Chapter 3
Existing Conditions and Impacts

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This chapter provides environmental analyses of the physical and biological changes that could occur as a result of implementation of the project. There is a separate section for each resource analyzed, as listed below. In each section, there is an introduction that includes a summary table with the impacts, a description of the regulatory and environmental setting, the significance criteria and methodology used in the impact analysis, the potential impacts, and the required mitigation measures.

This chapter is organized with the following sections:

- 3.1, *Water Resources and Water Quality*
- 3.2, *Land Use, Agriculture, Population and Housing*
- 3.3, *Hazards and Hazardous Materials*
- 3.4, *Geology and Soils*
- 3.5, *Air Quality and Climate Change*
- 3.6, *Noise*
- 3.7, *Biological Resources*
- 3.8, *Cultural Resources*
- 3.9, *Utilities and Public Services*
- 3.10, *Transportation and Traffic*
- 3.11, *Aesthetics*
- 3.12, *Socioeconomics*

Section 3.1
Water Resources and Water Quality

3.1 Water Resources and Water Quality

3.1.1 Introduction

This section describes the existing conditions and regulatory setting for water resources in the project area. This section also presents significance criteria for determining impacts to water resources, describes those impacts that may result from implementation of the project alternatives, and identifies mitigation measures that would reduce identified significant impacts.

This section analyzes potential impacts in both the remedial project area (OU1, OU2, and OU3) and the entire study area, which includes areas outside the remedial project area that may be affected by impacts to water resources and water quality due to remedial activities. As discussed in Chapter 2, *Project Description*, the study area was defined by the limits of the groundwater model. The study area and the remedial project area are shown on Figure 2-2a in Chapter 2, *Project Description*.

Groundwater is the primary water resource in the project area and is used both for domestic and agricultural supply. Surface waters in the remedial project area are limited to dry washes that either drain north to Harper Lake or south to the Mojave River. The Mojave River is located 1 mile south of the PG&E Compressor Station, but this stretch of the river flows only during major storms.

Additional information about water resources related to the groundwater modeling, historical water elevations, water quality measurements, and prior remedial activities is provided in Appendix A, *Groundwater and Remediation Supporting Documentation*. Growth-inducing and cumulative impacts on water resources are discussed in Chapter 4, *Other CEQA Analyses*.

This section refers to the "chromium plume" as the locations where Cr[VI] concentrations are greater than the adopted background values of 3.1 parts per billion (ppb) or where Cr[T] concentrations are greater than 3.2 ppb. Reference to different forms of chromium such as Cr[VI], Cr[T] or Cr[III] are made where appropriate.

Table 3.1-1 presents a summary of the impacts of the project alternatives on water resources and recommended mitigation measures that would reduce identified significant impacts. Table 3.1-2 presents a summary of the key differences between project alternatives in terms of water resource impacts.

Table 3.1-1. Summary of Water Resource Impacts

Impact	Applicable Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
Groundwater Drawdown				
WTR-1a: Groundwater Drawdown Effects on the Regional Water Supply	No Project Alternative	Less than Significant	N/A	--
	All Action Alternatives	Significant	WTR-MM-1: Purchase of New Water Rights to Comply with Basin Adjudication	Less than Significant
WTR-1b: Groundwater Drawdown Effects on the Local Water Supply	No Project Alternative	Less than Significant	N/A	--
	All Action Alternatives	Significant	WTR-MM-2: Water Supply Program for Wells that are Affected by Remedial Activities	Less than significant
WTR-1c: Groundwater Drawdown Effects on Aquifer Compaction	No Project Alternative	Less than Significant	N/A	—
	All Action Alternatives	Potentially Significant	WTR-MM-2	Potentially significant and unavoidable for the Aquifer Less than Significant for Water Supply Wells
Water Quality				
WTR-2a: Containment and Treatment of Existing Chromium Contamination	All Alternatives	Beneficial	N/A	--
WTR-2b: Conversion of Hexavalent Chromium to Trivalent Chromium	All Alternatives	Less than Significant	N/A	--
WTR-2c: Water Quality Effects due to use of Tracer Compounds	All Alternatives	Less than Significant	N/A	--
WTR-2d: Temporary Localized Chromium Plume Expansion ("Bulging") due to Remedial Activities	No Project Alternative	Less than Significant	N/A	--
	All Action Alternatives	Potentially Significant	WTR-MM-2 (see above)	Potentially Significant and Unavoidable for the Aquifer

Impact	Applicable Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
			WTR-MM-3: Boundary Control Monitoring, Enhancement and Maintenance of Hydraulic Control and Plume Water Balance to Prevent or Reduce Temporary Localized Chromium Plume Bulging	Less than Significant for Water Supply Wells
WTR-2e: Increase in Total Dissolved Solids, Uranium and other Radionuclides due to Agricultural Treatment	All Alternatives	Significant (TDS)	WTR-MM-2 (see above)	Potentially Significant and Unavoidable for the Aquifer (TDS)
	All Action Alternatives	Potentially Significant (Uranium/other Radionuclides)	WTR-MM-4: Restoration of the Hinkley Aquifer Affected by Remedial Activities for Beneficial Uses	Potentially Significant and Unavoidable for the Aquifer (Uranium/Other Radionuclides)
			WTR-MM-5: Investigate and Monitor Total Dissolved Solids, Uranium and Other Radionuclide levels in relation to Agricultural Treatment and Take Contingency Actions	Less than Significant for Water Supply Wells
WTR-2f: Change in Nitrate Levels due to Agricultural Treatment	No Project Alternative	Less than significant	N/A	--
	All Action Alternatives	Beneficial for the Aquifer (removal of nitrate overall)		Beneficial for the Aquifer overall
		Potentially Significant (localized increases of nitrate due to injection)	WTR-MM-6: Monitor Nitrate Levels and Manage Agricultural Treatment to Avoid Significant Increases in Nitrate Levels	Less than Significant for Water Supply Wells

Impact	Applicable Alternative	Significance before Mitigation	Mitigation Measures	Significance after Mitigation
WTR-2g: Increase in Other Secondary Byproducts (Dissolved Arsenic, Iron and Manganese) due to In-Situ Remediation	No Project Alternative	Less than Significant	N/A	--
	All Action Alternatives	Significant	WTR-MM-2 (see above) WTR-MM-4 (see above) WTR-MM-7: Construction and Operation of Additional Extraction Wells to Control Carbon Amendment In-situ Byproduct Plumes	Temporarily Potentially Significant and Unavoidable for the Aquifer Less than Significant for Water Supply Wells
WTR-2h: Potential Degradation of Water Quality due to Freshwater Injection	All Alternatives	Potentially Significant	WTR-MM-8: Ensure Freshwater Injection Water Does not Degrade Water Quality	Less than significant
WTR-2i: Taste and Odor Impacts due to Remedial Activities	No Project Alternative	Less than significant	N/A	--
	All Action Alternatives	Significant	WTR-MM-2 (see above) WTR-MM-4 (see above)	Less than significant
Drainage				
WTR-3: Impacts Related to Drainage Patterns and Runoff	All Alternatives	Less than Significant	N/A	--
Flooding				
WTR-4: Impacts Related to Flooding	All Alternatives	Less than Significant	N/A	--
Secondary Impacts of Water Supply Mitigation				
WTR-5: Secondary Impacts of Water Supply Mitigation	All Alternatives	Potentially Significant	Project Mitigation (see text)	Less than significant

Note:
The overall comparison of the No Project Alternative to Action Alternatives (Alternatives 4B, 4C-2 through 4C-5) follows in Table 3.1-2, below.

Table 3.1-2. Comparison of Water Resource Impacts by Alternatives

Impact	No Project	Alternative 4B	Alternative 4C-2	Alternative 4C-3	Alternative 4C-4	Alternative 4C-5
Groundwater Drawdown						
WTR-1a: Aquifer Drawdown- Regional	No change from Existing use of 1,774 acre-feet, which is less than allowance.	Up to 3,863 acre-feet of annual AU use. Requires acquisition of rights of up to 1,919 acre-feet.	Up to 5,109 acre-feet of annual AU use. Requires acquisition of rights of up to 3,165 acre-feet.	Up to 7,078 acre-feet of annual AU use. Requires acquisition of rights of up to 5,134 acre-feet.	Up to 7,078 acre-feet of annual AU use. Requires acquisition of rights of up to 5,134 acre-feet.	Up to 5,109 acre-feet of annual AU use. Requires acquisition of rights of up to 3,165 acre-feet.
WTR-1b: Aquifer Drawdown -Localized	No change from Existing	Up to 50 to 70 feet of drawdown potentially affecting up to 85 or more domestic wells.	Up to 50 to 70 feet of drawdown potentially affecting up to 108 or more domestic wells.	Up to 60 to 80 feet of drawdown potentially affecting up to 94 or more domestic wells.	Up to 70 to 100+ feet of drawdown potentially affecting up to 133 or more domestic wells.	Up to 50 to 70 feet of drawdown potentially affecting up to 108 or more domestic wells.
WTR-1c: Aquifer Compaction	No change from Existing	May exceed historic drawdown in northern part of aquifer and result in aquifer compaction	May exceed historic drawdown in northern part of aquifer and result in aquifer compaction	May exceed historic drawdown in northern part of aquifer and result in aquifer compaction	May exceed historic drawdown throughout the aquifer and result in aquifer compaction	May exceed historic drawdown in northern part of aquifer and result in aquifer compaction
Water Quality						
WTR-2a: Containment and Treatment of Existing Chromium Contamination						
Years to 50 ppb Cr[VI]	6	6	6	4	3	20
Years to 3.1 ppb Cr[VI]	150/1,000[a]	40	39	36	29	50
Years to 1.2 ppb Cr[VI]	325/1,000[a]	95	90	85	75	95
Years to 80% Conversion or Removal	13	10	7	6	6	15
WTR-2b: Conversion of Hexavalent Chromium to Trivalent Chromium	Agricultural treatment and in-situ remediation in all alternatives would leave Cr[III] in ground with low potential for reconversion to Cr[VI].Alternative 4C-3 would provide above ground treatment in winter which would remove some Cr[VI] from the aquifer. Alternative 4C-5 would provide above-ground treatment of the source area which would also remove the most Cr[VI] from the aquifer of all alternatives.					

Impact	No Project	Alternative 4B	Alternative 4C-2	Alternative 4C-3	Alternative 4C-4	Alternative 4C-5
WTR-2c: Tracer Compounds	Tracer compounds used in all alternatives would be non-toxic/non-reactive and expected to dissipate before affecting domestic wells.					
WTR-2d: Spreading of Chromium ("Bulging") due to Remedial Activities	No change from existing injection for in-situ remediation (190 gpm)	Injection for in-situ remediation, higher pumping rate (431 gpm) increases potential for plume "bulging."				Injection for in-situ remediation, higher pumping (244 gpm) than existing increases potential for plume "bulging", but lower than other alternatives
WTR-2e: Increase in Total Dissolved Solids, uranium, and Other Radio Nuclides due to Agricultural Treatment	No change from existing AU treatment flows (1,100 gpm)	Increase of AU Treatment flows (up to 2,395 gpm) increases TDS levels.	Increase of AU Treatment flows (up to 3,167 gpm) increases TDS levels	Increase of AU Treatment flows (up to 4,388 gpm) increases TDS levels	Increase of AU Treatment flows (up to 4,388 gpm) increases TDS levels	Increase of AU Treatment flows (up to 3,167 gpm) increases TDS levels.
WTR-2f: Change in Nitrate Levels due to Agricultural Treatment	No change from existing AU treatment flows (1,100 gpm)	Increase of AU Treatment flows (up to 2,395 gpm) potentially increases local nitrate levels.	Increase of AU Treatment flows (up to 3,167 gpm) potentially increases local nitrate levels	Increase of AU Treatment flows (up to 4,388 gpm) potentially increases local nitrate levels	Increase of AU Treatment flows (up to 4,388 gpm) potentially increases local nitrate levels	Increase of AU Treatment flows (up to 3,167 gpm) potentially increases local nitrate levels
WTR-2g: Increase in Other Byproducts due to In-Situ Remediation	No change from existing injection for in-situ remediation (190 gpm)	Injection for in-situ remediation (431 gpm) increases potential for byproducts.	Injection for in-situ remediation (431 gpm) increases potential for byproducts.	Injection for in-situ remediation (431 gpm) increases potential for byproducts.	Injection for in-situ remediation (431 gpm) increases potential for byproducts.	Injection for in-situ remediation (244 gpm) increases potential for byproducts, but less than other alternatives
WTR-2h: Degradation of Water Quality due to Freshwater Injection	No change from existing injection (80 gpm). Possible change in future water source/quality.	No change from existing injection (80 gpm). Possible change in future water source/quality.	No change from existing injection (80 gpm). Possible change in future water source/quality.	No change from existing injection (80 gpm). Possible change in future water source/quality.	No change from existing injection (80 gpm). Possible change in future water source/quality.	No change from existing injection (80 gpm). Possible change in future water source/quality.
WTR-2i: Taste and Odor Impacts due to Remedial Activities	All Alternatives could affect taste and odor due to agricultural treatment (increased TDS) and in-situ remediation (potential iron, manganese and arsenic effects).					
Drainage						
WTR-3: Potential Impacts on Local Drainage	All Alternatives would have less than significant effects on drainage.					

Impact	No Project	Alternative 4B	Alternative 4C-2	Alternative 4C-3	Alternative 4C-4	Alternative 4C-5
Flooding						
WTR-4: Potential Impacts on Flooding	All Alternatives would have less than significant effects on flooding.					
Secondary Impacts of Water Supply Mitigation						
WTR-5: Secondary Impacts of Water Supply Mitigation	Least need for alternative water supply due to groundwater drawdown but more need for alternative water supply replacement due to incomplete remediation of chromium plume	Lowest need for water supply mitigation of action alternatives due to groundwater drawdown and remedial byproducts from agricultural treatment. Same potential for water supply mitigation as 4C-2, 4C-3, and 4C-4 due to in-situ remediation byproducts	More need for water supply mitigation due to groundwater drawdown and remedial byproducts from agricultural treatment than 4B, but less than 4C-3 and 4C-4. Same potential for water supply mitigation as 4C-2, 4C-3, and 4C-4 due to in-situ remediation byproducts.	Highest need for water supply mitigation due to groundwater drawdown and remedial byproducts from agricultural treatment. Same potential for water supply mitigation as 4C-2, 4C-3, and 4C-4 due to in-situ remediation byproducts.	Highest need for water supply mitigation due to groundwater drawdown and remedial byproducts from agricultural treatment. Same potential for water supply mitigation as 4C-2, 4C-3, and 4C-4 due to in-situ remediation byproducts.	Same need for water supply mitigation due to groundwater drawdown and remedial byproducts from agricultural treatment as 4C-2. Lower potential for water supply mitigation than all other action alternatives due to in-situ remediation byproducts.

Notes:

[a] The No Project Alternative is defined as limited to actions to address the 2008–2010 plume area. As such, it would only result in remediation of this smaller plume area and would not address the wider plume (assumed to be 15% larger than the Q4 2011 plume for evaluation in this EIR). As such, the timeframes shown for cleanup to 3.1 ppb Cr[VI] or 1.2 ppb Cr[VI] are shown in two ways. The first number is for cleanup of the 2008–2010 plume and the second is for the expanded plume studied in this EIR. Thus for cleanup to 3.1 ppb Cr[VI], the cleanup time for the 2008–2010 plume is 150 years (based on Feasibility Study Alternative 4) and for the entire plume is 1,000 years or more (based on Feasibility Study Alternative 1–natural attenuation). For cleanup to 1.2 ppb Cr [VI], the cleanup time for the 2008–2010 plume is 325 years (based on Feasibility Study Alternative 4) and for the entire plume is 1,000 years or more (based on Feasibility Study Alternative 1).

3.1.2 Terminology

In the section below, the concentrations of constituents in groundwater are described in the following ways:

- 1 milligram per liter (mg/L) is equivalent to one part per million (ppm)
- 1 microgram per liter (µg/L) is equivalent to one part per billion (ppb)
- 1 nanogram per liter (ng/L) is equivalent to one part per trillion (ppt)
- 1 ppm = 1,000 ppb = 1,000,000 ppt
- 1 ppb = 0.001 ppm = 1,000 ppt
- 1 picoCurie per liter (pCi/L)

In the section below, the concentrations of constituents in soil are described in the following ways:

- 1 milligram per kilogram (mg/kg) is equivalent to one part per million (ppm).
- 1 microgram per kilogram (µg/kg) is equivalent to one part per billion (ppb)

In the section below, the following acronyms are commonly used:

- af = acre-feet
- afy = acre-feet per year
- AU =agricultural treatment units, also referred to in some remedial documents as land treatment units (LTUs)
- CAO = Cleanup and Abatement Order
- FS = The 2010 Feasibility Study prepared by PG&E for remediation of the Hinkley plume.
- gpm = gallons per minute
- IRZ = In-situ remediation zone
- MCL = Maximum Contaminant Level
- PHG = Public Health Goal
- RWQCB = Regional Water Quality Control Board, or more commonly, Water Board
- TDS = Total Dissolved Solids
- EPA = U.S. Environmental Protection Agency
- WDR = Waste Discharge Requirement

In the section below, the following convention is commonly used:

- Unless otherwise noted below, all references to nitrate concentrations are as nitrogen.

3.1.3 Regulatory Setting

The State Water Resources Control Board (State Water Board) is the state agency with primary responsibility for implementation of state and federally established regulations relating to water resource issues. Typically, all regulatory requirements related to water quality are implemented by the State Water Board through nine Regional Water Quality Control Boards (RWQCBs, also called Water Boards) established through the Porter-Cologne Water Quality Act. The Lahontan Water Board regulates water quality in the Mojave River watershed and the Mojave River Groundwater Basin.

3.1.3.1 Federal Regulations

Federal Safe Drinking Water Act (SDWA)

The Safe Drinking Water Act was passed in 1974 to protect drinking water quality. The U.S. Environmental Protection Agency (EPA) establishes the national standards for drinking water quality.

Maximum Contaminant Levels (MCLs)

Maximum Contaminant Levels are federal enforceable limits for contaminants in drinking water. The federal rules for chromium include a Maximum Contaminant Level of 100 parts per billion (ppb) for total chromium. There is no established federal Maximum Contaminant Level for Cr[VI]. Federal Maximum Contaminant Levels are presented below in Table 3.1-3.

Secondary Maximum Contaminant Levels (SMCLs)

Secondary Maximum Contaminant Levels (SMCLs) are established under the federal Safe Drinking Water Act to protect the public welfare. Such regulations apply to contaminants in drinking water that adversely affect its odor, taste or appearance. Secondary Maximum Contaminant Levels are not based on direct adverse health effects associated with the contaminant, although some contaminants may have both a primary and a secondary Maximum Contaminant Level. Secondary Maximum Contaminant Levels are considered as desirable goals and are not federally enforceable. Federal Secondary Maximum Contaminant Levels, which are shown in Table 3.1-3.

Clean Water Act

The federal Clean Water Act (CWA) is the primary federal law that protects the quality of the nation’s surface waters when they are traditionally navigable waters, are tributary or adjacent to traditionally navigable waters, or are interstate waters. Waters under the jurisdiction of the Clean Water Act are referred to as “waters of the United States.” The U.S. Army Corps of Engineers regulates fill in waters of the United States under Section 404 of the Clean Water Act. Point source discharges to waters of the United States are regulated under Section 402 of the Clean Water Act through National Pollution Discharge Elimination System (NPDES) permits; in California the regional Water Boards have been delegated the authority to issue NPDES permits. Under Section 401 of the Clean Water Act, state agencies review permits issued by the Corps for their effects on Water Quality.

The only surface waters in the study area are the Mojave River, small desert washes that flow south to the Mojave River and desert washes that flow north to Harper Lake during infrequent large rain events.

The Mojave River flows eastward from the project vicinity to Soda Lake and Silver Lake. The U.S. Army Corps of Engineers has previously determined that the Mojave River is a water of the United

States.[1] As a result, for this EIR, tributaries to the Mojave River, including desert washes, are presumed to also be waters of the United States.

Harper Lake is a dry lake except immediately during and after storm events and surface water either evaporates or infiltrates at the lake. Although the U.S. Army Corps of Engineers has not conducted a delineation of the specific study area described in the EIR, they have made a determination for the Abengoa Solar project (Mojave Solar) near Lockhart, that Harper Lake or drainages to it were not waters of the U.S.

Where the project may involve fill to drainages to the Mojave River, then the Clean Water Act would apply and PG&E would be required to complete a formal delineation to confirm federal jurisdiction under Section 404 of the Clean Water Act. If the Corps takes jurisdiction, then PG&E would need to get a permit from the U.S. Army Corps of Engineers under Section 404 and a water quality certification from the Lahontan Water Board, under Section 401. Where discharges of pollutants other than fill would occur, the regional board would determine jurisdiction under the Clean Water Act.

For the drainages to Harper Lake, which are the bulk of the drainages in the study area, they are considered state waters and are subject to state jurisdiction under the Porter-Cologne Water Quality Control Act, as discussed below.

The Federal Resource Conservation and Recovery Act

The State implements the federal Resource Conservation and Recovery Act's (RCRA's) Subtitle C (Hazardous Waste Regulations for Treatment, Storage, and Disposal) through the California Department of Toxic Substances Control. For the current project, the only activities that would come under the authority of RCRA would be potential use, generation, storage and transportation of hazardous wastes in relation to above-ground treatment which is included in two of the action alternatives.

3.1.3.2 State Regulations

Public Health Goals

The California Safe Drinking Water Act of 1996 (Health and Safety Code, Section 116365) requires the Office of Environmental Health Hazard Assessment (OEHHA) to perform risk assessments and adopt Public Health Goals for contaminants in drinking water based exclusively on public health considerations. Public Health Goals are based upon a risk assessment to identify a level at which no known or anticipated adverse effects on health will occur, with an adequate margin of safety.

Public Health Goals are used by the California Department of Health Services in establishing Maximum Contaminant Levels, but the Public Health Goals are not a legally enforceable standard (Health and Safety Code 116365(c)). Thus, Public Health Goals are not developed as target levels for cleanup of ground or ambient surface water contamination and may not be applicable for such purposes, given the regulatory mandates of other environmental programs (OEHHA 2010).

[1] The Army Corps of Engineers issued jurisdictional determinations that the Mojave River is a water of the United States prior to the U.S. Supreme Court ruling in the Rapanos case. Subsequent to the Rapanos ruling, the Corps has not made any formal determination for the Mojave River. For this EIR, the prior determinations are considered in effect.

Whereas Public Health Goals are to be based solely on scientific and public health considerations, drinking water standards or Maximum Contaminant Levels adopted by California Department of Public Health are to consider economic factors and technical feasibility. Each primary drinking Maximum Contaminant Level adopted by California Department of Public Health is required to be set at a level that is as close as feasible to the corresponding Public Health Goal, with emphasis on the protection of public health (OEHHA 2010).

State Public Health Goals are shown in Table 3.1-3 below.

Maximum Contaminant Levels

Maximum Contaminant Levels (MCLs)

Maximum Contaminant Levels established by California Department of Public Health must be at least as stringent as the federal Maximum Contaminant Level, if one exists. State Maximum Contaminant Levels are presented below in Table 3.1-3 below

Secondary Maximum Contaminant Levels (SMCLs)

Secondary Maximum Contaminant Levels are established under state water quality law to protect the public welfare. Such regulations apply to contaminants in drinking water that adversely affect its odor, taste or appearance. California does enforce Secondary Maximum Contaminant Levels, which are shown in Table 3.1-3 below. Narrative State water quality objectives for taste and odor are described in Table 3.1-4.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act (1967) (Porter-Cologne Act) is the primary law governing California's water quality regulations. The Porter-Cologne Act is established and implemented by the State Water Board and nine regional Water Boards. The State Water Board is the primary state agency responsible for protecting the quality of the state's surface and groundwater supplies. Under this act, the state is required to adopt a water quality control policy to be implemented by the State Water Board and nine regional Water Boards. The regional Water Boards carry out State Water Board policies and procedures throughout the state.

The State Water Board also approves water quality control plans (or Basin plans) prepared by the regional Water Boards. Basin plans designate beneficial uses for specific surface water and groundwater resources and establish water quality objectives to protect those uses. The basin plans define surface and groundwater quality objectives for multiple constituents. Some objectives are narrative, but many are quantitative with specific limits for constituents in various surface streams or specified groundwater basins.

State Maximum Contaminant Levels are shown in Table 3.1-3.

Table 3.1-3. Maximum Contaminant Levels and Public Health Goals for Constituents in Groundwater

Constituent	Primary MCL Federal	Primary MCL State	Secondary MCL Federal	Secondary MCL State	Public Health Goal (OEHHA)
Hexavalent chromium (Cr[VI])	NA	NA	NA	NA	0.02 ppb
Trivalent chromium (Cr[III])	NA	NA	NA	NA	NA
Total chromium (Cr[T])	100 ppb	50 ppb	NA	NA	NA
Arsenic	10 ppb	10 ppb	NA	NA	0.004 ppb
Iron	NA	NA	300 ppb	300 ppb	NA
Manganese	NA	NA	50 ppb	50 ppb	NA
Uranium	30 ppb	20 pCi/L	NA	NA	0.43 pCi/L
Gross Alpha		15 pCi/L	NA	NA	NA
Total Dissolved Solids (TDS)	NA	NA	500 ppm	500 ppm[a]/ 1,000 ppm[b]	NA
Nitrate	45 ppm (as NO_3)	10 ppm (as N)	N/A	Nitrate	45 ppm (as NO_3)

N/A—None adopted
MCL—Maximum Contaminant Level
As N = as nitrogen
NO_3 = nitrate
ppm = parts per million = milligrams per liter (mg/L) in water
ppb = parts per billion = micrograms per liter (μg/L) in water
pCi/L = picoCurie per liter
[a] Recommended
[b] Upper limit
Sources: California Department of Public Health 2011; CCR Title 22, Division 4. Environmental Health. Chapter 15.

State Water Board Resolution No. 92-49, "Policies and Procedures for Investigation and Cleanup and Abatement of Discharges"

Groundwater contamination is investigated and remediated following the provisions in the State Water Board Resolution No. 92-49, "Policies and Procedures for Investigation and Cleanup and Abatement of Discharges." The five basic elements are:

- **Preliminary site assessment:** To confirm the discharge and identity of dischargers; to identify affected or threatened waters of the State and their beneficial uses; and to develop preliminary information of the nature, and horizontal and vertical extent of the discharge.
- **Soil and water investigation:** To determine the source, nature, and extent of the discharge with sufficient detail to provide the basis for decisions regarding subsequent cleanup and abatement actions, if any are determined by the Water Board to be necessary.
- **Proposal and selection of cleanup action:** To evaluate feasible and effective cleanup and abatement actions, and to develop preferred cleanup and abatement alternatives.
- **Implementation of cleanup action:** To implement the selected alternative and verify progress via monitoring.
- **Monitoring:** To confirm short- and long-term effectiveness of cleanup and abatement.

State Water Board Resolution No. 92-49 also requires conformance with State Water Board Resolution No. 68-16 "Statement of Policy with Respect to Maintaining High Quality of Waters in California" (Non-Degradation Policy). The overall cleanup level established for a water body is based on its most sensitive beneficial use (i.e., domestic and municipal use, abbreviated as "MUN"). In all cases, the Water Board first considers high quality or naturally occurring "background" concentration objectives as the cleanup levels for polluted groundwater. Generally, compliance with approved cleanup levels must occur at all points within the plume of pollutants. Groundwater cleanup levels are approved on a case-by-case basis by the Water Boards.

The cleanup and abatement must be done in a manner that promotes attainment of background water quality, or the highest water quality that is reasonable if background levels of water quality cannot be restored. The determination of what is reasonable must consider all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible, and intangible. Approved cleanup levels above background concentrations will consider the mobility, toxicity, and volume of pollutants. Any cleanup level less stringent than background levels must be consistent with maximum benefit to the people of the state and not unreasonably affect present and anticipated beneficial uses of such water. Where cleanup to background is infeasible, cleanup standards will be set at the lowest concentrations for the individual pollutants that:

- are technically and economically achievable;
- do not exceed the maximum concentrations allowable under applicable statutes and regulations for individual pollutants;
- do not to pose a hazard to health or to the environment; and
- consider cumulative risks taking into account different routes of exposure and other pollutants.

State Board Resolution No. 88-63, "Sources of Drinking Water"

This resolution provides that all surface and groundwaters of the state are considered suitable or potentially suitable for municipal or domestic water supply with the exception of the following:

- waters with TDS greater than 3,000 pm that are not reasonably expected to supply a public water systems;
- contaminated waters, either by natural processes or human activity (not related to the pollution incident) that cannot be reasonably treated for domestic use;
- water sources that do not provide sufficient water to supply a single well with a sustainable yield of 200 gallons per day;
- surface water that is part of collection and treatment of municipal, industrial, or mining wastewater or stormwater or is designed specifically for conveying of holding agricultural drainage waters; or
- groundwater where the aquifer is regulated as geothermal energy sources or has been exempted for the purpose of production of hydrocarbon or geothermal energy.

If groundwater meets one of these exceptions, a site-specific de-designation may be appropriate, but is not automatic and requires a Basin Plan amendment.

State Board Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California" (Non-Degradation Policy)

This resolution establishes that it is state policy to maintain the highest water quality consistent with maximum benefit to the people of the State as follows:

- where existing water quality is better than established water policies, the existing water quality will be maintained until is demonstrated that any change is consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial uses, and will not result in water quality less than that prescribed in policies; and
- discharges to such waters will be required to meet WDRs that result in the best practicable treatment or control necessary to assure that pollution or nuisance will not occur and the highest water quality consistent with maximum benefit will be maintained.

Waste Discharge Requirements

Under the Porter-Cologne Act, the Regional Water Boards regulate the "discharge of waste" to "waters of the state." All persons proposing to discharge waste that could affect waters of the state must file a report of waste discharge with the appropriate water board. The Water Board may respond to the report of waste discharge by issuing waste discharge requirements (WDRs) in a public hearing, or by waiving WDRs (with or without conditions) for that proposed discharge. The Water Boards issue WDRs for surface, sub-surface and land discharges.

As described in Chapter 1, *Introduction*, PG&E is currently implementing remedial activities in the Hinkley area in compliance with WDRs which serve as both permits for individual projects (see list of WDRs in Chapter 1) and as a general permit for multiple remediation activities (General Permit—Order No. R6V-2008-0014). Implementation of the proposed alternatives (with the exception of the No Project Alternative) will require the Water Board to adopt new WDRs that will address discharges related to new and expanded remedial activities.

Water Quality Control Plan for the Lahontan Region (Basin Plan)

The Basin Plan for the Lahontan Region is the basis for the Water Board's regulatory program. It sets forth water quality standards for the surface and groundwater of the region, which include both designated beneficial uses of water and the narrative and numerical objectives that must be maintained to protect those uses. It identifies general types of water quality problems that can threaten beneficial uses in the region and lists required or recommended control measures for these problems. In some cases, it prohibits certain types of discharges in particular areas. The Basin Plan incorporates applicable provisions of State Water Board policies.

The 1995 Lahontan Basin Plan includes beneficial uses and water quality objectives for groundwater. The Hinkley chromium plume is located in the middle reach of the Mojave River Groundwater Basin. The beneficial uses for this basin are:

- municipal and domestic supply (MUN);
- agricultural supply (AGR);
- industrial service supply (IND);
- freshwater replenishment (FRSH); and
- aquaculture (AQUA).

Narrative and numerical water quality standards have been established for protection of these uses. The most sensitive use is municipal and domestic supply. As shown in Table 3.1-3, the current federal Maximum Contaminant Level for Cr[T] is 100 ppb, and the state Maximum Contaminant Level for Cr[T] is 50 ppb. There is no Maximum Contaminant Level established for Cr[VI] in groundwater for the prescribed beneficial uses, however there is a Public Health goal of 0.02 ppb. As described above, State Board Resolution 92-49 limits cleanup to background levels unless it can be shown that background is not attainable. For the purposes of this EIR, the current applicable background level is 3.1 ppb of Cr[VI] and 3.2 ppb of Cr[T]. These are the estimated maximum background levels which were adopted by the Water Board in 2008 based on sampling by PG&E in the Hinkley area in 2006, as discussed further below in Section 3.1.4.3, Hinkley Valley Groundwater Quality. Therefore, cleanup of chromium to background levels is expected to achieve beneficial use of groundwater within the Hinkley Valley, as defined by the Lahontan Basin Plan. This background level may be adjusted by the Water Board in the future if and when additional technical information becomes available. At this time, it is not known whether the background level will be adjusted and if it is, whether the revised level would be higher or lower than the currently adopted level. If the background level is revised to a higher level, then the amount of needed remedial action may be less than that assumed in this EIR. If the background level is revised to a lower level, then the amount of needed remedial action may be more than that assumed in this EIR. If and when the background levels are revised, the Water Board will need to examine whether the analysis in this EIR fully captures the environmental effects of needed remedial action or not.

There are no groundwater quality objectives established specifically for the Mojave River Groundwater Basin, water quality objectives that apply to all the Lahontan Region's groundwater basins, as specified in the Lahontan Basin Plan, are shown in Table 3.1-4.

Table 3.1-4: Groundwater Quality Objectives for all Groundwater Basins in the Lahontan Basin Plan

Constituent	Concentration
Bacteria, Coliform	In ground waters designated as MUN, the median concentration of coliform organisms over any seven-day period shall be less than 1.1/100 mL.
Chemical constituents	Ground waters designated as MUN shall not contain concentrations of chemical constituents in excess of the Maximum Contaminant Level or Secondary Maximum Contaminant Level based upon drinking water standards specified in the following provisions of Title 22 of the California Code of Regulations (CCR). Waters designated as AGR shall not contain concentrations of chemical constituents in amounts that adversely affect the water for beneficial uses (i.e., agricultural purposes). Ground waters shall not contain concentrations of chemical constituents that adversely affect the water for beneficial uses.
Radioactivity	Ground waters designated as MUN shall not contain concentrations of radionuclides in excess of the limits specified in Table 4 of Section 64443 (Radioactivity) of Title 22 of the CCR.
Taste and Odor	Ground waters shall not contain taste or odor-producing substances in concentrations that cause nuisance or that adversely affect beneficial uses. For ground waters designated as municipal (MUN), at a minimum, concentrations shall not exceed adopted Secondary Maximum Contaminant Levels.

Hinkley Compressor Station Chromium Cleanup and Abatement Orders

The Water Board has directed PG&E to undertake corrective actions through issuance of cleanup and abatement orders (CAOs) requiring investigation, cleanup, monitoring, and reporting. In response to these CAOs, PG&E has submitted a number of reports describing corrective actions, including plume definition, cleanup pilot projects, and remedial activities conducted under WDRs. Past CAOs and related orders from the Water Board are summarized in Chapter 1, *Introduction*. The major actions and requirements in each CAO are also listed in Chapter 1. Key CAOs concerning the current remedial actions are summarized below.

CAO R6V-2008-0002

The Water Board issued the 2008 CAO (CAO No. R6V-2008-0002) to PG&E on August 6, 2008, requiring PG&E to cleanup and abate the effects of waste discharges containing Cr[VI] and Cr[T] to waters of the State. The key requirements of the 2008 CAO are as follows.

- **Chromium Plume Containment**—PG&E was required to contain the chromium plume. The CAO defines containment as no further migration or expansion of the chromium plume to locations where Cr[VI] is below 4 ppb and where Cr[T] is below 50 ppb.
- **Interim Chromium Remediation—**PG&E was required to continue the in-situ corrective actions in the Central Area IRZ (In-situ Remediation Zone) and the Source Area IRZ.
- **Final Cleanup Actions—**PG&E was required to submit an feasibility study report by September 1, 2010, to evaluate remediation strategies and propose a comprehensive and complete groundwater remediation alternative.

The 2008 CAO has been amended three times:

- Amendment R6V-2008-0002A1 established background levels for Cr[VI] and Cr[T] in groundwater for the purpose of the final cleanup actions. These background levels were based on the *Groundwater Background Study Report, Hinkley Compressor Station* (2007 Background Study Report) (Pacific Gas and Electric 2007). The amended CAO required that the feasibility study include an evaluation of each remedial alternative's ability to achieve background water quality.
- Amendment R6V-2008-0002A2 allowed for 1,000-feet lateral migration of the 4 ppb Cr[VI] plume on the eastern boundary as a result of the injection of pumped groundwater taken from the north and enhanced with a carbon reagent, into the South Central Reinjection Area. The amendment requires the area of potential plume expansion to return to 2009 pre-boundaries conditions within 10 years after completing the SCRIA project.
- Amendment CAO R6V-2008-0002A3 requires PG&E to implement additional hydraulic containment of the plume south of Thompson Road by maintaining hydraulic containment on a year round basis and conducting monthly monitoring and reporting of water levels year-round to insure inward gradients. The amendment also requires additional actions to reduce plume migration in the area north of Thompson Road by conducting groundwater extraction starting in summer 2012, evaluating the need for more extraction and other methods, as necessary to implement further chromium removal.

CAO R6V-2011-0005

CAO No. R6V-2011-0005 (issued January 2011) requires PG&E to expand the domestic well sampling program and to supply uninterrupted replacement water service (i.e., bottled water or equivalent) to any domestic wells with more than 3.1 ppb of Cr[VI]/3.2 ppb Cr[T]detected or any wells within 3,000 feet of the chromium plume boundary, based upon the most current quarterly site-wide groundwater monitoring report.

Amendment CAO R6V-2011-0005A1 (issued October 2011) required PG&E to submit a plan to provide permanent replacement water for all indoor domestic uses (referred to as "whole house water") for all wells impacted by PG&E's discharge within the "affected area" (defined as the area within 1 mile downgradient or cross gradient from the plume). PG&E has completed a pilot study and a feasibility study to evaluate water treatment technologies for purposes of providing whole house water replacement to affected residences.

Amendment CAO R6V-2011-0005A2 (issued June 2012) modified the previous orders in consideration of PG&E's implementing a Voluntary Whole House Replacement Water Program that met certain requirements. The Order suspended several provisions of the previous Order as long as PG&E met certain requirements, including completing a community involvement process and providing whole house replacement water to all domestic or community wells located laterally within one mile of the plume boundary that have detectable levels of hexavalent chromium.

SB 610

SB 610 (Water Code Section 10912) is a state law that supports planning between water suppliers and local cities and counties. SB 610 requires a preparation of a water supply assessment for certain large projects, including those that have the demand an amount of water equivalent to, or greater than, the amount of water required by a 500 dwelling unit project. When a city or county is the CEQA lead agency, the assessment must be considered during the CEQA process. If there is insufficient water, the city or County must include that determination in its findings for the project.

SB 610 only applies to cities and counties in their capacity as a CEQA lead agency. As such, SB 610 does not apply to the Water Board, which is a state agency. Thus, a formal water supply assessment pursuant to SB 610 was not prepared for this project. However, the analysis in this section has examined the long-term water supply issues for this project, including the ability to support the proposed project's use, the regulations governing groundwater use in the area, and the potential impacts of groundwater use proposed by the project. Thus, this section provides the substantive information that will be used by the Water Board in considering water supply issues as decisions are made concerning this project.

3.1.3.3 Local Regulations

Mojave River Basin Adjudication

The Mojave River Basin Adjudication is based on the stipulated judgment in *City of Barstow, et al vs. City of Adelanto, et al* and related complaints (Case No. 2008568). The stipulated judgment, issued in 1996, addresses water shortages in the Mojave Basin Area through a designation of five subareas, all of which were found to be in overdraft, and each having an amount of groundwater that can be extracted by all parties based on a court-determined Production Safe Yield to maintain proper water balances within each subarea. The Mojave Water Agency (MWA) is the designated water master, and is responsible for administering the judgment, which involves measuring and tracking aquifer conditions and water use information in the Mojave River Basin. The Mojave Water Agency manages the recharge of the State Water Project water into the watershed, including a spreading basin located along the Mojave River upstream of the study area at Hodge and slightly downstream at Lenwood (both upstream of Barstow).

The Judgment assigned Base Annual Production rights to each producer using 10 acre-feet per year (afy)or more, based on historical production during the period 1986-1990. Parties to the Judgment are assigned a variable Free Production Allowance, which is the amount of water that may be produced (pumped or diverted) from a subarea. The Free Production Allowance is a uniform percentage of the Base Annual Production set for each subarea each year by the Watermaster that is reduced or "ramped-down" over time until total allowance comes into balance with the Production Safe Yield. Any amount of water that is taken beyond the allowance is subject to a replacement obligation.

The study area is located within the Centro subarea of Mojave Basin Area adjudicated boundary. The Free Production Allowance for Centro subarea for water year 2010-2011 is 39,519 afy (MWA 2012) with verified production of 21,130 afy, indicating a surplus of 18,389 afy (MWA 2012). The Production Safe Yield for the Centro subarea has been identified as 33,375 afy, indicating a surplus of 12,245 afy over the safe yield in 2010-2011 water year. A review of production estimates from 1993 indicates that the actual 5-year production averages have been less than the current Free Production Allowance and less than the sustainable yield. Over the last five water years (2006–2011), the verified production has averaged 25,193 afy, indicating a surplus over the Free Production Allowance of 14,329 afy and a surplus over the safe yield of 8,182 afy.

Most of the agricultural water users near the Hinkley Compressor Station are included in the Mojave River Groundwater Basin adjudication agreement. PG&E is a designated water user, owns water rights totaling approximately 2,429 afy and, based on the 2010–2011 Watermaster Annual Report, has a current base annual allowance of 1,944 afy (MWA 2012). The Gorman property (in the middle of the existing plume) was not a party to the adjudication and had been pumping at historical levels of about 250–300 gallons per minute (gpm) until it was purchased by PG&E in 2010. PG&E now owns the former Gorman property for agricultural treatment but pumping now falls under adjudication and is similar to prior levels (approximately 285 gpm).

San Bernardino County General Plan

The San Bernardino County General Plan (San Bernardino County 2007) includes goals and policies to safeguard surface and groundwater quality in San Bernardino County, mostly related to flood protection and stormwater runoff. These provisions are intended to reduce erosion and limit surface water quality impacts (which, as discussed below, are not concerns for this project).

San Bernardino County has a Stormwater Management Program, as a part of its municipal Phase I NPDES permit, for the portion of the County that drains to the Santa Ana River. In the Mojave River watershed, San Bernardino County, along with the town of Apple Valley, and the cities of Victorville and Hesperia have been issued a Phase II NPDES permit for those urbanized portions of the Mojave River watershed. The project area is not covered under a municipal NPDES permit.

3.1.4 Existing Conditions

This section discusses the existing conditions related to water resources (groundwater quantity and water quality) in the study area. Existing conditions are defined as the physical conditions on the ground as of late 2011 as described in Section 2.4. The existing conditions are the 2011 groundwater levels, water use patterns (for domestic and agricultural supply wells), the average background concentrations of minerals, nutrients, and metals in the groundwater of the Hinkley Valley, and the existing Cr[VI] concentrations in the plume of contamination from the PG&E Hinkley Compressor Station.

The summary of remedial components under existing conditions is described in Chapter 2. Because the proposed alternatives all include agricultural treatment and in-situ remediation, the monitoring results from previous testing and operations of these remedial measures are also summarized. Further technical details about the historical, existing, and likely future groundwater conditions and the modeling approach, assumptions, and results are provided in Appendix A. Recent groundwater quality data and chromium plume and treatment monitoring results for the agricultural treatment units, Desert View Dairy treatment unit and IRZs are also included in Appendix A.

3.1.4.1 Sources of Information

The key sources of data and information used in the preparation of this section are listed and briefly described below.

- The Lahontan Basin Plan (1995, as amended) includes all of the beneficial uses, water quality standards, implementation plans, and policies for the Water Board. The beneficial uses for groundwater and implementation procedures for groundwater cleanup projects are included.
- The Feasibility Study Report (Pacific Gas and Electric Company 2010a) and its 2011 addenda (Pacific Gas and Electric Company 2011a[2], 2011b[3], and 2011c[4]) prepared for PG&E pursuant to the Cleanup and Abatement Order No. R6V-2008-0002 were the major sources of information for site-specific groundwater conditions, including existing groundwater pumping and injection associated with the containment and in-situ treatment of the Cr[VI] plume.
- The Mojave River Basin Groundwater Model Report, prepared by U.S. Geological Survey (USGS) (Stamos et al. 2001) in cooperation with the Mojave Water Agency was used to characterize the regional aquifer conditions, including the aquifer near Hinkley.
- The 2010–11 Mojave Basin Area Watermaster Annual Report, prepared by the Mojave Water Agency (MWA 2012) was used to characterize the conditions of the Centro Subarea and PG&E's adjudicated rights within the subarea.
- *Chromium, Chromium Isotopes and Selected Trace Elements, Western Mojave Desert, USA* (U.S. Geological Survey 2008) was used to characterize the range of regional concentrations of chromium.

[2] PG&E 2011a. Addendum #1 to the Feasibility Study Pacific Gas and Electric Company Compressor Station Hinkley, California. January 31.

[3] PG&E 2011b. Addendum #2 to the Feasibility Study Pacific Gas and Electric Company Compressor Station Hinkley, California. March 3.

[4] PG&E 2011c. Addendum #3 to the Feasibility Study Pacific Gas and Electric Company Compressor Station Hinkley, California. September 15.

- *Groundwater Background Study Report Hinkley Compressor Station, Hinkley California*. (Pacific Gas and Electric 2007) provides results from chromium sampling of about 50 wells in the Hinkley area that indicate background concentrations in the Hinkley Valley aquifer.
- PG&E Status Reports (Pacific Gas and Electric 2008, 2009a, 2009b, 2010b, 2010c, 2011i, 2011j, 2012d) for the Desert View Dairy Land Treatment Unit (referred to in this EIR as an agricultural treatment unit), plume containment, and for in-situ remediation zones (IRZs) prepared for the Water Board. These status reports contain information derived from the two ongoing remediation programs at Hinkley: agricultural treatment and in-situ remediation, as well as freshwater injection wells, which is not technically a remediation program, but which is used to help contain the plume on the northwest edge.
- PG&E Quarterly Monitoring Reports (2011e). PG&E conducts quarterly monitoring of groundwater and reports the results on the current location, extent, stability, and concentrations of chromium found in Hinkley.

3.1.4.2 Groundwater Basins

Mojave River Groundwater Basin

The project is located in South Lahontan Hydrologic Region within the Centro Subarea of the Mojave River Groundwater Basin. The immediate study area is located within the Hinkley Valley aquifer west of Barstow and north of the Mojave River.

The Mojave River Groundwater Basin has a surface area of 1,400–square miles (DWR 2003). The aquifer system (i.e., water-bearing rocks and sediments) consists of unconsolidated alluvial materials such as gravel, sand, silt, and clay deposited by the recent Mojave River and the Pliocene-Pleistocene ancestral Mojave River. Also present are deposits of fine sand, silt and clay that accumulated in lakes and playas along the margins of the basin. The water-bearing deposits form two aquifers—a floodplain aquifer and a regional aquifer underlying and surrounding the floodplain aquifer. The floodplain aquifer is more productive than the regional aquifer, yielding most of the groundwater pumped from the basin. These alluvial deposits are 100 to 200 feet thick and are within about 1 mile of the Mojave River. Wells drilled in the river deposits typically yield between 100 and 2,000 gpm. Most of the water contained in the floodplain aquifer is recharge from the Mojave River.

Harper Lake is a terminal dry lake with no outlet. Harper Lake contained water and a natural marsh into the early 20th century, until agricultural development depleted the groundwater that sustained its level. In 2003, owners of a recently constructed solar power plant located just west of the lake began to deliver up to 75 afy from local groundwater that is managed by the BLM and transferred to the lake as part of the mitigation agreement for solar field expansion (BLM 2004).

