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DRAFT TECHNICAL MEMORANDUM

To: Jim Bennett and Leanne Crow (County of San Diego)
From: Trey Driscoll, PG, CHG
Subject: Borrego Springs Groundwater Subbasin Potential Groundwater Dependent Ecosystems
Date: February 28, 2019
cc: Geoff Poole, Lyle Brecht, David Duncan (Borrego Water District)
Attachment(s): Figures 1–22

The Sustainable Groundwater Management Act (SGMA) requires that all beneficial uses and users of groundwater, including environmental users of groundwater (Groundwater Dependent Ecosystems (GDEs)), be considered in Groundwater Sustainability Plans (GSPs) (California Water Code (CWC) Section 10723.2).[1] Each Plan shall provide a description of current and historical groundwater conditions in the basin, including data from January 1, 2015, to current conditions, based on the best available information that includes: Identification of groundwater dependent ecosystems within the basin, utilizing data available from the Department, as specified in Section 353.2, or the best available information (Title 23 California Code of Regulations (CCR) Section 354.16(g)).[2]

"A groundwater dependent ecosystem (GDE) is a plant and animal community that requires groundwater to meet some or all water needs" (TNC 2018). GDEs are defined under the SGMA as "ecological communities or species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface" (Title 23 CCR Section 351.(m)). GDEs encompass a wide range of natural communities, such as seeps and springs, wetlands and lakes, terrestrial vegetation and, rivers, streams and estuaries.

The Natural Communities Commonly Associated with Groundwater (NCCAG) dataset is provided by the Department of Water Resources (DWR) as a reference dataset and starting point for the identification of GDEs in groundwater basins (DWR 2018). Because the scale of the NCCAG dataset is statewide (i.e., coarse), and consists of a compilation of vegetation and surface hydrology feature (e.g., springs) mapping, it does not incorporate local, basin-specific groundwater conditions such as aquifer characteristics or current data on depth to groundwater. Therefore, the dataset is most appropriately used as an indicator of where GDEs, as defined by SGMA, are more likely to be present. A local, basin-specific analysis is required to verify the degree to which features mapped in the NCCAG dataset depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface. Accordingly, features mapped as NCCAG dataset are referred to herein as "potential" GDEs.

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1 SGMA is codified in California Water Code (CWC), Part 2.75 (Sustainable Groundwater Management), Section 10720–10737.8, et al.

2 GSP Regulations refers to the emergency regulations adopted by DWR as California Code of Regulations (CCR), Title 23 (Waters), Division 2 (Department of Water Resources), Chapter 1.5 (Groundwater Management), Section 350 et seq. Title 23 CCR Section 353.2(B). States, "The Department [DWR] shall provide information, to the extent available, to assist Agencies in the preparation and implementation of Plans, which shall be posted on the Department's website.

The NCCAG dataset and its source data can be reviewed in context of local understanding of surface water hydrology, groundwater conditions, and geology. The NCCAG dataset is comprised of 48 publicly available state and federal agency mapping datasets.[3] After the vegetation, wetland, seeps, and springs data from these 48 datasets were compiled into the NCCAG dataset, data were screened to exclude vegetation and wetland types less likely to be associated with groundwater and retain types commonly associated with groundwater. This initial screening was conducted by DWR, California Department of Fish and Wildlife (CDFW) and the Nature Conservancy (TNC).

1 Identifying Potential Groundwater Dependent Ecosystems

Potential GDEs were identified by completing a review of the NCCAG dataset and other pertinent datasets discussed further below. Three primary potential GDEs areas are mapped within the Borrego Springs Groundwater Subbasin (7-024.01; Subbasin) by the NCCAG dataset, and include: 1) GDE Unit 1 – Coyote Creek, 2) GDE Unit 2 – Borrego Palm Creek, and 3) GDE Unit 3 – Mesquite Bosque (Borrego Sink) (Figure 1). Other potential GDEs areas are primarily located along the eastern flanks of the mountainous terrain that abuts the Subbasin to the west. These watersheds were delineated using the U.S. Geological Survey's (USGS) StreamStats application (USGS 2017) (Figure 2). The watersheds were delineated from the point of intersection of major drainages with the downstream edge of the Subbasin boundary. Ten watersheds were delineated to complete a detailed review of the NCCAG dataset, along with additional dataset comprised of County of San Diego vegetation communities associated with primarily riparian habitat; USGS's National Hydrography Dataset flow lines; perennial creeks, streams and springs mapped by the Anza-Borrego Desert State Park (ABDSP); springs identified on USGS quadrangle maps; land use data; and satellite color-infrared photography (Figure 3 through Figure 12).[4] Potential GDEs mapped within the contributing watersheds include, but are not limited to, Coyote Creek, Henderson Canyon, Borrego Palm Creek, Hellhole Palms Canyon, Culp Canyon, Tubb Canyon, San Felipe Creek and other minor or unnamed stream segments entering the Subbasin (Figures 3 through Figure 12).

As the GSP is focused on the Subbasin, the potential GDEs should either be located within the Subbasin boundary or be sufficiently approximate to the boundary that there is a reasonable potential for a substantial nexus to exist between the Subbasin's regional groundwater levels and the potential GDEs.

1.1 Primary Potential GDEs

The three primary potential GDEs areas are discussed in the following subsections. These GDE "Units" were identified based on the presence of NCCAG mapped within the Subbasin boundary and their overlap/proximity to perennial segments of major streams that enter the Subbasin, namely Coyote Creek and Borrego Palm Creek.

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3 NCCAG dataset includes, but is not limited to, the following: VegCAMP – The Vegetation Classification and Mapping Program, California Department of Fish and Wildlife (CDFW); CALVEG – Classification and Assessment with Landsat Of Visible Ecological Groupings, USDA Forest Service; NWI V 2.0 – National Wetlands Inventory (Version 2.0), United States Fish and Wildlife Service; FVEG – California Department of Forestry and Fire Protection, Fire and Resources Assessment Program (CALFIRE FRAP); United States Geologic Survey (USGS) National Hydrography Dataset (NHD); and Mojave Desert Springs and Waterholes (Mojave Desert Spring Survey). NCCAG dataset viewer is available online at: https://gis.water.ca.gov/app/NCDatasetViewer/

4 The mapped location of springs was developed from multiple datasets including the ABDSP (2017), Water Quality Control Plan for the Colorado River Basin (Basin Plan) and National Hydrography Dataset.

Other potential GDEs identified in Figure 3 through Figure 12 include Henderson Canyon, Hellhole Canyon, Culp Canyon, Tubb Canyon, and other minor or unnamed stream segments entering the Subbasin. These areas were not selected for detailed evaluation because the potential GDEs mapped in these areas are edge cases confined to the outer fringes of the Subbasin boundary; their geographic confinement to the mountain front at the end of large watersheds indicates that the vegetation communities are supported by surface water flows originating outside the Subbasin (which are storm fed and/or spring-fed). These contributing watershed and fringe areas are described in Section 1.2.

1.1.1 Coyote Creek Mapped GDEs (GDE Unit 1)

The NCCAG dataset has mapped both wetlands and vegetation within GDE Unit 1, Coyote Creek (Figures 1 and 3). These communities are narrowly focused within the riparian corridors associated with Coyote Creek. Potential GDE vegetation types mapped in association with Coyote Creek include: Desert Willow, Narrowleaf Willow, Honey Mesquite and Catclaw Acacia (drought deciduous [lacks leaves for most of the year]). The ecological conditions in Coyote Canyon have been evaluated by the ABDSP (Ostermann and Boyce 2002). The following information is excerpted from *Ecological Conditions in Coyote Canyon, Anza-Borrego Desert State Park® An Assessment of the Coyote Canyon Public Use Plan*:

> "Riparian vegetation covers approximately 120 acres at Lower Willows, 54 acres at Middle Willows, and 40 acres at Upper Willows" (Figure 3). "The biological importance of Coyote Canyon is largely a function of the perennial surface water and islands of tall-structured wetland vegetation in Lower, Middle and Upper Willows." "Five sensitive habitat or vegetation types occur in Coyote Canyon, including: Desert Fan Palm Oasis Woodland, Mesquite Bosque, Mojave Riparian Forest, Sonoran Cottonwood Willow Riparian Forest, and Sonoran Riparian Woodland. Several of these riparian vegetation associations have been recognized for their rarity and sensitivity by the state of California. Lower and Middle Willows are identified as Significant Natural Areas (SNA) in the California Department of Fish and Game's Natural Diversity Data Base because they contain sensitive Desert Fan Palm Oasis Woodland, Sonoran Riparian Forest, and nesting habitat for least Bell's vireo. Upper Willows contains the same resources but was not designated as an SNA due simply to an oversight (California Department of Parks and Recreation 1995). All riparian habitat in Coyote Canyon is considered wetlands and is protected under the Keene-Nejedly California Wetlands Preservation Act of 1976. There are a variety of vegetation types both within riparian areas, and canyon wide. The tall-statured willow-dominated vegetation in Coyote Canyon is largely dominated by red willow (*Salix laevigata*), accompanied by arroyo willow (*Salix lasiolepis*), cottonwood (*Populus fremontii*), desert fan palm (*Washingtonia filifera*), and desert grape (*Vitis girdiana*). Perennial shrub species such as mulefat (*Baccharis salicifolia*), narrow-leaved willow (*Salix exigua*), and arrow weed (*Pluchea sericea*) are mixed with willow-dominated vegetation. Wetter portions of the wetlands are dominated by annual and perennial herbs such as cattail (*Typha latifolia*), tule (*Scirpus americanus*), and scratchgrass (*Muhlenbergia asperifolia*) (California Department of Parks and Recreation 2002). The boundary between wetland and upland habitats in Coyote Canyon is typically defined by stands of honey (*Prosopis glandulosa*) and screw-bean (*P. pubescens*) mesquite (California Department of Parks and Recreation 2002). These species have deep rooting systems and are able to better access subsurface moisture. Higher areas within the floodplain support sparse shrublands of low-statured drought-deciduous species such as alkali goldenbush (*Isocoma acradenia*), broom lotus (*Lotus rigidus*), and desert baccharis (*Baccharis*

> *sergiloides*) (California Department of Parks and Recreation 2002). It is the diversity and spatial arrangement of vegetation associations (i.e., wetland vegetation, mesquite bosque, dry wash vegetation, creosote bush scrub) in the Canyon, in combination with perennial surface water, that allow for a dense array of habitats and wildlife species. Vegetation is a key component of riparian habitat. It provides structure and cover for animals, shade which influences water temperature, and plays an important role in nutrient cycling and soil stabilization" (Ostermann and Boyce 2002).

1.1.2 Borrego Palm Canyon/Creek Mapped GDEs (GDE Unit 2)

The NCCAG dataset has mapped primarily vegetation within GDE Unit 2, Borrego Palm Canyon/Creek (Figures 1 and 6). These communities are narrowly focused within the riparian corridors associated with Palm Creek. Potential GDE vegetation types mapped in association with Palm Canyon include Desert Willow, California Fan Palm, and Catclaw Acacia.

1.1.3 Mesquite Bosque (Borrego Sink) GDEs (GDE Unit 3)

The NCCAG dataset has mapped primarily vegetation within GDE Unit 3, which consists of Mesquite Bosque narrowly focused along the Borrego Sink Wash east of the Borrego Sink (Figures 1 and 13). The potential GDE plant type primarily associated with the Borrego Sink is honey mesquite.

1.2 Contributing Watersheds Potential GDEs

Contributing watersheds along the eastern flanks of the mountainous terrain that abuts the Subbasin to the west were evaluated to identify potential GDEs. Watersheds were delineated from the point of intersection of major drainages with the downstream side of the Subbasin boundary. Ten watersheds including twenty-eight subwatersheds were delineated as listed in Table 1 and described in the following subsections.

1.2.1 Coyote Creek Watershed

The Coyote Creek watershed is comprised of two subwatersheds referred to as the Coyote Creek and Coyote Creek South subwatersheds. The area of the Coyote Creek watershed contributing to the Subbasin encompasses approximately 94,506 acres (Figures 1 and 3). The watershed is located almost entirely within the boundary of the ABDSP. Upper portions of the watershed are developed with rural residences in the Terwillinger Valley located in Riverside County. The maximum elevation of the watershed is 8,615 feet above mean sea level (amsl) on the flank of Toro Peak in the Santa Rosa Mountains that reaches a maximum 8,716 feet amsl at the peak. The minimum elevation of the watershed is approximately 1,200 feet at the Lower Willows. The Coyote Creek watershed is discussed further in Sections 2 and 5.

Table 1. Contributing Watersheds Area and Elevation

Contributing Watershed	Subwatershed	Area (Acres)	Total Area (Acres)[a]	Elevation (Feet, amsl)	
				Maximum	Minimum
Coyote Creek	Coyote Creek	92,722	94,506	8,615	1,200
	Coyote Creek South	1,784			
Horse Camp	North	556	1,931	3,700	940
	Middle North	569			
	Middle South	677			
	South	129			
Henderson Canyon	North 1	1,599	2,984	4,650	1,163
	North 2	123			
	North 3	209			
	South 1	45			
	South 2	582			
	South 3	426			
Borrego Palm Creek	NA	14,994	14,994	6,404	1,300
Hellhole Canyon	Panoramic Overlook Canyon	407	6,667	6,142	962
	North Fork	504			
	Middle Fork	1,535			
	South Fork	4,221			
Dry and Culp Canyons	Dry Canyon	1,009	6,140	4,491	956
	Culp Canyon	5,131			
Tubb Canyon	Tubb Canyon	2,396	3,095	4,520	920
	Road North	265			
	Road Middle	190			
	Road South	244			
Glorietta Canyon	Glorietta Canyon	1,852	2,595	4,589	1,250
	South Fork	743			
Yaqui Ridge	North 1	1,042	2,903	3,864	1,252
	North 2	47			
	North 3	979			
	Yaqui Pass	581			
	Yaqui Ridge	110			
	Cactus Valley	144			
San Felipe Creek	NA	117,339	117,339	5,719	992

Source: Watersheds delineated using StreamStats, USGS 2017.
Notes:
amsl = above mean sea level
NA = not applicable
a. Total area of the contributing watersheds does not include areas within the Subbasin.

1.2.2 Horse Camp Watershed

The Horse Camp watershed is comprised of four subwatersheds referred to as the North, Middle North, Middle South and South subwatersheds (Figure 4). In total, the Horse Camp Watershed area is 1,931 acres. The Horse Camp subwatersheds are characterized by narrow canyons that drain the eastern foothill hills of the San Ysidro Mountains. The maximum elevation of the watershed is 3,700 feet amsl attained in the Middle South subwatershed and the minimum elevation is about 940 feet amsl in the South subwatershed. The NCCAG dataset indicates no mapped vegetation, wetlands or springs in the watershed. An isolated pocket of mapped vegetation is noted where the Horse Camp drainages converge in a wash on the edge of the valley. These potential GDEs are edge cases mapped in areas confined to the outer fringes of the Subbasin boundary; their geographic confinement to the mountain front indicates that the vegetation communities are supported by surface water flows originating outside the Subbasin and not sustained by the regional groundwater table.

1.2.3 Henderson Canyon Watershed

The Henderson Canyon watershed is comprised of six subwatersheds referred to as the North 1, North 2, North 3, South 1, South 2 and South 3 subwatersheds (Figure 5). The total Henderson Canyon watershed area is 2,984 acres. The maximum elevation of the watershed is 4,650 feet amsl attained in the North 1 subwatershed and the minimum elevation is about 1,163 feet amsl in the North Fork subwatershed. No springs are mapped in the watershed. Potential GDEs vegetation is mapped by the NCCAG dataset in the North 2 and South 2 subwatersheds. The mapped vegetation occurs along narrow corridors associated with ephemeral drainages. Mapped vegetation occurs in the Subbasin at the upper portion of the alluvial fans that originate from the watersheds. These potential GDEs are edge cases mapped in areas confined to the outer fringes of the Subbasin boundary; their geographic confinement to the mountain front indicates that the vegetation communities are supported by surface water flows originating outside the Subbasin and not sustained by the regional groundwater table.

1.2.4 Borrego Palm Creek Watershed

Borrego Palm Creek watershed encompasses approximately 14,994 (Figures 1 and 6). The watershed is located almost entirely located within the boundary of the ABDSP. The watershed rises to a maximum elevation of 6,404 feet amsl near Hot Springs Mountain, the highest peak in San Diego County at an elevation of 6,535 feet amsl. The minimum elevation of the watershed in 1,300 feet amsl at the First Palm Grove. The Borrego Palm Creek Watershed is discussed further in Sections 2 and 5.

1.2.5 Hellhole Canyon Watershed

The Hellhole Canyon watershed is comprised of four subwatersheds referred to as the Panoramic Overlook Canyon, North Fork, Middle Fork, and South Fork subwatersheds (Figure 7). The total Hellhole Canyon watershed area is 6,667 acres. The maximum elevation of the watershed is 6,142 feet amsl attained in the South Fork subwatershed and the minimum elevation is about 962 feet amsl in the North 3 subwatershed. The Hellhole Canyon subwatersheds discharge through narrow canyons to the Subbasin where the constricted canyons broaden onto an alluvial fan. Vegetation on the alluvial fan is sparse compared to the dense vegetation in the South Fork subwatershed. The County vegetation layer maps a narrow corridor of riparian habitat in the South Fork. Satellite-color infrared photography reveals vegetation along additional drainage segments of the South Fork and lesser vegetation in the Middle Fork. One spring is mapped in the Middle Fork subwatershed. Four springs are mapped in the South Fork. None of the springs or GDEs identified within the watershed occur within the Subbasin.

1.2.6 Dry Canyon and Culp Canyon Watersheds

The Dry Canyon and Culp Canyon watersheds are comprised of two watersheds (Figure 8). The total Dry Canyon and Culp Canyon watersheds area is 6,140 acres. Dry Canyon is intersected by Montezuma Valley Road in the middle to lower part of the watershed. Dry Canyon is sparsely vegetated with no mapped potential GDEs or springs. Culp Canyon extends to a much higher elevation reaching 4,591 feet amsl where it abuts the community of Ranchita. Much of the watershed is located above 3,000 feet amsl where 14 springs are mapped. No vegetation is mapped in the area of the springs; however, review of aerial photography reveals narrow corridors of vegetation associated with the spring complexes. Where Culp Canyon enters the valley it joins with several canyons, including Tubb Canyon, to form an alluvial fan. The NCCAG dataset maps vegetation on the alluvial fan. These potential GDEs are edge cases mapped in areas confined to the outer fringes of the Subbasin boundary; their geographic confinement to the mountain front indicates that the vegetation communities are supported by surface water flows originating outside the Subbasin and not sustained by the regional groundwater table.

