FINAL
FIRST FIVE-YEAR REVIEW ON GROUNDWATER REMEDY FOR PG&E TOPOCK COMPRESSOR STATION REMEDIATION PROJECT SAN BERNARDINO COUNTY, CALIFORNIA

Prepared For:

U.S. Department of the Interior
1849 C St, NW, Room 7308
Washington DC, DC, 20240

Prepared By:
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DECEMBER 2023

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Approved by:

VERONICA DICKERSON

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Ms. Veronica Dickerson, ECCD/OEPC
Topock Program Manager
U.S. Department of the Interior

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LIST OF ACRONYMS

µg/L	micrograms per liter
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
AFFF	Aqueous Film Forming Foam
AOC	Area of Concern
APE	Area of Potential Effects
ARAR	Applicable or Relevant and Appropriate Requirement
BB&E	BB&E, Inc.
bgs	below ground surface
BLM	Bureau of Land Management
BNSF	BNSF Railway
BOD	Basis of Design
BOR	U.S. Bureau of Reclamation
CACA	Corrective Action Consent Agreement
Caltrans	California Department of Transportation
CD	consent decree
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CHPMP	Cultural and Historic Properties Management Plan
CIP	clean-in-place
CMS	Corrective Measures Study
CRMP	Cultural Resources Management Plan
Cr(III)	trivalent chromium
Cr(T)	total chromium
Cr(VI)	hexavalent chromium
COCs	Constituents of Concern
COPCs	Contaminants of Potential Concern
DCE	dichloroethane
DOI	Department of the Interior
DOI ECCD	Department of the Interior Environmental Compliance and Cleanup Division
DOI OEPC	Department of the Interior Office of Environmental Policy and Compliance
DTSC	State of California Environmental Protection Agency, Department of Toxic Substances Control
ECCD	Environmental Compliance and Cleanup Division
EIR	Environmental Impact Report
ESA	Endangered Species Act
FFS	Focused Feasibility Study
FI	Facility Investigation
FS	Feasibility Study
ft	feet
FMIT	Fort Mojave Indian Tribe
FYR	Five-Year Review
GETS	Groundwater Extraction and Treatment System
GWRA	Groundwater Risk Assessment
HAL	health advisory level
HNWR	Havasu National Wildlife Refuge
I-40	Interstate 40
IAS	Initial Assessment Study

ICs	Institutional Controls
ILCRs	Incremental Lifetime Cancer Risks
IM	Interim Measures
IRL	Inner Recirculation Loop
IRZ	In-Situ Reactive Zone
LTM	Long-Term Monitoring
MCL	Maximum Contaminant Level
MMRP	Mitigation Monitoring and Reporting Program
MNA	Monitored Natural Attenuation
MOA	Memorandum of Agreement
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No Further Action
NHPA	National Historic Preservation Act
NPL	National Priorities List
NRWQC	National Recommended Water Quality Criteria
NTH	National Trails Highway
O&M	Operation and Maintenance
OEPC	Office of Environment Policy and Compliance
OU	Operational Unit
OSWER	Office of Solid Waste and Emergency Response
PA	Programmatic Agreement
PAP	Perimeter Assessment Plan
PBA	Programmatic Biological Assessment
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
P.E.	Professional Engineer
PFAS	per- and polyfluoroalkyl substances
PG&E	Pacific Gas and Electric Company
PLC	Programmable Logic Controllers
PRP	Potentially Responsible Party
QA/QC	quality assurance/quality control
RAO	Remedial Action Objectives
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
ROW	Right of Way
RPWC	Remedy-Produced Water Conditioning
RSL	Regional Screening Level
SARA	Superfund Amendments and Reauthorization Act
SCADA	supervisory control and data acquisition
SCRMA	Special Cultural Resource Management Area
SDS	safety data sheets (SDS),
SHPO	State Historic Preservation Officer
SI	Site Inspection
SLERA	screening-level ecological risk assessment
SMP	Sampling and Monitoring Plan
SOP	standard operating procedure
SWRCB	California State Water Resources Control Board
SWMU	Solid Waste Management Unit
TAL	Target Analyte List

TCA	trichloroethane
TCE	trichloroethene or tetrachloroethylene
TCL	Target Compound List
TCS	Topock Compressor Station
TCRA	time-critical removal action
TDH	total dynamic head
TOC	total organic carbon
µg/L	micrograms per liter
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UU/UE	unlimited use/unrestricted exposure
VC	vinyl chloride
VOC	volatile organic compound

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Pacific Gas and Electric Company (PG&E) Topock Compressor Station		
EPA ID: CAT080011729		
Region: 9	**State:** CA	**City/County:** San Bernardino County

National Priorities List (NPL) Status: Non-NPL	
Multiple OUs? No	**Has the site achieved construction completion?** No

Lead agency: Other Federal Agency ***[If "Other Federal Agency", enter Agency name]*:** Department of the Interior (DOI)
Author name (Federal or State Project Manager): Veronica Dickerson, DOI ECCD/OEPC
Author affiliation: DOI Topock Program Manager in conjunction with BB&E, Inc.
Review period: 2018-2023
Date of site inspections: 5/10/2023 - 5/11/2023, 6/7/2023 - 6/8/2023, 8/9/2023 - 8/10/2023
Type of review: Statutory
Review number: 1
Triggering action date: 10/2/2018
Due date *(five years after triggering action date)*: 10/2/2023

1.0 INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy is and will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in FYR reports such as this one. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

On behalf of the Department of the Interior (DOI), BB&E, Inc. (BB&E) has prepared this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121, consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Section 300.430(f)(4)(ii)) and considering United States Environmental Protection Agency (USEPA) policy. This FYR was conducted in accordance with USEPA's Comprehensive Five-Year Review Guidance (USEPA, 2001).

This is the first FYR of the groundwater remedy (Selected Remedy) at the Pacific Gas & Electric Company (PG&E) Topock Compressor Station (TCS) site located in San Bernardino County, California (Topock Site) (**Figure 1**). The Topock Site is listed in the USEPA CERCLA Information System – CERCLIS EPA ID No. CAT080011729 but is not listed as a National Priorities List (NPL) site. This FYR has been prepared to address the hazardous substances, pollutants, or contaminants in groundwater that remain at the Topock Site above levels that allow for unlimited use and unrestricted exposure (UU/UE). The triggering action for this statutory review is based on the initiation of the Selected Remedy construction in October 2018. FYRs will continue to be conducted every five years until cleanup standards are achieved to ensure that the Selected Remedy is, or will be, protective of human health and the environment (USEPA, 2001).

The constituent of concern (COC) in groundwater at the Topock Site is hexavalent chromium (Cr[VI]) and the existing Cr(VI) contamination in groundwater (referred to as the plume) is attributable to prior discharges of wastewater from TCS operations into the Former Percolation Bed in Bat Cave Wash, designated as Solid Waste Management Unit (SWMU) 1 and the area around the Former Percolation Bed, designated as Area of Concern (AOC) 1, and within the East Ravine, designated as AOC 10 (**Figure 2**). In December 2010, the DOI issued a *Record of Decision* (herein referred to as ROD) (DOI, 2010) on behalf of the United States Fish and Wildlife Service (USFWS), the Bureau of Land Management (BLM), and the Bureau of Reclamation (BOR) (collectively referred to as the Federal Agencies) pursuant to the Federal Agencies' CERCLA lead agency authorities to address existing chromium contamination within SWMU1/AOC 1 and AOC 10. The DOI and the State of California Environmental Protection Agency, Department of Toxic Substances Control (DTSC) coordinated fully in the selection of the remedial action and the DTSC concurred with the Selected Remedy. The Selected Remedy for SWMU 1/AOC 1 and AOC 10 is in-situ treatment with freshwater flushing for the treatment of Cr(VI) in groundwater. **Section 2** provides a discussion of the Selected Remedy components. Details on the Selected Remedy can also be found in the ROD. The DOI and DTSC separated the groundwater and soil investigations and a final remedy to address contaminated soils within the Topock Site has not yet been selected.

Design and implementation of the Selected Remedy includes design and construction of the groundwater remedy components, followed by operations, maintenance, and monitoring to ensure the remedy is performing as designed. DOI conditionally approved the *Basis of Design Report/Final (100%) Design Submittal for the Final Groundwater Remedy* (herein referred to as the Final Basis of Design [BOD]; CH2M Hill, 2015a) for the Selected Remedy on April 3, 2018 (DOI, 2018) and on April 24, 2018, it was conditionally approved by DTSC (DTSC, 2018). Construction and start-up of the Selected Remedy is proceeding in phases (Phase 1, Phase 2A, and Phase 2B). Phase 1 construction initiation began on October 2, 2018 and included construction of the In-Situ Reactive Zone (IRZ) along National Trails Highway (NTH) and supporting components, monitoring wells, and riverbank recovery wells. On December 22, 2021, start-up began for Phase 1 including start-up of the IRZ system, operation, maintenance, and monitoring. Phase 2A construction began in March 2022 and is currently ongoing. Phase

2A includes construction of the TCS Recirculation Loop, freshwater injection well FW-2, and associated arsenic monitoring wells and pipelines. Phase 2B will include construction of the Inner Recirculation Loop (IRL), freshwater injection well FW-1 and monitoring wells in the uplands, facilities to convey water from freshwater supply well (HNWR-1A) in Arizona to California, and remaining TCS facilities and pipelines. **Section 2** provides details on construction phases and provides a status update on construction, operations, maintenance, and monitoring.

This FYR was led by the DOI Environmental Compliance and Cleanup Division (ECCD) Office of Environmental Policy and Compliance (OEPC) with support from its technical contractor, BB&E. The FYR Team is included in **Table 1**. A public notice of the initiation of the FYR was made available via newspaper postings, submittal to information repositories, posting online on the PG&E remediation website, through email notifications, and through distribution at a Consultative Work Group (CWG) meeting, as detailed in **Section 4.1** and **Appendix A**. Interviews were conducted from May 10, 2023 through July 28, 2023, as detailed in **Section 4.1** and **Appendix B**. The FYR process and schedule was presented to the CWG on May 9, 2023 in-person and via teleconference, as detailed in in **Section 4.3** and **Appendix C**. FYR site inspections were conducted on May 10-11, 2023, June 7-8, 2023, and August 9-10, 2023, as detailed in **Section 4.3**, **Appendix D,** and **Appendix E**.

Table 1: Five-Year Review Team Members

Name/Organization	Email	Phone	Role
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Ms. Katrice Depew; BB&E, Inc.	kdepew@bbande.com	(248) 489-9636	FYR Environmental Specialist

1.1 Land Ownership & Land Use

The Topock Site is located adjacent to the Colorado River in eastern San Bernardino County, California, approximately 12 miles southeast of Needles, California, south of Interstate 40 (I-40), in the north end of the Chemehuevi Mountains (**Figure 1**). The Topock Site encompasses land owned and/or managed by other government agencies and private entities including the BOR (managed by BLM), USFWS (managing the Havasu National Wildlife Refuge [HNWR]), San Bernardino County, BNSF Railway (BNSF), Fort Mojave Indian Tribe (FMIT), and the Metropolitan Water District of Southern California (**Figure 3**). In addition, several other entities have easements and/or rights of way (ROWs) including the California Department of Transportation (Caltrans), Southern California Gas Company, Transwestern Pipeline Company, Mojave Pipeline Company, PG&E, City of Needles Electric, Southwest Gas Corporation, and Frontier Communications. Landowners/leaseholders in Arizona where pipelines for freshwater are proposed in the Final BOD include Kinder Morgan, BNSF, Arizona Department of Transportation, Mohave County, and

private property owners. Ownership of land beneath the Colorado River includes the California State Lands Commission and the Arizona State Lands Department (CH2M Hill, 2015a).

The TCS occupies approximately 15 acres of the Topock Site. The TCS property is immediately surrounded by the HNWR. Recreational activities at HNWR include sightseeing, bird watching, fishing, hunting, and canoeing. All areas within HNWR and outside the TCS are currently accessible for some or all of these activities and are expected to remain accessible in the future (DOI, 2010).

Other land uses in the area are predominantly open space, interspersed with industrial facilities, recreational uses, and transportation infrastructure. Open space near the TCS is characterized primarily by sparse desert vegetation on steep, rocky slopes. The Topock Site is bisected by several steep-sided ephemeral streams, including Bat Cave Wash and several unnamed washes that flow north to the confluence of the Colorado River. Open space along the Colorado River floodplain is characterized by shifting sand dunes and associated riparian vegetation, primarily non-native tamarisk (salt cedar) (DOI, 2010).

The Topock Site is located in a sparsely populated, rural area. The nearest communities include a few residents at Topock, Arizona as well as mobile home parks at Topock, Arizona and Moabi Regional Park, California. The Pirate Cove Resort in Moabi Regional Park is a popular attraction for recreational boaters. The Topock Marina and Topock66 Resort are also popular tourist destinations. Topock is located on the Arizona (or eastern) side of the Colorado River, about 0.5 mile east-northeast of the TCS. Moabi Regional Park is located on the California (or western) side of the Colorado River about one mile northwest of the TCS. The community of Golden Shores, the largest nearby community, is approximately five miles north of the Topock Site on the eastern side of the Colorado River.

A major gas utility and transportation corridor is located within the Topock Site. This corridor includes six natural gas transmission pipelines, a BNSF railway line, and the I-40 freeway. Other developed land uses within the Topock Site include the NTH, former Route 66, and various unnamed access roads. A BOR gravel quarry is located approximately 1,500 feet southwest of the TCS. Evaporation ponds associated with TCS operations are located approximately 3,000 feet west of TCS (DOI, 2010). In addition, IM No. 3, an interim remedial measures groundwater treatment plant that has been in lay-up mode since March 22, 2022, and numerous groundwater wells related to the ongoing groundwater investigation and remedial activities are located at the Topock Site.

Current land uses at the Topock Site are likely to remain the same for the foreseeable future. PG&E owns the TCS and associated property and plans to continue the industrial operation for the foreseeable future. The railroad and highway will also continue in their current use for the foreseeable future. The primary conservation mission of USFWS, as it applies to HNWR, limits human use of HNWR property. In the future, human use of HNWR property will likely continue to be restricted to recreational uses. Although current uses of the BLM-managed land in the area are predominantly recreational, BLM has determined that residential use of some of this property cannot be precluded (DOI, 2010).

1.2 Site Background

Background information presented in this section was taken from the ROD, unless otherwise noted.

PG&E began operations at the TCS in December 1951 to compress natural gas supplied from the southwestern United States for transport through pipelines to PG&E's service territory in central and northern California. Historic records indicate that PG&E held rights to operate a gas pipeline and compressor station dating back to the Federal Act of February 25, 1920 (41 Stat. 449, as amended). Based on available title records, PG&E gained full ownership of the land in 1965.

Current operations at the TCS are very similar to the operations that began in 1951. The operations consist of six major activities: compression of natural gas, cooling of the compressed natural gas and compressor lubricating oil, water conditioning, wastewater treatment, facility and equipment maintenance, and

miscellaneous operations. The greatest use of chemical products involves treatment of cooling water, and the greatest volume of waste produced consists of blowdown from the cooling towers.

From 1951 to 1985, Cr(VI)-based corrosion inhibitors and biocides were added to the cooling water. Several different corrosion inhibitors were used during this period; however, all are believed to have contained Cr(VI). Product specification sheets available for one of the additives indicate that it contained 30 percent (%) sodium chromate. In the early 1960s, a separate biocide containing Cr(VI) was also apparently added to assist in the control of algae, fungi, and/or bacteria.