The Lockhart fault extends in a northwest to southeast direction, and is located near the southwest corner of the PG&E Compressor Station (Pacific Gas and Electric 2011c). The Lockhart fault extends through the northern part of Iron Mountain and south of Harper Lake through Hinkley Valley and into the unconsolidated rocks south of the Mojave River. This fault appears to impede the movement of groundwater in the regional and the floodplain aquifers, although there is no evidence of this effect in the floodplain aquifer along the river (Stamos et al. 2001). The fault is considered to be a zone of low hydraulic conductivity and appears to provide considerable resistance to westward flow from the Compressor Station (Pacific Gas and Electric 2011c). The Lockhart fault is considered active within Holocene time (past 11,000 years) but has no obvious surface expression. The Mount General fault also extends northwest-to-southeast along the northeast model boundary. There is no evidence of this fault extending into the north Hinkley Valley or that it is active.

The Mojave River Groundwater Basin is essentially a closed basin –very little groundwater enters or exists the basin. However, within the basin groundwater movement occurs between the different subareas, as well as surface-groundwater water and groundwater-atmosphere interchanges. Natural inflows to, or recharge of, the groundwater basin is from direct precipitation, ephemeral streamflow, infrequent surface flow of the Mojave River, and underflow of the Mojave River into the basin from the southwest (DWR 2003). Over 90 percent of the basin groundwater recharge originates in the San Gabriel and San Bernardino Mountains (MWA 2011). Average precipitation varies across the basin from 4 to 11 inches with the average for the basin near 6 inches (DWR 2003).

Groundwater is recharged into the basin predominantly by infiltration of water from the Mojave River, which accounts for approximately 80 percent of the total basin natural recharge (MWA 2011). However, the recharge from the Mojave River is very episodic, occurring only in periods of high runoff and flooding. The recharge to the portion of the Mojave River alluvial aquifer in the Hinkley Valley can be roughly estimated for the years when surface flow reaches Barstow. The Mojave River alluvial channel is periodically recharged (every 5–10 years) during major runoff events. The water levels along the Mojave River channel may be recharged by as much as 20 to 40 feet during these surface flow events (Stamos et al. 2001).Recent years with some recharge in the Hinkley Valley portion of the Mojave River aquifer are 1983, 1993, 1998, 2005, and 2010.

Some of the Mojave River recharge water flows into the Hinkley Valley aquifer north of the river, over a period of several years following the recharge event. The recharge events also can be identified from increasing water levels in wells along the river, as described in Appendix A. Sources of artificial recharge include irrigation return flows, waste water discharge, and enhanced recharge with imported water (Stamos et al. 2001). Groundwater is discharged from the basin primarily by well pumping, evaporation through soil, transpiration by plants, seepage into dry lakes where accumulated water evaporates, and seepage into the Mojave River.

Hinkley Valley Groundwater Basin

Figure 3.1-1 shows the upper portion of the Mojave River Groundwater Basin from between the San Bernardino Mountains and east of Barstow including the project study area. The Centro Subarea of the Mojave River Groundwater Basin includes the area from north of Victorville to Barstow and includes the project study area and the Harper Lake watershed. The Hinkley Valley Groundwater Basin (referred to as the Hinkley Valley aquifer in this EIR) is located north of the Mojave River between Iron Mountain on the west and Mt. General on the east and extends north to the approximate location of Red Hill at the north end of Hinkley Valley. Figure 3.1-2 shows the rough outline of the Hinkley Valley aquifer and the location of the chromium plume as of late 2011. The Hinkley Valley aquifer is about 40 square miles (25,600 acres).The east side of Hinkley Valley may have been a previous route for the Mojave River and is thought to have coarser alluvial sediments.

Figure 3.1-3 shows a diagram of the Hinkley aquifer, drawn as a cross section along the 3.1 ppb Cr[VI] plume centerline, starting at the Mojave River and continuing north about 6 miles to the underflow toward Harper Valley and Harper Dry Lake (the dry lake is also referred as a "playa") (shown as Cross Section A' in Figure 3.1-2). The ground elevation at the Mojave River is approximately 2,200 feet above mean sea level (amsl) and about 2,150 feet amsl north of Hinkley. The depth to bedrock is about 200 feet, and apparently slopes with the ground surface. The measured groundwater elevation generally follows this same elevation gradient. The groundwater contour elevations for February 2006 were about 2,150 feet amsl at the Mojave River, about 2,125 feet amsl at the Compressor Station, about 2,075 amsl north of the Cr[VI] plume at Thompson Road and about 2,050 at the north end of the Hinkley Valley. This measured water table gradient is about 20 feet per mile (0.004). The aquifer porosity is about 20%; if there is a 75-foot saturated depth of the upper aquifer, the water contained in the aquifer is equivalent to a 15-foot column of water only. Figure 3.1-4 presents the groundwater elevation contours for the upper aquifer, discussed below, in the aquifer surrounding the plume.

As described in the USGS modeling study (Stamos et al. 2001), the saturated upper aquifer thickness (i.e., the aquifer material that is filled with water) of the Hinkley Valley aquifer is about 75–125 feet, and the depth to groundwater is about 75–100 feet below the ground surface. Throughout most of the Hinkley Valley, there are two parts to the aquifer: an upper aquifer and a lower aquifer which are respectively located above and below the confining clay layer called the blue clay.

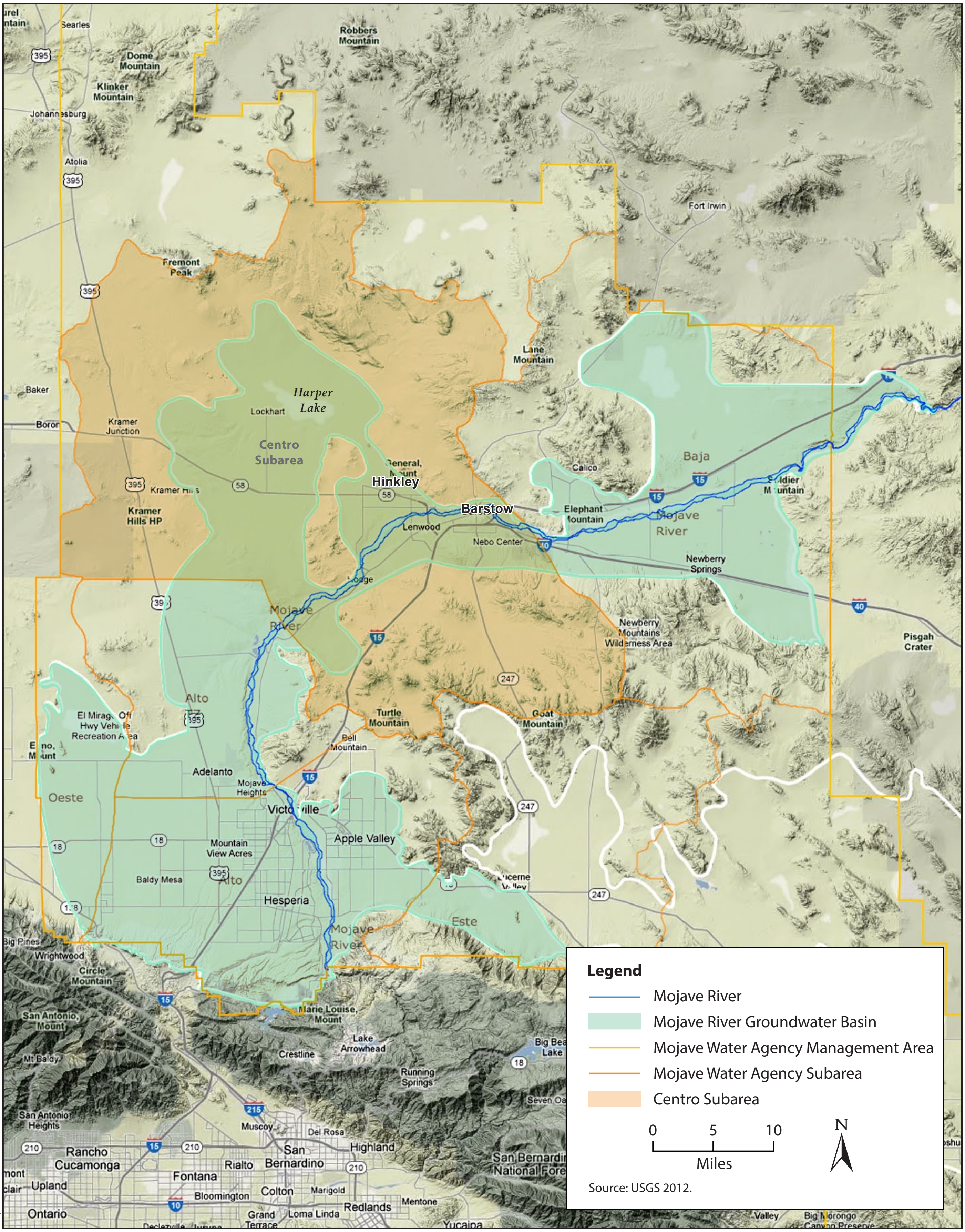
The upper aquifer near the Hinkley Compressor Station is above the blue clay layer. The blue clay ranges in thickness up to 40 feet and becomes thinner with distance from the Mojave River. Where the blue clay layer and lower aquifer thins out near above ground bedrock features (primarily, the northwestern site area), all saturated deposits above bedrock are part of the upper aquifer (Pacific Gas and Electric Company 2011e). Appendix A presents a simplified accounting of the Hinkley aquifer accounting for elevations and groundwater flow.

The upper and lower aquifer sediments have variable grain size and properties. Grain size can vary from coarse to fine over short distances laterally and vertically but generally become finer-grained away from the Mojave River. The upper aquifer is an unconfined aquifer while the lower aquifer is confined beneath the blue clay layer. These variable geological conditions influence the movement and distribution of chromium in the groundwater beneath the site. Because the upper aquifer is unconfined and less condensed than the lower aquifer, groundwater flow is more transmissive (free flowing) in the upper aquifer than it is in the lower aquifer. The upper aquifer groundwater elevations generally slope (indicating some groundwater movement) from the Mojave River toward the north, with flow moving towards Harper Valley and playa. It is calculated that at least 10% of groundwater from the Hinkley Basin flows into the Harper Valley.

Water levels in the Centro Subarea have been relatively stable with seasonal fluctuations and declines during dry years followed by recovery during wet periods. Minimal water level changes in the Harper Lake area indicate a slow recovery following reductions in pumping during the past several years. Water level declines in wells in the Hinkley vicinity (away from the river) prior to the adjudication of the Mojave River Groundwater Basin show the effects of pumping and limited recharge, primarily due to agriculture (MWA 2011). Water levels in Hinkley have been stabilizing and recovering since the adjudication (see further discussion below).

Hinkley Valley Water Supplies

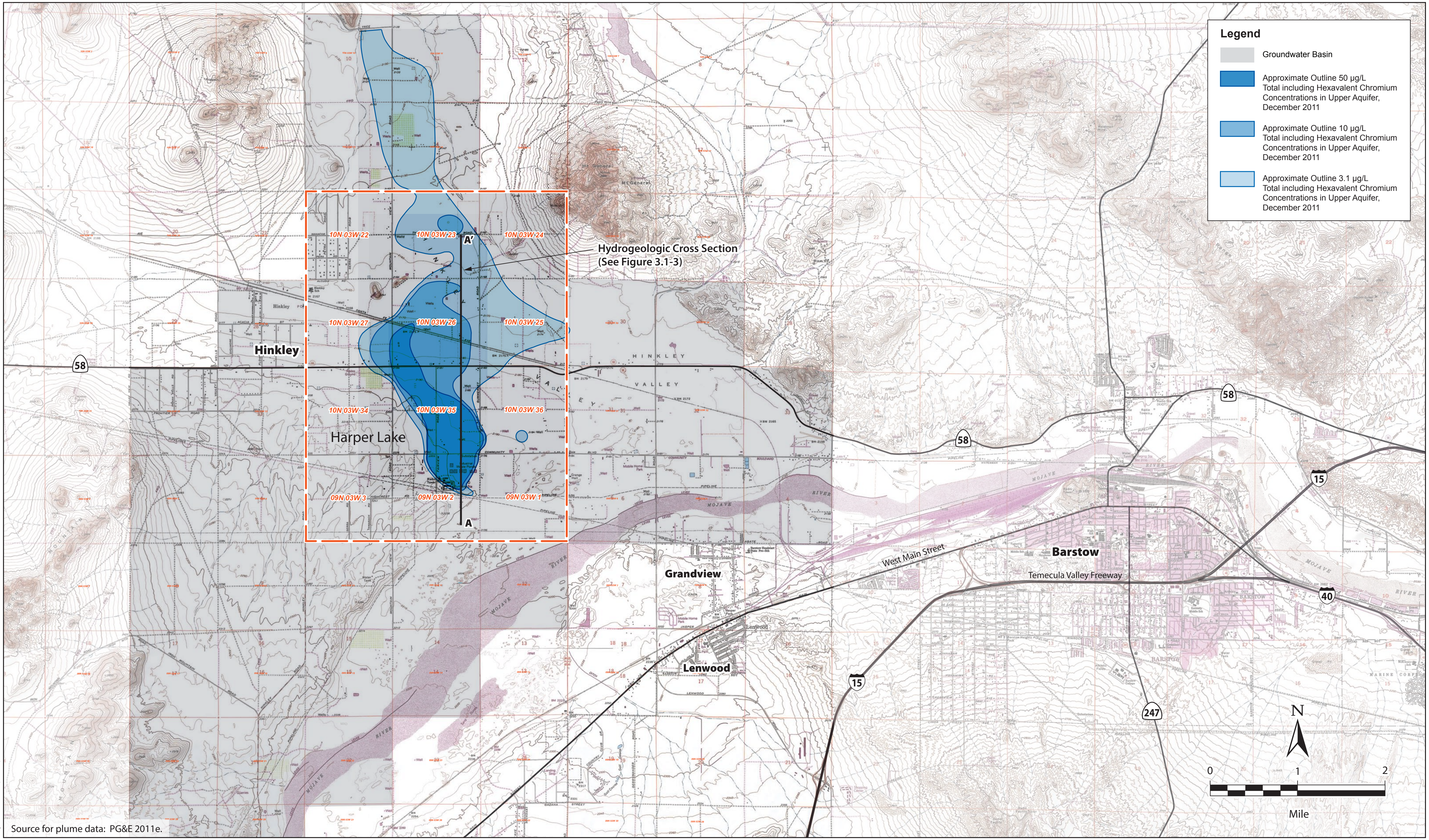
All of the existing water supplies in the Hinkley Valley and nearby Barstow are pumped groundwater. Historical water uses in the Hinkley Valley were dominated by agricultural use from the 1940s to the 1990s. There are an estimated 500 domestic wells in the Hinkley Valley, but the volume of water used for residential properties is generally small in comparison to agricultural use.



Graphics...00122.11 (8-16-12)

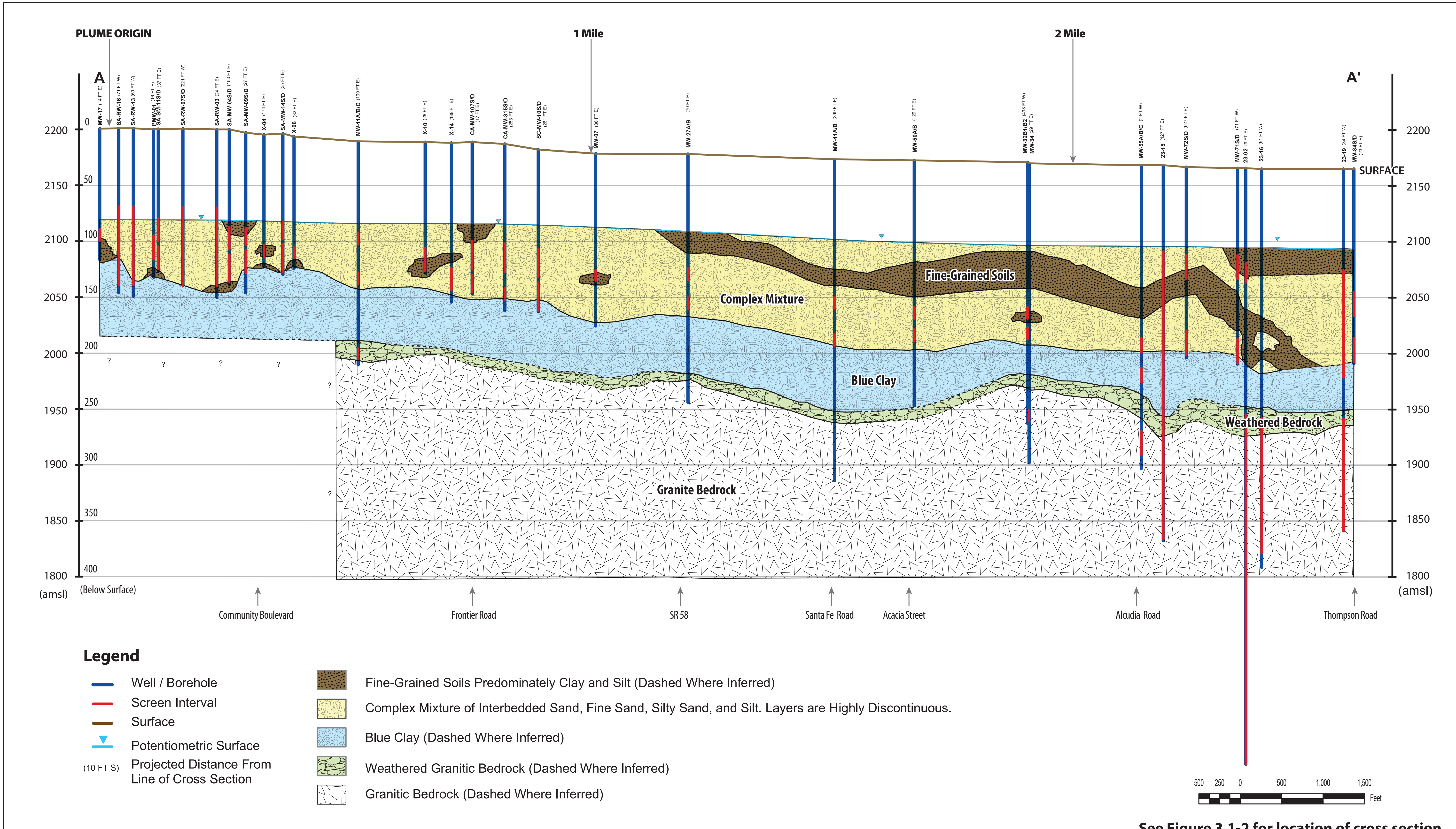
ICF INTERNATIONAL

Figure 3.1-1
Mojave River Groundwater Basin



Graphics...00122.11 (8-16-12)

Figure 3.1-2
Hinkley Valley Groundwater Basin



Source: PG&E 2010.

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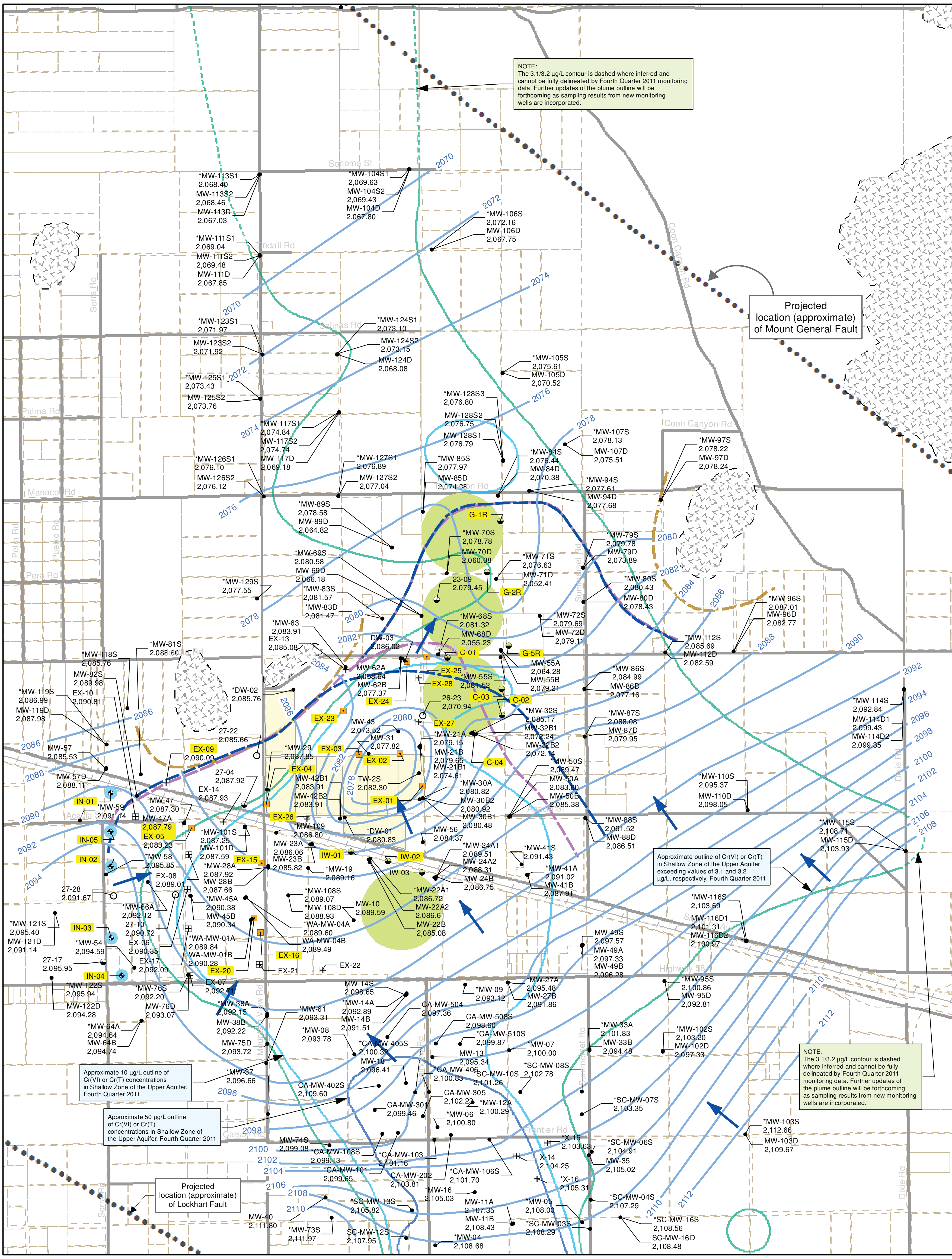
ICF INTERNATIONAL

Figure 3.1-3
Hinkley Groundwater Basin Hydrogeologic Cross Section



LEGEND

- Monitoring Well
- Agricultural Supply Well (active wells highlighted)
- Groundwater Extraction Well (active wells highlighted)
- Freshwater Injection Well (active wells highlighted)
- Multi-use Test Well, or Inactive Extraction/Injection Well
- Other Supply Well
- 2093 Groundwater elevation (feet above MSL)
- Potentiometric Elevation Contours (feet above MSL, 2 ft interval)
- General Flow Direction In Upper Aquifer
- Estimated Capture Zone based on October 2011 water level measurements
- Estimated Capture Zone based on July 2011 water level measurements
- Approximate Limit of Saturated Alluvium Shallow Zone of Upper Aquifer
- DVD LTU Irrigation Fields
- Active Agricultural Units
- Bedrock Exposed at Ground Surface
- Concealed Fault
- Approximate outline of Cr(VI) or Cr(T) in Shallow Zone of the Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011 (dashed where inferred)
- Approximate 10 µg/L outline of Cr(VI) or Cr(T) concentrations in Shallow Zone of the Upper Aquifer, Fourth Quarter 2011
- Approximate 50 µg/L outline of Cr(VI) or Cr(T) concentrations in Shallow Zone of the Upper Aquifer, Fourth Quarter 2011

Notes:

1) Groundwater elevation contours represent the hydraulic gradient in the shallow zone of the upper aquifer. The shallow wells of nested completions (wells designated "A" or "S") were preferentially used for contouring. In all cases, the screened interval of the well was taken into account, and data from deeper wells were given less weight for contouring.
2) Most groundwater elevations were measured October 24, 2011. See Table D-1 for dates.
3) * = Monitoring well used for contouring.

Graphics ... 00122.11 (6-18-2012)

Source: PG&E 2011e.

Figure 3.1-4
Groundwater Elevation Contours in the Vicinity of the Chromium Plume

After the chromium plume was reported in 1987, a number of drinking water wells were abandoned following property purchase by PG&E. The standard practice has been to seal these domestic wells, although a few were left to serve as monitoring wells.

PGE's primary groundwater supply consumption within the study area is twofold: industrial supply for the Compressor Station and current remedial actions for chromium. The latter involves different scenarios affecting the aquifer. In the case of in-situ remediation and fresh water injection, water that is extracted is re-injected into the subarea, and therefore, the activities do not alter the net groundwater balance. However, groundwater extraction for agricultural treatment results in loss of water due to high evapotranspiration rates during warmer months of the year (late spring to early fall). A portion of the extracted water percolates through the soil and returns to the aquifer during cooler months of the year (winter).

Through its water supply program ordered by the Water Board, PG&E is now providing many homeowners and the Hinkley Elementary School with bottled water. Thus, less aquifer water is currently being pumped by domestic wells for drinking and cooking purposes. This, however, is only a small amount of pumped water compared to other domestic uses, such as bathing, laundry, appliances, and landscaping. In addition, the use of bottled water will soon end and both the whole house water for residents and the alternate water supply for the Hinkley School will be from the Hinkley basin. As noted above, PG&E is currently planning to provide whole house water to residences within the affected area as required by CAO R6V-2011-0005, as amended. PG&E also recently agreed to provide an alternative water supply to the Hinkley Elementary School as part of a legal settlement related to violations of a prior Water Board order requiring containment of the chromium plume.

Effects of Existing and Historic Pumping on Groundwater Aquifer Levels

Groundwater pumping causes a localized drawdown of water elevations around the well because a pressure gradient (i.e., water slope) is needed for the groundwater to move through the aquifer material to the well (see Appendix A). This is sometimes called a "cone of depression." The size of this cone of depression will increase with higher pumping and/or less transmissive aquifer materials, such as silt and clay. Cones of depression within the study area change in response to variations in seasonal and intra-seasonal pumping rates, including changes in agricultural operations (Pacific Gas and Electric 2011c).

Historical pumping in the Hinkley Valley generally caused groundwater elevations to decline by as much as 90 feet or more from between 1930 and the late 1980s (Stamos et al. 2001). After the Mojave River Basin groundwater adjudication in 1995, pumping for irrigation in the Hinkley Valley has been reduced. As described previously, the Hinkley Valley aquifer currently has relatively stable regional groundwater conditions, characterized as constant elevations and northward flow, as shown in Figure 3.1-4.

Current groundwater pumping in the vicinity of the plume is generally limited to agricultural supply for farming, Compressor Station water supply, remedial supply by PG&E, and individual domestic water supply associated with rural residential land use. Groundwater extraction by PG&E and others, primarily for agriculture and secondarily for Compressor Station supply, has the greatest potential to influence localized groundwater flow and chromium movement. Domestic wells pump only a small amount of water (between 200 and 600 gallons per day) each year in comparison and therefore have the least influence on groundwater flow.

The pumping rates for agriculture can be estimated from the irrigated acreage and the typical evaporation rates of more than 5 feet per year. The USGS modeling study (Stamos et al. 2001) estimates irrigation pumping requirements at about 8 to 10 afy per acre. For a typical irrigation "pivot", or agricultural treatment unit, on a 40-acre field with about 30 acres irrigated (a circle within a square), the seasonal pumping would be 240 afy, which is equivalent to a pumping rate of about 180 gpm. There are a small number of orchards to the north and east of the Hinkley site and a large number of alfalfa fields to the east. The irrigated farming acreage to the east of the plume (owned and operated by others) is multiple times larger than the current acreage used for plume control by PGE. The Compressor Station water supply pumping rate is equivalent to about one-quarter of a 30-acre agricultural field.

Effects of Existing and Historic Pumping on Groundwater Movement

The regional movement of groundwater in the Hinkley Valley depends on the groundwater elevations along the Mojave River (increased by recharge events) and the underflow through the alluvial channel at the north end (towards Harper Valley). This regional water movement (together with the aquifer properties) will cause a pattern of groundwater elevation gradients (i.e., groundwater elevation contours) within the valley. Pumping will modify (increase) the regional groundwater movement and change the groundwater elevation patterns.

Groundwater movement through the Hinkley Valley alluvial channel is controlled by the aquifer geology, hydraulic conductivity and groundwater elevation. Because the Mojave River is located along the southern end of the Hinkley Valley, a majority of this recharge water flows to the north and increases groundwater elevations throughout the Hinkley Valley. Groundwater in the upper and lower aquifers generally flows in a north-northwesterly direction, from the Compressor Station to the northern end of the Hinkley Valley. Horizontal gradients in the upper aquifer, in the absence of pumping or injection, generally range from 0.002 to 0.004 feet per foot (ft/ft) (PG&E Proposed Workplan Background Study 2012a).

Groundwater will move along pathways with the least resistance, and will flow preferentially along gravel and/or sand deposits. Tracer studies can also help determine groundwater movement along an aquifer. The USGS groundwater modeling (Stamos et al 2001) estimated the average flow towards Harper Valley to be about 3,000 afy for 1930–1995. USGS assessed a two-mile portion of the aquifer, with an assumed depth of 75 feet and a porosity of 20%, and estimated flow would be about 825 feet per year (or 2.53 feet per day) and eventually reach Harper Lake. A similar value was found by PG&E based on tracer studies completed as part of remedial activities that determined groundwater velocity (not influenced by gradients induced by pumping or injection) ranges from approximately <1 to 2 feet per day (PG&E Proposed Workplan Background Study 2012a). This general flow pattern is further confirmed by the measured groundwater gradient and the relatively slow northward spread of the chromium plume. The northern edge of the plume has been moving progressively northward since the chromium release reached groundwater beginning in about 1960 or later. At present, the plume is thought to be at least 5.5 miles north of the Compressor Station, but the northern boundary is not fully delineated yet. The plume length, however, was greatly influenced by pumping and movement by others instead of under natural conditions.

Figures 3.1-1 and 3.1-2 show the Hinkley Valley aquifer. Groundwater movement towards the Harper Valley can be represented as pumping from the two sections at the north end of the Hinkley Valley. Although there may not be complete records of the locations and volumes of the historical pumping for irrigation in the Hinkley Valley, the location and magnitude of the existing groundwater pumping can be used to approximate the expected future movement of the chromium plume.

Effects of Historic Pumping on the Physical Environment

Long-term groundwater drawdown (also referred to as groundwater overdraft) where the pumping rate exceeds the recharge rate can lead to land subsidence and surface soil cracking due to compaction of the aquifer material. If aquifer compaction occurs, finer-grained soils such as silts and clays may never again hold as much water and the land surface can subside (i.e., sink) permanently. Land subsidence within the Mojave River Groundwater Basin has not been an issue historically because the aquifer is made up primarily of coarser sediments, such as sands and gravels, which are not as prone to compaction and possibly because subsidence beneath agricultural fields is not noticed as much. However, aquifer compaction and land subsidence associated with groundwater-level declines has been recognized as a potential problem in parts of the Mojave Desert (Sneed, Michelle et. al 2003). This section addresses the potential for aquifer compaction and its effect on water supply whereas Section 3.4, *Geology and Soils*, addresses the potential impact of land subsidence.

3.1.4.3 Hinkley Valley Groundwater Quality

The geochemistry of the Hinkley Valley aquifer is somewhat typical of the Mojave River Basin alluvial aquifer. Water quality sampling results for pH, chromium, arsenic, iron, manganese, nitrate, and salinity (i.e., TDS) from previous monitoring, including the background chromium groundwater study conducted in 2006, are discussed in Appendix A and summarized in this section. Water quality standards for these groundwater constituents have been established by the Water Board in the Basin Plan and are listed in the regulatory setting section.

Chromium in the Environment

Chromium is a metallic element in the periodic table. It is odorless and tasteless. Chromium is found naturally in rocks, plants, soil and volcanic dust, humans and animals. The most common forms of chromium in the environment are trivalent (Cr[III]), hexavalent (Cr[VI]) and the metallic form (Cr[0]). Cr[III] occurs naturally in many vegetables, fruits, meats, grains and yeast (U.S. Environmental Protection Agency 2011). Cr[VI] is found in nature dissolved in water from the erosion of natural deposits of Cr[III], typically from mafic rocks containing dark and heavy minerals. Major sources of anthropogenic Cr[VI]in drinking water are discharges from steel and pulp mills, and historic use of Cr[VI] as an anti-corrosion agent in the past (as at Hinkley). (U.S. Environmental Protection Agency 2010).

Source of Chromium Contamination

The Hinkley Compressor Station began operating in 1952 and added Cr[VI] to cooling tower water to prevent corrosion. The cooling towers are used to cool the compressed natural gas heated by friction before returning it to the pipeline. The untreated cooling tower water was discharged to unlined ponds until 1964. In 1965, phosphate replaced Cr[VI] as the corrosion inhibitor. While the ponds were taken out of service in 1966 and replaced with lined ponds, chromium wastewater continued percolating through the unsaturated zone to groundwater for years. Chromium-contaminated soil since has been excavated from shallow depths in the area of the former unlined ponds, pipelines, and beneath tanks (Lahontan Water Board 2008). In 1987, PG&E reported to the Water Board that off-site monitoring wells, located to the north of the facility, showed total chromium concentrations in groundwater exceeding the California Maximum Contaminant Level of 50 ppb.

Existing Chromium Contamination Plume

Upper Aquifer

Figure 3.1-5 shows the chromium plume as presented in PG&E's Fourth Quarter (Q4) 2011 Monitoring Report (2011e). The chromium plume of concentrations 3.1 ppb of Cr[VI] or greater covered about 2,949 acres in late 2011. In contrast, in the third quarter of 2008, the plume (defined at that time by the 4.0 ppb contour) was only 1,230 acres. However, the portion of the plume with concentrations greater than 10 ppb Cr[VI]and the plume "core," with concentrations greater than 50 ppb of Cr[VI] have had less expansion than the lower concentration plume in the upper aquifer. The highest concentrations of Cr[VI] are still almost directly below the former unlined ponds at the PG&E Compressor Station, 45 years after the Cr[VI] discharge (infiltration from ponds) was stopped in 1965. Chromium at the source area, either fixed to soil particles or trapped as wastewater in soil pores, appears to act as a continuing source affecting groundwater. The volume of water (measured as acre-feet) in the chromium plume can be conservatively estimated from these plume areas by assuming that there is about a minimum of 15 feet of water in the saturated upper aquifer (depth of about 75-feet with porosity of about 20%). Therefore, the water volume is simply 15 times the acreage of the plume. Because the plume covered about 2,950 acres in late 2011, with an assumed water depth of 15 feet, the total plume volume can be estimated at about 44,250 acre-feet.

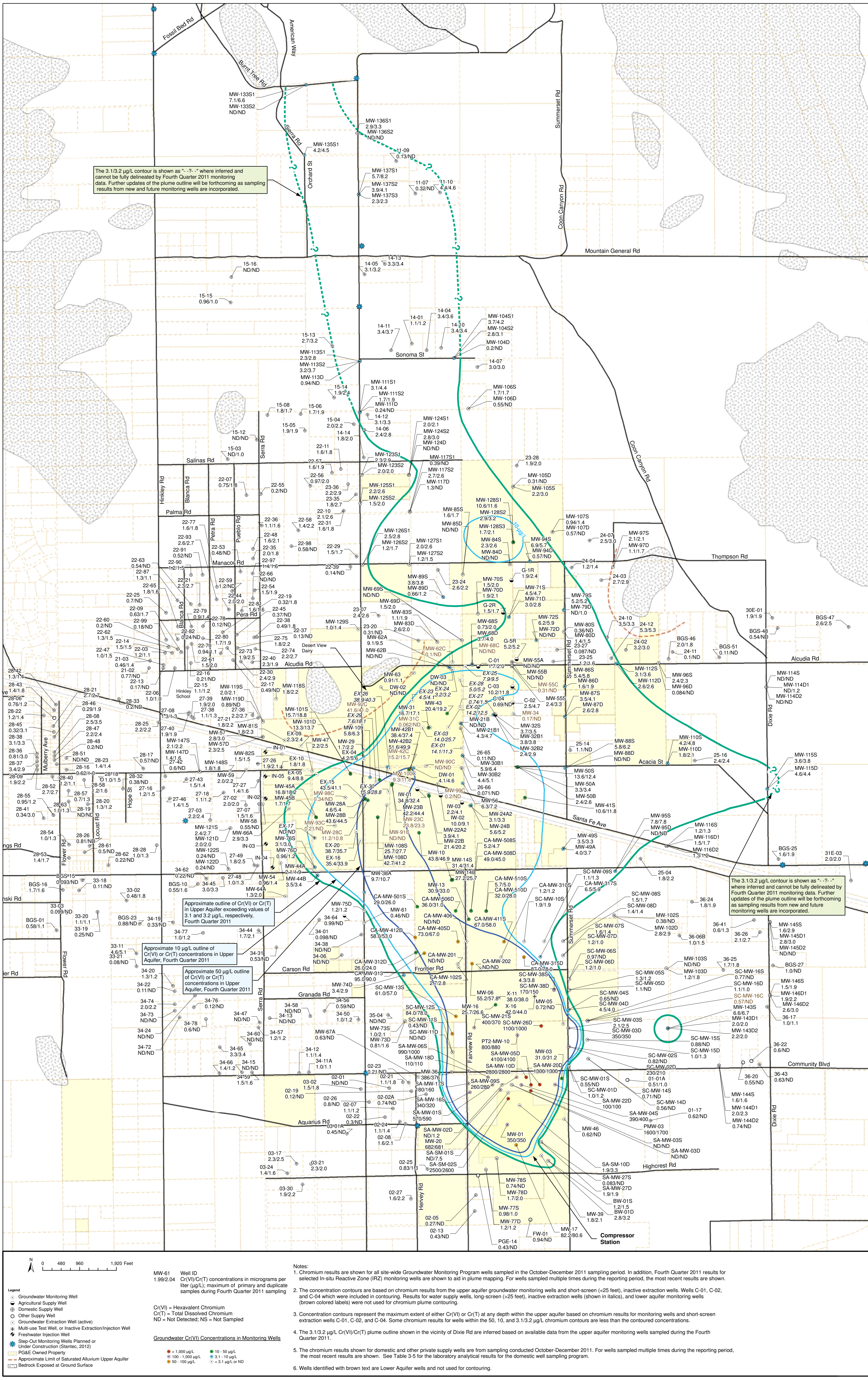
Lower Aquifer

PG&E conducted an investigation of the lower aquifer in response to the Water Board's Investigative Order R6V-2010-0055. Results of the investigation indicate that chromium concentrations increase in the vicinity of monitoring well MW-23, which is located south of the Desert View Dairy agricultural treatment unit and Santa Fe Avenue and east of Mountain View Road. The Fourth Quarter 2011 Monitoring Report shows chromium levels exceeding 10 ppb in the lower aquifer (Figure 3.1-6). The maximum detected Cr[VI] concentration was 41.6 ppb. The Cr[VI] plume of 3.1 ppb or greater in the lower aquifer covers a one-half mile wide area extending from the southern portion of the Desert View Dairy agricultural treatment unit to near SR 58. Chromium migration from the upper aquifer into the lower aquifer appears to have occurred where the regional blue clay layer is thin or not present. This chromium migration is likely a result of the downward hydraulic gradients produced by groundwater extraction in the lower aquifer to the east/northeast of MW-23C from the Desert View Dairy and the Gorman property. PG&E has since removed some agricultural wells screen from the lower aquifer on these properties to reduce the force acting on the chromium plume (Pacific Gas and Electric 2011e).

Background Chromium Concentrations

In 2006, sampling was conducted by PG&E to characterize existing background levels of chromium in the Hinkley Valley. In 2007, PG&E submitted the *Groundwater Background Study Report, Hinkley Compressor Station, Hinkley, California* (hereafter, the 2007 Background Study Report), summarizing results of the sampling done in 2006 to determine the range of background levels of chromium in groundwater.

Forty-eight wells in the Hinkley Valley were sampled for Cr[T] and Cr[VI]as part of the Background Study (Pacific Gas and Electric Company 2007). About 90% of the wells sampled were domestic wells and the remainder agricultural wells (Lahontan Regional Water Quality Control Board 2008). The number of sampling events for each well ranged from one to four during the year on a quarterly basis. However, water quality was not distinguished between the upper aquifer versus the lower



Source: PG&E 2011e.

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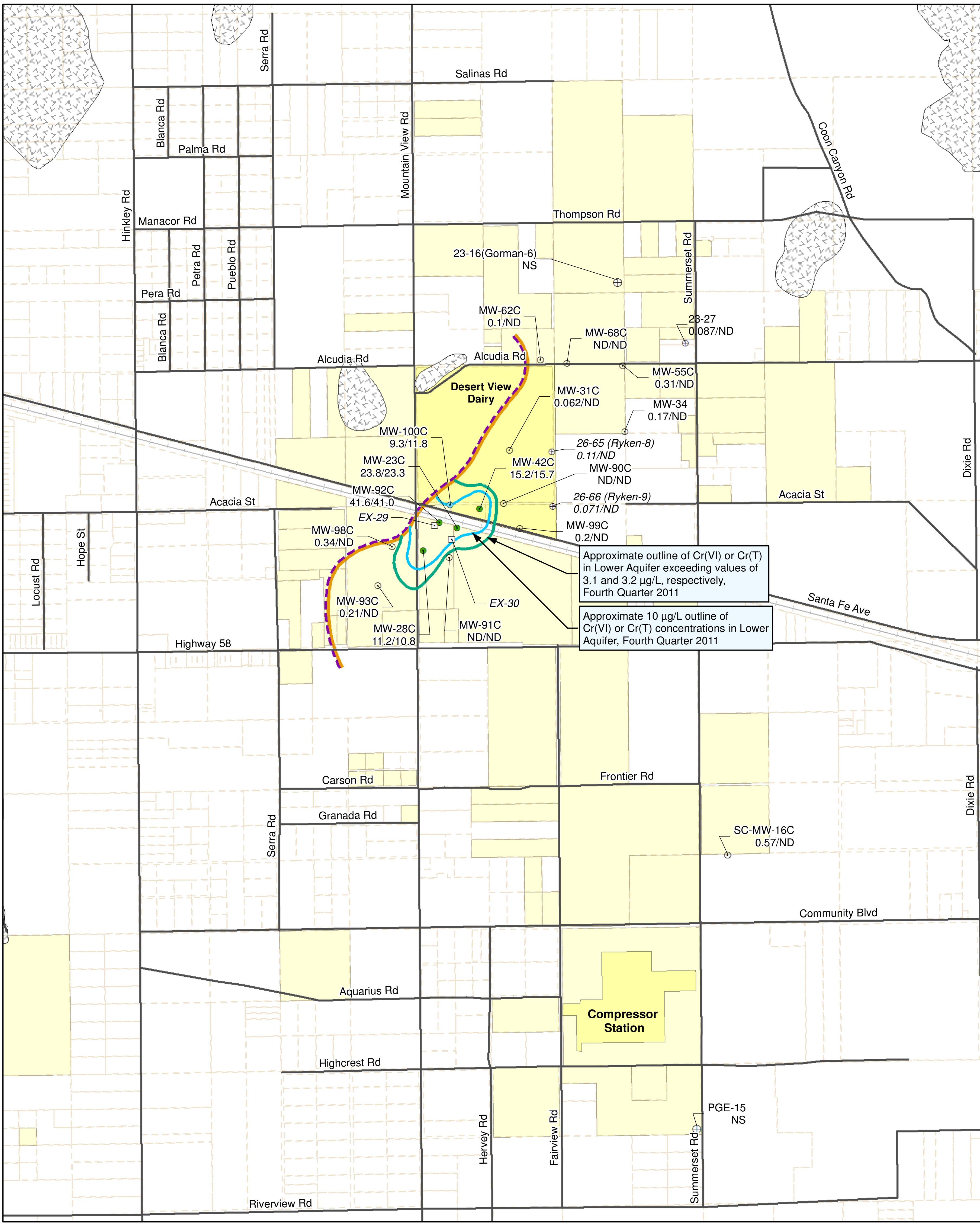
Figure 3.1-5
Existing Chromium Plume Boundaries and Concentrations for the Upper Aquifer, Fourth Quarter 2011



Legend

- Lower Aquifer Monitoring Well
- Water Supply Well Completed in Lower Aquifer, with Fourth Quarter 2011 Sampling Results
- Groundwater Extraction Well to be Operated for Lower Aquifer Migration Control
- Bedrock Exposed at Ground Surface
- Approximate Western Limit of Blue Clay Aquitard (Blue Clay extent indicated by shading)
- PG&E Owned Property

MW-100C Well ID
9.3/11.8 Cr(VI)/Cr(T) concentrations in micrograms per liter (µg/L); maximum of primary and duplicate samples during Fourth Quarter 2011 sampling

Groundwater Cr(VI) Concentrations in Monitoring Wells

- 10 - 50 µg/L
- 3.1 - 10 µg/L
- < 3.1 µg/L or ND

Cr(VI) = Hexavalent Chromium
Cr(T) = Total Dissolved Chromium
ND = Not Detected; NS = Not Sampled

1) Chromium concentration contours are based on October-December 2011 sampling of groundwater monitoring wells completed in the Lower Aquifer (saturated zone below the Blue Clay aquitard). Where the Blue Clay is not present, all saturated deposits above bedrock are part of the Upper Aquifer.

2) The western limit of the Blue Clay aquitard is based on available drilling information through January 2011 (Stantec 2011d).

Source: PG&E 2011e.

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Figure 3.1-6
Existing Chromium Plume Boundaries and Concentrations for the Lower Aquifer, Fourth Quarter 2011

aquifer or between different layers of the upper aquifer (Pacific Gas and Electric 2011c). Besides chromium, the water samples were analyzed for geochemical similarities, temporal trends, and outliers. As stated in Section 2.3, this study found that the average and maximum likely background concentrations within the Hinkley Valley aquifer outside the PG&E plume influence are those described in Table 3.1-5 below.

Table 3.1-5: Background Study Results for Cr[T] and Cr[VI] found in the Hinkley Valley Groundwater

Type of Concentration	Cr[VI] Concentration (ppb)	Cr[T] Concentration (ppb)
Average	1.2	1.5
Maximum	3.1	3.2
Source: CH_2HMHill 2007		

The Cr[T] and Cr[VI] concentrations were at low or undetectable levels near the Mojave River and increased with distance away from the river.

Some contaminants have no natural background concentrations because the chemical originates from a manufacturing process, so the only detectable concentrations would be from a waste discharge. However, chromium is a common element in the earth's crust and Cr[VI] is present in many groundwater basins.

Water quality data collected by the California Department of Public Health, the SWRCB, and the United States Geological Survey (USGS) confirm that Cr[VI] is naturally present in groundwater throughout California, including the Mojave Desert area and in the immediate vicinity of the Hinkley Valley (Pacific Gas and Electric 2011c). The California Department of Public Health conducted sampling for Cr[VI] from drinking water wells throughout California and found 35% had concentrations above 5 ppb (California Department of Public Health 2011).

