bank and structure protection

Reach 3:

15. concrete drop structure
16. concrete drop structure

Reach 2:

17. grading to stabilize the bank layback
18. paved road crossing
19. bridge and associated channel

Reach 1:

20. I-25 bridge and associated channel stabilization
21. sediment detention basins
22. concrete lined channel

Although changes in the channel resulting from anthropogenic activities have occurred, there is no indication that they have diverted, retained, or otherwise decreased the frequency or magnitude of flows in the arroyo. There is no indication from aerial photographs or other available information that there are uses of surface water that no longer exist. Stormwater flow within the arroyo is likely to be greater today than it was under predevelopment conditions due to the increased area of impermeable surfaces (e.g., buildings, roads, and parking lots) that drain to the arroyo.

7.0 Stream Channel Surveys

This UAA is following the standard rulemaking process for changing designated uses described in 20.6.4.15. Stream channel surveys of Tijeras Arroyo were conducted using the Hydrology Protocol methods to provide information on hydrologic conditions in the reach.

The Hydrology Protocol was developed specifically to aid in differentiating intermittent and ephemeral water bodies. Hydrology Protocol surveys are guided by questions about the hydrological, geomorphic, and biological indicators of the persistence of water. A numeric scoring system enables ranking of aquatic life and human contact characteristics of the water body and provides an indication of whether the water is intermittent or perennial. The Hydrology Protocol methods indicate that a score of 9 or less (on a scale of 0–37.5) is an indication of ephemeral conditions, and a score above 12 is an indication of intermittent conditions (a score between 9 and 12 is considered to be a gray area requiring additional characterization).

Hydrology Protocol field surveys were conducted June 17–28, 2019. To ensure adequate characterization of the entire Rio Grande to Four Hills Bridge reach, the reach was divided into eight sub-reaches (Figure 17). Each sub-reach is approximately one mile long. The highest score for a single sub-reach was 8.5, the lowest score was 5.5, and the average score for the entire reach was 6.1, which all indicate ephemeral conditions.

Sinuosity calculations are presented in Table 3, and channel and floodplain dimensions are presented in Table 4. In-channel and out-of-channel particle size distribution are presented in Table 5 and Table 6, respectively.

A full discussion of the Hydrology Protocol surveys is provided in Appendix I. Scores for each rating factor for each sub-reach are provided in Appendix I-2 and summarized in Table 7.

8.0 Establishing Highest Attainable Use

Once the factor that precludes the attainment of the use has been demonstrated, 40 CFR 131.10 requires the UAA to provide demonstration of the highest attainable use. The definition of highest attainable use can be found in 40 CFR 131.3(m):

> Highest attainable use is the modified aquatic life, wildlife, or recreation use that is both closest to the uses specified in section 101(a)(2) of the Act and attainable, based on the evaluation of the factor(s) in §131.10(g) that preclude(s) attainment of the use and any other information or analyses that were used to evaluate attainability. There is no required highest attainable use where the State demonstrates the relevant use specified in section 101(a)(2) of the Act and sub-categories of such a use are not attainable.

8.1 Highest Attainable Designated Uses

Due to limited ephemeral flows in response to stormwater run-off (40 CFR 131.10(g)), the highest attainable recreational use is secondary contact, which is defined in 20.6.4 NMAC as:

> any recreational or other water use in which human contact with the water may occur and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, wading, commercial and recreational boating and any limited seasonal contact.

Due to limited ephemeral flows in response to stormwater run-off (40 CFR 131.10(g)), the highest attainable aquatic life use is limited aquatic life, which is defined in 20.6.4 NMAC as:

> the surface water is capable of supporting only a limited community of aquatic life. This subcategory includes surface waters that support aquatic species selectively adapted to take advantage of naturally occurring rapid environmental changes, ephemeral or intermittent water, high turbidity, fluctuating temperature, low dissolved oxygen content or unique chemical characteristics.

Both secondary contact and limited aquatic life uses are consistent with ephemeral waters as identified under 20.6.4.97 NMAC. It is also assumed that the reach can attain uses for livestock watering and wildlife habitat which are also consistent with 20.6.4.97 NMAC.

9.0 Removal of a Designated Use

According to 40 CFR 131.10, states can remove a designated use if it is not an existing use, and if the rationale for removal of a designated use falls under one of the six factors in 40 CFR 131.10(g) (presented in Section 2 of this UAA).

9.1 Proposed Designated Use Removals

Based on the evidence provided in this UAA, DOE and NTESS have concluded that ephemeral low flow conditions (the second factor in 40 CFR 131.10(g)) prevent attainment of the current designated uses in the Rio Grande to Four Hills reach of Tijeras Arroyo.

This UAA recommends and proposes changing the classification of the Rio Grande to Four Hills reach of Tijeras Arroyo from intermittent to ephemeral. This would result in removing the designated use of primary human contact and marginal warmwater aquatic life and adding the highest attainable designated use of secondary human contact and limited aquatic life (Table 1).

9.2 Factors Preventing Attainment of the Current Designated Use

Designated uses may be removed or amended to have less stringent criteria if a UAA can demonstrate that attaining the designated use is not feasible based on one of the six factors in 40 CFR 131.10(g). As discussed in Section 2.0, DOE and NTESS believe that the attainment of current beneficial uses is not possible due to the second factor under 40 CFR 131.10(g), in this case, ephemeral low flow conditions.

> (2) Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met.

9.3 Demonstration that Designated Uses are Not Attainable

Natural low flow conditions or the lack of persistent water associated with the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo prevents the attainment of the current designated marginal warmwater aquatic life and primary human contact designated uses. Based on the information provided in this UAA, DOE and NTESS have concluded that in accordance with 40 CFR 131.10(g)(2) the current designated uses associated with intermittent waters are not attainable.

Fishing or boating is not attainable in the reach; the only potential recreational use would be wading, and even that would be limited to brief flows occurring during storm events. Therefore, the designated use of primary human contact is not attainable.

The reach is completely dry more than 90% of the time, and there was no evidence of aquatic life observed during field surveys. Therefore, the designated use of warmwater aquatic life in not attainable.

10.0 Quality Control and Quality Assurance

Environmental monitoring (which includes sampling) is conducted in accordance with programspecific sampling and analysis plans, work plans, or quality assurance plans, which contain quality assurance elements. These documents meet applicable federal, state, and local requirements for conducting sampling and analysis activities. Personnel in various programs collect environmental samples and submit the samples for analysis of radiological and nonradiological constituents.

Project sampling and analysis plans (or equivalent) include critical elements, such as procedures for collecting samples, preserving and handling samples, controlling samples, controlling laboratory quality, setting required limits of detection, controlling field quality, ensuring health and safety, setting schedules and frequency for sampling, reviewing data, determining data acceptability, and reporting.

10.1 Training and Qualifications

This work was conducted by a multidisciplinary staff of environmental professionals including, geologists, hydrologists, water quality specialists, biologists, ecologists, meteorologists, geographers, GIS analysts, and field technicians. All staff hold degrees, and/or professional certifications relative to their field of expertise:

Team Member	SNL/NM Program	Primary UAA Role	Degree/Certification
John Kay	Stormwater	Project Lead/geology	MS Hydrology, Professional Geologist (CA)
Kathie Deal	Stormwater	Regulatory review	MS Environmental Science
Carolyn Daniel	Stormwater	Flow and water quality	Certified Professional in Erosion and Soil Control
Joe Fontana	Meteorology	Climate/precipitation	MS Atmospheric Sciences
Jennifer Payne	Ecology	Vegetation/aquatic life	MS Water Resources Management, BS Biology, Certified Ecological Restoration Practitioner (Society for Ecological Restoration)
Mike Skelly	Groundwater	Groundwater	MS Geology, Professional Geologist (WY)
Sonny Casaus	GIS	Geographic data/maps	GIS Certified Professional
Steven Toler	Surveyor	Stream channel surveys	BS Civil Engineering NM Registered Professional Land Surveyor

10.2 Data Collection and Management

All data used in this analysis were collected in accordance with the approved Work Plan. All methods and sources used to obtain data are documented. All data and information originating from outside Sandia National Laboratories were obtained from reliable sources, such as the US Fish and Wildlife Service, US Geologic Survey, and Kirtland Air Force Base. Data and information developed by Sandia underwent the quality control and quality assurance measures described in Section 10.2.1.

Sample collection, analysis request and chain-of-custody documentation, and measurement data are reviewed and validated for each sample collected. Analytical data reported by contract laboratories are reviewed to assess laboratory and field precision, accuracy, completeness, representativeness, and comparability with respect to each program's method of compliance and data quality objectives. The data are validated at a minimum of three levels:

In addition to the three minimum validation levels, a technical assistance contractor may validate analytical data under direction of Sample Management Office personnel in accordance with applicable procedures and requirements. The purpose is to identify, through evaluation of supporting documentation, those monitoring results that do not meet the expected precision and accuracy of an analytical method. Groundwater monitoring data and Terrestrial Surveillance Program data are validated by a technical assistance contractor providing this additional level of quality assurance.

All analytical data packages, analysis request and chain-of-custody documents, and data validation reports are submitted to a Sandia record depository for cataloging and storage in accordance with internal procedures, DOE requirements, and the document control requirements of ISO 9001, *Quality Management*, and ISO 14001, *Environmental Management Systems*.

10.3 Document Review

This document has undergone a thorough technical review by staff, legal counsel, and management at SNL/NM. All information, results, and conclusions have been reviewed to ensure they are accurate.

11.0 Summary and Conclusions

Based on the information presented in this UAA, the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo (AU NM-9000.A_070) exhibits characteristics of an ephemeral water body. This conclusion is supported by historic and recent hydrologic, geomorphic, and ecologic indicators of flow as presented in this report. This conclusion is also supported by results of field surveys using the NMED Hydrology Protocol method for differentiating ephemeral and intermittent water bodies based on the designated uses supported by a water. The highest attainable aquatic life and human contact uses due to limited ephemeral flows are “limited aquatic life and secondary contact”, and the current designated uses of “marginal warmwater aquatic life and primary contact” are not attainable.

Geology is the primary factor that causes the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo to be ephemeral. The thick sequence of unconsolidated sediment in the Albuquerque Basin and the deep water table promote rapid infiltration of surface water, depleting any base flows that might originate from the shallow bedrock water table located upstream. While perennial flow occurs upstream in the Four Hills Bridge to headwaters reach, these flows infiltrate a short distance beyond the boundary between bedrock and basin fill.

Aside from occasional allowable non-stormwater discharges from municipal activities (such as water main breaks or fire hydrant testing), the only flows that occur in the Rio Grande to Four Hills Bridge reach are the result of localized storm events. No other permitted discharges occur to the reach (NPDES or otherwise). The historic record from a USGS flow gage near the bottom of the reach indicates that flow is detected above 0 cfs on 5–25% of the days in a month, depending upon the time of year (Figure 15). Average daily flow above 1 cfs occurs between 2% and 15% of days, and average daily flow above 10 cfs occurs on 0–5% of days. There is a strong correlation between the number of flow events and the number of rain events that occur during each month of the year (Figure 16). Most flow occurs during the summer monsoon season.