Until approximately 1970, cooling tower blowdown was discharged directly into percolation beds and the wash located in Bat Cave Wash, an unlined arroyo immediately west of the TCS, and either percolated into the ground or evaporated at the surface. The Former Percolation Beds are designated as SWMU 1 and the area around the Former Percolation Beds are designated as AOC 1 (**Figure 2**). Wastewater discharged to percolation beds consisted primarily of cooling tower blowdown (about 95%) and a minor volume of effluent from an oil/water separator and other facility maintenance operations (about 5%). Beginning in 1964, PG&E treated the cooling tower blowdown to remove chromium prior to discharge. In 1964, PG&E installed a wastewater line to the old supply well, designated as TCS-4, with intentions of injecting chromium wastewater into it. The continuous discharge of wastewater to Bat Cave Wash ceased in May 1970 when injection well PGE-08 was brought online. From May 1970 to September 1971, however, some treated wastewater may have been temporarily discharged to the percolation bed in Bat Cave Wash (SWMU 1) when injection well PGE-08 was offline for repairs or maintenance. All wastewater discharges to the percolation bed in Bat Cave Wash (SWMU 1) stopped when the first of four single-lined evaporation ponds was installed in September 1971, approximately 0.5 mile southwest of the TCS. PG&E replaced the Cr(VI)-based cooling water treatment products with phosphate-based products in 1985. Use of the four, single-lined evaporation ponds continued until 1989. In 1989, the single-lined ponds were replaced with four new, Class II (double-lined) ponds, located approximately 1.2 miles to the northwest. The cooling tower blowdown treatment system and the single-lined ponds were physically removed and clean-closed from 1988 to 1993. The four Class II double-lined ponds, which are on BLM-managed property, are still in use and are operated pursuant to a permit issued by the State of California Regional Water Quality Control Board, Colorado River Basin Region.

East Ravine, designated as AOC 10, is located southeast of the TCS, and includes four subareas, designated as AOC 10a, 10b, 10c, and 10d (**Figure 2**). Subarea 10a is the location of the termination of a storm drain leading from the southeastern portion of the TCS. The remaining subareas are locations within the East Ravine where water and sediment have collected within low areas or behind one of three earthen embankments. Six historical aerial photographs from the 1960s of this portion of the Topock Site show a low area within AOC 10c that apparently contained liquids behind the largest embankment. While the composition of the liquids is not known, it is noted that this is the location of some of the highest chromium concentrations detected in site soil sampling. Thin layers of a white powdery material have also been identified in the East Ravine area that are visually similar to the white waste layers located in Bat Cave Wash and the Railroad Debris Site. Drainage to East Ravine includes minor runoff from the access road to the facility, runoff from the mountains to the south, and some runoff from the TCS (CH2M Hill, 2009a).

1.3 Cultural and Historical Resources

The Area of Potential Effects (APE) for the Topock Site is contained within a larger area of traditional and cultural importance. Nine federally-recognized Native American tribes: Chemehuevi Indian Tribe, Cocopah Tribe of Arizona, Colorado River Indian Tribes, Fort Mojave Indian Tribe, Havasupai Indian Tribe, Hualapai Indian Tribe, Quechan Tribe of the Fort Yuma Indian Reservation, Twenty-Nine Palms Band of Mission Indians, and Yavapai-Prescott Tribe (herein referred to as the tribes) have ties to the area in which the Selected Remedy will be implemented. The tribes believe that the environmental, cultural, and spiritual resources in this area may not be physically perceptible. DTSC concluded in the January 2011 certified *Environmental Impact Report* (EIR; AECOM, 2011) that the 779.2-acre project site "appears to

qualify as a historic resource under the California Environmental Quality Act (CEQA) as an area that is significant in the social and cultural annals of California," and the BLM also has determined that a traditional cultural property or property of traditional religious and cultural significance that is eligible for listing on the National Register of Historic Places exists in the area of the Topock Site, within the APE, consisting of 1,600 acres of surface area and a section of the Colorado River (CH2M Hill, 2015a).

The Topock Site is also located in a Riparian and Cultural Area of Critical Environmental Concern (ACEC), designated under the BLM *Record of Decision and Lake Havasu Field Office Approved Resource Management Plan* (BLM Resource Management Plan; BLM, 2007). Thousands of years of human history are evident in the area surrounding the TCS. Among the larger and better-known cultural resources on the site is an expansive desert geoglyph or intaglio known as the Topock Maze. Although the Maze is viewed as one contiguous element of a larger area having unique value to some tribes, archaeological documents refer to three geographically distinct parts, two of which overlie the plume.

A broad spectrum of archaeological resources is also present within the project area and on adjacent lands. Properties on and near the Topock Site that are eligible for or listed on the National Register of Historic Places include Native American cultural resources and elements of the historic "built environment" (CH2M Hill, 2015a).

In recognition of this, all remedial activities at TCS are planned in such a way as to minimize impact to this area. Specifically, impacts to cultural resources will be minimized by implementing the mitigation measures required by the Mitigation Monitoring and Reporting Program (MMRP) adopted by DTSC in 2011 as part of the certified EIR (AECOM, 2011). In addition, mitigation measures will be implemented in accordance with *the Topock Remediation Project Programmatic Agreement (PA) Amendment 1* (BLM, 2017), the *Cultural and Historic Properties Management Plan* (CHPMP; BLM, 2012), and in consultation with the tribes. Work at the Topock Site is to be conducted in a manner that recognizes and respects these resources and the spiritual values of the area (CH2M Hill, 2015a).

1.4 Ecological Resources

A large portion of the Topock Site and surrounding area is the HNWR. The *Lower Colorado River National Wildlife Refuges Comprehensive Management Plan 1994-2014* (Comprehensive Management Plan; USFWS and BOR, 1994), adopted in 1994, currently guides land management at HNWR. The Comprehensive Management Plan emphasizes that HNWR should be used in a manner that will facilitate protection of (1) the endangered and threatened species found in HNWR, (2) the marsh and wetland habitat for both endangered and threatened species, and (3) the habitat for migratory, wintering, and nongame avian species. Portions of the Topock Site are also located in a Riparian and Cultural ACEC and the Topock-Needles Special Cultural Resource Management Area (SCRMA), designated under the BLM Resource Management Plan (BLM, 2007) (CH2M Hill, 2015a).

Activities associated with implementation of the Selected Remedy are conducted in accordance with the 2014 *Programmatic Biological Assessment* (PBA; CH2M Hill, 2014). The findings in the PBA state that the proposed action associated with the Selected Remedy was not likely to adversely affect five species listed under the ESA and was not likely to jeopardize one species proposed for listing as threatened under the ESA and one candidate species for listing under the ESA (CH2M Hill, 2015a).

1.5 Geology

The Topock Site is in the Basin and Range geomorphic province, characterized by roughly parallel north/south fault block mountains separated by alluvial valleys. The oldest rocks in the surrounding area are exposed in the Chemehuevi Mountains and include Precambrian and Mesozoic-age metamorphic and igneous rocks. Miocene-age sedimentary and volcanic rocks, associated with the tectonic uplift and faulting in the region, were deposited on the metamorphic and plutonic bedrock complex. The bedrock basement formations are, in turn, overlain by younger Tertiary and Quaternary to Recent-age sedimentary deposits (CH2M Hill, 2009a).

The most prominent geologic structural feature is the detachment fault that forms the northern boundary of the Chemehuevi Mountains. The Chemehuevi detachment fault, located near the southern boundary of the APE, is inferred to be a low-angle (15- to 20-degree), northeast-dipping normal fault that has displaced pre-Tertiary metamorphic bedrock and Miocene sedimentary rocks (upper plate) across underlying, lower plate crystalline bedrock. The surface trace of the Chemehuevi detachment fault is mapped in western Mohave County, Arizona, approximately 2 miles southeast of the Topock Site, indicating that this regional fault extends eastward from California into Arizona (CH2M Hill, 2009a).

1.6 Surface Features and Topography

The Topock Site is located in the southern portion of the Mohave Valley, north of the Chemehuevi Mountains. Overlying the plume, topography ranges from approximately 455 feet above mean sea level at the Colorado River floodplain to approximately 600 to 625 feet above mean sea level at the TCS (CH2M Hill, 2009a).

The Topock Site consists of a series of terraces divided by dry desert washes. The terraces are considerably eroded with very steep slopes. The TCS is located on a prominent alluvial terrace. Incised drainage channels separate the alluvial terraces. Overlying the plume, the largest incised channel is Bat Cave Wash, a north-south dry wash that bisects the plume. Bat Cave Wash flows on the surface only intermittently as an ephemeral stream following intense rainfall events and extends to the Colorado River (CH2M Hill, 2009a).

1.7 Hydrogeology

The Topock Site is located at the southern downstream end of the Mohave Valley groundwater basin. Groundwater in the Mohave Basin occurs in the Tertiary and younger alluvial fan and fluvial deposits. The unconsolidated alluvial and fluvial deposits are underlain by the Miocene Conglomerate and pre-Tertiary metamorphic and igneous bedrock. The bedrock typically has lower permeability; therefore, groundwater movement occurs primarily in the overlying unconsolidated deposits. In the Mohave groundwater basin, water-bearing zones may occur locally where bedrock formations are weathered or fractured, although no areas have been identified where saturated bedrock formations are capable of yielding significant quantities of groundwater (CH2M Hill, 2009a).

Groundwater occurs under unconfined to semi-confined conditions within the alluvial fan and fluvial sediments beneath most of the Topock Site. The alluvial sediments consist primarily of clayey/ silty sand and clayey gravel deposits interfingered with more permeable sand and gravel deposits. The alluvial deposits exhibit considerable variability in hydraulic conductivity between fine and coarse-grained sequences. The fluvial sediments similarly consist of interbedded sand, sandy gravel, and silt/clay. The fluvial deposits at the Topock Site include the older Pleistocene deposits as well as more recent fluvial deposits associated with the Colorado River. The saturated portion of the alluvial fan and fluvial sediments are collectively referred to as the Alluvial Aquifer. The TCS is located on an upland alluvial terrace near the southern edge of the Alluvial Aquifer where the aquifer pinches out against the underlying, sloping bedrock (CH2M Hill, 2009a).

The water table in the Alluvial Aquifer is flat and typically equilibrates to an elevation within 2 to 3 feet of the river level. Based on the variable topography, the depth to groundwater ranges from as shallow as 5 feet below ground surface (bgs) in floodplain wells near the Colorado River to approximately 170 feet bgs at the upland alluvial terrace areas. The saturated thickness of the Alluvial Aquifer is about 100 feet in the floodplain and thins to the south, pinching out along the Miocene Conglomerate and bedrock outcrops. In the western portions of the Topock Site, where the depth to bedrock increases, the saturated Alluvial Aquifer is over 200 feet thick (CH2M Hill, 2009a).

A summary of hydrogeologic and hydrogeochemical features of the Topock Site from the *Corrective Measures Study*/*Feasibility Study* (CMS/FS; CH2M Hill, 2009a) is provided below:

- Under natural conditions, groundwater flows from west-southwest to east-northeast across the Topock Site. Localized areas of northward flow likely occur along the mountain front to the south of the TCS. Gradients are very small due to the limited recharge, with a typical value of 0.0005 foot/foot in the alluvial area. Under average conditions, groundwater velocity ranges from about 25 to 46 feet/year, according to numerical model estimates. Gradients are upward between bedrock and the overlying Alluvial Aquifer and typically, but not universally, upward within the Alluvial Aquifer.
- Investigation and monitoring in the East Ravine area shows that the groundwater in fractured bedrock is in hydraulic communication with the Alluvial Aquifer and equilibrates to an approximate elevation similar to the water table in the Alluvial Aquifer. Compared to the Alluvial Aquifer, the fractured rock permeabilities are overall very low.
- Under ambient conditions in the vicinity of the Topock Site, the Colorado River recharges groundwater during the higher-flow stages in the spring and summer months, and groundwater discharges to the river during the months of lower river stages in fall and winter. From 2004 until shutdown/layup in 2021, the Interim Measures (IMs) groundwater extraction and treatment system maintained a consistent, year-round landward gradient in the area where the plume is present in the floodplain.

1.8 Surface Water

The primary surface water feature at the Topock Site is the Colorado River. The Colorado River channel ranges from approximately 600 to 700 feet wide in the area upstream of the I-40 bridge crossing. In 2005, the river depths ranged from 4 to 12 feet on two cross-river transects measured at and north of the I-40 bridge. On the river transect measured at the I-3 pipeline bridge, the channel depths ranged from 5 feet near the Arizona shoreline to a maximum of 22 feet near the California shoreline (CH2M Hill, 2009a). Additional historical information on Colorado River dredging, river morphology, and bridge crossing subsurface investigations were incorporated in the surface water characterization, as summarized in the *Revised Final RCRA Facility Investigation/Remedial Investigation Report, Volume 2* (RFI/RI Volume 2; CH2M Hill, 2009b).

The flow of the Colorado River is dynamic and fluctuates daily and seasonally as a result of BOR's power and water delivery schedule. The flow of the Colorado River at Topock is regulated by BOR, primarily by the controlled release of water from Davis Dam on Lake Mohave approximately 33 miles upstream. River levels at the Topock Site fluctuate by 2 to 3 feet per day, and flows vary anywhere from 4,000 to 25,000 cubic feet per second according to the dam releases (CH2M Hill, 2009b).

1.9 Groundwater and Surface Water Uses

Groundwater affected by or in the immediate vicinity of the plume is currently not used as a drinking water supply. The nearest groundwater supply wells in California are located approximately 1.3 miles west-northwest of the plume at the Park Moabi Marina. Groundwater supply wells are also located at private residences south of the Topock Marina on the eastern side of the Colorado River approximately 0.3 mile east-southeast of the eastern extent of the plume (DOI, 2010). The main source of water for the Topock Marina and operation of the TCS comes from wells Topock 2/3 located 4,700 feet northeast of the MW-20 Bench. This is the only source of groundwater or surface water supply for either the TCS or Topock Marina.

Given that the BLM has determined that the possibility of residential use of property overlying or adjacent to the plume area cannot be precluded, the possibility of future development of the groundwater aquifer as a drinking water supply was considered as a part of the ROD.

The Colorado River, located adjacent to and east of the plume, is a major source of water for irrigation, drinking, and other uses by humans and wildlife. The closest downstream supply intake is located approximately 21 river miles downstream of the Topock Site. The Colorado River also supports recreational

uses of swimming, boating, and fishing. In addition, the Colorado River provides essential habitat and supports various plant and wildlife species, including threatened or endangered species. It is expected that use of the Colorado River as a major source of water for irrigation, drinking, and other uses by humans and wildlife will remain the same for the foreseeable future (DOI, 2010).

2.0 RESPONSE ACTION SUMMARY

2.1 Basis for Taking Action

In November 2009, PG&E completed the *Final Human Health and Ecological Risk Assessment of Groundwater Impacted by Activities at SWMU 1/ AOC 1 and SWMU 2* (herein referred to as the Groundwater Risk Assessment [GWRA]) (Arcadis 2009), which was approved by DOI and DTSC in December 2009. At that time, the East Ravine (AOC 10) was not included in the GWRA. The GWRA developed the conceptual site model, including identifying sources of groundwater contamination, potential transport mechanisms, potential exposed receptors and exposure pathways, and potential exposure point concentrations for impacts by activities at SWMU 1/AOC 1 and SWMU 2. The key conclusions of the GWRA, as detailed in the ROD, are as follows:

- The potential transport of constituents in groundwater to the Colorado River represents an insignificant transport pathway; floodplain constituents of potential concern (COPCs) are not being transported to the Colorado River at concentrations that exceed screening-level surface water criteria.
- There are no current direct or indirect complete exposure pathways for human contact with impacted site groundwater; thus, there are no human populations currently at risk of adverse health effects due to groundwater at the Topock Site.
- There is no significant ecological exposure pathway for contact with impacted site groundwater; thus, there are no ecological receptors currently at risk of adverse effects due to the presence of COPCs in groundwater.
- Due to the possibility of future development of the groundwater as a drinking water supply, the GWRA included a quantitative risk characterization of future hypothetical human groundwater users that may be exposed to site groundwater in a residential setting. Both child and adult future hypothetical residential groundwater users were considered. Potential exposure through ingestion and dermal contact while bathing and showering was evaluated. Potential cumulative cancer risks and non-cancer hazard indices were estimated for all COPCs, including constituents that were not related to SWMU 1/AOC 1. The risk characterization concluded that:
    - Cr(VI) is present in site groundwater at concentrations that could pose a potential hazard to the future hypothetical human groundwater user if the groundwater were to be developed as a potable source of water in the future (Table 1 of the ROD). Based on the results of the risk estimates and the fact that the presence of Cr(VI) is related to historical releases from SWMU 1/AOC 1, Cr(VI) is a COC for this remedial action.
    - The calculated noncarcinogenic risk-based remediation goal for Cr(VI) is 46 micrograms per liter (µg/L) based on the hypothetical child receptor.