A detailed study of groundwater conducted by the USGS in 2008 also confirmed that Cr[VI] is present in groundwater throughout the Mojave area at concentrations up to 16 ppb, consistent with the SWRCB data. Drinking water extracted from the Alto subarea (containing Victorville and Hesperia approximately 25 to 30 miles south of Hinkley) and Este subarea (around Lucerne Valley approximately 30 miles southeast of Hinkley) of the Mojave River Basin show Cr[VI] at levels higher than those determined in the 2007 Background Study Report. The reason for the higher chromium levels in those locales were due to their close proximity to the San Gabriel and San Bernardino Mountains, both which contain mafic rocks. Cr[VI] concentrations ranged up to 5.1 ppb in the Desert View System and up to 6.3 ppb in the Apple Valley South system (both systems serve areas near Apple Valley, approximately 30 miles southeast of Hinkley). These data indicate the presence of natural Cr[VI] in groundwater throughout the Mojave River watershed, upgradient of the Hinkley Site. (Pacific Gas and Electric 2011c).

There are technical limitations in identifying the precise lateral extent of the Hinkley chromium plume near the edges, where the concentrations are less than or equal to the maximum background concentrations of 3.1/3.2 ppb. Because background concentrations could vary from non-detect to 3.1/3.2 ppb, positive detections of Cr[VI] or Cr[T] below these levels could be natural or could be due to spread of the chromium plume. Using standard sampling methods at present, the origin of chromium, whether man-made or natural, cannot be determined chemically. However, as part of the reexamination of the 2007 Background Study Report, the Water Board is examining potential new methods that may be able to look at different isotopes of chromium to potentially differentiate between man-made and natural chromium detections. The Water Board is requiring that the 3.1 ppb (for Cr[VI]) contour be used to detect the existing contaminant plume and any future spreading.

In 2011, the Water Board requested a peer review study of the 2007 Background Study Report. Water Board staff received peer review comments in October 2011. The peer reviewers' criticisms are grouped into four categories:

- lack of aquifer-specific sampling;
- statistical methods and assumptions;
- uncertainty regarding historic plume migration; and
- sample analysis quality control procedures.

In February 2012, PG&E submitted the *Proposed Work Plan for Evaluation of Background Chromium in the Upper Aquifer of the Hinkley Valley* (dated February 22, 2012). The work plan proposes the collection and evaluation of additional data to expand on the 2007 Background Study Report, and to address comments that were provided by the peer reviewers. Water Board staff is reviewing PG&E's proposed new background study, and considering the need for peer review and/or consultation with other experts, such as the US Geological Survey, so that any new study will yield a valid, credible and defensible result.

For the purpose of this EIR, the Water Board is using the values derived from the 2007 Background Study Report to define the chromium plume and as interim cleanup levels pending recalculation of background levels and/or completion of a new background study. It is important to note that any future changes to the adopted background concentrations would not affect the types of cleanup technologies or alternatives that would be analyzed in the EIR. If adopted background levels are revised, the main change of doing so may be the estimates of the time needed to achieve complete cleanup, and the area over which cleanup would occur. If any such changes in the background level result in a significant extension of project duration or a significant expansion of the project area, those changes might need to be further evaluated under CEQA.

Total Dissolved Solids Concentrations

"Total dissolved solids" is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. The principal constituents are calcium, magnesium, sodium, potassium, carbonate, hydrogen carbonate, chloride, sulfate, and nitrate (World Health Organization 2003a). On irrigated lands, salts concentrate in the soil due to evapotranspiration. When too much irrigation is applied, the excess water percolates through the soil carrying the dissolved solids to the water table. On dairy lands, animal wastewater and manure contribute significant levels of TDS to the soil and groundwater. Besides TDS, other constituents seen in groundwater on dairy lands at levels often exceeding drinking water standards are chloride, sodium, sulfate, and sometimes bacteria. The state of California has set a secondary Maximum Contaminant Level for TDS in drinking water at 500 ppm for a lower limit and 1,000 ppm as an upper limit.

Agricultural uses have affected the salt (total dissolved solids, or TDS) concentrations in the groundwater below irrigated and agricultural lands in the Hinkley Valley. Agricultural activities, primarily as irrigated crops and dairy operations, have been the major causes of increased TDS in the Hinkley Valley groundwater. While natural dissolution of salts from geologic materials (i.e., aquifer sediments) does occur as the water moves from the Mojave River toward the north, such concentrations are significantly less than that contributed by irrigated lands and dairy operations. The TDS limit in the General Permit (Order No. R6V-2008-0014) reflect the lower of either (1) the most restrictive beneficial use standard or existing water quality if presently higher than the most restrictive beneficial use standard; or, (2) a 25 percent increase above the background conditions if existing water quality is presently below the most restrictive beneficial use standard.

The background water quality entering the Hinkley Valley from the Mojave River is considered to be excellent. However, water quality ranges from good to very poor as groundwater migrates through the valley northward, mostly due to anthropogenic sources. TDS concentrations in groundwater are lower in the south nearest the recharge area along the Mojave River, and in the west along the channel leading north to Harper Lake. The 2007 Background Study Report found TDS levels in the areas sampled range from 90 ppm near the Mojave River up to 2,390 ppm near a former dairy or confined-animal property but are generally less than 1,000 ppm in most areas (Pacific Gas and Electric 2007).

Along the chromium plume, TDS concentrations range from less than 400 ppm to 5,800 ppm roughly on a south to north gradient (Pacific Gas and Electric Company 2011e). TDS concentrations increase starting at the Compressor Station in the south to Salinas Road in the north. The increasing concentrations are due to active and historic dairy operations, active and historic land treatment units operated for chromium removal, and prior agricultural activity (at the Gorman property). While the Compressor Station is not considered to be a source of TDS, the station supply wells have pulled the TDS plume from the former Mojave Dairy southwards (upgradient) and affected groundwater beneath the Compressor Station. This same process also explains why high chromium concentrations are detected on the Compressor Station's southern property line, which is upgradient of the area of former chromium releases to ground.

Water quality data collected from the monitoring wells at the Desert View Dairy indicate that active dairy operations account for the greatest increase in TDS along the chromium plume; the average TDS concentration detected in the monitoring wells increased from 3,257 ppm (2005 data) to 5,800 ppm (Fourth quarter 2011 data). The land treatment units used to convert Cr[IV] to Cr[III] have also added to the TDS plume. This combined TDS plume has been pulled to the northeast direction by the agricultural wells on the Gorman fields, which may also be contributing to higher TDS levels in groundwater. TDS pollution has been detected in residential wells at and north of the Desert View Dairy, to Salinas Road. Most of these residents are provided bottled water supplied by PG&E for the chromium program. One of these residential well owners receives alternate water supply from the Dairy operator under orders by the Water Board for nitrate pollution.

The above discussions point to active dairy or confined-animal operations as contributing the greatest amount of TDS to groundwater. This is likely followed by contribution from former dairies and then irrigated lands. For clarification, irrigated land using dairy waste water, such as occurs at the Desert View Dairy, is considered to provide the same contribution of impacts to groundwater quality as an active confined-animal operation. The conditions discussed here are considered to be the baseline prior to project implementation. Figure 3.1-7 shows current TDS levels in the project area, based on available data. In the future, the greatest source of TDS to groundwater is expected to continue to be from active dairy operations at the Desert View Dairy.

While groundwater from properties in the Hinkley Valley having irrigation or dairy operations may not meet the secondary Maximum Contaminant Level for TDS, the groundwater is generally suitable for irrigation of alfalfa and other fodder crops which can tolerate high salt levels.

Because previously authorized land treatment was identified as having the potential to increase TDS levels, a baseline annual average level for groundwater was established as 1,310 ppm TDS for the Desert View Dairy land treatment unit in 2010. The permit (R6V-2004-0034A2) allowed for a 25 percent increase for TDS to 1,713 ppm. This threshold concentration is calculated using a 12-month average for all monitoring wells. The Board order allowing prior land treatment acknowledges that should these levels increase during the project, mitigation and remedial measures must return concentrations to be no higher than the thresholds listed by the end of the project. The First Quarter 2011 Desert View Dairy monitoring report shows that the 12-month average for TDS was 1,743 ppm which is slightly above the threshold (Pacific Gas and Electric 2011e). PG&E's estimates that it takes about 5 to 6 years for percolation to reach the water table. So the levels reflect ground surface activities back to at least 2006. By the end of the first quarter of 2012, PG&E was implementing mitigation by way of containment for the chromium plume, which also acted to contain the TDS plume which puts PG&E into compliance with the Board Order.

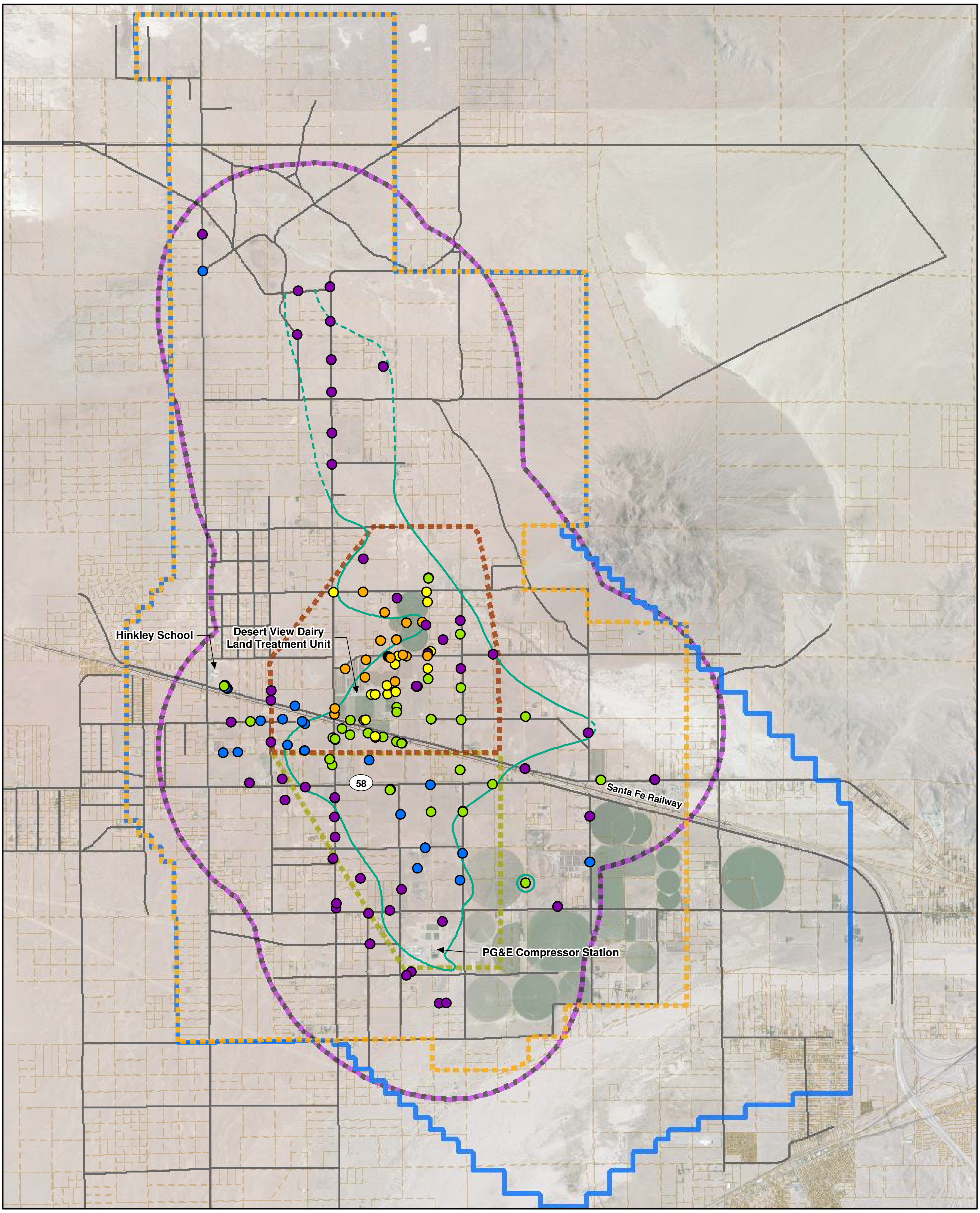
Nitrate Concentrations

Nitrates and nitrites are formed through the decomposition of organic materials in soil, which release ammonia. This ammonia oxidizes to form nitrate and nitrite; of the two, nitrate is more common. The primary beneficial use of nitrates is as a fertilizer used to add nutrients to crops. Often times, excess nitrate resides in the soil of agricultural fields following fertilizer application. Nitrate can percolate with irrigation water or precipitation to reach groundwater. Irrigation with high-nitrate water pumped from agricultural wells has the added beneficial use of providing more nutrients for crops. However, since crop irrigation is typically seasonal, nitrate plumes will migrate with natural groundwater flow during periods of non-irrigation and affect other beneficial uses, such as domestic and municipal wells and agricultural wells for confined animals.

The background nitrate concentrations in groundwater in the Hinkley Valley are generally less than a few parts per million. As mentioned above in the section discussing TDS, background Hinkley groundwater is considered to be excellent water quality. The primary Maximum Contaminant Level for nitrate in California drinking water is 10 ppm. The 2007 Background Study Report found nitrate levels in background areas to range from less than 0.5 ppm (equal to the method detection level) up to 21 ppm. Five out of forty-seven wells sampled had one or more detections of nitrate greater than 10 ppm (Pacific Gas and Electric 2007). These five wells, however, were located near former or active dairies and an active heifer ranch, which were likely sources of nitrate pollution rather than reflective of background conditions.

As discussed above with TDS, nitrate exist in groundwater beneath the Desert View Dairy at high concentrations, primarily due to dairy operations. Nitrate in groundwater applied to the Dairy's agricultural treatment unit has ranged in concentrations over the years from just about 9 ppm to 18 ppm (Pacific Gas and Electric Company 2010a). Data from lysimeters at 20-foot depths indicate that this nitrate is being effectively reduced by the treatment process at the agricultural treatment units. The resulting pore water that percolates through the soil beneath the Desert View Dairy to groundwater is generally at lesser concentrations for nitrate than that which was applied.

PG&E has calculated that the land application of pumped groundwater at the Desert View Dairy agricultural treatment unit has removed over 40 tons of nitrate from the environment between 2004 and 2009 (Pacific Gas and Electric Company 2010a). Historical lysimeter monitoring (2005–2010) indicates that nitrate applied at concentrations of approximately 15 ppm generally is reduced below the root zone. Current data from the agricultural treatment unit reveals that about half of the



LEGEND

- Approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011
- One-mile buffer from the contiguous portions of the approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011
- Study Area
- OU1
- OU2
- OU3
- County Parcel Boundary

TDS in mg/L

- 25 - 500
- 500 - 1000
- 1000 - 1500
- 1500 - 3000
- 3000 - 5900

Notes:
As requested by the Water Board for use in the EIR, Fourth Quarter 2011 laboratory-measured TDS data is shown. If TDS data were not collected in a well within Fourth Quarter 2011, but were collected within First Quarter 2012, then First Quarter 2012 data are shown.

Data shown are from private supply (e.g. domestic) and PG&E monitoring and extraction wells, where available.

N

0 2,000 4,000 6,000 8,000
Feet

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Source: Prepared by PG&E, 2012 for the EIR using recent monitoring data.

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Figure 3.1-7
Existing TDS Concentrations within the Project Area

samples from lysimeters in the alfalfa fields have nitrate concentrations of less than 1 ppm, and half of the samples have nitrate concentrations of more than 10 ppm. Thus, current and prior agricultural treatment, while reducing nitrate levels at the Desert View Dairy, has not necessarily reduced them to below the Maximum Contaminant Level of 10 ppm.

Nitrate and TDS contamination in groundwater tends to stay near the upper portion of the affected aquifer unless deeper wells act to pull the contamination lower in depth. In the Hinkley Valley, nitrate and TDS affected water occurs in the upper aquifer. Because the lower aquifer is isolated from the upper aquifer by the blue clay in most of the valley, the lower aquifer has not likely been affected by historical agricultural uses. The origin of the high nitrate is likely animal waste from historical dairy operations, either from animal confinement areas or from waste water or manure applied to the fields as a soil amendment and fertilizer. While groundwater from properties in the Hinkley Valley having irrigation or dairy operations may not meet the drinking water Maximum Contaminant Levels for nitrate, the groundwater is generally suitable for irrigation of alfalfa and other fodder crops.

In the area of the chromium plume, nitrate concentration in groundwater, just as with TDS, is highest between SR 58 to Salinas Road. Nitrate in this area has been detected up to 142 ppm, exceeding the 10 ppm Maximum Contaminant Level by fourteen times (Pacific Gas and Electric Company 2011f). Nitrate pollution has been detected in residential wells at and north of the Desert View Dairy. Under orders from the Water Board, the Dairy operator provided alternate water supply to affected well owners. Only one of these off-site residential well owners continues to receive alternate water supply while the remaining well owners sold their properties to PG&E and moved away.

Figure 3.1-8 shows current nitrate levels in the project area, based on available data.

As described above, because previously authorized land treatment (per R6V-2004-0034A2) was identified as having the potential to increase nitrate levels, a baseline annual average level for groundwater was established in 2010 of 9.0 ppm nitrate (as N) for the Desert View Dairy land treatment unit in 2010. The permit allowed for a 10 percent increase for nitrate (as N) to 9.9 ppm so that it didn't exceed the 10 ppm Maximum Contaminant Level. The threshold concentration is calculated using a 12-month average for all monitoring wells. The Fourth Quarter 2011 Desert View Dairy monitoring report shows that the nitrate 12-month average was calculated at 10.5 ppm of nitrate (as N), which is above the threshold level. By the end of the first quarter of 2012, PG&E was implementing mitigation by way of containment for the chromium plume, which also acted to contain the nitrate (as N) plume which puts PG&E back into compliance with the Board Order.

Concentrations of Other Constituents

The existing levels of other constituents are discussed below based on general water quality assessments and site sampling. The constituents discussed (arsenic, iron, manganese and uranium) are those that could be affected by implementation of the proposed remediation.

Arsenic

Background levels

Arsenic is a naturally occurring element in the earth's crust and is widely distributed in the environment. The USGS conducted sampling for various constituents in wells in the Mojave Water Agency management area from 1991 to 1997, including wells in the Hinkley area

(Christensen 2001). Naturally-occurring arsenic concentrations in water from wells in the western Mojave Desert commonly exceed 10 ppb and a few exceed 100 ppb. Along the Mojave River upgradient of the PG&E Compressor Station, the study found arsenic in wells (up to 200 feet in depth) ranging from less than 1 ppb to 12 ppb with most concentrations under 10 ppb. In the Hinkley area, within approximately 0.5 mile of SR 58, the study found concentrations of arsenic in three wells ranging from 3 ppb to 12 ppb. One to two miles north of SR 58, the study found arsenic in two wells ranging from less than 1 ppb to 2 ppb. Approximately four miles north of SR 58, the study found arsenic in one well at a concentration of 52 ppb. While the USGS study was conducted after the release of chromium from the Hinkley Compressor Station, sampling occurred before the use of carbon-amendment injections to groundwater, and thus reflects levels prior to in-situ remediation. The federal and state Maximum Contaminant Level for arsenic is 10 ppb.

The 2007 Background Study Report for the Hinkley Compressor Station (Pacific Gas and Electric 2007) found arsenic levels in background areas to range from less than 5 ppb (method detection level) up to 22 ppb (with one outlier sample at 200 ppb). Twenty out of forty-seven wells sampled had one or more detections of arsenic greater than 10 ppb.

Concentrations within IRZ Areas

As described in the 2010 Feasibility Study (Pacific Gas and Electric Company 2010a), pilot and extended-scale in-situ remediation of the chromium plume has resulted in temporary and localized increase of arsenic in parts of the plume area. Based on experience with in-situ remediation, arsenic (and other byproducts) concentration increases in correlation to the amount of injected organic carbon and then decreases in time as the organic carbon is consumed by microbial action. Arsenic levels in groundwater increase from less than 1 ppb to 15 ppb in areas up to 500 feet downgradient of the carbon injection point. Prior studies have indicated that after carbon amendment ceases, in-situ remedial byproducts declined back toward initial levels within several months to over a year as organic carbon levels dropped. Current data shows arsenic as by product only within the chromium plume and not beyond the plume boundaries.

Figure 3.1-9 shows current dissolved arsenic levels in the project area, based on available data.

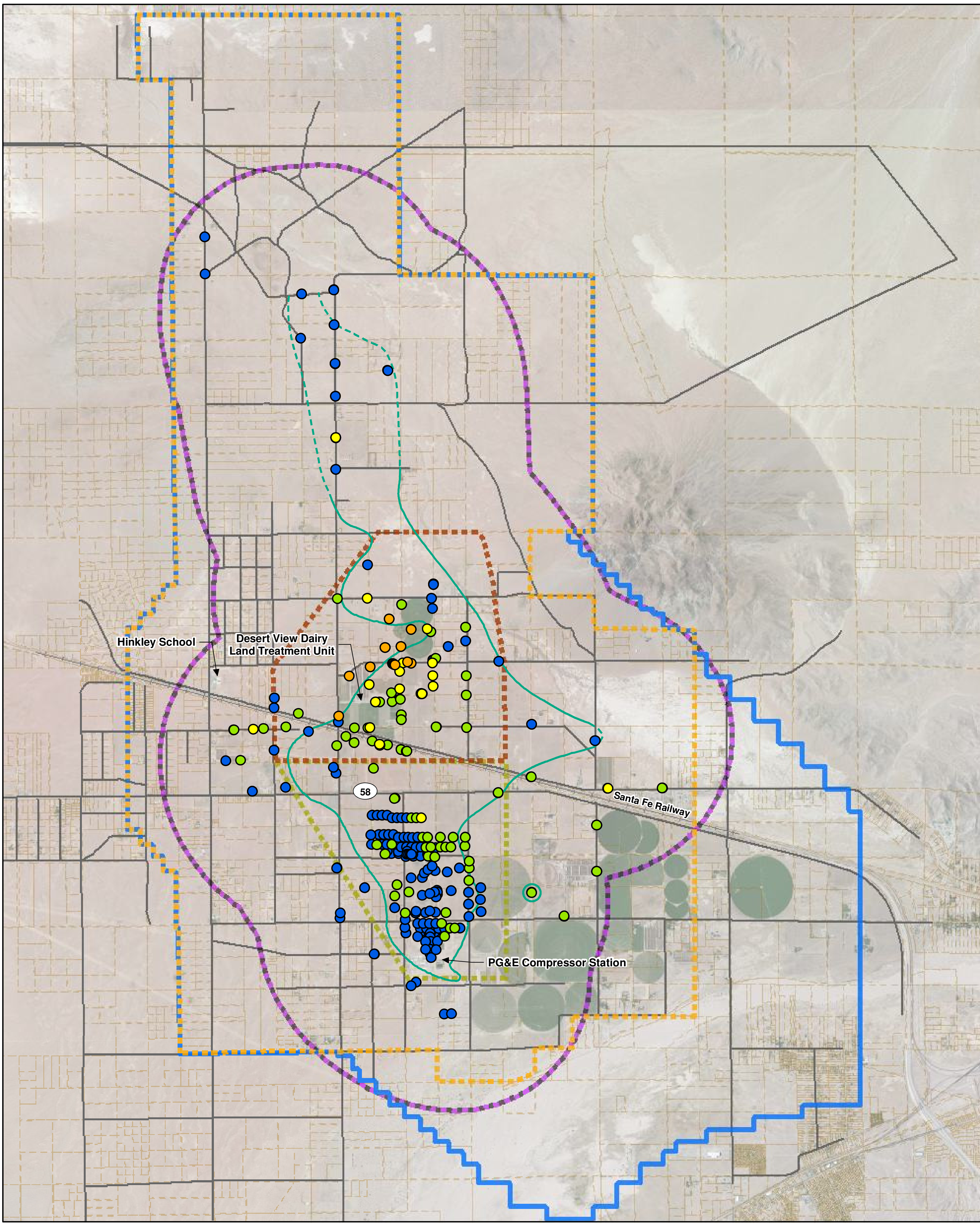
Iron

Background levels

Iron is the second most abundant metal in the earth's crust, and accounts for about 5% of the mass of the earth's crust. The 2007 Background Study Report (Pacific Gas and Electric 2007) found dissolved iron levels in forty-seven background wells at less than 500 ppb (the method detection level was 500 ppb). The secondary Maximum Contaminant Level for iron is 300 ppb.

Concentrations within IRZ Areas

As described in the September 2010 Feasibility Study (Pacific Gas and Electric Company 2010a), dissolved iron levels in groundwater increased from less than 500 ppb up to over 5,000 ppb in areas up to 1,000 feet downgradient of the carbon injection point and then declined back toward initial levels over time and distance as organic carbon levels dropped. The same or similar situation is expected to occur following implementation of the project alternatives and is not expected to have a significant or long-term impact upon the environment. Current data shows iron as by product only within the chromium plume and not beyond the plume boundaries.



LEGEND

- Approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011
- One-mile buffer from the contiguous portions of the approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011
- Study Area
- OU1
- OU2
- OU3
- County Parcel Boundary

Nitrate as N in mg/L

- 0 - 10
- 10 - 20
- 20 - 40
- > 40

Notes:
As requested by the Water Board for use in the EIR, Fourth Quarter 2011 laboratory-measured Nitrate as N data is shown. If Nitrate as N data were not collected in a well within Fourth Quarter 2011, but were collected within First Quarter 2012, then First Quarter 2012 data are shown.

Data shown are from private supply (e.g. domestic) and PG&E monitoring and extraction wells, where available.

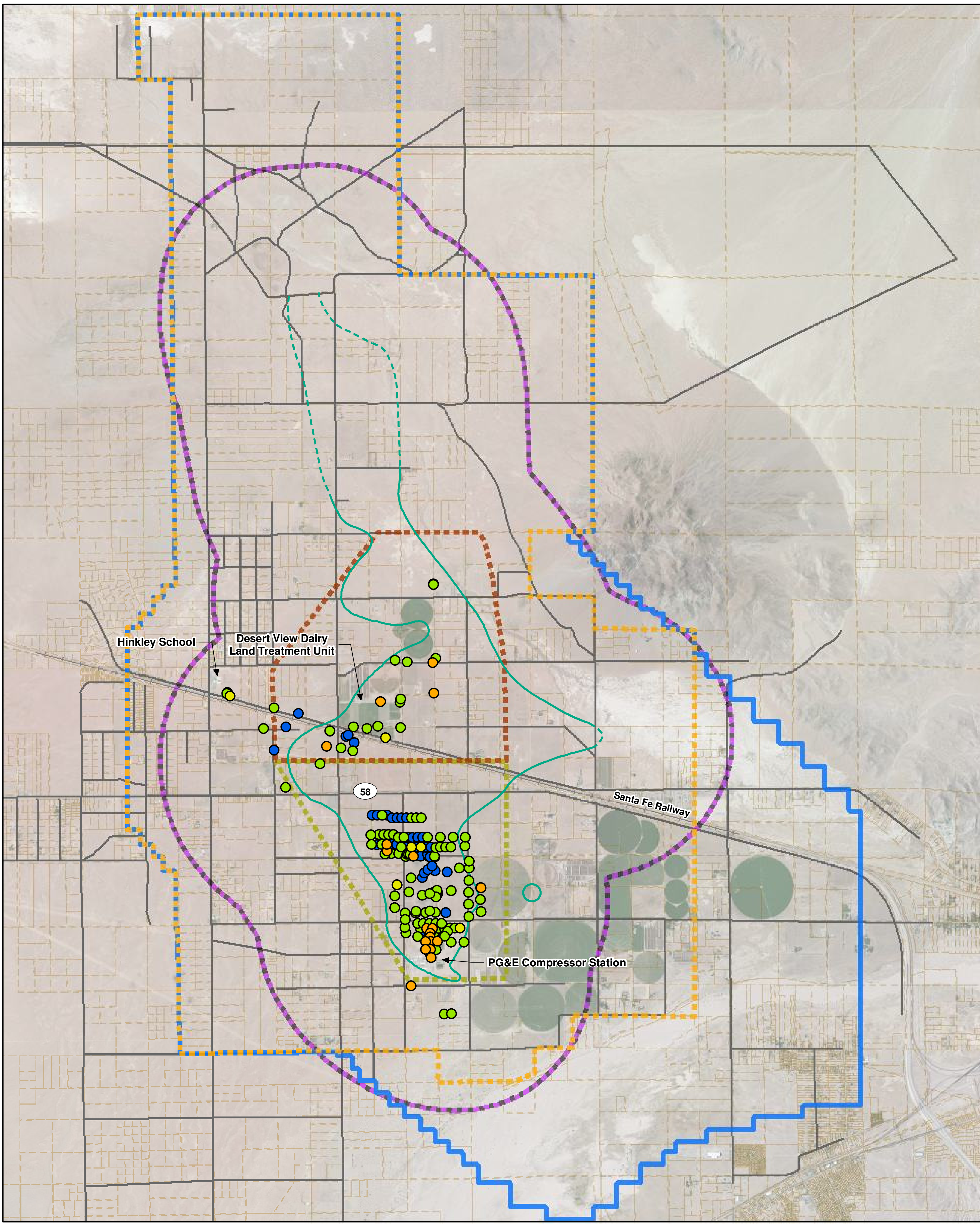
N

0 2,000 4,000 6,000 8,000
Feet

Graphics ... 00122.11 (8-14-2012)

Source: Prepared by PG&E, 2012 for the EIR using recent monitoring data.

Figure 3.1-8
Existing Nitrate as N
Within the Project Area



LEGEND

- Approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011
- One-mile buffer from the contiguous portions of the approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011
- Study Area
- OU1
- OU2
- OU3
- County Parcel Boundary

Dissolved Arsenic Concentrations µg/L

- 0-1
- 1-6
- 6-10
- >10

Notes:
As requested by the Water Board for use in the EIR, Fourth Quarter 2011 laboratory-measured Arsenic data is shown. If Arsenic data were not collected in a well within Fourth Quarter 2011, but were collected within First Quarter 2012, then First Quarter 2012 data are shown.

Data shown are from private supply (e.g. domestic) and PG&E monitoring and extraction wells, where available.

N

0 2,000 4,000 6,000 8,000
Feet

Graphics ... 00122.11 (8-14-2012)

Source: Prepared by PG&E, 2012 for the EIR using recent monitoring data.

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Figure 3.1-9
Existing Dissolved Arsenic within the Project Area

Figure 3.1-10 shows current dissolved iron levels in the project area, based on available data.

Manganese

Background Levels

Manganese is a naturally-occurring element that is common in the air, soil, and water. The 2007 Background Study Report (Pacific Gas and Electric 2007) found dissolved manganese levels in background areas to range from less than 1 ppb (method detection level of 1 ppb) up to 48 ppb. Five out of forty-seven wells sampled had one or more detections of manganese greater than 10 ppb. The state secondary Maximum Contaminant Level for manganese is 50 ppb.

Concentrations within IRZ Areas

As described in the September 2010 Feasibility Study (Pacific Gas and Electric Company 2010a), manganese levels in groundwater increased from less than 226 ppb up to over 4,000 ppb in areas downgradient of the carbon injection point and then declined back toward initial levels over time and distance as organic carbon levels dropped. In February 2011, dissolved manganese was detected at concentrations up to 1,300 ppb at two contingency monitoring wells, located approximately 1,600 feet downgradient of the Central Area in situ remediation system. Because the manganese levels for existing in-situ remediation exceed the levels in the WDRs for the current remediation PG&E is required to implement the Manganese Mitigation Plan (Pacific Gas and Electric Company 2011h). Current data shows manganese as by product only within the chromium plume and not beyond the plume boundaries.

Figure 3.1-11 shows current dissolved manganese levels in the project area, based on available data.

Uranium and Other Radionuclides

Background levels

Uranium (238U), a radionuclide, is a naturally occurring radioactive element in rocks, soil, water, plants, animals and humans. Uranium is typically measured in picocuries per liter (pCi/L). A curie is a standard unit of radioactivity, where 1 curie is the radioactivity associated with 1 gram of radium. A picocurie is one trillionth (10^{-12}) of a curie. However, uranium is also expressed in ppm, and thus both units may be used in discussing uranium concentrations. The average concentration of uranium is on the order of 2.7 ppm in the earth's crust (Skeppstrom and Olofsson 2007).

Uranium data for the Hinkley Valley groundwater are limited. Naturally occurring uranium (approximately 4 ppb) has been found in rocks in a number of locations in the Mojave Desert (USGS 2008). Uranium and other naturally occurring radioactive materials have been detected in Mojave River Groundwater Basin and are likely attributed to the mineralogy of the granitic rocks observed in the lower regional aquifer (Churchill 1991). Uranium in sediments leaches into groundwater in oxidizing environments, but is more strongly adsorbed in mineral complexes under anaerobic (oxygen-poor) conditions.

Besides uranium, gross alpha has also been detected in Hinkley Valley groundwater. Alpha radiation is a type of energy released when certain radioactive elements (such as uranium or radon) decay or break down. Alpha radiation normally exists everywhere: in soil, in the air, and also in water. Because the earth's bedrock contains varying amounts of radioactive elements, such as uranium and thorium, the amount of alpha radiation can also vary. Gross alpha refers to a group of radionuclides, in which radium is usually a main constituent. The alpha radiation in drinking water can be in the form of dissolved minerals, or in the case of radon, as a gas. Like uranium, gross alpha is measured in picocuries per liter (pCi/L).

Concentrations within Agricultural Treatment Units

Uranium was originally detected in the project area at the Gorman agricultural supply wells during PG&E's pilot testing of whole house water treatment systems in August 2011. In the February 2012 Agricultural Unit Monitoring Report, nine groundwater samples from combined agricultural supply were analyzed for uranium and/or gross alpha and gross beta particle activity. The maximum reported uranium and gross alpha and gross beta activities were 59.1 pCi/L (Cottrell Pivot), 75.1 pCi/L (Gorman-North Pivot), and 26.8 pCi/L (Gorman-North Pivot), respectively. These concentrations are greater than the California Maximum Contaminant Level of 20 pCi/L (equivalent to 30 ppb) for uranium and 15 pCi/L for gross alpha. In addition, PG&E has reported a detection of 34 pCi/L uranium and 34 pCi/L gross alpha particle activity at the former Ranch land treatment unit. These concentrations also exceed the Maximum Contaminant Levels. Detected uranium concentrations were found to increase from south to north (opposite the plume concentration gradient). Because the concentrations of these radionuclides are higher than the Maximum Contaminant Level but have only been found in one area to date, additional monitoring from more wells in the vicinity of Hinkley will be needed to fully characterize existing natural conditions.

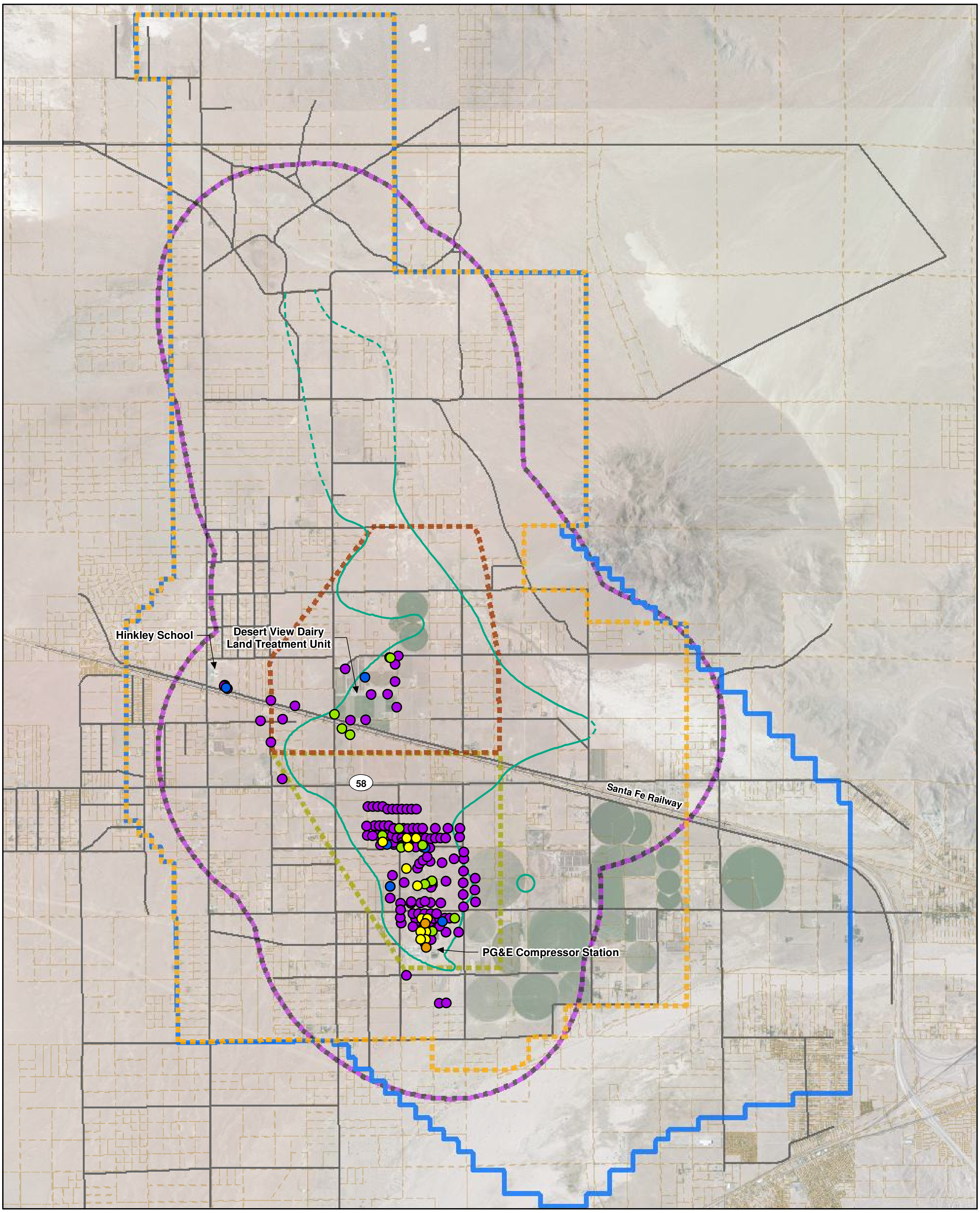
In a study on groundwater effects on uranium in the San Joaquin Valley in California, a possible link was found between increased bicarbonate concentrations in water from summer agricultural irrigation and the mobilization and migration of uranium to deeper aquifers tapped by water supply wells that may otherwise be sequestered under natural conditions (Jurgens. et al 2009). According to the authors of this study, development of the groundwater resource in the last 100 years has caused two major changes that may have resulted in the increased mobilization of uranium concentrations that may otherwise be sequestered under natural conditions: (1) changes in the chemistry of recharge water and (2) increases in the rate of downward groundwater flow (Jurgens et al 2009).

At this time, there is insufficient information to assess whether or not prior and ongoing agricultural irrigation in the Hinkley area or the current remedial agricultural treatment has had any influence on uranium levels in the Hinkley Valley.

3.1.5 Previous and Existing Remediation Efforts

A review of the previous plume containment and cleanup efforts will be helpful for evaluating the project alternatives, which include the continuation or acceleration of these efforts to complete the chromium plume cleanup. A more detailed description of the remedial processes is included in Appendix A. Chapter 2 describes the existing remediation facilities.

The primary plume containment efforts by PG&E have been through agricultural treatment (also called land treatment) of chromium-contaminated groundwater and freshwater injection. Cleanup of the chromium plume has primarily been implemented by in-situ remediation and agricultural treatment.



LEGEND

Approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011

One-mile buffer from the contiguous portions of the approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011

Study Area

OU1

OU2

OU3

County Parcel Boundary

Total Dissolved Iron Concentration in mg/L

- 0.0-0.1
- 0.1-0.3
- 0.3-1.0
- 1.0-6.0
- >6

Notes:
As requested by the Water Board for use in the EIR, Fourth Quarter 2011 laboratory-measured Iron data is shown. If Iron data were not collected in a well within Fourth Quarter 2011, but were collected within First Quarter 2012, then First Quarter 2012 data are shown.

Data shown are from private supply (e.g. domestic) and PG&E monitoring and extraction wells, where available.

N

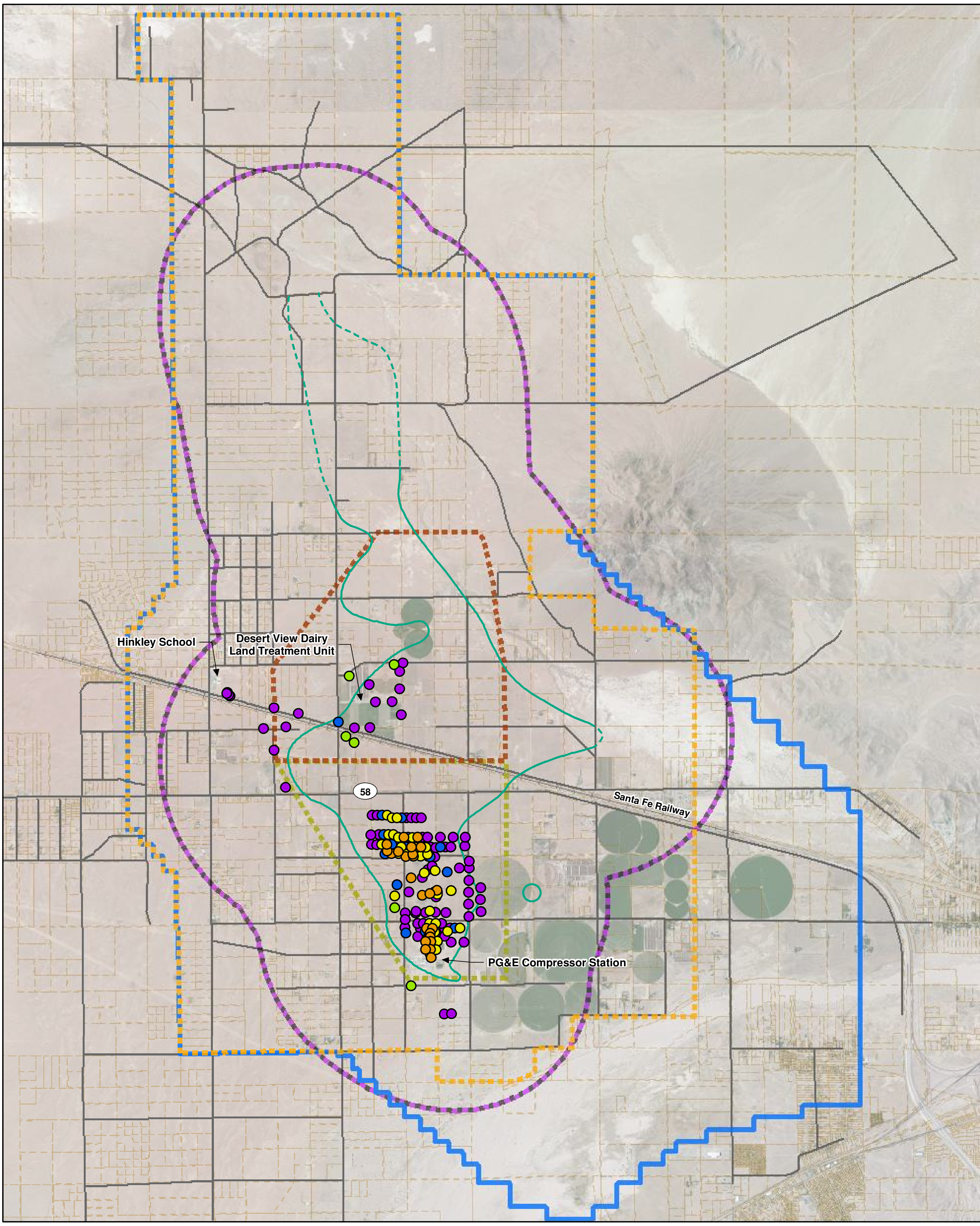
0 2,000 4,000 6,000 8,000

Feet

Source: Prepared by PG&E, 2012 for the EIR using recent monitoring data.

Graphics ... 00122.11 (8-14-2012)

Figure 3.1-10
Existing Total Dissolved Iron within the Project Area



LEGEND

- Approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011
- One-mile buffer from the contiguous portions of the approximate outline of Cr(VI) or Cr(T) in Upper Aquifer exceeding values of 3.1 and 3.2 µg/L, respectively, Fourth Quarter 2011
- Study Area
- OU1
- OU2
- OU3
- County Parcel Boundary

Dissolved Manganese Concentrations in mg/L

- 0.00-0.01
- 0.01-0.05
- 0.05-0.10
- 0.10-1.00
- >1

Notes:
As requested by the Water Board for use in the EIR, Fourth Quarter 2011 laboratory-measured Manganese data is shown. If Manganese data were not collected in a well within Fourth Quarter 2011, but were collected within First Quarter 2012, then First Quarter 2012 data are shown.

Data shown are from private supply (e.g. domestic) and PG&E monitoring and extraction wells, where available.

Source: Prepared by PG&E, 2012 for the EIR using recent monitoring data.

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Figure 3.1-11
Existing Dissolved Manganese within the Project Area

3.1.5.1 Agricultural Treatment

Agricultural activities for chromium treatment involve groundwater extraction and irrigation of crops in agricultural treatment units (also called AUs). Agricultural treatment units were first designed where extracted water containing chromium was sprayed onto crops from a center pivot system. Following public concern of hexavalent chromium in air emissions, agricultural treatment was converted to a subsurface drip irrigation system. This latter system was effective at water delivery but was maintenance-intensive. Beginning in 2011, PG&E has switched to a central-pivot irrigation system with attached drag-drip lines. The intent of this system was to deliver water to the fields without creating air emissions or puddles.

Figure 3.1-12 shows a diagram of an agricultural treatment unit. Water from extraction wells sent to agricultural treatment units provide for plume containment as well as treatment of the chromium contamination. The Cr[VI] in the groundwater is treated as it passes through the soil and root zone, through the following mechanisms:

- Cr[VI] in water interacts with electron donors in soil and organic matter and is reduced to solid Cr[III];
- Cr[VI] in water is taken up by plant roots and reduced to Cr[III];
- Cr [VI] adheres (or "adsorbs") onto organic matter in the root zone, and subsequent reactions involving soil microbes results in reduction to Cr[III]; and
- Cr[VI] forms compounds with organic elements and compounds involved in the reduction.

Pumping groundwater from the plume creates a "cone of depression" around the extraction wells and draws (or pulls) the chromium plume in groundwater toward the wells. The size of the capture zone typically increases with higher pumping, and/or finer-grained layers (such as silt and clay), and shallower saturated zones. Pumping for agricultural treatment prevents or slows expansion of the plume from spreading in the vicinity of the extraction wells. As shown in Figure 3.1-12, the water budget for agricultural treatment indicates a rather large net water loss. Of the amount applied to land, on average approximately 80% evaporates and 20% infiltrates back to the saturated zone.

PG&E began groundwater extraction and agricultural treatment in 1991. Groundwater from several small wells (about 150 gpm) was applied to the East agricultural treatment unit, a 29-acre central pivot irrigation system located just north of Community Boulevard and west of Summerset Road. The East agricultural unit was located at the former Mojave Dairy, across the street from the Compressor Station, and thus was very close to the chromium plume core. Chromium concentrations in water applied to land were typically in the thousands of parts per billion.

In 1997, groundwater (up to 250 gpm) was also extracted and applied to crops at the Ranch agricultural treatment unit, a 52-acre facility with spray irrigation fields, located east of Mountain View Road and north of SR 58. The Ranch agricultural treatment unit was located at the former Nelson Dairy, approximately 1.5 miles north of the Compressor Station. Chromium levels in water applied to crops at the Ranch agricultural treatment unit were less (in the hundreds of parts per billion) than those levels applied at the East agricultural treatment unit. PG&E discontinued the groundwater extraction systems at both agricultural treatment units in June 2001 in response to a Water Board order stating concerns over the potential for airborne Cr[VI] from center-pivot spray irrigation and for PG&E to cease creating potential nuisance conditions.