The hydrogeologic and stream flow conditions described in this UAA *do not meet* the following definition of intermittent listed in 20.6.4.7 NMAC:

> The water body contains water for extended periods only at certain times of the year, such as when it receives seasonal flow from springs or melting snow.

The hydrogeologic and stream flow conditions described in this UAA *do meet* the following definition of ephemeral listed in 20.6.4.7 NMAC:

> The water body contains water briefly only in direct response to precipitation; its bed is always above the water table of the adjacent region.

Water, fish, macroinvertebrates, algae, hydric soils, seeps, springs, and iron-oxidizing bacteria were not found anywhere in the reach. Geomorphic characteristics of the reach—including channel structure, substrate sorting, floodplain dimensions, and sinuosity—were all indicative of ephemeral characteristics.

Vegetation within and adjacent to the reach is similar in composition to upland vegetation outside the active floodplain. No riparian zones were encountered. The density of vegetation near large stormwater outfalls was somewhat greater due to the increased presence of water; however, these areas were not riparian. The vegetation was characteristic of ephemeral conditions.

Hydrology protocol scores for individual sub-reaches ranged from 4.0 to 8.0. The average score for the entire reach was 6.1. The Hydrology Protocol guidelines indicate that a score of 9 or less is an indication of ephemeral conditions.

Based on the designated use definitions provided in 20.6.4.7 NMAC (summarized in Table 1), the information developed during this study clearly shows that the primary contact and limited warmwater aquatic life uses supported by intermittent waters are not supported by the Rio Grande to Four Hills Bridge reach. Fishing, boating, swimming, or other "intimate human contact involving considerable risk of ingestion" are not existing or attainable uses within the reach. Similarly, the frequency of the presence of water is not sufficient to support "aquatic life on a continuous annual basis."

Regardless of any conceivable future anthropogenic influences, the reach is not able to attain the current designated uses for primary contact or limited warmwater aquatic life. Therefore, the potential anthropogenic impacts on water quality are not a factor in this UAA, which is basing the replacement of designated uses on natural, low-flow conditions.

It is the conclusion of this investigation that the classification of the Rio Grande to Four Hills Bridge reach of Tijeras Arroyo is consistent with ephemeral rather than intermittent waters. This is based on the historical, geomorphic, and ecological indicators of flow as well as field surveys using the NMED Hydrology Protocol. Accordingly, the recommendation is to change the stream type classification from intermittent to ephemeral, which would include changing the designated uses to the highest attainable uses of "limited aquatic life and secondary contact" along with the designated uses which would not change "livestock watering and wildlife habitat".

Tables

Table 1. Designated uses associated with intermittent and ephemeral waters in New Mexico (adapted from NMAC 20.6.4)

Water Type	Designated Use	Description
Intermittent	Livestock watering	Can be used as a water supply for livestock
	Wildlife habitat	Can be used by plants and animals
	Marginal warmwater aquatic life	Can support limited aquatic life on a continuous annual basis
	Primary human contact	Can support activities involving prolonged and intimate human contact involving considerable risk of ingestion
Ephemeral	Livestock watering	Can be used as a water supply for livestock
	Wildlife habitat	Can be used by plants and animals
	Limited aquatic life	Can support limited aquatic life specifically adapted to rapidly changing environmental conditions
	Secondary human contact	Can support activities involving human contact where risk of ingestion is minimal

Table 2. Occurrence of flow in Tijeras Arroyo from USGS Gage 08330600 (1984–2018)

Month	Number of Days in Record	Number of Days with Flow[1]	Percent of Days with Flow	Average Daily Flow Rate[2] (cfs)
January	512	37	7.2	0.11
February	467	34	7.3	0.25
March	799	38	4.8	0.13
April	977	63	6.5	0.24
May	1,020	71	7.0	0.19
June	984	64	6.5	0.24
July	987	208	21.0	0.55
August	956	198	20.7	1.76
September	928	120	12.9	0.86
October	967	89	9.2	0.09
November	775	56	7.2	0.07
December	561	47	8.4	0.10
Total	**9,933**	**1,025**	**10.0**	**0.38**

[1]Includes any measurable flow above 0 cfs.
[2]Average daily flow rate during days when flow occurs (does not include days in which flow does not occur).

Table 3. Sinuosity calculations

Sub-reach	Current Sinuosity (2018)	Predevelopment Sinuosity (1951)	Change
1	1.00	1.01	−0.01
2	1.17	1.08	0.09
3	1.22	1.13	0.09
4	1.41	1.21	0.20
5	1.12	1.19	−0.07
6	1.08	1.04	0.04
7	1.14	1.04	0.10
8	1.05	1.02	0.03
Entire reach	1.15	1.10	0.05

Table 4. Channel and floodplain dimensions

Transect Number	Sub-reach	Maximum Depth (ft)	Channel Width (ft)	Flood Prone Width (ft)	Floodplain to Channel Ratio
1	2	0.84	77.92	102.35	1.31
2	2	1.63	31.94	39.18	1.23
3	3	1.66	38.24	59.35	1.55
4	4	1.23	21.43	44.51	2.08
5	5	1.00	41.79	57.15	1.37
6	5	0.98	36.33	42.11	1.16
7	6	1.10	31.54	38.26	1.05
8	6	0.67	66.11	70.84	1.07
9	6	0.71	28.64	33.63	1.17
10	7	0.70	48.90	54.53	1.12
11	7	0.50	41.24	245.05	5.94
12	8	1.05	46.74	59.16	1.27
Median		**0.99**	**39.74**	**55.84**	**1.25**

Table 5. In-channel particle size distribution

Particle Class	Size Range (mm)	Count								
		Sub-reach 2	Sub-reach 3	Sub-reach 4	Sub-reach 5	Sub-reach 6-1	Sub-reach 6-2	Sub-reach 7	Sub-reach 8	Full Reach
Fines	< 0.5	17	20	11	13	20	24	19	4	128
Sand	0.5–2	62	53	44	18	19	11	26	18	251
Very fine gravel	2–4	13	22	20	38	30	29	32	41	225
Fine gravel	5–8	2	2	10	17	24	16	15	11	97
Medium gravel	9–16	5	3	7	7	5	8	7	13	55
Course gravel	17–32	1	0	4	7	2	6	1	8	29
Very course gravel	33–64	0	0	2	0	0	4	0	3	9
Small cobble	65–90	0	0	1	0	0	0	0	1	2
Medium cobble	91–128	0	0	1	0	0	2	0	0	3
Large cobble	129–256	0	0	0	0	0	0	0	1	1
Small boulder	257–512	0	0	0	0	0	0	0	0	0
Medium boulder	513–1,024	0	0	0	0	0	0	0	0	0
Large boulder	> 1,025	0	0	0	0	0	0	0	0	0

Particle Class	Size Range (mm)	Percent								
		Sub-reach 2	Sub-reach 3	Sub-reach 4	Sub-reach 5	Sub-reach 6-1	Sub-reach 6-2	Sub-reach 7	Sub-reach 8	Full Reach
Fines	< 0.5	17	20	11	13	20	24	19	4	16.00
Sand	0.5–2	62	53	44	18	19	11	26	18	31.38
Very fine gravel	2–4	13	22	20	38	30	29	32	41	28.13
Fine gravel	5–8	2	2	10	17	24	16	15	11	12.13
Medium gravel	9–16	5	3	7	7	5	8	7	13	6.88
Course gravel	17–32	1	0	4	7	2	6	1	8	3.63
Very course gravel	33–64	0	0	2	0	0	4	0	3	1.13
Small cobble	65–90	0	0	1	0	0	0	0	1	0.25
Medium cobble	91–128	0	0	1	0	0	2	0	0	0.38
Large cobble	129–256	0	0	0	0	0	0	0	1	0.13
Small boulder	257–512	0	0	0	0	0	0	0	0	0.00
Medium boulder	513–1,024	0	0	0	0	0	0	0	0	0.00
Large boulder	> 1,025	0	0	0	0	0	0	0	0	0.00

Table 6. Out-of-channel particle size distribution

Particle Class	Size Range (mm)	Count								
		Sub-reach 2	Sub-reach 3	Sub-reach 4	Sub-reach 5	Sub-reach 6-1	Sub-reach 6-2	Sub-reach 7	Sub-reach 8	Full Reach
Fines	< 0.5	28	29	34	25	16	9	10	30	181
Sand	0.5–2	18	19	6	8	9	11	15	4	90
Very fine gravel	2–4	4	1	6	7	12	14	14	8	66
Fine gravel	5–8	0	0	2	4	9	7	7	4	33
Medium gravel	9–16	0	1	1	6	2	6	2	3	21
Course gravel	17–32	0	0	1	0	2	2	1	1	7
Very course gravel	33–64	0	0	0	0	0	1	0	0	1
Small cobble	65–90	0	0	0	0	0	0	1	0	1
Medium cobble	91–128	0	0	0	0	0	0	0	0	0
Large cobble	129–256	0	0	0	0	0	0	0	0	0
Small boulder	257–512	0	0	0	0	0	0	0	0	0
Medium boulder	513–1,024	0	0	0	0	0	0	0	0	0
Large boulder	> 1,025	0	0	0	0	0	0	0	0	0

Particle Class	Size Range (mm)	Percent								
		Sub-reach 2	Sub-reach 3	Sub-reach 4	Sub-reach 5	Sub-reach 6-1	Sub-reach 6-2	Sub-reach 7	Sub-reach 8	Full Reach
Fines	< 0.5	56	58	68	50	32	18	20	60	45.25
Sand	0.5–2	36	38	12	16	18	22	30	8	22.5
Very fine gravel	2–4	8	2	12	14	24	28	28	16	16.5
Fine gravel	5–8	0	0	4	8	18	14	14	8	8.25
Medium gravel	9–16	0	2	2	12	4	12	4	6	5.25
Course gravel	17–32	0	0	2	0	4	4	2	2	1.75
Very course gravel	33–64	0	0	0	0	0	2	0	0	0.25
Small cobble	65–90	0	0	0	0	0	0	2	0	0.25
Medium cobble	91–128	0	0	0	0	0	0	0	0	0
Large cobble	129–256	0	0	0	0	0	0	0	0	0
Small boulder	257–512	0	0	0	0	0	0	0	0	0
Medium boulder	513–1,024	0	0	0	0	0	0	0	0	0
Large boulder	> 1,025	0	0	0	0	0	0	0	0	0

Table 7. Summary of Hydrology Protocol Level 1 indicator scores for all sub-reaches

Level 1 Indicator	Sub-reach 2	Sub-reach 3	Sub-reach 4	Sub-reach 5	Sub-reach 6	Sub-reach 7	Sub-reach 8	Average
1.1 Water in channel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.2 Fish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.3 Benthic macroinvertebrates	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.4 Filamentous algae/periphyton	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.5 Differences in vegetation	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.0**
1.6 Absence of rooted upland plants	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.0**
1.7 Sinuosity	1.0	1.5	2.0	1.0	1.0	1.0	1.0	**1.2**
1.8 Floodplain and channel dimensions	1.5	1.0	1.5	1.0	0.0	3.0	1.0	**1.3**
1.9 In-channel structure	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.10 Particle size and sorting	0.0	0.0	1.5	1.0	0.0	0.0	1.5	**0.6**
1.11 Hydric soils	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.12 Sediment on plants and debris	1.0	1.0	1.0	1.0	1.0	1.0	1.0	**1.0**
1.13 Seeps and springs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
1.14 Iron-oxidizing bacteria/fungi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Total[1]	**5.5**	**5.5**	**8.0**	**6.0**	**4.0**	**7.0**	**6.5**	**6.1**

[1] A total score of less than 9 is considered to be an indicator of ephemeral conditions. A total score between 9 and 12 is considered borderline. A total score of 12 or greater is considered to be an indicator of intermittent conditions.