1.2.7 Tubb Canyon Watershed

Tubb Canyon is comprised of four subwatersheds referred to as Tubb Canyon, and Tubb Canyon Road North, Middle and South subwatersheds. The total Tubb Canyon watershed area is 3,095 acres. The maximum elevation of the watershed is 4,520 feet amsl and the minimum elevation (i.e., outlet) is about 920 feet amsl. Tubb Canyon watershed discharges through a narrow canyon to the Subbasin where it broadens into an alluvial fan (Figure 9). Three springs are mapped in the watershed and include Big Spring, Middle Spring and Tubb Canyon Spring (ABDSP 2017). In the vicinity of Big Spring, seepwillow, catclaw and mesquite have been identified (San Diego Reader 2010). The satellite color-infrared photography indicates green, healthy vegetation as the color red (high reflection of near-infrared wavelengths). In a desert environment, the green healthy vegetation could represent a potential GDE. A narrow band of habitat appears in the Tubb Canyon Creek channel primarily associated with the mapped springs. A band of vegetation is mapped by the NCCAG dataset where Tubb Canyon opens into the Subbasin near Dry and Culp Canyons. As previously discussed for the Dry and Culp Canyon watersheds, this potential GDE is supported by surface water flows originating outside the Subbasin and not sustained by the regional groundwater table.

1.2.8 Glorietta Canyon Watershed

Glorietta Canyon watershed is comprised of two subwatersheds referred to as Glorietta Canyon and South Fork subwatersheds (Figure 10). The total Glorietta Canyon watershed area is approximately 2,595 acres. The maximum elevation of the watershed is 4,589 feet amsl and the minimum elevation (i.e., outlet) is about 1,250 feet amsl. The watershed discharges to the Yaqui Meadows area of the Subbasin. No springs are mapped in the Glorietta Canyon. The satellite color-infrared photography indicates limited vegetation associated with Glorietta Canyon, which agrees with the lack of mapped springs, vegetation and wetlands. No springs or potential GDEs are mapped in the Subbasin in the vicinity of Glorietta Canyon watershed.

1.2.9 Yaqui Ridge Watershed

The Yaqui Ridge watershed is comprised of six watersheds scattered along the ridgeline and referred to as the North1, North 2, North 3, Yaqui Pass, Yaqui Ridge and Cactus Valley subwatersheds (Figure 11). The total Yaqui Ridge Watersheds area is 2,903 acres. The maximum elevation of the watershed is 3,864 feet amsl and the minimum elevation (i.e., outlet) is about 1,252 feet amsl. Yaqui Pass Road crosses the South watershed. No vegetation or springs are mapped within the Yaqui Ridge Watershed. Sparse vegetation within the drainage channels is shown on aerial photography. No springs or potential GDEs are mapped in the Subbasin in the vicinity of Yaqui Ridge watershed.

1.2.10 San Felipe Creek Watershed

The San Felipe Creek watershed is comprised of one large watershed of approximately 117,339 acres (Figure 12). The watershed rises to a maximum elevation of 5,719 feet amsl in the Vulcan Mountains north of the town of Julian, and the minimum elevation (i.e., outlet) is about 992 feet amsl. San Felipe Creek enters the valley though a narrow canyon ("narrows") that cuts through Yaqui Ridge. A deeply incised broad wash extends from the narrows to the valley floor and beyond to the Palo-Verde Wash. Borrego Springs Road crosses the broad San Felipe Creek wash at what is known as the "Texas dip". This wash is often the location of periodic and dramatic flash floods. The San Felipe Creek wash forms the southern boundary of the Subbasin. The NCCAG dataset and County vegetation datasets map extensive vegetation in the upper portion of the watershed and in narrow corridors in the lower portions of the watershed. Limited vegetation is also mapped in the wash near where the San Felipe Creek enters the Subbasin. None of the potential GDE habitat identified occurs within the Subbasin.

2 Streamflow

2.1 Coyote Creek

Streamflow in the Coyote Creek watershed has been documented by USGS as the number one source of groundwater recharge to the Subbasin via stream flow leakage (i.e., infiltration of surface water runoff primarily during flood events). An estimated 65% of the surface water inflow to the Borrego Valley comes from Coyote Creek (USGS 1982).

Perennial stream flow in Coyote Creek occurs in the northern most section of the Subbasin. Groundwater daylights at lower elevations in the Collins Valley at the Oasis at Santa Catarina Spring and Lower Willows Spring where the stream is restricted by a narrow hard rock canyon. The restrictive canyon appears to act as a subsurface dam causing groundwater to daylight at the spring and flow into the Subbasin as surface water flow in Coyote Creek. This occurs approximately 1 mile upstream from the Subbasin boundary at an elevation of about 1,300 feet amsl. The spring was first documented in 1774 by members of the Anza Expedition near the site of a large Cahuilla Indian village.[5] "The creek contains three reaches where bedrock forces groundwater to the surface throughout the year, resulting in perennial surface or near-surface water. These areas, referred to as Lower, Middle, and Upper Willows, form three of the most verdant riparian wetlands of the California desert" (Ostermann and Boyce 2002). As the creek flows though the Subbasin, the alluvium becomes deeper and the surface flow either infiltrates into the Subbasin, is consumed by the riparian vegetation through transpiration and/or evaporates. During high rainfall events, flow extends Coyote creek further into the Subbasin for short periods of time.

Historical Stream Flow Measurements

There are two historical streamgages along Coyote Creek located at the northernmost boundary of the Subbasin, one of which stopped recording streamflow in 1983 and the other stopped recording flow in 1993. USGS Station Number 10255800 (Upper–Northern) recorded daily discharge data from 1950 – 1983; at this station, annual average stream flow was measured to be 1,831 acre-feet per year (USGS 2019). USGS Station Number 10255805

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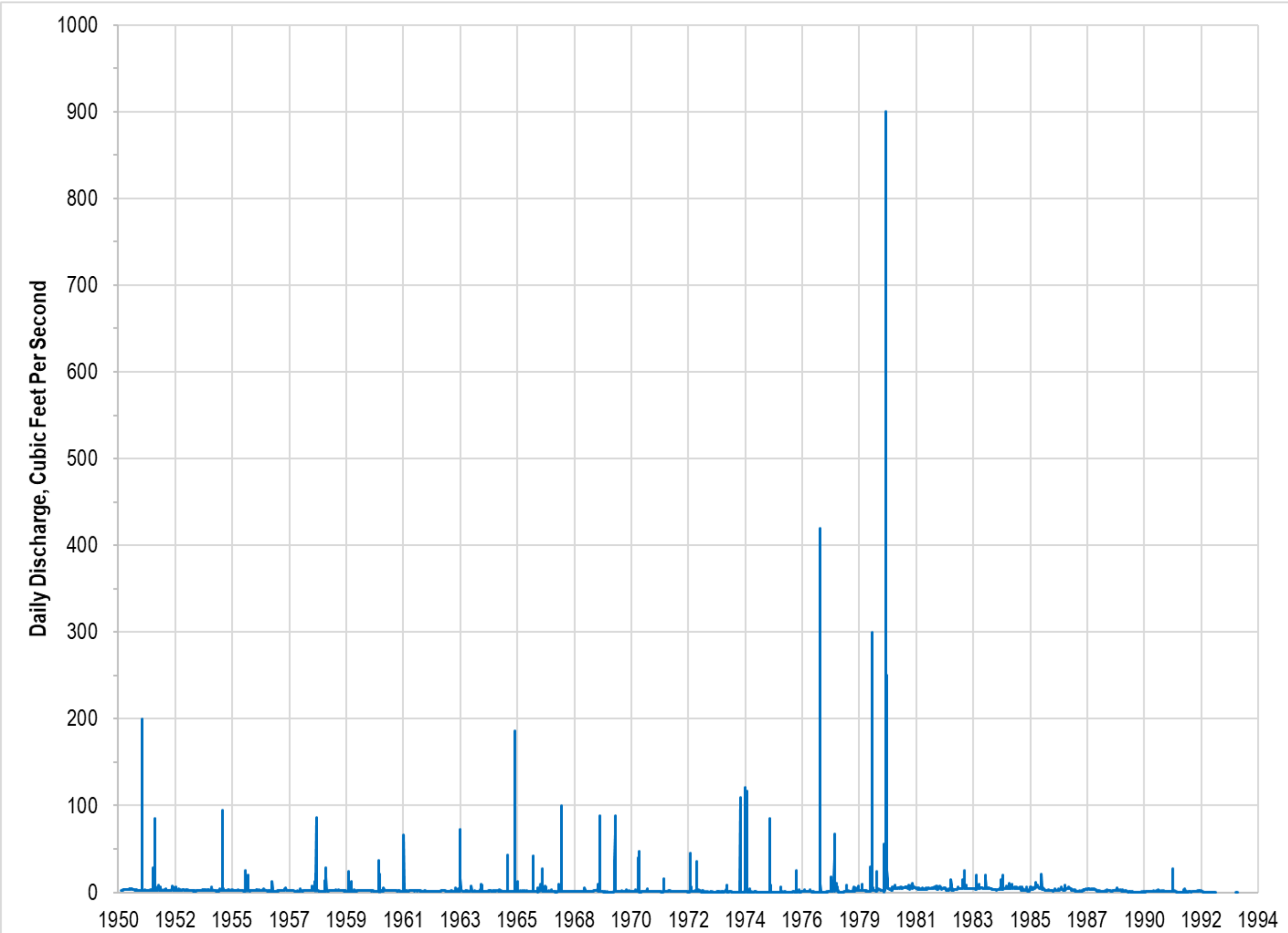
5 Over 85 archeological sites have been recorded along the main creek in the Coyote Canyon, including major villages, food processing centers, rock art, and ceremonial and cremation sites (Ostermann and Boyce 2002).

(Lower–Southern) recorded daily discharge data from 1983 – 1993; at this station, annual average stream flow was measured to be 1,774 acre-feet per year (USGS 2019).

Exhibit 1. USGS 10255800 and 10255805 Coyote Creek Stream Flow 1950 to 1993



Source: USGS 2019
Notes: Discharge data from 1950 to 1983 was recorded at the upper-northern Coyote Creek USGS gage (10255800), while data from 1983 to 1993 was recorded at the lower-southern gage (10255805).

Annual variability over the period measured ranges from 326 acre-feet to 10,715 acre-feet. This large annual variability is a function of large annual variability of precipitation falling on the Coyote Creek watershed. Coyote Creek stream flow is generally correlated with precipitation and spring discharge form Clark Valley. Exhibit 1 shows the combined daily discharge from Coyote Creek USGS streamgages 10255800 and 10255805 for the period from 1950 to 1993.

Manual Stream Flow Measurements

To evaluate the potential GDEs associated with Coyote Creek, the GSA has investigated whether the perennial and ephemeral creek segments are gaining water or losing water to the underlying aquifer system. To complete this analysis, the GSA has commenced mapping the perennial extent of flow in to the Subbasin on a semi-annual basis (spring and fall). The upper historical streamgage is the GSA's manual monitoring point for Coyote Creek. At this location, the GSA manually measured an instantaneous stream flow of 0.46 cubic feet per second (CFS) in the spring 2018, which converts to 206.5 gallons per minute. At that time, the former lower historical USGS streamgage station was observed to be dry.

In the spring of 2018, the perennial extent of flow in Coyote Creek was documented to cease downstream of the third-crossing and upstream of the second crossing. No flow was observed in the spring of 2018 at the lower inactive USGS streamgage, which is one of the permanent locations for manual flow readings. In the fall of 2017, stream flow extended almost half-way from the second crossing to the first crossing. The crossings refer to where an unimproved trail crosses the creek bed, and are shown in Figure 1. In the fall of 2017, there was a precipitation event in the Coyote Creek watershed that produced runoff in Coyote Creek; however, no stream flow measurements are available for this event. Flow in the stream was observed to decrease incrementally from the upper inactive USGS streamgage to 2 locations measured downstream.

"From 1951 to 1992, average daily streamflow in the creek measured at Lower Willows [USGS gages 10255800 and 10255805] was relatively stable and ranged from 0.5 cubic feet per second (cfs) to 4.9 cfs, with the exception of 1980, when the average was 14.8 cfs" (Ostermann and Boyce 2002). The streamflow measurements taken by the GSA at approximately the same location are within the range of historical measurements. The evidence gathered thus far indicates that the reach of Coyote Creek that was mapped as potential GDE by DWR is a "losing" stream, and that this habitat, where it occurs, is supported by intermittent storm events and/or flows emanating from the upland watersheds and basins. The evidence points to a losing stream because despite having a watershed size of 94,506 acres, Coyote Creek loses flow with distance downstream (i.e., within 1 – 2 miles of its crossing into the Subbasin). Stream flow, or lack thereof, has a clear and immediate relationship with runoff events from precipitation. If groundwater emanating from the Borrego Springs Subbasin were contributing to base flow within Coyote Creek, there would be a less rapid and obvious response to precipitation, and rather than going dry upon entering the Subbasin, flow would be expected to be maintained (or even increase) with distance downstream. Additionally, the depth to the regional groundwater table in the Subbasin in the vicinity of Coyote Creek is hundreds of feet below ground surface (288 feet at State Well ID No. 009S006E31E003SI) and disconnected from surface flows.

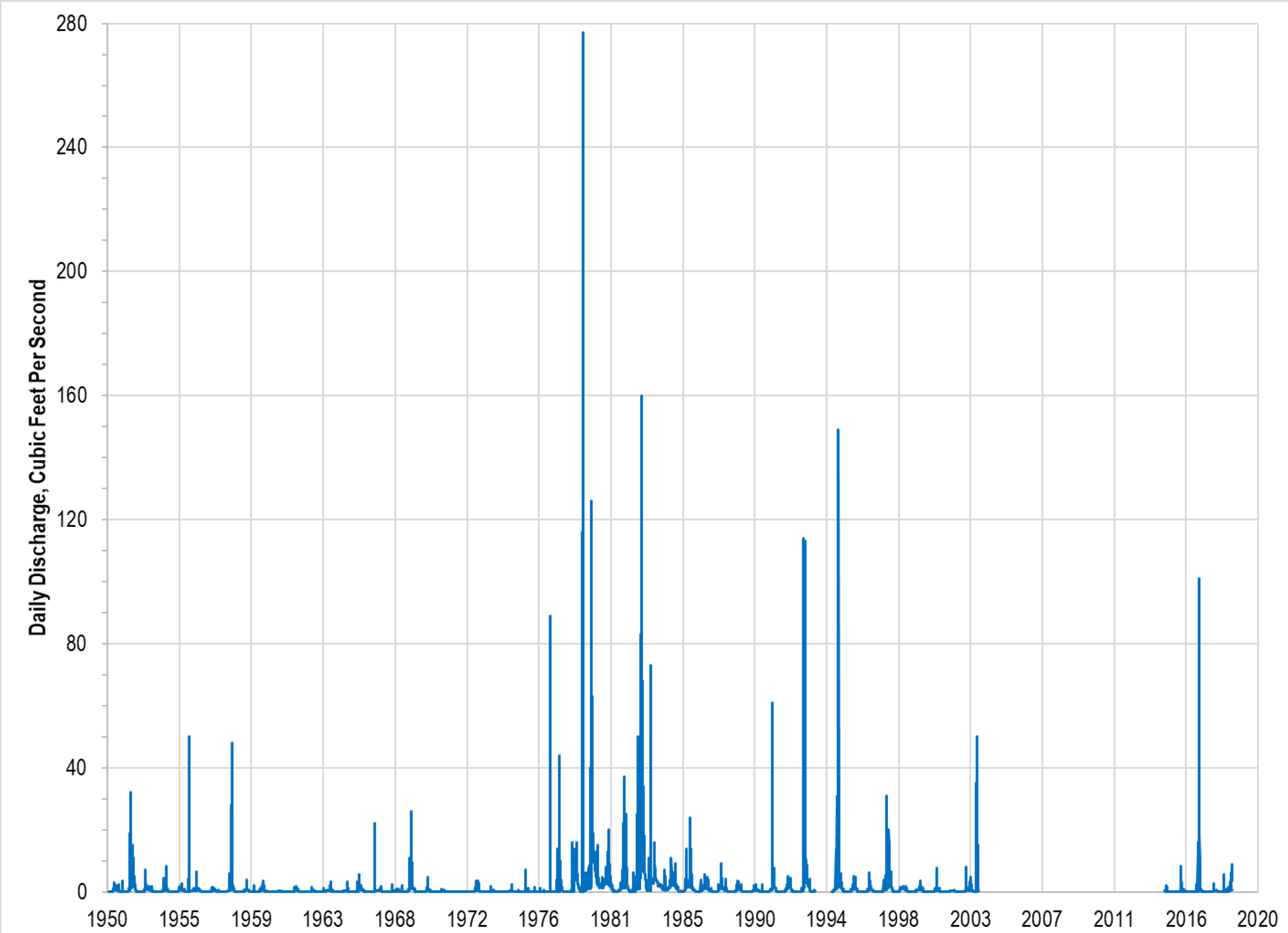
2.2 Borrego Palm Creek

Intermittent stream flow from the Borrego Palm Creek watershed is an important source of recharge to the Subbasin. Perennial flow occurs is observed to occur in Borrego Palm Creek upstream of the palm oasis but apart from wetter periods, the perennial flow infiltrates into the ground along the steep alluvial fan that emerges into the Subbasin.

Historical/Active Stream Flow Measurements

An active streamgage, USGS Station Number 10255810, is located on Borrego Palm Canyon downstream on the palm oasis. This streamgage has a 55-year period of record with sub-daily data (15 minute) from 2015 to 2019, and daily data from 1950 to 2003 (USGS 2019). The data indicate little to no flow over most of the period of record punctuated by higher flows associated with individual precipitation events. During wet years, prolonged stream flow after individual precipitation events is often recorded, but in most years little to no base flow is recorded in the summer months. Brief runoff events occur during occasional thunderstorms. Exhibit 2 shows the daily discharge from Borrego Palm Canyon USGS streamgage 10255810 for the period from 1950 to 2003, and 2015 to 2019.