Following three years of no actions for plume containment or cleanup, in 2004 PG&E started up (under a WDR from the Water Board) a more extensive agricultural treatment unit at the Desert View Dairy. Chromium-contaminated groundwater from four on-site extraction wells is applied to crops via a subsurface drip irrigation system, designed to prevent spray that could become airborne. Since the Desert View Dairy is located 2 miles north of the Compressor Station, chromium levels in groundwater were less than those levels seen at the former East and Ranch agricultural treatment unit but still above the Maximum Contaminant Level of 50 ppb total chromium. early 2007, chromium levels in groundwater near the Desert View Dairy have decreased to less than the Maximum Contaminant Level. The Desert View Dairy is an active dairy that uses the alfalfa grown in the fields. The Desert View Dairy agricultural treatment unit is primarily used today for plume containment and restoration of the aquifer to background conditions prior to the chromium release.

Over seven years of performance monitoring have demonstrated the Desert View Dairy agricultural treatment unit to be successful at treating Cr[VI] in extracted groundwater. Cr[VI] and Cr[T] concentrations in pore water (water in between soil particles) percolating through the soil below the root zone have remained well below the limits set forth in the Board Order R6V-2004-0034 (July 2004). Monitoring data indicate that the Desert View Dairy agricultural treatment unit operation has not resulted in significant accumulation of chromium in soils, because the concentrations of Cr[VI] in the applied water are less than 50 ppb, while the natural soil concentrations of Cr[T] are 5–10 ppm (100–200 times higher). The Cr[T] and Cr[VI] concentrations in plant tissue samples also have been consistently below the WDR limits of 100 mg/kg. Comparison of the Cr[VI] concentrations in the applied irrigation water with the Cr[VI] concentrations in the pore water collected from 5 feet below ground surface indicates Cr[VI] removal rates generally greater than 95% across the majority of the Desert View Dairy agricultural treatment unit. Data from some of the irrigation fields with higher sand content exhibit lower removal efficiencies.

Results from measurements below the irrigated fields of the East, Ranch, and Desert View Dairy agricultural treatment units demonstrate the performance of the agricultural treatment units in converting Cr[VI] to Cr[III], and the results are summarized in Table 3.1-6.

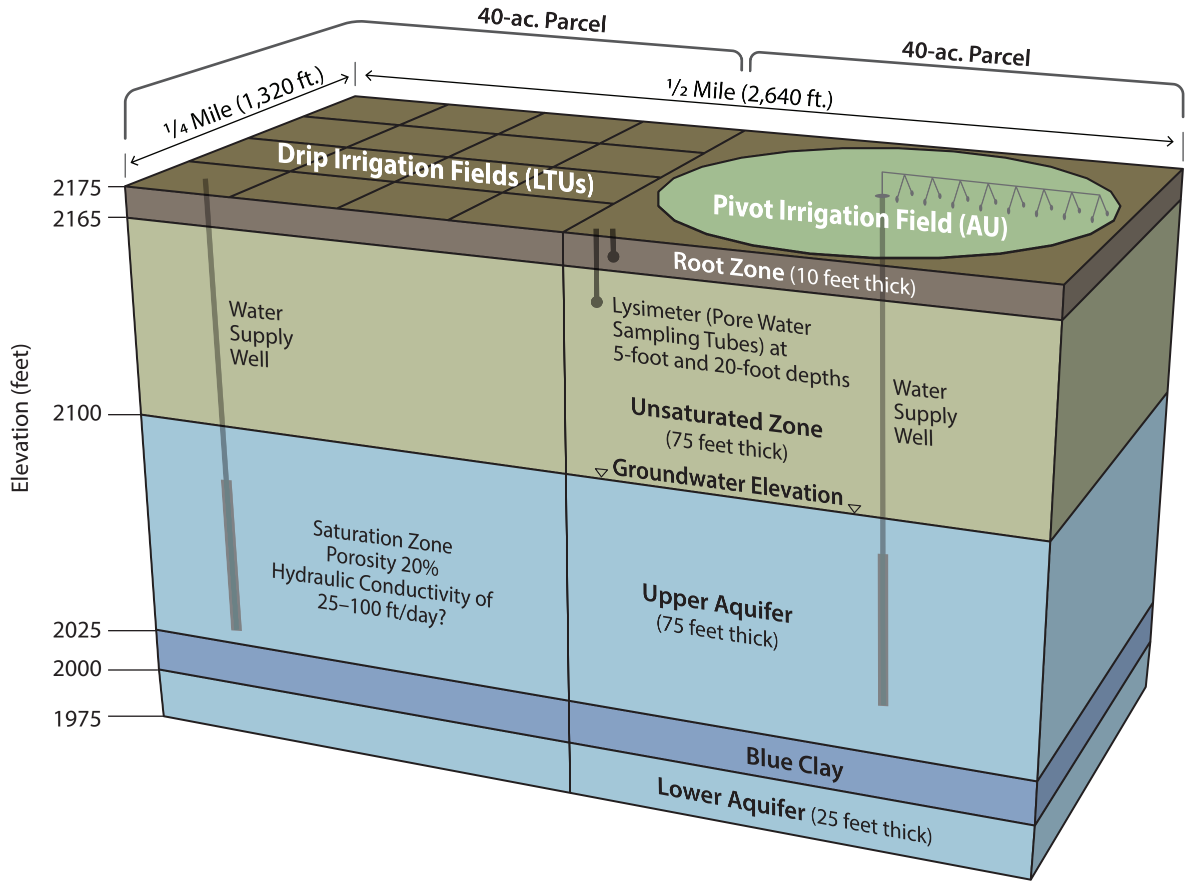
Operation of the Desert View Dairy agricultural treatment unit extraction wells, which have seen a general increasing trend in extraction rates as new wells have been installed, is generating a large area of declining water levels ("cone of depression") which is now present in the upper aquifer in the area of the Dairy. In general, greater pumping results in large cones of depression and thus large zones of hydraulic control. Because summer pumping rates are greatest during the summer, summer cones of depression are larger than those in other months. In unconfined alluvial systems that exist at the Desert View Dairy, steady-state water level conditions typically develop within weeks of adding new pumping.

3.1.5.2 In-Situ Reduction Treatment

PG&E has completed pilot-scale testing for in-situ treatment methods (i.e., in-place cleanup) and is now implementing full-scale cells in the core (high concentrations) of the plume throughout OU1.

In-Situ Treatment Mechanisms

In Hinkley, in-situ treatment involves the injection of carbon-containing compounds to stimulate microbial and chemical processes which convert Cr[VI] to Cr[III] through a chemical reaction known as "reduction." Reduction occurs when electrons are added to an element that makes its electric



Water Budget for Irrigated Land Treatment (feet)

Groundwater Pumping	8 ft/yr
Applied Water	8 ft/yr
Evapo-Transpiration Loss	5 ft/yr (assumed)
Seepage through Root Zone	3 ft/yr (treatment zone)
Deep Percolation to Saturated Zone	3 ft/yr
Net Water from Groundwater	5 ft/yr (assumed)

Source: Based on information from PG&E 2010.

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Figure 3.1-12
Diagram of Land Treatment for Cr (VI) Reduction to Cr (III) in Irrigated Root Zone

Table 3.1-6: Performance Summary for Cr[VI] to Cr[III] Conversion for the East and Ranch Agricultural Treatment Units

Agricultural Treatment Units Summary Data	East Agricultural Treatment Units	Ranch Agricultural Treatment Units	Desert View Dairy Agricultural Treatment Units
Area (acres)	30	52	80
Period of Operation	1991–2001	1998–2001	2005–ongoing
Amount of extracted groundwater over life of treatment (af)	2,400	1,050	550
Average Cr[VI] concentration [a] in extracted water (ppb) after treatment (concentrations before treatment were higher)	130	13	20
Reduction of Cr[VI] (lbs.) in extracted water to Cr[III] in soil	850	40	174
Cr[VI] Reduction Efficiencies[a]	95%	95%	>95%

Source: 2002 Feasibility Study (Pacific Gas and Electric 2002), 2010 Feasibility Study (Pacific Gas and Electric Company 2010a).

Notes:

[a] Efficiencies were calculated by PG&E based on sampling of water from lysimeters beneath the agricultural treatment units.

charge more negative. For example, when in-situ remediation results in reduction of Cr[VI], the chemical reaction results in addition of three electrons to Cr[VI],changing it to Cr[III] as its electric charge is changed from + 6 to +3. The opposite reaction is known as "oxidation" and occurs when electrons are removed from an element and the electric charge is made more positive. This process is referred to as oxidation because it usually occurs through a chemical reaction involving oxygen or compounds containing oxygen or elements that chemically act like oxygen. In-situ remediation includes actions by microbes in the soil in an "anaerobic" environment, which means an environment-lacking oxygen.

The Cr[VI] to Cr[III] conversion process involves both microbial reaction and chemical reduction. The injection of carbon essentially provides "food" for microbes, which break down the carbon and in the process creates favorable conditions to promote reduction of Cr[VI] to Cr[III]. Cr[III] is removed from groundwater through precipitation of relatively insoluble chromium hydroxides and iron-chromium hydroxides. The Cr[III] is adsorbed onto the aquifer matrix (sediments such as sand, silt and clay) but is very stable (i.e., it is bound to the mineral deposits on the sand, silt and clay) and is not expected to reconvert back to Cr[VI] and dissolved back into the groundwater because it is bound within the mineral deposits (Palmer and Puls 1994).

PG&E is implementing two techniques for injecting a carbon-based amendment to stimulate microbial growth and anaerobic (oxygen-poor) biochemical processing of the Cr[VI] to insoluble Cr[III]:

- Carbon-amendment and injection in a recirculation loop configuration ("barrier well IRZ"). Extraction wells and injection wells are separated by a relatively short distance (100–200 feet) to induce treated water movement between these wells and allow natural groundwater movement between the wells.

- Extraction, carbon-amendment and injection (also referred to as “dosed-injection IRZ”).Water is extracted from a well, dosed with a carbon source, and injected into another well (or extracted and re-injected into the same well using an extract, amend, store, and inject sequence).

In-Situ Treatment Experience to Date

Three pilot and three full-scale IRZ “cells” have been implemented: (1) Source Area, (2) the South Central Reinjection Area, and (3) the Central Area IRZ. The general IRZ results can be summarized as:

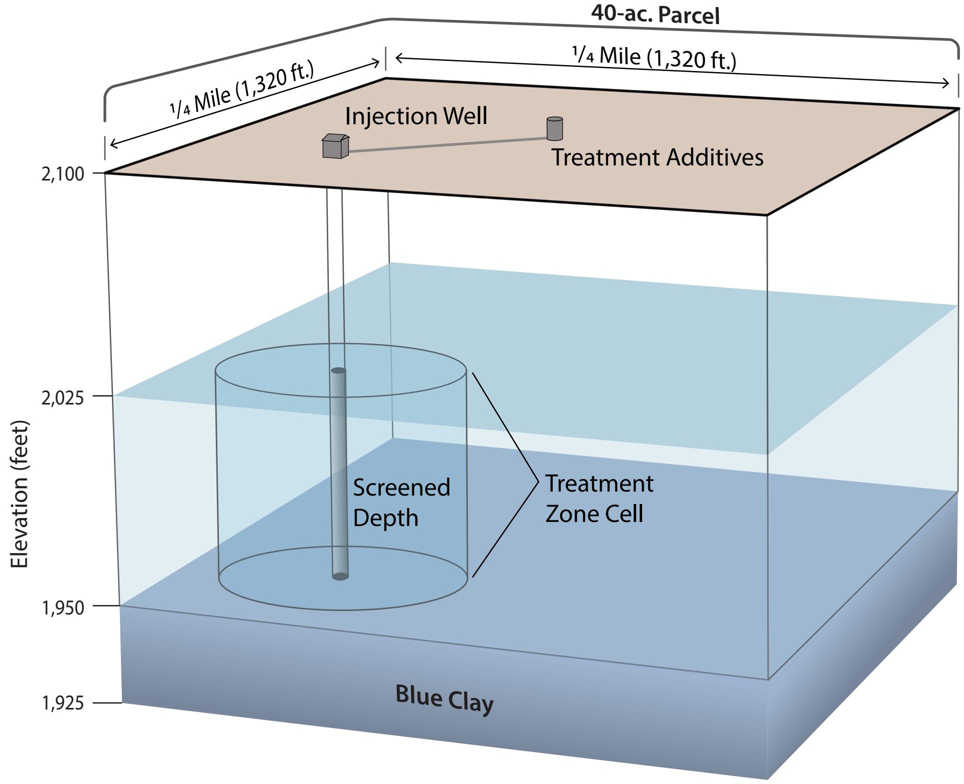
- Injection of organic carbon substrates is an effective technology for converting Cr[VI] in groundwater into Cr[III] in the soil. Several organic compounds (including ethanol, lactate, and emulsified vegetable oil) were shown to be effective reagents (ethanol is now favored).
- Separated extraction and injection wells (barrier well IRZ) are effective means of distributing amendment (i.e., organic carbon substrates), establishing IRZs, treating Cr[VI], and generating a clean water front with Cr[VI]concentrations that are less than background at some locations.
- The extent of amendment distribution and Cr[VI] treatment in the aquifer varies across the treatment area because of geologic heterogeneities and spatial variations in groundwater movement. Meaning, Cr[VI] treatment is best in preferential pathways such as coarse-grained sediments within the aquifer.
- Carbon injection in the study area has the potential to locally increase concentrations of total organic carbon and secondary byproducts, such as arsenic, dissolved manganese, and iron in the groundwater within IRZs. Total organic carbon will decrease with time to background conditions by consumption due to bacteria. The secondary byproducts also tend to reduce over time and distance from the reducing zone when exposed to oxidizing conditions in non-treated groundwater.

Figure 3.1-13 shows a diagram of a typical dosed injection well IRZ and a barrier well IRZ. The size of the treatment zone depends on the injection rate and the amount of mixing with the surrounding groundwater. For example, a 10-gpm dosed injection well operated for a year would create a treatment zone within the 75-foot upper aquifer of about 1 acre. The treatment zone for the barrier well IRZ design depends on the distance between the pumping and injection wells, the pumping rate, and the movement (ft/year) of groundwater between the wells.

Because there are only limited data from other remediation sites using in-situ bio-reduction IRZs elsewhere, the success of this treatment method had to be demonstrated from the pilot studies results in Hinkley. These results are summarized in the 2010 Feasibility Study and are described in further detail in Appendix A because this is a primary component of the final cleanup alternatives. Overall, injection of organic carbon substrates has been effective for removing Cr[VI] from groundwater (Pacific Gas and Electric Company 2010a). In-situ treatment to background chromium concentrations has been achieved at approximately 50% of the treated wells in the Central Area IRZ and approximately 60% of the treated wells in the Source Area IRZ as of 2010 (Pacific Gas and Electric Company 2010a).

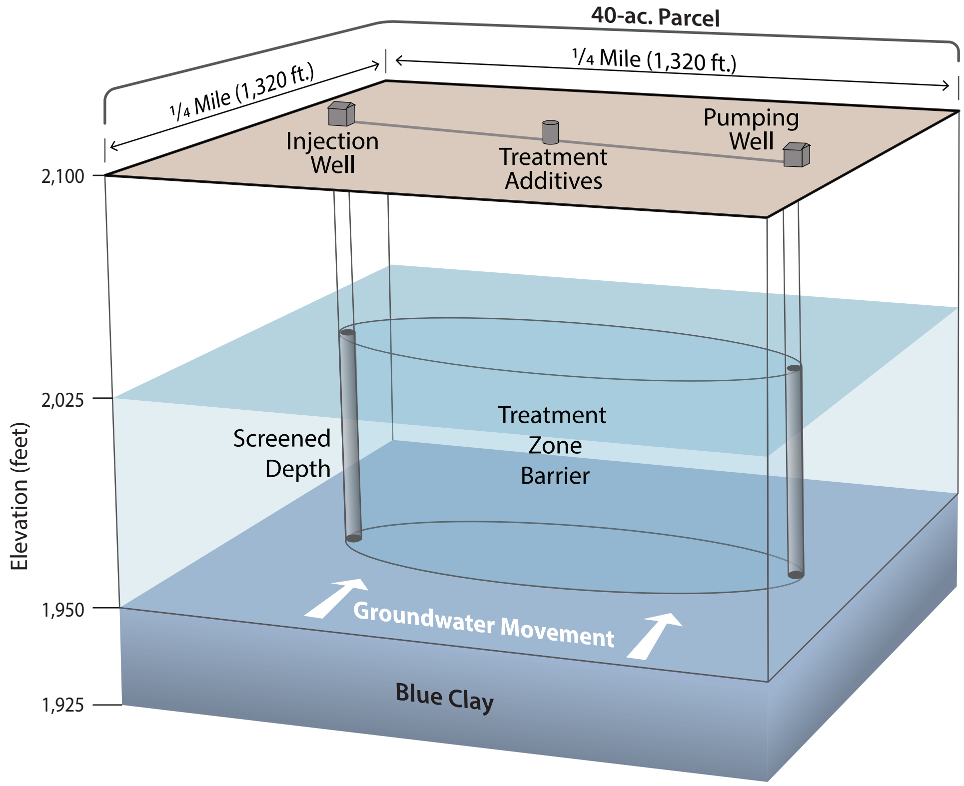
In-Situ Treatment Byproducts and Control

As stated before, the injection of carbon into the aquifer can result in the formation of byproducts, including dissolved metals such as manganese, iron, and arsenic. These byproducts are reduced out of groundwater from leaching of the aquifer sediments. Groundwater flow then carries these naturally occurring metals temporarily until they reach oxygenated water that converts them back to their original chemical state.



Treatment zone cell size depends on injection rate (gpm) and mixing ratio with groundwater around the injection well.

A. Dosed-Injection Treatment Zone



Treatment zone barrier size depends on pumping/injection rate (gpm) and mixing ratio with groundwater between the two wells and the movement of groundwater through the treatment barrier zone.

B. Recirculation Loop Configuration Treatment Zone

Source: Based on information from PG&E 2010.

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Figure 3.1-13
Diagram of In-Situ Reduction Zone Treatment for Contaminated Chromium Plume

Based on the experience with IRZs to date, elevated concentrations of byproducts occur in correlation to the level of organic carbon in the water: rising with the increased carbon and falling with the decrease of carbon. The time for return to initial levels is estimated as between months and several years based on analytical results for wells downgradient of IRZ injection locations to date. Dissolved byproduct metals are expected to oxidize and precipitate onto the aquifer sediments once the carbon has been depleted and/or the metals are exposed to aerobic (oxygen rich) groundwater conditions. The oxidized conditions will not cause the Cr[III] in the aquifer to be oxidized to Cr[VI] because the Cr[III] is incorporated in relatively low solubility chromium hydroxides and iron-chromium hydroxides. Based on prior IRZ experience, elevated byproduct concentrations at levels above primary or secondary Maximum Contaminant Levels have been detected at distances greater than 1,600 feet downgradient of injection points. If organic carbon injection rates are higher and/or groundwater movement is locally faster than in the IRZs implemented to date, then the area affected by elevated concentrations of byproducts will likely be greater than 1,600 feet experienced previously.

Byproducts are monitored with an extensive monitoring program that includes several lines of closely spaced designated monitoring wells. Preliminary results from byproduct monitoring are described in Appendix A.

Current permit requirements mandate that PG&E contain the spread of byproducts to the in-situ remediation area. For example, in response to detections of manganese at monitoring wells at concentrations above the threshold concentration established in the General Permit for the IRZ, PG&E drafted a manganese mitigation plans during 2011 and another revised plan in March 2012. The final mitigation plan, scheduled for implementation in summer 2012, includes the following components for wells where manganese exceedances are observed:

- installation and operation of a groundwater extraction well to capture groundwater with concentrations of dissolved manganese that exceed the threshold concentration;
- aeration of the extracted groundwater in an above ground system;
- percolation of treated groundwater via dry wells or an infiltration gallery; and
- installation of three new monitoring wells on the north side of SR 58 to monitor manganese in groundwater.

3.1.5.3 Plume Containment by Freshwater Injection

PG&E is using clean groundwater injections as another means to prevent the plume from migrating in one direction and deflecting plume movement to another direction. The freshwater injection area, located along Serra Road and south of Santa Fe Avenue, prevents plume migration to the west where sensitive nearby receptors, such as the Hinkley School, are located. Groundwater is extracted from three freshwater supply wells (PGE-14, FW-01, and FW-02) located south of the Compressor Station (i.e., up-gradient of the plume), conveyed about two-miles north through an underground pipeline, and re-injected at a flow rate of up to 80 gpm into five injection wells directly adjacent to the western boundaries of OU1 and OU2. The northwest reinjection system began operation in March 2010. Water from the supply wells is filtered through a granular ferric hydroxide (GFH) media system to remove naturally occurring arsenic present at concentrations that exceed its Maximum Contaminant Level for drinking water (10 ppb). Freshwater injection has been effective at locally controlling plume migration towards the west and deflecting plume migration towards the Desert View Dairy agricultural treatment unit.

3.1.6 Health Effects of Constituents in Groundwater

This section provides brief overview of the potential health effects of chromium in groundwater and other constituents that may be affected by the proposed groundwater remediation at the PG&E Hinkley site. Information in this section is derived from California and federal agency assessments of the toxicology and health effects of different constituents. This section is intended to provide information on the current understanding of health effects in general, and does not provide a specific assessment of health effects that may occur to individuals in the Hinkley area. Background levels of these constituents were discussed earlier in this section.

3.1.6.1 Chromium

Chromium is a heavy metal that occurs throughout the environment. The trivalent form is a required nutrient and has very low toxicity. The hexavalent form, also commonly known as "chromium 6," (Cr[VI]) is more toxic and has been known to cause cancer when inhaled. In recent scientific studies in laboratory animals, hexavalent chromium has also been linked to cancer when ingested. Soluble (i.e., dissolvable in water)Cr[VI]is relatively toxic, while the less-soluble Cr[III] has very low toxicity and is a required nutrient. Cr[VI] can convert into Cr[III] and vice-versa in the environment depending on the specific conditions present in groundwater and soil (OEHHA 2010).

Hexavalent chromium found in drinking water can be naturally occurring, reflecting its presence in geological formations throughout the state. However, there are areas of contamination in California from historic industrial use such as the manufacturing of textile dyes, wood preservation, leather tanning, and anti-corrosion coatings or from discharge of chromium (such as from the PG&E Compressor Station) where hexavalent chromium contaminated waste has migrated into the underlying groundwater.

While Cr[VI] has long been recognized as a cancer-causing substance (also referred to as a "carcinogen") via inhalation in occupation settings, there is sufficient evidence that Cr[VI] is also carcinogenic by the oral route of exposure (meaning drinking or consuming), based on studies in rats and mice conducted by the National Toxicology Program (OEHHA 2010).

Following oral consumption of Cr[VI] by humans or oral administration to experimental animals, increased levels of chromium in whole blood and plasma were observed, while little change was observed following trivalent chromium consumption or administration. Increases in blood/plasma total chromium levels following oral Cr[VI] administration show that the hexavalent form is available to interact with tissue (referred to as "bioavailability"), potentially causing harmful effects (OEHHA 2010). In addition to the ingestion of drinking water, exposure to Cr[VI] in a domestic water supply can occur due to inhalation of water droplets and skin ("dermal") contact with water during bathing, but dermal exposure does not appear to contribute significantly to the overall exposure (OEHHA 2010).

Mice that ingested drinking water containing high doses (14,000 ppb or greater) of Cr[VI] had statistically significant increases in stomach, oral cavity, and intestine tumors compared to control subjects (OEHHA 2010). Review of occupational studies in which humans were exposed to Cr[VI] primarily by the inhalation route identified reports of significantly increased risk of lung cancer. It is estimated that exposure to airborne Cr[VI] is 1000 times more potent than exposure from drinking water (OEHHA 2009).

In response to a query from the Water Board concerning the Hinkley site, OEHHA concurred with a conclusion that swamp coolers do not constitute an inhalation health risk based on findings in scientific literature that swamp coolers would not increase the concentration of airborne Cr[VI] (OEHHA, August 17, 2011 letter to Lahontan Water Board).

Existing California and EPA Maximum Contaminant Levels of total chromium in drinking water are 50 ppb and 100 ppb, respectively. Neither of these regulatory levels are specific for Cr[VI], and neither involves the assumption of potential carcinogenicity of Cr[VI]. The California Public Health Goal for Cr[VI] is 0.02 ppb, which OEHHA estimates is the "one in one million" lifetime cancer risk level. This means that for every million people who drink two liters of water with that level of Cr[VI] daily for 70 years, no more than one person would be expected to develop cancer from exposure to Cr[VI]. A Public Health Goal is not a regulatory level of a drinking water standard. It reflects the potential risk from long-term exposure to a contaminant and is not intended to estimate risks from short-term or acute exposure or to set cleanup levels (OEHHA 2009).

Research continues on the potential health impacts from Cr[VI]. Following the National Toxicology Program rodent study that utilized high doses of Cr[VI] (14,000 ppb or greater), recent research has focused on the mechanism of action and potential impacts from lower doses of Cr[VI]. In 2008, the EPA began a comprehensive review of chromium health effects and produced a draft update to their Toxicological Profile for chromium in September 2010 which then underwent external peer review including a peer review panel workshop open to the public in May 2011. Based on feedback from that peer review panel, the EPA delayed the finalization of that profile in order to await publication of emerging studies aimed at further understanding the mechanism of action of chromium and its impact on their assessment of the model by which they will consider a revised Maximum Contaminant Level for Cr[VI].

3.1.6.2 Total Dissolved Solids

The presence of dissolved solids in water may affect its taste. The palatability of drinking water has been rated by panels of tasters in relation to its TDS level as follows: excellent, less than 300 ppm; good, between 300 and 600 ppm; fair, between 600 and 900 ppm; poor, between 900 and 1,200 ppm; and unacceptable, greater than 1200 ppm (World Health Organization 2003a).

Water containing TDS concentrations below 1,000 ppm is usually acceptable to consumers, although acceptability may vary according to circumstances. However, the presence of high levels of TDS in water may be objectionable to consumers owing to the resulting taste and to excessive scaling in water pipes, heaters, boilers, and household appliances (WHO 2006).

Due to the lack of data on toxicity of TDS, neither the EPA nor California has established a health-based standard for TDS in drinking water. However the EPA adopted a secondary Maximum Contaminant Level of 500 ppm (and California adopted a recommended secondary Maximum Contaminant Level of 500 pm and an upper limit secondary Maximum Contaminant Level of 1,000 ppm respectively) for taste and scaling reasons.

Individual compounds that additively make up TDS such as sodium, chloride and sulfate may themselves create problems at certain concentrations. At present there are no national or California primary or secondary Maximum Contaminant Levels for sodium. However, the US EPA has established a Health Advisory level of 20 ppm for people on a restricted low-sodium diet and a Drinking Water Advisory Taste and Odor threshold of 30 ppm. Both numbers are to be used as guidance rather than regulatory standards.

There is a federal secondary Maximum Contaminant Level for aesthetics (i.e. taste and odor) for chloride of 250 ppm. In California, the secondary Maximum Contaminant Level for chloride includes a recommended level of 250 ppm and an upper limit of 500 ppm. Sodium and chloride together make salt as sodium chloride ($NACl_2$). High salt intake has the ability to make the body retain fluids and create high blood pressure (hypertension). When considering the health importance of sodium and chloride in order to determine whether or not to adopt water quality standards, US EPA assumed that water users consume two liters of water per day, and found that 10% or less of a person's daily sodium intake comes from drinking water with the rest usually coming from food. One of the reasons the EPA has not adopted a water quality standard to date is that it is easier and less expensive to make a dietary change than to excessively purify drinking water. This explains the EPA recommended sodium levels not exceed 20 mg/L for those persons on a physician-prescribed "no salt diet." This is the same level recommended by the American Heart Association. Many foods normally consumed can contain substantial amounts of sodium or sodium chloride.

Health concerns regarding sulfate in drinking water have been raised because of reports that diarrhea may be associated with the ingestion of water containing high levels of sulfate. Of particular concern are groups within the general population that may be at greater risk from the laxative effects of sulfate when they experience an abrupt change from drinking water with low sulfate concentrations to drinking water with high sulfate concentrations. The federal secondary Maximum Contaminant Level for sulfate is 250 ppm for aesthetic effects (i.e., taste and odor). In California, the secondary Maximum Contaminant Level for sulfate includes a recommended level of 250 ppm and an upper limit of 500 ppm.

3.1.6.3 Nitrate and Nitrite

Human exposure to nitrates and nitrites results primarily from dietary ingestion, particularly from vegetables and cured meats. Once taken into the body, nitrates are converted to nitrites (EPA 2011c). The average adult daily intake from food in the United States has been estimated to be 40 to 100 mg/day for nitrate, and 0.3 to 2.6 mg/day for nitrite. Exposure estimates indicate that for more than 99% of the adult population in the United States, only 1 to 3% of nitrate and nitrite intake comes from drinking water. Drinking water becomes an important contributor to total nitrate exposure only in areas of notable contamination. For infants, the exposure scenarios are somewhat different. For breast-fed infants, total nitrate exposure is negligible. For bottle-fed infants consuming drinking water used to prepare their formula, drinking water can be a substantial exposure pathway (OEHHA 1997).

Methemoglobinemia (a blood disorder in which an abnormal amount of a protein called hemoglobin builds up in the blood) is the primary adverse health effect associated with human exposure to nitrate or nitrite. Infants are generally recognized as the subpopulation most susceptible to nitrate-induced methemoglobinemia. When infants are affected by high nitrate levels, this is commonly referred to as "blue-baby syndrome." There are other individuals who may be predisposed to the development of nitrate-induced methemoglobinemia (OEHHA 1997).

More recent research shows that high nitrate concentrations can lead to a host of other health problems, such as hypertension, birth defects, diabetes, and non-Hodgkin's lymphoma (see Rosen and others, 2006 for references). In addition, a recent report by the National Cancer Institute for the first time links nitrates directly to thyroid cancer in humans (Ward 2010).

OEHHA developed Public Health Goals of 45 ppm for nitrate (equivalent to 10 ppm nitrate-nitrogen), 1 ppm for nitrite-nitrogen and 10 ppm for joint nitrate/nitrite (expressed as nitrogen) in drinking water. The calculation of these Public Health Goals is based on the protection of infants from the occurrence of methemoglobinemia, the principal toxic effect observed in humans exposed to nitrate or nitrite. California's current Maximum Contaminant Level for nitrate are the same as the Public Health Goals and were adopted by the California DHS in 1994 from the EPA's Maximum Contaminant Levels promulgated in 1991. The current federal and state Maximum Contaminant Levels for nitrate do not incorporate up-to-date research showing additional risk to human health from nitrates.

3.1.6.4 Arsenic

All humans are exposed to microgram quantities of arsenic (inorganic and organic) largely from food (25 to 50 micrograms per day) and to a lesser degree from drinking water and air. Some edible seafood may contain higher concentrations of arsenic which is predominantly in less acutely toxic organic forms. In certain geographical areas, natural mineral deposits may contain large quantities of arsenic and this may result in higher levels of arsenic in water. Waste chemical disposal sites may also be a source of arsenic contamination of water supplies. Burning of fossil fuels also produces low levels of arsenic emissions. Arsenic may also be found in low levels in tobacco smoke. Most ingested arsenic is quickly absorbed through the gastrointestinal tract into the blood stream. Most of the organic arsenic is excreted unchanged or metabolized. The inorganic arsenic which is absorbed is converted by the liver to methylated forms which may be more toxic and more efficiently excreted in the urine. Arsenic does not have a tendency to accumulate in the body at low environmental exposure levels (OEHHA 2005).

Many scientific studies conclude that long-term exposure to inorganic arsenic through drinking water is associated with relatively high risks of cancer of the lungs and bladder and, to a lesser extent, with an increased risk of cancer of the skin, liver, and kidneys. Recent studies have also associated chronic arsenic exposure through drinking water with a number of other serious health effects, including developmental defects, stillbirth, and spontaneous abortion as well as heart attacks, strokes, diabetes mellitus, and high blood pressure. Arsenic can also cause liver damage, nerve damage, and skin abnormalities (e.g., discoloration and unusual growths, which may eventually turn cancerous). Poor nutrition may play a contributing role in arsenic's most serious health effects, and some effects may take years to develop. The International Agency for Research on Cancer has classified arsenic as a carcinogen since 1980, and, in 1987, arsenic was one of the first chemicals placed on California's Proposition 65 list of chemicals known to cause cancer or reproductive harm (OEHHA 2003).

OEHHA proposed a Public Health Goal of 4 ppt (parts per trillion) for arsenic in drinking water based upon human studies of hundreds of thousands of patients in Taiwan, Chile, and Argentina with lung and bladder cancer caused by arsenic-contaminated drinking water. Exposure to arsenic at this level in drinking water results in a risk of less than one additional case of these forms of cancer in a population of one million people drinking two liters daily of the water for 70 years. While the Public Health Goal is based primarily on data from cancer studies, no other adverse health effects are expected to arise from arsenic at the level of the proposed Public Health Goal (OEHHA 2003). The Public Health Goal was formally adopted in 2005.

Existing California and EPA Maximum Contaminant Levels of arsenic in drinking water are 10 ppb.

3.1.6.5 Iron

Iron occurs as a natural constituent in plants and animals. Liver, kidney, fish, and green vegetables contain 20–150 mg/kg, whereas red meats and egg yolks contain 10–20 mg/kg. Rice and many fruits and vegetables have low iron contents (1–10 mg/kg).Reported daily intakes of iron in food—the major source of exposure—range from 10 to 14 mg/day. Drinking water containing 0.3 ppm (300 ppb) would contribute about 0.6 mg to the daily intake. Intake of iron from air is about 25 micrograms/day in urban areas (World Health Organization 2003b).

Iron is an essential element in human nutrition. Estimates of the minimum daily requirement for iron depend on age, sex, physiological status, and iron bioavailability and range from about 10 to 50 mg/day (World Health Organization 2003b).

Taste is not usually noticeable at iron concentrations below 0.3 ppm, although turbidity and color may develop in piped systems at levels above 0.05–0.1 ppm. Laundry will stain at iron concentrations above 0.3 ppm (World Health Organization 2003b).

Due to the low level of toxicity of iron and its role as an essential nutrient, neither the EPA nor California has established a health-based standard for drinking water. However, the EPA and California adopted secondary Maximum Contaminant Levels of 300 ppb (0.3 ppm) for taste and appearance reasons.

3.1.6.6 Manganese

Manganese is an essential nutrient for humans and animals. Adverse health effects can be caused by inadequate intake or over exposure. Manganese deficiency in humans is thought to be rare because manganese is present in many common foods. The greatest exposure to manganese is usually from food. Adults consume between 0.7 and 10.9 mg/day in the diet, with even higher intakes being associated with vegetarian diets (U.S. Environmental Protection Agency 2004).

Manganese intake from drinking water is normally substantially lower than intake from food. At the median drinking water level of 10 ppb determined in the National Inorganic and Radionuclide Survey (NIRS), the intake of manganese from drinking water would be 20 µg/day for an adult, assuming a daily water intake of 2 liters. Exposure to manganese from air is generally several orders of magnitude less than that from the diet, typically around 0.04 ng/day on average, although this can vary substantially depending on proximity to a manganese source (U.S. Environmental Protection Agency 2004).

Although manganese is an essential nutrient at low doses, chronic exposure to high doses may be harmful. The health effects from over-exposure of manganese are dependent on the route of exposure, the chemical form, the age at exposure, and an individual’s nutritional status. There are no studies that associated exposure to elevated inorganic manganese with cancer in humans. Cancer studies in animals have provided equivocal results. Therefore, there are little data to suggest that inorganic manganese is carcinogenic (EPA 2004).

Due to the low level of toxicity of manganese and its role as an essential nutrient, neither the EPA nor California has established a health-based standard for manganese in drinking water. However, the EPA and California adopted secondary Maximum Contaminant Levels of 50 ppb (0.05 ppm) for taste and staining reasons. The EPA’s lifetime health advisory level, which is advisory in nature, is 300 ppb (0.3 ppm) which is substantially higher than the secondary Maximum Contaminant Level.

3.1.6.7 Uranium and Alpha Radiation

The health effects of uranium in drinking water are chronic rather than acute. Uranium is a weak chemical poison than can cause kidney damage when ingested continuously over time. This damage is dosage dependent and somewhat reversible. The uranium ion (uranyl) can also deposit on bone surfaces and may be detected in bone matrix for several years following exposure.

Uranium has been identified as a toxic substance that affects the kidneys by the World Health Organization (WHO), and it is more harmful due to its toxic nature rather than its radioactivity. WHO recommends a uranium concentration drinking water limit of 15 ppb (approximately equivalent to about 10 pCi/L). The federal primary Maximum Contaminant Level for uranium is 30 ppb and the state primary Maximum Contaminant Level is 20 pCi/L (which is approximately equivalent to 30 ppb).

There are no immediate health risks from drinking water that contains alpha radiation. However, it may cause problems over time. Because alpha radiation loses energy rapidly, it does not pass through skin and is not a hazard outside the body. Yet, if an individual eats or drinks something containing alpha radiation or breathes it in, the radiation may be harmful. Over a long period of time, and at elevated levels, radium, and thus alpha radiation, increases one's risk of bone cancer and uranium increases one's risk of kidney damage. In addition, if radon is released into air from groundwater, elevated levels inside a home can be harmful. Actions such as showering, doing laundry, or running the dishwasher can increase radon levels inside a structure. Breathing air with elevated levels of radon over a lifetime increases a person's risk of getting lung cancer (Vermont Department of Health).

3.1.7 Significance Criteria

The State CEQA Guidelines Appendix G (14 CCR 15000 et seq.) have identified significance criteria to be considered when determining whether a project could have significant effects on existing water resources within the study area. The project significance criteria for this section are based on the criteria in Appendix G of the CEQA guidelines, Section VIII, Hydrology and Water Quality.

For this analysis, an impact pertaining to water resources was considered significant under CEQA if it would result in any of the following general environmental effects compared to existing conditions:

Groundwater Drawdown[5]

Would the project:

- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge, resulting in a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted)?
  - For this project, a significant impact was identified if any of the following were to occur due to the project:

[5] CEQA Guidelines, Appendix G, Criteria VIII (b).

- groundwater use by the project were to result or contribute to a regional exceedance of the adjudicated production amounts determined by the Mojave Water Agency for the Centro Area Subarea and thus cause regional aquifer drawdown;
- groundwater use by the project were to result in localized drawdown of aquifer levels in the Hinkley Valley such that domestic or agricultural wells were to experience water supply shortages and require alternative water supplies; or
- groundwater drawdown caused by the project were to result in permanent aquifer compaction that would substantially alter the physical capacity of the aquifer to store groundwater for domestic and agricultural use.

Water Quality[6]

Would the project:

- Violate any water quality standards or Waste Discharge Requirements or otherwise substantially degrade water quality?

  For this project, a significant water quality impact was identified based on whether *remedial actions*[7] would result in exceedance of the following criteria:

  - **Water Supply Well Impacts (Hexavalent Chromium):** There is no current MCL for hexavalent chromium. For hexavalent chromium, the Public Health Goal has been set at 0.02 ppb indicating the potential for health effects to occur at levels less than the background level (currently defined as maximum of 3.1 ppb). Because background levels of Cr[VI] are found in the Hinkley Valley at levels above the PHG and it is difficult to establish whether Cr[VI] levels below background levels are due to naturally occurring conditions or due to man-made conditions, the significance criteria is set at the maximum background level. The background level may change depending on further evaluation; if it does, the most recent background level adopted by the Water Board applies.
    - Impacts to water supply wells are considered significant when remedial actions cause concentrations of hexavalent chromium in a water supply well that was previously below background levels to exceed background levels.
    - If water supply wells already contain hexavalent chromium that exceed background levels, and remedial actions cause an increase in concentration by 10% or more, this is also considered significant.
    - If and when California adopts a MCL for hexavalent chromium, if the MCL exceeds the Hinkley Valley background level, then the background level shall continue to be used as the significance criteria due to the evidence of potential health effects from concentrations above the PHG. If the MCL is less than the Hinkley Valley background level, then the background level shall also continue to be used as the significance criteria because PG&E is only responsible for levels that exceed background levels.

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[6] CEQA Guidelines, Appendix G, Criteria VIII (a) and (f).

[7] Impacts associated with the chromium plume itself that are unrelated to the remedial actions are regulated by the Water Board under applicable requirements of state water law. See Chapter 2, *Project Description*, for the chromium cleanup and water replacement requirements related to the chromium plume.

- Because the plume is defined by the maximum background hexavalent chromium level, it is possible that wells may be affected by hexavalent chromium contamination due to remedial action at detectable levels below the maximum background level. Thus, impacts are also considered significant when remedial actions cause an increase in concentrations of hexavalent chromium within a water supply well within 1 mile of the defined chromium plume. This criterion is also designed to address the potential for wells to become affected in a short period of time after detection of increased hexavalent chromium levels in groundwater nearby due to remedial actions.

- **Water Supply Well Impacts (Total Chromium):** The existing California MCL for total chromium of 50 ppb is not used as a significance criterion for this EIR because (1) the ratio of hexavalent to total chromium in the Hinkley Valley is high (PG&E's groundwater monitoring report data show that 85 to 100% of the chromium detected in monitoring wells is in the hexavalent form) and (2) the MCL is outdated as it does not consider the more recent health data and information for hexavalent chromium; therefore, the MCL for total chromium is not adequately sensitive to determine significant impacts. Instead, the maximum background level for total chromium (currently 3.2 ppb Cr[T]) will be used as a significance criterion.

  - Impacts to water supply wells are considered significant when remedial actions cause concentrations of total chromium in a water supply well that was previously below background levels to exceed background levels.

  - Because the plume is defined by the maximum background total chromium level, it is possible that wells may be affected by chromium contamination due to remedial action at detectable levels below the maximum background level. Thus, impacts are also considered significant when remedial actions cause an increase in concentrations of total chromium within a water supply well within 1 mile of the defined chromium plume.

- **Water Supply Well Impacts (Remediation Byproducts:** Arsenic, Nitrate, Uranium, Other Radionuclides). The following are considered significant:

  - If a water supply well has concentrations of these remediation byproducts that are currently less than a California primary Maximum Contaminant Level (see Table 3.1-3) and remedial actions cause the concentrations of one or more of these constituents to exceeded these standards in a water supply well.

  - If a water supply well has concentrations of these remediation byproducts that currently exceed a California primary Maximum Contaminant Level (see Table 3.1-3), then a 10% increase above current levels in a water supply well is considered significant (unless it can be demonstrated that an increase is statistically significant at a different level). This criterion is set to address the significance threshold of substantial degradation to water quality, and the 10% increase level is set conservatively to recognize the known and recognized health risks associated with these constituents in drinking water.

  - If a water supply well has concentrations of these remediation byproducts that are currently less than a California primary Maximum Contaminant Level (see Table 3.1-3) then a 20% increase above current contaminant levels in a water supply well is considered significant (unless it can be demonstrated that an increase is statistically significant at a different level). This criterion is set to address the significance threshold of substantial degradation to water quality, and the 20% increase level is set to comply with the State Board Resolution 68-16 and the Nondegradation Objective (Lahontan Basin Plan at p. 3-14). The Nondegradation Objective is an integral part of the water quality objectives contained in the Lahontan Basin Plan, and provides that where the existing quality of water is better than that needed to protect all beneficial uses, that existing high quality is an appropriate goal to be maintained.

- Due to the inability to have 100 percent barrier monitoring network, the mobility of these constituents in groundwater, fluctuations in concentrations in groundwater, and the need for precaution, it is also considered a significant impact when any of the above conditions are found in monitoring wells within one-half mile upgradient or one quarter-mile cross gradient of a water supply well. This criterion is designed to address the potential for wells to become affected in a short period of time after detection of these byproducts nearby.

○ **Water Supply Well Impacts (Remediation Byproducts:** TDS, Iron, and Manganese). The following are considered significant:

- If a water supply well has concentrations of these remediation byproducts that are currently less than a Federal or California secondary Maximum Contaminant Level (see Table 3.1-3) or water quality objectives (see Table 3.1-4) and remedial actions causes the concentrations in a water supply well to exceed these standards.
- If remediation byproduct levels in a water supply currently exceed a Federal or California secondary Maximum Contaminant Level (see Table 3.1-3) or water quality objective (see Table 3.1-4), then a 20% increase above current levels in a water supply well is considered significant (unless it can be demonstrated that an increase is statistically significant at a different level). This criterion is set to address the significance threshold of substantial degradation to water quality. The criterion is set at 20% increase because there are no primary MCLs for these contaminants, only Secondary MCLs. Secondary MCLs are based on taste, odor, and visual thresholds rather than on adverse health effects, and so a higher significance threshold is appropriate.
- If remediation byproduct levels are currently less than a Federal or California secondary Maximum Contaminant Level (see Table 3.1-3) or water quality objective (see Table 3.1-4), then a 20% increase above current levels in a water supply well is considered significant (unless it can be demonstrated that an increase is statistically significant at a different level). This criterion is set to address the significance threshold of substantial degradation to water quality, and the 20% increase level is set to comply with the State Board Resolution 68-16 and the Nondegradation Objective (Lahontan Basin Plan at p. 3-14). The Nondegradation Objective is an integral part of the water quality objectives contained in the Lahontan Basin Plan, and provides that where the existing quality of water is better than that needed to protect all beneficial uses, that existing high quality is an appropriate goal to be maintained.
- Due to the inability to have a 100 percent barrier monitoring network, the mobility of these constituents in groundwater, fluctuations in concentrations in groundwater, and the need for precaution, it is also considered a significant impact when any of the above conditions are found within a monitoring well within one-half mile upgradient or one-

quarter mile cross gradient of a water supply well. This criterion is designed to address the potential for wells to become affected in a short (i.e. a matter of months) period of time after detection of these byproducts nearby.

- **Aquifer Impact (Remediation Byproducts, Drawdown Byproducts, Other Chemicals or Compounds Detected):** The following are considered significant:
  - Remedial actions result in groundwater concentrations that will exceed California primary or secondary Maximum Contaminant Level (see Table 3.1-3) or water quality objectives (see Table 3.1-4) after completion of chromium plume remediation for any constituent used or created during the course of remedial actions and that prevents beneficial uses of the aquifer after completion of the proposed project.
  - If baseline groundwater conditions already exceed California primary or secondary Maximum Contaminant Levels (see Table 3.1-3) and remedial action will resulted in water quality levels greater than baseline levels after completion of chromium plume remediation.

Drainage[8]

For this project, a significant drainage impact was identified based on whether remedial actions would:

- substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation onsite or offsite;
- substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding onsite or offsite; or
- create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?

Flooding[9]

For this project, a significant flooding impact was identified based on whether remedial actions would:

- place housing within a 100-year flood hazard area, as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map;
- place within a 100-year flood hazard area structures that would impede or redirect floodflows;
- expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam; or
- contribute to inundation by seiche, tsunami, or mudflow.

[8] CEQA Guidelines, Appendix G, Criteria VIII (c), (d) and (e).
[9] CEQA Guidelines, Appendix G, Criteria VIII (g), (h), (i) and (j).

3.1.8 Impacts

This section describes the impact analysis relating to groundwater quantity and quality for the project alternatives. It describes the methods used to determine the impacts of the project alternatives and relates the impact analysis to the thresholds (as defined by the significance criteria above) to conclude whether an impact would be significant. Measures to mitigate (i.e., avoid, minimize, rectify, reduce, eliminate, or compensate for) significant impacts accompany each impact discussion. Several of the mitigation measures include monitoring with adaptive control measures.