Figures

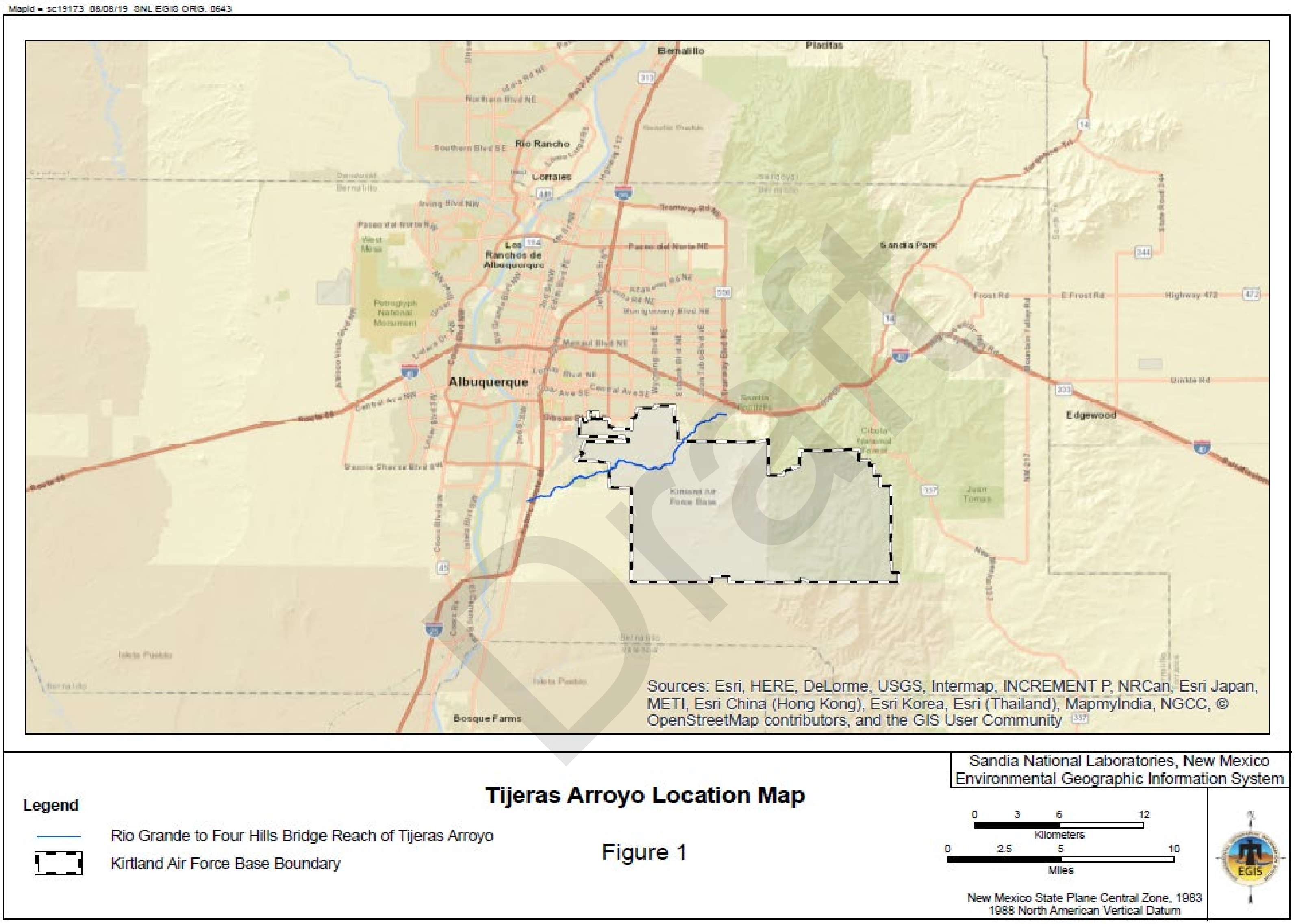

Figure 1. Tijeras Arroyo location map

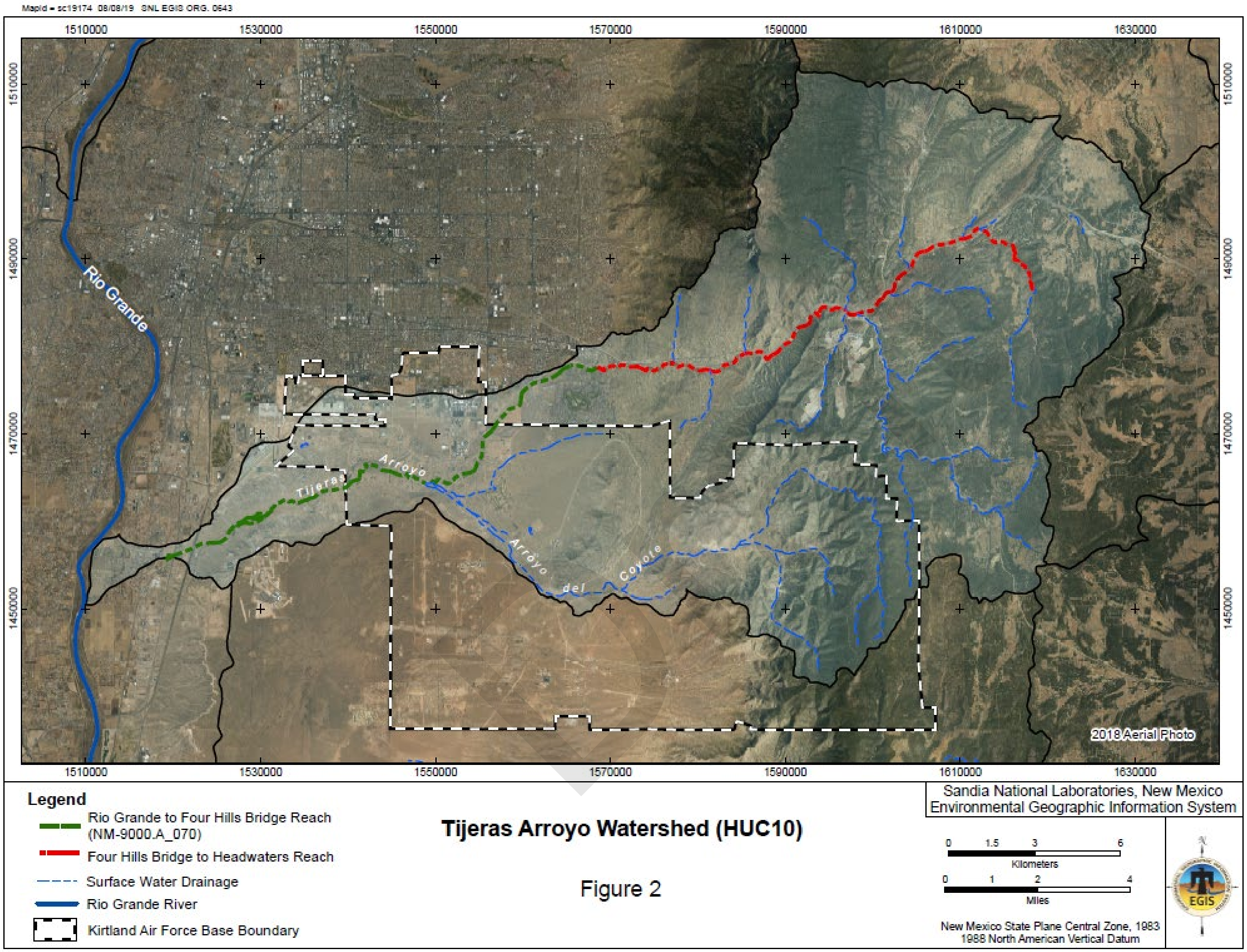

Figure 2. Tijeras Arroyo Watershed (HUC10)

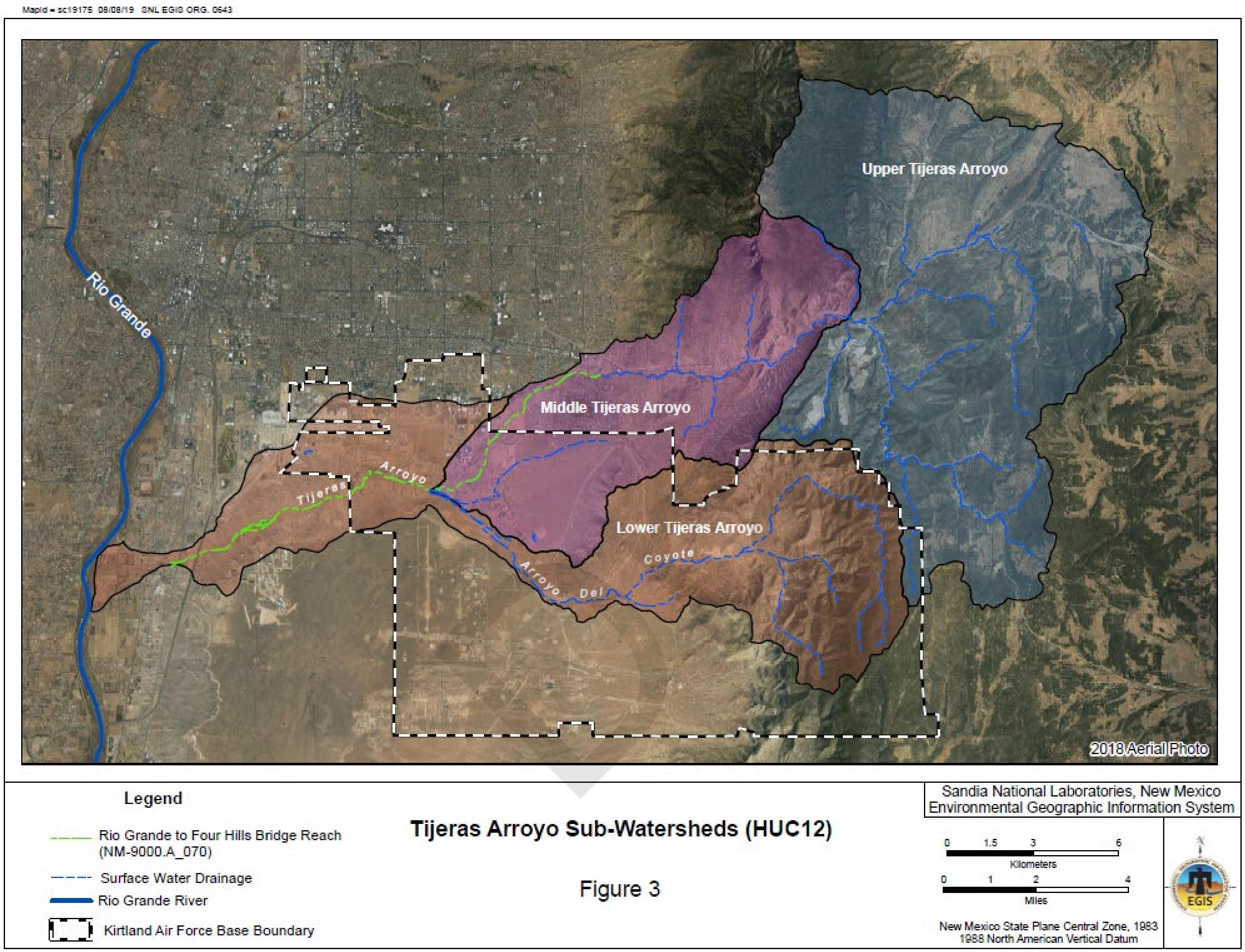

Figure 3. Tijeras Arroyo sub-watersheds (HUC12)