The GWRA determined that other COPCs either were not associated with SWMU 1/AOC 1 and/or are not present in site groundwater at levels of potential concern to human health or the environment. DTSC and DOI, however, concluded that although the non-cancer hazards associated with molybdenum, selenium and nitrate are much lower than those associated with Cr(VI), these constituents have risks above a hazard index of 1 and they contribute to a hazard quotient greater than 1 at localized areas within the plume. For example, Cr(VI) contributed 95% to the combined Cr(VI), molybdenum, selenium, and nitrate hazard index. DTSC directed PG&E to continue monitoring molybdenum, selenium, and nitrate and to consider their associated impacts in future soil and soil to groundwater risk evaluations (DOI, 2010).

2.2 Constituents of Concern

In December 2010, the DOI issued the ROD for the Former Percolation Bed in Bat Cave Wash, designated as Solid Waste Management Unit (SWMU) 1, the area around the Former Percolation Bed, designated as

AOC 1, and within the East Ravine, designated as AOC 10 (**Figure 2**). The remedial action (referred to as the Selected Remedy) is necessary to protect the public health, welfare, or the environment from actual or threatened releases of hazardous substances into the environment. Concentrations of Cr(VI) in groundwater exceed the regional background levels of 32 µg/L (there are no federal or California regulatory standards for Cr(VI) in groundwater). The GWRA concluded that Cr(VI) is present in groundwater at concentrations that pose an unacceptable risk to human health if the groundwater were to be used as a drinking water source therefore Cr(VI) is a COC for SWMU 1/AOC 1 and AOC 10.

2.3 Response Actions

2.3.1 Pre-ROD Activities

In 1988, PG&E completed a soil investigation in the Bat Cave Wash area at the request of DTSC and the USEPA. The soil investigation documented chromium releases to the environment. The percolation bed is considered a SWMU and the surrounding areas were designated as an AOC. In 1989, a RCRA Comprehensive Ground Water Monitoring Evaluation prepared by the California Regional Water Quality Control Board identified chromium releases in groundwater (DOI, 2010).

By letter dated May 29, 1995, PG&E reported the presence of chromium in groundwater samples taken on the east side of Bat Cave Wash near the north boundary of the PG&E TCS facility. In response, on February 26, 1996, DTSC and PG&E executed a Corrective Action Consent Agreement *(*CACA) pursuant to State law under which DTSC directed PG&E to perform an RFI and a CMS as well as certain IM determined to be necessary to address immediate or potential threats to human health and/or the environment (DOI, 2010).

In 2003, the Federal Agencies notified PG&E that it was a potentially responsible party (PRP) pursuant to Section 107 of CERCLA, 42 U.S.C. § 9607, as an owner and operator of a facility from which hazardous substances had been released into the environment. As the CERCLA lead agency for land under its jurisdiction, custody, or control, DOI initiated negotiations with PG&E on an administrative order by which PG&E would implement a RI/FS and other response actions pursuant to Section 104 of CERCLA, 42 U.S.C. § 9604.

In the course of the groundwater investigation at the site, PG&E documented an extensive plume of groundwater contaminated with Cr(VI) that stretches from the PG&E TCS facility under the HNWR and lands managed by BLM toward the Colorado River. On February 3, 2004, PG&E reported concentrations of Cr(VI) of 111 µg/L in groundwater taken from monitoring well MW34-80 located on BLM-managed property within 100 feet of the Colorado River (DOI, 2010).

Based on this finding, DTSC ordered PG&E to prepare and submit IM Work Plan No. 2 (IM No. 2) to immediately begin pumping, transporting, and disposing of groundwater from existing monitoring wells at the monitoring well MW-20 cluster. These monitoring wells located on or near the MW-20 Bench are on BLM-managed lands. By the Action Memorandum issued March 3, 2004, BLM selected a time-critical removal action (TCRA) under CERCLA and directed PG&E to implement this action, consistent with IM No. 2, to prevent or abate the release of Cr(VI) into the Colorado River. The scope of this removal action was to extract contaminated groundwater from existing or, if necessary, new wells to maintain a landward hydraulic gradient and ensure that Cr(VI) did not reach the Colorado River (DOI, 2010).

On May 20, 2004, BLM issued a second Action Memorandum selecting a subsequent TCRA and authorizing PG&E to operate, for a limited period of time, a batch treatment system on the MW-20 Bench. The purpose of this removal action was to reduce the volume of hazardous waste being shipped offsite by allowing treatment of contaminated groundwater onsite prior to offsite transport and disposal as non-hazardous waste (DOI, 2010).

On September 17, 2004, BLM issued a third Action Memorandum, in coordination with DTSC, authorizing PG&E to implement a larger-scale groundwater treatment system (known as IM No. 3). Via this third

Action Memorandum, PG&E installed conveyance piping, monitoring wells, and associated needed improvements to roads to facilitate and operate IM No. 3 as directed by DTSC on land acquired by PG&E (DOI, 2010).

BLM, the CA State Historic Preservation Office (SHPO), and PG&E entered into a Memorandum of Agreement (MOA) in 2004 for the IM No. 3 project. A *Cultural Resources Management Plan* (CRMP) was completed in September 2004 and subsequently incorporated into the MOA. The CRMP describes steps to be taken to avoid or minimize harm to cultural resources during implementation of IMs. It includes a plan for identifying, evaluating, and managing cultural resources within the APE, and describes the various treatment measures designed to address effects on historic properties that could result from the onsite remediation system (BLM, 2012).

In July of 2005, the Federal Agencies and PG&E entered into an Administrative Consent Agreement under which PG&E agreed to implement an RI/FS and certain removal actions, as directed and approved by the Federal Agencies, to protect public health or welfare or the environment from hazardous substances on or under land under the Federal Agencies' jurisdiction. Pursuant to the terms of the Administrative Consent Agreement, the parties agreed to coordinate, to the extent practicable, CERCLA response actions with actions required by DTSC pursuant to the requirements of the CACA. In particular, the parties agreed to coordinate the CERCLA RI/FS with the RFI and CMS required under the CACA, and to coordinate any CERCLA removal actions selected by DOI with any IMs required by DTSC (DOI, 2010).

PG&E completed the *Revised Final RCRA Facility Investigation and Remedial Investigation Report, Volume 1 – Site Background and History* (RFI/RI Volume 1 Report) in August 2007 which was approved later in 2007 by DTSC and DOI. The RFI/RI Volume 1 Report contains information on TCS operations, history, and descriptions of SWMUs, AOCs, and other undesignated areas (DOI, 2010).

The Revised *Final RCRA Facility Investigation and Remedial Investigation Report, Volume 2 – Hydrogeological Characterization and Results of Groundwater and Surface Water Investigations* (RFI/RI Volume 2 Report) was completed in February 2009 and was approved by DTSC and DOI in 2009. The RFI/RI Volume 2 Report contains information on the hydrogeologic characterization and results of groundwater, surface water, pore water, and river sediment investigations to evaluate and characterize the nature and extent of groundwater contamination resulting from the past discharge of wastewater from the TCS. Subsequent to the RFI/RI Volume 2 and Volume 2 Addendum, PG&E completed additional hydrogeologic and groundwater characterization activities in the East Ravine. This additional hydrogeologic and groundwater characterization in the East Ravine has been incorporated into the conceptual site model for the remedial action and was included as an addendum to the CMS/FS Report (DOI, 2010).

In November 2009, PG&E completed the GWRA which evaluated potential risks to human health and ecological receptors associated with groundwater affected by past discharges to supplement the RFI/RI Volume 2 Report. The GWRA provides information to assist risk management decision making about the COCs in groundwater and risk-based concentrations of those constituents detected at the time. DTSC and DOI approved the GWRA in December 2009 (DOI, 2010). The key conclusions of the GWRA are discussed in **Section 2.1**.

In December 2009, PG&E completed the CMS/FS. The purpose of the CMS/FS Report (CH2M Hill, 2009a) was to identify and evaluate groundwater remedial alternatives and to provide the basis for the identification of a preferred alternative to address the defined objectives for the remedial action (DOI, 2010).

As lead for Federal Agencies for purposes of Section 106 of the National Historic Preservation Act (NHPA), the BLM initiated a Section 106 consultation with the Arizona and California SHPOs and the Advisory Council on Historic Preservation (ACHP). The BLM invited the nine Native American tribes that attach religious and cultural significance to historic properties within the APE to participate in the Section 106 consultation process, which resulted in the development of a PA in December 2010 (BLM, 2010). PG&E

and affected Federal Agencies also participated in the Section 106 consultation. The PA acknowledges the tribes' historic and traditional interests in the area and establishes a process for further consultation on the potential effects to historic properties within the APE. In October 2010, BLM, AZ SHPO, CA SHPO, and the ACHP executed the PA. PG&E, USFWS, and the Hualapai Tribe also signed the PA as Invited Signatories. The PA was amended in 2017 (Amendment 1; BLM, 2017).

2.3.2 ROD

In December 2010, the DOI issued a ROD which identified the Selected Remedy for SWMU 1/AOC 1 and AOC 10 as in-situ treatment with freshwater flushing for the treatment of Cr(VI) in groundwater.

The Selected Remedy (identified as Alternative E in the CMS/FS [CH2M Hill, 2009a]) involves flushing to push the plume through an IRZ located along NTH. Flushing will be accomplished through a combination of freshwater injection and injection of carbon-amended water in wells to the west of the plume. Extraction wells in the area near the Colorado River will be utilized to capture and control the plume, accelerate cleanup of the floodplain area, and flush the groundwater with elevated Cr(VI) through the treatment zone. Additional extraction wells will be located in an area northeast of the TCS where the flushing efficiency from injection wells alone is relatively poor. Water extracted from the riverbank wells and wells northeast of the TCS will be treated with a carbon-source and the water will be reinjected west of and within the plume (DOI, 2010).

The key components of the Selected Remedy, presented in Section L of the ROD, includes:

- Construction of an IRZ along NTH using a line of wells that may be used as both injection and extraction wells to circulate groundwater and distribute an organic carbon source to promote bacteriological reduction of the Cr(VI) to a less toxic trivalent chromium (Cr[III]).
- Flushing accomplished through a combination of potable water injection and injection of carbon amended water in wells upgradient of the plume.
- Extraction wells near the Colorado River to provide hydraulic capture of the plume, accelerate cleanup of the floodplain, and enhance the flow of contaminated groundwater through the IRZ line.
- Bedrock extraction wells in the eastern (downgradient) end of the East Ravine to provide hydraulic capture of contaminated groundwater in bedrock. Extracted water will be treated and managed using the same active treatment system that will be used to treat and manage contaminated groundwater extracted from the Alluvial Aquifer.
- Institutional controls (ICs) to restrict surface land uses and prevent the use of groundwater.
- Monitored natural attenuation as a long-term component to address residual Cr(VI) that may remain in recalcitrant portions of the aquifer after in-situ treatment.

2.3.2.1 Applicable or Relevant and Appropriate Requirement (ARARs)

Applicable or Relevant and Appropriate Requirements **(**ARARs**)** for the Topock Site, as documented in the ROD, include chemical-specific, location-specific, and action-specific ARARs of federal, California, and Arizona laws and regulations. A summary of ARARs is included in *Table 2 Applicable or Relevant and Appropriate Requirements (ARARs) and other factors To Be Considered (TBCs)* of the ROD, provided in **Appendix F-1**. There are 57 ARARs that address several resource areas including biological, air quality, cultural, hazardous materials, and waterways (six chemical-specific, 38 action-specific, and 13 location-specific). Remedial Action Objectives (RAOs) were developed based on identified chemical-specific ARARs and attaining the RAOs will result in compliance with the chemical-specific ARARs. RAOs are discussed below in **Section 2.3.2.2**.

2.3.2.2 RAOs

The RAOs for groundwater, as defined in the ROD, include:

1. Prevent ingestion of groundwater having Cr(VI) in excess of the regional background concentration of 32 µg/L as a potable water source
2. Prevent or minimize migration of total chromium (Cr[T]) and Cr(VI) in groundwater to ensure concentrations in surface water do not exceed water quality standards that support the designated beneficial uses of the Colorado River (11 µg/L Cr[VI]).
3. Reduce the mass of Cr(T) and Cr(VI) in groundwater at the Topock Site to achieve compliance with ARARs (a summary of ARARs is included in **Appendix F-1)** in groundwater. This RAO will be achieved through the cleanup goal of the regional background concentration of 32 µg/L of Cr(VI).
4. Ensure that the geographic location of the target remediation area does not permanently expand following completion of the remedial action.

2.3.2.3 Short-Term Goal

In addition to the four RAOs outlined in the ROD, the Final BOD also outlines the following short-term goal related to the operation and function of the groundwater remedy:

- Operational and Functional: Pursuant to CERCLA, 40 CFR § 300.435(f)(2), the Selected Remedy becomes Operation and Functional either one year after construction is complete, or when the Selected Remedy is determined by DOI and DTSC to be functioning properly and performing as designed, whichever is earlier. DOI may grant extensions to the one-year period, as appropriate. This period is often referred to as "commissioning" or "shakedown," when the construction contractor(s) make minor adjustments as necessary to ensure that the remedy is operating as designed.

2.3.3 Post-ROD Activities

Per the requirements of the PA, BLM developed the CHPMP in January 2012. BLM is responsible for the implementation of the CHPMP, which specifies how cultural and historic properties within the APE are to be treated during implementation of the Selected Remedy (BLM, 2012).

PG&E and the United States executed a Remedial Design/Remedial Action Consent Decree (CD) under CERCLA, on behalf of the DOI, in 2012, which was approved by the U.S. District Court for the Central District of California in November 2013 (Jacobs, 2023).

On November 18, 2015, PG&E submitted the Final BOD which presents the final design basis, design criteria, drawings, specifications, and operation and maintenance (O&M) requirements for the Selected Remedy. On November 18, 2016, PG&E submitted *Supplemental and Errata Information for the Final (100%) Design for the Final Groundwater Remedy* (CH2M Hill, 2016). DOI conditionally approved the Final BOD on April 3, 2018 (DOI, 2018), and on April 24, 2018, it was conditionally approved by DTSC (DTSC, 2018).

2.3.3.1 Final BOD Key Features

The final design for the Selected Remedy, as detailed in the Final BOD, includes the following key features:

- An IRZ along NTH using a line of wells that may be used as both injection and extraction wells to circulate groundwater and distribute an organic carbon source to promote bacteriological reduction of the Cr(VI) to Cr(III).
- East Ravine extraction wells to provide hydraulic capture of contaminated groundwater in bedrock.

- A TCS Recirculation Loop to treat Cr(VI)-impacted groundwater in alluvial deposits located downgradient of the TCS and in shallow bedrock in the East Ravine through flushing facilitated by recirculation and direct treatment through carbon amendment.
- An Inner Recirculation Loop (IRL) consisting of extraction wells near the Colorado River to control migration of Cr(VI) in the floodplain, induce a hydraulic gradient for plume flushing toward the IRZ, facilitate cleanup of the floodplain, and control the migration of byproducts generated by the IRZ.
- A monitoring well network consisting of existing site wells and new monitoring wells.
- Installation of freshwater supply wells and injections wells.
- Other supporting features.

2.3.3.2 IRZ Design Features

The IRZ is a line of wells installed along NTH that targets Cr(VI)-impacted groundwater in the floodplain. The IRZ acts as a recirculating system in which all the water extracted via the IRZ extraction wells is amended with carbon substrate and re-injected into the aquifer via the IRZ injection wells. This circulates groundwater and distributes an organic carbon source to promote reduction of the Cr(VI) to Cr(III).