Exhibit 2. USGS 10255810 Borrego Palm Canyon Stream Flow 1950 to 2019



Source: USGS 2019
Notes: Streamgage was inactive September 30, 2003 to January 6, 2015.

Manual Stream Flow Measurements

The USGS regularly performs manual streamflow monitoring of its active gages including the Borrego Palm Canyon streamgage. Nineteen manual measurements were taken by USGS staff in 2018 and 2019 with recorded stream flow of no flow to 7.26 cubic feet per second (449 gpm) (USGS 2019). The clear and consistent relationship between seasonal and episodic precipitation and the patterns of recorded stream flow indicates that the reach of Borrego Palm Creek that was mapped as potential GDE by DWR is a “losing” stream, and that this habitat, where it occurs, is supported by intermittent storm events and/or flows emanating from the upland watersheds and basins.

3 Borrego Sink (Mesquite Bosque)

According to the USGS (2015), the Borrego Sink, a topographic low where the water table prior to development was within 10 feet of land surface, was the site of about 450 acres of honey mesquite bosque and other native phreatophytes,[6] indicating that shallow groundwater and occasional accumulations of surface water was historically sufficient to support a groundwater dependent ecosystem. Prior to development, mesquite trees, salt grass, willow and rushes were reported to be abundant in the valley (Mendenhall 1909).

As stated in General Plan Update Groundwater Study completed by San Diego County (2010): "The mesquite bosque, a rare and sensitive groundwater-dependent habitat, is believed by many experts to be desiccating in portions of Borrego Valley, even though their taproots can reach down to 150 feet for water." The habitat covered an approximate four-square mile area. However, while mesquite bosque as a species have been recorded to have extremely deep taproots, the USGS (2015) notes that the maximum rooting depth for phreatophytes found locally in around the Borrego Sink and areas to the north was at 15.3 feet. Recent groundwater levels from wells adjacent to the main mapped habitat range from approximately 55 to 134 feet below the ground surface. Mitten (1988) and other estimated that prior to 1946, about 4,300 acre-feet of water was discharged from phreatophytes annually by evapotranspiration.

The honey mesquite bosque, shown as pink and green areas in Figure 1 north of the Borrego Sink, is considered a pre-2015 impact, because groundwater levels have declined to a level that no longer supports a viable habitat. Groundwater levels have long since declined below a level which can support the estimated rooting depth of the habitat, which is 15.3 feet (USGS 2015). Natural discharge determined from the Borrego Valley Hydrologic Model (BVHM) attributable to evapotranspiration was approximately 6,500 acre-feet per year prior to development, but has been virtually zero in the last several decades (1990–2010) (USGS 2015). The BVHM includes a component of evapotranspiration in the water budget, and estimates close to 400 acre-feet of percolating surface water throughout the Subbasin is lost to evapotranspiration under existing conditions. Based on the land uses and mapped vegetation incorporated into the BVHM, this is dominated by losses from farms, golf courses, non-native tamarisk, and other land uses. The green area in Figure 1 depicts the pre-pumping mapped historical extent of phreatophytes in the Subbasin by USGS (USGS 2015). The pink area depicts the mapped pre-January 1, 2015 extent of potential GDEs (SANGIS 2017); and the orange area depicts the extent of mapped GDEs by the NCCAG dataset (DWR 2018).

Pumping in the Subbasin has resulted in a groundwater level decline of about 44 feet over the last 65 years in the vicinity of the Borrego Sink. The average rate of decline over this 65 year period is approximately 0.67 feet per year. The 1955 groundwater level was about 11 feet below ground surface and the most recent groundwater level measured in the fall of 2018 was 55.2 feet below ground surface. Because of the long-term imbalance of pumping with available natural recharge, an irreversible impact has occurred to the honey mesquite bosque, which is mostly desiccated prior to January 1, 2015. The "Sink" wells shown in Figure 1 (i.e., 12G1 and 7N1) have become dry based on measurements recently performed by DWR. Groundwater level measurements collected in 2009 of Sink Well 12G1 and well MW-5B indicated similar groundwater level elevations, whichsuggeststhat well MW-5B is sufficiently representative of depth to the groundwater table in the area of the Borrego Sink.

Old Borrego Spring

In 1963, Lester Reed wrote in Old Time Cattlemen and Other Pioneers of the Anza-Borrego Area, "Since so much recent pumping of water in the Borrego Valley, the old spring no longer flows. This spring was one of the watering

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6 Phreatophytes are long-rooted water loving plants that obtain water supply from groundwater or the capillary fringe just above the water table.

places upon which the Indians, and the old-timers could depend, although the water was of poor quality. The first time I visited Old Borrego Spring was just two or three days before Christmas 1913 when my brother Gilbert (Gib), and I were riding though on horseback from Imperial Valley to spend the holidays with our parents at the Mud Spring Ranch about fifteen miles southeast of Hemet. Since early boyhood, I heard old-timers talk about Borrego Springs water; so I thought I would try it. As I have said many times before, I found it to taste but very little better than the treated water we are expected to drink today (Reed 2004)."

The Old Borrego Spring was located in the vicinity of the Desert Lodge anticline, fold axes running perpendicular to the Veggie Line fault (notice uplifted sediments located south of the Old Borrego Spring and mapped NCCAG vegetation), Coyote Creek fault and Yaqui Ridge/San Felipe anticline associated with the San Jacinto fault zone (Steely 2009) (Figures 1 and 13). The faulting and folding effectively compartmentalize the deep sediments of the Subbasin from the adjacent Ocotillo Wells Groundwater Subbasin. When groundwater levels were closer to the surface in the Subbasin this resulted in 'daylighting' of groundwater at the Old Borrego Spring.

4 Potential GDEs Ecological Condition

To assess the ecological condition of potential GDEs, several additional datasets were reviewed.

4.1 Threatened and Endangered Species

The Environmental Conservation Online System (ECOS) contains spatial data of critical habitat for threatened and endangered species. Critical habitat for Peninsular bighorn sheep is identified in the Subbasin (Figure 14). Critical habitat for Least Bell's vireo is also identified in the vicinity of the Subbasin near where Coyote Creek enters the Subbasin. Potential effects to these critical habitats must be analyzed along with the endangered species themselves during the California Environmental Quality Act (CEQA) review of the GSP Projects and Management Actions. The U.S. Fish and Wildlife Information for Planning and Consultation (IPaC) lists the other endangered species in the larger contributing watershed to the Subbasin: 2 mammals, 24 migratory birds, 1 reptile, 2 amphibians, 2 fishes, 2 insects, and flowering plants (U.S Fish & Wildlife Service 2018). An official consultation based on the CEQA project description is required with the resource agencies in order to evaluate potential impacts, get an official species list, and make species determinations.

4.2 Areas of Conservation Emphasis

The Areas of Conservation Emphasis (ACE) is a California Department of Fish & Wildlife non-regulatory tool that brings together the best available map-based data in California to depict biodiversity, significant habitats, connectivity, climate change resilience, and other datasets for use in conservation planning. ACE project contains spatial data on native species richness, rarity, endemism, and sensitive habitats for six taxonomic groups: birds, fish, amphibians, plants, mammals, and reptiles. Information on the location of four sensitive habitat types (i.e., wetlands, riparian habitat, rare upland natural communities, and high-value salmonid habitat) are also summarized. The ACE dataset is available statewide based on watersheds using hydrological units at the 12-digit code level (HUC12) for aquatic habitat. The Borrego Valley HUC12 sub-watershed has a low Significant Aquatic Habitat Rank (Figure 15).

The ACE dataset is available statewide at a 2.5-square-mile hexagon grid for terrestrial habitat. The color ramp has been coded at the USDA Ecoregion level with each color approximate to the 20th percentile of land area in the Colorado Desert Ecoregion. The developed areas of Borrego Springs have a terrestrial habitat rank of 0 (Figure 16). Moving outward from the developed area of Borrego Springs the rank increases to higher terrestrial habitat values.

Species Biodiversity Summaries combine the three measures of biodiversity developed for ACE into a single metric. These three measures include: 1) native species richness; 2) rare species richness; and, 3) irreplaceability. Much of western flank of the Subbasin is ranked as high species biodiversity [grey hexagons] depicted in Figure 17. Interestingly, the Species Biodiversity Rank seems to conflict with the previous Significant Terrestrial Habitat Rank for the hexagons located in the central portion of the Subbasin.

The California National Diversity Database (CNDDB) or California Special Status Species contains text and spatial information on California's special status species (rare plants and animals). It is a positive detection database. Records in the database exist only where species were detected. This means there is a bias in the database towards locations that have more survey work. Also, the database is proprietary and shall be displayed at such a scale (no larger than a scale of 1:350,000), or in such a way that the viewers/users cannot determine exact location information of the elements mapped in the system. Several positive detections are noted in the CNDDB within the Subbasin (Figure 18).

The California Protected Areas Database (CPAD) contains GIS data about lands that are owned in fee and protected for open space purposes by over 1,000 public agencies or non-profit organizations. This dataset shows that the majority of lands surrounding Borrego Springs are protected areas managed by the Anza Borrego Desert State Park (Figure 19). Additional parcels are managed within the Subbasin by the Anza Borrego Foundation, Borrego Water District (BWD) and County.

5 Potential GDEs Hydrogeologic Conceptual Model

A Hydrogeologic conceptual model has been developed for the entire Subbasin to provide the framework for the development of water budgets, analytical and numerical models, and monitoring networks. A HCM differs from a mathematical (analytical or numerical) model in that it does not compute specific quantities of water flowing through or moving into or out of a basin, but rather provides a general understanding of the physical setting, characteristics, and processes that govern groundwater occurrence and movement within the basin. Figure 20 presents the parameters of the HCM developed for the Subbasin, which conceptually depicts basin boundaries, stratigraphy, water table, land use, and the components of inflow and outflow from the Subbasin. In order to better evaluate potential GDEs, it was necessary to refine the Subbasin-wide HCM to address specific areas of the Subbasin representative of the GDE Units. As such, large scale HCMs have been developed for the ephemeral and perennial creeks and drainages (Contributing Watersheds) and the Borrego Sink (Mesquite Bosque) to provide a better understanding of the physical setting, characteristics and processes that govern groundwater occurrence and movement in these unique settings within the larger HCM. The location-specific HCMs are described in the following subsections and shown where they occur in the context of the Subbasin-wide HCM in Figure 20.

5.1 Ephemeral and Perennial Creeks and Drainages (Contributing Watersheds)

A HCM was developed for the potential GDEs identified in the Subbasin and at the Subbasin margins. Figure 21 depicts a HCM applicable to GDE Unit 1 – Coyote Creek, GDE Unit 2 – Borrego Palm Creek and other similar canyons that drain mountainous terrain adjacent to the Subbasin. This HCM illustrates that the source of water for potential GDE Units 1 and 2, and other similar canyons is stream flow that originates from outside of the Subbasin. Ephemeral and perennial streams transition to disconnected streams as they flow across the numerous alluvial fans that descend on the Subbasin. Stream flow percolates into a thick unsaturated zone. The regional groundwater table is often hundreds of feet below the streams. At Coyote Creek, the nearest well, State Well ID No. 009S006E31E003SI, has a depth to groundwater of 288 feet below land surface. At Borrego Palm Canyon Creek, the nearest well, State Well ID No. 010S005E25R002S, has a depth to groundwater of 348 feet below land surface. Other wells located adjacent to the Subbasin margins all have depths to groundwater several hundred feet below land surface. Groundwater extraction from water wells in the Subbasin does not effect GDEs associated with ephemeral and perennial creeks and drainages because the groundwater accessed by the wells is not water that is accessible or available to the potential GDEs.

5.2 Borrego Sink (Mesquite Bosque)

A HCM was developed for the Borrego Sink (Mesquite Bosque) to evaluate potential GDEs. Figure 22 depicts a HCM for potential GDE Unit 3 - Borrego Sink (Mesquite Bosque). The Borrego Sink is a topographic low in the Subbasin. The sink in all but the most exceptional wet years acts as closed or terminal basin where flood waters pool and fine sediment settles. After flood events, most of the water that reaches the sink evaporates leaving a white crust of salt that is often visible on the surface of the sink. Some of the flood waters that reach the sink percolate into the fine sediment and may locally support perched groundwater zones. As previously discussed in Section 3, Old Borrego Spring no longer discharges to the Borrego Sink.

Driller's logs for wells located in the vicinity of the Borrego Sink were reviewed to characterize the subsurface lithology. In particular, the log for MW-5A and 5B and Rams Hill test borehole No. 12 were reviewed.

MW-5 is a multi-completion well constructed in 2006 drilled to a depth of 480 feet below ground surface (bgs) under the oversight of the BWD and DWR. MW-5 is located about 1.2 miles northeast of the Borrego Sink. "In general, the boring encountered variably thick interbedded materials (silt and clay). Based on the borehole cuttings and the geophysical logs, the geologic materials encountered can be separated into three main zones or sequences divided at prominent clay layers: an upper zone dominated by poorly consolidated coarse grained materials from the surface to about 165 feet below ground surface (bgs); a middle zone of moderately consolidated interbedded fine- and coarse-grained materials between 165 feet and 355 feet bgs; and a lower zone of consolidated or lithified beds for fine-grained and coarse-grained material between 355 to 480 feet bgs" (DWR 2007).

MW-5B is screened from 45 to 155 feet below ground surface and appears to sufficiently represent the depth of the groundwater table in the vicinity of the Borrego Sink though it is possible that it represents a semi-confined potentiometric surface rather than the unconfined water table. MW-5A is screened from 200 to 340 feet and has a similar groundwater level to the shallower MW-5B suggesting potentially unconfined conditions in this part of the Subbasin; however, it is uncertain whether a good well seal was obtained during installation of the multi-completion monitoring well.

Test borehole No. 12 was drilled in 2014 about 0.5 mile south of the Borrego Sink, immediately south of the Rams Hill Wastewater Treatment Facility. Interbedded sand, silt and clay was encountered to a total borehole depth of 764 below land surface. Coarser material was only encountered at the surface to a depth of about 30 feet, and in one zone from 490 to 610 feet below ground surface. Thick clay zones with thin interbedded silty sands were encountered from 30 to 490 feet and form 610 feet to 764 feet (Dudek 2014). The depositional environment indicated by log is often one of low energy as evidenced by thick fine grain deposits. The depositional environment of the upper portion of the log is consistent with that of a desert playa (current depositional environment) and lacustrine setting (lake setting that occurred in desert basins during the last ice age [Pleistocene Epoch]). Deeper sections of the borehole may have encountered the Palm Springs Formation. The Borrego Sink HCM illustrates the predominantly fine sediment characterized in the subsurface in the vicinity of the Borrego Sink with coarser sediment shown proximal to mountainous terrain from which the sediments are derived (Figure 22).

Groundwater levels in the vicinity of the Borrego Sink have been measured at "Sink" wells 7N1 and 12G1 since 1953 and 1965, respectively, and MW-5A and MW-5B since 2006. The "Sink" wells have since become dry based on measurements performed by DWR in 2009. It is not known exactly when the Sink wells went dry; however, the groundwater level in well 7N1 was last measured by the USGS in 1965 at a depth of 36.0 feet bgs and well 12G1 was measured by the DWR in 2009 at a depth of 64.0 feet bgs. The total well depth of of 7N1 is 30.0 feet and 12G1 is 65.2 feet as measured by DWR.[7] The overlap of a groundwater level measurement in 2009 of Sink Well 12G1 with MW-5B has a similar groundwater level elevation suggesting that well MW-5B is sufficiently representative of depth to the unconfined groundwater table in the area of the Borrego Sink. The depth to groundwater at MW-5B in the spring of 2018 was 55 feet bgs. The groundwater table in the vicinity of the Borrego Sink has declined approximately 44 feet over the period from 1953 to 2019. The decline in the groundwater table in the vicinity of the Borrego Sink has resulted in the drying of Old Borrego Spring and desiccation of the honey mesquite bosque as previously discussed in Section 3. Given that groundwater levels will not substantially recover under current climate conditions and pumping volumes, the impacts to the Borrego Sink are considered permanent and irreversible.

6 Evaluation of Nexus of GDEs with Subbasin Groundwater

The SGMA definition of GDEs was applied to evaluate reliance of ecological communities and species on Subbasin groundwater. The evaluation revealed that Subbasin creeks can be characterized as losing streams in that they primarily act as groundwater recharge areas rather than local discharge of groundwater from the Subbasin to the stream reach. Potential GDEs that exist within Subbasin creek drainages rely on both periodic surface flows and soil moisture, and not directly on the regional groundwater table, which based on groundwater levels recently measured adjacent to the creek drainages indicate groundwater levels are beyond the rooting depth zone of existing vegetation mapped as potential GDEs.

The impact of rapidly declining groundwater levels on GDE vegetation is most apparent in the Borrego Sink.. The honey mesquite bosque that previously flourished in the Borrego Sink has desiccated and its areal extent has decreased significantly as groundwater levels have dropped in response to increased groundwater extraction. Pumping in the Subbasin has resulted in a groundwater level decline of about 44 feet over the last 65 years in the vicinity of the Borrego Sink. Recent groundwater levels from wells adjacent to the main mapped habitat range from approximately 55 to 134 feet below the ground surface. Because of the long-term imbalance of pumping with

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7 The total well depth of Sink well 7N1 measured by DWR at 30 feet is less than the last groundwater level measured by USGS in 1965 of 36.0 feet. Sink well 7N1 likely either collapsed at 30.0 or is filled with sediment in the bottom of the well.

available natural recharge, an irreversible impact has occurred to the honey mesquite bosque, which is mostly desiccated prior to January 1, 2015.

Vegetation that occurs in the Borrego Sink has access to soil moisture in the unsaturated zone and potentially perched groundwater where present. Perched groundwater consists of local pockets (or lenses) of low permeability sediment (e.g., clay and silt) that "pinch out", meaning they are not laterally extensive enough to be considered a regionally significant aquitard. These zones are considered "perched" because they occur above the regional groundwater table, and thus are disconnected from changes experienced within regional aquifer (including outflows such as pumping). With these types of subsurface conditions, surface water may be slower to percolate into the underlying regional groundwater table, possibly providing conditions necessary to sustain remnant stands of Mesquite Bosque and/or support ongoing recruitment in combination with periodic storm flow events. The percolating groundwater used by this vegetation removes water that would otherwise constitute recharge. In other words, rather than the regional aquifer being a water source for the vegetation, the vegetation subtracts from the water available for deep infiltration.