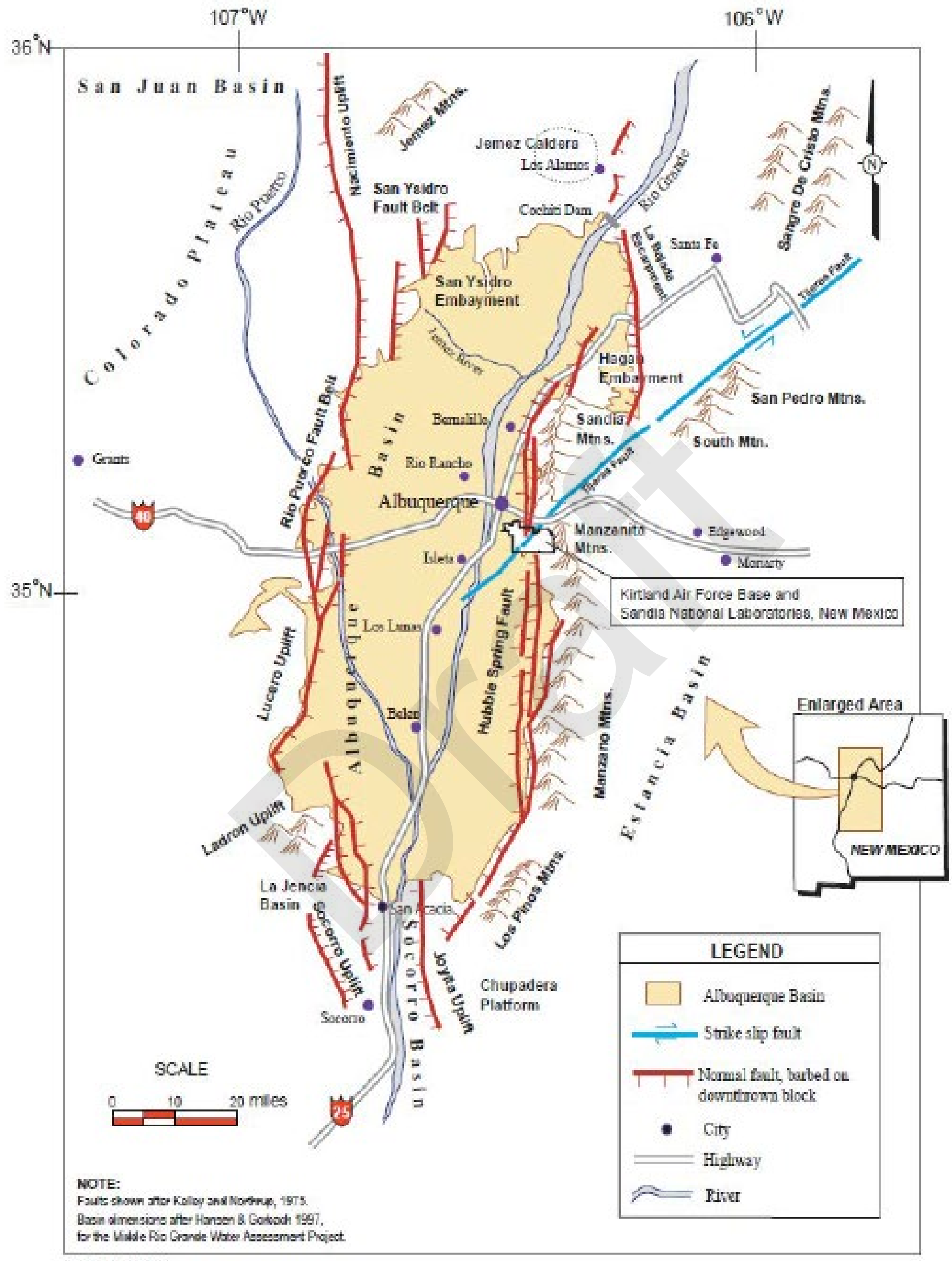

Figure 4. Regional geological setting

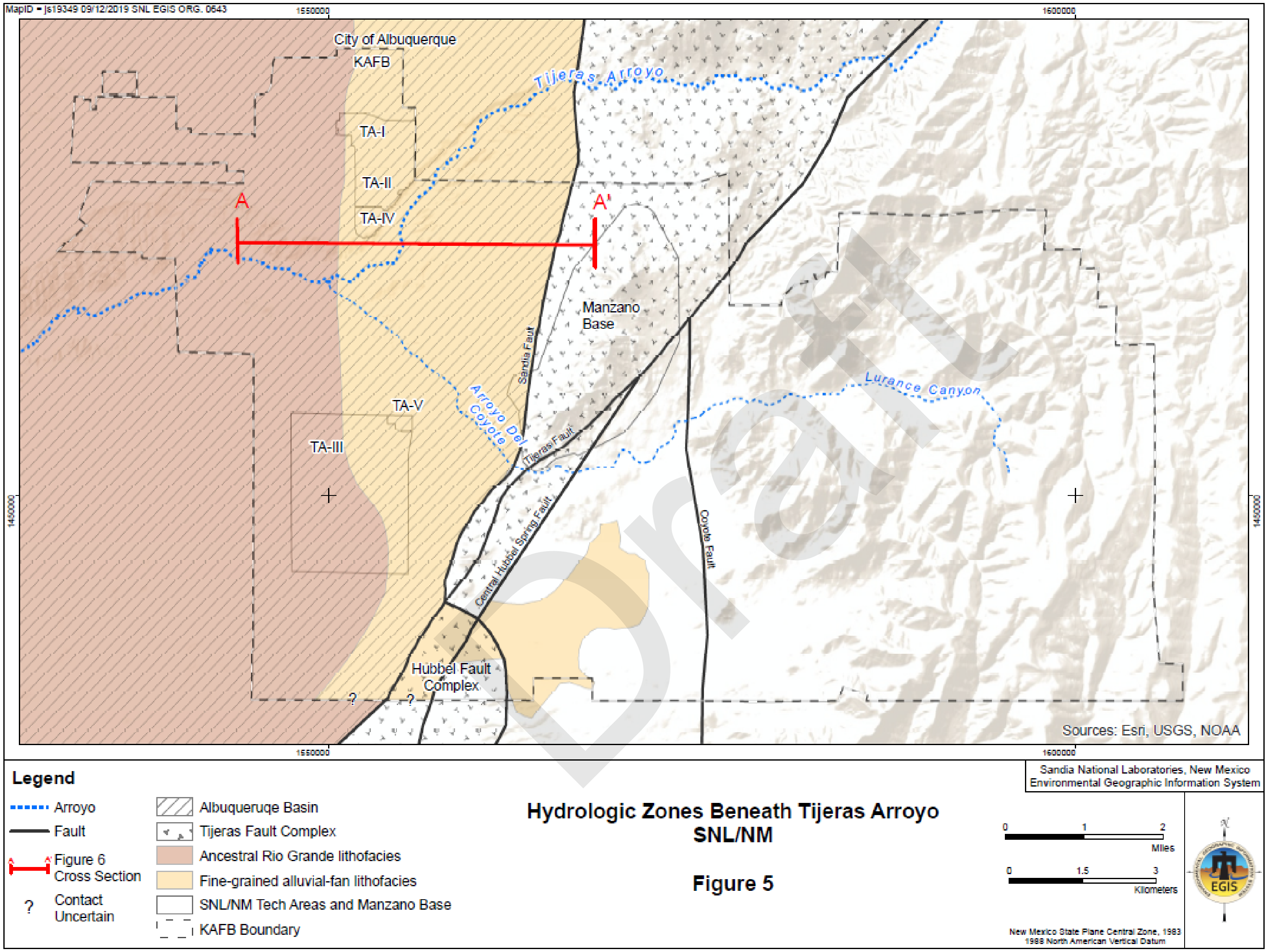

Figure 5. Hydrologic zones beneath Tijeras Arroyo at SNL/NM

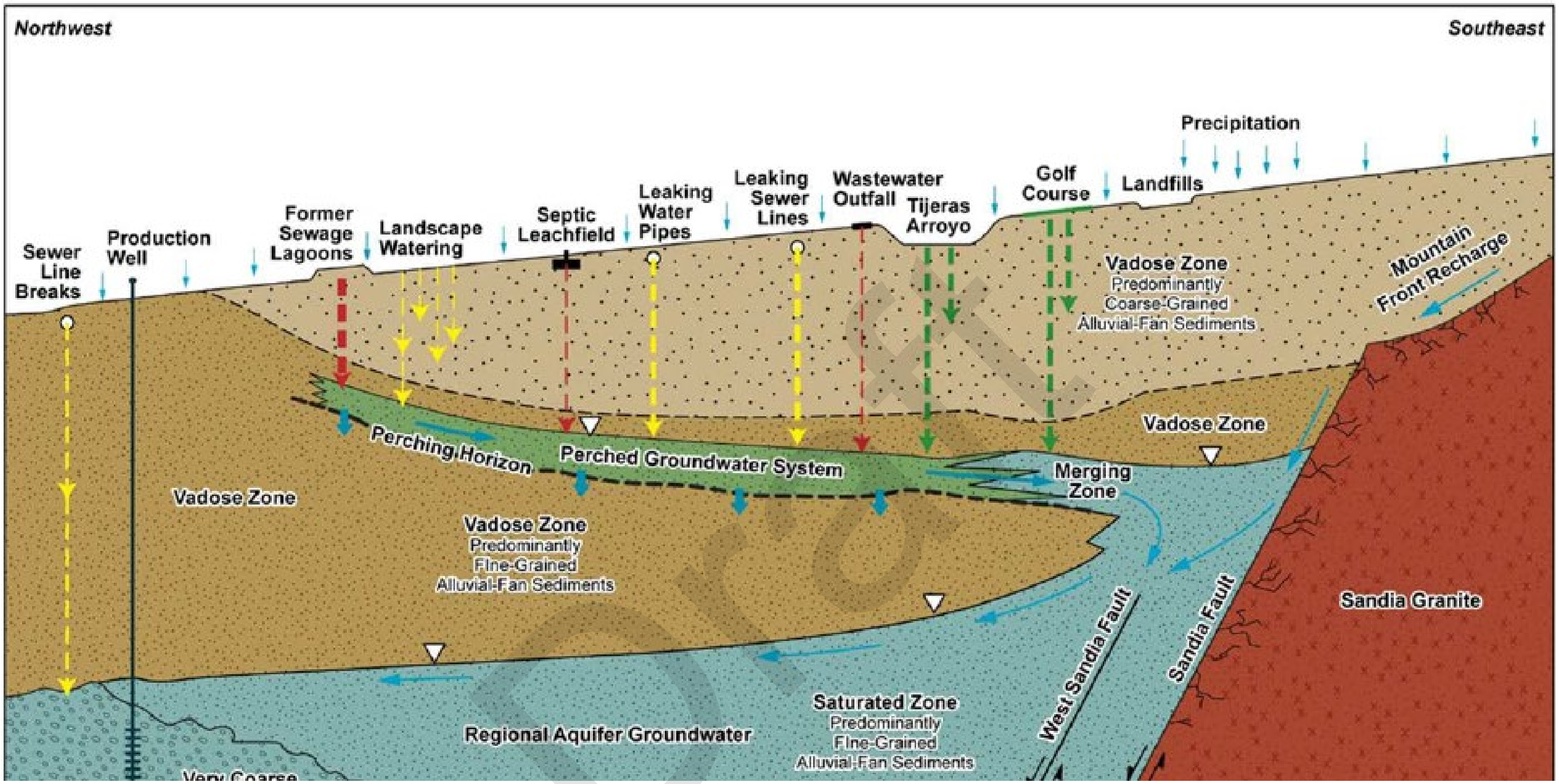