Per the Final BOD, the IRZ system was designed with the following components:

- Groundwater Extraction Wells (4): IRZ-1, IRZ-5, IRZ-9, and IRZ-23
- Carbon Amendment System located at the MW-20 Bench
- Injection Wells (24) at 16 locations: IRZ-11, IRZ-13, IRZ-15, IRZ-16, IRZ-17, IRZ-19, IRZ-20, IRZ-21, IRZ-25, IRZ-27, IRZ-29, IRZ-31, IRZ-33, IRZ-35, IRZ-37, and IRZ-39
- Provisional Extraction Well IRZ-40
- Provisional Injection Wells (up to 30) at 19 locations within the IRZ. Installation and activation depends on the monitored performance of the IRZ over time.
- Below-grade piping for the conveyance of extracted groundwater, carbon-amended water, freshwater, and/or water produced from routine remedy O&M activities (i.e., backwashing)
- A well maintenance system to facilitate routine backwashing of the injection wells and pipeline maintenance
- A clean-in-place (CIP) pipeline maintenance system

The design included injection wells spaced along the IRZ line with the extraction wells located at the ends and in the central portion of the IRZ line (**Figure 4**). This layout allows for adequate lateral dispersion of organic carbon while minimizing the potential for the extraction of carbon substrate or treated water. The nominal total IRZ injection flow rate per the Final BOD is 300 gallons per minute (gpm), with an anticipated range of 200 to 400 gpm. The anticipated nominal injection flow rates per injection well ranges from 4 to 20 gpm, with a maximum injection flow rate per well of 40 gpm (IRZ-11 and IRZ-13). Per the Final BOD, each extraction well has a flow rate ranging from 40 to 160 gpm at approximately 300 feet of water column (ft w.c.) total dynamic head (TDH). The nominal total extraction flow rate for the IRZ extraction wells is 300 gpm, with an anticipated range of 200 to 400 gpm. The extraction flow is aimed to balance injection flow and provide hydraulic control and the injection flow is aimed to develop and maintain the IRZ and the IRZ is operated in cycles. The result is a net flow of 0 gpm for the IRZ system. Extraction and injection wells are designed with one or two screened intervals to target specific intervals of the geologic formation. Details on well design parameters are summarized in *Appendix L Operation and Maintenance Manual* of the Final BOD (herein referred to as O&M Manual) *Table 2.1-1 Final Remediation Well Design Parameter*

Summary (Final BOD, Appendix L, Volume 1; CH2M Hill 2015a), provided in **Appendix F-1**. Well construction details are provided in Section 3.2.5.2 of the Final BOD. A status of implementation pertaining to the IRZ system is included in **Section 2.4.1**.

Per the Final BOD, MW-20 Bench is designated as the location for the Carbon Amendment System because of its proximity to the IRZ wells. The system consists of a tanker truck offload bay; the primary carbon amendment, metering, and control equipment (including valves, flow meters, pumps, and ancillary equipment); the primary carbon substrate storage and carbon substrate storage instrumentation; and extraction well header network monitoring equipment. Groundwater produced by the IRZ extraction wells is conveyed to MW-20 Bench Carbon Amendment Building. This extracted groundwater is dosed with carbon and flows through an in-line static mixer before being routed to the carbon-amended groundwater conveyance header. Primary carbon substrate storage is contained in a 15,000-gallon above-grade storage tank. Carbon Amendment System construction details are provided in Section 2.1.1.3 of the O&M Manual.

The well maintenance system consists of backwash pumps located in each of the remediation injection wells.

2.4 Status of Implementation

The infrastructure for the Selected Remedy is being constructed per the Final BOD and the *Construction/Remedial Action Work Plan* (C/RAWP) (CH2M Hill, 2015b), which was conditionally approved by DOI and DTSC in April 2018. Construction of the Selected Remedy began in October 2018. Construction and start-up of the Selected Remedy is proceeding in phases.

A preliminary construction schedule was included in the Final BOD and the C/RAWP, where it was indicated that a more detailed schedule would be prepared following approval of the final design and selection of contractors. The C/RAWP also indicated that the schedule would be regularly updated during construction and start-up of the Selected Remedy and that PG&E would use monthly progress reports to communicate progress related to the schedule and PG&E will notify DTSC and DOI of any changes to the schedule for performance of any activity prior to the performance of the activity, or as otherwise agreed to by PG&E, DTSC, and DOI. Construction and start-up per the Final BOD and C/RAWP were anticipated to take five years with construction beginning in June 2017 and Selected Remedy start-up occurring in January 2022 (CH2M Hill, 2015b).

Following conditional approval of the Final BOD and C/RAWP (CH2M Hill, 2015b), PG&E presented a revised remediation project schedule (this included the construction schedule) at the December 5, 2018 CWG (herein referred to as 2018 remediation project schedule), included in **Appendix F-2**. The 2018 remediation project schedule indicated that the construction schedule was preliminary for planning purposes. Per the 2018 remediation project schedule, construction and start-up was anticipated to take five years, beginning construction in October 2018 and Selected Remedy start-up occurring in September 2023. Per the 2018 remediation project schedule, the IRZ system had an anticipated completion date of September 2020 and the TCS Recirculation Loop, IRL, and freshwater supply system components had an anticipated construction completion date of September 2022. Full Selected Remedy operations were anticipated to start up in September 2023; however, construction has experienced significant delays, as discussed below.

Construction of Phase 1 began on October 2, 2018 and was completed in June 2022. Phase 1 included construction of 22 IRZ injection/extraction wells and 75 monitoring wells for measuring water levels and water quality, as well as a network of water conveyance piping and electrical components to power the remediation system, the carbon amendment building, and the Remedy-Produced Water Conditioning (RPWC) system. In December 2021, start-up began for the IRZ system operation, maintenance, and monitoring (Jacobs, 2023). Further details on the status of the IRZ can be found in **Section 2.4.1**, below.

Phase 2 of Selected Remedy construction began on March 2, 2022 and is currently ongoing at the time of this FYR preparation. Phase 2 focuses on the installation of the system's remaining components, including bedrock extraction wells in the East Ravine, IRL, freshwater injection wells, and supporting conveyance

lines for the freshwater flushing component of the Selected Remedy. Phase 2 construction is split into two subphases: Phase 2A and Phase 2B.

Construction of Phase 2A began in March 2022 and completion is scheduled for April 2024, see schedule in **Appendix F-2**. Phase 2A includes construction of the TCS Recirculation Loop, freshwater injection well FW-2, and associated arsenic monitoring wells and pipelines. At the time of this FYR preparation, Phase 2B construction has not yet started. Phase 2B will include construction of the inner recirculation loop (IRL), freshwater injection well FW-1 and monitoring wells in the uplands, facilities to convey water from freshwater supply well (HNWR-1A) in Arizona to California, and remaining TCS facilities and pipelines. Initiation of construction for Phase 2B is scheduled to begin in December 2023 and completion is scheduled for May 2026, see schedule in **Appendix F-2**.

In compliance with the 1996 CACA, the 2013 CD, and pursuant to the C/RAWP, PG&E reports construction progress on the Selected Remedy in the form of monthly progress reports (MPRs). These MPRs include a summary of construction and start-up activities pertaining to the Selected Remedy, as well as activities planned for the next six weeks, and present available results from sampling and testing performed during the reporting period. PG&E has submitted these monthly reports to DOI and DTSC since November 2018. The most current report reviewed at the time of this FYR preparation was the *June 2023 Monthly Progress Report for the Final Groundwater Remedy Construction and Startup* (Jacobs, 2023). *Table 2-4 Summary of Cumulative Percent Completeness of Key Phase 2 Construction Activities* from the *June 2023 Monthly Progress Report* (Jacobs, 2023) is included in **Appendix F-1**.

Based on a reviews of MPRs and review of the most current construction schedule updated on May 9, 2023 (**Appendix F-2)**, the following subsections provide a current status of each component of the Selected Remedy.

2.4.1 Status of IRZ

The IRZ system became operational on December 21, 2021. On December 22, 2021, PG&E initiated injection of ethanol into the groundwater at select IRZ injection wells using temporary power (i.e., portable generator). The IRZ extracts water from up to four IRZ extraction wells (IRZ-9, IRZ-13S, IRZ-13D, IRZ-23), amends it with carbon substrate (ethanol), and injects it at up to 25 IRZ injection intervals. In wells with triple screens (IRZ-25 and IRZ-27), two of the three well screens are combined into single intervals by packers. On March 24, 2022, the permanent power system (from TCS) was put in service. Between March and August 2022, the IRZ experienced intermittent power outages of various durations (contributing factors include TCS operations load shedding [i.e., power to the IRZ was shut off by TCS due to gas operational reasons] and/or functionality of electrical components). Portable generators were used to supply power from the end of August to the end of October 2022. The permanent power supply issue was resolved at the end of October 2022. The portable generators were kept onsite temporarily as contingencies and were removed from the site at the end of January 2023 (Jacobs, 2023).

The IRZ injection and extraction wells continued operations into the first quarter of 2023 (Q1 2023). On March 15, 2023, the IRZ was shut down due to a significant storm event that caused flooding in the IRZ well vaults in the southern portion of the IRZ line along NTH. Operation of injection wells IRZ-15, IRZ-16, IRZ-17, and IRZ-20, and extraction well IRZ-23 was resumed on March 17, 2023; however, the rest of the IRZ injection and extraction wells remained offline through the end of March 2023. Prior to the March 15, 2023 storm event, there was only one other reported unplanned outage that occurred on February 26, 2023 but operations resumed the same day (Arcadis, 2023a).

The IRZ was constructed largely in accordance with the design in the Final BOD but with several modifications. A summary of modifications is captured in *Table 2-3 Summary of Work Variance Requests* from the *June 2023 Monthly Progress Report* (Jacobs, 2023), provided in **Appendix F-1**. On the northern end of the IRZ, Cr(VI) concentration data from the installation of the monitoring well MW-75 well cluster (formerly MW-B) in conjunction with the existing well cluster MW-35, showed a lesser extent of the plume

(greater than 32 µg/L Cr[VI] plume) in comparison to the plume included in the Final BOD (**Figure 6**). In addition, the Cr(VI) plume north of planned well IRZ-23 was found to be present in two relatively thin, but separate, plumes in the shallow and deep portions of the Alluvial Aquifer, with Cr(VI) concentrations less than 32 µg/L in between (**Figure 7**) (Arcadis, 2021). Accordingly, the following modifications were made:

- Deferral of construction of extraction wells IRZ-1 and IRZ-5 and injection well IRZ-11.
- Conversion of injection well IRZ-13 to an extraction well.
- Injection wells IRZ-15, IRZ-16, IRZ-17, IRZ-18, and IRZ-20 were installed with two screens targeting the shallow and deep Cr(VI) plumes, rather than the four screens called for in the Final BOD.
- Provisional well IRZ-18 was installed rather than IRZ-19 based on low concentrations of Cr(VI) detected at IRZ-19 when a pilot borehole was drilled and declining concentrations at existing monitoring wells in the vicinity (Arcadis, 2021).

Per the Final BOD, the IRZ system is being operated by extracting groundwater from the primary extraction well IRZ-23, amending the water with carbon substrate, then injecting the amended water into the injection wells. The IRZ system is planned to operate for a period of time (originally planned for approximately 6 months) followed by a period of downtime (normally 18 months), during which time residual reducing capacity generated during injections will be monitored to evaluate the effectiveness of reducing Cr(VI) in groundwater (CH2M Hill, 2015a). At the time of this FYR preparation, the IRZ is currently in operation and the 18 monthly period of downtime has not yet occurred.

In December 2021, start-up began for Phase 1 of the Selected Remedy system, including the IRZ system operation, maintenance, and monitoring. Monitoring well performance is reported by PG&E in the form of quarterly well performance reports. These quarterly performance reports provide an overview of the Selected Remedy and well maintenance objectives; a summary of well operations, maintenance, and performance monitoring activities, and recommendations and planned activities for the next reporting period. PG&E has submitted quarterly performance reports to DOI and DTSC since March 2022. The most current quarterly performance report reviewed at the time of this FYR preparation was the *First Quarter 2023 Well Performance Report* dated June 29, 2023 (Arcadis, 2023b).

An evaluation of the performance of the Selected Remedy to attain the Final BOD RAOs and comply with ARARs is reported by PG&E in the form of quarterly progress reports. These quarterly reports provide an overview of the Selected Remedy and RAOs; a summary of communications, operations, and performance; and recommendations and planned activities for the next reporting period. PG&E has submitted quarterly progress reports to DOI and DTSC since March 2022. The most current quarterly report reviewed at the time of this FYR preparation was the *First Quarter 2023 Quarterly Progress Report* dated June 14, 2023 (Arcadis, 2023a).

2.4.2 Status of TCS Recirculation Loop

The TCS Recirculation Loop was designed to treat Cr(VI)-impacted groundwater in alluvial deposits located downgradient of the TCS and in shallow bedrock in the East Ravine through flushing facilitated by recirculation and direct treatment through carbon amendment. The design includes five extraction wells in the East Ravine bedrock (ER-1 to ER-4 and ER-6) and two extraction wells (TWB-1 and TWB-2) in the Transwestern Bench area. Extracted groundwater is to be amended with carbon at the MW-20 Bench, conveyed to the TCS area, and injected into the two injection wells, TCS-1 and TCS-2 (CH2M Hill, 2015a).

Per the 2018 remediation project schedule, TCS Recirculation Loop construction completion was anticipated in September 2022; however due to delays, construction of the TCS Recirculation Loop is ongoing as part of Phase 2A. The inside TCS Recirculation Loop pipeline installation was completed in November 2022. The outside TCS Recirculation Loop pipeline is under construction with an anticipated completion date of April 2024. As part of Phase 2A, extraction wells TWB-1 and TWB-2, injection wells

TCS-1 and TCS-2, and extraction wells ER-1, ER-2, ER-3, and ER-4 have been installed. The remainder of TCS Recirculation Loop facilities and pipelines will be constructed in Phase 2B with forecasted start-up in May 2026. Therefore, the TCS Recirculation Loop installation has not been fully completed, the TCS Recirculation Loop is not operational, and construction is projected to be four years delayed from the 2018 remediation project schedule, included in **Appendix F-2**.

2.4.3 Status of IRL

The intent of the IRL is to control migration of Cr(VI) in the floodplain, induce a hydraulic gradient for plume flushing toward the IRZ, facilitate cleanup of the floodplain, and control the migration of byproducts generated by the IRZ. The Final BOD includes five riverbank extraction wells (RB-1 through RB-5) installed along the Colorado River and four IRL injection wells (IRL-1 through IRL-4) installed near the western edge of the plume. The Final BOD also included three provisional IRL injection wells (IRL-5 through IRL-7) to be installed and activated depending on monitored performance of the Selected Remedy over time.

Per the 2018 remediation project schedule, IRL construction completion was anticipated in September 2022; however due to delays, construction of the IRL is currently ongoing with an anticipated completion date of February 2026, see schedule in **Appendix F-2**. Components of the IRL that have been installed to date include installation of four riverbank extraction wells (RB-2, RB-3, RB-4, RB-5) completed during Phase 1. Full construction completion of RB-5 is currently planned in Phase 2A. Buildout of RB-2, RB-3, and RB-4, and the construction of the four IRL wells are planned to be completed in Phase 2B starting in December 2023. It is anticipated that all Phase 2B IRL construction activities will be completed in February 2026, with intended start-up of the IRL in May 2026 (PG&E, 2023). Therefore, construction of the IRL has not been completed, the IRL is not operational, and construction completion of the IRL is projected to be four years delayed from the 2018 remediation project schedule, included in **Appendix F-2**.

2.4.4 Status of Freshwater Supply System

The primary objectives of the freshwater system is to facilitate flushing of the Cr(VI) plume through the IRZ and to control and confine plume migration and spread of carbon-amended water and IRZ byproducts from the IRL to the west. The freshwater source is supply well HNWR-1A in Arizona. A pipeline is planned to connect freshwater supply well HNWR-1A to the remedy infrastructure with an additional segment to the contingent Site B supply well. The majority of this piping will be underground. A 10,000-gallon tank is planned for freshwater storage for the remedy, separate from the TCS water storage. Two freshwater injection wells located upgradient of the Cr(VI) plume are planned: FW-1 located to the northwest of the Cr(VI) plume and FW-2 located to the southwest (CH2M Hill, 2015a).