This impact analysis compares all project alternatives to existing conditions, which is the CEQA baseline. This section provides a general summary of the potential impacts, detailed impact analysis by alternative, and mitigation measures.

Mitigation measures are referenced in text where appropriate and are described in Section 3.1.9.

3.1.8.1 Groundwater Drawdown Impacts

This section discusses impacts to groundwater quantity due to remedial action including potential effects on the regional water supply, local water supply, and aquifer compaction due to groundwater drawdown. Water quality impacts to groundwater are discussed separately in the next section, 3.1.8.2, Water Quality.

Impacts related to the groundwater drawdown (overdraft) are analyzed in three different ways:

- *Regional Water Supply*: Evaluation of impacts on regional water supplies within the Mojave Basin Centro Subarea
- *Local Water Supply:* Evaluation of local water supplies (i.e., private domestic and agricultural wells) within the study area based on PG&E groundwater drawdown modeling results, surface elevations, current groundwater elevations, and well screen depths of private domestic and agricultural wells
- *Aquifer Compaction:* Evaluation of potential physical aquifer impacts (i.e., compaction or subsidence) due to groundwater drawdown based on studies conducted in the Mojave Desert and Hinkley Valley aquifer characteristics (i.e., depth and composition).

Impact WTR-1a: Groundwater Drawdown Effects on the Regional Water Supply (Mojave River Basin, Centro Subarea) (Less than Significant, No Project Alternative; Less than Significant with Mitigation, All Action Alternatives)

Methodology

Groundwater drawdown could affect regional water supplies in the Centro Subarea of the Mojave River Basin. The Mojave Water Agency oversees the Mojave River Basin Adjudication, which allocates an annual allowance called the Free Production Allowance (FPA or allowance) to each water user within a designated subarea that participated in the adjudication. Groundwater drawdown effects on the Centro Subarea were evaluated by determining the amount of agricultural treatment pumping necessary for the project alternatives and comparing it to the amount of Free Production Allowance held by PG&E at present. This impact is deemed significant if PG&E's projected annual water use (or production) exceeds their annual allowance; however, the impact can be mitigated if PG&E increases their allowance by acquiring water rights through purchase or transfer.

The feasibility of mitigation was evaluated by determining what recent groundwater production rates have been in the Centro Subarea and whether or not there is available surplus that could be purchased by PG&E if they do not possess adequate water rights.

Localized groundwater drawdown effects on wells in the Hinkley Valley are evaluated separately below under Impact WTR-1b.

Overview of Impacts

As described above under 3.1.3.3, *Local Regulations, Mojave River Basin Adjudication*, in the Centro subarea, verified production has been less than the Free Production Allowance and less than the sustainable yield since 1993. In the last five years, production has been less than the Free Production Allowance by approximately 14,329 afy and less than the Production Safe Yield by 8,182 afy.

Total annual agricultural treatment pumping volumes for each of the alternatives were estimated for the average annual agricultural treatment pumping rates (estimated assuming up to 15% plume growth beyond the Q4/2011 plume for the purposes of the EIR) with the exception of that for the No Project Alternative, which is based on current pumping rates. The expected agricultural treatment pumping volumes are shown in Table 3.1-7 below.

Total agricultural treatment pumping quantities for each alternative were compared to PG&E's current Free Production Allowance. As noted above, PG&E currently owns 2,429 afy of water rights and has a current Free Production Allowance of 1,944 afy. Although this analysis is conducted based on the current water rights, recent property purchases are likely to gain an additional 729 afy for a total of 3,158 afy (which would increase their Free Production Allowance to 2,526 afy). In order to comply with the Basin Adjudication, PG&E will have to acquire additional water rights in order to maintain the flows estimated in Table 3.1-7. Since there has been a consistent surplus over the Free Production Allowance and the Production Safe Yield that is greater than the maximum amount of water use in Table 3.1-7, there is adequate unused allowance available that PG&E could acquire to achieve the pumping volumes for any of the alternatives.

It is feasible to acquire water rights from other owners. A recent example is the recent large-scale acquisition of water rights and allowances to support new projects. The Abengoa Solar project (now Mojave Solar project) near Lockhart acquired water rights of primarily former agricultural land in the amount of approximately 10,500 afy (Free Production Allowance of 8,400 afy).

If PG&E acquires unused allowances through outright purchase or yearly transfer, then this would not result in any displacement of other land uses in the Centro subarea. However, if PG&E were to acquire allowances in use, such as for current agricultural use, then the acquisition could result in abandonment or displacement of the current supported land use. This potential land use impact is discussed in Section 3.2, *Land Use, Agriculture, Population, and Housing*.

No Project Alternative: Effects on Regional Water Supply

The No Project Alternative would involve continued implementation of plume containment and reduction of the Cr[VI] plume concentrations. The primary differences between the No Project Alternative and existing conditions are increased in-situ remediation and associated infrastructure and activities. The No Project Alternative would not increase agricultural extractions and irrigation above existing conditions and would thus not result in increased drawdown of the aquifer compared to late 2011 conditions.

Table 3.1-7 Annual Agricultural Treatment Pumping Amounts Compared to PG&E's Current Mojave Basin Adjudication Free Production Allowance

Alternative	Average Annual Agricultural Treatment Units Pumping Flow (gpm)	Total Annual Agricultural Treatment Units Pumping Volume (afy)[a]	Volume of Pumping Above PG&E's Current FPA (1,944 afy)
No Project	1,100	1,774	Flow is below FPA
Alternative 4B	2,395	3,863	1,919
Alternative 4C-2	3,167	5,109	3,165
Alternative 4C-3	4,388	7,078	5,134
Alternative 4C-4	4,388	7,078	5,134
Alternative 4C-5	3,167	5,109	3,165

Key:

afy: Acre-feet per year

FPA: Free Production Allowance

Notes:

[a] Total annual agricultural treatment pumping rates are scaled according to methodology described in Chapter 2, with the exception of the No Project Alternative, which is based on continued implementation of existing pumping rates.

As shown in Table 3.1-7, pumping rates for the No Project Alternative are within PG&E's allowance, and thus are not expected to contribute to regional groundwater drawdown. In addition, extraction is designed such that existing private wells do not experience a decrease in water level that results in a loss of yield for existing or potential beneficial uses. Given the apparent surplus in groundwater conditions within the Centro Subarea, and the fact that the remediation will extract groundwater within PG&E's allowance, approved remedial activities would not deplete groundwater supplies in the project vicinity. Therefore, the No Project Alternative will have no impact on regional groundwater supplies compared to existing conditions.

Alternative 4B: Effects on Regional Water Supply

Agricultural treatment water use would be greater under Alternative 4B (up to 3,863 acre-feet per year) than existing conditions (1,774 afy) because summer pumping for agricultural treatment would increase in proportion to the increased irrigated acreage for agricultural treatment. On a regional scale, the total pumping by PG&E from the Hinkley Valley aquifer with Alternative 4B would be greater than PG&E's current allowance under the Mojave River Basin Adjudication (Table 3.1-7).

In order to implement this alternative and comply with the Basin Adjudication, PG&E must acquire sufficient water rights to allow the proposed water use with agricultural treatment. As noted above, there is a present surplus above the regional Free Production Allowance indicating it is feasible to acquire additional water rights while avoiding regional drawdown. Provided PG&E keeps its overall water use within the assigned allowances from the Mojave Water Agency, the project will not impair the Production Safe Yield of the Centro Subarea overall. PG&E will be required to demonstrate to the Water Board that it has acquired the necessary water rights before ramping up agricultural treatment (per **Mitigation Measure WTR-MM-1**). Therefore, impacts associated with this alternative would be less than significant with the implementation of **Mitigation Measure WTR-MM-1**.

Alternative 4C-2: Effects on Regional Water Supply

Alternative 4C-2 would include additional agricultural treatment water use (up to 5,109 afy) compared to existing conditions (1,774 afy). It involves similar components to Alternative 4B, with the exception of increased number of agricultural treatment units and year-round operation of agricultural treatment, through the addition of winter crops (winter rye or similar crop) to most of the existing and new agricultural treatment units.

Due to increased agricultural treatment activities, particularly during the winter months, Alternative 4C-2 would result in greatly increased annual groundwater extraction rates compared to existing conditions.

As shown in Table 3.1-7, annual agricultural treatment pumping volumes would be greater under Alternative 4C-2 than PG&E's current allowance by 3,165 afy. The implementation of **Mitigation Measure WTR-MM-1** (PG&E water right purchase) would reduce this impact to less than significant.

Alternative 4C-3: Effects on Regional Water Supply

Alternative 4C-3 has similar agricultural treatment water use as Alternative 4C-2 and substantially greater (7,078 afy) use compared to existing conditions (up to 1,774 afy).

Above-ground treatment would return treated water to the aquifer and would thus have no effect on groundwater levels unless the point of reinjection was substantially different from the point of extraction. However, this would likely not have a significant impact on regional groundwater drawdown compared to agricultural treatment activities.

As shown in Table 3.1-7 annual agricultural treatment pumping volumes would be greater under Alternative 4C-3 than PG&E's current allowance by 5,134 afy. The implementation of **Mitigation Measure WTR-MM-1** (PG&E water rights purchases) would reduce this impact to less than significant.

Alternative 4C-4: Effects on Regional Water Supply

This alternative involves similar components as Alternative 4C-2, with the exception of a large increase in agricultural treatment. Alternative 4C-4 would have substantially higher agricultural treatment water use (up to 7,078 afy) than existing conditions (1,774 afy) and the same water use as Alternatives 4C-3.

As shown in Table 3.1-7, annual agricultural treatment pumping volumes would be much greater under Alternative 4C-4, by 5,134 afy, than PG&E's current allowance. The implementation of **Mitigation Measure WTR-MM-1** (PG&E water rights purchases) would reduce this impact to less than significant.

Alternative 4C-5: Effects on Regional Water Supply

This alternative involves more agricultural treatment flows than Alternative 4B, the same agricultural treatment flows as Alternative 4C-2, but less than Alternatives 4C-3 and 4C-4. Alternative 4C-5 would have substantially higher agricultural treatment water use (up to 5,109 afy) than existing conditions (1,774 afy).

Similar to Alternative 4C-3, this alternative involves above-ground treatment that would return treated water to the aquifer and would thus have no effect on groundwater levels unless the point of reinjection was substantially different from the point of extraction. Overall, Alternative 4C-5 would have less of a significant impact on regional groundwater drawdown compared to Alternatives 4C-3 and 4C-4 but the same significant impact as Alternative 4C-2.

As shown in Table 3.1-7, annual agricultural treatment pumping volumes would be greater under Alternative 4C-5 than PG&E current allowance by 3,165 afy. The implementation of **Mitigation Measure WTR-MM-1** (PG&E water rights purchases) would reduce this impact to less than significant.

Impact WTR-1b: Groundwater Drawdown Effects on the Local Water Supply (Hinkley Valley Aquifer) (Less than Significant, No Project Alternative; Less than Significant with Mitigation, All Action Alternatives)

Methodology

Impacts of project alternatives on groundwater drawdown within the localized area of Hinkley Valley were evaluated using the following data:

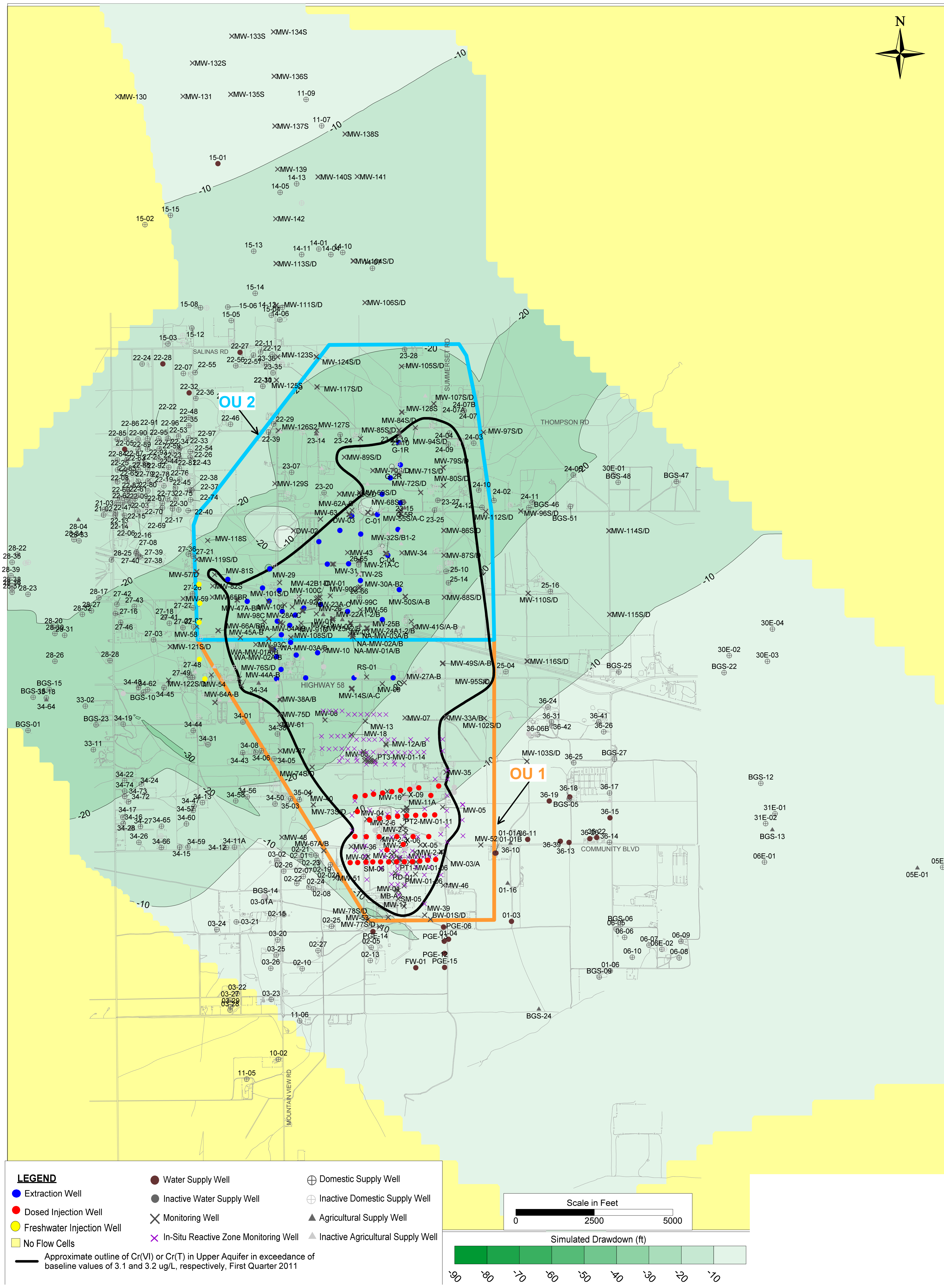
- PG&E's groundwater drawdown modeling results;
- existing surface elevations for the study area;
- existing groundwater elevations for the study area; and
- screen depths for water supply wells.

Potential effects of regional drawdown on individual private domestic and agricultural wells in the study area were evaluated by comparing well screen depths to forecasted groundwater drawdown depth contours generated by PG&E's groundwater model. This analysis was conducted for the <u>maximum</u> extent of groundwater drawdown forecasted for all the alternatives and thus represents the worse-case scenarios. Results are expressed in the percent of private wells partially (25%–75% of total screen depth) and fully (76%–100% of total screen depth) affected by maximum groundwater drawdown. The analysis was conducted by first determining the following two items:

- **Groundwater drawdown elevations relative to each well.** PG&E's groundwater drawdown model estimated maximum drawdown for Alternatives 4B through 4C-5 using a steady state simulation. The steady state estimates are worst-case scenario predictions, provided to compare maximum potential drawdown among alternatives for the EIR. The exact timeframe for full drawdown is difficult to predict, because there are uncertainties in recharge due to variations in climate (e.g., rainfall and Mojave River flow) and basin management practices.
- **Screen depth elevations for each well.** Existing ground surface elevations and groundwater elevations were used as the baseline for comparison of drawdown depths with the depths and extents of well screens. Wells with a top screen located within the maximum drawdown depth below the datum were evaluated for potential impacts on water supplies for each alternative.

Overview of Impacts

As shown in Table 3.1-7, the magnitude of groundwater use of the upper aquifer in the study area increases with increasing agricultural treatment units pumping rates. The extent of groundwater drawdown for each alternative is shown in Figures 3.1-14 through 3.1-18. These drawdown



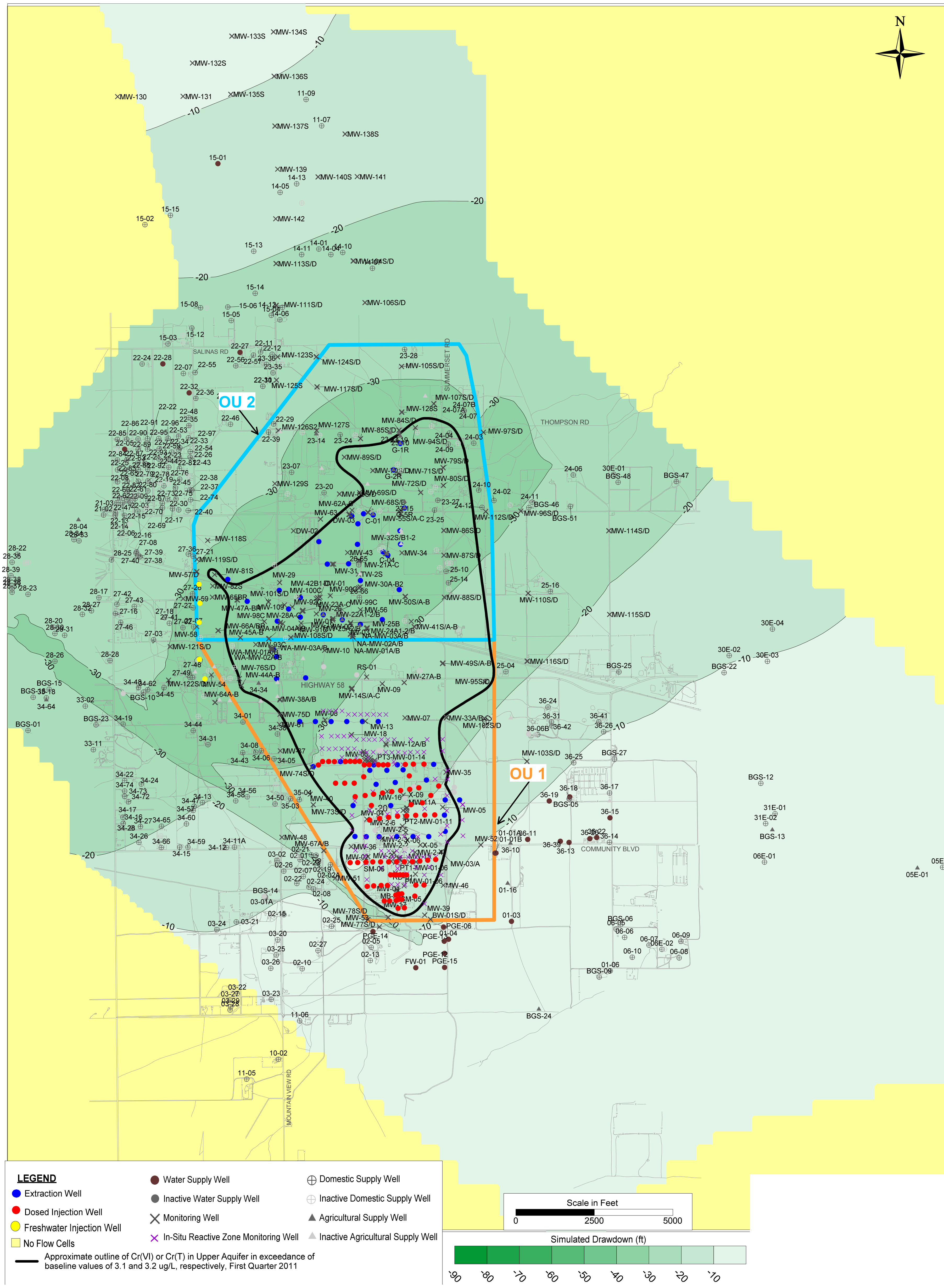
Note: Simulated drawdown shown for extraction rates from the Feasibility Study/Addenda for this alternative. The drawdown amounts shown on the figure are the maximum drawdown levels for the FS/Addenda extraction rates after many years of operations; these levels would likely not be achieved for 10 to 15 years. As described in text, in order to treat the expanded plume area, AU extraction rates will likely exceed FS/Addenda rates and groundwater drawdown may be greater than shown on this figure.

Source: PG&E 2011c.

Graphics ... 00122.11 (8-16-12)

ICF INTERNATIONAL

Figure 3.1-14
Simulated Groundwater Drawdown for Alternative 4B

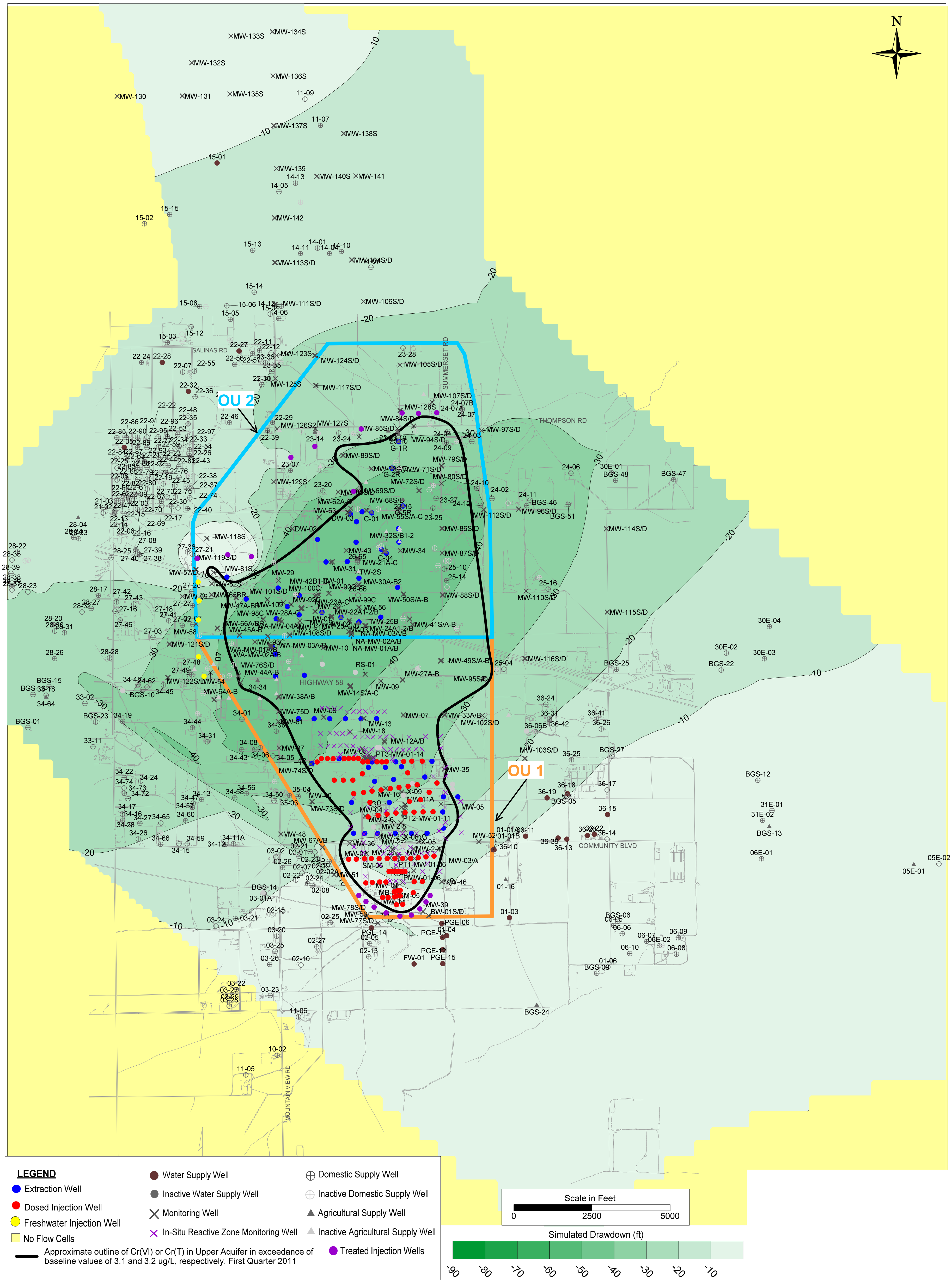


Note: Simulated drawdown shown for extraction rates from the Feasibility Study/Addenda for this alternative. The drawdown amounts shown on the figure are the maximum drawdown levels for the FS/Addenda extraction rates after many years of operations; these levels would likely not be achieved for 10 to 15 years. As described in text, in order to treat the expanded plume area, AU extraction rates will likely exceed FS/Addenda rates and groundwater drawdown may be greater than shown on this figure.

Source: PG&E 2011c.

Graphics ... 00122.11 (8-16-12)

Figure 3.1-15
Simulated Groundwater Drawdown for Alternative 4C-2



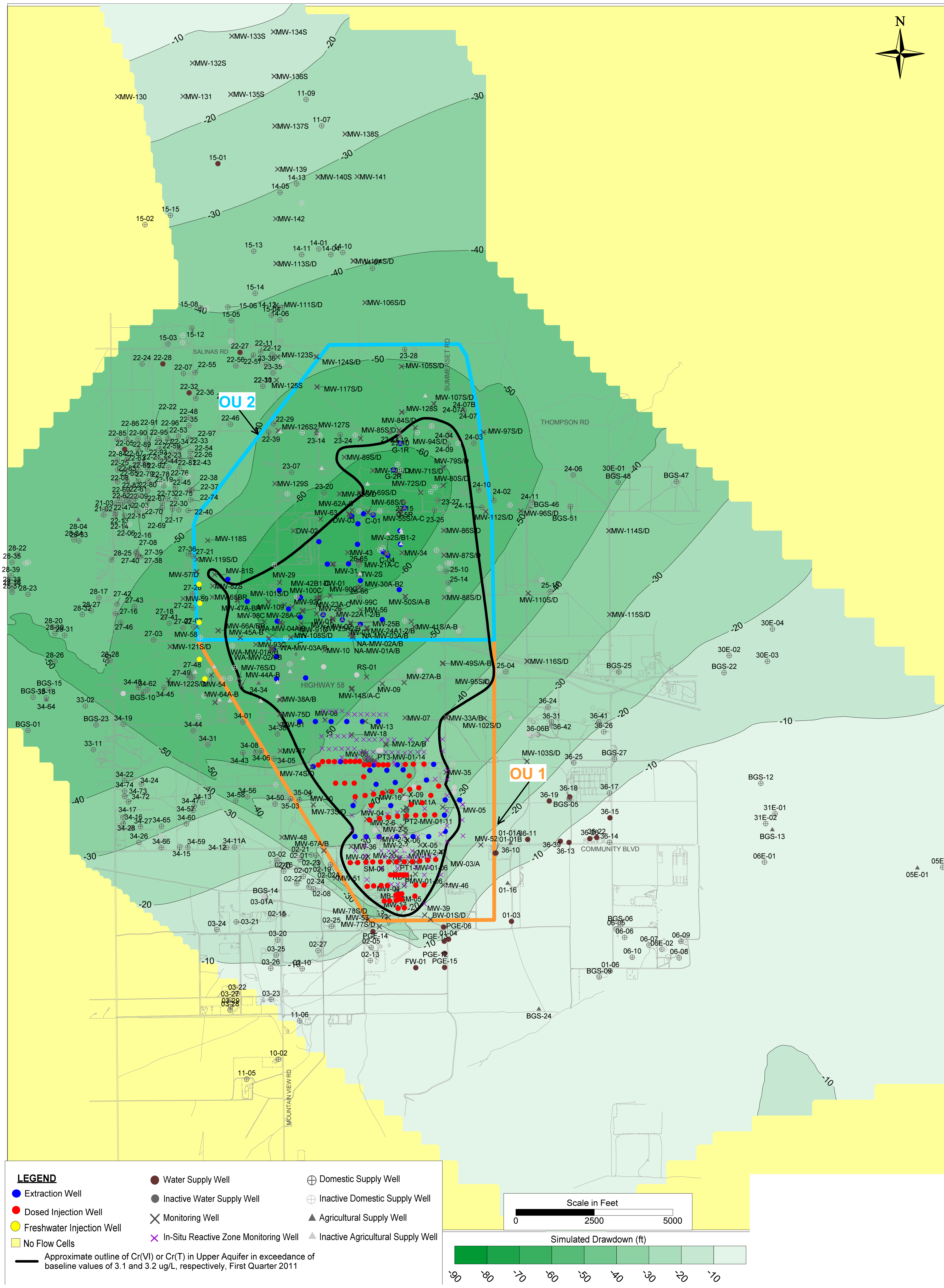
Note: Simulated drawdown shown for extraction rates from the Feasibility Study/Addenda for this alternative. The drawdown amounts shown on the figure are the maximum drawdown levels for the FS/Addenda extraction rates after many years of operations; these levels would likely not be achieved for 10 to 15 years. As described in text, in order to treat the expanded plume area, AU extraction rates will likely exceed FS/Addenda rates and groundwater drawdown may be greater than shown on this figure.

Source: PG&E 2011c.

Graphics ... 00122.11 (8-16-12)

ICF INTERNATIONAL

Figure 3.1-16
Simulated Groundwater Drawdown for Alternative 4C-3

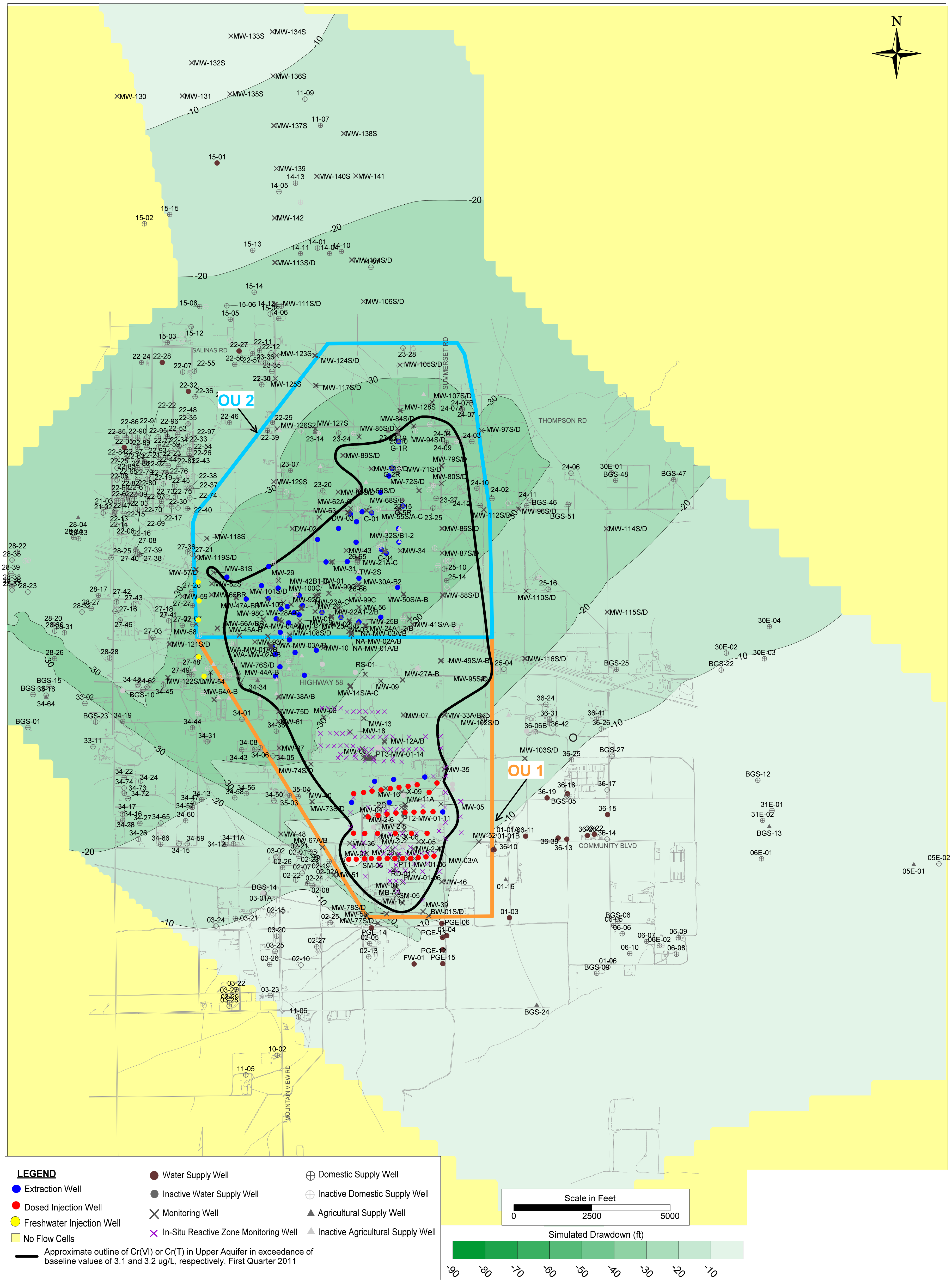


Note: Simulated drawdown shown for extraction rates from the Feasibility Study/Addenda for this alternative. The drawdown amounts shown on the figure are the maximum drawdown levels for the FS/Addenda extraction rates after many years of operations; these levels would likely not be achieved for 10 to 15 years. As described in text, in order to treat the expanded plume area, AU extraction rates will likely exceed FS/Addenda rates and groundwater drawdown may be greater than shown on this figure.

Source: PG&E 2011c.

Graphics ... 00122.11 (8-16-12)

Figure 3.1-17
Simulated Groundwater Drawdown for Alternative 4C-4



Note: Simulated drawdown shown for extraction rates from the Feasibility Study/Addenda for this alternative. The drawdown amounts shown on the figure are the maximum drawdown levels for the FS/Addenda extraction rates after many years of operations; these levels would likely not be achieved for 10 to 15 years. As described in text, in order to treat the expanded plume area, AU extraction rates will likely exceed FS/Addenda rates and groundwater drawdown may be greater than shown on this figure.

Source: PG&E 2011c.

Figure 3.1-18
Simulated Groundwater Drawdown for Alternative 4C-5

estimates are for the flows included in the Feasibility Study/Addenda which are 55 to 90% less than the scaled flows estimated for the expanded plume. The No Project Alternative would have no increased drawdown over existing conditions as extraction rates would not increase.

Table 3.1-8: Maximum Localized Groundwater Drawdown in the Hinkley Valley Alternative

Alternative	Maximum Drawdown at Feasibility Study flows (feet below water existing GW elevation)[b]	Maximum Drawdown at Scaled Flows (feet below water existing GW elevation)[b]	Estimated Time to Reach Maximum Drawdown Predicted by Steady State Model (years)
No Project	--	--	--
Alternative 4B	32	50–70	10–15
Alternative 4C-2	40	50–70	10–15
Alternative 4C-3	50	60–80	10–15
Alternative 4C-4	69	70–100+	15–25
Alternative 4C-5	39	50–70	10–15

Notes:

[a] Based on Feasibility Study pumping rates, which do not account for the expanded plume.

[b] Based on scaled pumping rates identified in Table 3.1-6 and roughly estimated using drawdown analysis for the Feasibility Study. It is unknown if the scaled flows for Alternatives 4C-3 and 4C-4 can be sustained, thus these levels may overstate the impact.

GW = Groundwater

The modeling results indicate increasing magnitude and extent of drawdown as pumping rates are increased from Alternative 4B through 4C-2, 4C-3, and 4C-4 (4C-5 is similar to 4C-2). Continuous pumping for alternatives 4C-3 and 4C-4 were evaluated with constant pumping rates, consistent with how the alternatives were developed for Addendum #3 of the Feasibility Study. In practice, continuous pumping scenarios such as 4C-3 and 4C-4 would not likely be run at the modeled extraction rates over long timeframes. As the aquifer would begin to dewater, pumping rates would be adjusted, while maintaining capture. For example, the geologic unit with Cr[VI] in groundwater in the Summerset Road area between MW-87S/D and MW-79S/D, has a saturated thickness of 30 to 40 feet thick (Pacific Gas and Electric 2011g). Maximum drawdown in this area for Alternatives 4C-3 and 4C-4 is predicted to be more than 30 to 40 feet. In implementation, pumping would be optimized and rates would be reduced as the Cr[VI]-impacted layer in this area is drawn down to establish the designed plume capture zone, while minimizing aquifer dewatering. Thus, the analysis in this EIR represents the worst-case drawdown depth scenario that is unlikely to occur.

Potential impacts of drawdown on private domestic and agricultural wells within the study area were evaluated using well screen depth data. Well screen depth data were available for 173 of the 360 domestic and agricultural wells located within the study area. As shown in Table 3.1-9, the number of private wells that are both partially and fully affected by maximum drawdown varies by alternative.

Table 3.1-9: The Number of Existing Private Wells Affected by Drawdown for Each Project Alternative in the Hinkley Valley (Using Feasibility Study Extraction Rates and Available Data)

Alternative	Maximum drawdown based on Feasibility Study Extraction Rates(feet)	Number of Private Wells Partially Affected by maximum groundwater drawdown			Number of Private Wells Fully Affected by maximum groundwater drawdown		
		Water Supply	Agricultural	Domestic	Water Supply	Agricultural	Domestic
No Project	No change	N/A	N/A	N/A	N/A	N/A	N/A
Alternative 4B	32	6	0	75	5	0	10
Alternative 4C-2	40	7	0	94	5	0	14
Alternative 4C-3	50	6	0	82	5	0	12
Alternative 4C-4	60	6	1	83	7	0	50
Alternative 4C-5	39	7	0	93	5	0	15

Notes:

Well data was only available for 173 of the 360 domestic and agricultural wells located within the study area included in PG&E's well database.

Wells "partially" affected were analyzed as 25%–75% or more of the well screen depth being reduced by drawdown. It was presumed that less than 25% drawdown within a well would not result in substantial disruption of well productivity.

Wells "fully" affected were analyzed as 76% to 100% or more of the well screen depth being reduced by drawdown.

Based on Feasibility Study Extraction Rates; As shown in Table 3.1-8, extraction rates may be higher than identified in the Feasibility Study in order to address the expanded plume.

Since well construction data was only available for perhaps half of the wells in the project study area, the number of affected wells could be higher than shown in Table 3.1-9. In addition, it is possible that over time there may be new water supply wells installed on occupied or vacant wells that could also be affected by remedial activity-caused drawdown.

The drawdown levels shown above are the projected maximum drawdown based on feasibility study extraction rates. Modeling by PG&E indicates that these maximum drawdown levels could be reached within 10 to 15 years of commencing large-scale groundwater extractions for agricultural treatment and then would stabilize at these levels for as long as groundwater extraction continues at these increased levels. The action alternatives include agricultural treatment for 30 to 50 years to get to 3.1 ppb Cr[VI] and 75 to 95 years to get to 1.2 ppb Cr[VI]. After groundwater extraction for agricultural treatment is ceased, it will take a number of years for groundwater levels to recover to baseline conditions. The post-project recovery period will depend on climate, precipitation and aquifer recharge events from the Mojave River, and the level of other pumping in the aquifer at the time and is difficult to predict with great accuracy, but recovery could take many years. As such, groundwater drawdown effects could occur for perhaps 75 to 95 years and even longer.

Mitigation will be required to provide alternative water supply for wells that are substantially affected by groundwater drawdown per **Mitigation Measure WTR-MM-2**. A substantial effect is defined as groundwater drawdown that would be more than 25% of the screen depth of any affected well. Alternative water supplies could be derived from deeper wells (below the projected drawdown level), from storage tanks and hauled water, or from water delivered via pipeline from an off-site source, including a community supply. Based on the maximum number of domestic wells affected in Table 3.1-9 (133 wells partially or fully affected for Alternative 4C-4), if all the water had to be provided from an off-site source, and assuming each domestic well needed to supply 0.8 afy, a total of 106 af could be required. The feasibility study for the alternative water supply required by CAO R6V-2011-0005 described needing a 12 gpm yield to supply 25 residences. The PG&E well south of the Compressor Station being used to provide water for freshwater injection on the west side of plume is providing 80 gpm (sufficient to supply over 160 residences), indicating that yields near the Mojave River should be adequate to provide an alternative water supply for all affected residences should an offsite water source be needed. Thus, provision of alternative water supplies is feasible to address this impact.

No Project Alternative: Aquifer Drawdown Affecting Local Water Supply Wells (Hinkley Valley)

Remedial pumping rates for the No Project Alternative would be the same as those for existing conditions and groundwater drawdown would not be increased over existing conditions. However, groundwater extraction at existing remedial wells could result in temporary reductions in local groundwater levels at nearby domestic or agricultural wells that will ultimately be replenished from sources of groundwater recharge.

PG&E is currently required to monitor water levels at several monitoring wells during extraction for remedial purposes, and adjusts pumping rates, as necessary, to maintain beneficial uses. PG&E will continue to employ these measures to address potential temporary groundwater level lowering at nearby water supply wells.

Therefore, the No Project Alternative will not cause significant aquifer drawdown that would adversely local water supply wells.

Alternative 4B: Aquifer Drawdown Affecting Local Water Supply Wells (Hinkley Valley)

The additional pumping for increased agricultural treatment for Alternative 4B could have impacts on individual wells. As shown in Table 3.1-9, the estimated number of private domestic and agricultural wells affected by the maximum groundwater drawdown (32 feet) estimated for Alternative 4B (for feasibility study flows of 1,270 gpm) is 81 (partially affected) and 15 (fully affected), respectively. Without mitigation, such drawdown could disrupt domestic or agricultural supply, forcing construction of deeper wells, use of alternative water supplies, or abandonment of domestic/agricultural activity. As described in Chapter 2, in order to address the expanded plume, groundwater extraction for corrective actions (such as agricultural treatment units) may need to be increased above the Feasibility Study/Addenda amounts. Thus, groundwater drawdown for Alternative 4B may exceed 32 feet due to the estimated scaled extraction rate of up to 2,395 gpm needed. At this rate, the drawdown would likely be somewhere between 50 and 70 feet and the affected wells could be similar to the feasibility study flow effects described below for Alternative 4C-3 and 4C-4.

To address local groundwater drawdown effects, PG&E would provide alternative water supply for wells that are affected by localized drawdown impacts from remedial activities (per **Mitigation Measure WTR-MM-2**)**,** which would reduce impacts to a less than significant level.

Alternative 4C-2: Aquifer Drawdown Affecting Local Water Supply Wells (Hinkley Valley)

As shown in Table 3.1-9, based on feasibility study level flows (2,042 gpm) and estimated drawdown (40 feet) the number of private domestic and agricultural wells affected by the maximum groundwater drawdown estimated for Alternative 4C-2 is 101 (partially affected) and 19 (fully affected), respectively. As described in Chapter 2, in order to address the expanded plume, agricultural treatment units and groundwater extraction may need to be increased above the Feasibility Study/Addenda amounts. Thus, groundwater drawdown for Alternative 4C-2 may exceed 40 feet due to the estimated scaled extraction rate of up to 3,167 gpm. At this rate, the drawdown would likely be somewhere between 50 and 70 feet and the number of affected wells could be similar to that estimated for the feasibility study flows for Alternative 4C-4.

To address local groundwater drawdown effects, PG&E would provide alternative water supply for wells that are affected by localized drawdown impacts from remedial activities (per **Mitigation Measure WTR-MM-2**), which would reduce impacts to a less than significant level.

Alternative 4C-3: Aquifer Drawdown Affecting Local Water Supply Wells (Hinkley Valley)

As shown in Table 3.1-9, the number of private domestic and agricultural wells partially and fully affected by the maximum groundwater drawdown (50 feet) estimated for Alternative 4C-3 for feasibility study level flows (2,829 gpm) is 88 (partially affected) and 17 (fully affected). As described in Chapter 2, in order to address the expanded plume, agricultural treatment units and associated groundwater extraction may need to be increased above the Feasibility Study/Addenda amounts. Thus, groundwater drawdown for Alternative 4C-3 may exceed 50 feet due to the estimated scaled extraction rate of up to 4,388 gpm needed. At this rate, the drawdown could be somewhere between 60 and 80 feet and the number of affected wells could be similar to that or greater than that estimated for the feasibility study flows for Alternative 4C-4.

To address local groundwater drawdown effects, PG&E would provide alternative water supply for wells that are affected by localized drawdown impacts from remedial activities (per **Mitigation Measure WTR-MM-2),** which would reduce impacts to a less than significant level.

Alternative 4C-4: Aquifer Drawdown Affecting Local Water Supply Wells (Hinkley Valley)

As shown in Table 3.1-8, maximum groundwater drawdown for Alternative 4C-4 is greater than all of the other alternatives and significantly greater than for existing conditions. PG&E's groundwater drawdown model results suggest that the proposed pumping rates under Alternative 4C-4 may not be sustainable at all extraction wells, as they may drawdown groundwater levels to the base of the upper aquifer. If selected, pumping rates would be adjusted to balance flow, plume capture, and drawdown. The actual groundwater pumping rates may need to be adjusted during operation if long-term drawdown reduces sustainable yields from wells.

As shown in Table 3.1-9, the number of private domestic and agricultural wells affected by the maximum groundwater drawdown (69 feet) estimated for Alternative 4C-4 for feasibility study flows (2,829 gpm) is 90 (partially affected) and 57 (fully affected). As described in Chapter 2, in order to address the expanded plume, agricultural treatment units and groundwater extraction may need to be increased above the Feasibility Study/Addenda amounts. Thus, groundwater drawdown for Alternative 4C-4 may exceed 69 feet due to the estimated scaled extraction rate of up to 4,388 gpm needed. At this rate, the drawdown could be greater than 100 feet and the number of affected wells would be higher. As noted above, this level of flow and drawdown may not be sustainable or physically achievable.

To address local groundwater drawdown effects, PG&E would provide alternative water supply for wells that are affected by localized drawdown impacts from remedial activities (per **Mitigation Measure WTR-MM-2**), which would reduce impacts to a less than significant level.

Alternative 4C-5: Aquifer Drawdown Affecting Local Water Supply Wells (Hinkley Valley)

The agricultural treatment extraction rates for this alternative would be the same as Alternative 4C-2. As shown in Table 3.1-8, groundwater drawdown for Alternative 4C-5 would be similar to Alternative 4C-2.

As shown in Table 3.1-9, the number of private domestic and agricultural wells affected by the maximum groundwater drawdown (39 feet) estimated for Alternative 4C-5 feasibility study flows (2,042 gpm) is 100 (partially affected) and 20 (fully affected). As described in Chapter 2, in order to address the expanded plume, agricultural treatment units and groundwater extraction may need to be increased above the Feasibility Study/Addenda amounts. Thus, groundwater drawdown for Alternative 4C-5 may exceed 39 feet due to the estimated scaled extraction rate of up to 3,167 gpm. At this rate, the drawdown would likely be somewhere between 50 and 70 feet and the number of affected wells could be similar to that estimated for the feasibility study flows for Alternative 4C-4.

To address local groundwater drawdown effects, PG&E would provide alternative water supply for wells that are affected by localized drawdown impacts from remedial activities (per **Mitigation Measure WTR-MM-2**), which would reduce impacts to a less than significant level.