Figure 6. Cross section showing perched and regional groundwater zones beneath Tijeras Arroyo

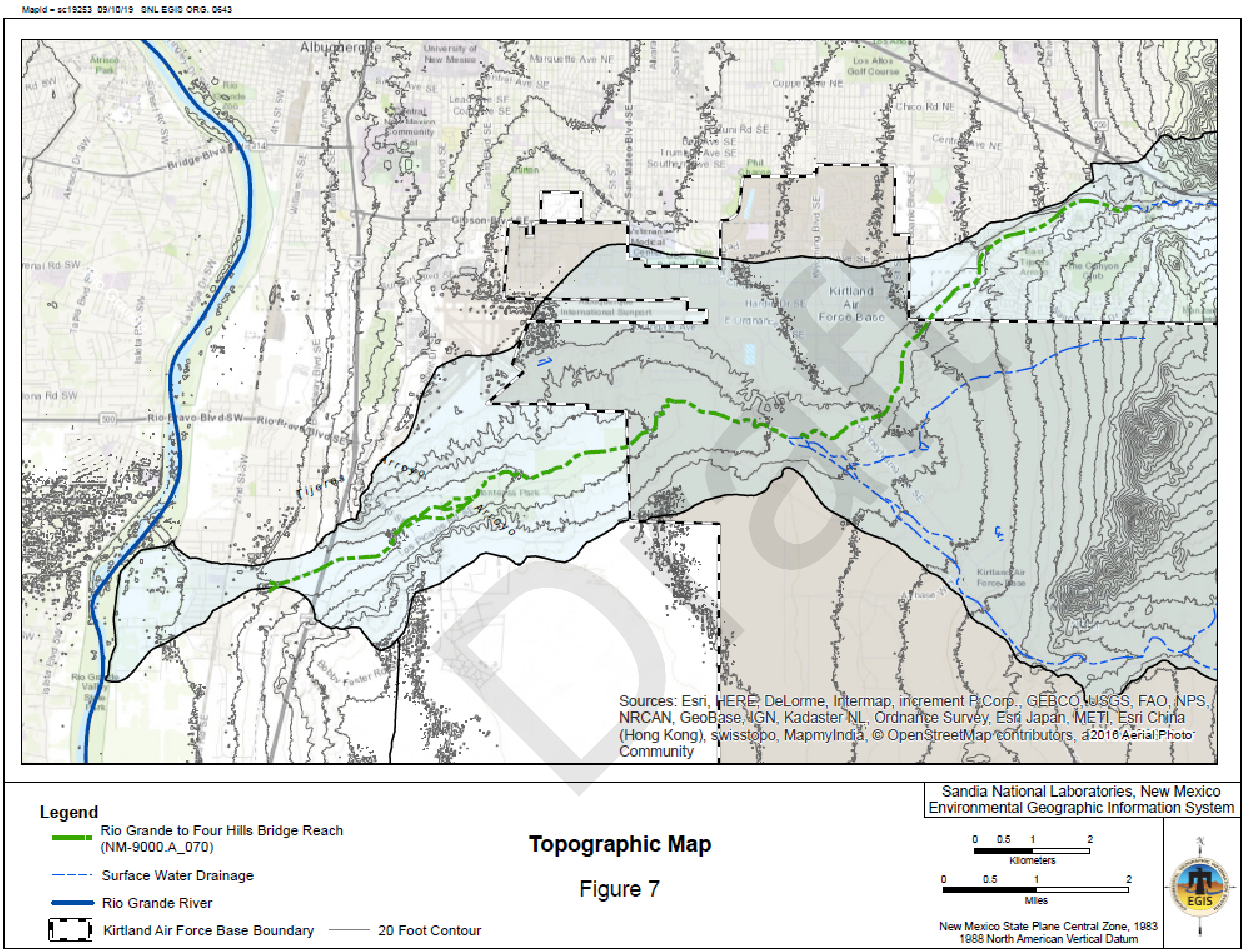

Figure 7. Tijeras Arroyo topographic map

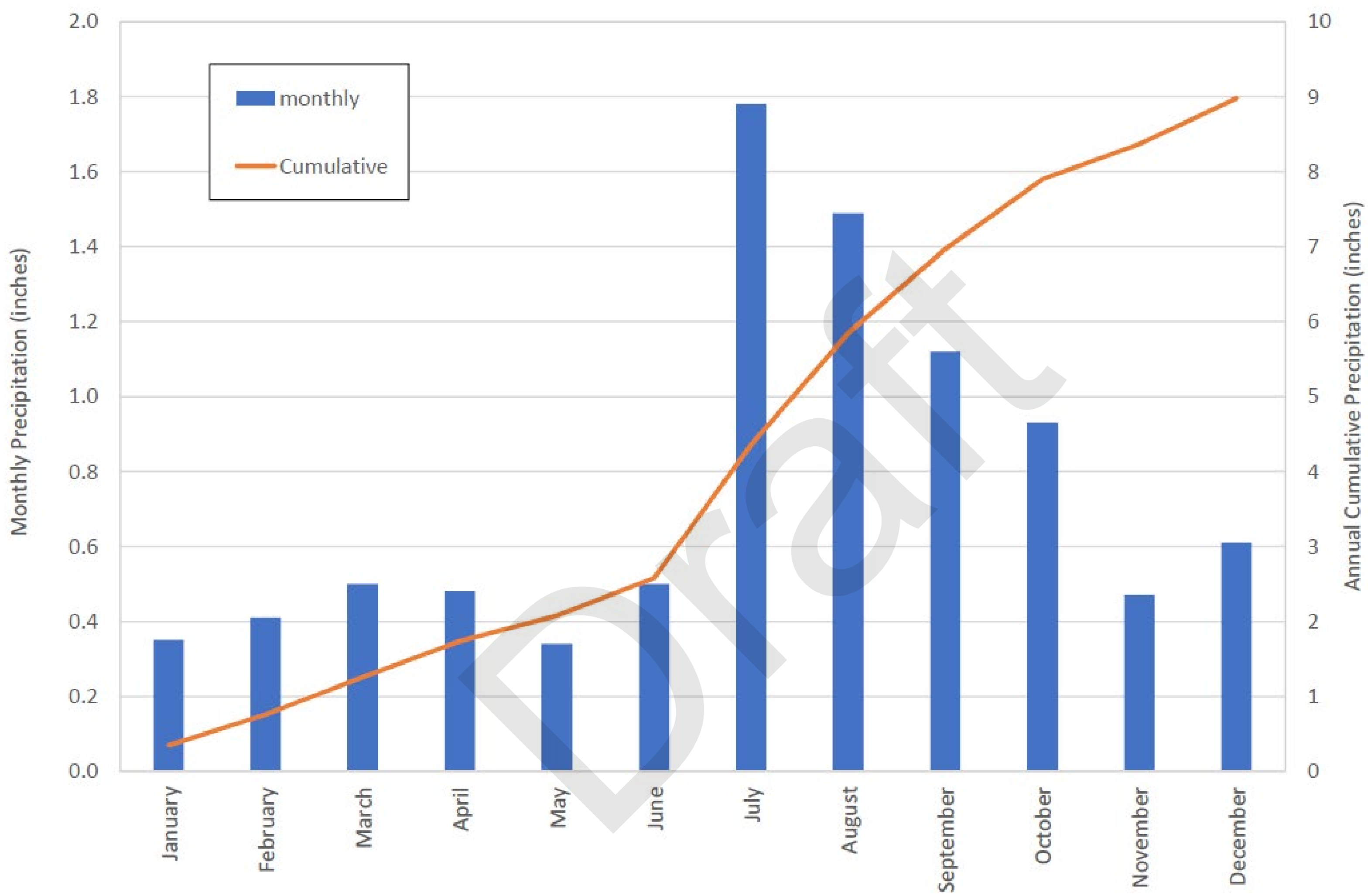

Figure 8. Average precipitation at SNL/NM meteorological Tower A21 (1994–2018)