Per the 2018 remediation project schedule, freshwater injection system construction completion was anticipated in September 2022; however due to delays, construction is ongoing. Installation of Freshwater Injection Well FW-2 (also designated as FW-02B) was completed in 2022 as part of Phase 2A. It should be noted that DOI and DTSC have not identified this as a freshwater injection well to date due to sampling showing that the well may be located within the plume. Installation of freshwater injection well FW-1 will be constructed during Phase 2B with completion forecasted for September 2024. Installation of the HNWR-1 pipeline is forecasted to begin in January 2024 and completion is expected in July 2024. Therefore, the freshwater supply system has not been completed, the freshwater supply system is not operational, and construction is projected to be two years delayed from the 2018 remediation project schedule, included in **Appendix F-2**.

2.4.5 Status of Monitoring Well Network

The O&M Manual includes the *Volume 2: Sampling and Monitoring Plan* (SMP; Final BOD, Appendix L, Volume 2, CH2M Hill, 2015a) for the Selected Remedy. In October 2021, the *Groundwater Remedy Phase 1 Interim Monitoring Plan* (Phase 1 Interim Monitoring Plan; Arcadis, 2021), which revised the SMP to suit the as-built Phase 1 of the Selected Remedy, was approved. The Phase 1 Interim Monitoring Plan

was designed to evaluate the performance of the Selected Remedy to attain the RAOs and comply with ARARs. The Phase 1 Interim Monitoring Program has several main components: Process Control Monitoring, Remedy Compliance Monitoring, Former IM No. 3 Injection Area Monitoring, Mitigation Measure Hydro-6a Monitoring, and COPC Monitoring. Specifically, the Remedy Compliance Monitoring component monitors surface water and groundwater for compliance with RAOs 2, 3, and 4. The purpose of compliance groundwater monitoring is to monitor Cr(VI) concentrations to assess progress towards reducing mass of Cr(VI) in groundwater and achieving the cleanup goal of 32 µg/L (RAO 3), and to ensure that the geographic location of the target remediation area does not permanently expand following completion of the remedial action (RAO 4). RAO 3 is evaluated with monitoring wells located inside the plume, while RAO 4 is evaluated with monitoring wells located outside of the plume. The Phase 1 Interim Monitoring Plan replaced the monitoring and reporting programs associated with IM No. 3 (Arcadis, 2021).

The monitoring well network is comprised of 174 existing monitoring wells and 75 new monitoring wells that were installed as part of Phase 1. Phase 1 monitoring wells were installed as outlined in the C/RAWP with the following exceptions, as detailed in the Phase 1 Interim Monitoring Plan (Arcadis, 2021):

- MW-A cluster north of MW-75 (formerly MW-B) was deferred based on the extent of the Cr(VI) plume on the north end of the IRZ. This modification was proposed in the PG&E letter dated January 9, 2020.
- The deferred MW-A cluster (see above) was shifted to downgradient of the deferred well IRZ-11 per a request from the DTSC dated February 14, 2020. This became well cluster MW-96.
- A monitoring well was installed in the location of deferred injection well IRZ-11 per a request from the DTSC dated February 14, 2020. This became well cluster MW-97.
- IRZ-19 pilot boring was repurposed to monitoring well cluster MW-81 based on a proposal from PG&E dated January 6, 2020.
- Installation of uplands monitoring wells (MW-FF, MW-DD, MW-BB, and MW-P) were deferred.
- Installation of the deeper monitoring well cluster at MW-Z was deferred.
- Other monitoring wells deferred per the Final BOD include MW-AA, MW-CC, MW-GG, MW-MW-HH, MW-II, MW-I, MW-J, MW-Q, and MW-T

The changes to the monitoring well network were documented in Attachment A of the Phase 1 Interim Monitoring Plan (Arcadis, 2021). Start-up of Phase 1 began in December 2021 and select monitoring wells were monitored monthly for the first year and select wells have transitioned to quarterly monitoring in the second year. The transition to quarterly sampling was approved by DOI and DTSC prior to implementation. Construction of the monitoring well network was completed prior to Phase 1 start-up in December 2021; therefore, construction of this component of the Selected Remedy has been completed except for the well installations deferred, as noted above.

2.4.6 Status of Other Supporting Features

Key supporting features of the Selected Remedy include utilities, site safety and security, access roads for O&M, operations facilities, field staff, and the Remedy-Produced Water Conditioning (RPWC) system. The RPWC system is designed to adjust the pH of the remedy-produced water through the addition of caustic or acid and to remove solids with cartridge filters to render the water suitable for re-injection. The RPWC system was constructed during Phase 1 and became operational in June 2022. Other supporting features are completed as necessary as part of other components of the Selected Remedy.

2.4.7 Status of Monitored Natural Attenuation

Monitored natural attenuation (MNA) will be implemented after active remediation is complete as a long-term component of the Selected Remedy. MNA will address residual chromium that may remain in

recalcitrant portions of the aquifer following the efforts to enhance and optimize in-situ treatment and flushing systems during O&M. As specified in the Final BOD, a determination of the areas of the plume appropriate for MNA will be made during future evaluations. This determination will be based on information about the types and options for active remediation system adjustments, data evaluating the effectiveness of active remediation systems, and the location of the proposed MNA areas relative to natural reducing zones of the aquifer. During these future evaluations, distinct geographical areas of the Topock Site where RAOs have been attained and/or where it has been determined that MNA is appropriate to address residual Cr(VI) may be designated for Corrective Action/Remedial Action Completion (CH2M Hill, 2015a).

As MNA is a long-term component, evaluation of appropriate areas for MNA is planned after active remediation. After this evaluation and determination, the active remedy may transition to MNA.

An aspect of long-term monitoring includes monitoring of arsenic in groundwater in compliance with the California State Water Resources Control Board (SWRCB) direction issued in a letter to DTSC on November 20, 2013 on the use of Arizona water for flushing in the Remedy. This letter requires PG&E to monitor the arsenic concentrations in the injection freshwater and if the arsenic concentrations in the leading edge of the injected freshwater extends more than 150 feet away from the injection locations. If the arsenic concentrations exceed 10 ug/L at 225 feet from the injection locations, injections would have to cease. The anticipated remedial timeframe is 30 years of active remediation followed by up to 10 years of long-term monitoring and up to 20 years of arsenic monitoring. SWRCB also requires arsenic monitoring in the vicinity of the injection locations for 10 years after cessation of remediation (CH2M Hill, 2015a).

2.4.8 Status of IM No. 3

On December 20, 2021, PG&E requested DTSC and DOI approvals for turning off the IM No. 3 system as Phase 1 equipment and systems were in place and ready to begin start-up. PG&E received written approvals from DTSC and DOI in December 2021. After receipt of the agencies' approvals, PG&E turned off the IM No. 3 extraction wells (TW-2D and TW-3D) on December 21, 2021 and began preparation for the lay-up of IM No. 3. Treatment activities at IM No. 3 were terminated on December 28, 2021 and IM No. 3 was put on lay-up mode starting March 22, 2022. A report that summarizes activities to prepare IM No. 3 for lay-up was submitted to DTSC and DOI on June 1, 2022 (Jacobs, 2023).

The IM No. 3 treatment plant and other IM infrastructure that are not used for the Selected Remedy are expected to be decommissioned following determination by DTSC and DOI that the Selected Remedy is operating properly and successfully. This determination cannot be made until the full Remedy system is in place and operating.

2.4.9 Status of Institutional Controls

In addition to the features described above, Institutional Controls (ICs), are also a component of the Selected Remedy. ICs are legal and administrative mechanisms adopted to limit or prohibit activities on a specified property that could interfere with the integrity of the remedy or compromise the continued protection of human health and the environment. The target timeframe for having the ICs in place is prior to remedy construction (CH2M Hill, 2015a).

The GWRA concluded that Cr(VI) is the principal threat present in groundwater at the Topock Site at concentrations that could pose a potential hazard to the future hypothetical groundwater user, if the groundwater were to be used as a source of drinking water (DOI, 2010).

As defined in the Final BOD, potential restrictions of lands at the Topock Site are categorized as Category 1 or Category 2 ICs. Category 1 IC objectives are to prevent the use of groundwater and to protect the hydraulic gradient of the Selected Remedy. Category 1 IC objectives will be met by prohibiting the installation of new groundwater wells, in specified areas, for purposes other than site investigation and remediation activities as directed by DTSC and DOI, until RAOs are attained. These Category 1 restrictions

cover the footprint of the plume and any additional areas outside of the plume footprint where control of groundwater flow directions and gradients is necessary to contain and remediate the plume (CH2M Hill, 2015a). Properties with Category 1 ICs are shown on **Figure 8**.

Category 2 IC objectives will be met by restricting future development and surface uses of the land, in specified areas, that could compromise the integrity of the remedial facilities or otherwise interfere with the construction and operation of the facilities and the ability for PG&E to construct, monitor, operate and maintain the Selected Remedy. Category 2 restrictions cover areas with planned remedial structures, many of which are still being constructed as part of Phase 2A and Phase 2B.

The status of ICs in areas with Category 1 restrictions are included in **Table 2**. The following landowners/managers are impacted by Category 1 restrictions:

1. BOR (land managed by BLM and land managed by USFWS)
2. HNWR (land managed by USFWS)
3. FMIT
4. BNSF
5. PG&E

BOR (land managed by BLM and USFWS) & HNWR (land managed by USFWS)

ICs in the form of a recorded covenant are not implemented for the federally administered parcels, which compose the majority of the Topock Site. Rather, ICs adopted by the Selected Remedy are to be specified in the BLM Resource Management Plan (BLM, 2007) and in the Comprehensive Management Plan (USFWS and BOR, 1994).

Per the ROD, these plans restrict surface uses and use of groundwater and ICs are to remain in place for the duration of the remedy until RAOs are achieved (DOI, 2010). During FYR site inspections, BOR and HNWR properties were inspected for any land use changes or drinking water well installations and none where observed. Details of the FYR site inspections are provided in **Section 4.2** and **Appendix E**.

FMIT

A formal IC process/policy for FMIT parcel 650-151-06 could not be found. The 2006 settlement agreement (Case 05CS00437) between FMIT and DTSC appears to indicate that DTSC retains authority to take or require PG&E to perform any and all response actions or corrective actions. The settlement agreement allows PG&E access to the property to implement the remedy, which would include ICs, until such time DTSC determines the remediation is complete. At the time remediation is considered complete by DTSC, the property ownership would transfer into a trust by the federal government. Therefore, it appears that PG&E is responsible for implementing the ICs on the FMIT parcel. This item has been added as a recommendation in **Section 6**.

During FYR site inspections, the FMIT property was inspected for compliance with ICs, including any land use changes or drinking water well installations. No land use changes or drinking water well installations were observed. Details of the FYR site inspection are provided in **Section 4.2** and **Appendix E**.

BNSF

During FYR site inspections, BNSF property was inspected for compliance with ICs, including any land use changes or drinking water well installations. No land use changes or drinking water well installations were observed. According to site personnel, PG&E leases BNSF property in order to operate their installed remedy infrastructure. This land lease restricts PG&E from installing anything additional on the property. If PG&E wishes to install additional remedy infrastructure, they must apply for an additional land lease or lease amendment with BNSF. Details of the FYR site inspection are provided in **Section 4.2** and **Appendix E**.

PG&E

The implementation of land use covenants is identified as an enforceable IC mechanism. It is also understood that access agreements from existing landowners are appropriate IC mechanisms for privately-owned lands. A covenant is part of the Selected Remedy and PG&E has negotiated all necessary land use covenants and restrictions required to protect the Selected Remedy with DTSC. These restrictions are filed with the County Recorder (CH2M Hill, 2015a). ICs are captured in the *Land Use Covenant and Agreement* recorded July 18, 2018 between PG&E and DTSC (County of San Bernardino, 2018).

Table 2: IC Summary Table

Land Owner/Land Manager	Impacted Parcels (Shown on Figure 3)	ICs Needed	ICs Called for in the ROD	IC Objectives	Title of IC/Land Restriction Instrument Implemented and Date	Status of IC
Bureau of Reclamation (BOR) (Managed by BLM and USFWS)	650-151-03, 650-151-04	Yes	Yes	Restrict surface uses and use of groundwater. ICs in the form of a recorded covenant are not implemented for the federally administered parcels.	Record of Decision and Lake Havasu Field Office Resource Management Plan, May 2007 (BLM, 2007)	The Resource Management Plan includes processes for managing groundwater by restricting development of riparian areas and designating Wildlife Habitat Areas. Incompatible uses, development, and modification are prohibited in designed Wildlife Habitat Areas. BLM is managing soil and surface uses by increasing enforcement of access to restricted areas, restrictions of mineral development, and disposal areas. 69,123 acres of BLM property are restricted with a no surface occupancy stipulation.
	650-151-05	Yes	Yes			
	650-151-07	Yes	Yes			
	650-161-09 (Caltrans ROW)	Yes	Yes			
	650-161-14	Yes	Yes			
	National Trails Highway (portion that runs through the site)	Yes	Yes			
Havasu National Wildlife Refuge (HNWR) (Managed by USFWS)	650-161-09	Yes	Yes	Restrict surface uses and use of groundwater. ICs in the form of a recorded covenant are not implemented for the federally administered parcels.	Lower Colorado River National Wildlife Refuges Comprehensive Management Plan, 1994-2014 (USFWS, 1994)	The Comprehensive Management Plan includes processes for managing groundwater by restricting groundwater pumping, restricting public use of groundwater through flow rights to maintain and protect wildlife habitat, and restricting development of land with existing water features.
	650-161-11	Yes	Yes			
	650-161-12	Yes	Yes			
Fort Mojave Indian Tribe (FMIT)	650-151-06	Yes	Yes	Not Available	Not Available	A formal IC process/policy for FMIT parcel 650-151-06 could not be found. PG&E retains easement of this property until remedy completion; therefore it appears that PG&E would be responsible for IC implementation until the Selected Remedy has been completed. This item has been added as a recommendation in **Section 6**.
BNSF	650-161-07	Yes	Yes	Not Available	Not Available	PG&E leases BNSF property in order to operate installed remedy infrastructure. This land lease restricts PG&E from installing anything additional on the property. If PG&E wishes to install additional remedy infrastructure, they must apply for an additional land lease or lease amendment with BNSF.
PG&E	0650-161-08	Yes	Yes	Prohibit use of the property for housing, human hospital, school, or as a children's day care center, prohibit soil disturbing activities such as excavation, mining, or drilling, and prohibit extraction or removal of groundwater from the Topock Site. Activities occurring on PG&E land that would disturb soil or groundwater must be approved by the DTSC through a Soil Management Plan or Groundwater Management Plan. Prohibit activities such as drilling for any water without prior written approval by DTSC.	Land Use Covenant and Agreement, recorded July 18, 2018 (County of San Bernardino, 2018)	PG&E performs annual inspections & documents compliance with the Land Use Covenant. The most current *Annual Report of Compliance with Land Use Covenant* dated December 13, 2022, documented that no prohibited activities were performed including drilling, groundwater extraction, or interfering with remedial or monitoring systems.

2.5 Systems Operations/Operation & Maintenance

Start-up of Phase 1 of the Selected Remedy included the start-up of the IRZ system, O&M, and monitoring. At the time of this FYR preparation, the operation of the IRZ and O&M on the IRZ and monitoring wells are being performed in accordance with the O&M Manual and monitoring is being performed in accordance with the Phase I Interim Monitoring Plan (Arcadis, 2021). The O&M Manual presents the strategy and procedures for performing O&M on the Selected Remedy system. Operational flexibility was built into the design to allow foreseeable future issues to be addressed by procedural changes rather than equipment design changes.

2.5.1 System Operations

The IRZ, associated supporting features, and a portion of the monitoring well network are the only completed components of the Selected Remedy that are in operation at the time of this FYR preparation. The remaining components of the Selected Remedy, including the TCS Recirculation Loop, IRL, and freshwater supply system have not been completed and are not in operation. The status of the Selected Remedy components is discussed in **Section 2.4**.