7 Conclusion and Recommendations

A review of available pertinent spatial datasets, historical data including stream flow and groundwater levels, and geology was completed to develop a robust HCM to evaluate nexus of GDEs with Subbasin regional groundwater levels. The comprehensive assessment revealed potential GDEs identified within the Subbasin no longer have direct reliance on groundwater emerging from aquifers or on groundwater occurring near the ground surface, and instead are sustained by periodic stormwater flows, soil moisture, and potentially perched groundwater where present. These findings indicate that based on best available data there is no need for the GSP to address minimum groundwater level thresholds with respect to potential GDEs.

Detailed mapping of vegetation is lacking for the area in the vicinity of the Borrego Sink. Groundwater level monitoring of wells located in the vicinity of the Borrego Sink should continue.

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9 Advisory Committee Meeting GDEs Presentations

GDE presentations by DUDEK at SGMA Borrego Valley GSP Advisory Committee meetings in chronological are as follows:

ACM 2017.11.27	Coyote Creek
ACM 2018.05.31	Groundwater Dependent Ecosystems
ACM 2018.07.26	Groundwater Dependent Ecosystems
ACM 2019.01.31	Groundwater Dependent Ecosystems (GDEs) Approach in GSP

Presentations are available from the County of San Diego's Borrego Valley Groundwater Basin website: https://www.sandiegocounty.gov/content/sdc/pds/SGMA/borrego-valley.html

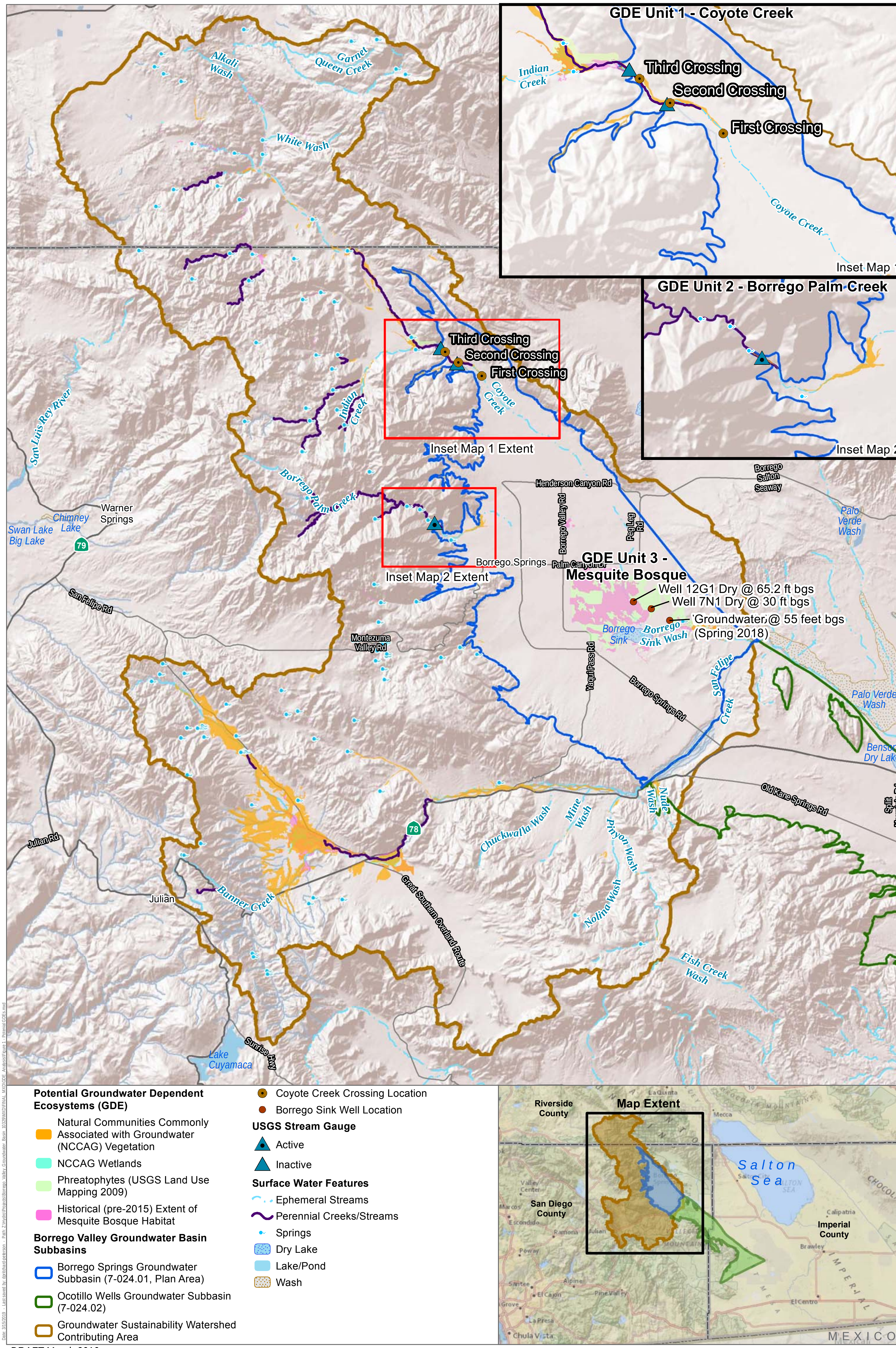
Tables and Figures

Table List

Exhibit List (exhibits are located within body of text)

Figure List

Figures 1-22



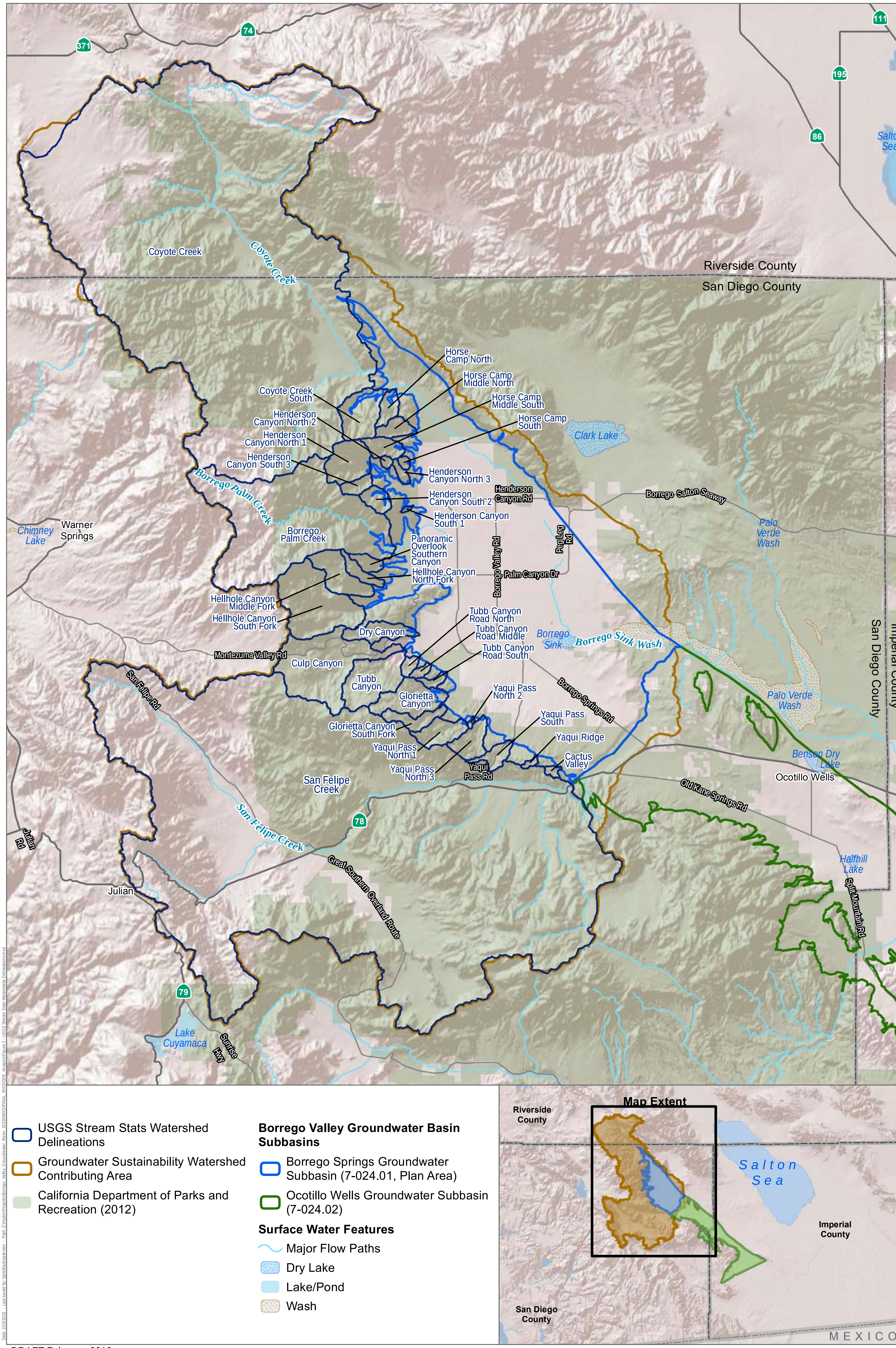
DRAFT March 2019

DATUM: NAD 1983. DATA SOURCE: DWR 2018; USGS NHD 2017; State Parks 2017; SanGIS 2017

Figure 1

Borrego Springs Subbasin and Potential Groundwater Dependent Ecosystems

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



DRAFT February 2019

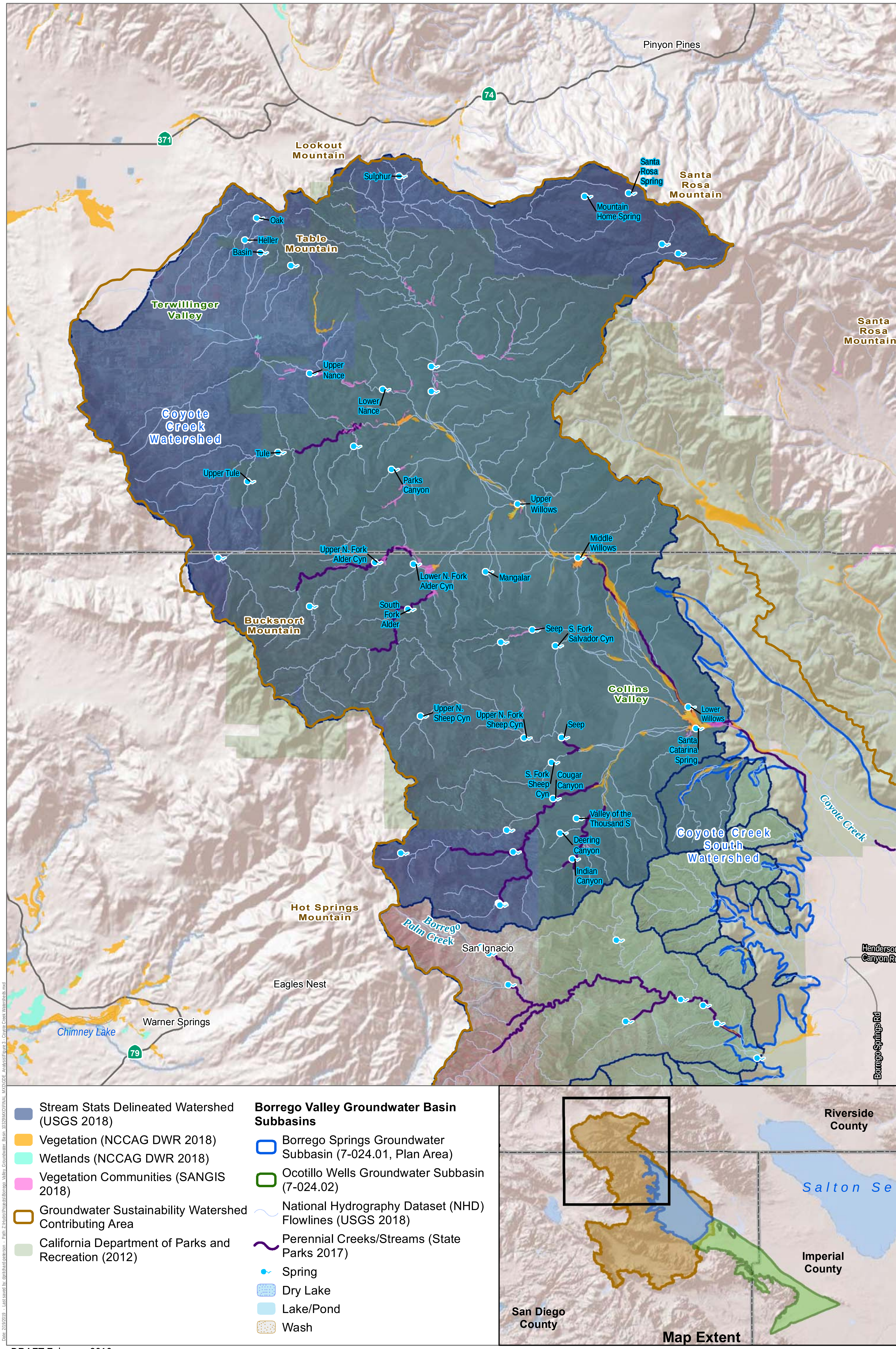
DATUM: NAD 1983. DATA SOURCE: USGS Stream Stats 2018

DUDEK

Figure 2

USGS Stream Stats Watershed Delineations

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



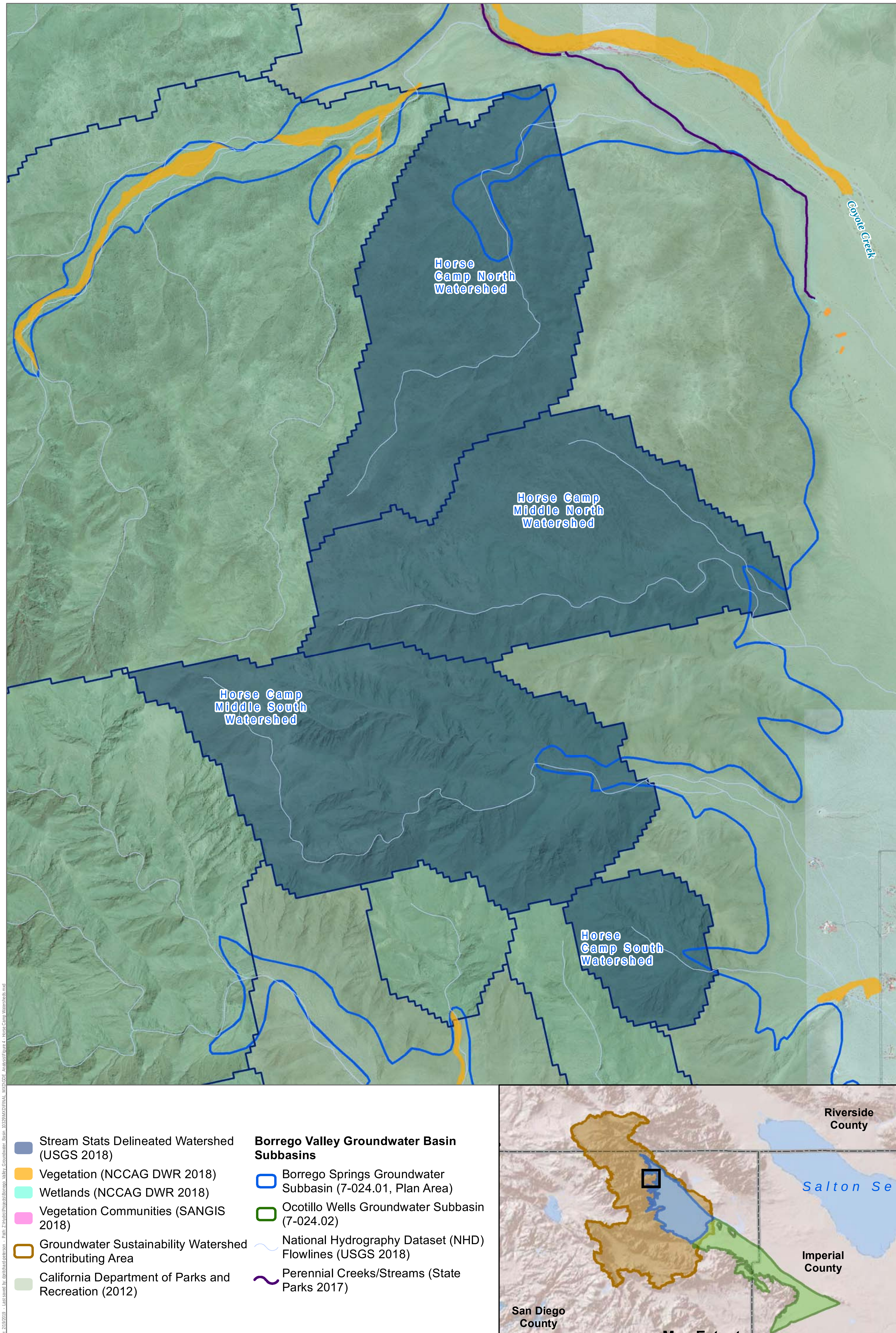
DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK 0 2 4 Miles

