Appendix A

Topock Compressor Station Groundwater Remediation Project, Havasu National Wildlife Refuge, Habitat Restoration Plan

Revised Final

Topock Compressor Station Groundwater Remediation Project, Havasu National Wildlife Refuge, Habitat Restoration Plan

Prepared for

Pacific Gas and Electric Company

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Prepared by

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Acronyms and Abbreviations

ARAR	Applicable or Relevant and Appropriate Requirement
BLM	Bureau of Land Management
BNSF	Burlington Northern Santa Fe
Caltrans	California Department of Transportation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CIP	clean-in-place
compressor station	Topock Compressor Station
C/RAWP	Construction/Remedial Action Work Plan
DOI	Department of the Interior
DTSC	Department of Toxic Substances Control
ER	East Ravine
GIS	geographical information system
GPS	global positioning system
HNWR	Havasu National Wildlife Refuge
I-40	Interstate 40
IRL	inner recirculation loop
IRZ	in situ reactive zone
ISA	International Society of Arboriculture
O&M	operation and maintenance
PBA	Programmatic Biological Assessment
PG&E	Pacific Gas and Electric Company
PPD	preconstruction photo documentation
project	implementation of the groundwater remedy
RB	riverbank
ROD	Record of Decision
RPD	revegetation photo documentation
SWPPP	stormwater pollution prevention plan
TCS	Topock Compressor Station
TWB	Transwestern Bench
U.S.	United States
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USFWS	United States Fish and Wildlife Service

SECTION 1

Introduction

In December 1951, Pacific Gas and Electric Company (PG&E) began operations near Topock, Arizona, to compress natural gas supplied from the southwestern United States (U.S.) for transport through pipelines to PG&E's service territory in central and northern California. The Topock Compressor Station (TCS or compressor station) is approximately 15 miles southeast of Needles in San Bernardino County, California (Figure 1). The station is still active and is anticipated to remain active into the foreseeable future. Operations at the compressor station consist of six major activities: water conditioning, compressing natural gas, cooling compressed natural gas and compressor lubricating oil, wastewater treatment, facility and equipment maintenance, and miscellaneous operations.

Historical wastewater discharge from TCS operations to Bat Cave Wash and the East Ravine have resulted in chromium contamination in groundwater. In 1996, PG&E entered into a Corrective Action Consent Agreement with the California Department of Toxic Substances Control (DTSC) to oversee the investigation and remediation of the TCS site under California state law. DTSC is the California state lead agency charged with directing investigative activities in the action area in accordance with the Resource Conservation and Recovery Act. The U.S. Department of the Interior (DOI) is the lead federal agency overseeing response actions for land under its jurisdiction, custody, or control near the TCS pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

In July 2005, PG&E and the federal agencies (DOI, Bureau of Land Management [BLM], Bureau of Reclamation [USBR], and U.S. Fish and Wildlife Service [USFWS]) entered into an Administrative Consent Agreement. In addition, PG&E and the United States have entered into a Remedial Design/Remedial Action Consent Decree under CERCLA governing the groundwater remedy, which was entered by the U.S. District Court for the Central District of California in November 2013.

In January 2011, the DOI issued a Record of Decision (ROD) selecting the groundwater remedy for the site, and at the same time, DTSC adopted the Final Remedy for groundwater contamination at the site. The 2013 Consent Decree requires the planning, design, construction, operation and maintenance (O&M), post-remediation monitoring, decommissioning, and restoration of the groundwater remedy selected in the ROD.

Implementation of the groundwater remedy (the project) consists of several phases, including construction, O&M, post-remediation monitoring, decommissioning, and restoration. Activities associated with the project are described in Section 2.

Figures 2A through 2C show the planned final groundwater remedy system layout in California, Moabi Regional Park, and Arizona, respectively. The project is expected to operate for several decades (estimated duration between 30 and 50 years). Generally, the Final Groundwater Remedy will include the following key features:

- An in situ reactive zone (IRZ) along the National Trails Highway that will use a line of wells that may be used as both injection and extraction wells to circulate groundwater and distribute an organic carbon source that will promote reduction of the hexavalent chromium to trivalent chromium.
- An inner recirculation loop (IRL) that comprises:
  - Extraction wells near the Colorado River (referred to as the riverbank [RB] extraction wells) to provide hydraulic capture of the deep hexavalent chromium groundwater concentrations, accelerate cleanup of the floodplain, enhance the flow of contaminated groundwater through the IRZ line, and control migration of IRZ-generated byproducts toward the Colorado River.

  - Injection wells to re-inject groundwater extracted from the RB extraction wells, which may be amended with an organic carbon source, in the upgradient portion of the hexavalent chromium plume to flush the plume through the IRZ.

- A TCS recirculation loop, which includes:
  - East Ravine (ER) extraction wells near the eastern end of the East Ravine to capture contaminated groundwater in the shallow bedrock.
  - Transwestern Bench (TWB) extraction wells near the eastern portion of the TCS parcel to capture contaminated groundwater downgradient of the compressor station.
  - TCS injection wells located within the compressor station for the re-injection of groundwater extracted from the ER and TWB extraction wells. The extracted water will be amended with an organic carbon source to promote reduction of hexavalent chromium to trivalent chromium and reduce elevated hexavalent chromium groundwater concentrations from the alluvial aquifer in the vicinity of the compressor station.
- The freshwater supply system will convey water from supply well(s) in Arizona to assist with flushing the chromium plume through the National Trails Highway IRZ and constrain the westward spread of carbon-amended water and in situ byproducts from the IRL.

The purpose of this HNWR Habitat Restoration Plan is to describe the overall program approach for restoration for the duration of the project beginning with the completion of the remedy construction and extending through the operation phase of the remedy system up to the decommissioning and removal phases. Specifics related to the actual impacts are presented in this document, as available. However, some specifics related to mitigation plantings and precisely how the plantings will take place within a restoration area (e.g., number of species, plant size and container type, locations, and irrigation system design) will be provided to the agencies for review in a separate Planting Plan prior to implementation. Furthermore, a separate Final Restoration Plan will be prepared to address restoration and planting after the final groundwater remedy system has been decommissioned and removed.

1.1 Groundwater Remedy In Relation to the Havasu National Wildlife Refuge

The Havasu National Wildlife Refuge (HNWR), managed by USFWS, includes 37,515 acres and stretches for approximately 26 miles along the Colorado River, extending from Needles, California, to Lake Havasu City, Arizona. Portions of the project will be located on HNWR lands in California on the southern side of the Burlington Northern Santa Fe (BNSF) Railroad and in Arizona along the Oatman-Topock Highway (Figures 2A through 2C).

1.2 Regulations and Project Requirements

This document has been prepared to comply with the requirement in Paragraph 13(b) of the Consent Decree, that the Construction/Remedial Action Work Plan (C/RAWP) shall include a Habitat Restoration Plan. Appendix C to the Consent Decree, *Scope of Work*, further describes the Habitat Restoration Plan at Section 3.6, stating: “If during the design, complete avoidance of sensitive habitats under the jurisdiction of the United States Fish and Wildlife Service (“FWS”), United States Army Corps of Engineers (“USACE”), or the California Department of Fish and Game [now Department of Fish and Wildlife] cannot be achieved, PG&E will be responsible for preparing a Habitat Restoration Plan that includes measures for restoration, rehabilitation, and/or replacement of the habitats. The Plan will be developed in coordination with the FWS Havasu National Wildlife Refuge Manager.”

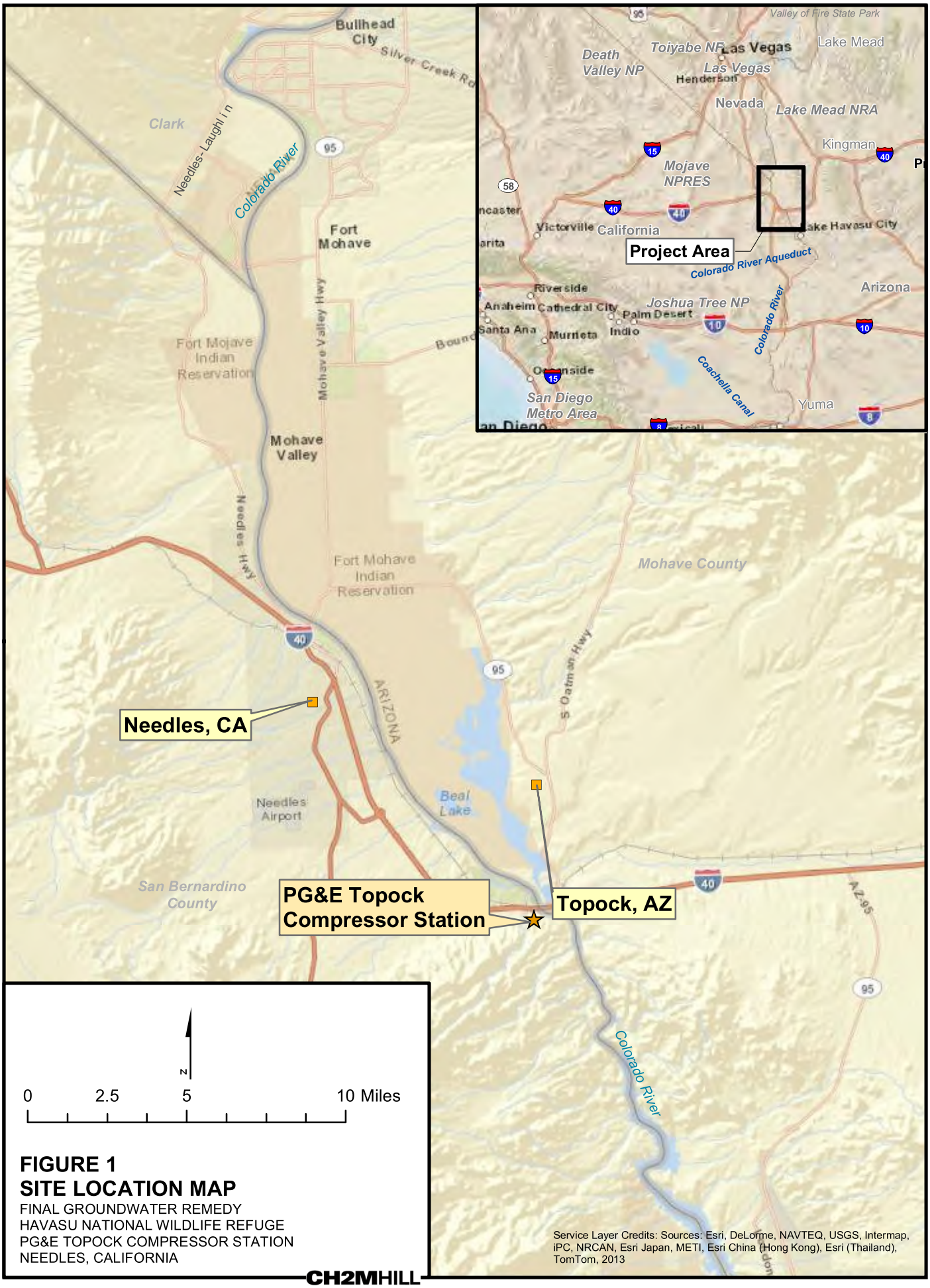


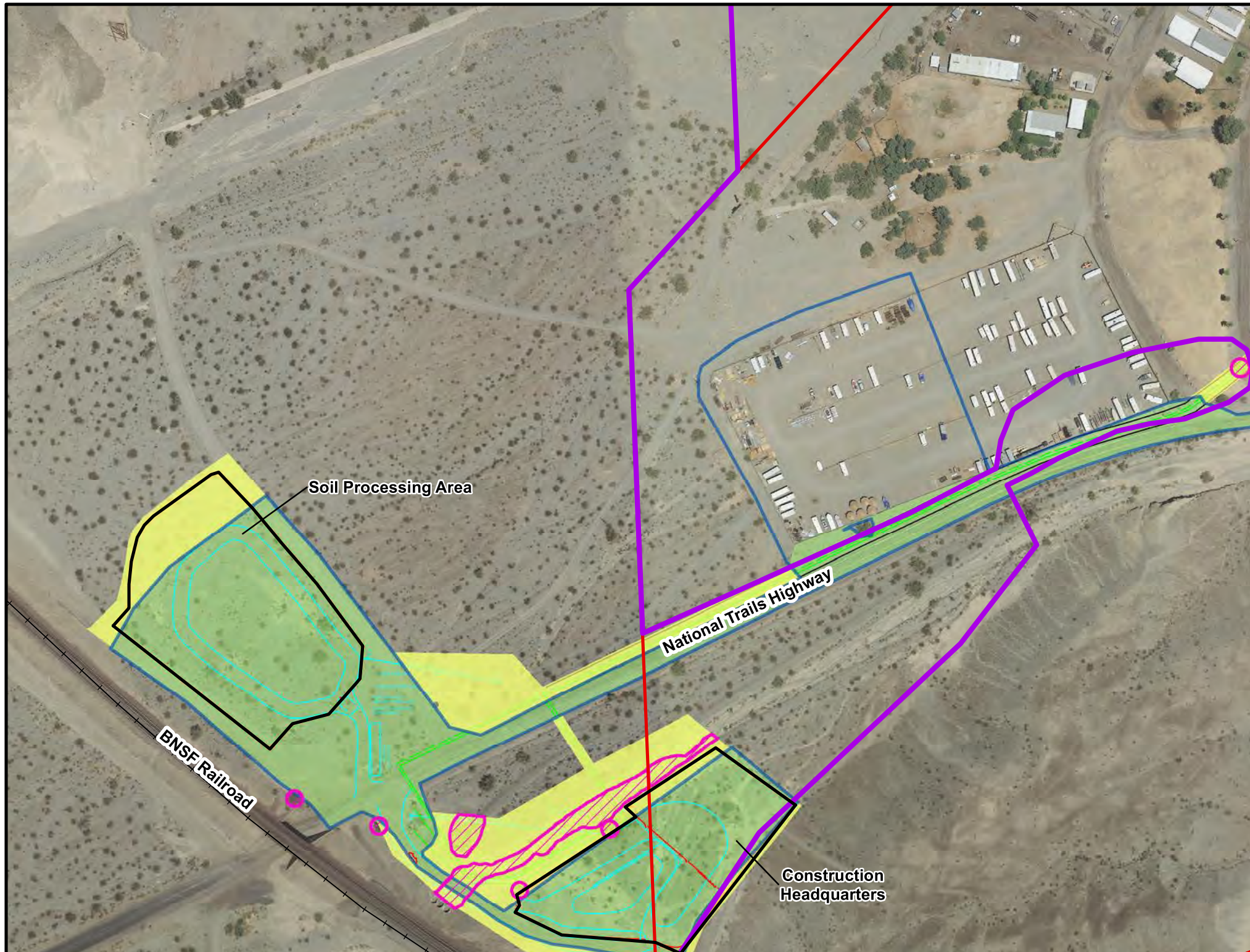
FIGURE 1
SITE LOCATION MAP
FINAL GROUNDWATER REMEDY
HAVASU NATIONAL WILDLIFE REFUGE
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