During operation of the IRZ, the IRZ injection wells are routinely backwashed to maintain high well efficiency and prolong well life. The remedy-produced water is conveyed to a conditioning system located at the TCS (RPWC Plant). Unconditioned remedy-produced water is pumped through a conveyance piping system to the backwash storage tank at the MW-20 Bench, and four influent tanks at the RPWC Plant. The conditioning system is used to treat the remedy-produced water to make it suitable for re-use or reinjection onsite. The conditioning system is divided into two identical systems for "dirtier" water from the IRZ and carbon-amended injection wells (both backwash and second flush rehabilitation water) and first flush rehabilitation water from all sources and "cleaner" water from the injection wells receiving freshwater (both backwash and second flush rehabilitation water). The conditioning system can operate in batch or continuous modes. In the event the onsite reuse/reinjection options are not available or the conditioned water fails to meet the effluent design criteria, the water will be disposed of at the TCS evaporation ponds or trucked off site (Final BOD, Appendix L, Volume 1; CH2M Hill 2015a).

An electrical power, control, and communications system is used to operate and control the different elements of the IRZ with power supplied from the TCS. The primary power system is transmitted along the pipeline corridors to serve remedy facilities located in California. A supervisory control and data acquisition (SCADA) controls and monitors the remedy (Final BOD, Appendix L, Volume 1; CH2M Hill 2015a).

2.5.2 Well Maintenance

Routine well maintenance is performed to aid in maintaining the IRZ wells. Injection wells are prone to fouling, as the injection of organic carbon stimulates the growth of bacteria, generation of gases such as carbon dioxide, and formation of mineral precipitates. To mitigate fouling, injection wells are backwashed by extraction of groundwater for a short period using a downhole pump to loosen and remove sediments and deposits present on the well screen or in the filter pack. Extraction wells are less prone to fouling and, as such, rehabilitation was not anticipated in the Final BOD. Additional well maintenance activities to reduce fouling include mechanical and chemical rehabilitation. Mechanical and chemical rehabilitation will occur after periods of extended injection well operation and before planned extended downtime (approximately every six to 18 months) (Arcadis, 2023b). Since the start-up of the IRZ, mechanical and chemical rehabilitation has been conducted on the IRZ wells since December 2022.

Well performance tracking is performed to assess the frequency and methods required for well maintenance, report well performance trends, and identify potential performance declines within the IRZ system and monitoring wells. Long-term well performance monitoring consists of specific capacity monitoring, water quality monitoring, and wellhead inspection. One measure used to assess well performance is a specific capacity evaluation. The specific capacity for each extraction, injection, and monitoring well is determined

by the rate of extraction or injection per unit of drawdown or draw up in the well and compared to a baseline specific capacity established for each well (Arcadis, 2023b).

Starting in the third quarter of 2022, specific capacities for each well were calculated monthly and compared to the baseline values to assess well performance decline over time. As presented in the O&M Manual, specific capacities greater than or equal to 90% of the baseline capacities will be classified as having good performance; specific capacities that fall between 80 and 90% of the baseline capacities will be classified as having fair performance; specific capacities below 80 percent of the baseline capacities will be classified as having poor performance. Specific capacities that fall below 80 to 90% of the baseline capacities will be flagged as needing evaluation and potential additional maintenance such as increasing the frequency of backwashing or rehabilitation.

Water quality monitoring, including field parameter collection and sampling, provides information on system status, which may help diagnose well clogging issues and provide information for designing corrective measures.

In accordance with the Final BOD, well performance is reported by PG&E in the form of quarterly well performance reports. The most current quarterly performance report reviewed as part of this FYR was the *First Quarter 2023 Well Performance Report* dated June 29, 2023 (Arcadis, 2023b). Well performance is discussed further in **Section 4.2**.

3.0 PROGRESS SINCE THE LAST REVIEW

This is the first FYR for the groundwater Selected Remedy at the Topock Site.

4.0 FIVE-YEAR REVIEW PROCESS

4.1 Community Notification, Involvement & Site Interviews

A public notice was made available via newspaper postings, submittal to information repositories, posting online on the PG&E remediation website, through email notifications, and was presented at a Consultative Work Group (CWG) meeting. All publications stated that a FYR was underway and public participation is encouraged and welcomed. These public notices are included as **Appendix A**.

The public notice was made available at the following newspapers:

- *Daily News,* Mojave, CA, published on May 2, 2023
- *The Sun,* San Bernardino, CA, published on May 1, 2023
- *The Sun,* Yuma, AZ, published on May 1, 2023
- *Today's News-Herald,* Lake Havasu City, AZ, published on May 1, 2023 and May 3, 2023
- *Desert Star,* Needles, CA, published on May 3, 2023
- *Parker Pioneer,* Parker, AZ, published on May 3, 2023

The public notice was made available at the following information repositories:

- DTSC
- Chemehuevi Indian Reservation
- Colorado River Indian Tribes Library
- Golden Shores Community
- Lake Havasu City Library
- Needles Branch Library
- Parker Public Library
- PG&E Remediation Website

The FYR process was presented in-person and via teleconference at the CWG meeting in Lake Havasu City, Arizona on May 9, 2023. The FYR presentation included an introduction to the FYR process, a review of the Selected Remedy, the purpose of conducting a FYR, the anticipated schedule for FYR activities, locations where the public could find additional information, and how the public could request a FYR interview. The CWG PowerPoint presentation, Public Notice document, and Fact Sheet document were distributed to CWG members and are included in **Appendix C**.

The final version of this FYR report will be made available to the public at the above-listed information repositories.

During the FYR process, interviews were conducted to document any perceived problems or successes with the Selected Remedy that has been implemented to date. Seventeen interviews were conducted, and the results of these interviews are summarized below. Completed interview questionnaires are included as **Appendix B**.

The majority of interviewees responded with favorable or neutral overall impressions of the Selected Remedy however, many respondents noted that it is difficult to gauge their impression of the Selected Remedy effectiveness given that it has not been fully implemented. One interviewee, DTSC, responded with an unfavorable overall impression of the Selected Remedy largely due to significant construction schedule delays, the fact that the majority of the freshwater injection and IRL components of the Selected

Remedy have yet to be built, the cultural/aesthetic impacts are larger than conceptualized in the Final BOD, and that there are uncertainties associated with the outcome of PG&E's recent proposed modifications. DTSC noted that flexibility or "adaptive management" that was built into the Final BOD makes determining if the Selected Remedy is operating within expectations very difficult. DTSC also noted that PG&E continues to struggle with infrastructure damage due to rain events and recommended PG&E review design features and methods to protect against water damage in the future. To avoid future damage, DTSC recommended that PG&E avoid installing wells in active washes in the future, if options are available.

Interviewees reported a number of difficulties which have impacted the Selected Remedy construction including COVID-19, supply chain delays, large storm events which have damaged infrastructure, and power supply problems. Many of these reported difficulties appear to have been rectified, however, delays in the construction schedule still appear to be a concern.

Although tribal representatives did not provide feedback in the form of an interview, the DOI noted that from a stakeholder perspective, the Selected Remedy appears to have an unfavorable effect on the tribes largely due to the location of the Topock Site being in an area of cultural and historical significance. DTSC noted that the tribes will continue to be concerned about the extent of change and disturbance to their cultural landscape. DTSC also noted that an unresolved concern from the tribes remains to be worked out regarding the final disposition of some removed isolated artifacts gathered by PG&E as part of the remedy and investigation activities. This concern was being discussed by the tribes, PG&E, and BLM at the time of the DTSC interview.

PG&E communicates Selected Remedy activities in a variety of ways including the CWG meetings, Technical Working Group (TWG) meetings, and consultation opportunities. Interviewees generally responded that they felt well informed about Selected Remedy activities and progress. PG&E also communicates Selected Remedy activities with DOI and DTSC through weekly coordination calls. DOI and DTSC noted that PG&E is generally good at keeping them up to date, however, there have been a few instances when they were notified of activities after the fact.

4.2 Data Review

As discussed in **Section 2.4**, construction of some key components of the Selected Remedy is ongoing. The IRZ system, supporting components, and a portion of the monitoring well network are the only key component of the Selected Remedy that have been completed and are operational. The data review for this FYR is focused on data generated during remediation monitoring to determine if the IRZ component of the Selected Remedy is functioning as intended in the Final BOD. This data review focuses on the most current remediation monitoring reviewed at the time of this FYR preparation (Q1 2023) in comparison to baseline concentrations collected in Q4 2021 and Q1 2022.

IRZ Operation

Groundwater extracted via the IRZ extraction wells is processed through the RPWC system, amended with carbon substrate at the MW-20 Bench Carbon Amendment Building, and then re-injected into the aquifer via IRZ injection wells. Locations of the IRZ wells, RPWC system, and Carbon Amendment Building are shown on **Figure 5**. Average systemwide uptime was 86% in first quarter 2023 (Arcadis, 2023a). The average uptime of the system was impacted by the March 15 storm event. Only seven of the 19 injection wells were operational after the storm. IRZ extraction wells IRZ-9 and IRZ-13S, and IRZ-13D were also impacted by the storm event. IRZ-13S and IRZ-13D were not restarted during Q1 2023 because the southern IRZ injection wells were not restarted.

During Q1 2023, the four operating extraction wells had average extraction flow rates of 117, 106, and 80 gpm for January, February, and March 2023, respectively. Approximately 11,133,389 gallons of extracted groundwater were conditioned by the RPWC system and injected in the IRZ injection wells during Q1 2023. At the time of this FYR, the primary extraction well being used is IRZ-23. *Table 2.1 NTH IRZ System*

Operational Overview and *Table 2.2 Summary of NTH IRZ System Discharges to Groundwater* of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a) are provided in **Appendix F-1**.

Per the Final BOD, and as discussed in **Section 2.4.1**, the IRZ injection wells were designed with an anticipated total injection flow rate of 300 gpm, with an anticipated range of 200 to 400 gpm, and the anticipated nominal injection flow rate per well ranging from 4 to 20 gpm, with a maximum injection flow rate of 40 gpm. During Q1 2023, the average injection flow rates were 123, 112, and 85 gpm for January, February, and March 2023, respectively, which is below the anticipated injection range in the Final BOD of 200 to 400 gpm. Approximately 11,722,337 gallons of recirculated groundwater were injected in the IRZ injection wells during Q1 2023. The discrepancy between the amount of water extracted (11,133,389 gallons) and the amount reinjected (11,722,337 gallons) was attributed to inaccuracy of the water meters. March 2023 injection flow rates were impacted by the March 15 storm event which damaged eight of the IRZ injection wells. The lower average injection rates appear to be affected by the portions of the Selected Remedy still under construction and not in operation.

In Q1 2023, 11 of the 14 IRZ injection wells were operating. Of the 11 operating injection wells, only IRZ-39 had average injection flow rates below the target nominal average flowrate of 4 to 20 gpm. IRZ-39 had average injection flow rate for the months of January, February, and March 2023 of 1.3, 1.0, and 0.6 gpm, respectively. *Table 2.1* and *Table 2.2* of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a) is provided in **Appendix F-1**. The actual total average injection flowrate is lower than the BOD estimated injection flowrate likely due to fewer IRZ injection wells/intervals installed, two non-operational IRZ wells (IRZ-21 and IRZ-25), and significant impacts to the operational time at 12 of the 19 IRZ well intervals due to the March 2023 flood event.

In January, February, and March 2023, ethanol (carbon substrate) was injected into operating injection wells twice weekly. The amount of ethanol dosed weekly was a time-weighted target average of 60 milligrams per liter (mg/L), which is 60% of the nominal dosing design in the Final BOD. A total of 1,641 gallons of ethanol was injected in first quarter 2023. Ethanol injection was focused in selected plume areas, resulting in Cr(VI) concentrations decreasing along the line of IRZ treatment wells. *Table 2.1* of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a) is provided in **Appendix F-1**.

IRZ System O&M

The O&M Manual presents the O&M Plan for the Selected Remedy and presents the strategy and procedures for performing operations and maintenance. It was anticipated in the Final BOD and O&M Manual that changes would be necessary to the operation of the system over time as more operational data and monitoring data are generated and evaluated. Any changes made to the system are reported in the quarterly progress reports per the O&M Plan. Any changes to the system that involve a design change from the Final BOD requires PG&E to submit a work variance request to DTSC and DOI for approval. The O&M Plan also requires tracking and reporting of all administrative changes, such as changes in point of contact information, etc. In addition to work variances and administrative changes, Future Activity Allowances can be issued for an activity that is not considered in the remedy design but necessary to support the project objectives. Future Activity Allowances are not intended to account for minor adjustments (work variances) of the remedy design during construction resulting from field conditions. A Future Activity Allowance is to consider the potential impacts of needing to take additional but previously unforeseen activities that were not contemplated as part of the Final Remedy Design but are activities that would improve the performance of the remedy.

At the time of this FYR, the IRZ is being operated in accordance with the O&M Manual and monitoring is being performed in accordance with the Phase I Interim Monitoring Plan (Arcadis, 2021). The IRZ system is still in the shakedown phase of operation, where PG&E is making minor adjustments as necessary to ensure that the Selected Remedy is operating as designed. These adjustments are typically made in response to system operating data, groundwater monitoring data, observations made during routine maintenance, system equipment failures (not common), and/or system operation errors (not common). If a release

occurred during equipment failure or during a system operation error, the release(s) are reported to the agencies, a cleanup/action is performed, and a corrective action is identified to prevent reoccurrence. Releases are summarized on *Table 2-5 Summary of Releases Occurred During Groundwater Remedy Construction* from the *June 2023 Monthly Progress Report* (Jacobs, 2023), provided in **Appendix F-1**.

IRZ system operations and non-routine maintenance are summarized in *Table 2.3 NTH IRZ System Operations and Non-Routine Maintenance Log* of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a), provided in **Appendix F-1**. The log notes events such as system offline, ethanol dosing, injection well rehabilitation, injection well backwashing, injection of reconditioned water, changes in operational parameters, etc. Maintenance of injection, extraction, and monitoring wells is reported in the quarterly well performance reports. Review of the non-routine maintenance log, provided in *Table 2.3 NTH IRZ System Operations and Non-Routine Maintenance Log* and review of well specific capacities, provided in *Table 3.3 Summary of NTH IRZ System Operations and Non-Routine Maintenance Log* of the *First Quarter Well Performance Report* (Arcadis, 2023b), provided in **Appendix F-1**, indicates the IRZ injection wells and extraction wells are experiencing decreasing well specific capacities and are requiring more frequent maintenance efforts including backwashing and well rehabilitation.

Well rehabilitation of injection wells typically consists of mechanical cleaning of downhole equipment, well pipe, and screen and chemical treatment of the well. During the well rehabilitation efforts, well deposits including bacterial and mineral deposits were noted on the packer and downhole equipment in three injection wells (IRZ-16, IRZ-20, and IRZ-35). The specific capacity of the injection wells initially improved with the increased maintenance efforts but again showed gradual decreasing specific capacities over time. The decreasing capacities in the injection wells is likely due to fouling of the screens by biological processes or mineral crustation as a result of the injection activities. Even with these additional maintenance efforts, the majority of IRZ injection wells still have a poor performance rating and show gradual decreasing specific capacities.

Several releases were noted during the operation of the IRZ, as summarized on *Table 2.5 Summary of Releases During Remedy Construction and Startup* in the *June 2023 Monthly Progress Report*, included in **Appendix F-1**. Most of the releases were related to construction incidents and not related to O&M activities or operation of the IRZ system. The releases that occurred on November 2, 2022 and February 18, 2023 are described in further detail below.

The November 2, 2022 release was the result of a broken flange in the IRZ-13 extraction well which triggered the IRZ to shut down due to flooding in the IRZ well vault. The system operator bypassed the system alarm, allowing the extraction well to restart, which caused the extracted water to overflow the well vault. PG&E updated the existing standard operating procedure (SOP) and conducted operator training on the updated SOP to prevent a reoccurrence.

The February 18, 2022 release occurred due to a system operator error overriding the program logic communications, which allowed the backwash pumps to continue operating when the storage frac tank value was in the closed position. PG&E implemented corrective actions to revise the Programmable Logic Controllers (PLC) to prevent a reoccurrence.

Process Control Monitoring

In Q1 2023, monthly sampling from the process control monitoring network were conducted to assess how well the treatment and system are operating compared to baseline conditions, per the Final BOD. The process control monitoring network is shown on **Figure 9**. The process control monitoring program consists of five components:

- dose-response monitoring,
- downgradient well monitoring,
- northern IRZ extraction monitoring,

- extraction well monitoring, and
- carbon amendment system monitoring.