Impact WTR-1c: Groundwater Drawdown Effects on Aquifer Compaction (Less than Significant, No Project Alternative; Potentially Significant, All Action Alternative)

Methodology

Aquifer compaction within the Mojave River Groundwater Basin has not been an issue in general where the aquifer is predominantly made up of sand which is less vulnerable to compaction than are smaller particles, such as silt and clay. But where silts and clay occur more often in the aquifer with distance from the river, compaction may indeed become an issue.

Increased pumping rates for agricultural treatment could have long-term effects on the capacity of the aquifer if it lowers groundwater levels and if it results in compaction of the aquifer. Therefore, an evaluation of potential aquifer compaction due to pumping for agricultural treatment was conducted.

This evaluation of potential physical impacts of aquifer compaction is based on the following studies on groundwater conditions and land subsidence in the Mojave Desert:

- USGS Water Resources Investigations Report 03-4015 on Detection and Measurement of Land Subsidence using Interferometric Synthetic Aperture Radar and Global Positioning System, San Bernardino County, Mojave Desert, California (Sneed et al. 2003).
- Stamos et al. (2001). Water Supply in the Mojave River Ground-Water Basin, 1931–99, and the Benefits of Artificial Recharge.
- Pacific Gas and Electric Company. 2011g. Technical Report—Response to Investigative Order No. R6V-2011-0043. Delineation of Chromium in the Upper Aquifer. Pacific Gas and Electric Company's Hinkley Compressor Station, Hinkley, California. September 1.
- Pacific Gas and Electric Company. 2012b. Technical Memorandum—Update to Upper Aquifer Groundwater Investigation Activities-Pacific Gas and Electric Company's Hinkley Compressor Station, Hinkley California. February 8.

- Historic aerial photographs of the Hinkley Valley area to identify areas of past agricultural activity.
- Review of available monitoring well bore logs to identify substrates present in different parts of the project area.

Overview of Impacts

Overall pumping in the Mojave River Basin peaked in the mid-1980s at approximately 240,000 afy, but then declined by 1998 to 150,000 afy. In the Centro Subarea, peak pumping approached 60,000 afy in the mid-1950s which was sustained more or less until 1990 and then declined to approximately 25,000 afy by 2000. Groundwater drawdown modeling by Stamos et al. (2001) indicates that groundwater levels in the Hinkley Valley began to decline in the 1950s and reached a peak drawdown by 1990 of more than 90 feet in the Hinkley Valley (compared to the baseline year of 1930). In 1996 the Mojave Water Agency adjudication was adopted, limiting pumping levels in the various subareas of the Mojave River Basin in order to restore groundwater levels, including in the Hinkley Valley. By 1999, water levels had recovered partially from their earlier lower levels but some areas still had drawdown levels of over 50 feet (compared to 1930 baseline). Since 1993, pumping has been reduced due to the requirements of the adjudication which has allowed groundwater levels to recover.

Between 1993 and 2011, average pumping within the Centro subarea has been approximately 28,000 afy with a recent 5-year average between 2006 and 2011 of 25,000 afy. The Free Production Allowance from the Mojave Water Agency totals 39,000 afy, indicating that there has been, on average a surplus of approximately 14,000 afy in recent years.

Based on the historic changes in groundwater levels from 1931 to 1990, the aquifer in the southern and central parts of Hinkley Valley (where agricultural activity occurred during this period based on historic aerial photographs) has been previously "stressed" due to more than 90 feet of historic drawdown. Agricultural wells in the study area have apparently retained their productive ability but the effect upon production of individual domestic wells between 1930 and after 1990 is not fully known. This information suggests a hypothesis that historic groundwater drawdown may not have resulted in substantial aquifer compaction in the Hinkley Valley area, however compaction that may have occurred in the subsurface below open fields or desert may not have been noticed or reported.

Research literature (Galloway et al. 1999) seems to indicate that aquifer compaction is more of a concern in relatively thick semi-consolidated silt and clay layers.

A review of monitoring well bore logs was conducted to characterize the variability in aquifer sediments:

- The upper zone of the Upper Aquifer (A1) is generally between 80 and 120 feet bgs. The brown clay layer that separates the A1 and A2 in the Upper Aquifer is generally located within 120 and 140 feet bgs and the lower zone of the Upper Aquifer (A2) is generally between 140 and 160 bgs.
- In the southern Hinkley Valley near the Mojave River, soils are made up of mostly sand or mixed soils (interspersed sand/silt/clay layers).
- In the central Hinkley Valley, there is a pronounced hydraulic depression in the lower zone of the Upper Aquifer (A2) beneath the Desert View Dairy and extending northward to the Gorman AU and eastward to the Cottrell AU. To the east of the depression, there is the exposed bedrock

that differentiates the North and South Hinkley Valleys, and south of the depression, there is no brown clay layer present so there is no separation between the upper and lower zones (A1 and A2) of the Upper Aquifer.

- Although the site stratigraphy varies throughout the project area, in the northern part of the project area, the brown clay layer is thicker and more abundant, such as near Burnt Tree Road, where clay soils (fine-grained soils) are present between 80 and 150 feet bgs.
- The confined lower aquifer is composed of more consolidated weathered granite, sands, and finer-grained sediments and may be less subject to compaction.

Based on the data review, the upper aquifer at Hinkley includes a mix of unconsolidated coarser-grained material (medium- to coarse-grained sand) and finer-grained (primarily silt with some clay) sediments. In the floodplain depositional environment in the Hinkley Valley, sediments making up the aquifer generally become smaller in size with distance from the river. Farther from the river, there are more areas containing finer-grained sediments that may have more potential for compaction. Throughout the aquifer, coarser-grained sediments are likely to be the primary water-bearing strata and are not likely to suffer permanent compaction. However, where fine sediments dominate, there is greater potential for compaction and adverse effects on aquifer yields.

As described above, there has been historic groundwater drawdown due to agricultural irrigation between the 1930s and early 1990s that reportedly resulted in up to 90 feet of groundwater drawdown in the Hinkley Valley (Stamos et al 2001). The likely area of this drawdown is between the Mojave River and Thompson Road based on historic areas of agricultural use over this period. In these areas, the substrate has likely been “pre-stressed” by prior historic drawdown, such that any aquifer compaction would likely have already occurred in the past. This area also contains substrates that are dominated by coarse materials (such as sand) that are less susceptible to compaction and associated subsidence. In these areas, substantial aquifer compaction due to new groundwater drawdown is not considered likely. However, evidence of compaction (such as land subsidence) is often difficult to detect in active agricultural areas (due to frequent plowing which can make localized subsidence difficult to observe). In addition, compaction and associated land subsidence may have occurred in open desert areas and may not have been noticed or reported. The southern and central portions of the project area contain limited localized areas containing the “brown clay” layer of fines and thus there may still be limited potential for land subsidence in the southern and central portions of the project area.

The northern portions of the project area (in OU-3) contain areas where the substrate has a higher percentage of fine silts and clays that may be more susceptible to aquifer compaction. In addition, since the historic areas of agriculture extended from the Mojave River to around Thompson Road, areas further north of Thompson Road are less likely to have been “pre-stressed” by historic groundwater drawdown compared to the southern and central portions of the project area. Although large areas of the northern portion of the project area contain coarse substrates dominated by sand (such as along Mountain View Road between Sonoma Road and Mountain General Road), there are also some areas where the substrate has large intervals of fines, such as near Burnt Tree Road. Thus, there is a greater potential for aquifer compaction to occur in the northern portion of the project site.

As shown in Table 3.1-7, the No Project Alternative would not increase agricultural extractions and irrigation pumping volumes above existing conditions, and therefore, would not result in an increase in groundwater drawdown that would cause aquifer compaction.

As shown in Table 3.1-7 all of the action alternatives would increase groundwater pumping above existing conditions and would result in groundwater drawdown in portions of Hinkley Valley. Based on scaled pumping volumes and qualitative extrapolation of associated maximum drawdown depths and extents based on groundwater drawdown figures (Figures 3.1-14 through 3.1-18), as shown in Table 3.1-10, only Alternative 4C-4 is estimated to result in more than 90 feet of drawdown which would exceed the historic drawdown in the southern and central parts of the project area. However, all action alternatives would result in drawdown that would affect the northern part of the project area, possibly in excess of that resulting from historic agricultural activities.

Table 3.1-10: Estimated Effects of Groundwater Drawdown on Potential Aquifer Compaction

Alternative	90 feet or more of drawdown		Potential drawdown exceeding historic levels in southern and central part of project area?	Potential drawdown exceeding historic levels in northern part of project area?
	Feasibility Study flows	Scaled Flows		
No Project	No	No	No	No
Alternative 4B	No	No	No	Yes
Alternative 4C-2	No	No	No	Yes
Alternative 4C-3	No	No	No	Yes
Alternative 4C-4	No	Yes	Yes	Yes
Alternative 4C-5	No	No	No	Yes

Considering the specific characteristics of the upper aquifer in the Hinkley Valley and the historic drawdown in excess of 90 feet in most of the Hinkley Valley due to historic agricultural pumping, the evidence supports the following conclusions:

- The aquifer has been pre-stressed down to at least 90 feet and possibly deeper in the southern and central parts of Hinkley Valley. It is possible that drawdown affected domestic wells that were unreported to authorities. And it is possible that subsidence at open fields or desert may have gone unnoticed or were not reported in the past. All alternatives, other than Alternative 4C-4, should not result in groundwater drawdown levels that exceed historic drawdown levels in the southern and central parts of Hinkley Valley and thus should not result in stress levels to the aquifer in areas that have not been "pre-stressed" due to prior groundwater drawdown.
- The aquifer near the Mojave River continues to be productive today despite the prior historic drawdown, likely indicating that the productive capacity of the aquifer at this location was likely not substantially affected by prior compaction.
- However, since all of the alternatives include agricultural treatment units in the central part of the project area and all will include extraction for agricultural treatment in the northern part of the project area, there is the potential for significant compaction in the northern part of the project area which has relatively greater fines in the aquifer than areas closer to the river. It is possible that drawdown in this area of the Hinkley Valley could result in permanent compaction of part of the upper aquifer, resulting in permanent loss of aquifer water yield.

The areas of expected groundwater drawdown are shown in Figures 3.1-14 to 3.1-18 based on the feasibility study levels of groundwater extraction and drawdown that may affect additional areas with the potential levels of groundwater extraction necessary to address the expanded plume.

Given the available data about aquifer sediments in the project area and the prior historic groundwater drawdown, the overall potential for groundwater drawdown to result in substantial aquifer compaction is considered to be low, but the data do not support a definitive conclusion that compaction will not occur in the northern part of the project area or in localized other parts of the project areas where fine substrates may be present in portions of the substrate. Aquifer compaction can often only be detected after it occurs (due to changes in surface elevation or changes in aquifer yield) and it will be difficult to detect aquifer compaction due to remedial action. Given these facts, this is considered a potentially significant impact.

The environmental impact of aquifer compaction is considered significant because of the potential for loss of aquifer storage capacity and its effect on water supply (land subsidence is addressed separately in Section 3.4, *Geology and Soils*). **Mitigation Measure WTR-MM-2** would require monitoring of groundwater drawdown, modification of remedial actions to address drawdown and/or provision of replacement water. Water replacement for affected wells would be required for the duration of significant impairment including in perpetuity if remedial actions were to be identified to result in a significant permanent loss of aquifer capacity. The mitigation would reduce impacts to water supply to a less than significant level, but if aquifer capacity is diminished permanently this would be considered a significant and unavoidable impact.

No Project Alternative

Current agricultural treatment extractions are reportedly resulting in localized drawdown of about 10 feet. As described above, aquifer compaction would be less than significant for the No Project Alternative, because it would not increase agricultural extractions and irrigation pumping volumes above existing conditions. Therefore, this impact is less than significant.

Alternative 4B: Aquifer Compaction

As shown in Table 3.1-10, the maximum estimated groundwater drawdown for Alternative 4B (up to 70 feet) would not result in groundwater drawdown exceeding historic drawdown depths in the southern and central part of Hinkley and thus would not cause new "stress" which could result in aquifer compaction in this portion of the aquifer. However, Alternative 4B could result in groundwater drawdown in the northern part of the Hinkley Valley that may exceed historic levels and could result in aquifer compaction in this area, which is considered potentially significant. **Mitigation Measure WTR-MM-2** would reduce the impact to water supply wells to less than significant, but the impact to the aquifer may be significant and unavoidable.

Alternative 4C-2: Aquifer Compaction

As shown in Table 3.1-10, the maximum estimated groundwater drawdown for Alternative 4B (up to 70 feet) would not result in groundwater drawdown exceeding historic drawdown depths in the southern and central parts of Hinkley Valley and thus would not cause new "stress" which could result in aquifer compaction in this portion of the aquifer. However, Alternative 4C-2 could result in groundwater drawdown in the northern part of the Hinkley Valley that may exceed historic levels and could result in aquifer compaction in this area, which is considered potentially significant. **Mitigation Measure WTR-MM-2** would reduce the impact to water supply wells to less than significant, but the impact to the aquifer may be significant and unavoidable.

Alternative 4C-3: Aquifer Compaction

As shown in Table 3.1-10, the maximum estimated groundwater drawdown for Alternative 4B (up to 80 feet) would not result in groundwater drawdown exceeding historic drawdown depths in the southern and central part of Hinkley Valley and thus would not cause new "stress" which could result in aquifer compaction in this part of the aquifer. However, Alternative 4C-3 could result in groundwater drawdown in the northern part of the Hinkley Valley that may exceed historic levels and could result in aquifer compaction in this area, which is considered potentially significant. **Mitigation Measure WTR-MM-2** would reduce the impact to water supply wells to less than significant, but the impact to the aquifer may be significant and unavoidable.

Alternative 4C-4: Aquifer Compaction

As shown in Table 3.1-10, Alternative 4C-4 may, in theory, result in groundwater drawdown levels (> 100 feet) in excess of historic drawdown levels (>90 feet). This alternative has the greatest potential of all the alternatives to cause physical "stress" which could result in aquifer compaction in the Hinkley Valley aquifer. As discussed above, compaction is more likely to affect semi-consolidated finer-grained sediments than coarse-grained sediments. Given that the Hinkley Valley aquifer specific yield is dominated by coarse-grained sediment near the Mojave River, any compaction that might occur would likely be located farther in the downgradient flow direction or to the north. Since a large part of project implementation for Alternative 4C-4 will occur north of Highway 58, there is greater potential for significant compaction of the aquifer as one proceeds northward from the river.

As a consequence, Alternative 4C-4 may result in groundwater drawdown exceeding historic drawdown levels that may lead to permanent compaction of portions of the upper aquifer where fines dominate. This may result in permanent loss of aquifer water yield causing this impact to be considered potentially significant. **Mitigation Measure WTR-MM-2** would reduce the impact to water supply wells to less than significant, but the impact to the aquifer may be significant and unavoidable.

Alternative 4C-5: Aquifer Compaction

As shown in Table 3.1-10, the maximum estimated groundwater drawdown for Alternative 4C-5 (up to 70 feet) would not result in groundwater drawdown exceeding historic drawdown depths in the southern and central part of the Hinkley and thus would not cause new "stress" which could result in aquifer compaction in this part of the aquifer. However, Alternative 4C-5 could result in groundwater drawdown in the northern part of the Hinkley Valley that may exceed historic levels and could result in aquifer compaction in this area, which is considered potentially significant. **Mitigation Measure WTR-MM-2** would reduce the impact to water supply wells to less than significant, but the impact to the aquifer may be significant and unavoidable.

3.1.8.2 Water Quality Impacts

This section discusses the following impacts to groundwater quality:.

- containment and treatment of existing chromium contamination, which is a beneficial impact of remediation;
- conversion of hexavalent chromium to trivalent chromium;
- use of tracer compounds;

- incidental temporary localized chromium plume expansion due to remedial actions;
- increase in TDS (salts), uranium and other radionuclides due to agricultural treatment;
- increase in nitrate due to agricultural treatment;
- increase in iron, manganese, arsenic, or other constituents as byproducts due to in-situ remediation;
- potential degradation of water quality due to freshwater injection; and
- taste and odor effects on groundwater supply due to remedial actions.

Impact WTR-2a: Containment and Treatment of Existing Chromium Contamination (Beneficial Impact, All Alternatives)

All of the remedial action alternatives would reduce chromium contamination in the groundwater aquifer relative to existing conditions, which would be a beneficial effect on the environment, although the methods, scale, and time to cleanup are different for each alternative. The remedial action alternatives themselves would not increase chromium contamination nor be the cause of downgradient migration (except in the case of plume "bulging" which is considered a project impact and is addressed under Impact WTR-2d below).

Figure 3.1-5 shows the fourth quarter 2011 (Q4 2011) plume boundaries. Any future movement and spreading cannot be predicted exactly, but without additional plume containment and treatment, the chromium plume will likely continue to spread since current containment is only to Thompson Road. This existing condition is considered to be a risk to water quality and public health and would result in exposing additional domestic and agricultural wells to chromium-contaminated groundwater without further action. The health risks associated with chromium were previously discussed in Section 3.1.6, *Health Effects of Constituents in Groundwater*.

The "project" being analyzed in this EIR is the remediation of the chromium plume caused by a release to ground beginning more than 50 years ago. Since all the alternatives would result in varying degrees of remediation beyond that occurring at present, they would all provide an environmental benefit with respect to chromium. With the obvious concern about reducing current risks associated with the chromium plume, the analysis under this impact is focused on the differences between the alternatives in terms of how much benefit they would provide in terms of how fast they would clean up the Hinkley Valley aquifer.

Impacts related to containment and remediation of the chromium plume were determined using PG&E's Groundwater Flow Model developed by CH2MHILL in March 2010. The conceptual model is used to forecast likely future chromium plume movement (described in more detail in Appendix A and in PG&E's Feasibility Study and Addenda). This conceptual model was derived from the previous measurements of groundwater elevations and Cr[VI] concentrations, from the measured movement and concentrations of the Cr[VI] plume during the 20 years of intermittent remediation efforts (1991–2010), and from the results of PG&E modeling of groundwater elevations, movement, and Cr[VI] concentrations for treatment alternatives (Pacific Gas and Electric Company 2010a).

All of the remedial action alternatives would ultimately contain the entire plume, with the exception of the No Project Alternative. Data submitted to the Water Board at the end of 2011 show that the northern portion of the chromium plume past Thompson Road is not being captured by PG&E's current groundwater extraction (Pacific Gas and Electric Company 2011a).

The No Project Alternative is limited to actions to address the 2008–2010 plume area, as authorized in previous permits and environmental documents, and thus cannot contain the full plume. The recently issued CAO R6V-2008-0002A3 states that, as part of its effort to prevent further migration of chromium-affected groundwater, PG&E shall operate and maintain the existing groundwater extraction system (as of January 15, 2012) to achieve and maintain hydraulic capture within targeted areas on a year-round basis (Lahontan Regional Water Quality Control Board 2012). As shown in Table 3.1-11, with no new remedial measures, the timeframe for remediation of the entire chromium plume to the interim cleanup levels with the No Project Alternative could be closer to 1,000 years for areas outside the Q1/2010 plume. During this time, it is possible that the plume could reach as far as Harper Lake (approximately 5 miles north of the current known northern location of the chromium plume).

As shown in Table 3.1-11, the alternatives vary in the estimated time periods to reach the maximum background levels of 3.1 ppb for Cr[VI] and 3.2 ppb for Cr[T] and to achieve cleanup of the high concentration (>50 ppb) Cr[VI] area of the plume. Treatment of the lower concentration portion of the plume is addressed by agricultural treatment, whereas treatment of the high concentration (> 50 ppb) and some of the medium concentration (>10 ppb) portions of the plume are addressed with alternatives using in-situ remediation and ex-situ remediation with above-ground treatment facilities. The alternatives with the greatest area of agricultural treatment activities are expected to be more effective at treating the low concentration plume whereas, the alternatives with the greatest emphasis on in-situ and ex-situ remediation are expected to be more effective at treating the higher and medium portions of the plume.

Of the action alternatives, Alternative 4C-4 would have the shortest time period for treatment of the chromium plume because of the combination of in-situ treatment with the greatest extraction rate for agricultural treatment. Alternative 4C-5 would have the slowest time to remediation of the plume, but would remove the most mass of chromium from the aquifer instead of converting Cr[VI] to Cr[III] like the other alternatives. Alternative 4C-3 will also remove some chromium mass from the environment but not nearly to the extent as Alternative 4C-5.

Table 3.1-11: Estimated Time to Reach Cleanup of the Chromium (Cr[VI]) Plume

Alternatives	No Project	4B	4C-2	4C-3	4C-4	4C-5
Time to 50 ppb	6[a]	6	6	4	3	20
Time to 3.1 ppb cleanup	150/1,000[b]	40	39	36	29	50
Time to 1.2 ppb cleanup	325/1,000[b]	95	90	85	75	95
Time to 80% Cr[VI] Mass Conversion to Cr[III] or Removal	13[a]	10	7	6	6	15

Notes:

[a] Based on Feasibility Study Alternative No. 4 cleanup times because Feasibility Study Addendum No. 3 did not identify cleanup times for No Project conditions.

[b] The No Project Alternative has a projected cleanup time to 3.1 ppb of 150 years and to 1.2 ppb of 325 years based on Feasibility Study Alternative 4, but this time is limited to addressing the 2008—2010 plume. The time to cleanup areas outside of the Q1 2010 plume is estimated as > 1,000 years based on Feasibility Study Alternative 1.

As a beneficial impact, containment and remediation of the chromium plume relative to existing conditions is not an adverse water quality effect under CEQA and is not analyzed further in this section. However, the differences in containment, remedial methods, and timeframes to cleanup will be considerations for the Water Board when determining cleanup requirements in the new Cleanup and Abatement Order and associated WDRs for this site.

Impact WTR-2b: Conversion of Hexavalent Chromium to Trivalent Chromium (Less than Significant, All Alternatives)

One of the ways that remedial activities could alter chromium concentrations is via potential reconversion of Cr[III] to the Cr[VI] within the aquifer post remedial treatment. Cr[III] is common in soils and naturally occurs at levels of 0.5 to 6 mg/kg in the Hinkley area. PG&E estimated in Feasibility Study Addendum No. 3 that the potential contribution of in-situ remediation to Cr[III] levels would be approximately 0.01 to 0.8 mg/kg and thus would only change soil levels in a minimal way compared to existing naturally occurring levels (Pacific Gas and Electric Company2011c). The greatest mass of Cr[III] left in the environment from in-situ remediation will be in OU-1, at and just north of the Compressor Station. This mass would be left at the depth of the water table and deeper, or 75 to 105 feet below ground surface. Agricultural treatment will leave Cr[III] mass in soil at lesser concentrations within the top 5 feet of the soil, and over a wider area farther north in OU-2 and possibly OU-3.

Cr[III] is relatively stable in soil unless oxidizing agents (such as manganese oxides or oxygen at high pH) are present. Treated groundwater will be dominated by a reducing environment, with minimal to no oxidants present in the soil to convert Cr[III] to Cr[VI]. Cr[III] is a cation (positively charged molecule) with a strong affinity for a diverse array of anions (negatively-charged molecules) in the soil. As a result, Cr[III] is tightly bound to negatively-charged soil particles present at the site. The presence of organics in the shallow soils, and slightly alkaline soil pH with low natural oxidants in the soil, indicate that the Cr[III] will be unlikely to re-oxidize to Cr[VI] in the project area under normal conditions.

Significant conversion from Cr[III] back to Cr[VI] will only take place if there are changes in geochemical conditions, such as a significant change in pH. There can, however, be a limited reconversion as a result of natural geochemical processes, which typically result in overall Cr[VI] levels in groundwater at or around the natural background concentration.

In summary, several factors limit the re-conversion of Cr[III] to Cr[VI] after in-situ reduction: the minimal amount of Cr[III] added to the soil due to remediation when compared to naturally occurring levels, the limited solubility of the Cr[III] formed, and the lack of reactivity of an adequate oxidizer. Together, these factors are expected to limit reconversion of Cr[III] to Cr[VI]to levels similar to natural background. The Department of Toxic Substances (2011) also identified the general stability of Cr[III]in soil in their review of the Feasibility Study.

Therefore, there will be a less than significant impact to groundwater quality due to reduction of Cr[VI] to Cr[III] with agricultural treatment or in-situ remediation. This conclusion applies equally to all alternatives.

Impact WTR-2c: Water Quality Effects due to Use of Tracer Compounds (Less than Significant, All Alternatives)

Tracers, such as bromide and fluorescent dyes, are infrequently injected to groundwater to characterize flow conditions within the treatment areas. These tracer compounds are non-toxic and not expected to be reactive with current contaminants to be treated or other compounds used in the remediation process. For example, potassium bromide, a salt, is injected into the groundwater as a tracer compound at a concentration of approximately 500 ppm. The tracer is diluted during groundwater recirculation. As the tracer moves with groundwater, it decreases in concentration with distance from the injection point and should achieve water quality standards within the remedial cell boundaries. Similarly, dyes that are used are also non-toxic and would dilute during recirculation and would not affect water quality or result in staining for domestic or agricultural wells. Therefore, the tracer impacts on water quality are short term and will not affect beneficial uses outside the remedial cells during or after remediation activities. Therefore, there will be a less than significant impact to groundwater quality due to use of tracer compounds. This conclusion applies equally to all alternatives.

Impact WTR-2d: Temporary Localized Chromium Plume Spreading ("Bulging") Due to Remedial Activities (Less than Significant, No Project Alternative; Significant and Unavoidable for Aquifer and Less than Significant with Mitigation for Water Supply Wells, All Action Alternatives)

Methodology

As described above, increased remediation activities are intended to stop the spreading of the chromium plume and reduce concentrations in the drinking water aquifer. The long-term benefit of implementation of the project would be cleanup of the chromium plume to background levels and restoration of beneficial uses. However, in the following cases, remedial activities could cause the temporary spreading (referred to as "bulging") of the chromium beyond existing plume boundaries:

- direct injection into aquifer of reductant compounds and contaminated groundwater (IRZs);
- direct injection of uncontaminated groundwater (freshwater injections); and
- agricultural unit irrigation that occurs on the plume margins[10].

These plume movement occurrences are evaluated by examining the potential to alter the distribution of the plume (i.e., "bulge" effect).

This impact is considered significant if:

- remedial actions cause concentrations of hexavalent or total chromium in a water supply well to increase from below background levels to above background levels or increase by 10% or more if current levels are exceed the background level; or
- remedial actions cause an increase in concentrations of hexavalent or total chromium within a water supply well within 1 mile of the defined chromium plume.

Impact Overview

With the implementation of increased agricultural treatment and in-situ remediation, compared to existing conditions, temporary localized chromium plume bulging in the upper aquifer could occur in limited areas. Increased injection and irrigation could cause localized bulging. (Pacific Gas and Electric 2011c).

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[10] As shown in figures in Chapter 2, *Project Description*, most agricultural treatment units are currently proposed in the center of the plume area. However, it is possible that irrigation at the plume margin could result in plume bulging to the addition of water that would infiltrate to the aquifer.

For the No Project Alternative, continued implementation of plume containment measures required under Cleanup and Abatement Order R6V-2008-0002A3 will require adaptive measures (increased pumping or clean water injection) to maintain or reduce the existing plume boundaries.

Groundwater modeling for Alternatives 4C-2, 4C-3, 4C-4, and 4C-5 using the feasibility study injection and extraction rates did not indicate increased potential for plume bulging, given the balance of injection and extraction rates and the addition of extraction for agricultural treatment in the in-situ remediation area in these alternatives. However, remediation of the expanded plume will likely require greater extraction rates and possible changes in injection rates and thus it is possible that the balance of injection and extraction rates may ultimately not be completely effective at avoiding plume bulging in all locations at all times during remediation. Although hydraulic control (through groundwater extraction) can be used to prevent spread of chromium on a large-scale basis from remedial actions, in order to feasibly complete the remediation, localized plume bulging may at times be necessary to allow for effective operations. Where plume bulging results in any expansion of the plume, this is considered a potentially significant and unavoidable temporary impact to the aquifer. This impact is considered temporary as the Water Board will require all areas with chromium above background levels due to the original chromium plume or due to remedial actions to be remediated to background levels pursuant to its authority under California water law. Mitigation measures to control these impacts include: enhancement and maintenance of hydraulic control and plume water balance (**Mitigation Measure WTR-MM-3**) and provision of alternative water supply to affected wells (**Mitigation Measure WTR-MM-2**), as necessary.

With the implementation of plume containment monitoring, control, and alternative water supply as mitigation measures, this impact would be alleviated to a less than significant level for domestic and agricultural wells for all alternatives. The impact to the aquifer within the localized plume bulging areas will remain potentially significant and unavoidable until final cleanup of the chromium has returned the entire aquifer to background levels.

No Project: Spreading of Chromium Plume Due to Remedial Activities

The No Project Alternative would not meet project objectives to fully remediate the chromium plume. This alternative would not increase agricultural treatment irrigation over existing conditions. Localized expansion of the plume may occur in certain locations due to injection of water associated with in-situ remediation This localized expansion would be controlled through plume containment measures required under Cleanup and Abatement Order R6V-2008-0002A3 and modification of extraction rates and/or through provision of whole house replacement water to any affected residences required by existing Water Board orders.

Alternative 4B: Spreading of Chromium Plume Due to Remedial Activities

With the implementation of increased agricultural treatment irrigation and in-situ remediation injection with Alternative 4B, compared to existing conditions, temporary localized chromium plume bulging in the upper aquifer could occur. Alternative 4B would have greater agricultural treatment extraction and irrigation (up to 2,395 gpm compared to 1,100 gpm) and substantially higher in-situ remediation injection flows (up to 431 gpm compared to 190 gpm) compared to existing conditions. Thus, with increased irrigation and injection, there is a greater potential for localized plume bulging to occur during implementation.

Mitigation measures to control these impacts include: enhancement and maintenance of hydraulic control and plume water balance (**Mitigation Measure WTR-MM-3**) and alternative water supply (**Mitigation Measure WTR-MM-2**), as necessary. With these mitigation measures, this impact will be less than significant for domestic and agricultural wells. The impact to the aquifer within the plume bulging areas will remain potentially significant and unavoidable until final cleanup of the chromium has returned the entire aquifer to background levels.

Freshwater injection for plume control would similar to increased conditions.

Alternative 4C-2: Spreading of Chromium Plume Due to Remedial Activities

With the implementation of increased agricultural treatment irrigation and in-situ remediation injection with Alternative 4C-2, compared to existing conditions, temporary localized chromium plume bulging in the upper aquifer could occur. Alternative 4C-2 would have greater agricultural treatment extraction and irrigation (up to 3,167 gpm compared to 1,100 gpm) and substantially higher in-situ remediation injection flows (up to 431 gpm compared to 190 gpm) compared to existing conditions. Thus, with increased injection and irrigation, there is a greater potential for localized plume bulging to occur during implementation.

Mitigation measures to control these impacts include the following: enhancement and maintenance of hydraulic control and plume water balance (**Mitigation Measure WTR-MM-3**) and alternative water supply (**Mitigation Measure WTR-MM-2**), as necessary. With these mitigation measures, this impact will be less than significant for domestic and agricultural wells. The impact to the aquifer within the plume bulging areas will remain temporarily significant and unavoidable until final cleanup of the chromium has returned the entire aquifer to background levels.

Freshwater injection for plume control would similar to increased conditions.

Alternative 4C-3: Spreading of Chromium Plume Due to Remedial Activities

With the implementation of increased agricultural treatment irrigation and in-situ remediation injection with Alternative 4C-3, compared to existing conditions, temporary localized chromium plume bulging in the upper aquifer could occur. Alternative 4C-3 would have greater agricultural treatment extraction and irrigation (up to 4,388 gpm compared to 1,100 gpm) and substantially higher in-situ remediation injection flows (up to 431 gpm compared to 190 gpm) compared to existing conditions. Thus, with increased injection and irrigation, there is a greater potential for localized plume bulging to occur during implementation.

Mitigation measures to control these impacts include: enhancement and maintenance of hydraulic control and plume water balance (**Mitigation Measure WTR-MM-3**) and alternative water supply (**Mitigation Measure WTR-MM-2),** as necessary. With these mitigation measures, this impact will be less than significant for domestic and agricultural wells. The impact to the aquifer within the plume bulging areas will remain temporarily significant and unavoidable until final cleanup of the chromium has returned the entire aquifer to background levels.

Freshwater injection for plume control would similar to increased conditions.

Alternative 4C-4: Spreading of Chromium Plume Due to Remedial Activities

Alternative 4C-4 would have similar effects as Alternative 4C-3 because it would have similar levels of groundwater extraction and irrigation and in-situ remediation injection flows.

Mitigation measures to control these impacts include: enhancement and maintenance of hydraulic control and plume water balance (**Mitigation Measure WTR-MM-3**) and alternative water supply (**Mitigation Measure WTR-MM-2**), as necessary. With these mitigation measures, this impact will be less than significant for domestic and agricultural wells. The impact to the aquifer within the plume bulging areas will remain temporarily significant and unavoidable until final cleanup of the chromium has returned the entire aquifer to background levels.

Freshwater injection for plume control would similar to increased conditions.

Alternative 4C-5: Spreading of Chromium Plume Due to Remedial Activities

With the implementation of increased agricultural treatment irrigation and in-situ remediation injection with Alternative 4C-5, compared to existing conditions, spreading the chromium plume in the upper aquifer could occur. Alternative 4C-5 would have greater agricultural treatment extraction and irrigation (up to 3,167 gpm compared to 1,100 gpm) and higher in-situ remediation injection flows (up to 244 gpm compared to 190 gpm) compared to existing conditions. Because Alternative 4C-5 would use ex-situ treatment for the high concentration source area, it would have lower carbon-amended injection flows in the source area than all other action alternatives and would have less potential for plume bulging in the southern part of the plume. Thus, even though Alternative 4C-5 would have less in-situ injection then other alternatives, compared to existing conditions, the increased injection would have a greater potential for localized plume bulging.

Mitigation measures to control these impacts include: enhancement and maintenance of hydraulic control and plume water balance (**Mitigation Measure WTR-MM-3**) and alternative water supply (**Mitigation Measure WTR-MM-2**), as necessary. With these mitigation measures, this impact will be less than significant for domestic and agricultural wells. The impact to the aquifer within the plume bulging areas will remain temporarily significant and unavoidable until final cleanup of the chromium has returned the entire aquifer to background levels.

Freshwater injection for plume control would similar to increased conditions.

Impact WTR-2e: Increase in Total Dissolved Solids, Uranium, and Other Radionuclides due to Agricultural Treatment (Temporarily Significant and Unavoidable for Aquifer and Less than Significant with Mitigation for Water Supply Wells)

Methodology

The use of agricultural treatment could result in increased concentrations of certain elements in groundwater, such as TDS, uranium, and other radionuclides in groundwater (nitrate is discussed separately under Impact WTR-2f). Potential impacts related to TDS were analyzed by reviewing the remedial history at the PG&E Hinkley site in terms of the effect of prior agricultural treatment and the concentrations of TDS in the aquifer at present. Potential impacts related to uranium and other radionuclides were analyzed by review of the limited data available at Hinkley, studies of agricultural irrigation and uranium levels in the San Joaquin Valley, and consideration of groundwater chemistry.

Where existing levels of TDS, uranium or other radionuclides are less than the primary or secondary Maximum Contaminant Level and remedial activities result in concentrations that exceed a primary or secondary Maximum Contaminant Level, this is considered a significant impact. Where existing levels of TDS in groundwater in the study area already exceed the secondary Maximum Contaminant

Levels (both federal and state), an increase of more than 20% above existing levels is considered significant. Where existing levels of uranium and gross alpha already exceed the primary Maximum Contaminant Level (presently known to occur in wells near the Gorman agricultural treatment unit) a 10% increase in uranium and gross alpha concentrations above current levels is considered significant. In areas where TDS, uranium or other radionuclide levels do not exceed the Maximum Contaminant Levels, this impact is considered significant if levels increase by 20%. Finally, where any of the above conditions are found in a water supply well or monitoring well within one-half mile upgradient or one-quarter mile cross gradient of another water supply well, this is also considered a significant impact.

Impact Overview

Total Dissolved Solids

Agricultural treatment of chromium in groundwater would likely result in increased TDS in the water that infiltrates back to the aquifer below the irrigated land as a result of increased concentrations of TDS in the root zone due to evaporation. During periods where more irrigation water is applied that is taken up by evapotranspiration, the solids in the root zone are flushed down to the water table. Such irrigation periods typically occur when seeds and plants are starting to germinate and the weather is on the cool side.

In some of the proposed areas for increased agricultural treatment, TDS levels already exceed 1,500 ppm (up to nearly 6,000 ppm near Thompson Road), but some of the easternmost and westernmost areas where agricultural treatment is proposed have current levels of less than 1,000 ppm. Levels greater than 1,000 ppm would compromise the drinkability of domestic supply wells. Crop sensitivity varies. Some crops can experience decreased yields when TDS levels are in excess of 1,000 ppm, whereas more salt-tolerant crops (such as alfalfa) will only experience substantial decreases in yields at much higher concentrations.

There is a potential for remedial actions to cause an increase of TDS levels above levels that would compromise domestic supply wells (or increase levels substantially that are already above secondary Maximum Contaminant Levels). In addition, given that existing levels between SR 58 and Thompson Road are already highly elevated, in large part due to prior and ongoing dairy operations, the project could contribute over time to increases that may compromise agricultural uses. This is considered to impair the beneficial use of the aquifer for other users in the Hinkley Valley. As a result, this impact of agricultural treatment would be significant.

Mitigation of increased TDS concentrations in the aquifer as a whole is generally feasible but challenging. TDS can be removed from the water by reverse osmosis or boiling but is expensive and energy-intensive. These methods separate out TDS which would then need to be disposed of outside of the area. PG&E has successfully implemented one such above ground treatment plant involving reverse osmosis at the Topock Compressor Station on the Colorado River. This facility, which began operating in 2005, treated contaminated groundwater up to 135 gallons per minute and successfully removed chromium, other metals, and TDS. The added benefit from this system was the offsite disposal of treatment brine that resulted in improved water quality to the aquifer.

Another option to reduce this impact to the aquifer (to less than 1,000 ppm TDS) would be to move some of the irrigated agricultural treatment to locations above the chromium plume where TDS concentrations are relatively low (less than 750 ppm), or by using extracted groundwater from the chromium plume with relatively low TDS concentrations for agricultural treatment. However, some of the existing plume has TDS concentrations greater than 1,000 ppm. If agricultural treatment were discontinued or limited to only using water with low TDS concentrations, this would reduce remedial options available to PG&E to completely clean up the chromium plume. Because agricultural treatment is one of the major methods being proposed by PG&E for successful chromium remediation, the impact of all alternatives of increasing TDS concentrations in the aquifer is considered significant and would need to be mitigated to protect the other beneficial users of the aquifer.

For drinking water supply wells, mitigation of increased TDS concentrations is feasible. Either the impact to drinking water wells could be avoided or treated after the fact. In the past, PG&E implemented agricultural land treatment by purchasing land from willing sellers and also acquired drinking water wells that were removed from potable uses. For drinking water wells previously contaminated from dairy operation, the Water Board has required the provision of alternate water supply or well head treatment to remove TDS prior to potable use. Alternative water supplies could be provided through provision of an alternative water supply (through tanks and water trucking, or alternative wells and piping) or possibly through drilling of deeper wells if the deeper aquifer can be shown to meet standards for TDS.

Because prior dairy activities have resulted in elevated TDS levels in the project area, it is important to determine separately the effect of new agricultural treatment activities on TDS levels. **Mitigation Measure WTR-MM-5** requires investigation and monitoring of TDS levels to identify where and when remedial actions result in significant impacts in order to determine when replacement water and/or aquifer restoration are warranted. **Mitigation Measure WTR-MM-2** requires alternative water supplies for all affected wells and control of byproduct plumes where feasible. While replacement water can address water supply wells effects, there would remain the potential for long-term impairment of beneficial uses of the aquifer, even after completion of remediation of the chromium plume. **Mitigation Measure WTR-MM-4** requires restoration of the drinking water aquifer from all substantial water quality impairments resultant from remedial activity within a timely manner.

With implementation of these mitigation measures, the impacts from all alternatives to water supply wells and the long-term beneficial uses of the aquifer would be reduced to less than significant. However, where full avoidance of significant byproduct increases are not feasible there could be a temporary significant and unavoidable impact on the aquifer as TDS levels could increase in order to implement chromium plume remediation activities.

Uranium and Other Radionuclides

In-Situ Remediation is not likely to result in increases in uranium or other constituents. As described above, in-situ remediation using carbon amendments creates chemically reducing conditions, resulting in the conversion of Cr[VI] to Cr[III]. Uranium chemistry is similar to that of chromium, in that the U[VI] form is much more mobile than the reduced Ur[III] form, which tends to bind to soils. Like Cr[VI], U[VI] can be changed to U[III] by microbial action in low oxygen, reducing conditions. This process has been studied by the U.S. Department of Energy, most notably at Hanford, Oak Ridge and Old Rifle sites which all have uranium contamination in groundwater (Seyrig 2010; DOE 2012 at http://ifchanford.pnnl.gov/; NRC 2008). The tendency of uranium to bind to soils is also influenced by soil grain size (tends to adhere to more fine grain soils), and pH/carbonate effects (DOE 2012). In-situ remediation with carbon amendment has been used successfully at several sites with man-made uranium groundwater contamination (DOE 2012). At the Hinkley site, because reducing conditions created by in-situ remediation for addressing the chromium plume also support reduction of U[VI] to the less mobile U[III], U[VI] concentrations should not increase in groundwater due to in-situ remediation and this impact is not considered further in this analysis.

As described above for in-situ remediation, uranium in groundwater can be reduced to a less mobile form under reducing conditions. Agricultural treatment for chromium plume remediation works by exposing chromium-contaminated irrigation water to subsurface root zone conditions that contain a reducing environment that converts soluble Cr[VI] to relatively immobile Cr[III]. Thus, naturally-occurring uranium in agricultural treatment water should also be immobilized by the reducing environment, and remain bound to soil particles.

However, other geochemical conditions and pumping could also affect uranium and other radionuclide conditions. One study in the San Joaquin Valley suggested that the combination of increased bicarbonate concentrations in the soil zone and increases in the rate of downward groundwater flow due to groundwater pumping for agricultural use could increase the mobilization of uranium and cause it to migrate to deeper parts of the aquifer (Jurgens, B.C. et al 2009). However, there are only limited data to date on uranium levels in the agricultural treatment areas so the actual potential for agricultural treatment to affect naturally occurring uranium levels is currently unknown. In addition, it is unknown if carbonate conditions may be present in a similar way in the local aquifer as described in the San Joaquin Valley study.

In addition, uranium and radionuclide levels are generally found to be higher in groundwater closer to bedrock strata since they originate in bedrock. As a result, when groundwater pumping results in a lowering of the water table, it can draw more preferentially from deeper levels which can have higher concentrations of these constituents. Further, as part of implementing Mitigation Measure WTR-MM-2, deeper wells may be provided in order to supply replacement water which may result in further draw on deeper aquifer waters.

Since data is limited on uranium and radionuclide conditions in the project area and the net effect of agricultural treatment and other pumping, this EIR conservatively considers this impact to be potentially significant and requires further evaluation. This impact is considered potentially significant and unavoidable for the aquifer but can be mitigated for potentially affected water supply wells. Investigation, monitoring and contingency actions will be required in the event that agricultural treatment is found to have the potential to increase naturally-occurring uranium or other radionuclides in groundwater per **Mitigation Measure WTR-MM-5** and if necessary alternative water supplies will be required to be provided to affected wells per **Mitigation Measure WTR-MM-2**. **Mitigation Measure WTR-MM-4** would require restoration of the drinking water aquifer from all substantial water quality impairments resultant from remedial activity within a timely manner.

No Project: Increase in Total Dissolved Solids, Uranium and Other Radionuclides due to Agricultural Treatment

Although there will be no increase in irrigation for the agricultural treatment activities above existing conditions as part of the No Project Alternative, continued operations will likely temporarily increase TDS concentrations depending on the applied concentrations and crop uptake.

Measures included in prior WDRs to keep TDS concentrations within these levels include monitoring and adjustment of groundwater extraction and discharge and groundwater treatment and other methods. WDR R6V-2008-0014 specifies that TDS shall not increase more than 25 percent above current conditions. With implementation of the prior WDR requirements, the effects of agricultural treatment on TDS would likely be less than significant for this alternative.

As described above, there is currently a lack of data to determine whether or not existing agricultural treatment has affected naturally occurring uranium or other radionuclide levels. Given that the existing CAOs and WDRs do not address this potential effect, should the No Project Alternative be selected, then **Mitigation Measures WTR-MM-2, WTR-MM3 and WTR-MM-5** would be required to reduce this impact for affected wells to a less than significant level.

Alternative 4B: Increase in Total Dissolved Solids, Uranium and Other Radionuclides due to Agricultural Treatment

Alternative 4B would have greater agricultural treatment extraction and irrigation (up to 2,395 gpm) compared to existing conditions and the No Project Alternative (1,100 gpm) and thus will have increased impacts on TDS. Larger areas of the chromium plume compared to existing conditions will be affected by increased TDS concentrations during remediation. The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-19. With implementation of **Mitigation Measures WTR-2, WTR-MM-4, and WTR-MM-5**, impacts to drinking water supplies related to TDS can be reduced to less than significant. Where complete avoidance of significant TDS increase is not feasible during remediation, there would be temporary degradation of the aquifer during remediation which would be significant and unavoidable, but **Mitigation Measure WTR-MM-4** would require ultimate remediation of any significant TDS increases due to remedial actions in the end.

As described above, there is currently a lack of data to determine whether or not existing agricultural treatment have affected naturally-occurring uranium and other radionuclide levels. If existing agricultural treatment has increased levels of these constituents, then Alternative 4B would increase them further due to the increase in agricultural treatment. Potential impacts to water supply wells and permanent impacts to the aquifer can be mitigated to a less than significant level through investigation, monitoring, alternative water supply, and aquifer restoration per **Mitigation Measures WTR-MM- 2, WTR-MM-4, and WTR-MM-5**. However, temporary impacts to the aquifer may be significant and unavoidable if increases in uranium or other radionuclides cannot be avoided during remediation without substantially impeding chromium remediation progress.

Alternative 4C-2: Increase in Total Dissolved Solids, Uranium and Other Radionuclides due to Agricultural Treatment

Alternative 4C-2 would have greater agricultural treatment extraction and irrigation (up to 3,167 gpm) compared to existing conditions and the No Project Alternative (1,100 gpm) and thus will have greater impacts on TDS. Larger areas of the plume than existing conditions will be affected by increased TDS concentrations during remediation. The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-20. With implementation of **Mitigation Measures WTR-2, WTR-MM-4, and WTR-MM-5**, impacts to the drinking water aquifer and wells related to TDS can reduce impacts to less than significant. Where complete avoidance of significant TDS increase is not feasible, there would be temporary degradation of the aquifer during remediation which would be significant and unavoidable, but **Mitigation Measure WTR-MM-4** would require ultimate remediation of any significant TDS increases due to remedial actions in the end.

As described above, there is currently a lack of data to determine whether or not existing agricultural treatment have affected naturally-occurring uranium and other radionuclide levels. If existing agricultural treatment has increased levels of these constituents, then Alternative 4C-2 would increase them further due to the increase in agricultural treatment. Potential impacts to water supply wells and permanent impacts to the aquifer can be mitigated to a less than significant level through investigation, monitoring, alternative water supply, and aquifer restoration per **Mitigation Measures WTR-MM- 2, WTR-MM-4, and WTR-MM-5**. However, temporary impacts to the aquifer may be significant and unavoidable if increases in uranium or other radionuclides cannot be avoided during remediation without substantially impeding chromium remediation progress.