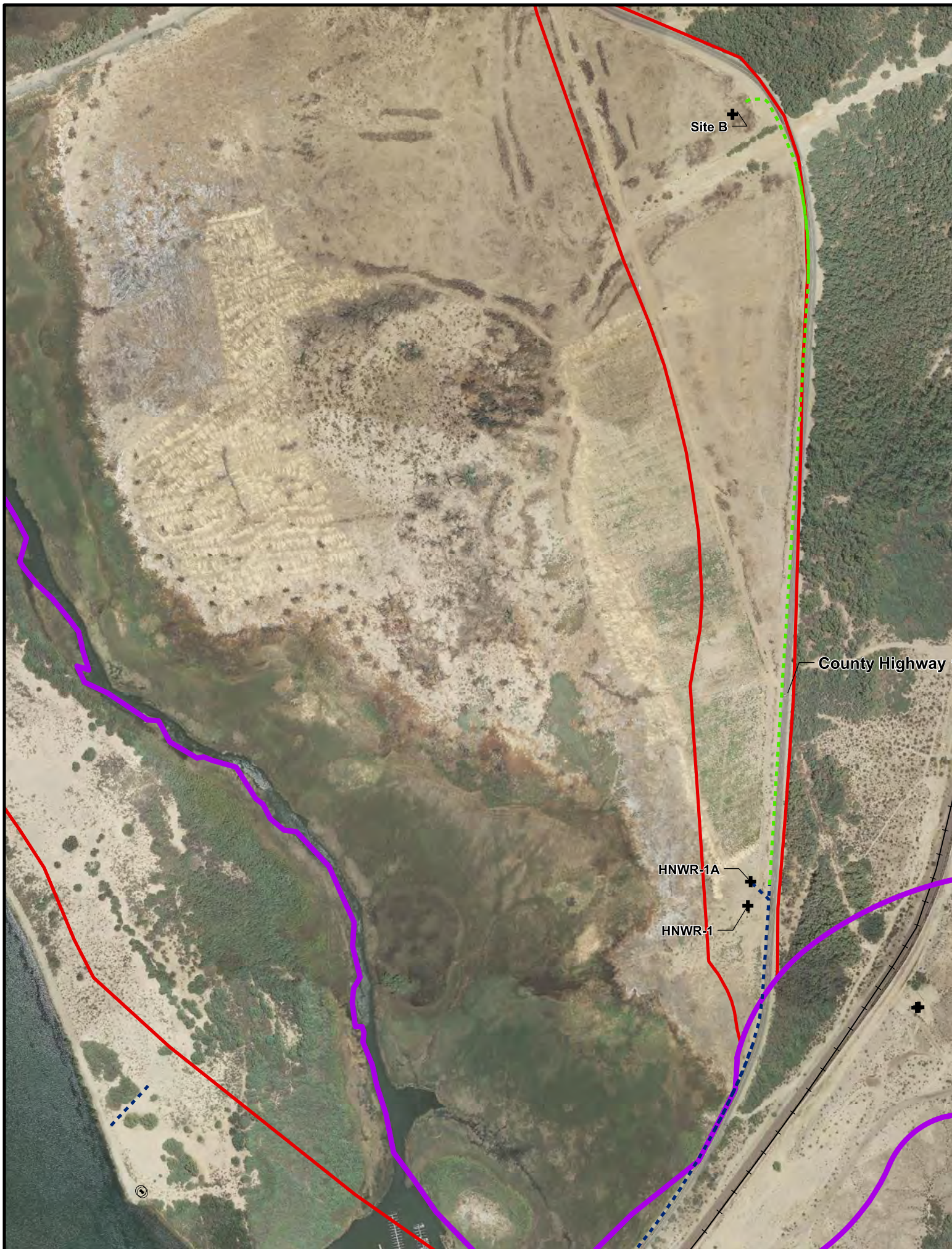
Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013

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Path: \\Zinfandel\proj\PacificGasElectricCo\TopockProgram\GIS\MapFiles\2014\HNWR\FIG1_SiteLocationHNWR.mxd Date Saved: 5/7/2014 8:43:36 AM


COLORADO RIVER
National Trails Highway
Northern Aerial Crossing
BNSF Railroad
40
IRZ-1
IRZ-02
IRZ-03
MW-A
RB-1
IRZ-04
IRZ-5
IRZ-06
MW-B
IRZ-07
IRZ-9
IRZ-08
IRZ-10
RB-2
IRZ-11
IRZ-13
MW-O
IRZ-12
MW-C
IRZ-14
IRZ-15
RB-3
IRZ-16
MW-H
IRZ-17
MW-D
IRZ-18
IRZ-19
RB-4
IRZ-20
IRZ-21
IRZ-22
IRZ-23
IRZ-24
IRZ-25
RB-5
IRZ-26
MW-E
IRZ-27
IRZ-28
IRZ-29
IRZ-30
MW-F
IRZ-31
IRZ-32
MW-W
IRZ-33
IRZ-35
IRZ-34
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MW-G
IRZ-37
IRZ-38
IRZ-40
IRZ-39
TCS-1
TWB-3
MW-K
ER-1
TWB-1
TWB-2
ER-2
TWB-4
ER-3
TCS-2
MW-10D
MW-11D
MW-I
MW-AA
MW-P
IRL-1
MW-BB
IRL-2
FW-1
MW-DD
IRL-3
MW-EE
MW-L
MW-J
MW-GG
MW-Q
MW-FF
MW-R
IRL-4
MW-M
MW-N
IRZ-23
IRZ-24
Operations Building
Carbon Amen
Storage Ta
(3,000 gall
Hazardous Mater
Storage Building


Soil Processing Area
National Trails Highway
BNSF Railroad
Construction
Headquarters


Site B
County Highway
HNWR-1A
HNWR-1

Additionally, the National Wildlife Refuge System Administration Act of 1966, as amended, is an Applicable or Relevant and Appropriate Requirement (ARAR) that was identified in the ROD. This previous act is amended by the National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57), which is also considered as an ARAR. The ROD states that the Act "requires that FWS evaluate ongoing and proposed activities and uses to ensure that such activities are appropriate and compatible with both the mission of the overall National Wildlife Refuge System, as well as the specific purposes for which the Havasu National Wildlife Refuge was established" and that "[p]rior to selection of a remedial action by DOI/FWS, that remedial action must be found by the Refuge Manager to be both an appropriate use of the Refuge and compatible with the mission of the Refuge and the Refuge System as a whole."

The ROD also states that "[a]s the Selected Remedy is designed and implemented, DOI will continue to consult with USFWS to ensure that proposed activities remain appropriate and compatible with the Refuge mission…" This document will provide information to the Refuge Manager for their analysis under the National Wildlife Refuge System Improvement Act, Additional relevant information was provided to the Refuge Manager in Attachment B to RTC# 2 to the 60% Basis of Design Report. This information was updated and included in Table 6.2-1A of the Final Basis of Design Report.

This plan also fulfills the requirements of Mitigation Measure BIO-1 in the TCS Final Remedy Environmental Impact Report for areas within the HNWR. Mitigation Measure BIO-1 requires PG&E to prepare a habitat restoration plan for areas that would be subject to jurisdiction by USACE or the California Department of Fish and Wildlife ("sensitive habitat areas") absent an exemption and that will be disturbed by final remedy activities. As required by Mitigation Measure BIO-1, this restoration plan includes measures to achieve "no-net-loss" of habitat functions and values existing before remedy implementation. This document also includes an assessment of the anticipated project impacts and the techniques that will be used to mitigate potential loss of functional values for refuge habitat while the Final Groundwater Remedy is in operation.

1.3 Refuge Goals and Objectives

The Mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. The 1997 National Wildlife Improvement Act established general policies and goals for the Refuge System that includes the following:

- Conserve a diversity of fish, wildlife and plants
- Develop and maintain a network of habitats
- Conserve those ecosystems, plant communities, wetlands that are unique within the United States
- Provide and enhance opportunities to participate in compatible wildlife dependent recreation
- Help to foster the public's understanding and appreciation of the diversity of fish, wildlife, and plants and their habitats

The policy also established three management priorities:

- Conserve fish, wildlife, and plants and their habitats
- Facilitate compatible wildlife dependent recreational uses
- Consider other appropriate and compatible uses

The 1997 National Wildlife Improvement Act specifically identifies appropriate wildlife dependent activities as hunting, fishing, wildlife observation and photography, environmental education, and interpretation.

1.3.1 Havasu National Wildlife Refuge

The HNWR was established by Executive Order by President Franklin D. Roosevelt in 1941 for the primary purpose of providing breeding habitat for migratory birds and other wildlife. The 37,515-acre refuge consists of two management units. The Topock Marsh Management Unit includes all of the refuge lands, water, and

wildlife resources from the northern border of the refuge south to the southern end of the Topock Marsh and the Interstate 40 (I-40) bridge over the Colorado River. The Topock Gorge Management Unit includes all of the lands, waters, and wildlife resource located south of the I-40 bridge to the southern boundary of the refuge at Lake Havasu City in Arizona.

Management of the refuge is focused on three primary subunits: Topock Marsh, Topock Gorge, and the Havasu Wilderness Area. Primary management concerns include federal and state–listed threatened and endangered species including the Yuma clapper rail (*Rallus longirostris yumanensis*), California black rail (*Laterallus jamaicensis coturniculus*), southwestern willow flycatcher (*Empidonax traillii extimus*), Arizona Bell's vireo (*Vireo bellii arizonae*), razorback sucker (*Xyrauchen texanus*), and bonytail chub (*Gila elegans*). Additionally, waterfowl, wading birds, shorebirds, and other migratory birds are another major management focus of the refuge. While not actively managed, the desert uplands provide habitat for a number of species of raptors and other birds, as well as mammals, reptiles, and other fauna and flora.

The HNWR has no visitor center and no wildlife trails; however, wildlife tours are led by private contractors in some areas of the refuge under a special use permit. Refuge staff provide presentations, talks, and tours to groups upon request. Hunting includes open hunting on the Topock Marsh and limited reservation hunting in the Pintail Slough Management subunit. Upland game hunting for quail, dove, and rabbit is permitted on refuge lands. Fishing for catfish, largemouth bass, and crappie is one of the most popular uses of the refuge, particularly in the Topock Marsh and the Colorado River. Other non-wildlife oriented recreation such as boating, jet skiing, waterskiing, and swimming are popular during the summer months on the Colorado River.

Camping is not permitted on the HNWR; it was formerly allowed at the Five Mile Landing Concession, but no longer is. However, off-road vehicles are still permitted. Illegal trespass by off-road vehicles is a considerable problem on the refuge particularly in the desert upland habitats where damage to fences, gates, soils, and vegetation as well as vandalism and trash dumping continue to be problems.

1.4 Description of Existing Conditions in the Project Area

The following sections provide general descriptions of the habitats and vegetation within HNWR in the areas where remedial activities will occur.

1.4.1 Colorado River

The Colorado River is the primary surface water feature in the area. Upstream of the I-40 bridge, the river channel ranges from approximately 600 to 740 feet wide. Downstream of the bridge, the river traverses the exposed bedrock of the Chemehuevi Mountains, and the channel width narrows to approximately 435 feet.

Significant changes to the Colorado River hydraulic regime occurred after construction of Hoover Dam and Parker Dam. With the completion of Hoover Dam in 1936, annual spring floods and associated scouring events ended. With the completion of Parker Dam in 1938, and subsequent filling of Lake Havasu, the Colorado River channel between Needles and Topock rapidly aggraded (Metzger and Loeltz, 1973). By 1944, the aggradation of the river channel caused elevated groundwater levels and flooding in low-lying areas. In response to this condition, USBR conducted extensive dredging of the river channel to maintain channel geometry and reduce flooding.

The water elevations in the Colorado River fluctuate seasonally and daily due to upstream flow regulation from the Davis Dam, located approximately 41 river miles upstream of the I-40 bridge. Data from the U.S. Geological Survey river gauge at the Topock Marsh inlet shows that average flows in this section of the river ranges from a low of 14 cubic feet per second (cfs) in January to a high of 99 cfs in June.

The channel banks along the Arizona side of the river north of the Topock Marina are characterized by steep slopes that have been armored along much of this reach with large boulders. The banks along the inlet to the Topock Marina are characterized by narrow sandy beaches and eroded sandy banks. Low sandy beaches also are present along the Arizona side of the river south of the Topock Marina and the BNSF Railroad

Bridge. Steep sandy banks with dense vegetation are present along most of the channel on the California side of the river, with narrow sandy beaches occurring in scattered locations. Along the California side of the channel north of the Park Moabi inlet/slough (outside the project area), the banks have been modified by constructed elevated campgrounds and low sandy beaches. Patches of emergent vegetation including southern cattail (*Typha domingensis*), southern bulrush (*Schoenoplectus californicus*), common reed (*Phragmites australis*), and giant reed (*Arundo donax*) occur in scattered locations along edges of the river.