Figure 3
Coyote Creek Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



DRAFT February 2019

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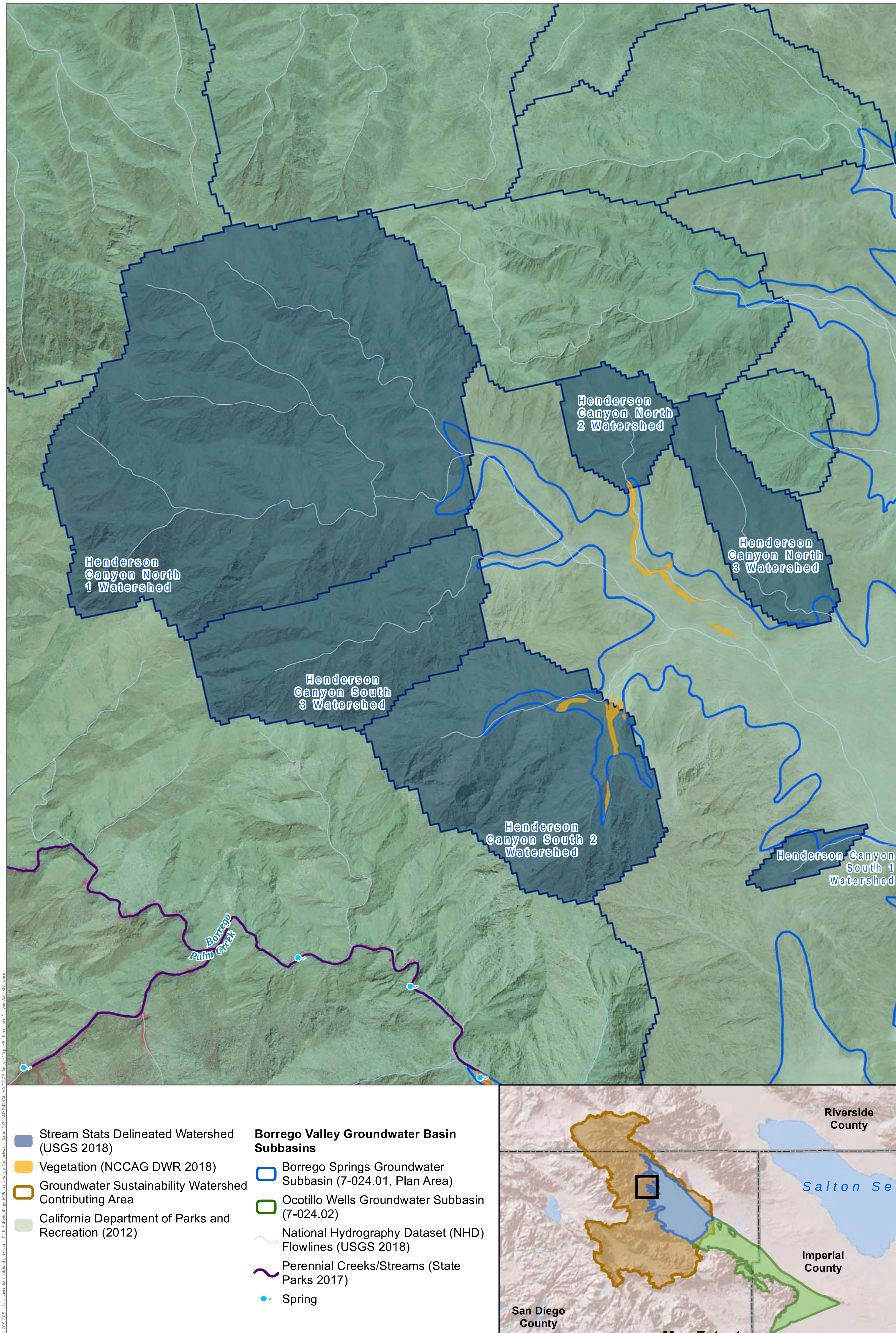
Figure 4
Horse Camp Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



DRAFT February 2019

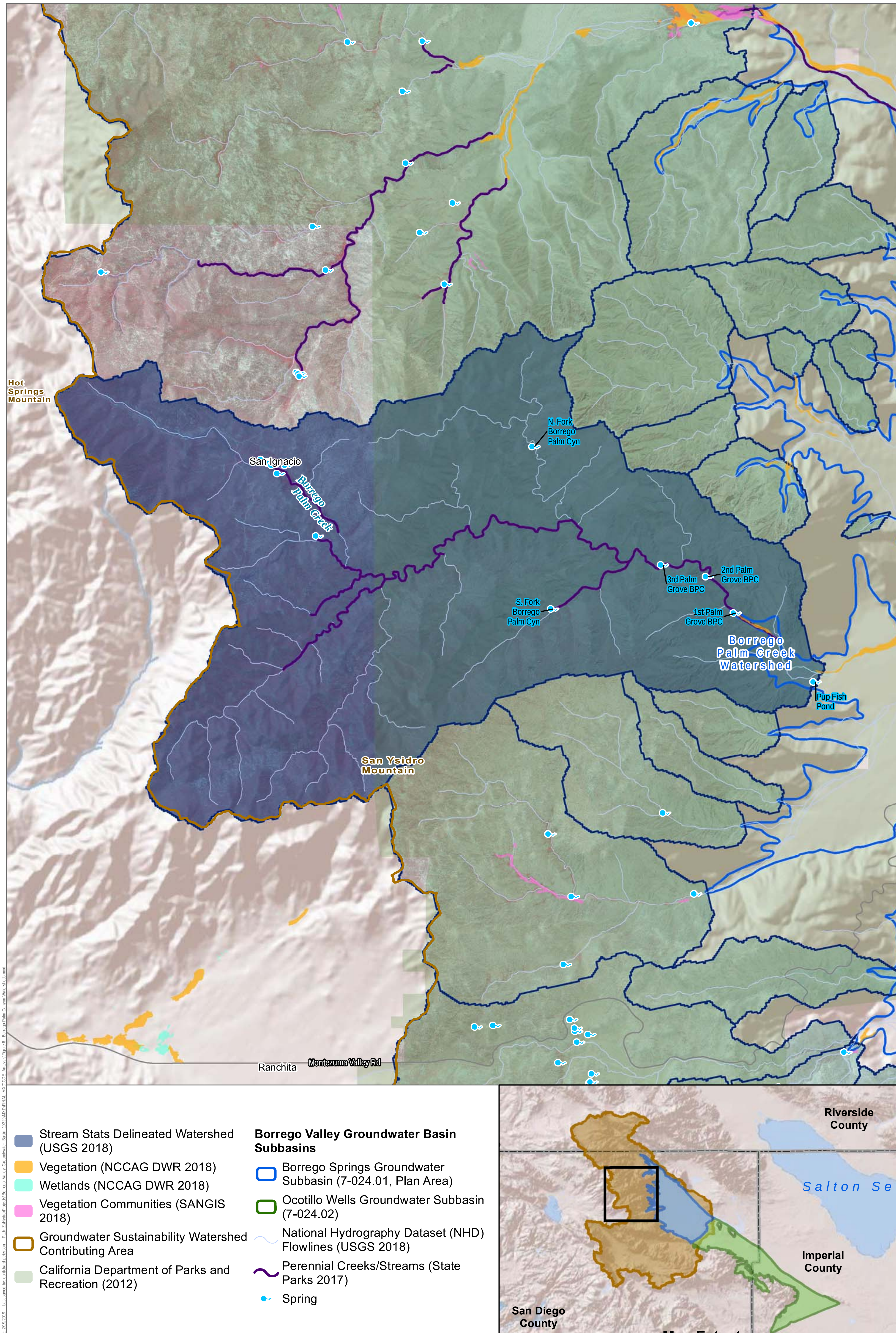
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.5 1 Miles

Figure 5
Henderson Canyon Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



DRAFT February 2019

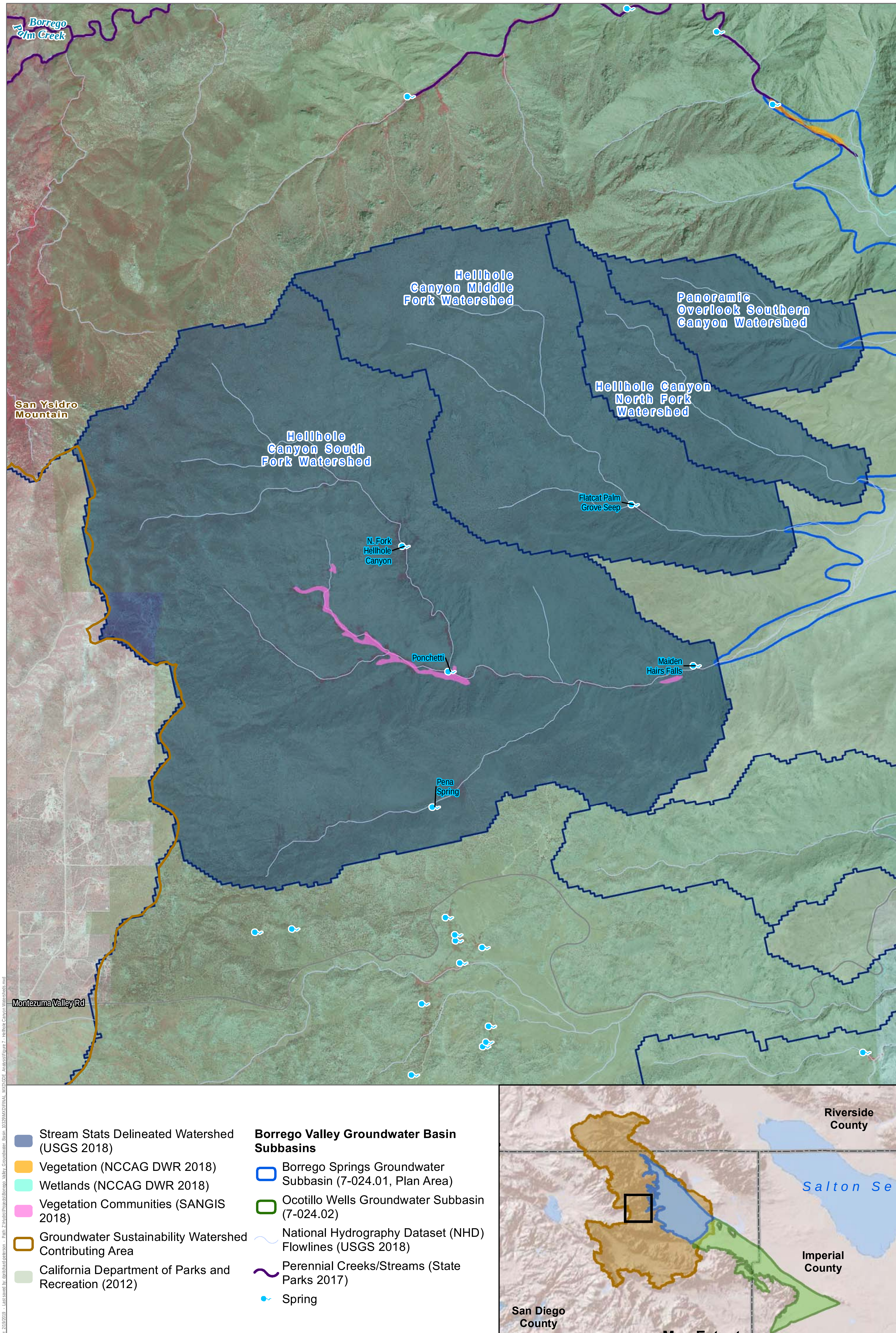
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 1 2 Miles

Figure 6
Borrego Palm Canyon Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



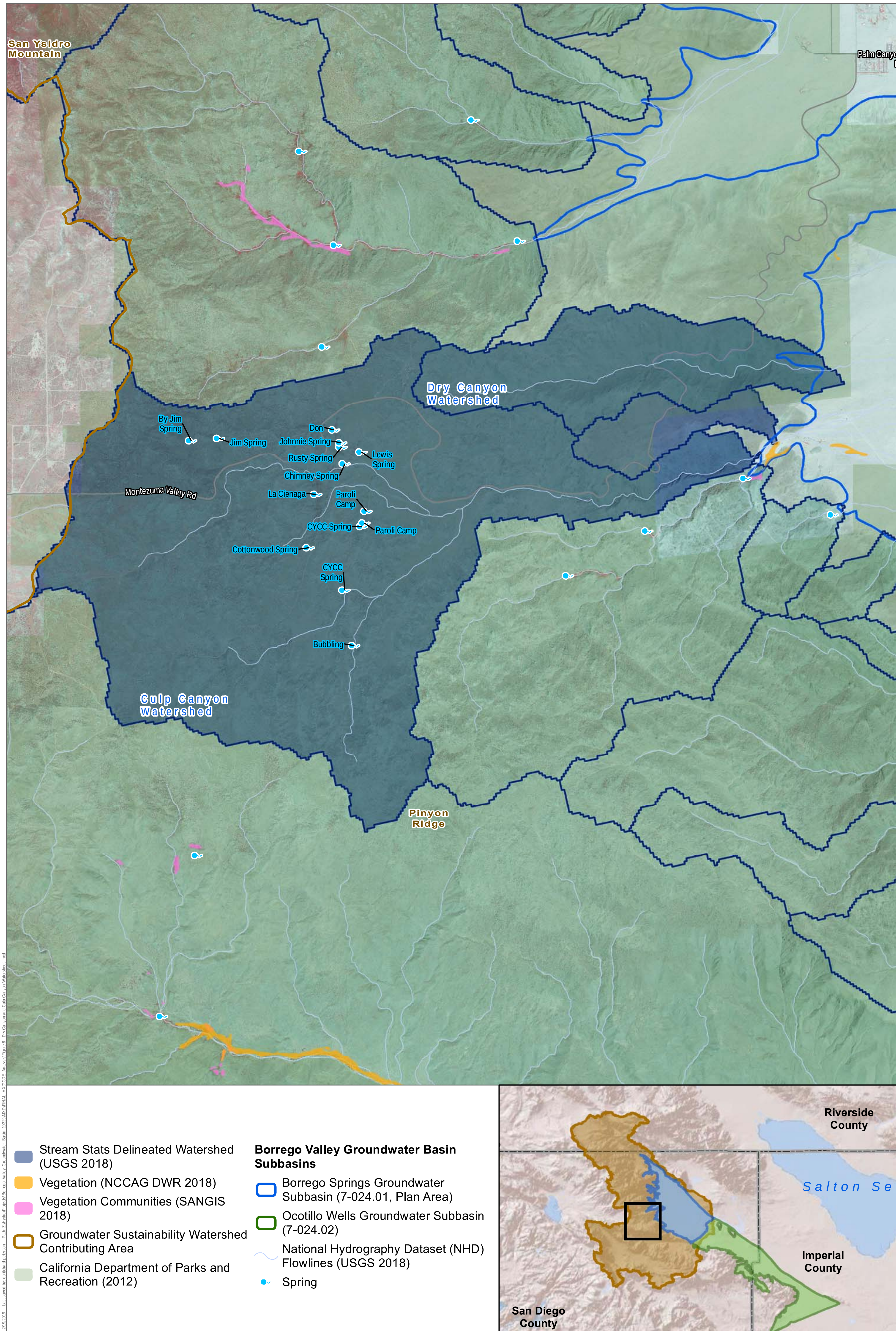
DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK 0 0.5 1 Miles

Figure 7
Hellhole Canyon Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



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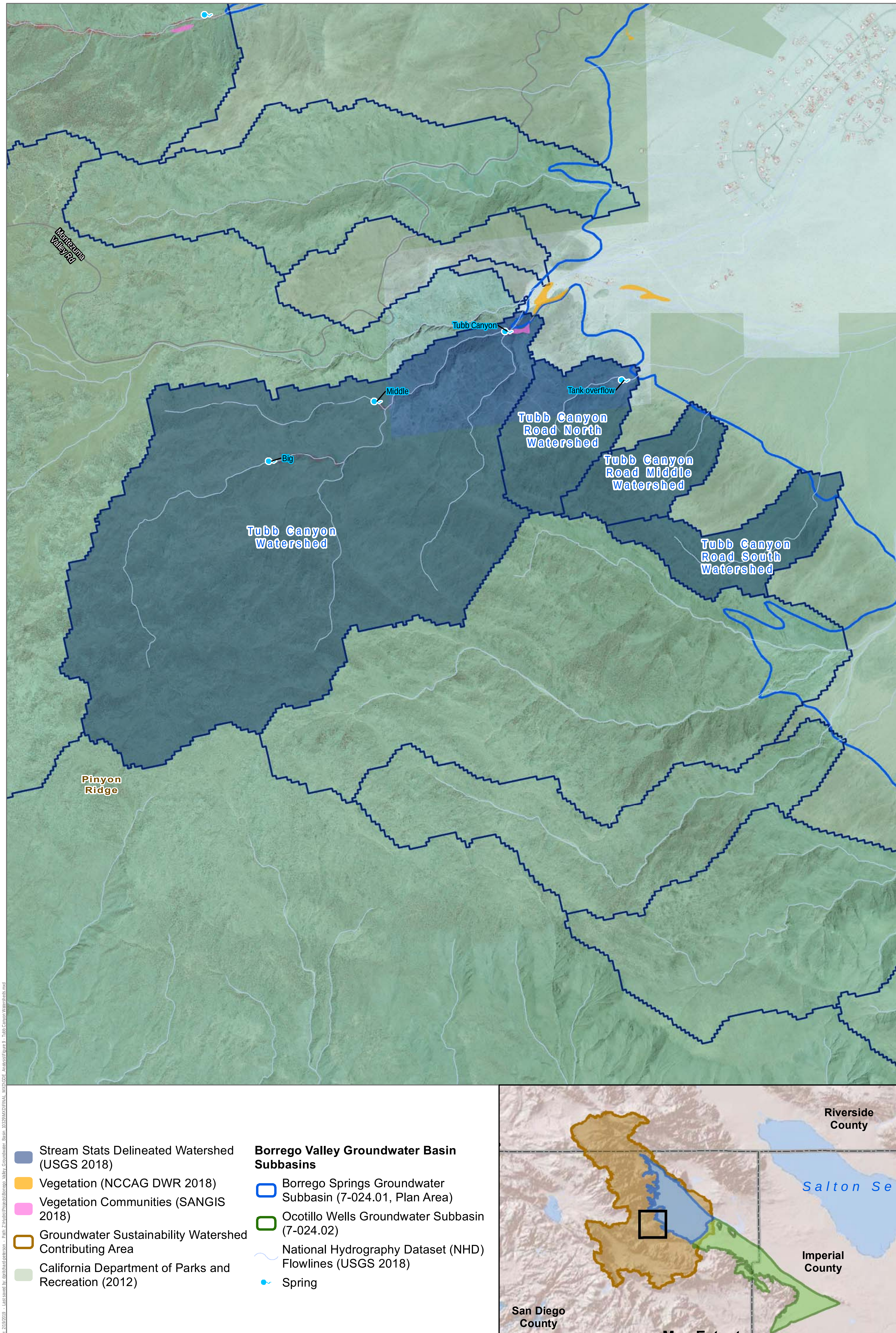
DUDEK