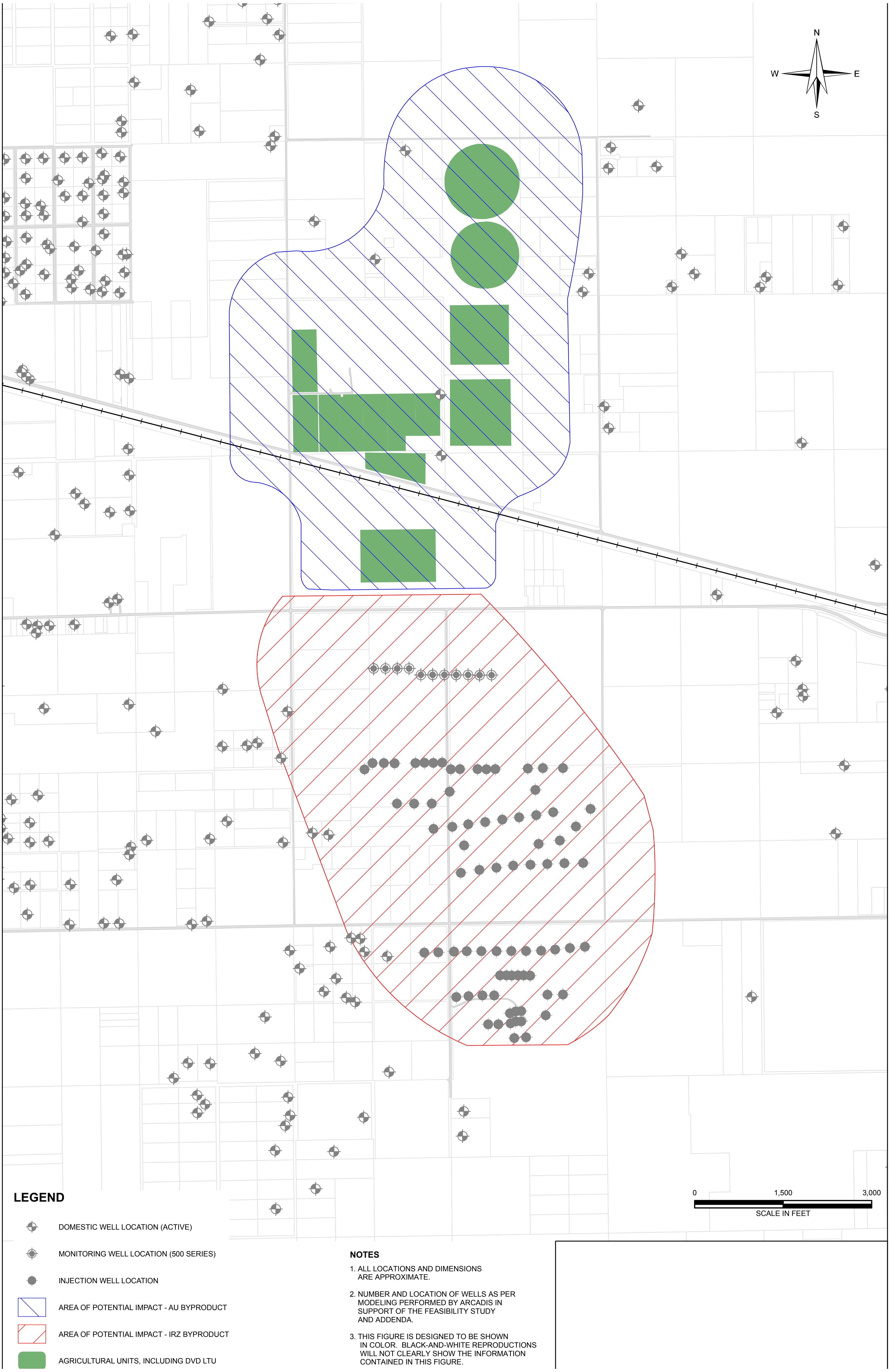
Alternative 4C-3: Increase in Total Dissolved Solids, Uranium and Other Radionuclides due to Agricultural Treatment

Alternative 4C-3 would have greater agricultural treatment extraction and irrigation (up to 4,388 gpm) compared to existing conditions and the No Project Alternative (1,100 gpm) and thus will have greater impacts on TDS. Larger areas of the plume than existing conditions will be affected by increased TDS concentrations during remediation. During winter, this alternative would employ some above-ground treatment for hexavalent chromium removal and reduced agricultural treatment. Above-ground treatment would not result in increased concentration of TDS because it would avoid evaporation that occurs with irrigation. Since treatment wastes would be transported offsite for disposal, this alternative would have the added benefit of permanently removing TDS, chromium, other metals, and radionuclides from the environment. The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-21. With implementation of **Mitigation Measures WTR-2, WTR-MM-4, and WTR-MM-5**, impacts to the aquifer in wells related to TDS can be reduced to less than significant. Where complete avoidance of significant TDS increases is not feasible, there would be temporary degradation of the aquifer during remediation which would be significant and unavoidable, but **Mitigation Measure WTR-MM-4** would require ultimate remediation of any significant TDS increases due to remedial actions in the end.

As described above, there is currently a lack of data to determine whether or not existing agricultural treatment have affected naturally-occurring uranium or other radionuclide levels. If existing agricultural treatment has increased levels of these constituents, then Alternative 4C-3 would also increase levels further due to the increase in agricultural treatment. Potential impacts to water supply wells and permanent impacts to the aquifer can be mitigated to a less than significant level through investigation, monitoring, alternative water supply, and aquifer restoration per **Mitigation Measures WTR-MM- 2, WTR-MM-4, and WTR-MM-5**. However, temporary impacts to the aquifer may be significant and unavoidable if increases in uranium or other radionuclides cannot be avoided during remediation without substantially impeding chromium remediation progress.

Alternative 4C-4: Increase in Total Dissolved Solids, Uranium and Other Radionuclides due to Agricultural Treatment

Alternative 4C-4 would have the greatest agricultural treatment extraction and irrigation (up to 4,388 gpm) compared to existing conditions and the No Project Alternative (1,100 gpm) and thus will have far greater impacts on TDS. Larger areas of the plume than existing conditions will be affected by increased TDS concentrations during remediation. While Alternative 4C-4 has the same maximum extraction flows for agricultural treatment as Alternative 4C-3, it would have a higher impact on TDS in groundwater due to continuous, year-round agricultural treatment. In comparison, Alternative 4C-3 would use above-ground treatment to treat only the winter excess water the AUs could not use and agricultural treatment the rest of the year. The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-22. With implementation of **Mitigation**



NOTES

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Source: Prepared by PG&E, 2012 for the EIR considering remedial byproduct monitoring results to date.

Graphics ... 00122.11 (8-16-12)

Figure 3.1-19
Likely Areas Affected by Remedial Byproduct Plumes, Alternative 4B

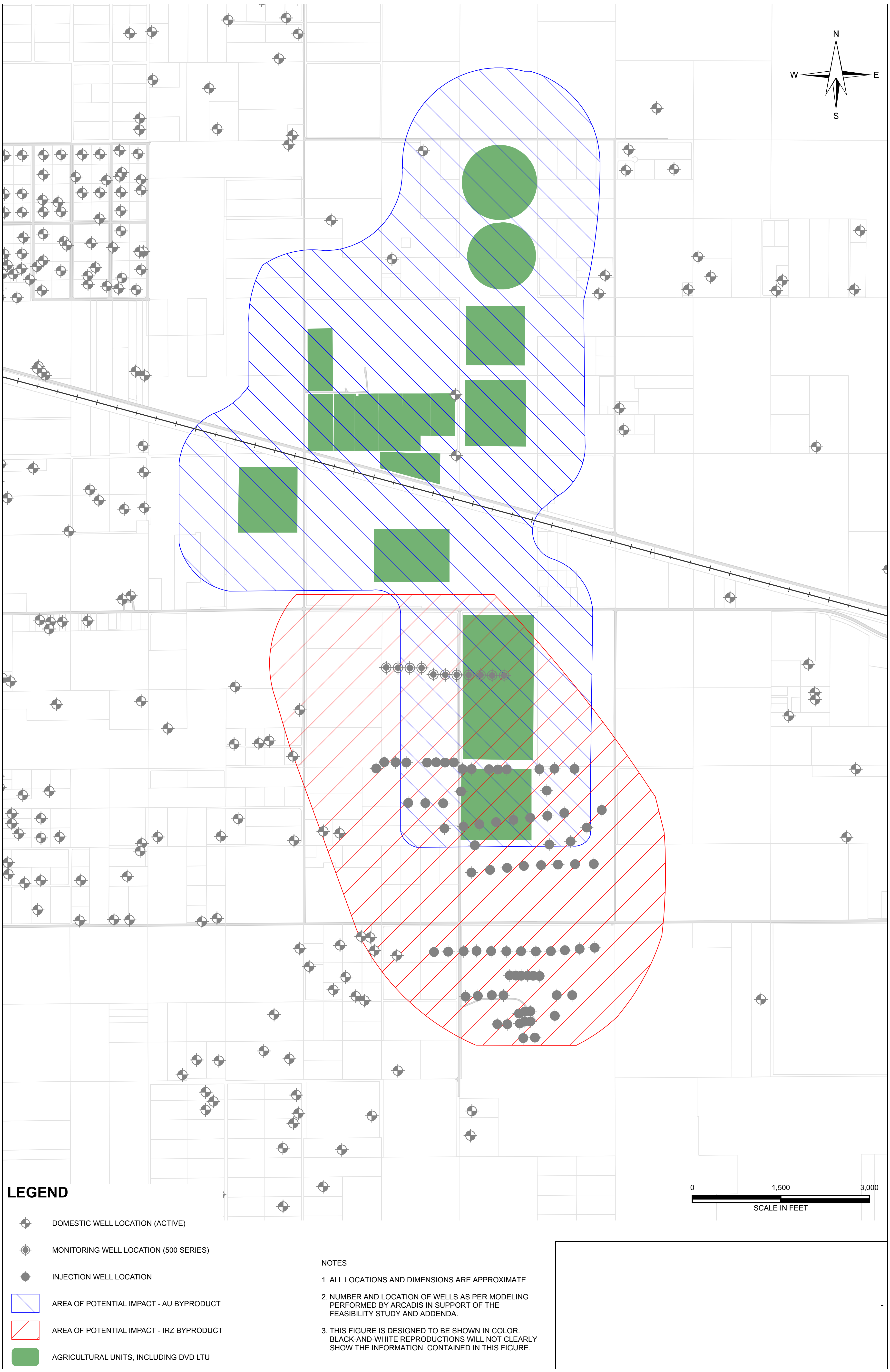

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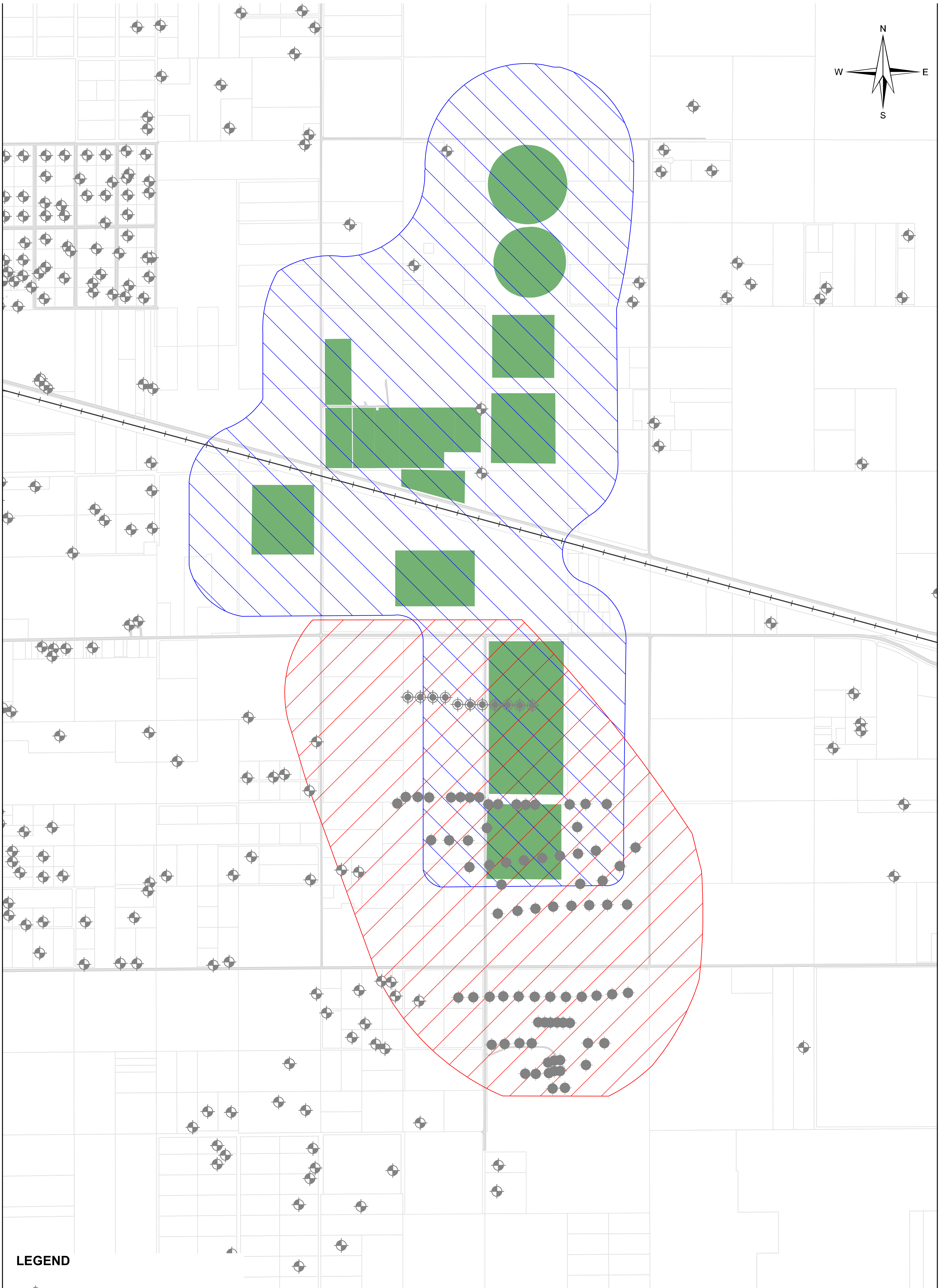
Figure 3.1-20
Likely Areas Affected by Remedial Byproduct Plumes, Alternative 4C-2



LEGEND

- DOMESTIC WELL LOCATION (ACTIVE)
- MONITORING WELL LOCATION (500 SERIES)
- INJECTION WELL LOCATION
- AREA OF POTENTIAL IMPACT - AU BYPRODUCT
- AREA OF POTENTIAL IMPACT - IRZ BYPRODUCT
- AGRICULTURAL UNITS, INCLUDING DVD LTU

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Source: Prepared by PG&E, 2012 for the EIR considering remedial byproduct monitoring results to date.

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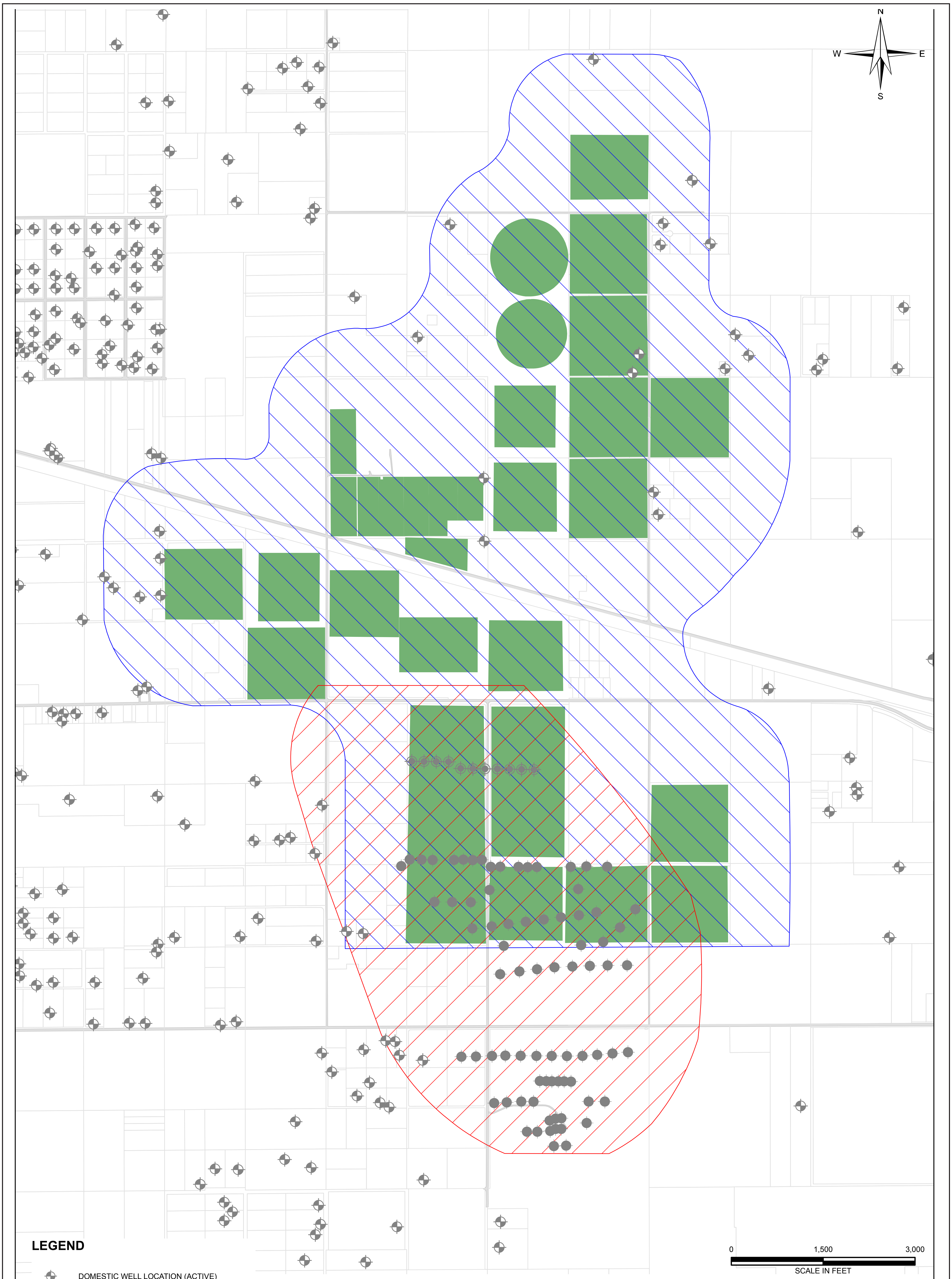
Figure 3.1-21
Likely Areas Affected by Remedial Byproduct Plumes, Alternative 4C-3



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Source: Prepared by PG&E, 2012 for the EIR considering remedial byproduct monitoring results to date.

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Figure 3.1-22
Likely Areas Affected by Remedial Byproduct Plumes, Alternative 4C-4

Measures WTR-2, WTR-MM-4, and WTR-MM-5, impacts to the aquifer and drinking water wells related to TDS can reduce impacts to less than significant. Where complete avoidance of significant TDS increases is not feasible, there would be temporary degradation of the aquifer during remediation which would be significant and unavoidable, but **Mitigation Measure WTR-MM-4** would require ultimate remediation of any significant TDS increases due to remedial actions in the end.

As described above, there is currently a lack of data to determine whether or not existing agricultural treatment have affected naturally occurring uranium or other radionuclide levels. If existing agricultural treatment has increased levels of these constituents, then Alternative 4C-4 would also increase them further due to the increase in agricultural treatment. Potential impacts to water supply wells and permanent impacts to the aquifer can be mitigated to a less than significant level through investigation, monitoring, alternative water supply, and aquifer restoration per **Mitigation Measures WTR-MM- 2, WTR-MM-4, and WTR-MM-5**. However, temporary impacts to the aquifer may be significant and unavoidable if increases in uranium or other radionuclides cannot be avoided during remediation without substantially impeding chromium remediation progress.

Alternative 4C-5: Increase in Total Dissolved Solids, Uranium and Other Radionuclides due to Agricultural Treatment

Although this alternative would use above-ground treatment for remediation of hexavalent chromium in the source area where concentrations are greatest, it would still utilize agricultural treatment for remediation of the lower concentration part of the plume. Therefore, impacts from implementing Alternative 4C-5 would be similar to other alternatives in regards to TDS. Alternative 4C-5 would have greater agricultural treatment extraction and irrigation (up to 3,167 gpm) compared to existing conditions and the No Project Alternative (1,100 gpm) and thus will have greater impacts on TDS. Larger areas of the plume than existing conditions will be affected by increased TDS concentrations during remediation. The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-23. With implementation of **Mitigation Measures WTR-2, WTR-MM-4, and WTR-MM-5** impacts to drinking water aquifer and wells related to TDS can reduce impacts to less than significant. Where complete avoidance of significant TDS increase is not feasible, there would be temporary degradation of the aquifer during remediation which would be significant and unavoidable, but **Mitigation Measure WTR-MM-4** would require ultimate remediation of any significant TDS increases due to remedial actions in the end.

As described above, there is currently a lack of data to determine whether or not existing agricultural treatment have affected naturally occurring uranium and other radionuclide levels. If existing agricultural treatment has increased levels of these constituents, implementing Alternative 4C-5 would also increase them due to the increase in agricultural treatment. Potential impacts to water supply wells and permanent impacts to the aquifer can be mitigated to a less than significant level through investigation, monitoring, alternative water supply, and aquifer restoration per **Mitigation Measures WTR-MM- 2, WTR-MM-4, and WTR-MM-5**. However, temporary impacts to the aquifer may be significant and unavoidable if increases in uranium or other radionuclides cannot be avoided during remediation without substantially impeding chromium remediation progress.

Impact WTR-2f: Changes in Nitrate Levels due to Agricultural Treatment (Less than Significant, No Project Alternative; Beneficial for the Aquifer Overall and Less than Significant with Mitigation for Water Supply Wells, All Action Alternatives)

Methodology

The overall long-term effect of agricultural treatment will be removal of nitrate from groundwater due to crop uptake, which will be a beneficial effect for the aquifer as a whole. However, if groundwater were extracted from an area of higher nitrate concentrations and then treated in agricultural units in an area with lower nitrate concentrations, it is theoretically possible that nitrate concentrations could increase locally in the latter areas if plant uptake was not complete or extensive percolation occurs to groundwater such as in cooler times of the growing season.

This potential localized impact was analyzed by examining the possibility for different alternatives to extract groundwater from locations with relatively higher nitrate concentrations and discharge to areas of lower nitrate concentrations.

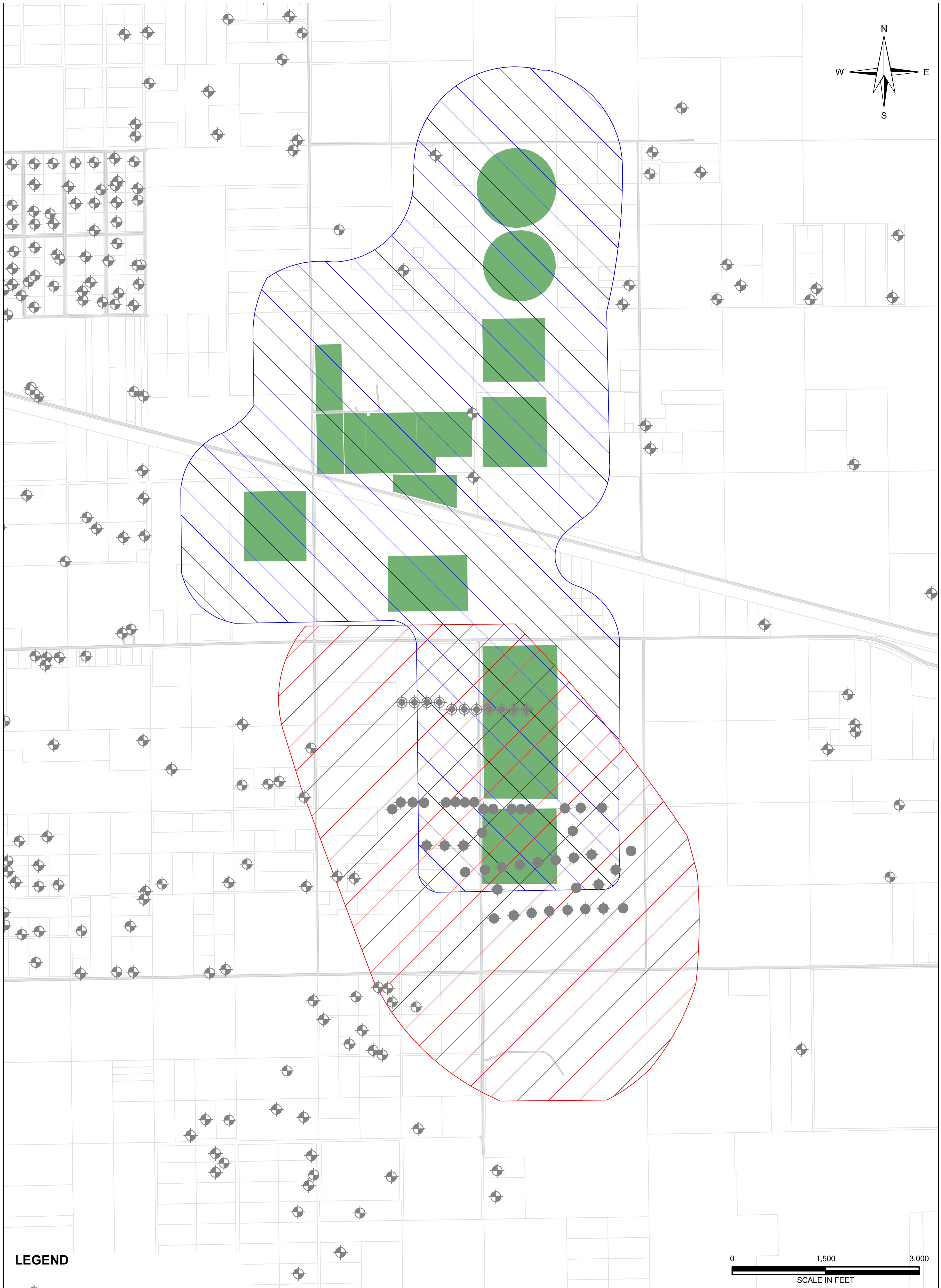
This impact is considered significant if remedial activities would increase nitrate concentrations in groundwater or water supply wells to levels above Maximum Contaminant Levels (if current concentrations are less than the standard) or would increase nitrate concentration by more than 10% (if current concentrations exceed the standard) or would increase nitrate concentration by more than 20% (if current concentrations do not exceed the standard). Finally, where any of the above conditions are found in a water supply well or a monitoring well within one-half mile upgradient or one-quarter mile cross gradient of a water supply well, this is also considered a significant impact

Impact Overview

All alternatives discussed in this document would not add nitrates as part of remedial actions and thus would not increase the amount of nitrate in the aquifer overall beyond that which already exists. However, since all alternatives involve agricultural treatment of the chromium plume, they all could change concentrations of nitrate in the aquifer locally as extracted water may have different levels of nitrate than present in the aquifer beneath irrigated land. If the extracted water has higher levels of nitrate than present in the aquifer beneath irrigated land, irrigation could result in increased of nitrate concentrations in the local part of the aquifer and in water supply wells.

Agricultural treatment has the potential to reduce the nitrate concentration in the aquifer when the applied nitrate water is used by crops as nutrients. Agricultural treatment units located in the same area as groundwater extraction will reduce nitrate concentration in that area over time. As described above under Existing Setting, nitrate concentrations in extracted groundwater applied to existing agricultural treatment units have been shown to be reduced by up to 90%. The overall effect of agricultural treatment will be removal of nitrate from groundwater, which will be a beneficial effect for the aquifer as a whole.

There is, however, potential for localized nitrate increases to still occur due to movement of water during remediation. The project areas with known highest nitrate concentrations (40 ppm as N or higher) are in the central part of the project area between Acacia Road and Thompson Road (See Figure 3.1-8). As shown on Figure 3.1-8, south of Acacia Road, most of the nitrate concentrations are less than 20 ppm N with some areas, such as west of Summerset Road, having concentrations less than 10 ppm N. If groundwater were extracted from an area of higher nitrate concentrations and



LEGEND

- DOMESTIC WELL LOCATION (ACTIVE)
- MONITORING WELL LOCATION (500 SERIES)
- INJECTION WELL LOCATION
- AREA OF POTENTIAL IMPACT - AU BYPRODUCT
- AREA OF POTENTIAL IMPACT - IRZ BYPRODUCT
- AGRICULTURAL UNITS, INCLUDING DVD LTU

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Source: Prepared by PG&E, 2012 for the EIR considering remedial byproduct monitoring results to date.

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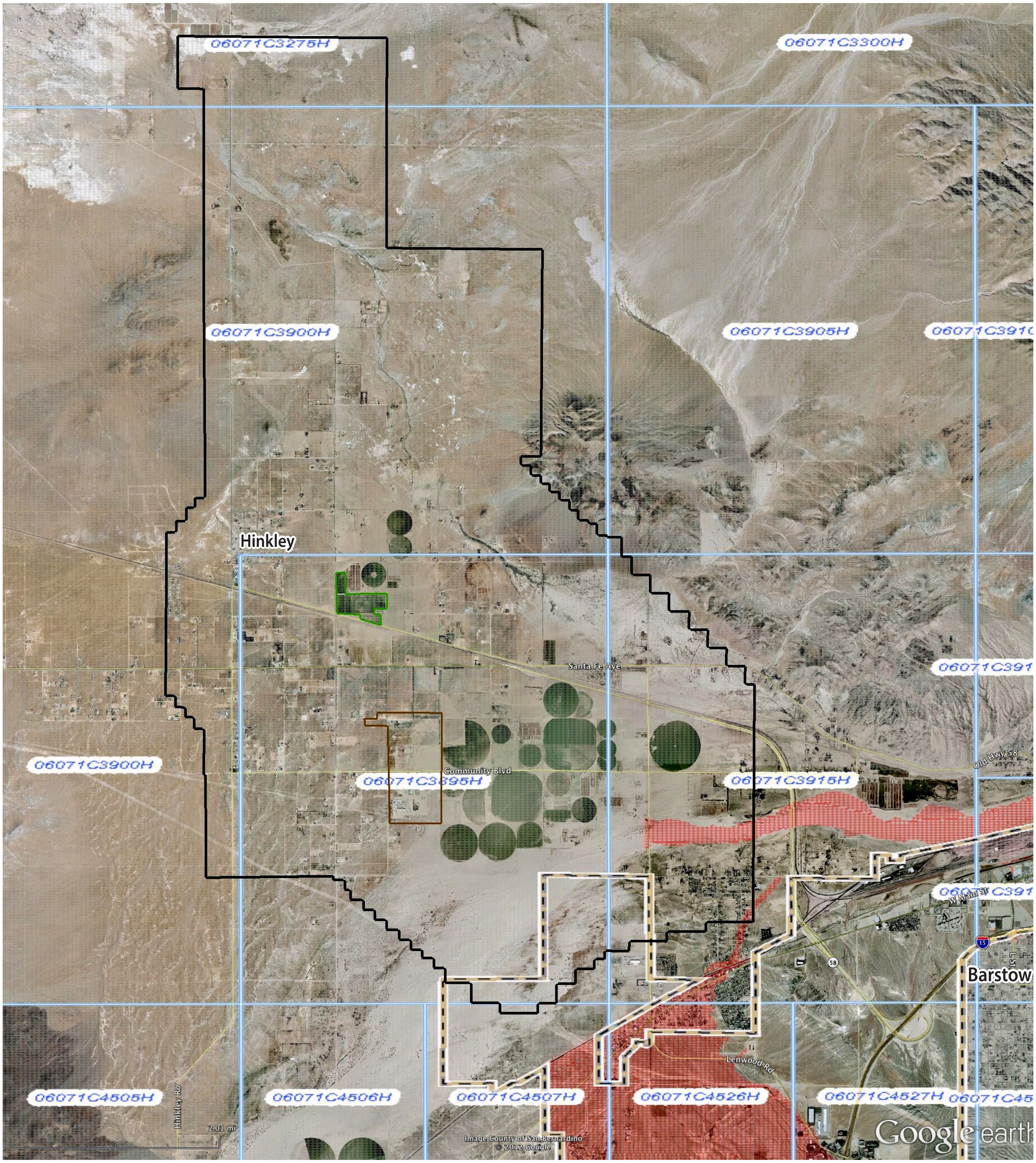
Figure 3.1-23
Likely Areas Affected by Remedial Byproduct Plumes, Alternative 4C-5



Project Study Area

High Risk Areas: A and V zones

AE A AH AO AR A99 VE V

Other information: Jurisdictions

0 1 2

Miles

N

Sources: Google Inc. 2012. Google Earth Pro, Version 6.1. Mountain View, CA. Accessed: April 11, 2012; National Flood Hazard Layer Web Map Service *Stay Dry v. 2* (https://hazards.fema.gov/femaportal/wps/portal/NFHLWMSkmzdownload).

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Figure 3.1-24
Flood Hazard Map

then discharged in an area with lower nitrate concentrations, it is theoretically possible that nitrate concentrations could increase in those areas due to percolation. Adversely changing the water quality of the aquifer may be a significant impact if the time of impact was long term or if there is a significant increase in nitrate concentrations in a water supply well.

However, this potential impact can be addressed with the implementation of mitigation measures that involve monitoring nitrate levels and managing agricultural treatment to avoid increases in nitrate concentration above 10 ppm (as N) by more than significance criteria compared to existing conditions (per **Mitigation Measure WTR-MM-7**). This may be done by monitoring nitrate levels at agricultural treatment units, managing extraction source water, and or providing alternative water supplies (for affected wells) if necessary. Implementation of this mitigation measure would reduce nitrate impacts to a less than significant level.

No Project: Changes in Nitrate Levels in the Hinkley Valley Aquifer due to Agricultural Treatment

As described above, prior agricultural treatment activities as part of remediation of the chromium plume has resulted in reduction of nitrate levels overall. The No Project Alternative does not propose to change agricultural treatment compared to existing conditions.

WDR R6V-2008-0014 specifies that nitrate levels shall not exceed water quality standards or increase more than 25 percent above current conditions. Current monitoring and management of nitrate levels during remediation activities will continue as required by current Water Board orders. Therefore nitrate concentrations are unlikely to increase as part of the No Project Alternative compared to existing conditions and this impact would be less than significant.

Alternative 4B: Changes in Nitrate Levels in the Hinkley Valley Aquifer due to Agricultural Treatment

Alternative 4B involves increased groundwater pumping for agricultural treatment of the chromium plume compared to existing conditions, which could change concentrations of nitrate in the aquifer below the irrigated land. Overall, Alternative 4B would over time result in reduction of nitrate levels through agricultural treatment.

Alternative 4B would include a new pivot (the Yang pivot) directly south of the Cottrell agricultural treatment unit, in an area where existing nitrate concentrations are mostly of 10 ppm or less. Depending on where groundwater is extracted from, it may contain nitrate concentrations greater than 10 ppm. In addition, additional agricultural treatment units will be required for this alternative to address the expanded plume and they may also be located in areas with nitrate concentration less than 10 ppm, such as along Summerset Road. Where agricultural treatment uses water extracted from areas with higher nitrate concentrations than that in the groundwater beneath the agricultural treatment unit, nitrate concentrations could increase.

The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-19.

This potential impact to local parts of the aquifer can be addressed with the implementation of mitigation measures that involve monitoring nitrate levels and managing agricultural treatment to avoid significant increases in nitrate concentrations (per **Mitigation Measure WTR-MM-7**). This may be done by only applying water with nitrate concentrations less than 10 ppm and/or through demonstrated pilot studies showing that application of water with higher concentrations is not resulting in any significant increase in nitrate levels. Where necessary, alternative water supplies will be required for affected water supply wells. Implementation of this mitigation measure would reduce this impact to a less than significant level.

Alternative 4C-2: Changes in Nitrate Levels in the Hinkley Valley Aquifer due to Agricultural Treatment

Alternative 4C-2 involves increased groundwater pumping for agricultural treatment of the chromium plume compared to existing conditions, which could change concentrations of nitrate in the water that infiltrates back to the aquifer below the irrigated land. Overall, Alternative 4C-2 would over time result in reduction of nitrate levels through agricultural treatment.

Alternative 4C-2 would include new pivots (the Yang, Bell South and North, and West pivots) in areas with existing nitrate concentrations mostly of 20 ppm or less. Depending on where groundwater is extracted from, it may contain nitrate concentrations greater than 20 ppm. In addition, additional agricultural treatment units will be required for this alternative to address the expanded plume and they may also be located in areas with nitrate concentration less than 10 ppm, such as along Summerset Road. Where agricultural treatment uses water extracted from areas with higher nitrate concentrations than that in the groundwater beneath the agricultural treatment unit, nitrate concentrations could increase.

The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-20.

This potential impact to local parts of the aquifer can be addressed with the implementation of mitigation measures that involve monitoring nitrate levels and managing agricultural treatment to avoid significant increases in nitrate concentrations (per **Mitigation Measure WTR-MM-7**). This may be done by only applying water with nitrate concentrations less than 10 ppm and/or through demonstrated pilot studies showing that application of water with higher concentrations is not resulting in any significant increase in nitrate levels. Where necessary, alternative water supplies will be required for affected water supply wells. Implementation of this mitigation measure would reduce this impact to a less than significant level.

Alternative 4C-3: Changes in Nitrate Levels in the Hinkley Valley Aquifer due to Agricultural Treatment

This impact would be similar to that previously described for Alternative 4C-2. The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-21. Impacts to the aquifer from agricultural treatment would be overall beneficial by reducing nitrate levels over time.

Although pumping for agricultural treatment would be greater for this alternative compared to Alternative 4C-2, the agricultural treatment unit acreages would be the same. As described for Alternative 4C-2, potential impacts to local parts of the aquifer would be addressed with implementation of **Mitigation Measure WTR-MM-7** (monitoring and management of nitrate levels). Where necessary, alternative water supplies will be required for affected water supply wells. Implementation of this mitigation measure would reduce this impact to a less than significant level.

Alternative 4C-4: Changes in Nitrate Levels in the Hinkley Valley Aquifer due to Agricultural Treatment

Alternative 4C-4 involves increased groundwater pumping for agricultural treatment of the chromium plume compared to existing conditions, which could change concentrations of nitrate in the water that infiltrates back to the aquifer below the irrigated land. The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-22. Overall, Alternative 4C-4 would over time result in reduction of nitrate levels in the aquifer through agricultural treatment.

Alternative 4C-4 would include new pivots, some in areas with existing nitrate concentrations mostly of 20 ppm or less and some such as along Summerset Road, with nitrate concentrations of 10 ppm or less. Depending on where groundwater is extracted from it may contain nitrate concentrations greater than 20 ppm or 10 ppm. Where agricultural treatment uses water extracted from areas with higher nitrate concentrations than that in the groundwater beneath the agricultural treatment unit, nitrate concentrations could increase locally.

This potential impact to local parts of the aquifer can be addressed with the implementation of mitigation measures that involve monitoring nitrate levels and managing agricultural treatment to avoid significant increases in nitrate concentrations (per **Mitigation Measure WTR-MM-7**). This may be done by only applying water with nitrate concentrations less than 10 ppm and/or through demonstrated pilot studies showing that application of water with higher concentrations is not resulting in any significant increase in nitrate levels. Where necessary, alternative water supplies will be required for affected water supply wells. Implementation of this mitigation measure would reduce this impact to a less than significant level.

Alternative 4C-5: Changes in Nitrate Levels in the Hinkley Valley Aquifer due to Agricultural Treatment

This impact would be similar to that previously described for Alternative 4C-2 due to a similar level of agricultural treatment. Impacts to the aquifer from agricultural treatment would be overall beneficial by reducing nitrate levels over time.

The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-23. Potential impacts to local parts of the aquifer from agricultural treatment would be addressed through implementation of **Mitigation Measure WTR-MM-7** (monitoring and management of nitrate levels). Where necessary, alternative water supplies will be required for affected water supply wells. Implementation of this mitigation measure would reduce this impact to a less than significant level.

Impact WTR-2g: Increase in Other Secondary Byproducts (Dissolved Arsenic, Iron and Manganese) due to In-Situ Remediation (Less than Significant, No Project Alternative; Temporarily Potentially Significant and Unavoidable for Aquifer and Less than Significant with Mitigation for Water Supply Wells, All Action Alternatives)

Methodology

In-situ remediation may result in temporary mobilization of byproduct metals (arsenic, manganese, and iron) naturally present in aquifer soils as a result of anaerobic (oxygen-poor, also called "reducing") groundwater conditions caused by injecting carbon into the aquifer for remediation of the chromium plume. Mobilization of these metals can result in an increase in the concentration of dissolved arsenic, manganese, and iron in groundwater.

This impact was evaluated by examining monitoring data from pilot testing of in-situ remediation using carbon amendment to date in terms of the generation of byproducts and the use of in-situ remediation by the different alternatives.

This impact is considered significant if in-situ remediation results in an increase of concentrations above primary or secondary Maximum Contaminant Levels, an increase of 10% or more of arsenic if current levels are more than the primary Maximum Contaminant levels, an increase of 20% of more of iron or manganese if current levels are more than secondary Maximum Contaminant Level, or an increase of 20% or more if current levels are less than the primary or secondary Maximum Contaminant Levels. Finally, where any of the above conditions are found in a water supply well or a monitoring well within one-half mile upgradient or one-quarter mile cross gradient of a water supply well, this is also considered a significant impact.

Impact Overview[11]

All alternatives would increase in-situ remediation compared to existing conditions. Temporary degradation of the aquifer near carbon amendment injection points is unavoidable if in-situ remediation is to be employed. As previously described, elevated byproduct concentrations in groundwater have been detected at distances estimated greater than 1,600 feet downgradient of injection points. If carbon amendment injection rates are increased and/or groundwater movement is locally faster than in the IRZs implemented to date, then the zone of influence could be greater than 1,600 feet experienced previously.

As well as measures already being performed to reduce potential impacts, proposed mitigation measures can help further reduce impacts to domestic water supplies.

If iron, manganese, or arsenic levels in a domestic water supply well are increased above the primary or secondary Maximum Contaminant Levels, PG&E will be required to provide alternative water supply (per **Mitigation Measure WTR-MM-2**). In addition, PG&E will be required to construct and operate additional extraction wells downgradient of the IRZ treatment area to intercept carbon amendments and secondary by product to prevent effects to domestic water supply wells (per **Mitigation Measure WTR-MM-7**) and other receptors. Implementation of these mitigation measures would reduce this impact to a less than significant level for domestic, community, and agricultural wells.

While this impact can be mitigated, control of the byproduct plumes by limiting the byproduct plume extent through extraction wells, or limiting the rate of carbon injections to the aquifer could compromise the pace of chromium plume remediation. Should the Water Board allow temporary aquifer degradation due to byproduct plume generation to achieve more rapid or complete chromium plume remediation, then the aquifer would be temporarily degraded and this would be a significant and unavoidable impact.

[11] Aboveground ex-situ treatment (Alternatives 4C-3 and 4C-5 only) would include filtering of any precipitated metals prior to reinjection into the aquifer, thus managing potential increases in arsenic, iron, manganese or other metals and their effect on the aquifer. As described in Chapter 2, *Project Description*, filter precipitates may contain hazardous waste levels of chromium or other elements and will be disposed of in offsite facilities approved to receive such material. There would be less than significant impacts on byproduct concentrations due to aboveground treatment and this impact is not analyzed further under this impact.

Prior experience with in-situ remediation has shown that concentrations of remedial byproducts return to background levels as the injected carbon is consumed by microbial processes and is diluted with downgradient migration. This has occurred within a matter of months with prior pilot studies and prior remediation efforts. Thus, concentrations of iron, manganese, and arsenic are expected to return to pre-injection background levels within several months to several years following the end of carbon injection based on experience with in-situ remediation to date. However, in case any residual effect were to be present near the end of chromium plume remediation activities, PG&E would be required to restore aquifer water quality conditions to the pre-project (pre-remedial) condition in order to restore beneficial uses of the aquifer to what they were before implementation of the remedial actions included in the proposed project as described in **Mitigation Measure WTR-MM-4**.

No Project: Increase in Other Byproducts Due to In-Situ Remediation

As part of the No Project Alternative, in-situ remediation will not be increased above existing conditions. As described above, in-situ remediation has resulted in an increase in byproduct (arsenic, iron, manganese) generation in areas downgradient from injection points and these increases can exceed primary and/or secondary Maximum Contaminant Levels.

WDR R6V-2008-0014 specifies that groundwater concentrations of byproducts outside the plume area shall not exceed water quality standards.[12] Degradation of water quality in domestic supply wells can be avoided through the existing IRZ Contingency Plan which includes specific measures to be performed if threshold concentrations of byproducts specified in the General Permit for IRZ treatment (Lahontan Regional Water Quality Control Board 2009) are exceeded at designated monitoring wells within the project area. This plan includes adaptive measures, such as reduced carbon amendment concentrations or additional extraction wells near the plume boundary to avoid byproduct increases compromising domestic water supply well water quality.

The IRZ Contingency Plan (Pacific Gas and Electric 2011c, *Appendix H—Contingency Plan for Hydraulic Capture and Treatment*) requires avoidance of the following in domestic water supply wells:

- increases in arsenic concentrations above current conditions;
- increase in iron concentrations above the secondary drinking water Maximum Contaminant Level of 300 ppb (or increases in iron if already above the Maximum Contaminant Level); and
- increases in manganese concentrations above the secondary drinking water Maximum Contaminant Level of 50 ppb (or increases in manganese if already above the Maximum Contaminant Level).

Mobilization of these metals would be controlled by decreasing injected carbon concentrations in the injection wells. This would minimize the size and magnitude (i.e., redox potential) of the reduction zone and would allow the carbon to be depleted more quickly from the groundwater.

[12] R6V-2008-0014 requires groundwater concentrations of remedial byproducts outside the plume area to meet all primary and secondary Maximum Contaminant Levels except for Total Dissolved Solids and nitrate which already exceed standard levels. See discussion of existing TDS and Nitrate levels in Section 3.1.4.3 above and Figures 3.1-7 and 3.1-8.

This impact would be less than significant with PG&E's continued implementation of previously required requirements such as the IRZ Contingency Plan (Lahontan Regional Water Quality Control Board 2009) and the latest Manganese Mitigation Plan (Pacific Gas and Electric 2011h). With the implementation of these previously required mitigation measures, this impact would be less than significant for the No Project Alternative.

Alternative 4B: Increase in Other Byproducts Due to In-Situ Remediation

The implementation of increased in-situ remediation as part of Alternative 4B could result in increased levels of byproducts, such as dissolved arsenic, iron, and manganese in the groundwater compared to existing conditions. Alternative 4B would increase carbon-amended injection rates from 190 gpm (at present) up to 431 gpm. Mobilization of byproduct metals can be controlled by reducing injected carbon concentrations and/or reducing injection flows, as described in the existing IRZ Contingency Plan. However, decreasing carbon injections could interfere with achieving project cleanup goals, and maintaining higher injection rates may be desired to maintain cleanup speed. In managing the tradeoff between faster cleanup and greater byproduct creation, faster cleanup may be desirable in the long run.

The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-19.

Where byproduct concentrations are increased above the significance criteria described above, this is considered a significant impact to the aquifer. Byproduct concentrations could also be exceeded at designated monitoring wells, and if unmitigated could affect domestic wells and this impact would be significant. Implementation of **Mitigation Measure WTR-MM-2** (alternative water supply)and/or **Mitigation Measure WTR-MM-7** (use of extraction wells to intercept byproduct plumes) would reduce this impact to less than significant for domestic and agricultural wells.