1.4.2 Sacramento Wash

The Sacramento Wash is near the northern end of the project area east and northeast of the Topock Marsh. The Oatman-Topock Highway bisects the wash with an at-grade crossing. Within the project area, the Sacramento Wash is a broad, open sandy channel that is largely confined within constructed levees. The channel ranges from approximately 50 to 70 feet wide and has a flat, generally uniform bed that lacks well-defined low flow channels. Minor benches and terraces are along the channel in a few locations, but there is no active floodplain outside the channel because of the constructed levees along this section of the wash. On the eastern side of the highway, the main flow channel is nearly devoid of vegetation; however, the adjacent sides of the wash are covered with extensive athel tamarisk (*Tamarix aphylla*) thickets.

On the western side of the highway, the wash continues to flow through a channel confined by levees for approximately 950 feet where it then broadens out along the floodplain adjacent to the Topock Marsh west of the project area. Some blue palo verde (*Parkinsonia florida*) trees are present along the levees on the western side of the road, and a few small trees and shrubs including salt cedar (*Tamarix ramosissima*), smoke tree (*Psorothamnus spinosus*), bush seepweed (*Suaeda nigra*), and creosote bush (*Larrea tridentata*) occur within the wash channel.

Before a large wildfire in October 2008, dense salt cedar and athel tamarisk (*Tamarix aphylla*) thickets also were present along both sides of the wash in this area. The Sacramento Wash has a large and generally unaltered watershed, and as a result, significant flows, sediment transport, and flooding of the highway area are relatively common in this area when heavy rainstorms occur in the region.

1.4.3 Ephemeral Drainages and Washes

The alluvial terraces located along the southern and western sides of the Colorado River and north of the Chemehuevi Mountains are characterized by numerous incised drainage channels and ephemeral washes. One of the largest ephemeral drainages in the project area is Bat Cave Wash, a north-south trending channel immediately west of TCS that flows into the Colorado River. Large volume surface flows are generally infrequent and occur only briefly in response to high intensity rainfall events. Within the project area, the upper part of Bat Cave Wash is confined by steep rocky slopes and has an approximately 30-foot-wide gravel-cobble floodplain.

Vegetation in the upper reaches is sparse, consisting of scattered shrubs such as Anderson's box-thorn (*Lycium andersonii*), catclaw acacia (*Senegalia greggii*), and desert lavender (*Hyptis emoryi*). As the wash continues downslope, the channel broadens to more than 190 feet wide in some areas and multiple low flow channels are present. Vegetation cover also increases downslope with blue palo verde and salt cedar trees scattered throughout the channel. Other common shrubs on or immediately adjacent to the channel include brittlebush (*Encelia farinosa*), creosote bush (*Larrea tridentata*), white bur-sage (*Ambrosia dumosa*), sweetbush (*Bebbia juncea*), and white rhatany (*Krameria bicolor*). Total vegetative cover throughout most of the wash is less than 30 percent, with the exception of a dense stand of salt cedar present at the northern end of the wash, just southwest of the Bat Cave Wash viaduct that crosses under National Trails Highway.

Several small, incised tributary drainages also are present within the project area. These drainages are characterized by a single low-flow channel and generally have sandy-gravel, cobble, or rocky substrates. The low-flow channels are devoid of vegetation or have only sparse scattered herbaceous species such as spurge (*Chamaesyce* spp.), Spanish needle (*Palafoxia arida*), ovate plantain (*Plantago ovata*), and needle grama (*Bouteloua aristidoides* var. *aristidoides*). Common trees and shrubs along the lower slopes and channel

edges in these areas include blue palo verde, catclaw acacia, Anderson's box-thorn, creosote bush, white bur-sage, white rhatany, and sweetbush.

1.4.4 Topock Marsh

The project area includes a small piece of the Topock Marsh on the northern side of Oatman-Topock Highway in Arizona. In this location, the marsh is characterized by dense growth of southern bulrush. Surface water to a depth of 7 inches was present at the sample location at the time of the February 2012 survey.

1.4.5 Adjacent and Shore Zone Wetlands along the Colorado River

Shore zone emergent wetlands include scattered patches of southern cattail, southern bulrush, common reed, and giant reed growing along the edges of the Colorado River below the ordinary high water line. These wetlands are found in scattered locations along the Colorado River and are most developed near the Topock Marina and in the southern part of the project area.

Adjacent emergent wetlands include wetland features that are immediately adjacent to the Colorado River, but occur above the ordinary high water and inland of the shore zone wetlands. The largest adjacent wetland is on the southern side of the I-40 bridge on the western side of the Colorado River. This wetland is characterized by a dense monoculture of common reed. At the time of the February 2012 survey, saturated soils and groundwater were present at a depth of 8 inches. Based on the location and elevation of this wetland, surface water is likely present in the summer months (May through July) during higher flow levels of the Colorado River.

An adjacent wetland also is present on the eastern side of the Colorado River, north and east of the Topock Marina. This wetland is characterized by a strip of emergent wetland immediately above the shoreline and includes a narrow band of low trees and shrubs further inland. Emergent vegetation is characterized by iris-leaved rush (*Juncus xiphioides*), Dallis grass (*Paspalum dilatatum*), and marsh pennywort (*Hydrocotyle verticillata*) with scattered common reed and southern bulrush. A shallow water table and saturated soils were present at 12 inches below ground surface at the time of the February 2012 survey. This area appears to be just above the ordinary high water elevation of the river. Given the low topographic position, this area is likely subject to some flooding during higher flows and appears to have saturated conditions in the upper part of the soil for most of the year.

1.4.6 Creosote Bush Scrub

The most common and widespread plant community in the upland deserts is creosote bush scrub. This vegetation type is characterized by widely spaced creosote bush with associated species such as white bursage, white rhatany, brittlebush, beavertail cactus (*Opuntia basilaris* var. *basilaris*), and silver cholla (*Cylindropuntia echinocarpa*). Creosote bush scrub occurs throughout the dissected alluvial terraces north and west of the Chemehuevi Mountains in California and east of the BNSF Railroad tracks, north of I-40 in Arizona.

1.4.7 Blue Palo Verde Woodland

Blue palo verde woodland occurs along the edges and throughout the channel bottoms of the larger ephemeral washes of the dissected alluvial terraces south of the Colorado River. Total vegetation cover is generally low, but species diversity is relatively high. Blue palo verde is the dominant tree with scattered individuals of salt cedar, athel tamarisk, and smoke tree also present in some areas. Associated shrubs include catclaw acacia, Anderson’s box-thorn, brittlebush, sweetbush, cheesebush (*Hymenoclea salsola*), climbing milkweed (*Funastrum hirtellum*), desert lavender, white bursage, white rhatany, and creosote bush. Common herbaceous species include small-seeded spurge (*Chamaesyce polycarpa*), small-flowered California poppy (*Eschscholzia minutiflora*), Emory rock daisy (*Perityle emoryi*), Spanish needle, and Arizona lupine (*Lupinus arizonicus*).

1.4.8 Foothill Palo Verde Scrub

Foothill palo verde scrub is restricted to a small area east of TCS along the slopes of the Chemehuevi Mountains, south and west of the Colorado River. Vegetation in this area is characterized by scattered foothill palo verde (*Parkinsonia microphylla*). Associated species include creosote bush, pygmy-cedar (*Peucephyllum schottii*), brittlebush, white rhatany, beavertail cactus, buckhorn cholla (*Cylindropuntia acanthocarpa*), California barrel cactus (*Ferocactus cylindraceus* var*. cylindraceus*), and inflated desert trumpet (*Eriogonum inflatum* var*. inflatum*).

1.4.9 Western Honey Mesquite Bosque

Western Honey Mesquite bosque is restricted to the low sandy terraces along the Colorado River where it often intermixes with tamarisk thickets. This vegetation type is characterized by western honey mesquite (*Prosopis glandulosa*). Common associated species include salt cedar and some areas where screwbean mesquite (*Prosopis pubescens*) has been planted.

1.4.10 Quailbush Scrub

Quailbush scrub is dominated by big saltbush (*Atriplex lentiformis*) and occurs on low-lying alkaline or saline soils. In the project area, it is most common along the Topock-Oatman Highway where it occurs on sandy saline/alkaline soils north of the Topock Marsh.

1.4.11 Tamarisk Thicket

Tamarisk thicket is found primarily on the low sandy terraces adjacent to the Colorado River. Vegetation is characterized by open to dense stands of salt cedar. In many locations, salt cedar trees and shrubs occur as monospecific stands; in other areas, associated trees or shrubs include athel tamarisk, western honey mesquite, screwbean mesquite, blue palo verde, and arrow weed (*Pluchea sericea*). Herbaceous vegetation is absent within dense thickets of salt cedar, but occurs in openings between such thickets where scattered individuals of fanleaf crinklemat (*Tiquilia plicata*), Spanish needle, and *Cryptantha* spp. may be present.

1.4.12 Burn Area

The area on the eastern side of the Oatman-Topock Highway previously was dense salt cedar and athel tamarisk that was burned during a wildfire in October 2008. In early 2011, USFWS initiated restoration activities in the burn area that included removing logs and woody debris, irrigation to leach salts form the soils, and planting of native vegetation. To date, 22 acres of the 240-acre burn area have been planted with native vegetation. Native species planted in this area include screwbean mesquite, blue palo verde, desert broom (*Baccharis sarothroides*), four-wing saltbush (*Atriplex canescens*), needle grama (*Bouteloua aristidoides*), alkali sacaton (*Sporobolus airoides*), James' galleta (*Pleuraphis jamesii*), and desert globe mallow (*Sphaeralcea ambigua*). The remaining areas are barren with the exception of the occasional seedlings of athel tamarisk and Russian thistle (*Salsola tragus*). Some of these areas have been covered with wood chips, and scattered logs and woody debris piles are present in a few locations.

SECTION 2

Resource Impact Assessment

The following subsection provides a brief summary of project activities that may have impacts to sensitive natural resources. The assessment of potential impact areas is provided in the following subsection.

2.1 Summary of the Groundwater Remedy Features

A detailed description of all the proposed activities associated with the groundwater remedy is provided in the Programmatic Biological Assessment (PBA; CH2M HILL, 2014). Figures 2A-C provides a visual depiction of the entire remedy layout.

A brief description of the key project features is provided in Section 1. The project also will include utility and support facilities necessary to make the remedy effective and safe over the anticipated decades-long operation. Utilities will include electrical power supply, communications systems, and instrumentation and control systems. Support facilities will include carbon amendment facilities, access routes, facilities to manage wastewater, operator's facilities (office space, bathrooms, etc.), long-term storage of excess soil, equipment and materials storage, equipment maintenance and testing areas, waste or refuse containers, and an onsite laboratory.

In addition, temporary facilities will be required for construction of the remedy. Potential locations within the project area have been identified for temporary staging locations during construction, including a construction yard. These temporary staging areas and the construction yard are in existing developed or disturbed areas. It is anticipated that the construction yard will include at a minimum multiple trailers serving as a work place for personnel, a central check-in/out location for site visitors, a place for daily briefings/project meetings, and a staging area for equipment and materials as well as other construction-related functions.

In compliance with Mitigation Measure CUL-1a-9, the Groundwater Remediation Mitigation and Monitoring Reporting Program, the remedy infrastructure has been designed in a manner that gives: (1) priority to previously disturbed areas for the placement of new physical improvements, and (2) priority to reuse of existing physical improvements, such as, but not limited to, wells and pipelines, but not including the IM 3 Treatment Plant.

2.2 Summary of the Groundwater Remedy Activities

Project activities are divided into different components that include construction, O&M, sampling and monitoring, decommissioning, and restoration. While soil storage is another activity associated with the remedy, no soil storage facilities are proposed on HNWR lands. Construction of the remedy facilities is expected to take approximately 3 years to complete, and the remedy will operate between 30 and 50 years until the groundwater remedial action objectives have been achieved.

The construction footprint represents the maximum project footprint because it includes the construction areas that will be needed to build each of the proposed wells. It also includes the construction corridors for the associated pipeline, which will range in total width from 25 to 60 feet, and encompasses the access routes. It is assumed that project decommissioning and restoration activities will occupy the same areas as the construction footprint. Other activities related to O&M and sampling and monitoring will affect a much smaller footprint within the existing construction footprint. Furthermore, these activities will be periodic or infrequent, of short duration, and generally less intensive than the construction phase. For these reasons, the assessment of project impacts is based on the maximum construction footprint, rather than the footprint, for other activities because the construction footprint represents a conservative (worst-case) estimate of the area requiring restoration.