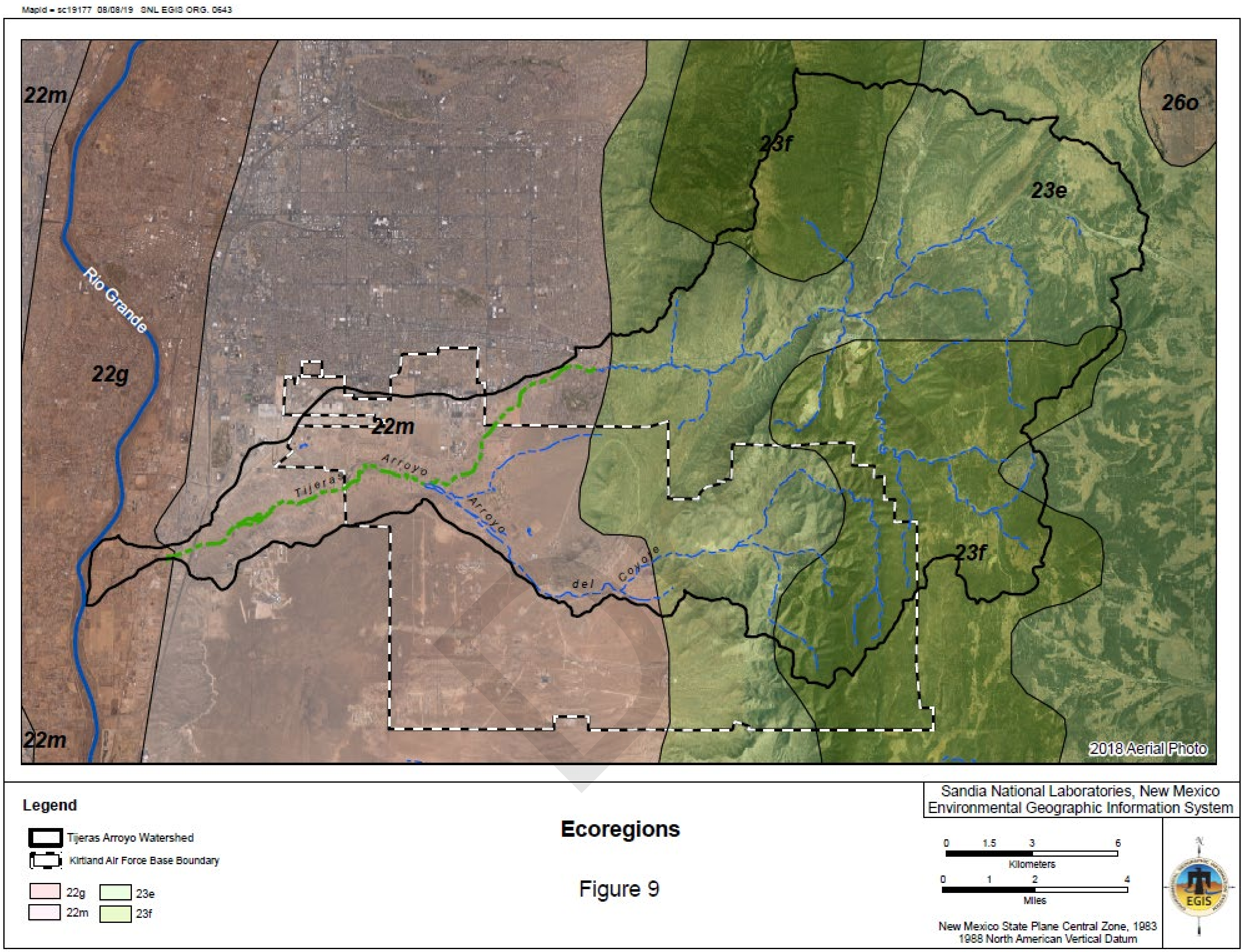

Figure 9. Ecoregions

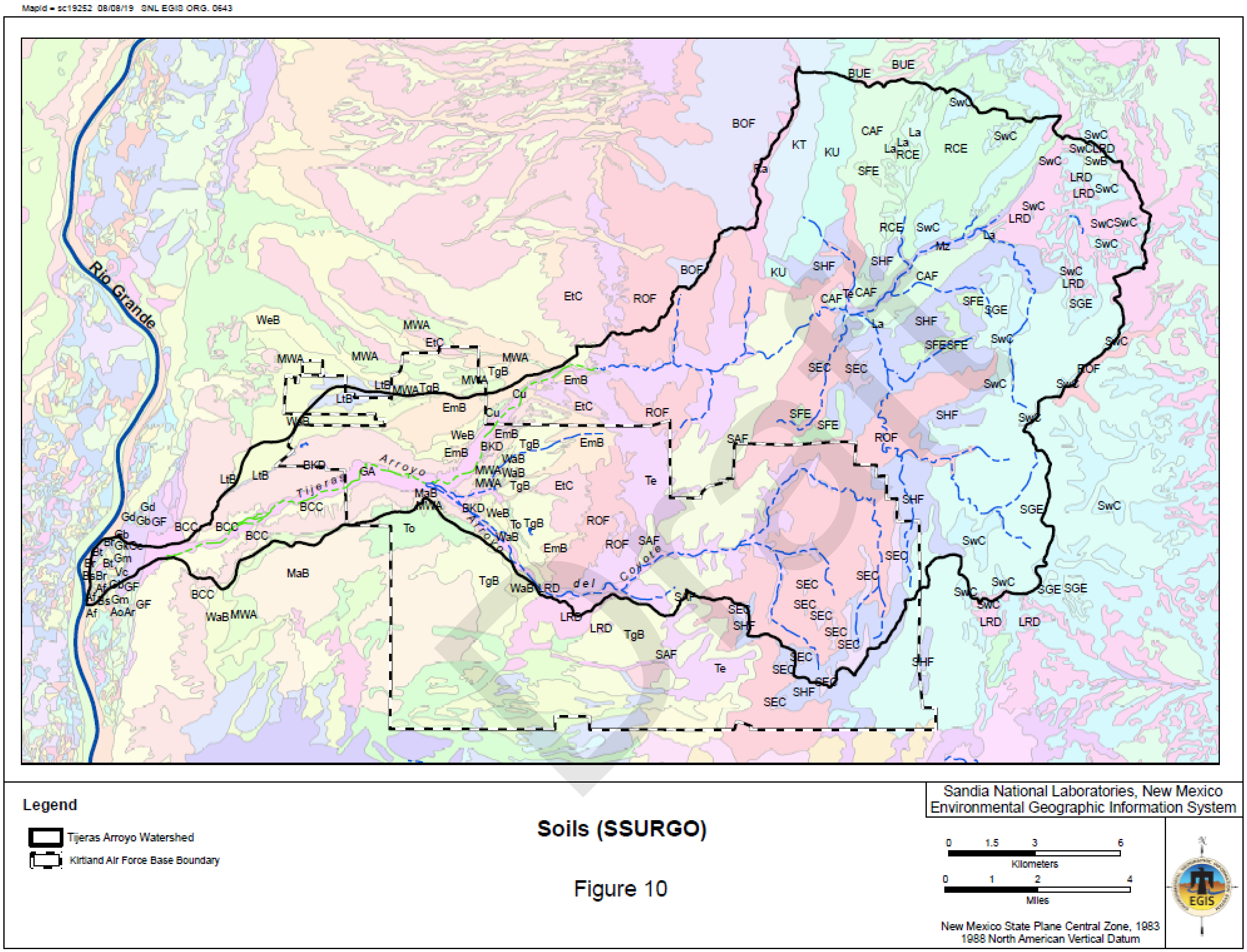

Figure 10. Soils (Natural Resources Conservation Service Soil Survey Geographic Database)

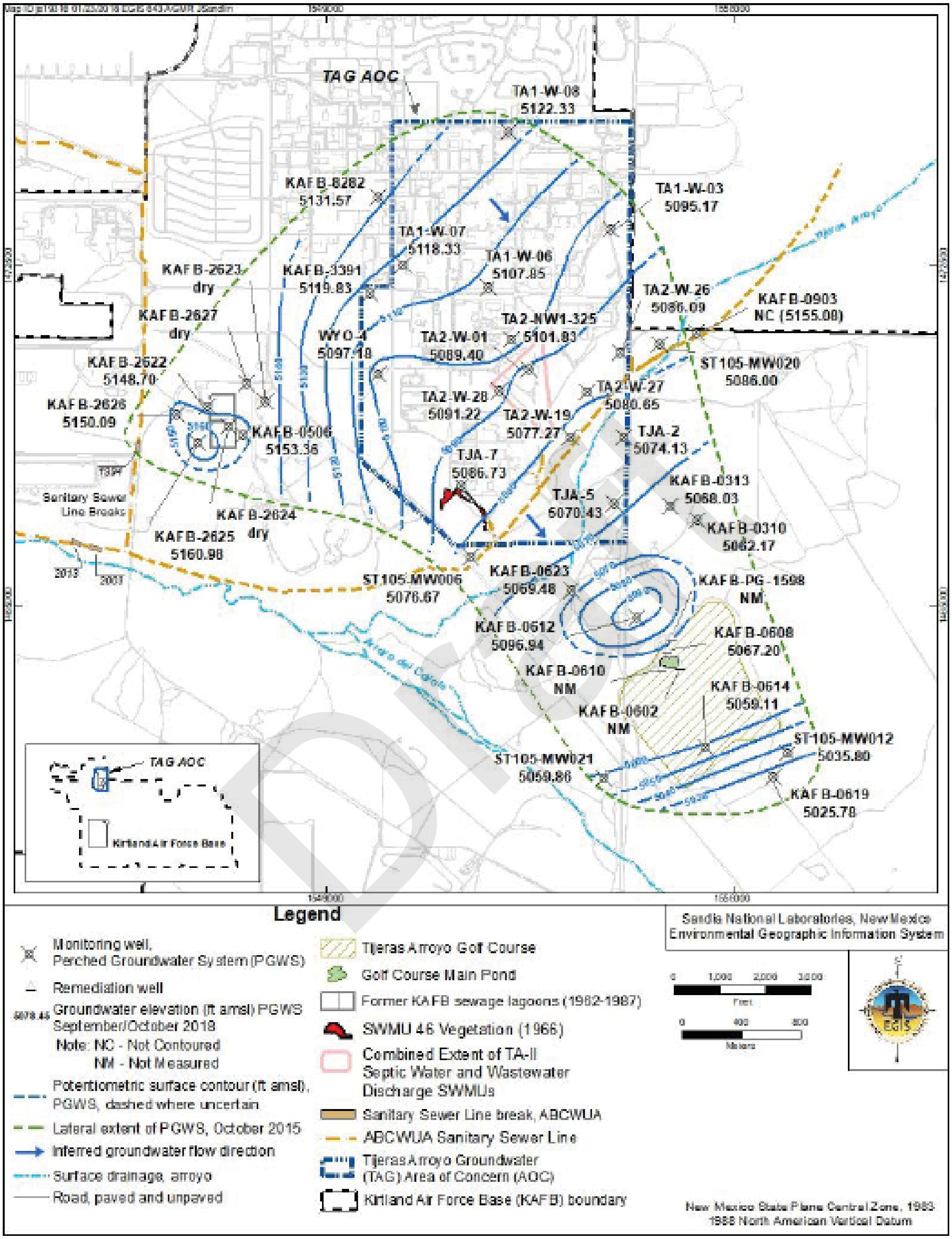

Figure 11. Potentiometric surface map for the perched groundwater system near sub-reaches 5 and 6 (September and October 2018)