Figure 8

Dry Canyon and Culp Canyon Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



DRAFT February 2019

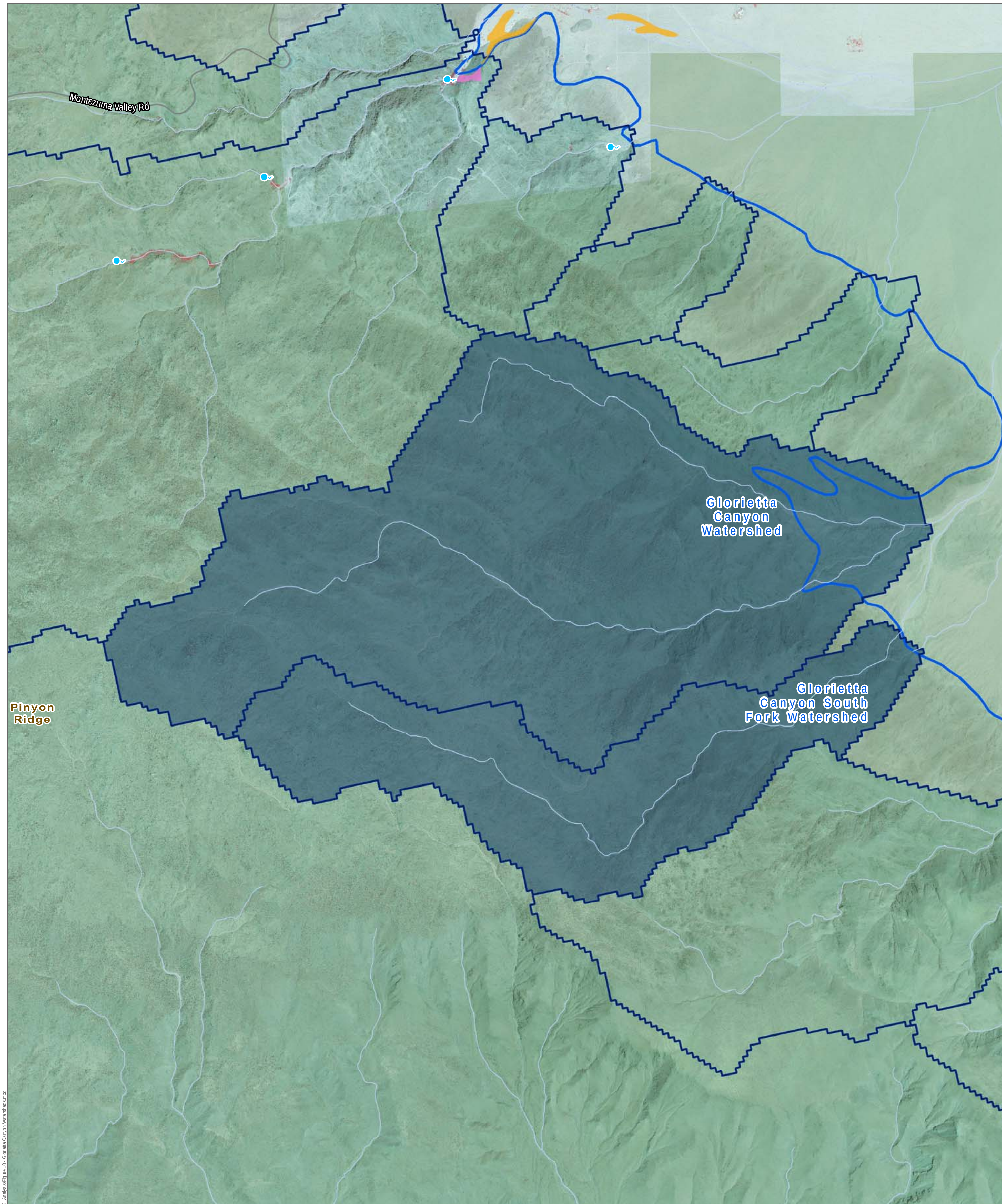
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.5 1 Miles

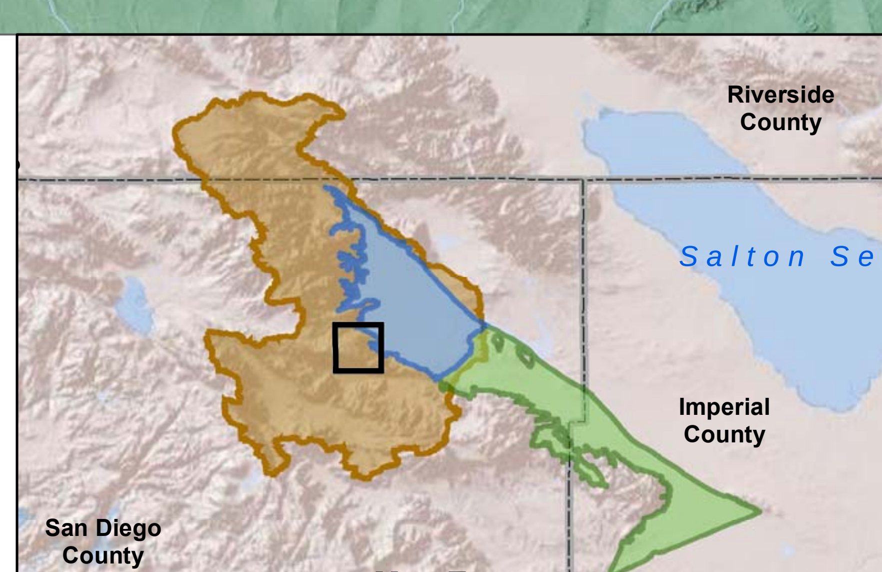
Figure 9
Tubb Canyon Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



Stream Stats Delineated Watershed (USGS 2018)
Vegetation (NCCAG DWR 2018)
Vegetation Communities (SANGIS 2018)
Groundwater Sustainability Watershed Contributing Area
California Department of Parks and Recreation (2012)

Borrego Valley Groundwater Basin Subbasins
Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)
Ocotillo Wells Groundwater Subbasin (7-024.02)
National Hydrography Dataset (NHD) Flowlines (USGS 2018)
Spring



DRAFT February 2019

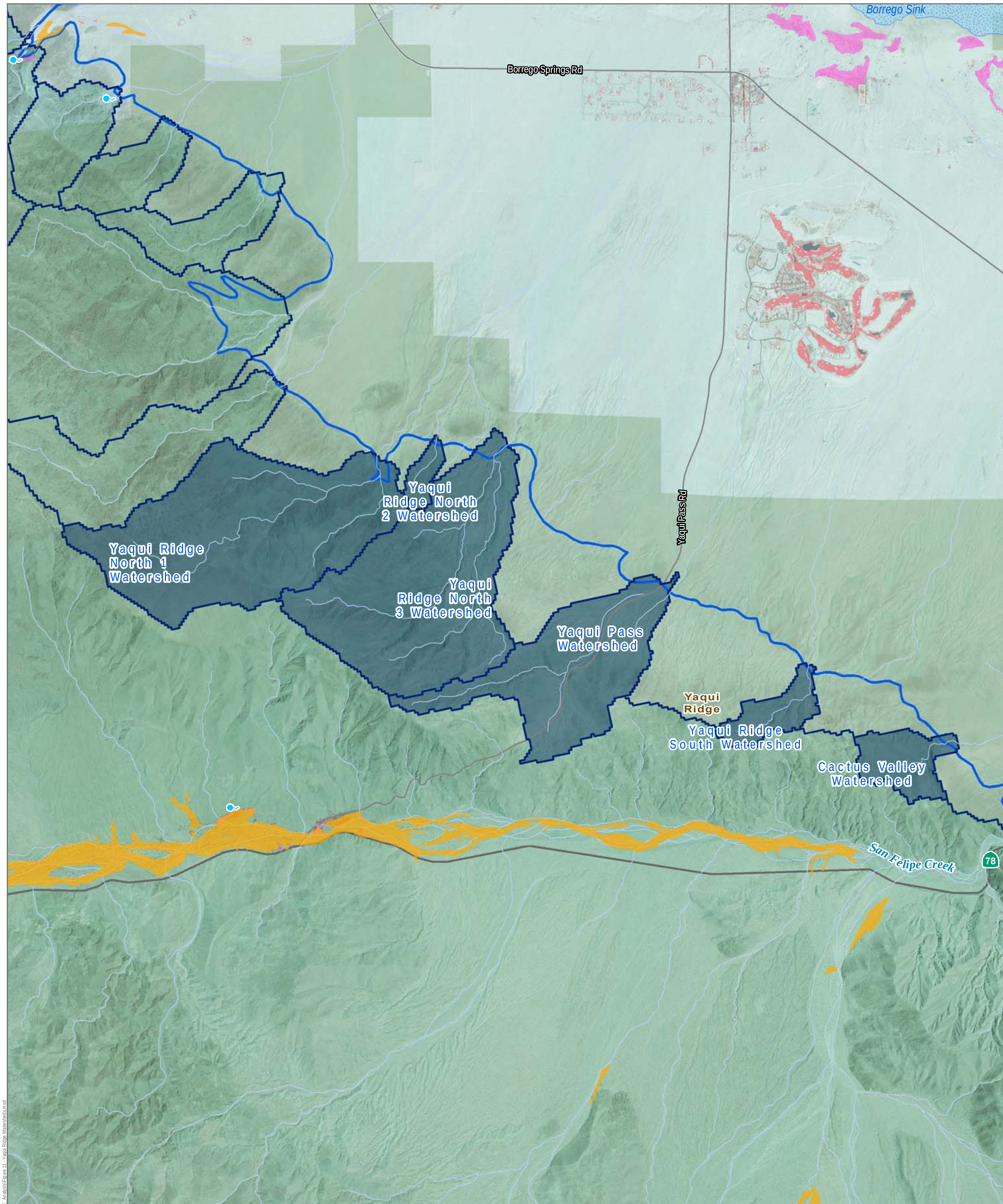
DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.5 1 Miles

Figure 10
Glorietta Canyon Watersheds

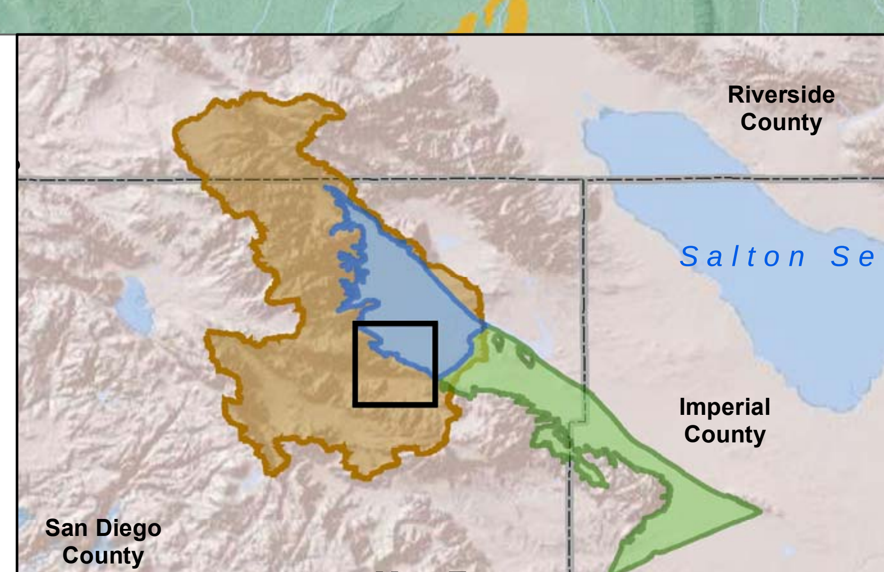
Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



Stream Stats Delineated Watershed (USGS 2018)
Vegetation (NCCAG DWR 2018)
Wetlands (NCCAG DWR 2018)
Vegetation Communities (SANGIS 2018)
Groundwater Sustainability Watershed Contributing Area
California Department of Parks and Recreation (2012)

Borrego Valley Groundwater Basin Subbasins

Borrego Springs Groundwater Subbasin (7-024.01, Plan Area)
Ocotillo Wells Groundwater Subbasin (7-024.02)
National Hydrography Dataset (NHD) Flowlines (USGS 2018)
Spring
Dry Lake



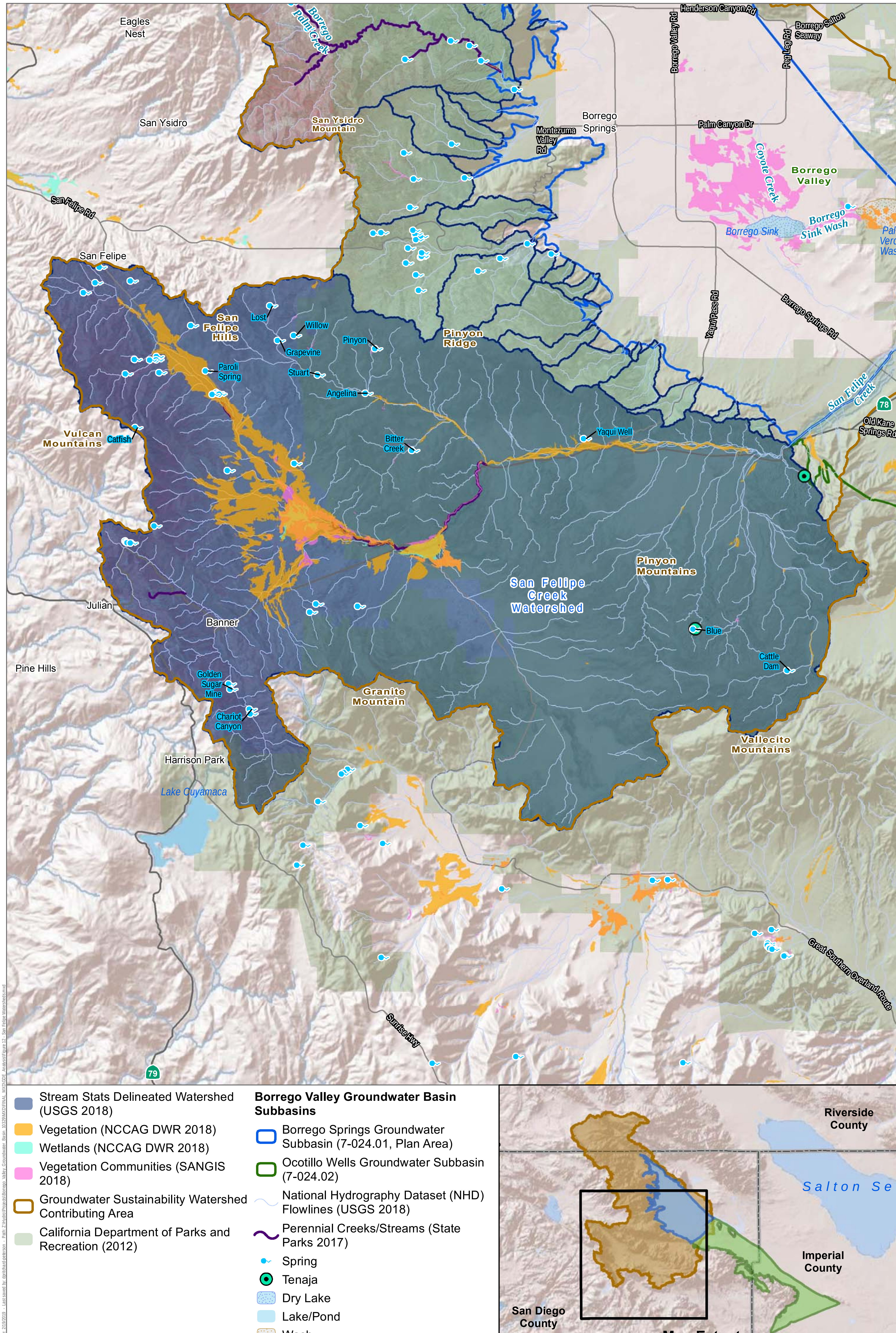
DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

0 0.5 1 Miles

Figure 11
Yaqui Ridge Watersheds



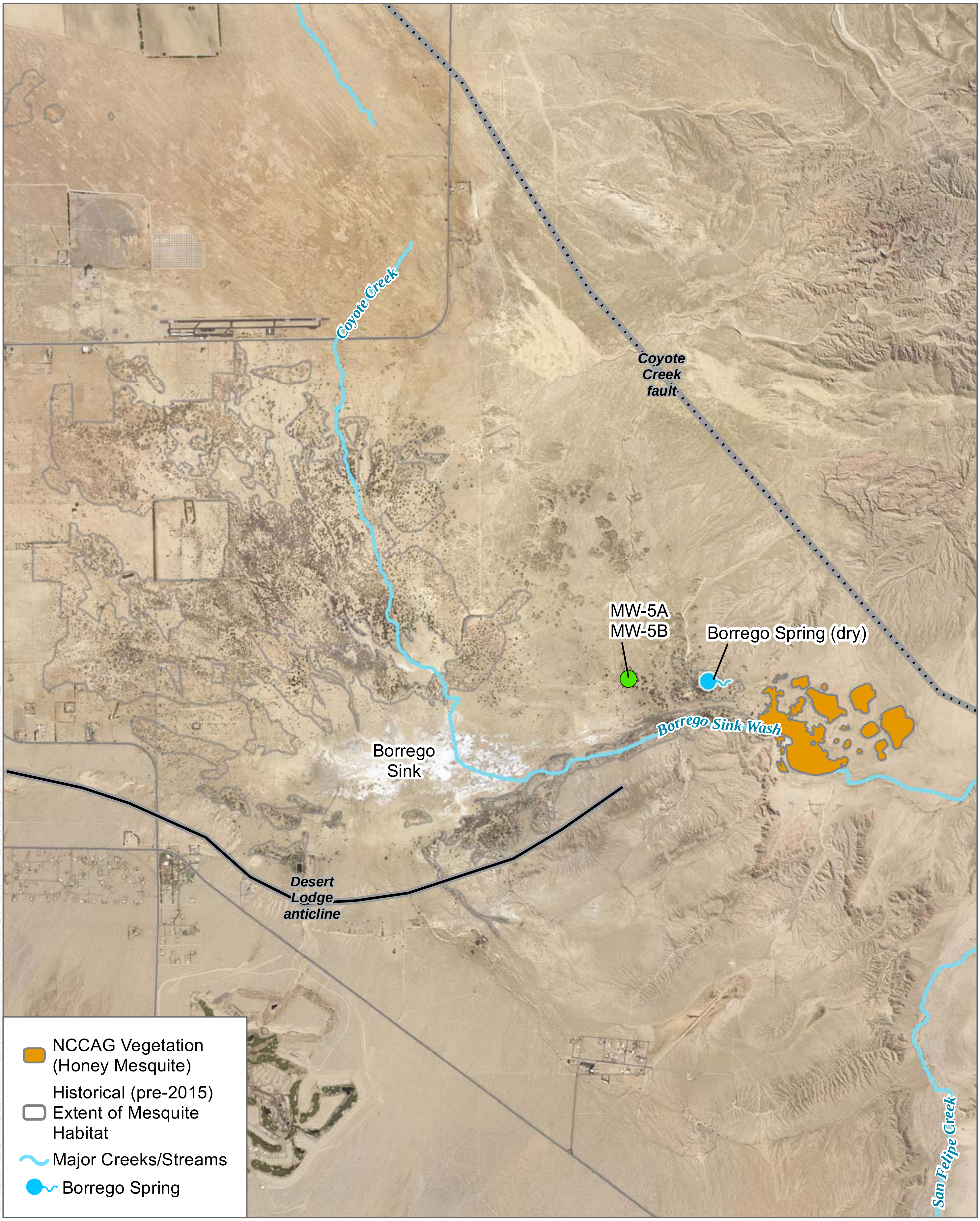
DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: USGS NHD 2018; USGS Stream Stats 2018; California State Parks 2017; USDA 2016; DWR 2018