2.2.1 Construction Activities

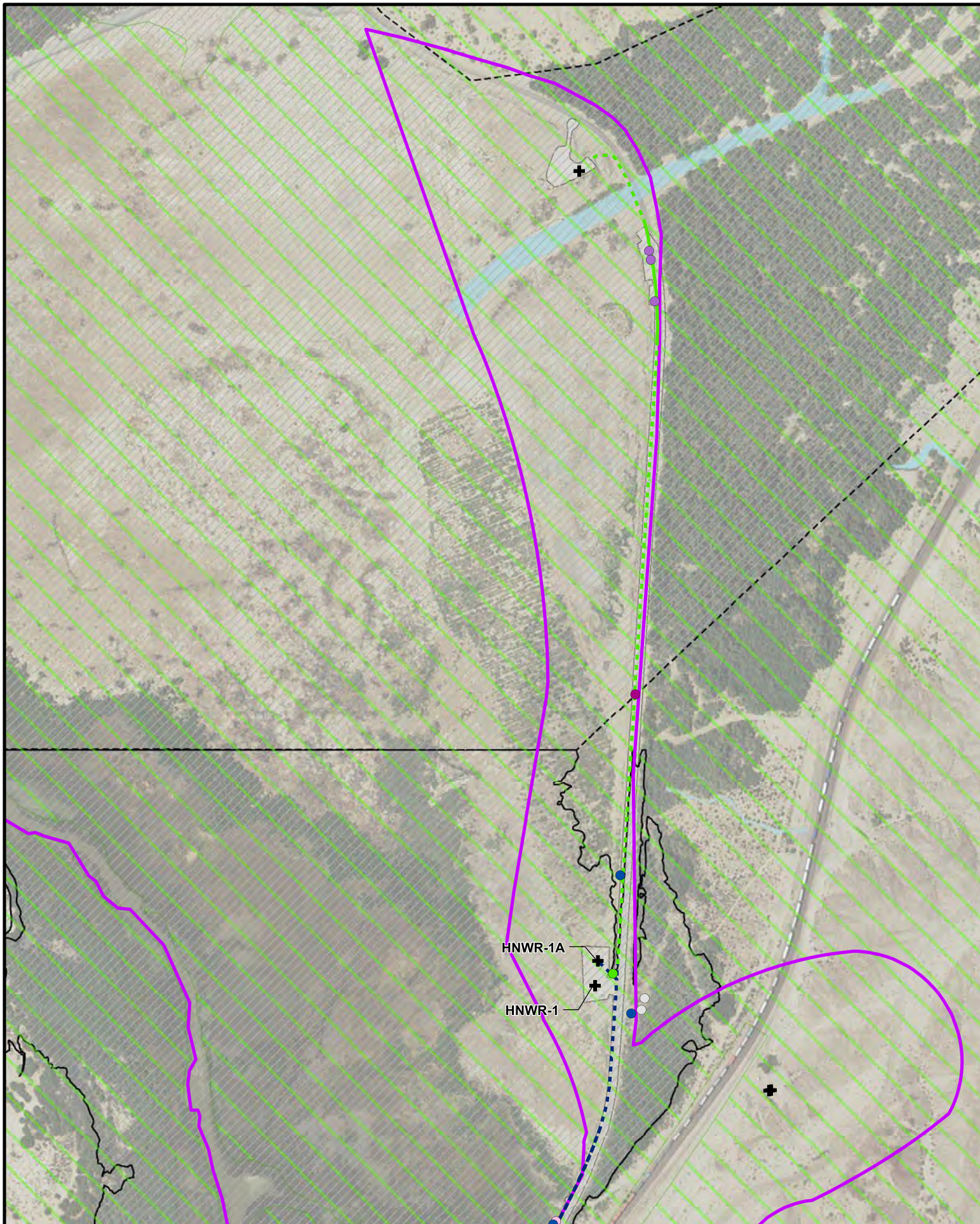
The groundwater remedy freshwater supply system begins with two existing wells: HNWR-1 and Site B well, which are west of the Oatman-Topock Highway in Arizona (Figure 3). A new, third well, HNWR-1A, was constructed in close proximity to HNWR-1 and will be the primary supply well. Both the HNWR-1 and the Site B wells are for contingency use only depending on the results of water quality and quantity testing from the new well. The freshwater supply pipeline will extend from HWNR-1A within a narrow trench within the existing shoulder of the Oatman-Topock Highway. Options for installing the power supply for the water supply well are currently under discussion with DOI and the Refuge but will include some combination of new power poles and overhead or underground utility lines.

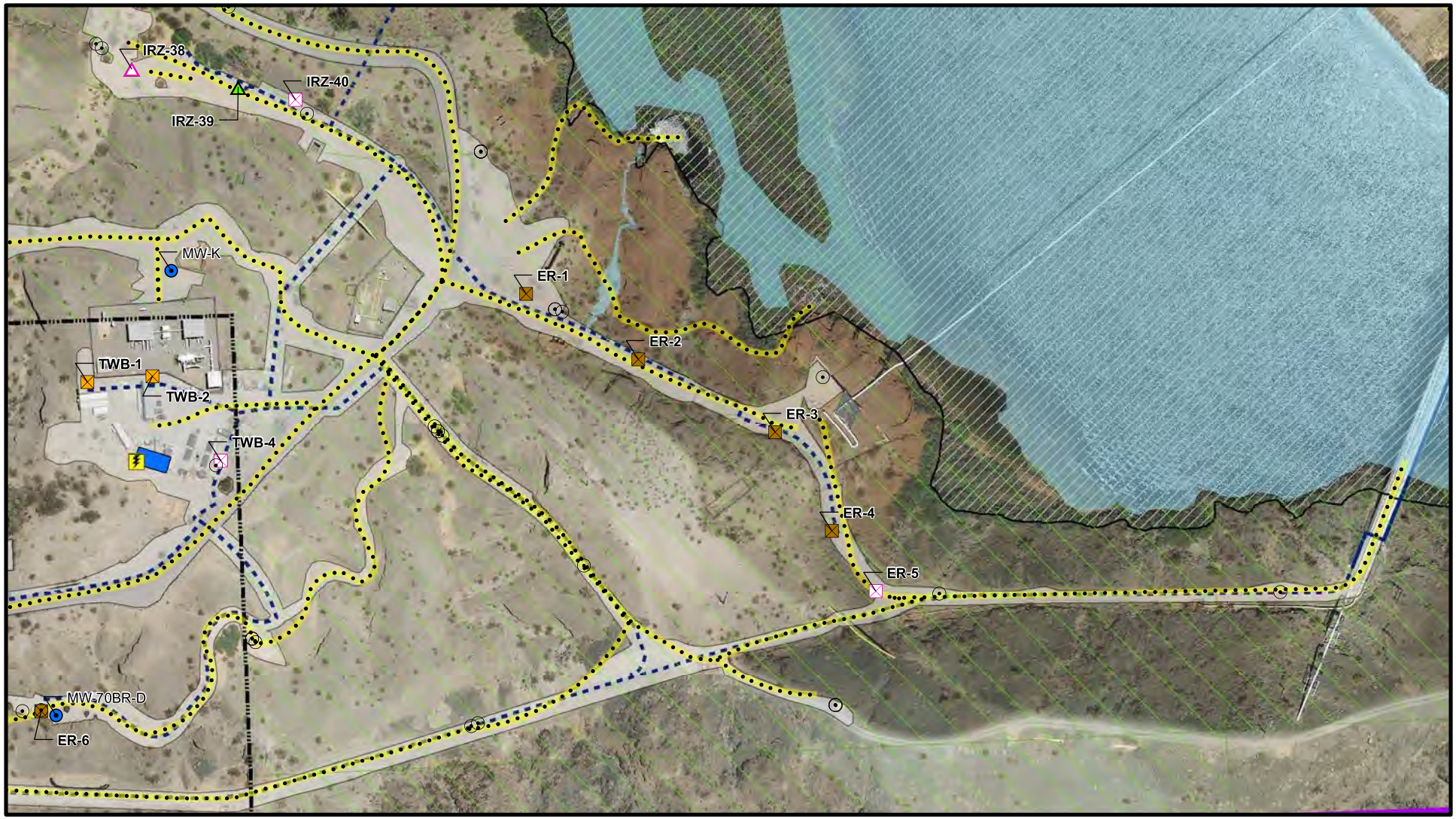
If piping to the Site B well is included, the adjacent soil berms to the north and south would be avoided. Ancillary facilities that will be constructed for the freshwater supply system will include two small concrete pads with shade structures at each functioning well to support pump and electrical control facilities. A sand separator also will be installed at the freshwater well HNWR-1A to allow for purging of sand at the wellhead and minimize sand settling in the pipe. The purged sand and water stream will be allowed to percolate into the ground via a dry well that will be filled with rock and located near HNWR-1A. The well, pump and electrical control facilities will be protected with security fencing and cameras. The pipeline leaves the HNWR property at the point where it enters the privately owned property associated with the Topock Marina. It does not cross into HNWR lands again until it crosses over the Colorado River on the existing pipe bridge (i.e., former Route 66 bridge).

Upon reaching the California side of the Colorado River, the freshwater supply pipeline will be installed underground to follow the existing access roadway and gas pipeline corridor to the west approximately 500 feet to where it will split into two separate lines (Figure 4). One line will follow the access road to the north and west to where it will cross over the TCS access road into the developed area just northeast of the Transwestern Bench, which is just outside the HNWR property. The second underground freshwater supply line will follow the existing roadway and gas pipeline corridor to the west-southwest to the point where it leaves the HNWR property and enters the TCS property. Other activities include the installation of a new monitoring well (MW-K) and a new access roadway to the north-northeast of the Transwestern Bench.

The northern branch of the pipeline will be installed beneath the TCS access road using a horizontal drilling technique to extend the pipeline east of the roadway (Figure 5). From this point, the pipeline will follow an existing access route through a tamarisk stand beneath the I-40 bridge. These activities occur within the California Department of Transportation (Caltrans) right-of-way until the freshwater pipeline corridor crosses a narrow strip (approximately 150 feet wide) of HNWR land between the I-40 bridge and the BNSF Railroad bridge.

The last of the construction activities on HNWR land will occur west of the TCS property (Figures 6A and 6B). At this location, the freshwater pipeline will follow an existing access roadway to the northwest to where it enters and crosses Bat Cave Wash. The pipeline will then follow an existing access roadway on the western side of Bat Cave Wash to the south for approximately 400 feet until it reaches the freshwater injection well FW-2 as shown on Figure 6A. Additional monitoring wells (Well S, MW-V, MW-HH, MW-II, and MW-11D) will be installed on the northern side of the freshwater injection well FW-2 within the existing access routes or along Bat Cave Wash. Additional activities in this area include improvements to an existing access road and associated stormwater features on the western side of Bat Cave Wash


HNWR-1A
HNWR-1



LEGEND

Existing Wells:
- Monitoring Well

Provisional Wells:
- Extraction Well
- Injection Well

Planned Wells:
- Extraction, East Ravine
- Extraction, NTH IRZ
- Extraction, Transwestern Bench
- Injection, NTH IRZ

- Planned Transformer
- Proposed Access Routes
- Aboveground Pipe
- Underground Pipe/Conduit
- Future Provisional/Contingent Fresh Water Pipe
- Wetlands and/or Waters of the U.S.
- Havasu National Wildlife Refuge (HNWR)
- Property Boundaries
- Proposed Remedy Structure
- Area of Potential Effects (APE)
- Construction Footprint
- 100yr. Floodplain