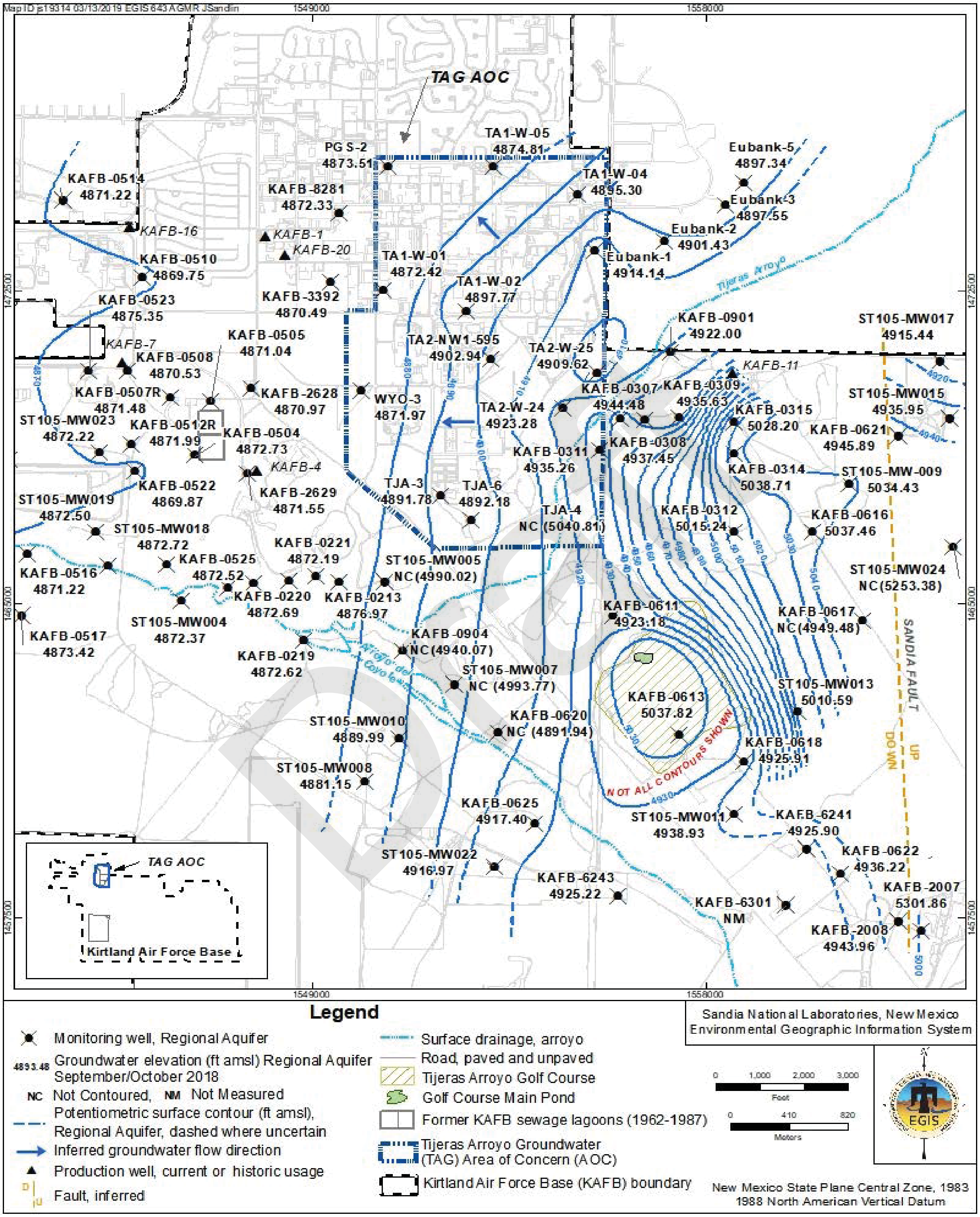

Figure 12. Potentiometric surface map for the regional groundwater system near sub-reaches 5 and 6 (September and October 2018)

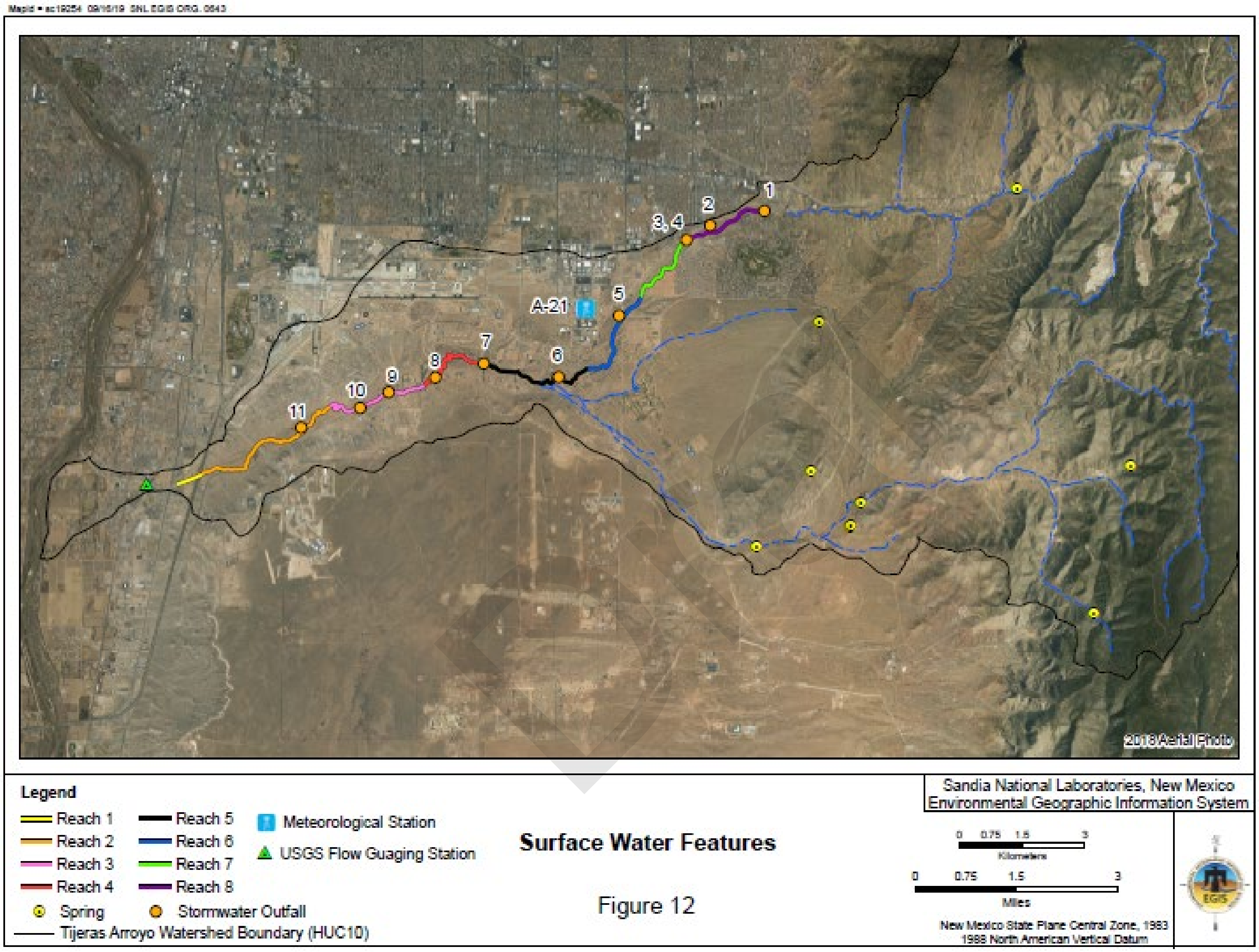

Figure 13. Surface water features

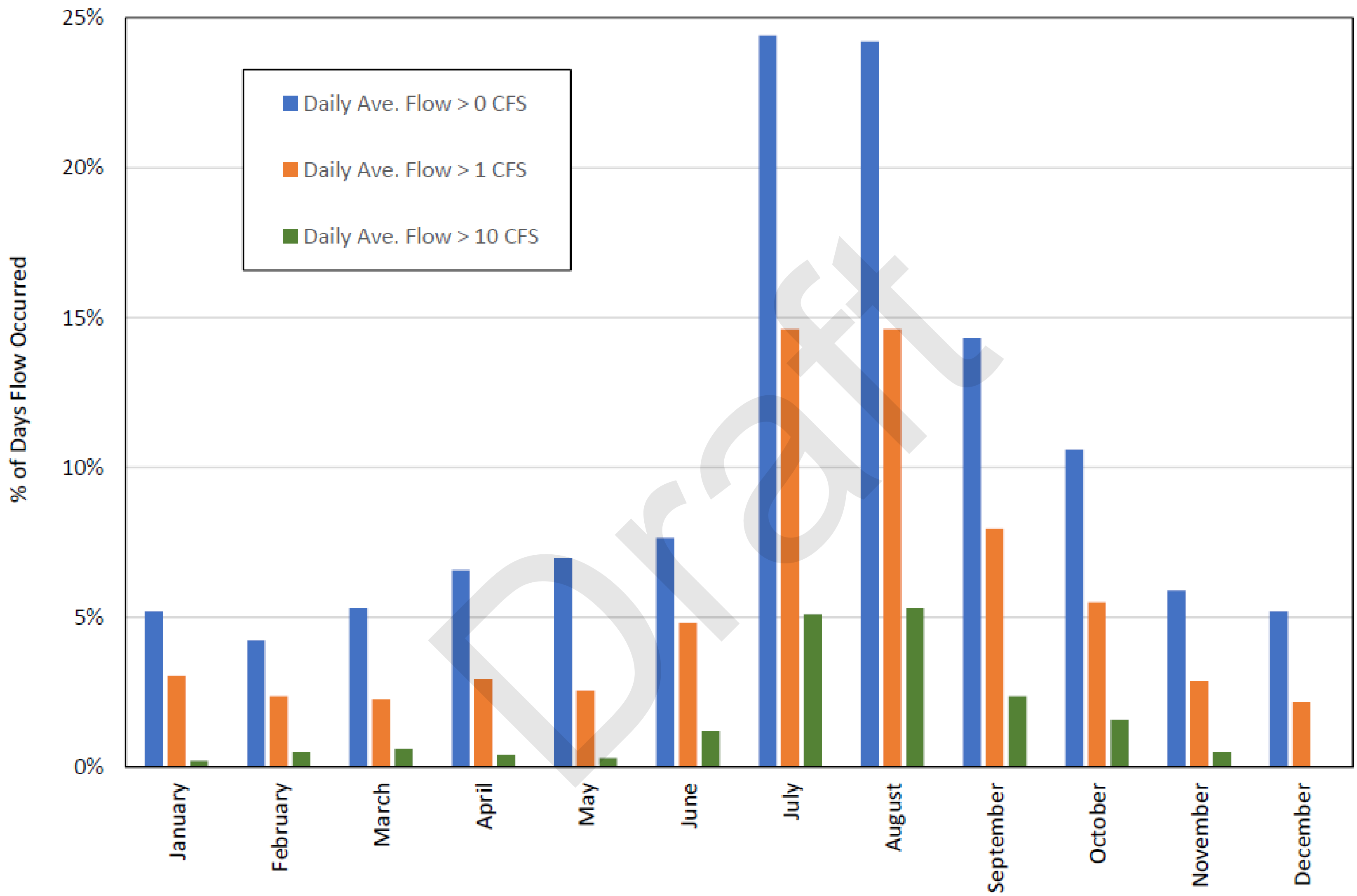

Figure 14. Monthly flow frequency in Tijeras Arroyo at USGS gage (1984–2018)