DUDEK

Figure 12
San Felipe Watersheds

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems

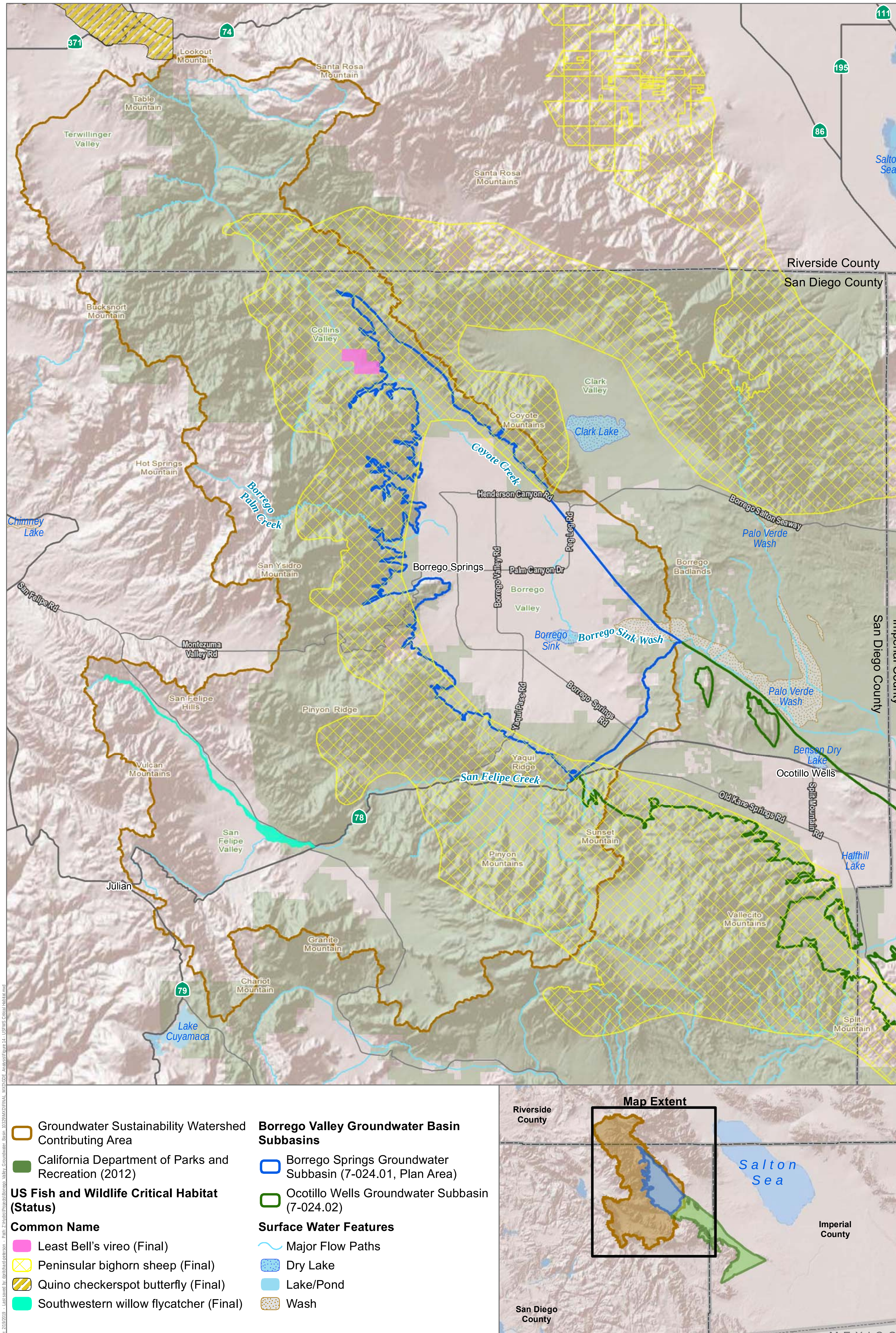


SOURCE: DWR; USGS NHD; SanGIS

DUDEK

Figure 13
Borrego Sink Potential GDEs

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



DRAFT February 2019

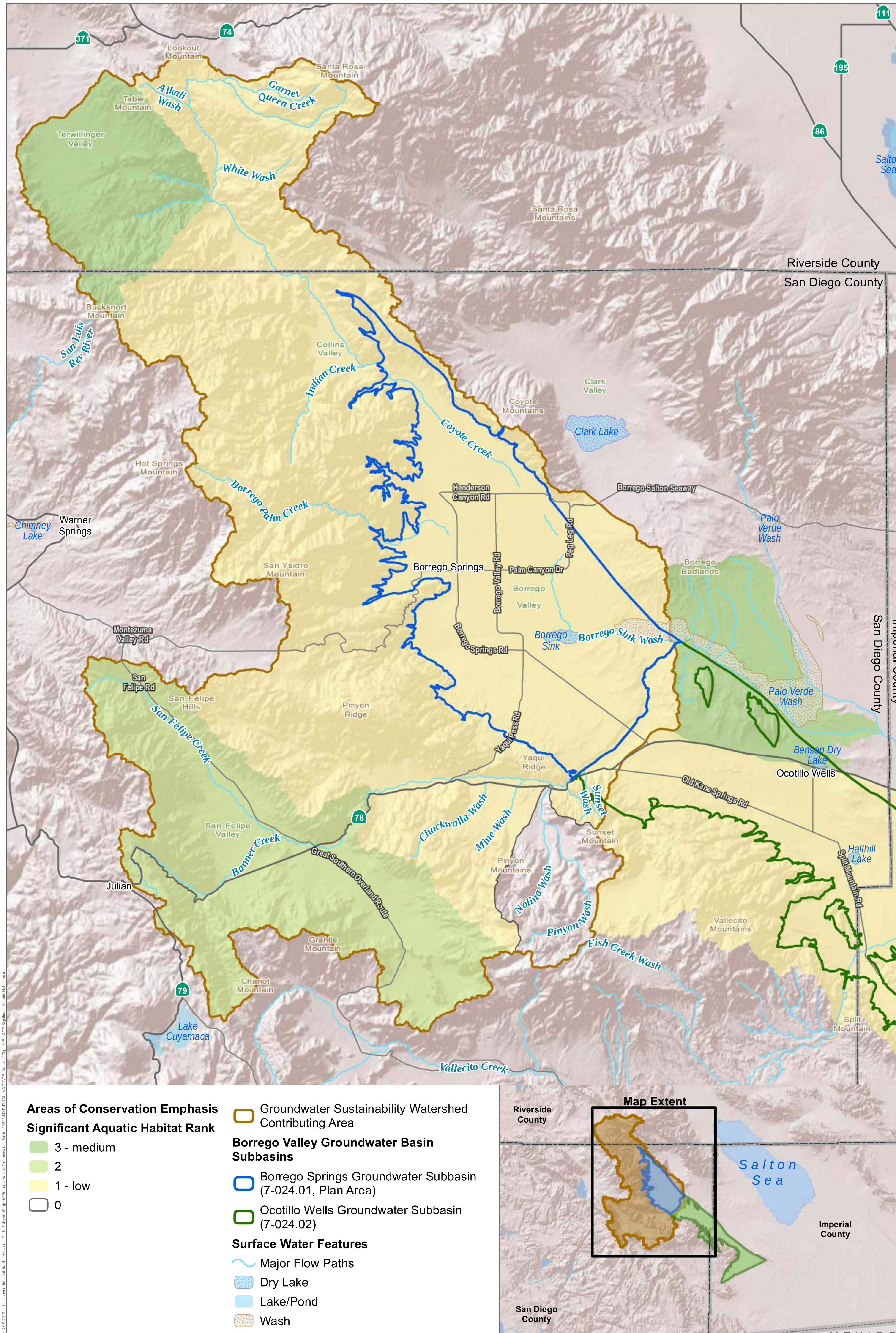
DATUM: NAD 1983. DATA SOURCE: USFWS 2018

DUDEK

0 2 4 Miles

Figure 14
US Fish and Wildlife Critical Habitat

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



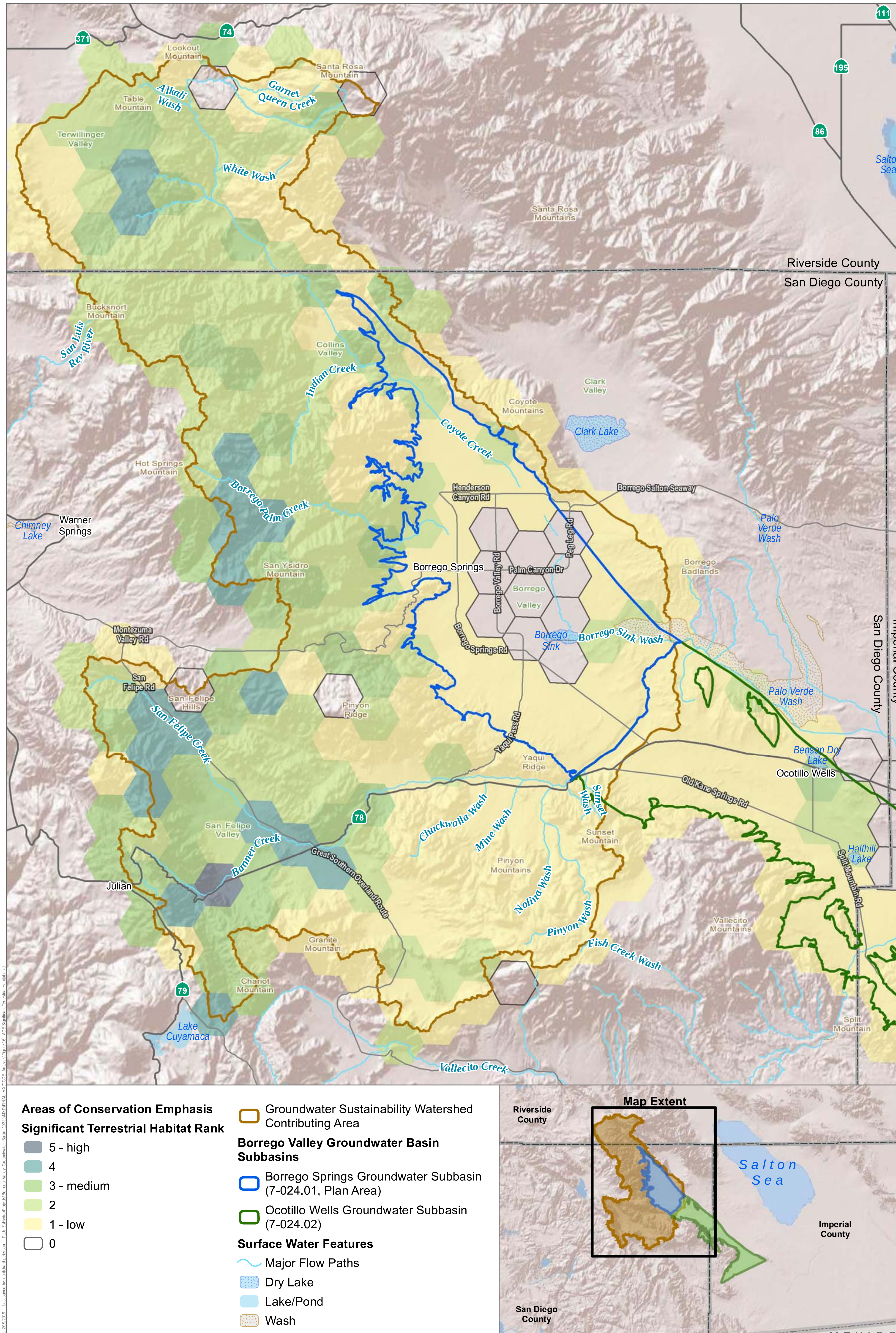
DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: CDFW 2018

DUDEK

0 1.5 3 Miles

Figure 15
Areas of Conservation Emphasis (ACE) - Significant Aquatic Habitat
Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