0 100 200 400 Feet

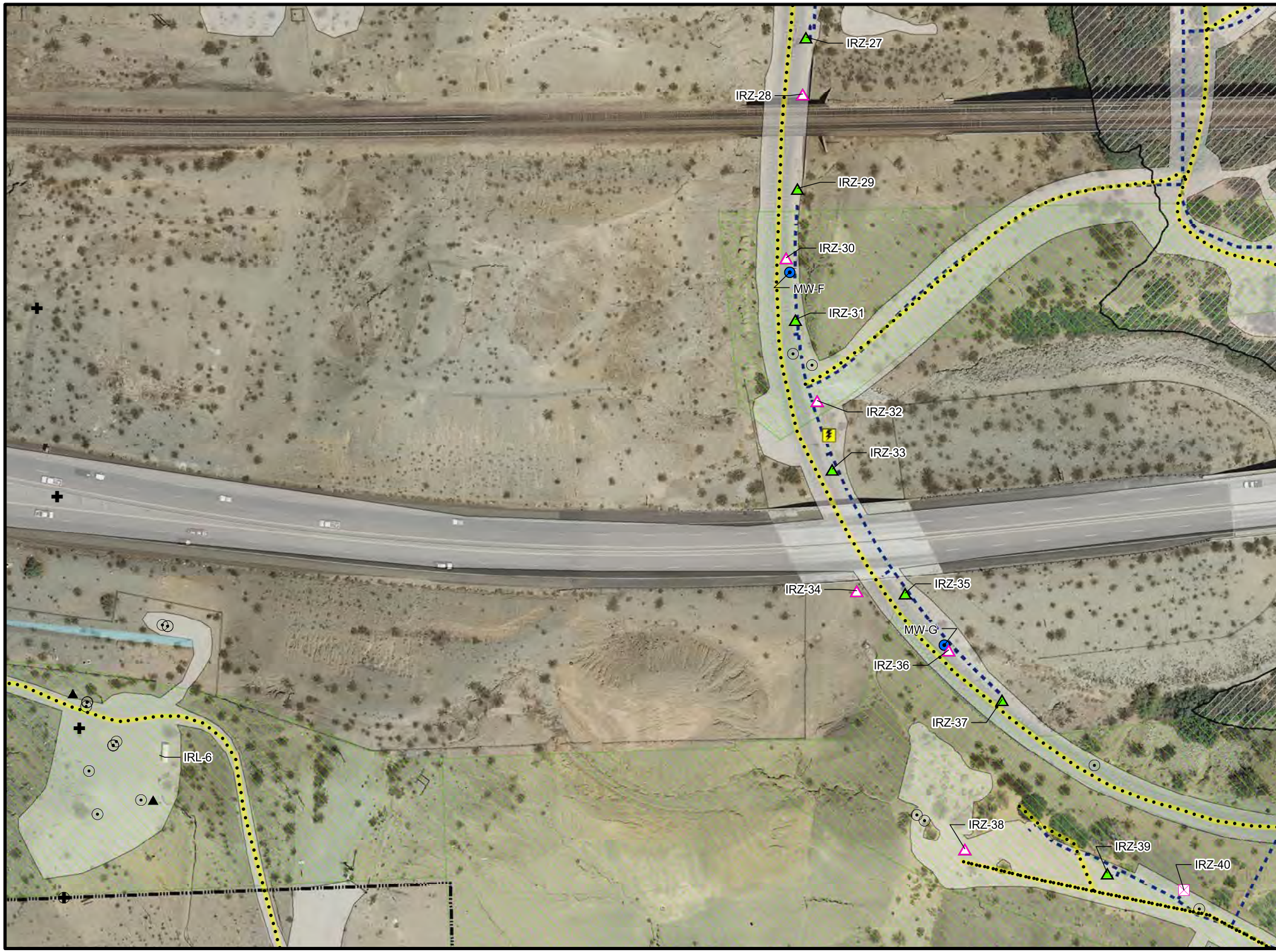
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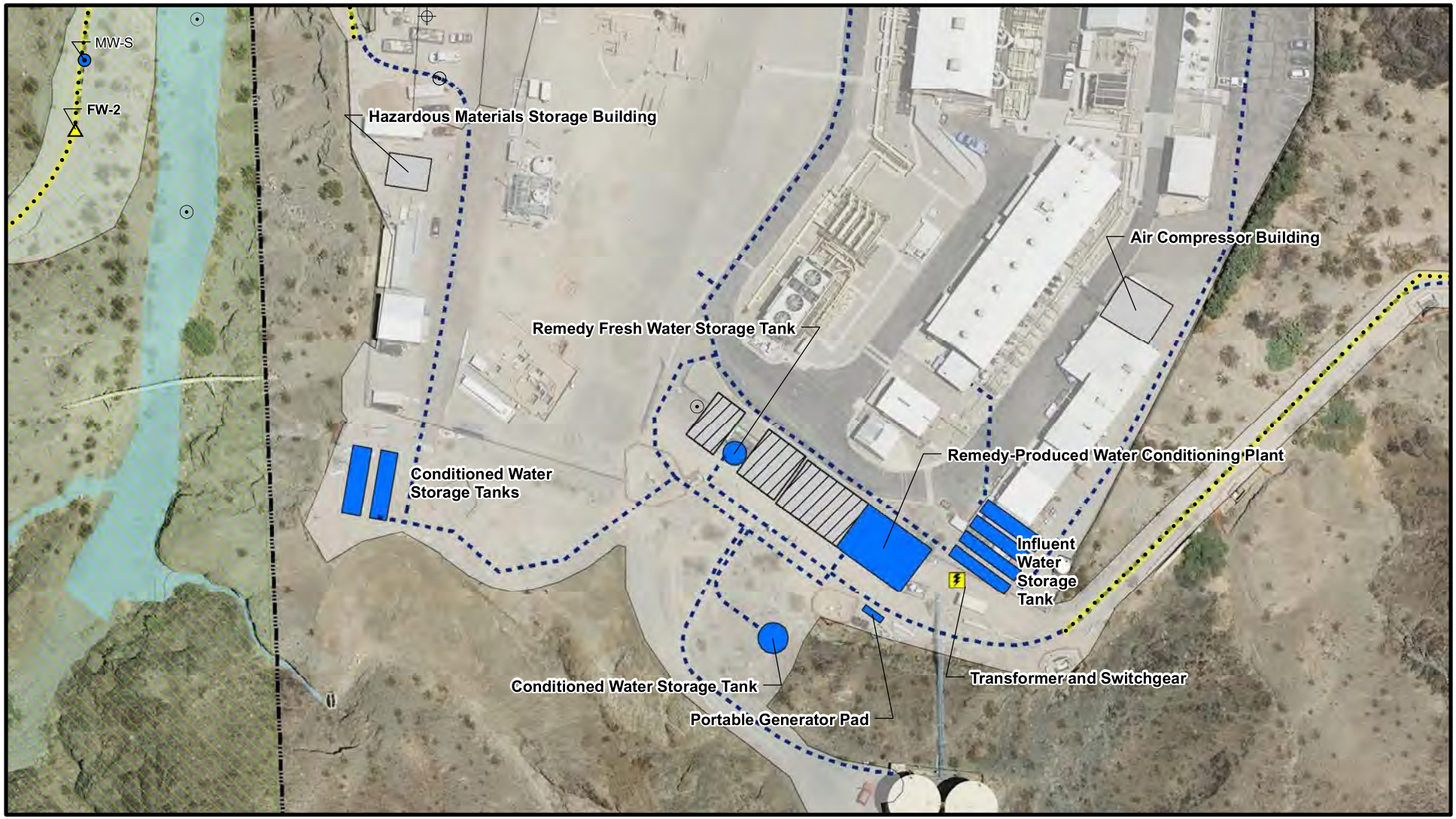
FIGURE 4
AREA 2- EAST SIDE OF COMPRESSOR STATION

FINAL GROUNDWATER REMEDY
HAVASU NATIONAL WILDLIFE REFUGE
PG&E TOPOCK COMPRESSOR STATION,
NEEDLES, CALIFORNIA

CH2MHILL

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IRZ-27
IRZ-28
IRZ-29
IRZ-30
MW-F
IRZ-31
IRZ-32
IRZ-33
IRZ-34
IRZ-35
MW-G
IRZ-36
IRZ-37
IRL-6
IRZ-38
IRZ-39
IRZ-40



LEGEND

Existing Wells:
- Injection Well
- Monitoring Well

Planned Wells:
- Injection, Freshwater
- Remedy Monitoring Well

- Planned Transformer
- Proposed Access Routes

Pipeline Corridor for Remedy
- Aboveground Pipe
- Underground Pipe/Conduit
- Future Provisional/Contingent Fresh Water Pipe

- Property Boundaries
- Proposed Remedy Structure
- Contingent Freshwater Pre-injection Treatment System
- Havasu National Wildlife Refuge (HNWR)
- Wetlands' to 'Wetlands and/or Waters of the U.S.
- Construction Footprint

0 25 50 100 Feet

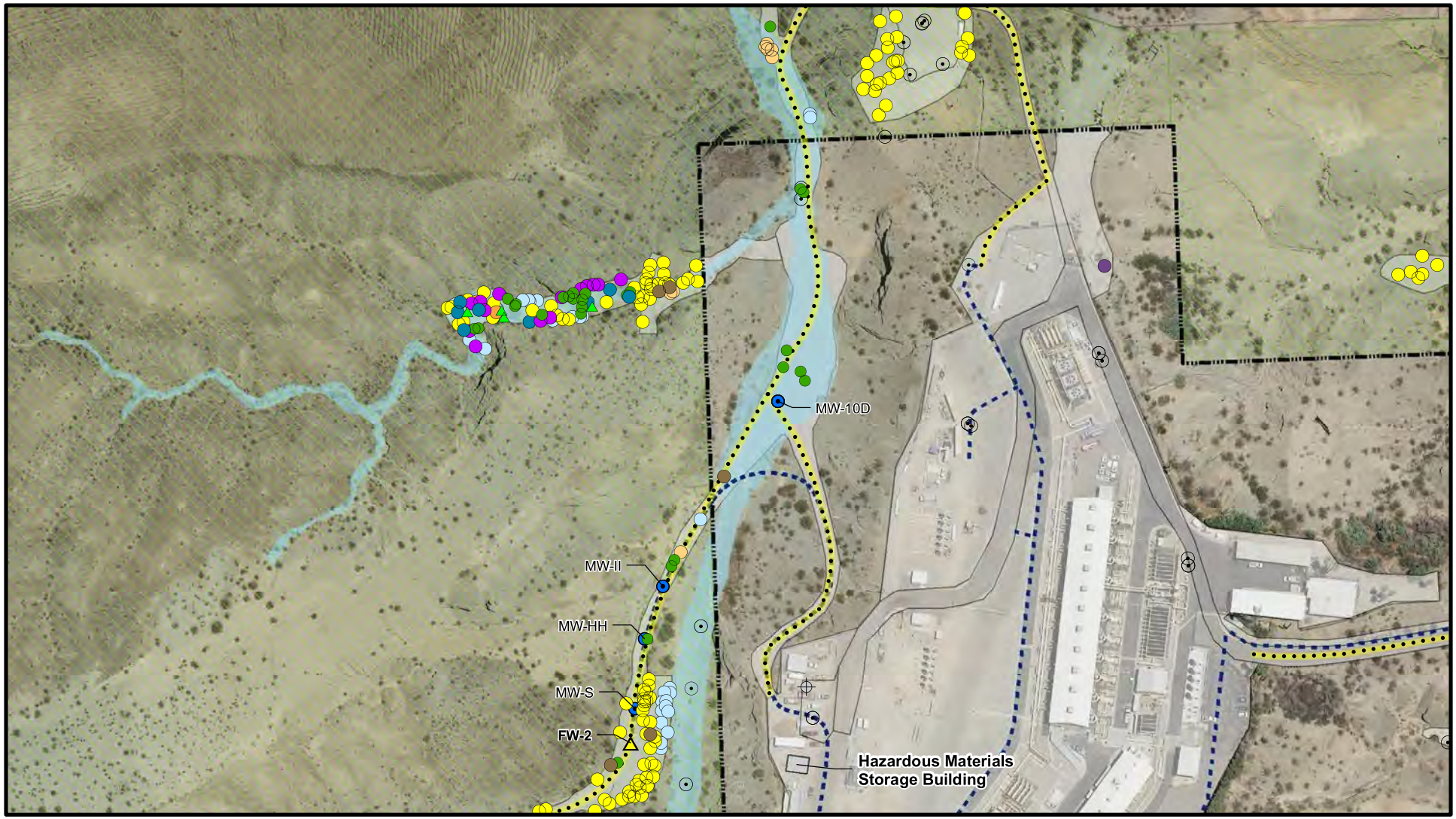
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FIGURE 6A - SOUTH AREA 1 – WEST SIDE OF COMPRESSOR STATION

FINAL GROUNDWATER REMEDY
HAVASU NATIONAL WILDLIFE REFUGE
PG&E TOPOCK COMPRESSOR STATION,
NEEDLES, CALIFORNIA

CH2MHILL

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LEGEND

Listed Plants
- Anderson desert thorn
- Beavertail
- Brittlebush
- Catclaw Acacia
- Cattle Saltbush
- Cheesebush
- Creosote Bush
- Desert Lavender
- Honey Mesquite
- Sweetbush
- White rhatany

Existing Wells:
- Injection Well
- Monitoring Well

Planned Wells:
- Injection, Freshwater
- Remedy Monitoring Well
- Planned Transformer
- Proposed Access Routes

Pipeline Corridor for Remedy
- Aboveground Pipe
- Underground Pipe/Conduit
- Future Provisional/Contingent Fresh Water Pipe
- Property Boundaries
- Proposed Remedy Structure
- Contingent Freshwater Pre-injection Treatment System
- Havasu National Wildlife Refuge (HNWR)
- Wetlands' to 'Wetlands and/or Waters of the U.S.
- Construction Footprint

0 50 100 200 Feet

N

FIGURE 6B - NORTH AREA 1 – WEST SIDE OF COMPRESSOR STATION

FINAL GROUNDWATER REMEDY
HAVASU NATIONAL WILDLIFE REFUGE
PG&E TOPOCK COMPRESSOR STATION,
NEEDLES, CALIFORNIA

CH2MHILL

Path: R:\PGEAlliance\Topock\MapFiles\2015\CMS\Final_HNWR_RestorationPlan\Figure6b_RemedyFacilities.mxd

Because the existing water supply wells in Arizona, as well as the pipeline corridors, will be constructed in previously cleared areas associated with the former 2008 Sacramento Wash burn area or within developed portions along shoulder of the Oatman-Topock Highway, there will be no habitat impacts within Arizona. Minor trimming of perennial vegetation, including honey mesquite and blue palo verde, may be required along the southern side of Topock Marsh, but no tree removal will be required. Similarly, two new monitoring wells will be constructed along the shoreline of the Colorado River to the north of the Topock Marina in Arizona. These wells will be constructed within previously cleared areas and will not result in any new habitat impacts.

Within California, the northern freshwater supply pipeline crosses the HNWR property between I-40 and the BNSF Railroad bridges. This segment occurs along an existing access route within the 100-year flood elevation of the Colorado River and will affect primarily tamarisk. On the western side of Bat Cave Wash, the underground freshwater pipeline will require removing several creosote bushes.

Work in the project area would not have impacts on fish species, and impacts to wildlife would be limited to temporary disturbance resulting from noise and increased human activity during construction and monitoring events. Some tree trimming may be required during installation of the freshwater supply pipeline between the Oatman-Topock Highway and the Topock Marsh. Tree trimming (like other construction activities) would be avoided during the breeding season when immobile young may be present (i.e., March 15 to May 31). Any tree trimming (or construction activities) within the remaining portion of the breeding season (June 1 to July 1) would be limited to a single USFWS-approved work window (7 to 10 days in length). In other areas, some creosote bush may be trimmed to allow access of equipment, but the root systems will be left intact to the extent possible. Following construction, plants left in this trimmed condition are expected to naturally recover by resprouting from the rootstocks. Sensitive habitat areas including wetland will be avoided, and impacts in upland areas will consist primarily of removing creosote, which is an abundant and widespread species occurring throughout the uplands in this part of the HNWR. The minor impacts to this vegetation type resulting from the project are not expected to result in significant adverse habitat impacts. No wildlife dependent recreational activities are within the parts of the refuge in the project area.

2.2.2 Operation and Maintenance Activities

Normal operation of the remedy facilities include groundwater extraction and recirculation within remediation wells and pipelines, carbon substrate storage and deliveries, carbon substrate injections, and regularly scheduled maintenance and repairs of the remedy system. Remediation wells will be subject to operation activities that will be mostly automated; however, carbon substrate dosing of individual wells may occur periodically. In these cases, a vehicle will carry the dosing tank along the existing access routes to complete the procedure. Normal O&M activities also will include the freshwater supply and conveyance system, as well as the power supply and distribution system.

Non-intrusive routine maintenance of the wellhead and wells includes regular surging and pumping techniques. A more aggressive routine maintenance technique uses AquaGard that injects cryogenic liquid carbon dioxide into existing well access tubes and requires all or some of the following: an injection trailer, a storage vessel, pump rig and/or crane (if a pump or pipe needs to be installed/removed), and a support truck.