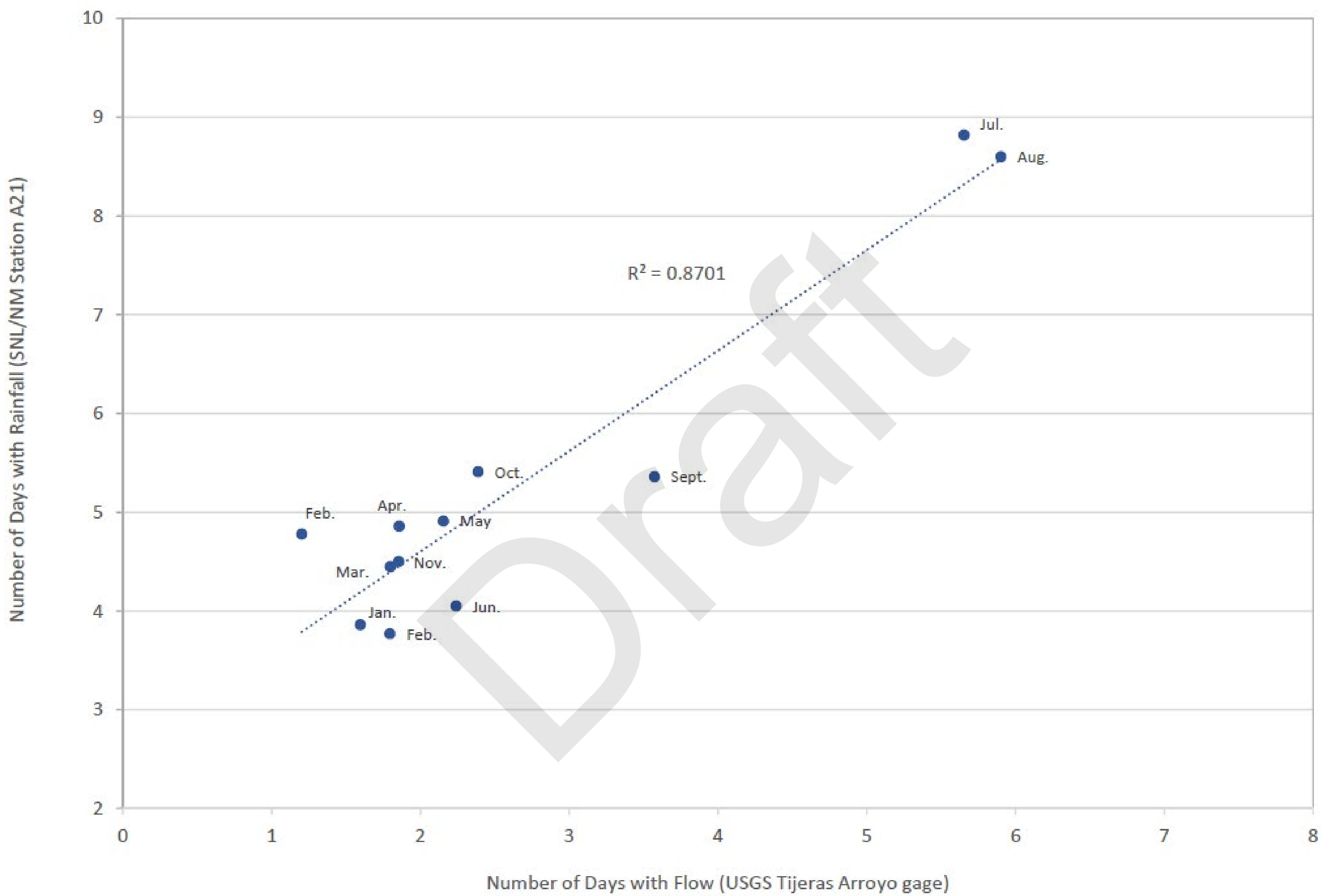

Figure 15. Average monthly days with rainfall versus average monthly days with flow

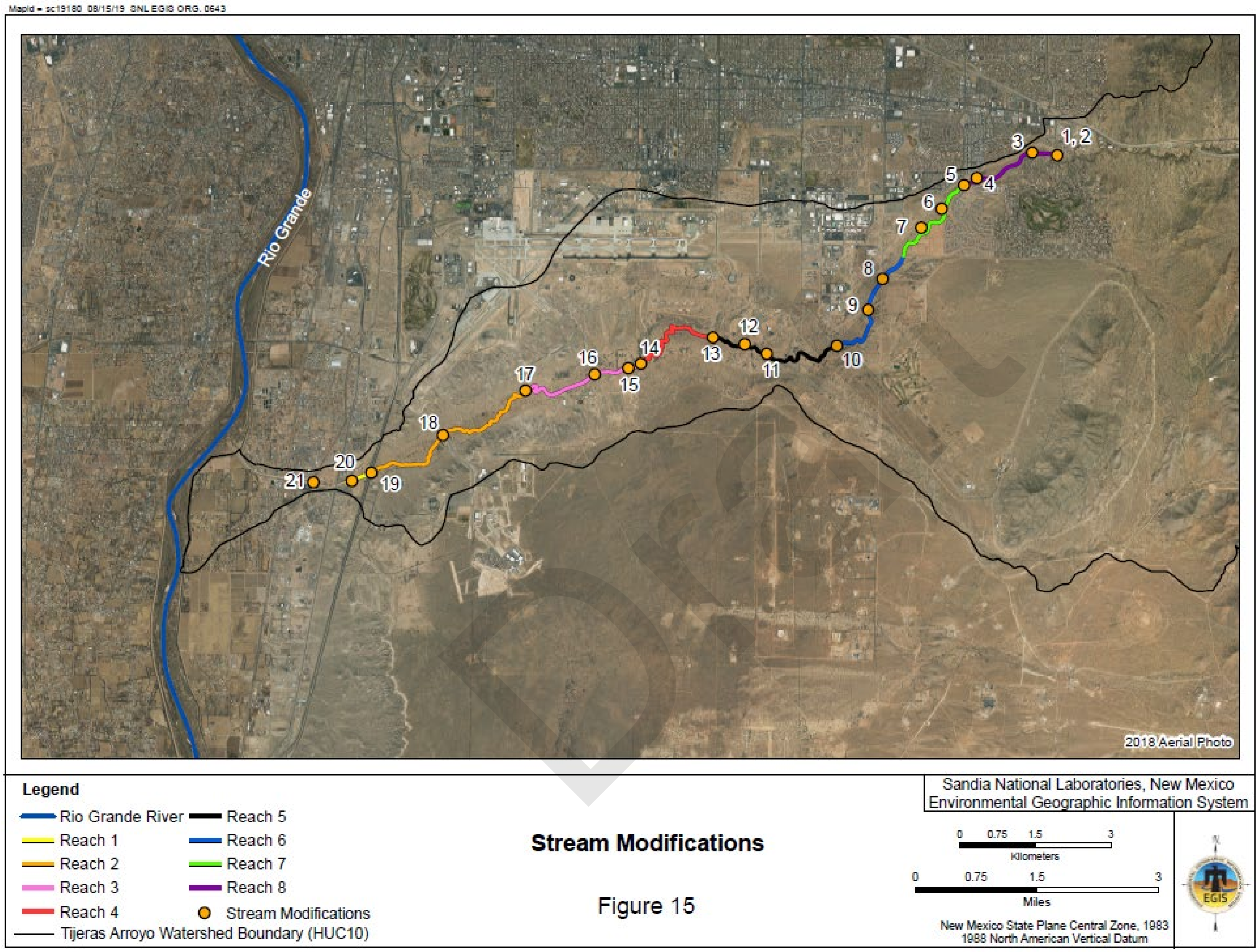

Figure 16. Stream modifications

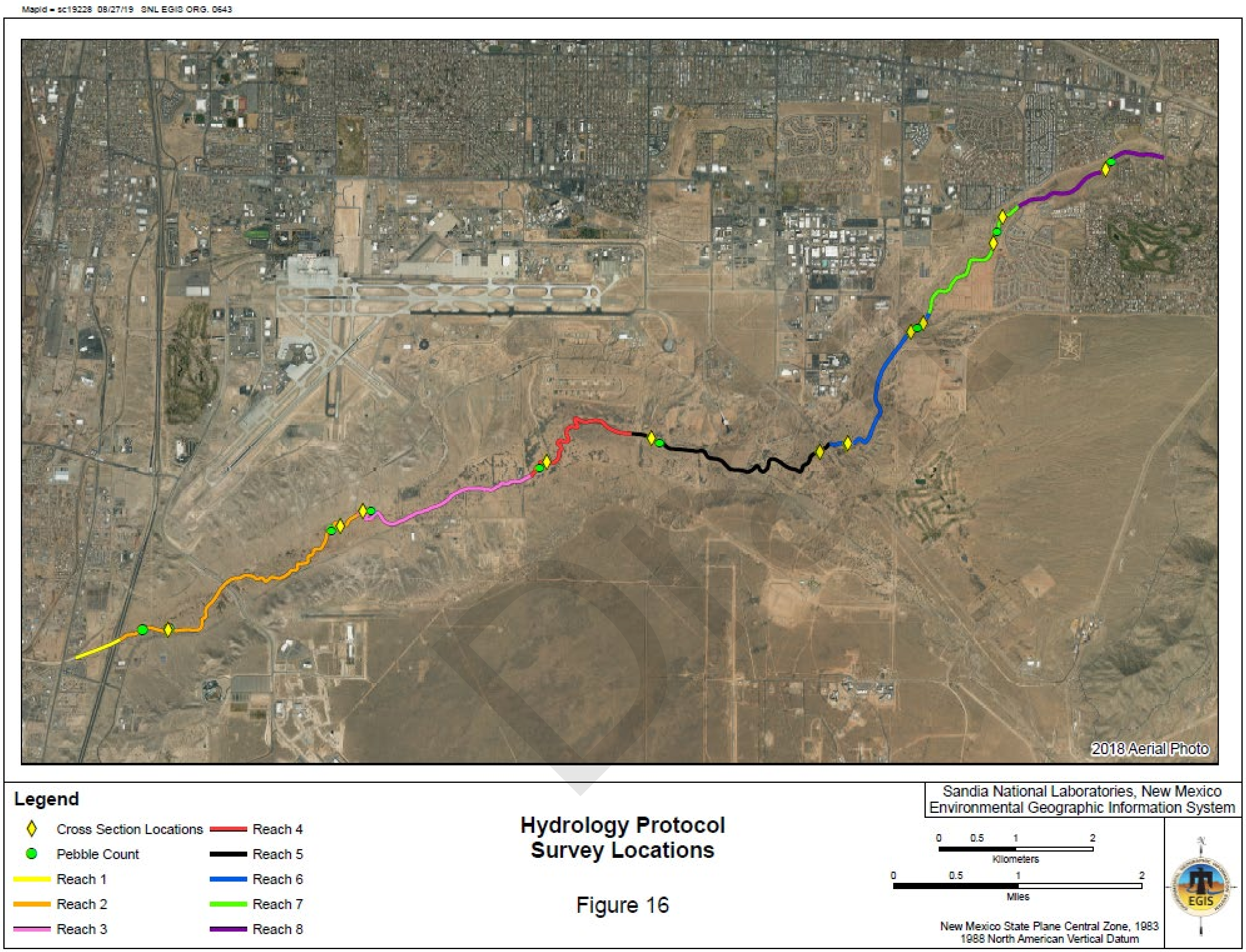

Figure 17. Hydrology Protocol survey locations

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