Analytical results for Cr(VI) and in-situ byproducts from the dose-response and downgradient monitoring wells are used to evaluate IRZ treatment and evaluate if in-situ byproduct generation and migration from the IRZ is controlled. The data generated for these monitoring components during Q1 2023 were reviewed, except for the carbon amendment system, to assess if the IRZ is functioning as intended. Carbon amendment system monitoring is performed semiannually; therefore, was not sampled during Q1 2023. A data review of process control monitoring is discussed below for each component.

Dose-Response Wells

Dose-response wells located within the vicinity of the IRZ injection wells (i.e., within the IRZ footprint) are used to assess the completeness of carbon substrate distribution, establishment of Cr(VI) reducing conditions, and in-situ byproduct generation. Based on the review of Q1 2023 data, 22 dose-response wells (each interval counted as a separate well) were monitored within the IRZ footprint. *Table 3.5 NTH IRZ Dose-Response Monitoring Well Performance Summary* of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a) is provided in **Appendix F-1**. Dose-response wells were sampled each month during first quarter 2023 for Cr(VI), Cr(T), dissolved iron, arsenic, manganese, and other parameters per the *Phase I Interim Monitoring Plan*. The following key items were noted:

- Cr(VI) concentrations decreased from baseline concentrations in 16 of the 22 dose-response wells, or approximately 72% of the wells monitored, with reductions ranging from 14% to 100%.
- Cr(VI) concentrations remained unchanged from baseline concentrations in three of the 22 dose-response wells or approximately 14% of the wells monitored.
- Cr(VI) concentrations increased from baseline concentrations in three of the 22 dose-response wells or approximately 14% of the wells monitored.
- Cr(VI) concentrations were either below 32 µg/L or decreased to below 32 µg/L in 11 of the 22 dose-response wells, or approximately 50% of the wells monitored.
- Evidence of treated water was present in 14 of the 22 dose-response wells, or approximately 64% of the wells monitored.
- No evidence of treated water was present in eight of the 22 dose-response wells, or approximately 36% of the wells monitored.
- Seven dose-response wells were associated with the IRZ injection wells that were impacted by the March 2023 storm event.

Downgradient Response Monitoring Wells

In the floodplain located to the east of NTH (i.e., downgradient of the IRZ), monitoring wells were evaluated during Q1 2023 for Cr(VI) distribution and changes in Cr(VI) concentrations. A total of 61 monitoring wells were sampled per the *Phase I Interim Monitoring Plan*. Per the Final BOD, Cr(VI) concentrations in downgradient monitoring wells were anticipated to decrease to lower than 32 µg/L within two to 10 years of system operation. Within the first six months to one year of system operation, Cr(VI) concentration trends were expected to vary, with increasing Cr(VI) concentrations at some monitoring wells and decreasing or stable conditions at others. *Table 2.1-4* of the *SMP* (Final BOD, Appendix L, Volume 2; CH2M Hill 2015a) describes the anticipated changes in Cr(VI) concentrations at specific monitoring wells during the first six months to one year of system operation. Based on the monitoring results presented in

Table 3.6 NTH IRZ Downgradient Response Monitoring Wells Performance Summary of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a), included in **Appendix F-1**, the following is noted:

- Six of the 61 downgradient response monitoring wells showed increasing Cr(VI) concentrations, or approximately 9.8% of the wells monitored. The increase in Cr(VI) concentrations ranged from 15% at MW-34-055 to 6,921% at MW-39-080.
- 12 of the 61 downgradient response monitoring wells showed decreases in the Cr(VI) concentrations, or approximately 20% of the wells monitored. The decrease in Cr(VI) concentrations ranged from 9% to 99%.
- 43 downgradient response monitoring wells showed no Cr(VI) concentration increases or decreases.
- All downgradient response monitoring wells showed Cr(VI) concentrations lower than 32 µg/L except for three wells located in the floodplain to the east of IRZ-23: MW-39-080, MW-39-100, and PT5D.

Cr(VI) concentrations at MW-39-100 have increased since the start-up of IRZ operations. To improve hydraulic control of the plume and limit potential eastward migration of the plume, PG&E is proposing to extract groundwater from existing remedial well, PTI-1D. The *PTI-1D Floodplain Extraction Test Workplan* dated September 20, 2023 by Arcadis was approved by DTSC on September 25, 2023 and DOI on September 26, 2023.

Northern IRZ Extraction Monitoring

The northern end of the IRZ system is designed to control potential migration of Cr(VI) via groundwater extraction rather than the establishment of an IRZ. The Cr(VI) plume north of the northernmost operating IRZ injection well, IRZ-16, is situated within a shallow lobe and a deep lobe as presented in *Figure 3.1a*, *3.1d*, and *3.5e* of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a). Multiple lines of evidence are used in the quarterly progress reports to evaluate achievement of control of the Cr(VI) plume at the northern end of the IRZ (including interpreted water levels, concentration trends, and numerical modeling). The 2020 to 2023 groundwater monitoring data, presented in *Appendix B* of *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a), indicates the shallow lobe in the floodplain is relatively stable with minor fluctuations in the Cr(VI) concentrations which are generally below 32 µg/L (except for well MW-75-033). In addition, water level monitoring indicates a very low hydraulic gradient with localized flow toward extraction well IRZ-13S. The deep lobe appears to be controlled based on the low concentrations of Cr(VI) (less than 32 µg/L) in floodplain monitoring wells, and the operation of IRZ extraction well IRZ-13D, which creates an inward gradient toward extraction well IRZ-13D.

Extraction Well Monitoring

The potential for IRZ extraction well fouling resulting from carbon injection is monitored during system operations. This monitoring includes measuring total organic carbon (TOC) and metal byproduct concentrations for conditions that may generate well fouling as well as monitoring specific capacity of the IRZ extraction wells. Overall, Q1 2023 TOC, total iron, dissolved iron, and dissolved manganese concentrations were generally lower than the laboratory reporting limits and baseline concentrations. Overall, Q1 2023 data does not suggest well fouling is occurring in the extraction wells. Specific capacities in extraction wells IRZ-13D and IRZ-23 operated below 80 percent baseline capacity during Q1 2023. The *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a) indicated that the lower specific capacities were the result of varying flowrates during the quarter and not plugging of the well filter pack or screen by sediments or mineral encrustation. Therefore, no routine well maintenance was performed during Q1 2023 on the extraction wells. Baseline and first quarter 2023 TOC and metal byproduct results provided in *Table 3.4 Process Control Monitoring Analytical Results* of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a) are included in **Appendix F-1**.

RPWC Monitoring

The operating IRZ injection wells were backwashed at least once per week at the start of Q1 2023. Backwash water was pumped to the RPWC influent tanks, processed through filters, and was then monitored for Cr(VI), Cr(T), dissolved iron, dissolved manganese, and field parameters. This conditioned water is then conveyed from the TCS RPWC system to a holding tank at MW-20 Bench before being reinjected into the IRZ injection wells. The Final BOD specifies that conditioned water should have a pH between 6.5 and 8.5 prior to reinjection to the IRZ. During Q1 2023, the pH met the requirements for reinjection except for a brief period. Re-injection was paused during this period and restarted after some pH adjustments were made (Arcadis, 2023a).

Remedy Compliance Monitoring

Remedy compliance monitoring consists of surface water and groundwater sampling to evaluate achievement of RAOs 2, 3, and 4. The remedy compliance monitoring network is shown on **Figure 10**. *Table 3.8 Remedy Compliance Monitoring Analytical Results* of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a) is included in **Appendix F-1**. RAO 1, which involves prevention of the ingestion of water with elevated Cr(VI) concentrations, requires no action because ICs are being implemented to achieve this RAO. As detailed in **Section 4.3**, prevention of ingested water with elevated Cr(VI) concentrations appears to be being accomplished, as documented during the FYR site inspections.

- RAO 2 is evaluated by monitoring Cr(VI) concentrations in the Colorado River to verify that concentrations do not exceed the surface water quality standard of 11 µg/L. During Q1 2023, Cr(VI) concentrations at the 16 surface water monitoring locations (some locations have multiple intervals) were less than the water quality standard of 11 µg/L and all results were non-detect at the reporting limit. In-situ byproducts are also monitored even though RAO 2 does not specifically include the potential IRZ byproducts. Dissolved arsenic and dissolved manganese concentrations in the Colorado River did not exceed the surface water quality standards (arsenic only) or the California primary and secondary maximum contaminant levels (MCLs) of 10 µg/L (primary arsenic MCL) and 0.05 mg/L (secondary manganese MCL) (California Water Resources Control Board, 2022a and 2022b).
- RAO 3 is evaluated by monitoring changes in groundwater Cr(VI) concentrations inside the plume boundary (i.e., mass reduction) and assessing the lateral and vertical distributions of Cr(VI) concentrations across the plume. This RAO will be achieved by meeting the cleanup goal of 32 µg/L of Cr(VI). In Q1 2023, Cr(VI) concentrations were below 32 µg/L in a number of dose-response wells and downgradient monitoring wells.
- RAO 4 is evaluated by monitoring Cr(VI) and in-situ byproduct concentrations (dissolved arsenic and dissolved manganese) outside of the target remediation area to verify that concentrations do not permanently increase during and following completion of the remedial action (Arcadis, 2023a). Trends in Cr(VI) as well as COPCs will be evaluated during remedy operation to ensure that the plume does not permanently expand and that corrective action can be implemented if the data indicates the plume is expanding.

COPC Monitoring

The DOI and DTSC consider selenium, molybdenum, and nitrate as COPCs potentially related to site activities and have directed monitoring of these constituents throughout remediation. The COPC monitoring program consists of surface water and groundwater sampling to monitor COPC concentrations. The *COPC Perimeter Assessment Plan* included in the O&M Manual (PAP; Final BOD, Appendix L, Volume 2, CH2M Hill, 2015a) was developed to monitor COPC concentrations in 31 outer plume compliance monitoring wells. The trigger levels are based on Shewhart control limits calculated from the most recent eight sample results for each monitoring well. In general, the COPCs were not detected above the trigger levels established in the *COPC PAP* in Q1 2023 except in a few instances. The COPC network

is shown on **Figure 11**. *Table 3.9 COPC Monitoring Analytical Results* of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a) are included in **Appendix F-1**.

Well Performance and Maintenance

The purpose of well performance tracking is to assess the frequency and methods required for well maintenance, report well performance trends, and identify potential performance declines within the IRZ system and monitoring wells (Arcadis, 2023b). As outlined in the O&M Manual, long-term performance monitoring consists of specific capacity monitoring, water quality monitoring, and wellhead inspection.

The specific capacity for each extraction, injection, and monitoring well is determined by the rate of extraction or injection per unit of drawdown or draw up in the well. As presented in the O&M Manual, specific capacities greater than or equal to 90% of the baseline capacities will be classified as having good performance. If a specific capacity of a well falls below 80 to 90% of the baseline capacities, the well will be flagged as needing evaluation and potential additional maintenance. Specific capacities are included in *Table 3.3 Summary of NTH IRZ Well Specific Capacities First Quarter Well Performance Report* (Arcadis, 2023b), provided in Appendix **F-1**.

Water quality monitoring, including field parameter collection and sampling, is also performed to evaluate well clogging issues. TOC, total iron, dissolved iron, and dissolved manganese concentrations are measured as identifiers for well fouling. Water quality concentrations during Q1 2023 were generally lower than the laboratory reporting limits and baseline concentrations, with a few isolated exceptions. The isolated detections did not indicate a consistent trend that would be a concern for causing fouling. Baseline and first quarter 2023 TOC and metal byproduct results provided in *Table 3.4 Process Control Monitoring Analytical Results* of the *First Quarter 2023 Quarterly Progress Report* (Arcadis, 2023a) are included in **Appendix F-1**.

Extraction wells, injection wells, and monitoring wells are also inspected quarterly at minimum for visible leaks and damage.

Well maintenance is incorporated into the routine operations of the IRZ. Routine maintenance is performed on the injection wells which can be prone to fouling due to the injection of the carbon substrate. Routine maintenance includes backwashing and mechanical and chemical rehabilitation. The frequencies of injection well rehabilitation may be increased in frequency or manner of application in response to well performance monitoring data.

Routine injection well maintenance during Q1 2023 included backwashing of injection wells during system operation. Well rehabilitation was performed on injection wells IRZ-18 and IRZ-33 in the fourth quarter 2022 and on the remaining injection wells in Q1 2023. Many wells exhibited fair or poor well performance during Q1 2023. At the beginning of Q1 2023, injection wells exhibiting fair or poor well performance were backwashed twice weekly, while the remaining injection wells were backwashed once weekly. On January 16, 2023, backwash frequency increased to twice weekly for all operating injection wells to improve performance and manage well fouling. *Table 2.3 Summary of NTH IRZ System Operations and Non-Routine Maintenance Log* of the *First Quarterly Progress Report* (Arcadis, 2023a) shows the maintenance activities performed during Q1 2023.

The specific capacities of the IRZ injection and extraction wells are reported on *Table 3.3 Summary of NTH IRZ Well Specific Capacities First Quarter Well Performance Report* (Arcadis, 2023b). The table summarizes the injection and extraction wells monthly average specific capacities, baseline specific capacities, well performance rating, and response based on the well performance since December 2021 (system start-up). The average monthly specific capacities in March 2023 showed 10 of the 14 injection wells were rated poor (specific capacity less than 80% of the baseline specific capacity) and four injection wells were not operating. The table provided the response taken when a specific capacity was rated as poor in accordance with the O&M Manual. The response to a well exhibiting a poor specific capacity was either increased backwashing and/or rehabilitation. Rehabilitation was performed throughout Q1 2023 and

methods included both mechanical and chemical rehabilitation. Commonly after a well was rehabilitated, the backwash frequency was increased to twice a week to maintain the specific capacity. In a majority of the IRZ injection wells, the well performance initially increased after maintenance was performed but eventually decreased again to a poor rating. A recommendation has been added to **Section 6** for specific capacities to be closely monitored as the system continues to operate.

During injection well rehabilitation efforts, well deposits were observed on the packer and downhole well equipment in multiple wells. Subsequent testing of the deposits indicated the presence of bacteria and mineral deposits including sulfate reducing bacteria and other anaerobes, carbonate precipitates, and iron precipitates likely in the form of iron sulfides (Arcadis, 2023b).

Extraction wells are less prone to fouling and, as such, routine rehabilitation was not planned. No routine maintenance was performed on the extraction wells in Q1 2023. The well performance of extraction well IRZ-23 has been rated as poor for Q1 2023 with the specific capacity declining from 17 gpm/ft in January 2023 to 8.9 gpm/ft in March 2023. The report indicated the well did sustain lower specific capacities when the well was pumping at higher flowrates.

Monitoring wells are inspected to determine whether monitoring well maintenance, such as wellhead repair, well redevelopment to remove sediment buildup, or well screen redevelopment is needed. In March 2023, some monitoring wells were flooded during a significant storm event. Well maintenance was performed on the flooded wells including replacing the well caps with watertight units and redevelopment of a well to remove surface water that had entered the well during the storm event. Additional well maintenance activities included redevelopment of wells where the measured depth covered greater than 20% of the screened interval. Other maintenance includes measuring specific capacity, turbidity, and depth to well bottom.

During Q1 2023, monitoring wells MW-27-020, MW-31-135, MW-32-020, and MW-77-046 showed measured depths covering greater than 20% of the screened interval during consecutive sampling events; however, sediment infiltration is likely in these wells given the screen slot size and/or filter pack combination with the fluvial sediments. Redevelopment was not recommended for these wells. Purging of monitoring wells during sampling is conducted at rates between 100 and 500 milliliters per minute, and drawdown at these rates typically ranges from a few hundredths to a few tenths of a foot. If drawdown of greater than one foot is observed for a fluvial or alluvial well, the well will be flagged for further evaluation to determine if it needs rehabilitation. No wells were identified for potential rehabilitation in Q1 2023 based on this criterion (Arcadis, 2023b).