Non-routine maintenance consists of intrusive methods requiring removal of existing equipment from well and include drop-pipe replacement, submersible pump repair/replacement, and well repair and well rehabilitation methods. Depending on the specific plan for well rehabilitation, some or all of the following equipment may be required: a pump rig and/or crane, support or pipe truck, generator(s), air compressor, chemical trailer (mixing tanks and pumps), neutralization trailer (mixing tanks and pumps), video van, vacuum or tanker truck, forklift, and 20,000-gallon portable, aboveground storage tank.

Pipeline maintenance and repair also will be required. Cleanouts and blowoffs will be installed to allow access to the pipeline for removing sediment. A sand separator will be installed at the freshwater well HNWR-1A to allow for purging of sand at the wellhead and minimize sand settling in the pipe. The purged sand and water stream will be allowed to percolate into the ground via a dry well that will be filled with rock and located near the freshwater supply well. Pipeline maintenance also will be required. A clean-in-place (CIP) system for the IRZ will operate as a closed loop system to use approved chemicals to remove biological films and mineral scale deposits within remedy pipelines. Spent CIP solutions will be collected and managed as liquid wastes.

Sections of underground pipe that requires repairs will need to be exposed by excavation, whereas below ground pipe section insides precast concrete trenches can be accessed via maintenance manhole(s). Aboveground pipeline repairs will be done according to manufacturer's recommendations. Aboveground pipeline will need to be repainted periodically for upkeep and aesthetic reasons.

Over time, access roads and pathways are likely to exhibit deterioration and/or overgrowth, and will require maintenance for safety and to ensure access to and protection of remedy infrastructure and facilities. This maintenance will be coordinated with the Refuge to limit the potential for conflicts. Depending on the road or pathway surface and condition, the proper maintenance method(s) will be different. Typically, road maintenance consists of stabilizing disturbed areas, filling/regrading, and pruning overgrowth.

A number of other facilities will be required to support long-term O&M activities, including the main Operations Building at the TWB, satellite equipment/tools storage and maintenance yard at Park Moabi, onsite laboratories at the Water Condition Plant at the TCS/Carbon Amendment Building at the MW-20 Bench/a trailer at Park Moabi. These facilities will not be on HNWR lands.

None of the O&M activities is anticipated to affect new habitat because these activities can be accomplished within a smaller footprint than was disturbed during the construction phase.

2.2.3 Sampling and Monitoring Activities

Once the groundwater remedy and associated new monitoring wells are installed, a new flexible, adaptive program will be developed as part of the remediation compliance monitoring and the remedial system performance monitoring. This will determine the analytes and monitoring frequencies for particular wells, as dictated by the location and well category during remedy operations. As data are collected during remedy installation and initial operations, the conceptual site model will be updated. The monitoring program may be refined based on baseline data before remedy operation, and the sampling program will be revisited and refined after the first 2 years of operation.

All sampling events will follow standard operating procedures that will be provided in the O&M manual and will provide detailed method descriptions of activities, including purging and sampling of groundwater monitoring wells; purging and sampling of active and inactive water supply wells; depth-specific surface water sampling; sample field filtration and preservation for metals analyses; decontamination of water sampling equipment; spill prevention, containment, and control measures for monitoring well sampling; access routes; process water sampling; and safe fueling and fuel handling procedures.

Access to monitoring wells typically will occur using a pickup truck or all-terrain utility vehicle with a trailer. On HNWR lands, vehicle access is limited to existing roads. On average, two field personnel will be involved in sampling activities for each well. Sampling procedures require purging the wells before sampling can be conducted. Depending on the well characteristics, approximately 15 to 200 gallons of water typically will be purged. This water will be either re-injected into the IRZ or transported to the onsite remedy-produced water treatment facility. Pumping of purge water typically will involve using a portable generator unless the well pump has a dedicated (direct line) power source.

The period to complete field sampling activities at an individual well ranges from approximately 15 minutes to several hours. Several of the monitoring sites include clusters of two to three wells sampled at different groundwater depths. The total time to complete a sampling event ranges from 1 day for monthly events or

2 days for surface water/river sampling events, to 7 or 8 weeks for a biennial event. Existing and new access routes that are kept as part of the new groundwater monitoring program will be used to access these wells.

Baseline soil sampling will be conducted in conjunction with the installed remedy facilities to provide comparable data to evaluate potential impacts of the final remedy features at the time that they are being decommissioned. Baseline soil samples will be collected along the remedy pipelines/conduits alignments, which include direct burial pipelines/conduits, pipeline trenches, and the new remediation wells (i.e., injection and extraction wells) that are connected to those pipelines, as well as at the new remedy monitoring well locations. Baseline soil sampling will not occur along the alignment of the freshwater pipeline in Arizona, and on the California side, leading to TCS because the freshwater from HNWR-1 has low concentrations of inorganic compounds, so potential risks to underlying soil from incidental releases, spills, or leaks from the pipeline are negligible.

None of the sampling and monitoring activities is anticipated to affect new habitat because these activities can be accomplished within a smaller footprint than was disturbed during the construction phase.

2.2.4 Decommissioning and Restoration Activities

PG&E will submit a decommissioning plan within 120 days of DOI's certification of completion of the remedial action and a determination by DOI that removal of such facilities is protective of human health and the environment (the "Plan for Decommissioning of Remedial Facilities and Restoration"). The Plan for Decommissioning of Remedial Facilities and Restoration will describe procedures for the removal of the remedy facilities and associated infrastructure. The plan will also describe the post-remedy restoration of the site to the conditions existing prior to the implementation of the remedy construction, to the extent practicable.

After decommissioning and removal of the remediation facilities, the areas will be restored using decompaction and grading techniques designed to decrease erosion and accelerate revegetation of native species. The decommissioning of monitoring wells will occur after an appropriate time span following the decommissioning of the remediation facilities. The Plan for Decommissioning of Remedial Facilities and Restoration for the remedy facilities will incorporate the approaches and feedback gathered from the previously prepared IM- 3 Restoration Plan. It is anticipated that some details related to restoration, such as the amount of earthwork and earth material needs for the restoration, will be deferred until decommissioning is complete because these details will best be determined when the actual conditions of ground surface are known.

The decommissioning and restoration activities are not anticipated to affect new habitat because these activities can be accomplished within the same footprint that was disturbed during the construction phase. One possible exception to this might be habitat that develops within the previously disturbed construction footprint over the course of 30 to 50 years of remedy system operation.

2.3 Summary of Potential Impacts for the Groundwater Remedy Activities

This impact assessment is specific to HNWR lands and was completed using a geographical information system (GIS) to combine the expected project construction footprint based on the 90 percent design with previously mapped areas that were considered to be undisturbed land, sensitive resources, including wetlands and waters of the United States, and focused vegetation inventory and mapping within the project footprint.

2.3.1 Disturbed and Undisturbed Areas

The Topock area has cultural significance to a number of local and regional tribes and, as such, measures have been taken during the design stages of the final remedy to avoid or minimize any impacts to culturally significant resources, including ethnobotanical plants. The Final Environmental Impact Report included Cultural Resources Mitigation Measure CUL-1a-9 that specifically states:

During selection of the design and specific locations for physical remediation facilities, PG&E shall, in communication with the Interested Tribes (and subject to their review), and to the maximum extent feasible, as determined by DTSC, give: (1) priority to previously disturbed areas for the placement of new physical improvements; and (2) priority to re-use of existing physical improvements, such as but not limited to wells and pipelines, but not including IM-3 facilities.

"Disturbed" areas in this context means those areas outside of documented archaeological site boundaries that have experienced ground disturbance in the last 50 years. PG&E shall produce an aerial map of these disturbed areas to guide project design, and PG&E shall make a good faith effort to provide tribes with an opportunity to review and comment on the information displayed on the map in determining "disturbed" areas.

The proposed methodology for the identification and mapping of disturbed areas was presented to the project team (including tribal representatives) at the team meeting held on February 24, 2011. In late February and early March of 2011, field surveys were conducted and the disturbance area maps were circulated to the project team for review and comment. These disturbance maps were then used to guide the design of the final remedy. The following disturbance categories were used in the impact assessment for the HNWR:

1) **Highly Disturbed** areas include existing infrastructure and facilities, paved and unpaved but graded and maintained roads, and well-used access routes. Highly disturbed areas also included dredged sand deposits adjacent to the Colorado River and other highly disturbed areas that were generally devoid of vegetation, such as the portion of the HNWR where vegetation has been cleared within the Sacramento Wash following a wildfire in 2008.

2) **Lightly Disturbed** areas include areas that have some level of disturbance including some vehicle tracks, utilities, bank cuts, or other types of disturbance, but also support some vegetation. Such areas include access routes and well locations within Bat Cave Wash and other low-impact access routes.

3) **Undisturbed** areas include areas that were not mapped as either disturbed or lightly disturbed on the 2011 disturbance maps and are located outside of an existing roadway or well-established access routes.

Within the project footprint that occurs on HNWR lands (27.95 acres total), the three mapped different levels of disturbance occur as follows: highly disturbed areas comprise 24.47 acres or about 88 percent; lightly disturbed areas comprise 2.23 acres or about 8 percent; and undisturbed areas comprise 1.25 acres or about 4 percent of the total HNWR lands within the proposed final groundwater remedy footprint.

2.3.2 Wetlands and Waters of the United States

A wetland delineation for the entire project area was completed in February 2012 and submitted to DTSC and DOI on August 22, 2013. Consultation occurred with the USACE and it was determined that a permit (under Section 404 of the Clean Water Act) would not be required for this project due to the CERCLA exemption. However PG&E is required to comply with all substantive permit requirements.

The project has been designed to avoid impacts to wetlands and waters of the U.S. to the extent possible. The 90 percent design footprint includes 0.99 acre of desert wash habitat. This includes 0.70 acre of Bat Cave Wash that will mostly be used for temporary construction. Long term impacts within the wash will be limited to a few well locations and the continued use of existing access routes. The freshwater supply pipeline will span Bat Cave Wash parallel to an existing natural gas pipeline on the west side of the Compressor Station. An additional 0.29 acre of a tributary to Bat Cave Wash could also be impacted by installation of a provisional monitoring well. The downstream portion of the wash (0.04 acre) is highly disturbed and there is an existing large earthen berm across the channel. Upstream of the berm the remainder of the wash (0.25 acre) is mapped as undisturbed. In addition 6.66 acres of the project area is located on uplands that are within the current 100-year floodplain of the Colorado River.

2.3.3 Vegetation Impacts

Focused surveys to identify and map all vegetation in the 90 percent design footprint were conducted between August 6 and 8, 2014. The vegetation assessment and inventory included any identifiable persistent perennials, succulents, and all woody shrubs and trees. Non-persistent perennial and annual plants were not included in the inventory. Most of the plants were individually mapped using a Trimble GEO XT global positioning system (GPS) device; however, some vegetation including dense stands of arrow weed, salt cedar, or abundant and widespread creosote bushed were mapped on aerial photos and later digitized into GIS. Plants that were just outside of the polygon footprint were generally not mapped unless they represented an important resource to avoid. Dead vegetation within the footprint was also not mapped. This methodology provided a fairly comprehensive inventory of vegetation located on the HNWR within the 90 percent design project footprint.

For most species, the vegetative cover associated with individual perennial plants was approximated by buffering the mapped GPS points to approximate the canopy cover evident on the aerial photograph. A few areas of dense salt cedar and scattered arrow weed were mapped as polygons and in these areas vegetative cover was estimated on the estimated areal extent of the vegetation within the polygon. Vegetation impacts and the associated estimated acreage impacts within the 90 percent design footprint on HNWR lands are shown in Table 1. Vegetation maps, photo points, and preconstruction photographs are provided in Appendix A.

It should be noted that the plant information depicted on the Appendix A maps shows a mixture of polygons and symbols, not the actual impact areas. The symbols may deviate slightly from the underlying aerial photograph images. These deviations are due to inherent sources of error associated with GIS technology which include: changes in vegetation cover since the aerial photograph base map was taken in 2011, satellite geometry over the course of the mapping; the “canyon effect” near buildings and very steep slopes, geo-referencing changes where measured vertical elevation deviates from actual, and effect of high temperatures on the accuracy of the GPS unit.

The last footnote in Table 1 above indicates that the boldface entries are the only plants that will be transplanted or replaced and the total acreage for just those items is 0.0843 acres. While it is recognized that, ultimately, the entire construction footprint on HNWR land will be subject to revegetation/ restoration, that process will occur primarily in the final phase of the project after operation, decommissioning, and removal of the groundwater remedy facilities. If there are portions of the construction footprint that can be re-planted in the interim, they will be.

2.3.4 Preconstruction Photo-Documentation

As part of the vegetation surveys for the 90 percent design, representative photographs were taken of the preconstruction conditions. Photo locations and photographs are provided in Appendix A.