DRAFT February 2019

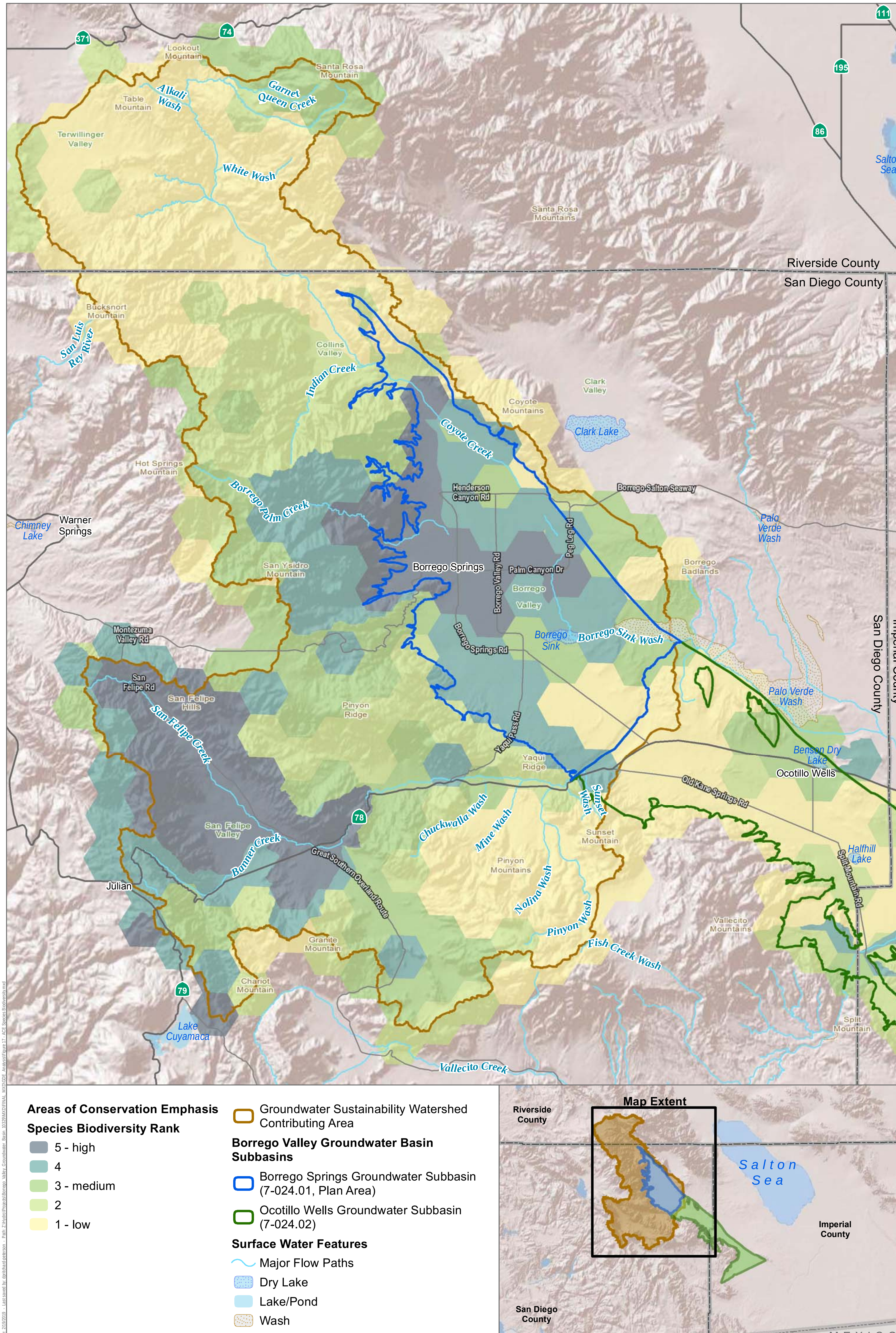
DATUM: NAD 1983. DATA SOURCE: CDFW 2018

DUDEK

0 2 4 Miles

Figure 16
Areas of Conservation Emphasis (ACE) - Significant Terrestrial Habitat

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: CDFW 2018

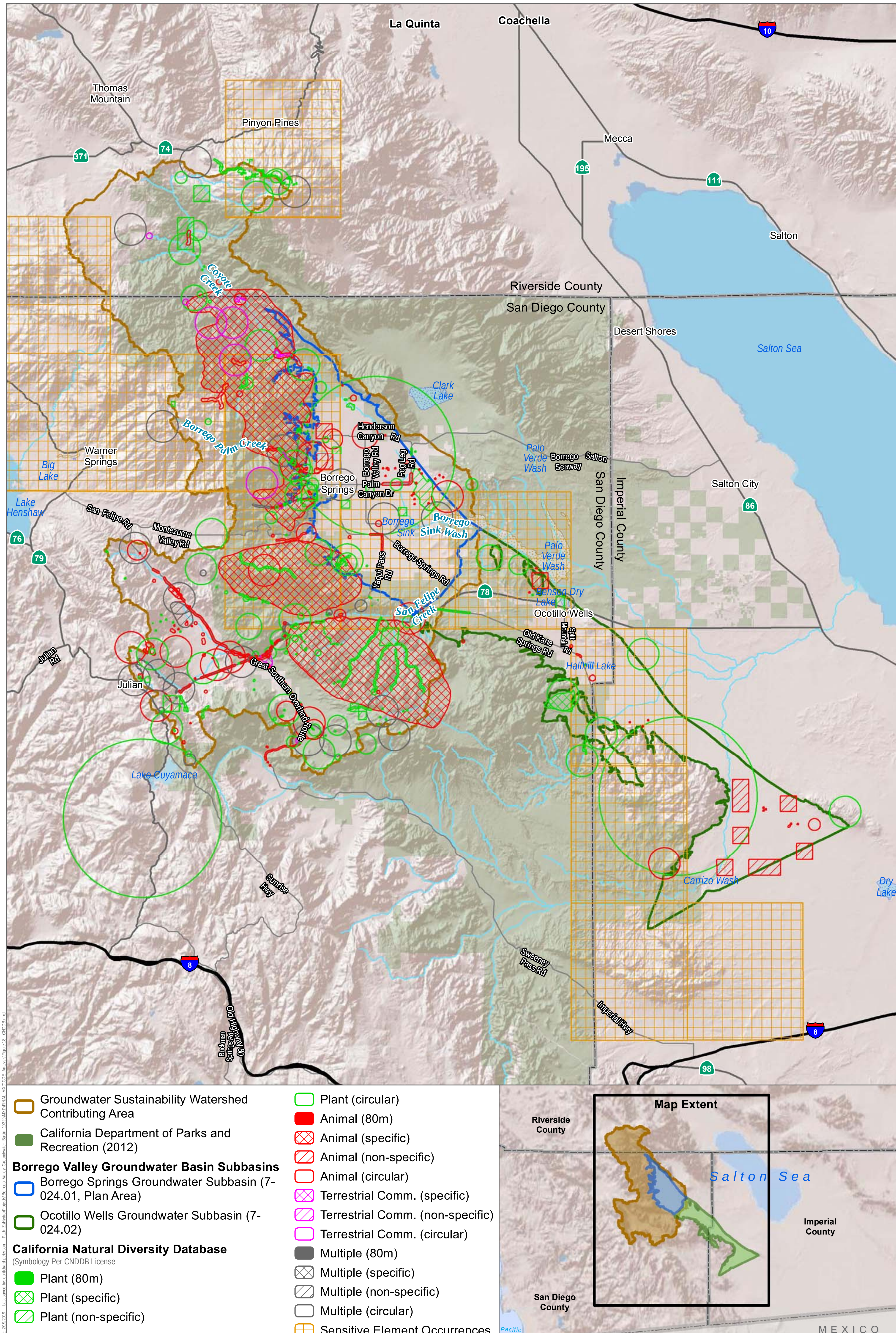
DUDEK

0 2 4 Miles

Figure 17

Areas of Conservation Emphasis (ACE) - Species Biodiversity

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: CDFW 2018

DUDEK

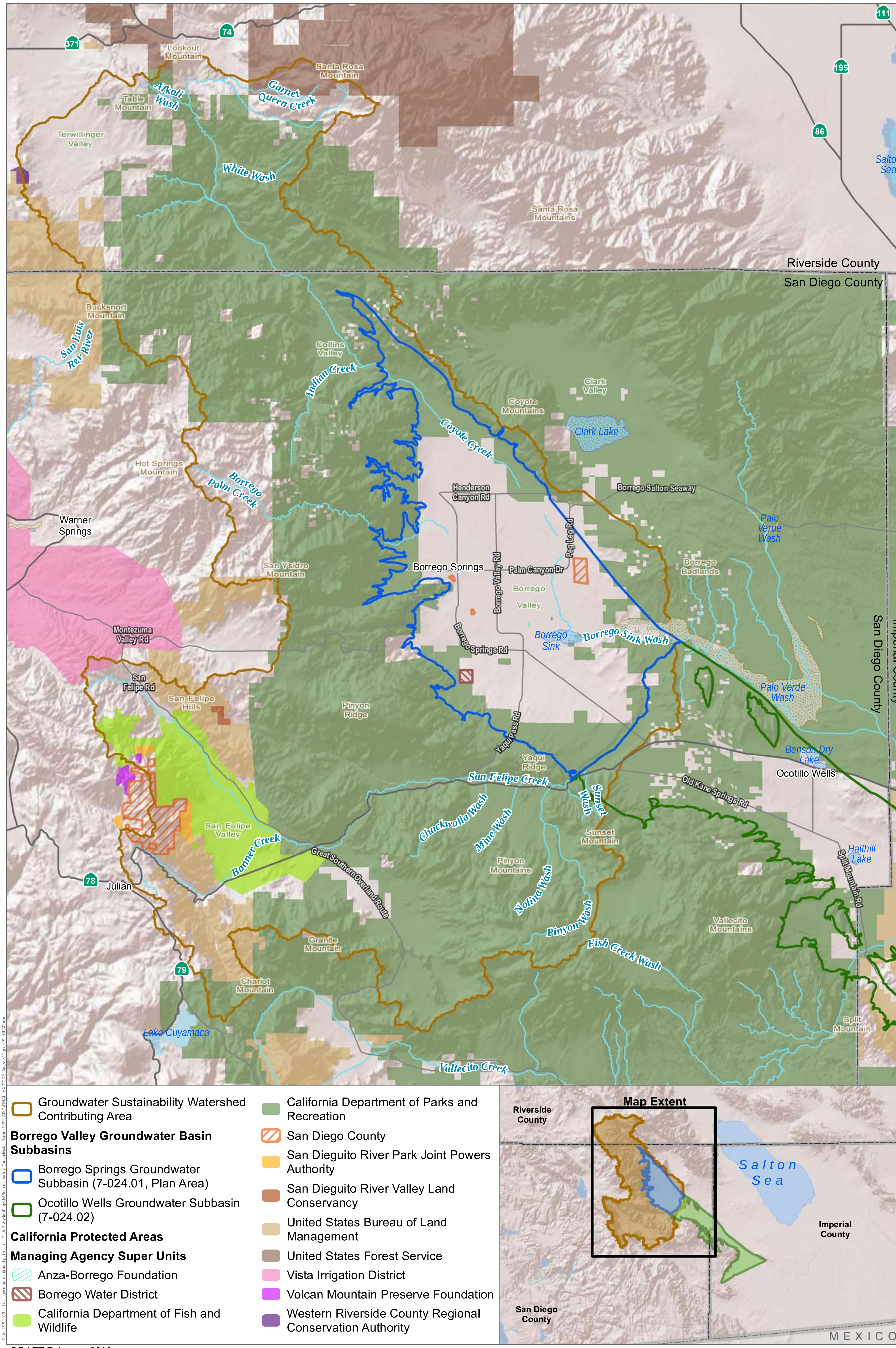
0 2.5 5 Miles

Scale Per CNDDB License Agreement

Figure 18

California Natural Diversity Database (CNDDB)

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



DRAFT February 2019

DATUM: NAD 1983. DATA SOURCE: CPAD 2017a

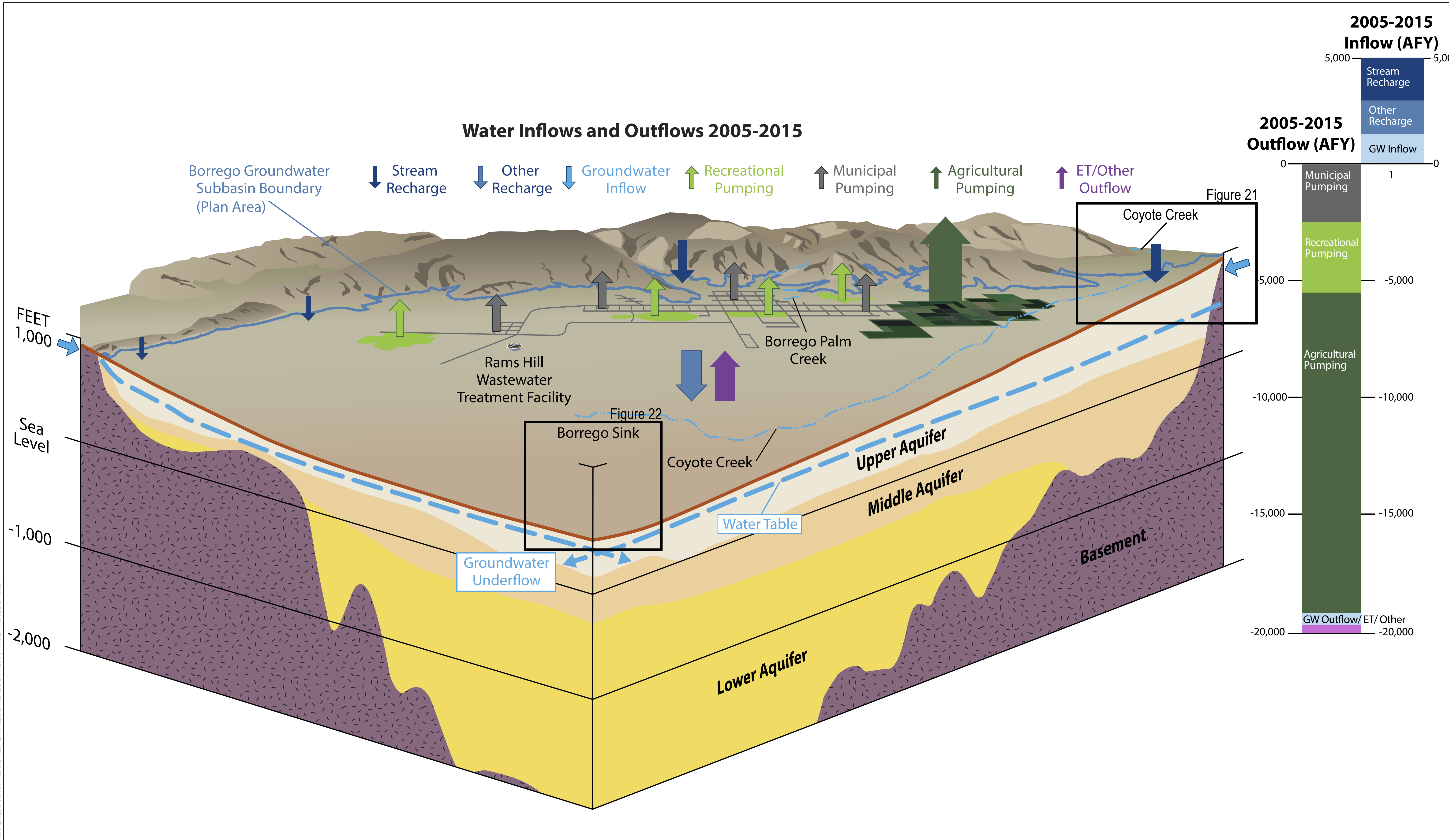
DUDEK

0 2 4 Miles

Figure 19

California Protected Areas Database (CPAD)

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems



SOURCE: USGS 1982 and USGS 2015

DUDEK

FIGURE 20

Borrego Valley Hydrogeologic Conceptual Model

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems

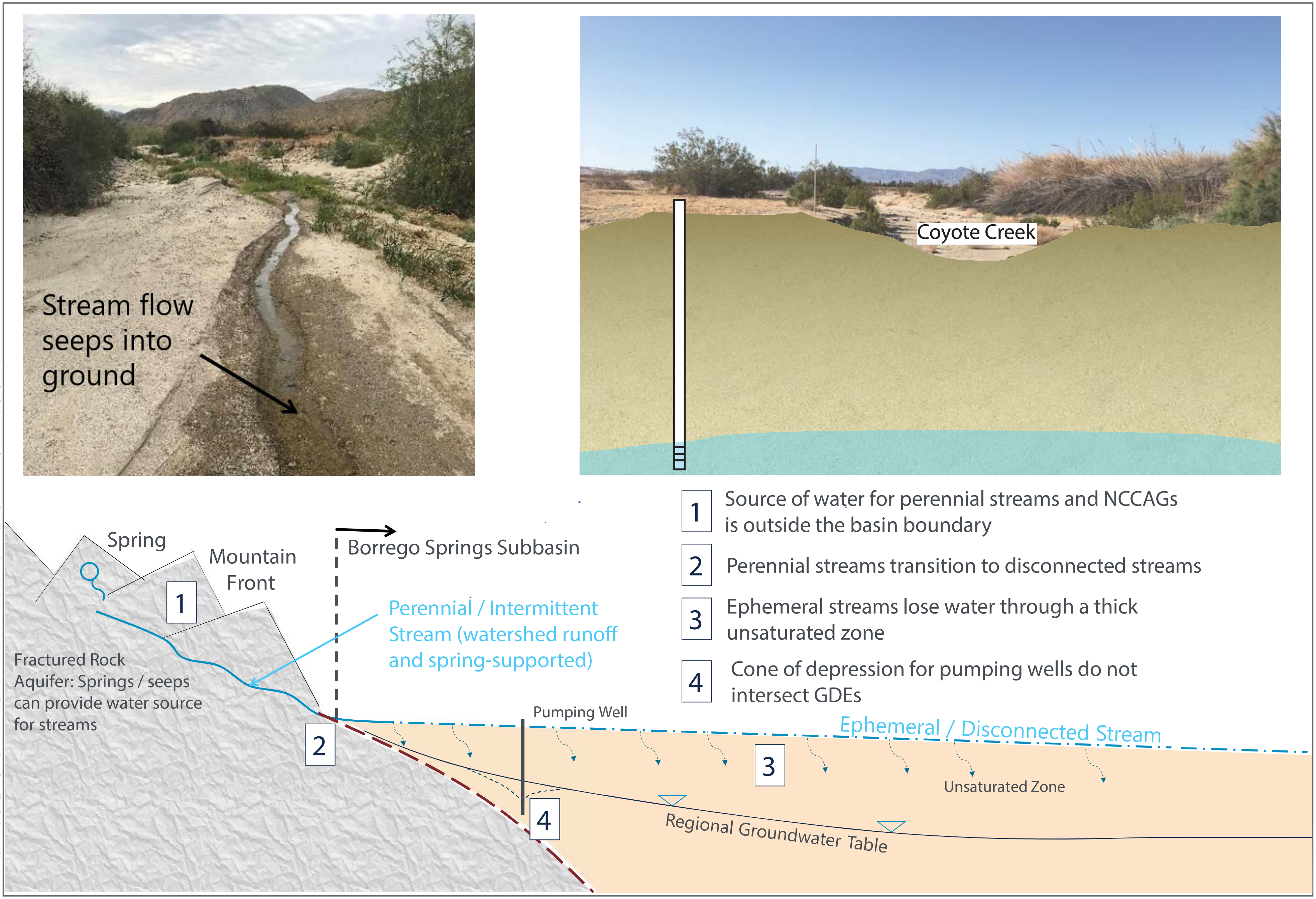


FIGURE 21

Contributing Watersheds Hydrogeologic Conceptual Model

Borrego Springs Subbasin Potential Groundwater Dependent Ecosystems

DUDEK

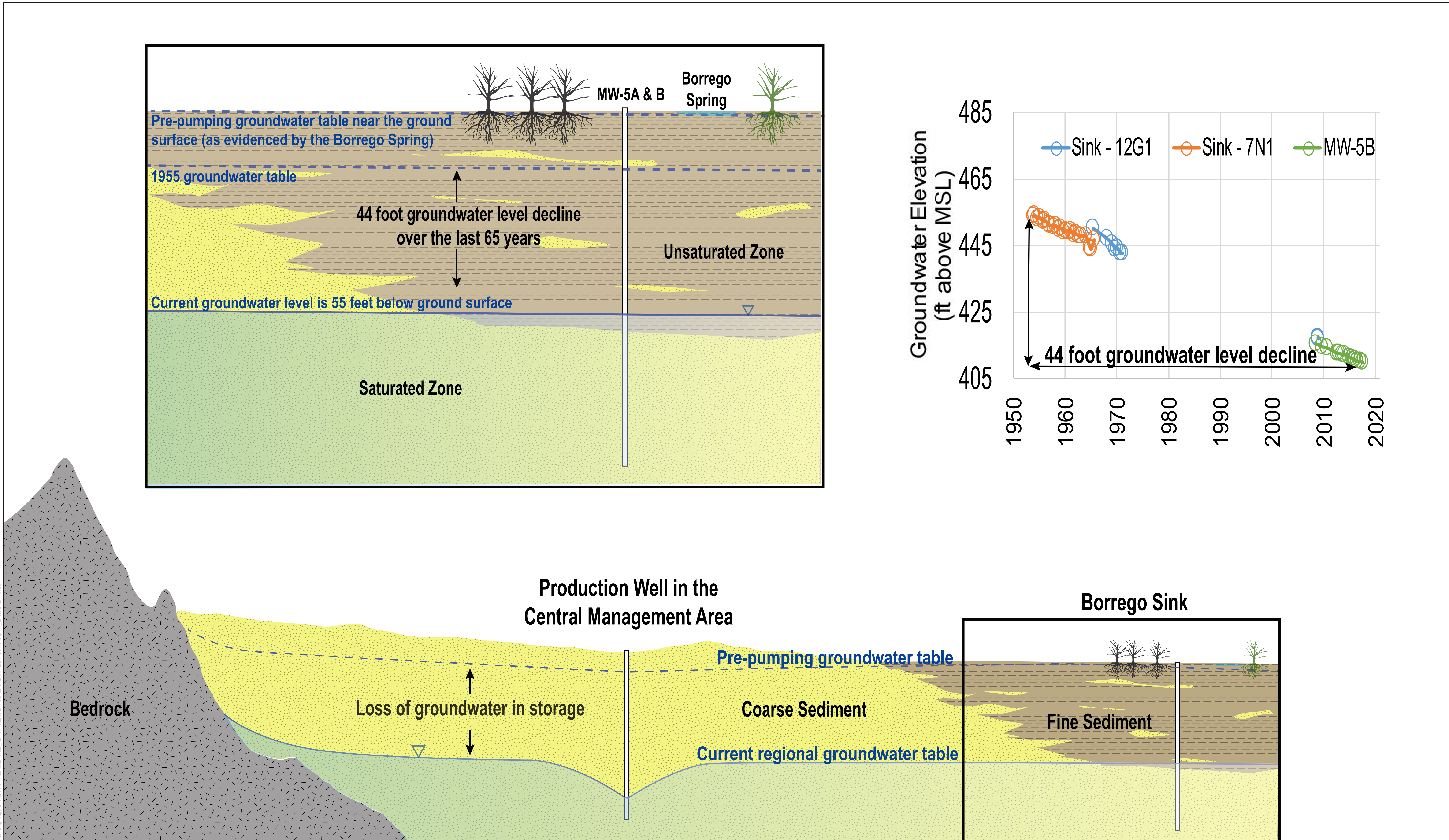


FIGURE 22

Borrego Sink (Mesquite Bosque) Hydrologic Conceptual Model