In May 2023, during bailing at MW-28-025, MW-30-030 and MW-39-040, sediment infiltrated the wells and inhibited the ability to effectively remove sediment and complete redevelopment. During redevelopment of monitoring well MW-30-030, the surge block that was used to disturb settled sediments at the bottom of the well and the surge block became sand locked during the process. the surge block at MW-30-030 became stuck and was unable to be removed by jetting and mechanical means. Additionally, during attempted surge block removal, the well casing and monument moved approximately 3 inches, causing the field team to cease efforts to retrieve the surge block. Well MW-30-30 will be abandoned by overfilling and replaced with a new well in Fourth Quarter 2023.

4.3 Site Inspection

Three site inspections were conducted as part of this FYR on May 10-11, 2023, June 7-8, 2023, and August 9-10, 2023. In attendance were representatives from the DOI ECCD/OEPC and the DOI's technical contractor, see **Table 1**. The purpose of the site inspections were to assess the protectiveness of the Selected Remedy.

During site inspections, the TCS, IM No. 3 facilities, and active construction sites appeared to limit public accessibility with fencing, barricades, and signage, however, most other areas of the Topock Site appeared accessible to the public. Based on the site inspections, no land use changes, vandalism, or other issues were

observed that may impact the current protectiveness of the Selected Remedy. ICs on properties impacted by the Selected Remedy are discussed in **Section 2.4.9**. Prevention of ingested water with elevated Cr(VI) concentrations appears to have been accomplished, as documented during the site inspections which verified that there were no known installations of new groundwater wells for purposes other than site investigation and remediation activities as directed by DTSC and DOI since the start of construction activities in 2018.

Photologs from site inspections conducted on May 10-11, 2023, June 7-8, 2023, and August 9-10, 2023 are included in **Appendix D**. A site inspection checklist was completed during the August 9-10, 2023 site inspection and is included in **Appendix E**.

5.0 TECHNICAL ASSESSMENT

The following sections summarize the technical assessment component of the FYR process for groundwater at the Topock Site.

5.1 QUESTION A: Is the remedy functioning as intended by the decision documents?

The function of the Selected Remedy, as summarized in **Section 2.3.2**, **Section 2.3.3.1**, and **Section 2.3.3.2** has been assessed using the stated RAOs and short-term goal detailed in **Section 2.3.2.2** and **Section 2.3.2.3**. At the time of this FYR preparation, key components of the Selected Remedy, such as the TCS Recirculation Loop, IRL (including associated monitoring wells), and freshwater supply system, are not fully constructed and operational. The IRZ system, supporting components, and associated monitoring wells are the only components of the Selected Remedy that have been completed and are operational. The IRZ system became operational on December 21, 2021 but has operated intermittently due to power outages and damage caused by storm events during the early months of the shakedown phase. The intermittent power supply issue during start-up was resolved initially with a temporary power supply until a permanent solution, which resolved the power supply issue, was implemented. Repairs to the IRZ system from the significant storm event in March 2023 have been completed; however, repairs experienced delays due to supply chain issues, resulting in several IRZ wells being offline for an extended period.

Minor adjustments to the operation of the IRZ system continue during the shakedown phase as more operational and monitoring data is generated and evaluated. As with most remedial systems, routine adjustments during the shakedown phase are typical and were anticipated in the Final BOD. The IRZ system has not been operational for a sufficient period to properly assess if the IRZ is preventing or minimizing migration of the plume; however, surface water sampling performed in Q1 2023 does not indicate any Cr(T) or Cr(VI) detections in the Colorado River above water quality standards (RAO 2). The IRZ system appears to be capable of operating as designed in the Final BOD, which is supported by a number of associated monitoring wells showing reductions in Cr(VI) concentrations, indicating progress towards RAO 3.

RAO 1, which involves prevention of the ingestion of water with elevated Cr(VI) concentrations, is accomplished through ICs per the Final BOD. ICs on properties impacted by the Selected Remedy are discussed in **Section 2.4.9**. Prevention of the ingestion of water with elevated Cr(VI) concentrations appears to be accomplished, as documented during the FYR site inspections. These inspections verified there were no known installations of new groundwater wells for purposes other than site investigation and remediation activities as directed by DTSC and DOI since construction activities began in 2018.

DOI and DTSC cannot determine if the Selected Remedy is properly functioning as designed until the entire Selected Remedy construction and the shakedown period is completed. This short-term goal is discussed in **Section 2.3.2.3**.

5.2 QUESTION B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

The Topock Site exposure assumptions and cleanup levels identified in the ROD and GWRA are still considered valid, applicable, and relevant and appropriate for protection of human health and the environment. ARARs for the Topock Site include chemical-specific, location-specific, and action-specific ARARs of federal, California, and Arizona laws and regulations. RAOs were developed based on identified chemical-specific ARARs and attainment of these RAOs will result in compliance with the chemical-specific ARARs. This discussion focuses on RAOs and chemical-specific ARARs. A list of all ARARs is provided in **Appendix F-1**, a discussion of ARARs is provided in **Section 2.3.2.1**, and a list of RAOs is provided in **Section 2.3.2.2**.

There have been no changes to the RAOs specified in the ROD and RAOs remain protective of human health and the environment. Remedy compliance monitoring continues to be conducted to evaluate progress towards achieving RAOs 2, 3, and 4. Until the RAOs are attained, ICs will be maintained to prohibit

development of drinking water supply wells within the plume and any additional area outside of the plume footprint where control of groundwater flow directions and gradients is necessary to contain and remediate the plume (CH2M Hill, 2015a). RAO 1 is currently achieved through implementation of ICs. Details on RAOs and remedy compliance monitoring are provided in **Section 2.3.2.2**, **Section 2.4.5**, and **Section 4.2**.

Based on input from the FYR team, the exposure assumptions cited in the GWRA are still valid. The GWRA concluded that Cr(VI) is the principal threat present in groundwater at the Topock Site at concentrations that could pose a potential hazard to the future hypothetical groundwater user, if the groundwater were to be used as a source of drinking water (DOI, 2010). The cleanup level for Cr(VI) in groundwater at the Topock Site is the regional background level of 32 µg/L. There are currently no federal or California regulatory standards for Cr(VI) in groundwater. Cr(VI) has been regulated under the 50 µg/L primary MCL for Cr(T). The California Water Resources Control Board has recently proposed an MCL of 10 µg/L for Cr(VI) in drinking water however, this has not been finalized (California Water Resources Control Board, 2023).

The DOI and DTSC consider selenium, molybdenum, and nitrate as COPCs in groundwater potentially related to site activities. The COPC PAP was developed to monitor COPC concentrations in 31 outer plume compliance monitoring wells. The trigger levels are based on Shewhart control limits calculated from the most recent eight sample results for each monitoring well.

Cr(VI) is monitored in surface water to ensure that concentrations do not exceed water quality standards that support the designated beneficial use of the Colorado River (11 µg/L). This water quality standard used at the time of remedy selection is still valid.

Dissolved arsenic and dissolved manganese, byproducts generated by the IRZ, are also monitored in the Colorado River to verify that concentrations do not exceed the surface water quality standards. The National Recommended Water Quality Criteria (NRWQC) for aquatic life for dissolved arsenic is 150 µg/L. There is no NRWQC for aquatic life for dissolved manganese. Water quality criteria for aquatic life for dissolved arsenic and dissolved manganese used at the time of remedy selection are still considered valid (NRWQC, 2023). Dissolved arsenic is also compared to the California primary MCLs of 10 µg/L and dissolved manganese is compared to the California secondary MCL of 50 µg/L. MCLs used at the time of remedy selection for dissolved arsenic and dissolved manganese are still considered valid (California Water Resources Control Board 2022a and 2022b).

5.3 QUESTION C: Has any other information come to light that could call into question the protectiveness of the remedy?

Two items that may affect the protectiveness of the remedy since the design are emerging contaminants, specifically per-and polyfluoroalkyl substances (PFAS), and extreme storm events. These are discussed further in this subsection.

To address PFAS, a review of historical chemical usage provided by PG&E in Tables 3-1 through 3-4 of the RFI/RI Volume 1 Report was conducted. During a meeting in Q2 2023 on the RFI/RI, PG&E representatives indicated that they were not aware of any historic PFAS usage. Although PG&E may not have any specific knowledge of PFAS usage, agencies such as the USEPA and the Centers for Disease Control note the widespread use of these compounds in pesticides and dispersants, both of which were used at the TCS according to the RFI/RI Volume 1 Report. Without historical safety data sheets (SDSs), it is difficult to determine whether the chemicals used at the TCS contained PFAS. Even with an SDS, it still may be difficult to determine if chemicals contained PFAS in their composition due to a cutoff rule found in 29 CFR 1910.1200 which states that an ingredient must be disclosed if it meets Globally Harmonized System classification criteria as a hazardous substance and its content exceeds the cutoff value which is typically equal to or greater that 0.1% for a carcinogen and equal to or greater than 1% for a non-carcinogen. It is therefore possible that a chemical manufacturer may not have disclosed PFAS on an SDS if it was less than 1% of the chemical mixture. With some PFAS human health advisory limits being in the parts per

trillion range, the presence of PFAS at the site is likely an issue which may require further assessment. PFAS were not considered COCs at the time of the remedy selection or remedy design; therefore, the current Selected Remedy likely will not address any existing groundwater PFAS contamination. This item has been added as an issue/recommendation in **Section 6**, **Table 3**.

A primary concern frequently discussed by climate scientists revolves around the impending temperature escalation, known as global warming (NASA, 2023). Significant storm events at the site in November 2019, March 2022, August 2022, and March 2023 have caused damage to the Selected Remedy infrastructure and construction. Damage occurred to access roads, segments of pipeline, monitoring wells, and flooding in the IRZ well vaults along NTH. The March 15, 2023 storm event yielded over 1.6 inches of rain in just three hours. By comparison, the area, nestled within the Mohave Valley and surrounded by nearby mountain ranges, has averaged an annual precipitation of 3.77 inches over the past 23 years (NWS, 2023). According to the USEPA's Creating Resilient Water Utilities (CREAT) Climate Change Scenarios Projection Map, the Mohave Valley is projected to see an increased 100-year storm intensity between 21 and 25% by 2035 (USEPA, 2023b). If these types of storm events continue more frequently, continuous damage to infrastructure and site access can occur that may affect the protectiveness of the Selected Remedy. This item has been added as an issue/recommendation in **Section 6**, **Table 3**.

6.0 ISSUES AND RECOMMENDATIONS

Issues that affect the current and/or future protectiveness of the Selected Remedy have been included in **Table 3** below. Additional issues and recommendations that do not affect the protectiveness are provided in the **Other Findings** section below.

Table 3: Issues and Recommendations Identified in the Five-Year Review

Issue Category: Remedy Performance				
Issue: The construction of the full Selected Remedy, as outlined in the Final BOD, has not been completed and has experienced significant construction delays. The full Selected Remedy is scheduled to start-up in May 2026.				
Recommendation: Complete the construction of the full Selected Remedy per the Final BOD, or any DOI and DTSC approved design modifications, by May 2026.				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
Yes	Yes	PRP	Federal Facility	5/31/2026

Issue Category: Changed Site Conditions				
Issue: Cr(VI) concentrations have increased at several downgradient monitoring wells located in the floodplain to the east of IRZ-23. These concentration increases may indicate migration of residual Cr(VI) that was present in the floodplain prior to operation of the IRZ system. PG&E has been approved to conduct an extraction test utilizing an existing pilot test injection well (PTI-1D) in the area of the increasing Cr(VI) concentrations to improve hydraulic control of the plume and limit eastward migration of Cr(VI) in the floodplain. The extraction test will also remove Cr(VI) mass which will be treated in the IRZ system.				
Recommendation: Implement the extraction test at PTI-1D and monitor the hydraulic gradient and Cr(VI) concentrations in this area of the plume.				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
Yes	Yes	PRP	Federal Facility	12/31/2024

Issue Category: Operations and Maintenance				
Issue: The specific capacities of several IRZ injection and extraction wells have been steadily decreasing and the well performances have been rated as poor since start-up, even after well rehabilitation techniques have been implemented per the O&M Manual.				
Recommendation: Continue to closely monitor specific capacities of injection and extraction wells as the system continues to operate and continue to perform maintenance as needed.				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	Federal Facility	Ongoing

Issue Category: Institutional Controls				
Issue: ICs do not appear to be properly implemented on FMIT properties impacted by the Selected Remedy. PG&E retains easement of this property until remedy completion.				
Recommendation: PG&E should establish ICs and a monitoring program to ensure compliance with ICs at properties impacted by the Selected Remedy.				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
Yes	Yes	PRP	State	12/31/2024

Issue Category: Other	***Note:*** *Emerging COPC*			
Issue: Potential historical PFAS usage at TCS.				
Recommendation: PG&E should review historic fire suppression systems at the TCS and other related information (SOPs for firefighting efforts, fire protection studies, third party fire suppression system inspections, etc.) and chemical usage at TCS for chemicals that could have contained PFAS.				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	PRP	Federal Facility & State	12/31/2024

Issue Category: Other	***Note:*** *Increased storm intensity*			
Issue: Damage to Selected Remedy infrastructure and construction delays caused from significant storm events.				
Recommendation: Design features should be reviewed to protect against potential water damage from flooding and significant storm events in the future. One option may be to avoid the installation of wells in active washes, if possible.				
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
Yes	Yes	PRP	Federal Facility & State	12/31/2024

Other Findings

In addition to the table above, the following recommendations are provided for items that were identified during this FYR which may improve performance of the remedy, reduce costs, improve management of O&M, accelerate site close out, conserve energy, and promote sustainability; but do not affect current and/or future protectiveness:

- *Finding:* There does not appear to be a formal process for requesting and approving the construction schedule changes with DOI and DTSC. The 2018 remediation schedule was intended to be a preliminary schedule for planning purposes and some schedule changes were anticipated. However, DOI and DTSC did not anticipate the extent of the construction delays. PG&E currently presents schedule delays and changes at CWG meetings.

Recommendation: A formalized approval process should be implemented for construction schedule changes to ensure that the Selected Remedy is completed and operational in a timely manner.

- *Finding*: RAO 3 includes reduction of mass of Cr(T) and Cr(VI) in groundwater which will be achieved by reaching the regional background concentration of 32 µg/L for Cr(VI). Reporting of monitoring relies on qualitative metrics such as "decreasing trends" or pass-fail triggers, which make it difficult to determine Selected Remedy mass reduction progress towards achieving RAO 3.

  Recommendation: Illustrate progress in the form of mass removal graphs.

7.0 PROTECTIVENESS STATEMENT

As discussed in **Section 2.4**, construction of some key components of the Selected Remedy is ongoing with the IRZ system, supporting components, and associated monitoring wells being the only key components of the Selected Remedy that have been completed and operational at the time of this FYR. The IRZ system is still in the shakedown phase but appears to be capable of functioning as intended as a vital remedy component in the Final BOD. The O&M data generated to date appears to indicate the IRZ is reducing Cr(VI) concentrations. Additional operating and monitoring data are needed to fully assess if the IRZ is hydraulically controlling the plume and limiting eastward migration from the floodplain towards the Colorado River.

The site inspections performed during this FYR verified there were no changes in the land use or any installation of new groundwater wells for purposes other than site investigation and remediation activities as directed by DOI and DTSC since the start of construction activities in 2018. ICs on tribal and private lands impacted by the Selected Remedy are not well documented or enforced, apart from the PG&E-owned TCS property.

Completion of construction of the full Selected Remedy is anticipated in 2026. Based on the data and information reviewed during this FYR, the human and ecological exposures are currently under control and no unacceptable risks are occurring at the Topock Site. The remaining components of the Selected Remedy are in various stages of construction and are anticipated to be protective once completed, if no implementation or performance issues occur.

Table 4: Protectiveness Statement

Groundwater Remedy for SWMU 1/AOC 1 and AOC 10 Protectiveness Statement
Protectiveness Determination: Will be Protective
Protectiveness Statement: The Selected Remedy is expected to be protective of human health and the environment upon completion for the COCs listed in the ROD and Final BOD. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks to human and ecological receptors.

8.0 NEXT REVIEW

The next FYR report for the groundwater Selected Remedy at the Topock Site will be required five years from the signature date of this report.

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