TABLE 1
Summary of Vegetation Impacts within the Final Design Footprint on HNWR Lands

Species	Number of Plants[a, b.]	Estimated Acreage
Anderson's desert thorn (*Lycium andersonii*)	4	0.0003
Arrow weed (*Pluchea sericea*)[c]	NA	0.0830
Beaver tail (*Opuntia basilaris*)	14	0.0005
Big saltbush (*Atriplex lentiformis*)	3	0.0002
Brittlebush (*Encelia farinosa*)	83	0.0015
White bursage (*Ambrosia dumosa*)	21	0.0060
Catclaw acacia (*Senegalia greggii*)	23	0.0338
Cattle saltbush (*Atriplex polycarpa*)	9	0.0001
Cheesebush (*Ambrosia salsola*)	44	0.0008
Creosote bush (*Larrea tridentata*)	300	0.4103
Desert lavender (*Hyptis emoryi*)	14	0.0088
Desert smoke tree (*Psorothamnus spinosus*)	1	<0.0001
Honey mesquite (*Prosopis glandulosa*)	8	0.0006
Jimson weed (*Datura wrightii*)	1	<0.0001
Honey sweet (*Tidestromia oblongifolia*)	3	0.0001
Blue palo verde (*Parkinsonia florida*)	18	0.0491
Pygmy cedar (*Peucephyllum schottii*)	2	0.0006
Salt cedar (*Tamarix ramosissima*)	NA	0.1209
Silver cholla (*Cylindropuntia echinocarpa*)	1	0.0003
Skeletonweed (*Stephanomeria paucifolia*)	1	<0.0001
Sweetbush (*Bebbia juncea*)	45	0.0032
White Rhatany (*Krameria grayi*)	5	0.0004
Total of Vegetation	**617**	**0.7206**

Notes
[a] Number of plants and estimated cover within the final percent design footprint. Actual plant impacts will be less with implementation of avoidance measures in the field.
[b] NA = Not assessed. Arrow weed and salt cedar were assessed as mapped polygons, not individuals.
[c] Acreage estimated based on an estimated average of 25% cover within 0.3321 acre of mapped polygons

BOLDFACE species are those that will be transplanted or replaced with new plantings.

SECTION 3

Avoidance, Minimization, and Salvage/ Replanting Measures

This section provides information on avoidance and minimization measures that will be implemented to reduce impacts to vegetation resources and provides information on plant salvage and other replacement methods that will be used where long-term impacts to vegetation are unavoidable. The information included in this section also is intended to provide general guidance on salvage, planting, and seed collection that may be used for mitigation, habitat enhancement, and/or revegetation following decommissioning of the project. Detailed planting plans will be provided at a later date.

3.1 Design and Construction

Throughout the design process for the project, efforts have been made to locate pipelines and wells along roadways, pipeline rights-of-way, and other previously disturbed areas to avoid impacts to vegetation. Construction areas, as well as staging and storage areas, have also been located in previously disturbed and/or developed areas to minimize and avoid impacts to vegetation and other sensitive resources. To further minimize impacts, a biologist will conduct preconstruction surveys and areas of native vegetation and sensitive habitats in the immediate vicinity of the construction areas will be identified and clearly marked with flagging, fencing, and/or signage. Construction workers also will be provided with environmental awareness training regarding biological resources including sensitive species and habitats.

The issue of soil stabilization is being addressed separately under a stormwater pollution prevention plan (SWPPP) that will be included in the C/RAWP and O&M Manual. However, the use of herbaceous vegetation covers as a soil stabilization technique is not being proposed for this project because this approach was not considered appropriate for this environment. Soil stabilization techniques will be an integral part of the SWPPP because these measures minimize dust and protect desert topsoil, particularly in areas of contamination or with minimal surface soil. Vegetative covers are not discussed further in this document.

Similarly, grading plans also will be developed and submitted for review as part of the 90 percent design submittal.

3.2 Habitat Requirements for Mitigation Planting

Native plants in the project area have different habitat requirements and ecological tolerances, which are reflected in the sites that they occupy. Blue palo verde is a relatively large tree associated with sandy areas, is widely distributed on the edges and bottoms of the ephemeral washes that dissect the upland alluvial terraces, and occurs along sandy roadsides. In contrast, the related hillside palo verde is a tree of shorter stature that is restricted to rocky hillsides above the Colorado River in the southern portion of the project area.

Western honey mesquite and screw bean mesquite typically grow in areas with root access to permanent underground water; however, western honey mesquite is more likely to occur in somewhat drier habitats than screwbean mesquite. While both species are salt tolerant, screwbean mesquite has a higher tolerance level than western honey mesquite (Miyamoto et al., 2004), an important consideration when planting mitigation trees. Transplanting or replacement planting of native species will be located in areas where the species are growing to ensure appropriate environmental conditions are present for the establishment and survival. The exact planting locations will be determined as part of the final design based on the number of transplants and/or mitigation plantings and the locations and extent of the work areas and access routes.

3.3 Transplantation, Salvage and Replacement of Trees, Shrubs, and Perennial Species

The following section provides general guidelines for salvage, transplant, and replacement of trees, shrubs, and perennial species.

3.3.1 Transplanting Trees

Native trees identified in the project area can exceed 20 feet in height when mature. However, large individuals are unlikely to survive salvage and replanting because of "transplant shock" caused by extensive and unavoidable loss of roots. Therefore, salvage of native trees should be limited to small individuals or saplings whose root systems are small enough to excavate and transport with minimal damage. Such individuals are more likely to recover and survive the physiological stress of transplanting. In general, trees most suitable for transplanting will be less than 4 inches in diameter at the base of the trunk and no more than 6 feet tall. Trees shall be transplanted between November and March, when temperatures are cooler, trees are dormant, and irrigation demands are less. Transplanting will occur before bud break to allow the roots time to recover and proliferate before they are required to withstand excessive transpirational loads caused by higher ambient temperatures. To the extent possible, young trees will be relocated to areas in the immediate vicinity of the work area that have similar soil types, exposure, and drainage conditions, but distant enough that they will not be affected by future work activities. If there are no suitable transplantation areas in the vicinity of the work area, the trees will be relocated to other sites within the project area where the species is known to occur and will not be affected by work activities.

The following transplanting specifications follow general guidelines from the International Society of Arboriculture (ISA, 2013) and the American Standard for Nursery Stock (American Nursery and Landscape Association, 2004).

To minimize the time the roots of a salvaged tree are exposed and to increase survivability, the transplant location will have been identified and a hole excavated before the tree is removed from the soil. The transplant hole will be large enough to accommodate the root system at the same depth or slightly shallower than the tree being moved. The initial hole shall be at least two to three times the width of the root ball near the surface and taper down to the size of the root ball at the bottom. The depth of the hole shall be no greater than the distance from the trunk flare[1] to the bottom of the root ball.

Where possible, pre-dig the perimeter of the root ball using a sharp spade or shovel to avoid breaking and tearing of the roots. Pre-digging the root ball can stimulate regeneration of roots and increase root density in the final root ball. If a backhoe is used to excavate the root ball, the initial hole shall be larger than the final root ball. The final root ball will be shaped by hand using loppers to cut the roots cleanly. Table 2 provides size guidelines for the minimum size of the root ball for transplanted trees.

Depth of the root ball is variable depending on the size of the tree but generally will be between 24 and 36 inches deep. The root ball shall taper along the sides slanting inwards slightly toward the base. If the soil is hard and compact, it may be necessary to add water before cutting the root ball. The final root ball shall stand on a pedestal before being undercut. Once the root ball has been cut and shaped, wrap the sides and top in burlap to secure the roots and soil. A skirt shall be left hanging to cover the bottom of the root ball. Secure the burlap wrapping with rope or twine before lifting from the hole. If necessary secure any branches with burlap or ropes to prevent damage and breaking. Pruning of branches should generally not be required, but if some branches need to be trimmed it will be kept to a minimum with no more than 20 percent of the canopy removed in accordance with ANSI 300A Part 1 (American National Standard, 2008). Once the root ball and any branches have been secured, lift the tree straight up from the root ball to remove from the hole; do not lift by the trunk as this can damage the trunk and roots.

[1] The area at the base of the plants stem or trunk where the stem or trunk broadens to form roots

TABLE 2
Size Guidelines for Root Balls when Transplanting Trees

Trees Height or Stem Diameter*	Minimum Root Ball Diameter (Inches)
Trees < 6 feet tall and/or stem < ¾ inch in diameter near the base	16
Trees > ¾ inch diameter and stem < 2 inches in diameter near the base	24
Trees 2-3 inches in diameter near the base	32
Trees 3 -4 inches in diameter near the base	42

Note:
*Stem diameter for trees less than 4 inches is measured at 6 inches above the ground surface

Transport the excavated tree immediately to its new location and lower it (by holding the root ball not the trunk) into the hole. Remove the burlap from around the root ball and backfill around the roots with the soil that was removed from the planting hole. Do not add any additional soil amendments, fertilizer, or mulch to the soil, as these have been found to be unnecessary for desert trees and shrubs (Bainbridge et al., 2001). When backfilling, add water to minimize air pockets. Be sure the soil is firmly packed around the bottom of the root ball to ensure the tree is vertical and well supported. The remaining soil shall be tamped down lightly around the roots, but not firmly compacted. Water thoroughly and slowly after the hole is completely filled.

Staking of the trees shall be avoided, as staking can often result in detrimental effects such as reduced trunk taper, smaller root system development, and greater instability once the stakes are removed (ISA, 2013). If additional support is required, a single stake located upwind of the tree may be sufficient. The stake shall be driven into the ground outside the newly planted root zone. Stabilize the tree as low on the trunk as possible, while still providing support with broad, slightly elastic, material that will not damage the tree. Any staking supports shall be removed within 2 years of the initial planting.

3.3.2 Shrubs

There is little available information on transplanting of native shrubs. Most desert shrubs have extensive fibrous root systems that would likely be extensively damaged during excavation and transplanting. Some desert shrub species, such as creosote bush and arrow weed, are capable of regeneration as long as the roots remain intact and undamaged. In areas were vegetation clearing is necessary for temporary construction access, cutting or flattening the aboveground stems while leaving the root systems intact generally will facilitate natural regeneration in a relatively short time. Additionally, many desert shrubs are propagated by seed or nursery stock (Abella and Newton, 2009; Clary and Slayback, 1984). In areas where natural regeneration is not possible, seed collection from local material can be used to establish container plants that can be used to establish new shrubs in selected planting areas.

3.3.3 Perennial Species

Cacti and other succulents typically do well when transplanted because they have lower water demand and smaller root systems than trees and shrubs. Generally, plants are salvaged before construction using machinery (e.g., a front loader or excavator), although smaller plants may be dug by hand (Bainbridge, 2007). Cactus tend to survive better if they are replanted in the same orientation they were growing, so before removal, mark the northern side of the plant. Survival of transplanted succulents can be high as long as the work is timed carefully, plants are handled gently and after care at the transplant site is good (Bainbridge, 2007).

Bulbs such as desert lily (*Hesperocallis undulata*) may be transplanted, but only when they are dormant. Therefore, it is important to identify their location with a flag and/or GPS in order to locate them later for transplant during flowering. Bulbs shall be stored in a cool, dry, shaded area until they can be replanted

either immediately or in late summer or early fall. Plants also can be grown from seed, but this is more time consuming and would require nursery facilities.

Other small perennials that have herbaceous stems and a woody base may be transplanted. Such plants often benefit from pruning stems back to about 12 inches above ground. The plants can then be transplanting to a new position away from the impacted area or directly into 1-gallon containers for temporary storage. Bowler (1994) recommends harvesting and transplanting during the winter immediately during or immediately following rain when the soil is moist to saturated. Other salvage methods for desert perennials include collection and storage of seeds during late spring or early summer. Seed should be stored in a cool dry environment and then sown directly into the soil in early winter. Additionally, seed can be collected and germinated in containers and grown in a nursery until plants are at least 12 inches tall. The container grown plants can then be planted out in late winter or early spring.

3.4 Replacement Planting and Seeding

This section includes specific methods that may be used for re-establishing plant populations within the project area. The restoration method will be dependent on the site conditions as well as during remediation activities at the site.

3.4.1 Seed Collection

Where transplanting of trees, shrubs and herbaceous plants is not possible, seed can be collected from the site for mitigation. Rainfall is variable in the project area and dry years can dramatically affect germination of annual plants as well as flowering and seed production of trees, shrubs and perennial species. Therefore, seed collection should only occur during “good” years with sufficient rainfall to stimulate germination and abundant flowering of the target species. The specific number and distribution of collection sites will vary according to size, density, continuity of populations, as well as the desired quantity of seed to be obtained. A general rule of thumb is to collect from a minimum of five collection sites at least 0.5 to 1 mile apart, and from no more than 20 percent of an individual’s seed crop. Collection from multiple populations in the project area may not be possible, since the number of known populations is limited for some species. If additional seed is needed, collections should be made from the regional project vicinity (within 10 miles if possible). Seed that is not used immediately should be stored in a cool, dry place until mitigation sites can be prepared or seeds can be sown in containers for propagation in a nursery. Reseeding of small disturbed sites (less than 0.5 acre) may be done by hand sowing in fall or early winter.

3.4.2 Container Grown Plants

Impacts to shrub species as well as larger trees (over 4 inches in diameter) likely will require replacement plantings using container-grown materials. Trees and shrubs including palo verde, western honey mesquite, screwbean mesquite, cattle saltbush, and big saltbush are relatively easy to propagate in a nursery and well adapted to transplanting with a minimal amount of care and maintenance (Bainbridge and Virginia, 1990; Bainbridge, 2007; Romney et al., 1989). Several commercial nurseries grow native plants from the Mojave Desert (Appendix B).

Depending on the number of trees and shrubs that are required for revegetation of disturbed areas, PG&E will consider contracting with a nursery that specializes in desert plant propagation to collect local seed and establish trees, shrubs and other plants from on-site material prior to mitigation planting. This would ensure that replacement plants are suitable for local environmental conditions. If only a small number of plants are required, appropriate available nursery stock may also be used.

Replacement planting for native trees including blue palo verde, hillside palo verde, western honey mesquite, and screwbean mesquite will consist largely of container-grown plants. Containers shall be long and narrow to encourage deep root growth such as Tall One Tree Pots (Steuewe & Sons, Inc., 4.5 inches wide by 14 Inches deep). Seedlings/saplings shall be between 4 to 6 months old when transplanted to prevent the plants from becoming root-bound in the pots. Replacement planting of shrubs such as

mesquite, cattle saltbush, big saltbush, and others shall be grown in 4- to 6-inch tube packs and transplanted when 9 to 12 months old.

Based on experimental results from the Mojave Desert, the median survival rate for species such as western honey mesquite is around 50 percent (Edwards et al., 2000; Grantz et al., 1998). Therefore, to achieve the desired density of plant species the number of container grown plants should be more a higher ratio to account for anticipated mortality.

Transplanting of container-grown trees and shrubs typically is done in the late winter to early spring between February and April (Romney et al., 1989; Edwards et al., 2000). Planting holes shall be excavated using an 8- to 10-inch-diameter power auger to a depth equal or just slightly more than the depth of the container (Grantz et al., 1998). Carefully remove the saplings from the container and place against one side of the planting hole, using excavated soils to backfill around the roots. Do not add additional soil amendments, fertilizer, or mulch to the soil as these have been found to be unnecessary for desert trees and shrubs (Bainbridge et al., 2001; Romney et al., 1989). When backfilling, add water simultaneously to minimize air pockets. Be sure the soil is firmly packed around the roots, but not firmly compacted. Water thoroughly and slowly after the hole is completely filled.

Trees will be spaced to maintain a density similar to the area from which they are removed or in similar spacing based on undisturbed areas near the project, but no closer than 8 feet apart. Shrubs will be spaced in a density similar to the density in the undisturbed surrounding vegetation, but no closer than 3 feet apart. To ensure soil and other environmental factors are most favorable for establishment, replacement plants will be planted in areas where individuals of the same species are healthy and growing well.

Some type of initial herbivore protection (such as wire mesh or tree shelters placed around the seedlings) is necessary to ensure good survival and growth of transplanted trees and shrubs (Romney et al., 1989; Grantz et al., 1998). Plastic tree shelters such as Tree-Pee (Bailey's Inc.) have been found to result in significantly higher survivorship than using wire mesh (Grantz et al., 1998).

Transplanted trees and shrubs should be watered using deep irrigation pipes (Bainbridge, 2006; Bainbridge et al., 2001). Deep pipe irrigation has been shown to produce much better survival rates and to require less water than other irrigation methods (Bainbridge et al., 2001). Bainbridge et al. (2001) had an establishment success rate of 71 percent for seedlings of western honey mesquite, by using only 5.3 gallons over 3.5 years with deep pipe irrigation when trees were planted with tubular tree protectors to minimize herbivory.

The method for using deep irrigation is described in Bainbridge (2006). For each transplanted tree or shrub, a hole is drilled to a depth of 20 to 30 inches with a soil auger. A polyvinyl chloride pipe (2 inches in diameter and 20 inches long with a series of 1/16-inch holes drilled 2 to 3 inches down one side beginning 7 inches below the top) is inserted to the bottom of the hole such that the side with holes faces the seedling or shrub with about 4 inches protruding above the ground surface for easy filling. The pipe shall be situated about 3 to 4 inches from the seedling. Two or three pipes can be situated around the root ball for transplanting shrubs or small trees.

Water (1 quart) will be directly applied to seedlings once every week for the first 8 weeks. Then irrigation pipes will be filled with 2 quarts every other week for at least 3 months after the initial watering. Watering will be continued at least until the end of August each year and will be done for the first 2 years after planting.

For relatively small areas where a large number of replacement trees may be needed, a gravity feed drip irrigation system from a large 4,000- to 5,000-gallon storage tank shall be used as an alternative watering method. This method will depend on the ability to situate the tank in an area accessible to a water truck for periodic refilling. This method was used successfully for the screwbean mesquite restoration project under the freeway bridge next to the Colorado River from 2006–2009 at TCS (C. Smith, pers. comm., 2013). For that project, newly planted trees were watered three times per week for about 3 to 4 hours per day for the first year and once per week in the subsequent 2 years.

There is generally no evidence that additional mulching enhances long-term survival and plant growth and some indication it may do more harm than good (Bainbridge et al., 2001), so no additional mulching is recommended. If tree seedlings or shrubs are planted from containers, inoculation of soil biota can be done by backfilling with excavated soil. In general, inoculation of soil biota is only required for severely degraded sites where the natural soil biota has been significantly depleted or is absent (Bainbridge and Virginia, 1990).

SECTION 4

Success Criteria, Monitoring, and Adaptive Management

Due to the fact that replacement saplings do not provide the same habitat value as mature trees a mitigation ratio of 3:1 will be used to offset impacts to riparian trees. Replacement trees will be propagated from locally collected seeds and grown in a nursery for 1 year prior to planting in selected mitigation sites. The success criteria for mitigation plantings will be a final minimum plant replacement ratio of 2.25:1 (75% overall survival rate) of mitigation plantings at the end of a minimum 5-year monitoring period.

Monitoring will continue for a minimum of 5 years following mitigation plantings. In the event that mortality rates or trends in declining vigor of the mitigation plantings result in less than a minimum of a final 2.25:1 mitigation ratio additional saplings will be planted. Any replacement plantings will be monitored for 5 years from the time of the initial planting to ensure that the mitigation success criteria have been met.

In order to account for anticipated mortality rates that may be as high as 50 percent for desert mitigation plantings, the initial replanting will include twice as many saplings as required by the mitigation ratios. This initial higher planting ratio is intended to compensate for expected sapling mortality over time and ensure that the final mitigation ratios are obtained. For example, if three palo verde trees will be removed during construction they would be replaced at a 3:1 ratio with seedlings grown from locally sourced seeds. The initial mitigation would therefore require nine replacement plantings. The success criteria would be 75% overall survival of these plantings after 5 years, resulting in a final mitigation ratio of 2.25:1 or survival of 6.75 (rounds to 7) out of nine initial plantings.

Taking into account expected mortality rates, the initial mitigation planting would be doubled to include 18 replacement plantings during the first year (see Table 3). It is anticipated that with the higher number of initial plantings and adaptive management at least 7 of the 18 saplings will become successfully established after 5 years. It is possible that even more plants may become established if adaptive management techniques result in increased survival. In the event mortality or trends in declining vigor indicate that success criteria will not be met, additional plantings and monitoring will be required to ensure that the final mitigation ratio is met.

TABLE 3
Example of Replacement Planting Ratios and Success Criteria

Number of Trees Impacted	3:1 Replacement Plantings	Initial Planting to Account for Anticipated Mortality	Final Success Criteria Minimum of 2:1 Replacement After 5 Years
3	9	18	7

Assuming 18 initial plantings with a potential 50% mortality rate and a final success criteria of 7 replacement trees

Monitoring	Anticipated Minimum Survivorship (Vigor Class of 2 or Greater)	Number of Plantings Remaining*	Mortality Thresholds Triggering Additional Plantings	Number of Plantings Remaining*
Year 1	90%	17	60% or less survivorship	11 or less
Year 2	80%	14	60% or less survivorship	11 or less
Year 3	70%	13	50% or less survivorship	9 or less
Year 4	60%	11	40% or less survivorship	7 or less
Year 5	50%	9	Success criteria not met	Less than 7

Note:
*Values are rounded to nearest whole number where required.

4.1 Tree and Shrub Assessment

Assessment of the vigor of trees and shrubs will use a modified index initially developed by Bainbridge et al. (2001):

- 0 = dead, stems brown brittle with no green or purple
- 1 = barely alive, stems still flexible with some green or purple
- 2 = some green or purple on stem, a few green leaves
- 3 = green or purple stem and a number of green leaves
- 4 = green or purple stem and green leaves, vigorous

4.2 Herbaceous Plant Assessment

Response of herbaceous plants can be highly variable depending on the amount and timing of rainfall. Therefore, monitoring of any transplanted bulbs (e.g., desert lily) as well as seeded areas will need to assess conditions relative to undisturbed areas. In years with good rainfall and an abundance of flowering annuals and good plant growth in the project area, mitigated areas should exhibit similar abundances of the seeded annuals and transplanted perennials. Annual monitoring for herbaceous plants will include both reference areas (undisturbed sites) and revegetation areas. Representative photographs of each area as well as a qualitative description of each site will be included as part of the monitoring.

4.3 Maintenance and Adaptive Management

Adaptive management involves learning from experience and modifying subsequent behavior in light of that experience. Data may be collected and analyzed throughout the monitoring period and the results used to modify (adapt) restoration approaches, as appropriate, to ensure successful establishment of transplanted species and the desired density and cover of plants. Maintenance and adaptive management will focus on the following areas: weed control, irrigation modification, herbivory protection, and mortality rates.

4.3.1 Weed Control

Weedy species, such as Russian thistle (*Salsola tragus*), Sahara mustard *(Brassica tournefortii*), and salt cedar can significantly affect growth and survival of transplants. Transplant and seed sites shall be relatively weed-free and shall be monitored regularly for weed infestations. It is much easier to prevent the establishment of weeds in an area than it is to eradicate weed populations once they have become established. Monitoring for weed seedlings of Russian thistle, Sahara mustard, and salt cedar will be done early in the growing season (March–April) to allow for treatment and removal of weedy species before flowering and seed dispersal. In addition, young weed seedlings can be removed by hand, thereby avoiding the need for more intensive mechanical or chemical treatments.

4.3.2 Irrigation Modification

Because the objective is to obtain the maximum survival rate of transplanted individuals, it may be necessary to modify the irrigation schedule and/or amount of water during the restoration process. While irrigation will only be used during the initial establishment phase, the condition of the plants will be monitored throughout the monitoring period. If after the initial watering, plants show a notable decline in vigor, it may be necessary to increase the amount and or timing of irrigation to prevent mortality and reduced vigor. Care will be taken not to overwater the plants.

4.3.3 Herbivory Protection

Tree and shrub protectors will be maintained until the plants are large enough to withstand herbivory or prior to the growth of the plant being impacted by the barrier. PG&E will be responsible for removing the tree and shrub protectors.

4.3.4 Mortality Rates

It is expected that the initial plantings will experience some level of mortality. If survivorship drops below target levels of 50 percent, additional plantings will be required. To prevent further mortality, adjustments to the watering regime and/or herbivore protection will be necessary, depending on the most probable cause of the mortality.

4.4 Photo Monitoring Stations

Photo-monitoring stations will be established at selected locations throughout the project area to document preconstruction conditions, document natural recovery and as part of the monitoring of revegetation and restoration areas. The following methods and procedure are adapted from the U.S. Department of Agriculture's Photo Point Monitoring Handbook (Hall, 2002).

4.4.1 Objectives

The objectives of the photo-monitoring include the following objects:

- Document the preconstruction site conditions of the project work areas on the HNWR for restoration activities after decommissioning
- Document the post-construction site conditions of the project work areas on the HNWR
- Document changes in vegetation over time in the work areas, including natural regeneration and recovery of native plants
- Document revegetation and/or restoration sites, including vegetation changes over time as well as general qualitative documentation of plant cover and vegetation condition

4.4.2 Equipment

The following equipment will be needed for the photo monitoring:

- Digital camera
- GPS unit with sub-meter accuracy
- White board and black dry erase pen
- Compass
- Photo monitoring data sheets (Appendix C)

4.4.3 Methods

Before starting construction, multiple photo monitoring locations will be selected throughout the project area that will be used to document the pre- and post-construction conditions. This will be referenced to as preconstruction photo documentation (PPD). PPD will be completed to assist in restoration activities after remedy decommissioning. A subset of the PPD photo points will be located in areas to specifically document areas where existing vegetation and habitats will be impacted by project activities. These photo points will be referred to as revegetation photo documentation (RPD). The exact locations and views of the photo monitoring stations will be determined once the final project design has been completed and the limits of the work areas have been firmly established. Additional photo monitoring stations also will be established at revegetation/restoration sites as well as any reference plant community locations.

Once the photo monitoring sites have been determined, a GPS unit with sub-meter accuracy will be used to record the location of the camera position. Notes will be taken on the locations including any notable landmarks and other information that will assist in easily relocating the position. Photo point locations will then be mapped on aerial photographs that have roads and other major landmarks clearly labeled.

Once the scene to be captured by the photo point has been determined, record the compass direction of the camera view in both cardinal directions (north, south, southwest, etc.) and degrees. Subsequent photographs taken from the same photo point will be taken in the same direction each time.

On the data sheet, describe the scene including notable items in the view that mat help with reorientation of the camera during subsequent monitoring. Provide a general description of the photo point including plant species, ground cover, disturbance, vegetation condition, etc.

After the first photo monitoring event is completed, maps, directions, and instructions on the orientations and views for each photo location will be prepared that will be used as the basis for subsequent monitoring events at each location.

After photographing the selected scene at each location, it may be useful to include additional site photographs of particular features and plants to provide additional detail on the site. For each additional photo, include a description of the setting or conditions that are being documented and include the photos and additional information with the photo monitoring report.

4.4.4 Frequency

Photo monitoring will occur before starting construction and following construction concurrent with monitoring of the revegetation sites. Photo documentation will be taken for 5 years post-construction and will occur in years 1, 2, 3 and 5. Post-construction and RPD monitoring will occur with each vegetation monitoring event, and photos will be appropriately archived in monitoring reports for use during post-decommissioning restoration.

4.5 Reporting

Following each monitoring event, a monitoring report will be prepared. The first monitoring report will be prepared during the first year following completion of construction activities. The first monitoring report will include specific information on the number, species, and locations of trees and shrubs that were removed or otherwise permanently impacted during construction as well as the number, species, and locations of mitigation plantings. The report also will include information on areas where aboveground trimming of shrubs occurred, but belowground root systems were left intact. The first monitoring report will include pre- and post-construction photographs from the photo monitoring stations, as well as photographs of the revegetation sites. The first report also will include the necessary documentation to relocate the photo monitoring stations in subsequent years.

Additional monitoring reports will be prepared for the following year 2, 3, and 5 monitoring events. These reports will include observations of natural recovery in construction areas, with particular emphasis on those areas where the belowground roots were left intact. Assessment of the revegetation areas including the condition of the revegetation plantings, discussion of any problems, and recommendations for adaptive management actions needed to be taken to address the problems. These reports also will include photographs and information from each of the photo monitoring stations.

Monitoring reports will be submitted to USFWS within 90 days of the completion of each monitoring event.

SECTION 5

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