However, temporary impacts to the aquifer (not to water supply wells) during remediation may be significant and unavoidable in the event that the Water Board allows temporary degradation to occur in favor of accelerated chromium plume remediation.

Alternative 4C-2: Increase in Other Byproducts Due to In-Situ Remediation

The implementation of increased in-situ remediation as part of Alternative 4C-2 would have the same impacts as Alternative 4B as it would have the same level of in-situ remediation.

The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-20.

Where byproduct concentrations are increased above the significance criteria, this is considered a significant impact to the aquifer. Impacts to domestic supply wells due to in-situ remediation byproducts would be less than significant with implementation of **Mitigation Measure WTR-MM-2** (alternative water supply) and/or **Mitigation Measure WTR-MM-7** (use of extraction wells to intercept byproduct plumes).

However, temporary impacts to the aquifer (not to water supply wells) during remediation may be significant and unavoidable in the event that the Water Board allows temporary degradation to occur in favor of accelerated chromium plume remediation.

Alternative 4C-3: Increase in Other Byproducts Due to In-Situ Remediation

The implementation of increased in-situ remediation as part of Alternative 4C-3 would have the same impacts as Alternatives 4B and 4C-2 as it would have the same level of in-situ remediation.

The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-21.

Where byproduct concentrations are increased above the significance criteria this is considered a significant impact to the aquifer. Impacts to domestic supply wells due to in-situ remediation byproducts would be less than significant with implementation of **Mitigation Measure WTR-MM-2** (alternative water supply) and/or **Mitigation Measure WTR-MM-7** (use of extraction wells to intercept byproduct plumes).

However, temporary impacts to the aquifer (not to water supply wells) during remediation may be significant and unavoidable in the event that the Water Board allows temporary degradation to occur in favor of accelerated chromium plume remediation.

Alternative 4C-4: Increase in Other Byproducts Due to In-Situ Remediation

The implementation of increased in-situ remediation as part of Alternative 4C-4 would have the same impacts as Alternative 4B, 4C-2, and 4C-3 as it would have the same level of in-situ remediation.

The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-22.

Where byproduct concentrations are increased above the significance criteria, this is considered a significant impact to the aquifer. Impacts to domestic supply wells due to in-situ remediation byproducts would be less than significant with implementation of **Mitigation Measure WTR-MM-2** (alternative water supply) and/or **Mitigation Measure WTR-MM-7** (use of extraction wells to intercept byproduct plumes).

However, temporary impacts to the aquifer (not to water supply wells) during remediation may be significant and unavoidable in the event that the Water Board allows temporary degradation to occur in favor of accelerated chromium plume remediation.

Alternative 4C-5: Increase in Other Byproducts Due to In-Situ Remediation

This impact would be similar to that previously described for other action alternatives. However, Alternative 4C-5 does not include in-situ remediation in the Source Area IRZ; it includes only the Central Area IRZ and the South Central Reinjection Area, and as such, the overall in-situ treatment and thus the magnitude of this impact under this alternative would be less than for other action alternatives.

The area of likely effect for remedial byproducts for this alternative is shown in Figure 3.1-23.

Where byproduct concentrations are increased above the significance criteria, this is considered a significant impact to the aquifer. Impacts to domestic supply wells due to in-situ remediation byproducts would be less than significant with implementation of **Mitigation Measure WTR-MM-2** (alternative water supply) and/or **Mitigation Measure WTR-MM-7** (use of extraction wells to intercept byproduct plumes).

However, temporary impacts to the aquifer (not to water supply wells) during remediation may be significant and unavoidable in the event that the Water Board allows temporary degradation to occur in favor of accelerated chromium plume remediation.

Impact WTR-2h: Potential Degradation of Water Quality due to Freshwater Injection (Less than Significant with Mitigation, All Alternatives)

Freshwater is extracted from three supply wells (PGE-14, FW-01, and FW-02) located south of the Compressor Station property and injected at the western plume boundary. This action would continue under all alternatives.

One of the current supply wells used by PG&E at its Compressor Station for freshwater injection has concentrations of arsenic up to 60 ppb, which far exceeds the Maximum Contaminant Level of 10 ppb. Prior to injection of this water into the injection well field, the water is filtered through an ion exchange system to remove naturally-occurring arsenic to concentrations below the Maximum Contaminant Level (Pacific Gas and Electric 2010a). As described in Chapter 2, *Project Description*, all alternatives will include filtration or pretreatment of water for arsenic to ensure that naturally-occurring arsenic is not introduced into the injection area.

As shown in Figures 3.1-7 (TDS), Figure 3.1-8 (Nitrate), Figure 3.1-10 (TDS), and Figure 3.1-11 (Manganese), the location of the current supply well is in an area with relatively low levels of these constituents compared to other parts of the Hinkley Valley Aquifer. Use of water from the current source would not degrade water quality for these constituents at the injection point.

Data on uranium or other radionuclide levels for the current water supply wells used for freshwater water injection was not located and is limited in general for the Hinkley Valley. Thus, it is possible that uranium or other radionuclide levels in a water supply well used for freshwater injection could be higher that the location of injection.

Given the decades-long duration of remedial activities, it is also possible that future water supply wells may be located in other locations and/or the water quality of the current source water could change due to external factors. In order to ensure that freshwater injection does not result in significant degradation of water quality, **Mitigation Measure WTR-MM-8** will require water used for freshwater injection to meet applicable water quality standards or, if injection point water quality does not meet water quality standards, injection water must have water quality equal to or better than that at the injection point.

With this mitigation, freshwater injection would not result in a significant impact on water quality.

Impact WTR-2i: Taste and Odor Impacts due to Remedial Activities (Less than Significant, No Project Alternative; Less than Significant with Mitigation, All Action Alternatives)

Methodology

Agricultural treatment could increase TDS concentrations in groundwater, which could result in exceedance of taste standards for drinking water. Increase in the introduction of carbon amendments or other treatment byproducts to the groundwater due to in-situ remediation could affect taste and odor characteristics of the groundwater used for drinking water supplies.

This impact was analyzed by considering the potential for remedial activities to impair taste or odor characteristics of groundwater. Since potential taste and odor issues are related to TDS and other remedial byproducts (such as iron and manganese), this impact is considered significant if remedial activities result in exceedance of the significance criteria described above for remedial byproducts.

Impact Overview

Implementation of all alternatives would involve more intense application of the in-situ treatment compared to existing conditions, which would increase the introduction of carbon amendments and/or other treatment byproducts to the groundwater that could affect taste and/or odor. In most cases, carbon amendments should dissipate by anaerobic or aerobic microorganisms before reaching domestic water supply wells unless such wells are close to the injection point (experience to date indicates substantially elevated total organic carbon concentrations 400 to 800 feet downgradient of injection wells). Similarly, byproducts may migrate from the treatment zone, but it is expected that the concentrations of these compounds would usually dissipate before reaching domestic wells unless such wells are relatively close to the injection point. Taste and odor impacts to domestic supply wells due to in-situ remediation reagent injection would be less than significant with implementation of **Mitigation Measure WTR-MM-2** (alternative water supply), **Mitigation Measure WTR-MM-4** (remediation of byproduct plumes) and/or **Mitigation Measure WTR-MM-7** (use of extraction wells to intercept byproduct plumes).

All alternatives, other than the No Project Alternative, would also include more agricultural treatment than existing conditions, which could increase TDS as discussed above under Impact WTR-2e which could result in significant taste and odor impacts to domestic water supply wells. Taste and odor impacts to domestic supply wells due to agricultural treatment would be less than significant with implementation of **Mitigation Measure WTR-MM-2** (alternative water supply) and/or **Mitigation Measure WTR-MM-4** (remediation of byproduct plumes).

No Project: Taste and Odor Impacts Due to Remedial Activities

Implementation of the No Project Alternative would involve additional extraction and injection wells for in-situ treatment compared to existing conditions which would increase the potential for taste and odor impacts (agricultural treatment would be the same as existing conditions).

WDR R6V-2008-0014 requires that groundwater outside the proposed project boundaries not contain taste or odor-producing substances that cause nuisance or adversely affect beneficial uses. For groundwater designated as municipal or domestic supply, at a minimum, concentrations shall not exceed the secondary Maximum Contaminant Levels.

The IRZ Contingency Plan includes specific measures to be performed if threshold concentrations of Total Organic Carbon and/or secondary byproducts are exceeded at designated monitoring wells within the project area (Lahontan Regional Water Quality Control Board 2009). This plan requires adaptive measures (reduced carbon amendment concentrations) to eliminate any taste and odor concerns outside of the chromium plume boundary.

With the implementation of previously required mitigation measures, impacts of this alternative on taste and odor objectives would be less than significant.

All Action Alternatives: Taste and Odor Impacts Due to Remedial Activities

The implementation of both increased agricultural treatment and in-situ remediation as part of Alternatives 4B, 4C-2, 4C-3, 4C-4, and 4C-5 could degrade taste and odor characteristics of groundwater used for drinking water compared to existing conditions. Agricultural treatment impacts would result in increased TDS in groundwater which would increase with the amount of agricultural treatment and thus would be highest with Alternative 4C-4, roughly similar for Alternatives 4C-2, 4C-3, and 4C-5, and relatively the smallest with Alternative 4B. In-situ remediation impacts would be the same for Alternatives 4B, 4C-2, 4C-3, and 4C-4 due to similar levels of carbon-amended flows and somewhat less impacts with Alternative 4C-5 due to less use of carbon-amended flows.

Taste and odor impacts to domestic supply wells would be less than significant with implementation of **Mitigation Measure WTR-MM-2** (alternative water supply), **Mitigation Measure WTR-MM-4** (remediation of byproduct plumes) and/or **Mitigation Measure WTR-MM-7** (use of extraction wells to intercept byproduct plumes).

3.1.8.3 Drainage Impacts

This section discusses drainage impacts. Flooding impacts are discussed separately in Section 3.1.8.4

Impact WTR-3: Impacts Related to Drainage Patterns and Runoff (Less than Significant, All Alternatives)

The areas where project remedial activities would occur are located in geographically flat areas where most of the drainage will likely accumulate as localized pools and ultimately evaporate or infiltrate into surface soils, rather than being transported as sheet flow.

Implementation of project alternatives would not result in an alteration of drainage patterns such that erosion, siltation, or flooding will result on or off the project site. The project area has no surface drainage features other than surface irrigation drainage ditches (from historical flood irrigation) and small floodwater channels and washes. The nearest substantial surface water body to the project site is the Mojave River, located approximately 1 mile south of the Hinkley Compressor Station. There is also a sizable desert wash that runs parallel to Coon Canyon Road that drains much of Hinkley Valley toward Harper Lake.

The project alternatives would not exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of runoff. There would be an increase in impervious area due to new road segments, parking lots, and structures associated with the construction and operation of above-ground treatment plants (Alternatives 4C-3 and 4C-5 only). Implementation of project alternatives will create minor impervious surfaces for supporting infrastructure, such as treatment system equipment pads, wellhead protection pads, etc. However, these impacts would be minimal compared to the overall project area, as it would cover a small area compared to 21,093 acre project area, most of which consists of pervious land. Therefore, project alternatives would have less than significant impacts on drainage patterns and runoff.

3.1.8.4 Flooding Impacts

This section discusses physical impacts related to flooding.

Impact WTR-4: Impacts Related to Flooding (Less than Significant, All Alternatives)

Based on Federal Emergency Management Agency (FEMA) flood zone designation maps, the majority of the project area is not located within the 100-year floodplain and would not be subject to flood-related hazards. However, as shown in Figure 3.1-2, a small portion of the southeastern edge of the project area lies within a FEMA Special Flood Hazard Area (SFHA) Zone A, which is defined as area subject to inundation by the 1-percent-annual-chance flood event.

The portion of the project area that lies within an area of flood risk is located in an area where no structures are expected to be placed, with the exception of potential installation of new monitoring wells which would not impede or increase flood flows. Housing is not part of the project and therefore it will not involve placing housing within a 100-year flood hazard area. In addition, this project would likely not place structures within a 100-year flood hazard area that would impede or redirect flood flows or result in an increased risk in loss, injury or death due to flooding.

The majority of infrastructure associated with new wells lies underground, and surface well pads typically cover a small area (i.e., 10 square feet and 1 ft. in height) compared to the surrounding area and would not significantly impede flood flows.

This project would not expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam. As previously described, the flood hazard zone is located in a small area in the southeastern portion of the project area where minimal to no remedial activity is anticipated. There will be no significant alteration in drainages or large structures that would cause flooding in a non-flood hazard zone within the project area. Because the Mojave River is located outside of the area where remedial actions would take place and there are no levees located immediately upstream of the Mojave River in relation to the project area, there would be no associated flood risk with the failure of a levee.

There is a dam upstream on the Mojave River south of Hesperia (the Mojave River Dam also called Mojave River Forks Dam) which is used for flood control. In the unlikely event of breach of this dam, dam inundation maps indicate that the Mojave River could overflow into the Hinkley Valley. Were this to occur, underground remedial infrastructure would be unaffected, but surficial features such as roads, well pads, irrigation equipment, and above-ground treatment plants could be damaged. Should these features be damaged by this low-probability event, they could be rebuilt. Given the remote nature of this potential impact, and the fact that the project does not include residential use, this is considered a less than significant impact.

The project area is not subject to risk from a seiche, tsunami, or mudflow because there are no water bodies, such as a large lake or ocean, located nearby that would pose a risk of a seiche or tsunami. There are no known areas where landslides or mudflows have occurred in the project area.

For these reasons, the project alternatives are all considered to have a less than significant impact relative to flooding.

3.1.9 Mitigation Measures

Mitigation Measure WTR-MM-1: Purchase of Water Rights to Comply with Basin Adjudication

Regional groundwater drawdown may reduce the availability of regional and state water supplies in the Centro Subarea.

The Water Board will include requirements in the new CAO and/or associated WDRs issued for the remediation as follows:

- By December 31 of every year, PG&E will document its total water rights and its Free Production Allowance for groundwater pumping relative to the remedial project to the Water Board.

- By December 31 of every year, PG&E will document the expected total amount of net agricultural treatment water use for the following year.
- At all times, PG&E will possess adequate water rights and Free Production Allowance that meet or exceed the current expected agricultural treatment water use.
- If PG&E fails to acquire adequate water rights and FPA to support proposed agricultural treatment, PG&E will be required to implement above-ground treatment adequate to compensate for any loss in planned agricultural treatment.

Mitigation Measure WTR-MM-2: Mitigation Program for Water Supply Wells Affected by Remedial Activities, including Impacts Due to Chromium Plume Expansion, Remediation Byproducts and Groundwater Drawdown

PGE& will implement a comprehensive program to determine residences and agricultural land owners whose wells may be adversely affected by remedial actions in relation to chromium plume expansion, remediation byproducts, or groundwater drawdown.

Implementation of the program described below is designed to provide advance warning before water supply well impairment occurs and is designed to either expedite remediation before a water supply well becomes affected, or provide reliable water supply for the entire duration of well impairment due to remedial activities.

The Mitigation Program will determine all "actually affected" and all "potentially affected" wells (defined for each sub-mitigation measure, WTR-MM-2a through 2c, below).

If a well is determined to be an "actually affected" well, then PG&E will provide alternative water supply meeting the requirements described below.

If a well is determined to be "potentially affected" well, then PG&E will either 1) expedite remediation of the conditions causing the well to be potentially affected such that actual impacts do not occur; or 2) provide alternative water supply. If PG&E chooses to remediate the triggering condition, it will provide a feasibility study and plan to the Water Board demonstrating feasible means to avoid actually affecting any domestic or agricultural well.

If expedited remediation is not feasible, PG&E will provide alternative water supply to all "potentially affected" wells prior to the wells being actually affected by chromium plume expansion, remedial byproducts or substantial groundwater drawdown. Because the definition of a "potentially affected" well includes any well that is projected to be affected in the next year, this provides adequate advanced warning to feasibly provide the alternative water supply before impacts to affected wells occur.

Water Quality Requirements for Alternative Water Supply

- Domestic Wells - For domestic wells affected by remedial activities, the alternative water supply will meet the following water quality requirements:
  - Alternative water supply will meet all primary and secondary Maximum Contaminant Levels for any constituent that is affected by remedial activities as defined in this mitigation.
  - For constituents not affected by remedial activities, the alternative water supply will be consistent with pre-project water quality.

  - California and federal requirements for public water systems will apply if the replacement water supply is defined as a public water system.[13]
- Agricultural Wells - PG&E will provide replacement water suitable for agricultural use to all potentially affected agricultural wells, as defined below, in an amount and quality sufficient to support existing agricultural use.

Water Supply Options

In advance of implementing the project PG&E will provide a feasibility study and plan to provide alternative water supplies. Provision of alternative water supplies may be through one or more of the following methods:

- Deeper Well Option—PG&E may opt to drill supply wells deeper if the deeper well is shown to have sufficient water supply yield and to meet the water quality requirements (defined above) or be treatable to such levels through on-site treatment provided by PG&E.
- Storage Tank and Hauled Water Option—PG&E may opt to provide water storage tanks and haul water to the affected location provided water meets the water quality requirements (defined above) or be treatable to such levels through on-site treatment provided by PG&E. If a homeowner rejects this option for their residence, PG&E must offer them an alternative.
- Well Head Treatment Option—PG&E may opt to provide treatment systems at the well head to provide water that meets the water quality requirements.
- Well Modification—For wells only affected by groundwater drawdown due to remediation, existing wells may be modified to provide water, such as by lowering the well pump, provided that the modification provides adequate water supply to support domestic or agricultural use, as appropriate.
- Alternative Supply Option—PG&E may opt to provide an alternative water supply that draws water from a source of water that is not affected by the chromium plume such as a community water system, provided that the water source is not projected to be affected by plume expansion, remedial byproducts, or groundwater drawdown for the lifetime of remediation and can meet the water quality requirements.

Regarding a community water system, while technically feasible, there may be challenges to implementing such a system in Hinkley.

- According to the EPA, very small systems (those serving 25 to 500 people) have the largest number of violations (mostly monitoring/reporting violations), and they experience one maximum Contaminant Level Violation for every 80 people serve, which is the highest ratio of all system service population categories. By comparison, large urban systems (serving more than 100,000 people) experience one Maximum Contaminant Level violation for every 200,000 people service (EPA 2012)[14].

[13] The federal Safe Drinking Water Act and derivative legislation define public water system as an entity that provides "water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serves an average of at least 25 people for at least 60 days a year.

[14] See http://www.epa.gov/nrmrl/wswrd/dw/smallsystems/regulations.html.

- The California Department of Public Health (CDPH) has regulatory authority over community water systems. Under the provisions of Section 116330 of the California Health and Safety Code, CDPH has delegated approval of small water systems with less than 200 connections to local primary agencies, which in this case would be the San Bernardino County Public Health Department, Division of Environmental Health Services. A permit application for a community water system would require comprehensive technical, managerial, and financial assessments to gain CDPH (if more than 200 connections) or San Bernardino County (if less than 200 connections) approval. In order to be approved, Small water systems must demonstrate that they can be sustainable for the long term.
- An additional concern is the long lead time to implement a community water system, given the approval and review process, and more extensive construction activities than other options, which could take as long as 5 years.
- Hinkley is dominated by rural residences, many of which are highly dispersed, which increases the amount of piping, pumping, and associated cost and construction.
- Some individuals in Hinkley may prefer a community water system, but other individuals may prefer the independence of their own well, which may complicate the implementation of this option.

Monitoring

Water Quality Monitoring and Groundwater Modeling

- PG&E will monitor water quality and model groundwater conditions as required by Mitigation Measures WTR-MM-2a, -2b, and -2c below.

Reporting

- PG&E will incorporate reporting on water supply program implementation into annual reporting to the Water Board. Reporting will include descriptions of all completed and planned expedited remediation actions and alternative water supplies for the following year.

Mitigation Measure WTR-MM-2a: Mitigation Program for Water Supply Wells Affected by the Chromium Plume Expansion due to Remedial Activities

Defining Actually and Potentially Affected Domestic Supply Wells

"Actually affected domestic wells" will be defined as any domestic water supply well with chromium (hexavalent or total) concentrations that exceed any of the following criteria due to remedial actions:

- background levels (if the well previously had concentrations below background levels); or
- concentrations increase by 10% or more (if the well previously had concentrations that exceed background levels).

"Potentially affected domestic wells" will be defined as domestic supply wells that have an increase in chromium concentrations due to remedial actions and which:

- are located within one-mile of the defined chromium plume; or
- are predicted to have any of the above conditions within one year as indicated by groundwater modeling.

Monitoring

Water Quality Monitoring

- PG&E will monitor Cr[VI] and Cr[T] in domestic wells where levels (wherever allowed by well owners) within one mile down gradient or cross gradient of the previously defined chromium plume, on a quarterly basis.
- Monitoring requirements may be adjusted by the Water Board's Executive Officer based on contaminant concentration trends, plume geometry changes, or other factors.

Water Quality and Groundwater Modeling

- PG&E will annually model the movement of the chromium plume and will provide maps of estimated plume movement for the following three years. The modeling effort will be provided to the Water Board by December 31 of each year.
- The results of the modeling will include predictions for wells that may become affected within the following year and such predictions will be used to plan for the provision of alternative water supplies in advance of effects on domestic and agricultural wells.
- The report will also define the down gradient and cross gradient monitoring program areas under this section for the following year. Monitoring areas may be modified over the course of the year as described in the water quality monitoring section above.

Mitigation Measure WTR-MM-2b: Water Supply Program for Water Supply Wells Affected by Remedial Activity Byproducts

Defining Potentially Affected Wells

"Actually affected domestic wells" will be defined as any domestic water supply well with remediation byproduct concentrations that exceed any of the following criteria due to remedial actions:

- concentrations above a California primary or secondary Maximum Contaminant Levels if the well currently contains concentrations that are less than California primary or secondary Maximum Contaminant Level or water quality objective; or
- a 10% increase above current levels if the well has concentrations that currently exceed a California primary Maximum Contaminant Level (unless it can be demonstrated that an increase is statistically significant at a different level); or
- a 20% increase above current levels if the well has concentrations that currently exceed a California secondary Maximum Contaminant Level or water quality objective (unless it can be demonstrated that an increase is statistically significant at a different level); or
- a 20% increase above current levels if the well has concentrations that currently are less a California primary or secondary Maximum Contaminant Level or water quality objective (unless it can be demonstrated that an increase is statistically significant at a different level).

"Potentially affected domestic wells" will be defined as wells that meet any of the following criteria:

- All wells located within one-half mile downgradient or one-quarter mile cross gradient of an "actually affected domestic well" or an affected monitoring well (when no domestic well exists within these intervals).
- All wells predicted to be within one-half mile downgradient or one-quarter mile cross gradient of an "actually affected domestic well" or an affected monitoring well (when no domestic well exists within these intervals) in the next year by water quality modeling.

"Actually affected agricultural wells" will be defined as an agricultural well where the following has occurred:

- remedial action has caused an increase in TDS or otherwise affected water quality such that (1) agricultural yields are predicted to be reduced by at least 25% or (2)agricultural product is predicted to be substantially reduced in quality. Examples of substantial changes in quality include changes in palatability, appearance, or other factors that would impede the ability to sell crops at prevailing crop prices.

"Potentially affected agricultural wells" will be defined as wells that meet any of the following criteria:

- Agricultural wells within one-half mile downgradient or one-quarter mile cross gradient of an "actually affected agricultural well" or an affected monitoring well (when no agricultural well exist within these intervals);
- All wells where any of the above conditions is predicted to occur through water quality modeling within one year.

Monitoring

Water Quality Monitoring

- PG&E will conduct an initial monitoring of domestic and agricultural wells within one-mile downgradient or cross-gradient of any proposed in-situ or agricultural treatment unit commencing immediately upon approval of a new order allowing expanded remediation. Where possible without delaying planned remediation efforts, initial monitoring will be done before operation of new agricultural treatment units for a minimum of one-year on a quarterly basis. Where initial monitoring cannot be done for a full year prior to operations without delaying planned remediation efforts, then initial monitoring can be done concurrently with commencement of operations of new agricultural treatment units. Groundwater elevation and constituents analyzed will include all potential remedial activity byproducts to ensure that pre-remediation baseline water quality is defined for all domestic and agricultural wells for which well owners provide permission.
- PG&E will monitor for remedial activity byproducts in domestic and agricultural wells (wherever allowed by well owners) within one-half mile down gradient and one-quarter-mile cross gradient of any in-situ or agricultural treatment unit, on a twice-yearly (semi-annual) basis.
- If any domestic or agricultural wells are found to be impacted by remedial byproducts (as described below), PG&E will increase monitoring of the impacted well to once-a-month until alternate water supply is provided to the satisfaction of the well owner, after which monitoring can be reduced to twice-yearly.

- In addition, if any domestic or agricultural wells are found to be actually affected by remedial byproducts (as described above), PG&E will further monitor for that byproduct in domestic and agricultural wells (wherever allowed by well owners) within one-half mile downgradient/one-quarter mile cross gradient of that impacted well for the following two years on a semi-annual basis. This program is intended to expand the area of monitoring in advance of any potential byproduct plume, and to expand and contract the monitoring area in response to the observed byproducts and remedial progress.
- In-situ treatment byproduct monitoring will consist of iron, manganese, arsenic and total organic carbon.
- Agricultural treatment unit byproduct monitoring will consist of TDS, nitrate, and any chemicals applied to fields as fertilizers, pesticides, etc. If the investigation required by Mitigation Measure WTR-MM-5 identifies that agricultural treatment would significantly affect uranium or gross-alpha levels in groundwater, then agricultural treatment unit byproduct monitoring will also include uranium, gross-alpha, and any other applicable radionuclide, such as radium.
- Monitoring requirements may be adjusted by the Water Board's Executive Officer based on contaminant concentration trends, byproduct plume geometry, or other factors.

Water Quality and Groundwater Modeling

- PG&E will annually model the movement of any byproduct plumes and will provide maps of estimated plume movement and groundwater level changes for the following three years. The modeling effort will be provided to the Water Board by December 31 of each year.
- The results of the modeling will include predictions for wells that may be impacted within the following year and such predictions will be used to plan for the provision of alternative water supplies in advance of effects on domestic and agricultural wells.
- The report will also define and confirm the down gradient and cross gradient monitoring program areas under this section for the following year. If there are insufficient wells within the monitoring areas, as determined by the Water Board in its review of the yearly reporting, then quarterly monitoring of areas of insufficiency will be required.

Mitigation Measure WTR-MM-2c: Water Supply Program for Wells Affected by Groundwater Drawdown due to Remedial Activities

Defining Actually and Potentially Affected Wells

"Actually affected domestic wells" will be defined as follows:

- All wells where groundwater drawdown of more than 25% of the potentially affected well screen depth has occurred due to remedial pumping compared to the 2011 water levels, unless it can be demonstrated that the well remains capable of providing an adequate flow rate for domestic supply and the well owner concurs that the flow rate is adequate for their use.
- All wells where groundwater drawdown of at least 10 feet occurs and water quality sampling shows at least a 10% increase over baseline conditions of arsenic, uranium, or gross alpha.

"Potentially affected domestic wells" will be defined as follows:

- All wells where any of the above conditions is predicted to occur through groundwater modeling within one year.

"Actually affected agricultural wells" will be defined as follows:

- Agricultural wells where groundwater drawdown of more than 25% of the potentially affected well screen depth has occurred due to remedial pumping.

"Potentially affected agricultural wells" will be defined as follows:

- All wells where any of the above conditions is predicted to occur through groundwater modeling within one year.

Monitoring

Groundwater Drawdown Monitoring

- PG&E will conduct an initial monitoring of groundwater levels and water quality in all domestic and agricultural wells (wherever allowed by well owners) within one-mile downgradient or cross-gradient of any existing or proposed groundwater extraction well commencing immediately upon approval of a new order allowing expanded remediation. Initial monitoring will be for a minimum of one-year, will be done quarterly, and will include monitoring in March and October. Initial monitoring will be done for one year prior to operation of groundwater extraction wells where feasible without delaying planned remediation. Were initial monitoring cannot be done for a full year without delaying planned remediation, then monitoring may be done concurrently with extraction commencement.
- PG&E will monitor the groundwater levels in all domestic and agricultural wells (wherever allowed by well owners) within one-quarter mile of any groundwater extraction point for the duration of remedial pumping until groundwater levels have stabilized for a minimum of two years following commencement of groundwater extraction.
- In addition, if any domestic or agricultural wells are found to be impacted or potentially impacted by excessive drawdown as described below, PG&E will (1) conduct byproduct monitoring (for arsenic, uranium and gross alpha) and (2) measure the groundwater levels in or adjacent to domestic and agricultural wells (wherever allowed by well owners) within one-quarter mile of that well until groundwater levels have stabilized for a minimum of two years. This program is intended to expand the area of monitoring in advance of any excessive drawdown, and to expand and contract the monitoring area in response to the observed drawdown.
- PG&E will monitor groundwater levels semi-annually in October (after peak irrigation months) and March (after winter rains and before peak irrigation months).
- Monitoring requirements may be adjusted by the Water Board's Executive Officer based on groundwater level conditions or other factors.

Groundwater Modeling

- PG&E will annually model predicted groundwater levels based upon the month with the greatest well water use and will provide maps of estimated groundwater level changes for the following three years. The modeling effort will be provided to the Water Board by December 31 of each year.

- The results of the modeling will include predictions for wells that will be impacted within the following year and such predictions will be used to plan for the provision of alternative water supplies in advance of effects on domestic and agricultural wells.
- The report will also define the monitoring program area under this section for the following year.

Mitigation Measure WTR-MM-3: Boundary Control Monitoring, Enhancement and Maintenance of Hydraulic Control and Plume Water Balance to Prevent or Reduce Potential Temporary Localized Chromium Plume Bulging

The Water Board will include requirements in the new CAO and associated WDRs issued for the remediation as follows:

- PG&E will develop a Boundary Monitoring Plan to identify the entirety of the chromium plume over time.
- During remedial pumping and injection activities, PG&E will limit plume bulges by maintaining hydraulic control with adjustments to pumping rates where necessary, and inward gradients will be maintained as long as necessary to prevent Cr[VI] migration. Hydraulic control can be obtained by capturing the plume at extraction wells. Although the plume can be allowed to move toward these extraction wells, the extraction wells will be designed to stop the spread of the plume beyond the wells.
- PG&E will operate and maintain the existing groundwater extraction system to achieve and maintain hydraulic capture within targeted areas on a year-round basis consistent with CAO R6V-2008-0002A3, (Lahontan Regional Water Quality Control Board 2012). PG&E will expand plume containment and monitoring to include the entirety of the chromium plume over time and develop a contingency plan in case containment is not met.
- Agricultural treatment units and/or above-ground treatment can be used for water treatment as appropriate to assist with inward hydraulic gradients, plume water balance, and water quality restoration of the aquifer.
- PG&E will implement the Contingency Plan for AU Operations as described in the Feasibility Study Addendum No. 3 (Pacific Gas and Electric Company 2011c).

Mitigation Measure WTR-MM-4: Mitigation Program for Restoring the Hinkley Aquifer Affected by Remedial Activities for Beneficial Uses

This requirement holds PG&E responsible for restoring the Hinkley aquifer back to baseline conditions.

No later than 5 years prior to the conclusion of the proposed project, PG&E will conduct an assessment to evaluate adverse impacts or potential adverse impacts to the Hinkley aquifer from its remedial actions.

- If the assessment finds that the aquifer contains constituents, exceeding drinking water standards or water quality objectives and are in excess baseline conditions, and that these constituents are likely to be present upon the conclusion of remedial actions, PG&E will propose cleanup actions to restore the aquifer for beneficial uses as soon as possible, as approved by the Water Board. Aquifer water quality restoration to baseline conditions will occur no longer than 10 years after completion of chromium remediation.

- If the assessment finds that the aquifer includes groundwater drawdown such that domestic or agricultural wells were still experiencing water supply shortages and require alternative water supplies, and these excess levels are likely to exist upon the conclusion of remedial actions, PG&E will propose actions to restore the aquifer for beneficial uses as soon as possible, as approved by the Water Board or Mojave Water Agency. Groundwater levels will be restored to baseline conditions no longer than 20 years after the completion of chromium remediation.
- Every year afterwards, PG&E must submit a status report of actions to restore the aquifer for beneficial uses. The status report will describe all actions taken over the course of the year and list proposed actions for implementation during the following year. An updated schedule will be provided predicting fulfillment of aquifer restoration.

Mitigation Measure WTR-MM-5: Investigate and Monitor Total Dissolved Solids, Uranium, and Other Radionuclide Levels in relation to Agricultural Treatment and Take Contingency Actions

The Water Board will include requirements in the new CAO and/or associated WDRs issued for the remediation as follows:

- PG&E will submit an investigation plan to the Water Board concerning TDS, uranium, and other radionuclides levels in relation to existing agricultural treatment by sampling water used for agricultural treatment and in groundwater upgradient, beneath and downgradient of agricultural treatment units
- After approval of the investigation plan by the Water Board, PG&E will conduct the investigation and provide the results to the Water Board along with an analysis of whether agricultural treatment is affecting naturally occurring uranium levels.
- PG&E will monitor all new agricultural treatment units by establishing a baseline of TDS, uranium, and other radionuclides levels at the outset agricultural treatment and during operation.
- If TDS, uranium, and other radionuclides levels are determined to increase measurably by a statistically significant amount due to agricultural treatment, then PG&E will monitor these levels in and adjacent to all agricultural treatment units for the duration of operation and propose remedial methods to restore the aquifer to baseline conditions.
- If the study of agricultural units indicates that TDS, uranium, and other radionuclide concentrations increase in association with agricultural operations and boundary monitoring confirms an increase in these levels, then corrective actions and or alternative water supplies will be provided per **Mitigation Measure WTR-MM-2** and **Mitigation Measure WTR-MM-4** will be implemented toward the end of chromium plume remediation to restore aquifer beneficial uses.

Mitigation Measure WTR-MM-6: Monitor Nitrate Levels and Manage Agricultural Treatment to Avoid Significant Increases in Nitrate Levels and Provide Alternative Water Supplies As Needed

Agricultural treatment will likely reduce nitrate levels in the groundwater aquifer overall. However, if groundwater is extracted from an area of higher nitrate concentrations and then treated in an area with much lower nitrate concentrations, it is possible that nitrate concentrations could increase in those areas.

The Water Board will include requirements in the new CAO and/or associated WDRs issued for the remediation as follows:

- Given that prior agricultural treatment at the Desert View Dairy has been shown to reduce nitrate levels substantially, it is possible that use of irrigation water with higher nitrate levels may not result in increased nitrate levels in groundwater beneath new agricultural treatment locations. In order to confirm if this is occurring, PG&E will monitor nitrate levels for one year before creating new agricultural treatment units (as feasible without delaying remediation), monitor at the start of new agricultural treatment, and continue monitoring nitrate levels during implementation of all new agricultural treatment units. If nitrate levels do not increase above 10 ppm (as N) or by more than 10% compared to existing levels (if current levels are already above 10 ppm as N), or by more than 20% compared to existing levels (if current levels are less than 10 ppm as N) then no further action, other than monitoring, will be required.
- If monitoring indicates that nitrate levels are approaching 10 ppm (as N) or increasing by more than the criteria noted above, then PG&E will implement a contingency plan for managing nitrate levels which may include some combination of the following:
  - Extraction source water will be shifted from application where it would raise concentrations substantially to locations with existing higher concentrations provided it would not cause an exceedance of nitrate levels at any domestic well.
  - Extraction source water will be blended before application to agricultural treatment units so as to avoid exceedance of 10 ppm as N and avoid increases in existing levels that exceed the criteria noted above.
  - Above-ground treatment may be used as necessary to meet the concentration levels described above.
  - If control of nitrate cannot meet these requirements, PG&E may request permission from the Water Board to allow temporary increases in nitrate conditions at certain agricultural treatment units, if and only if, the following can be demonstrated:
    - no domestic wells will contain nitrate concentrations above 10 ppm or an increase in nitrate levels exceeding the criteria above; or
    - PG&E will provide whole house water for any affected domestic well until such a time as nitrate concentrations return to existing concentrations at the affected well, and
    - PG&E will be held accountable for implementing remedial methods to restore the aquifer to baseline conditions.
  - PG&E will estimate the duration of nitrate impairment of water quality due to remedial activities and will identify how affected groundwater nitrate levels will return to background conditions prior to the timeframe for remediation of the chromium plume to the established cleanup levels. The duration of nitrate impairment due to remedial activities may possibly extend beyond the time necessary to remediate the chromium plume; the goal of remedial operation in the later stages of the cleanup should be to minimize the duration of all impacts.

  - The Water Board will retain the authority to approve or deny temporary impairment of the aquifer due to nitrate contamination and will make determinations on a case by case basis taking into account information on remedial progress, the affected wells and community, the certainty of returning affected groundwater to background water quality over time and any other relevant considerations.

Mitigation Measure WTR-MM-7: Construction and Operation of Additional Extraction Wells to Control Carbon Amendment In-situ Byproduct Plumes

Increased in-situ remediation could result in increased levels of byproducts, such as dissolved arsenic, iron, and manganese in the groundwater compared to current levels.

The Water Board will include requirements in the new CAO and/or associated WDRs issued for the remediation as follows:

- PG&E will monitor secondary byproducts in groundwater as required by Mitigation Measure WTR-MM-2.
- If arsenic levels are increased at designated monitoring wells or iron or manganese are increased above their respective secondary Maximum Contaminant Levels, or reagent levels exceed taste or odor criteria, PG&E will construct and operate additional extraction wells or implement an equally effective mitigation measure along or upgradient of the IRZ treatment boundary to intercept or reduce reagent concentrations and secondary byproducts to prevent effects to domestic water supply wells.
- If control of byproduct plumes cannot be achieved without compromising the pace of cleanup such that domestic wells may be affected by byproduct plumes, then PG&E will request permission from the Water Board to allow byproduct plume migration provided the following are implemented:
  - PG&E will provide fate and transport modeling of byproduct plume migration, in absence of complete boundary control, including identification all affected domestic and agricultural wells.
  - PG&E will demonstrate the duration of byproduct plume impairment of water quality and will identify how affected groundwater will return back to background conditions. The duration of byproduct plume impairment may possibly extend beyond the time necessary to remediate the chromium plume. The goal of remedial operation in the later stages of the cleanup should be to minimize the duration of all impacts.
  - PG&E will provide alternative water supplies to all wells proposed to be affected, per Mitigation Measure WTR-2.
  - The Water Board will retain the authority to approve or deny temporary impairment of the aquifer due to byproduct generation and will make determinations on a case by case basis taking into account information on remedial progress, the affected wells and community, the certainty of returning affected groundwater to background water quality over time and any other relevant considerations.

Mitigation Measure WTR-MM-8: Ensure Freshwater Injection Water Does Not Degrade Water Quality

The Water Board will include requirements in the new CAO and/or associated WDRs issued for the remediation as follows:

- PG&E will sample all water sources proposed for use in freshwater injection for all basic water quality parameters and will specifically include chromium (total and hexavalent chromium), TDS, uranium, other radionuclides (including gross alpha), nitrate, arsenic, manganese, iron and sulfate. Data will be provided to the Water Board for review.
- Concentrations of all constituents in freshwater injected for plume control must either be 1) less than the applicable primary or secondary Maximum Contaminant Level or 2) if the concentrations of certain constituents at the injection point already exceed a Maximum Contaminant Level already, then the injection water must have concentrations of the constituent equal to or less than that in the ambient groundwater at the injection point.
- PG&E will identify the filtration or pretreatment necessary to meet the water quality levels described above to the Water Board. After approval of the water source for use for freshwater injection, PG&E will sample the treated water on an annual basis at a minimum to demonstrate that the water source is still acceptable for use for freshwater injection.

3.1.10 Secondary Impacts of Water Supply Replacement Mitigation

Impact WTR-5: Secondary Physical Impacts of Water Supply Replacement Mitigation (Less than Significant with Mitigation)

Mitigation Measure WTR-MM-2 requires provision of alternative water supplies where remedial activities significantly affect domestic and agricultural water supply wells. This may include drilling of deeper wells, wellhead treatment systems, storage tanks and trucking of water, and/or creation of a water supply system with wells and pipelines. The construction of alternative water supplies could have physical effects on the environment and result in impacts related to land use, hazards and hazardous materials geology and soils, air quality/greenhouse gas emissions, noise, biological resources, cultural resources, utilities, traffic, and aesthetics.

CEQA allows for a lesser level of detail of analysis of the secondary impacts of mitigation measures. Project-level CEQA compliance may be necessary for alternative water supply systems, once the methods of providing alternative water supplies is more specifically defined.

Facilities and actions that may be needed to provide alternative water supplies would include the following:

- Drilling of deeper wells: This approach would require temporary drilling equipment activity at or adjacent to existing water supply locations. In many cases, these locations will be previously disturbed.
- Wellhead treatment systems: This approach would require of treatment systems and possible storage tanks at affected locations. In many cases, these locations will also be previously disturbed.

- Storage Tanks and Trucking of Water: This approach would require placement of storage tanks at affected locations, addition of piping from the tanks to the water supply location, and periodic trucking of water to the storage tanks, including associated traffic. It should be noted that CDPH, which regulates water supply systems, has taken the position that hauling water is not a long-term water supply strategy.
- New Water Supply System: The most likely configuration of this approach would be use of wells near the Mojave River (upgradient of the chromium plume), pumps, and pipelines from the supply location to the supply points. It is possible that the source well could be located elsewhere.

At this time, the exact extent and location of new facilities that would be needed to provide alternative water supplies is not known, although most facilities are expected to be located within OU1, OU2, and OU3. However, if sources or connections are made outside of these areas, construction could affect additional parts of the project area. If water to be provided through a connection to another water system, this could affect areas outside the project study area.

The section below summarizes potential secondary physical impacts of water supply replacement. As noted below, all relevant project mitigation measures would also apply to alternative water supply efforts.

- **Water Quality**: Construction of new water supply facilities may result in minor erosion which has the potential for sedimentation of downstream water bodies. However, compliance with San Bernardino County erosion control requirements and state/federal SWPPP requirements would keep this impact to a less than significant level. Disposal of any treatment by products, such as brine, would need to comply with all applicable disposal requirements.
- **Land Use:** The provision of new water supply facilities at affected domestic and agricultural locations would not introduce incompatible uses or displace existing land uses. The construction of a new water supply system may require centralized treatment facilities, which would be a light industrial use that would be highly similar to the above-ground treatment facilities included in Alternatives 4C-3 and 4C-5, but on a much smaller scale. With compliance with local land use regulations and requirements, it is expected that any such treatment facility would not result in significant land use impacts. Construction of pipelines may temporarily disrupt land uses, but similar to pipelines for remedial actions, this temporary disturbance is not considered significant. Relevant mitigation measures from Section 3.2, *Land Use, Agriculture, and Population, and Housing,* would also apply to construction of water supply mitigation facilities and would be able to reduce impacts to a less than significant level.
- **Hazards and Hazardous Materials:** Construction of water supply facilities would include handling of petroleum and other materials. Treatment facilities may also handle certain treatment chemicals and would generate wastes (such as brine if reverse osmosis is used and other wastes for other treatment methods) requiring disposal. Application of all local, state, and federal regulations for handling and transport of hazardous materials will control the potential for exposure to hazardous materials and thus construction should result less than significant impacts. Relevant mitigation measures from Section 3.3, *Hazards and Hazardous Materials,* would also apply to construction of water supply mitigation facilities and would be able to reduce impacts to a less than significant level.
- **Geology and Soils:** Construction of new water supply facilities may result in minor erosion. However, compliance with San Bernardino County erosion control requirements and state/federal SWPPP requirements would keep this impact to a less than significant level.

Construction or operation of new water supply facilities are not expected to result in any other significant geology or soils impacts.

- **Air Quality/Greenhouse Gas Emissions:** Construction of new water supply facilities will result in construction emissions of criteria pollutants and greenhouse gases. During operations, where pipelines are used, pumping will also result in electricity emissions. Where trucking of water is done for alternative water supplies, trucking will result in gasoline and/or diesel emissions. Relevant mitigation measures from Section 3.5, *Air Quality and Climate Change,* would also apply to construction and operations of water supply mitigation facilities and would be able to reduce impacts to a less than significant level.
- **Noise:** Construction of new water supply facilities will generate noise from equipment and vehicles similar to construction of remedial facilities. Operations of alternative water supply systems will have limited noise generation and would result in less than significant impacts. Relevant mitigation measures from Section 3.6, *Noise*, would also apply to construction of water supply mitigation facilities and would be able to reduce impacts to a less than significant level.
- **Biological Resources:** Construction of new water supply facilities could disturb habitats and individual special status species, sensitive vegetation communities as follows:
  - Drilling of deeper wells: In many cases, these locations will be previously disturbed and thus the potential for significant impacts to biological resources would be limited from this activity.
  - Wellhead treatment systems: In many cases, these locations will also be previously disturbed and thus the potential for significant impacts to biological resources would be limited from this activity.
  - Storage Tanks and Trucking of Water: In many cases, these locations will also be previously disturbed and thus the potential for significant impacts to biological resources would be limited from this activity.
  - New Water Supply System: Of the water supply options, this approach has the greatest potential to disturb biological resources, in particular due to the need for construction of new water pipelines from water supply sources to end users and the need to construct new treatment facilities. In addition, new source wells may also have the potential to disturb biological resources.

  Relevant mitigation measures from Section 3.7, *Biological Resources*, would also apply to construction of water supply mitigation facilities and would likely be able to reduce impacts to a less than significant level.
- **Cultural Resources:** Construction of new water supply facilities could disturb cultural and paleontological resource. Operations of alternative water supply systems should not disturb cultural resources unless new ground disturbance is necessary for system maintenance and would result in less than significant impacts. Relevant mitigation measures from Section 3.8, *Cultural Resources*, would also apply to water supply mitigation facilities and would likely be able to reduce impacts to a less than significant level.
- **Utilities:** For the most part, construction of new water supply facilities will not disrupt existing utilities; however in some cases, in particular for construction of new pipelines, there could be disturbance of existing utilities. However, local and state regulations require planning for and avoidance of disruption to existing utilities and thus construction impacts will be less than significant. Extension of electrical power lines will be needed for new pumping and water

treatment facilities for new water supply systems. Operations of alternative water supply systems should not disrupt existing utilities or create need for additional public services.

- **Traffic:** Construction of new water supply facilities will generate traffic similar to construction of remedial facilities. It is possible that construction might affect traffic safety or emergency access, but application of mitigation from Section 3.10, *Transportation and Traffic*, would reduce impacts to a less than significant level. Operations of deeper wells or wellhead treatment systems will generate minimal new traffic due to the need for maintenance. Operations of alternative water supply systems will generate routine traffic for the tank/truck option and the new water supply system operation. However, given the uncongested conditions on local roadways, such traffic is not considered to result in any significant traffic conditions.
- **Aesthetics.** Construction of new water supply facilities will temporarily disturb local aesthetic conditions due to construction noise, dust, and presence of equipment and vehicles, but these impacts would be limited in scale and extent at any one location and thus less than significant. Deeper wells or wellhead treatment systems will have less than significant effects on aesthetics due to limited apparent facilities that would be located at existing residences and structures. The tank/truck water supply option would require new water storage tanks to be placed adjacent to existing residences. However, this is not an uncommon site in rural residential areas which often have existing storage tanks for water and propane and would not substantially degrade visual character of the local area. A new water supply system would require a treatment facility to treat source water and provide pumps to deliver water to end users. This facility would have similar aesthetic effects as the above-ground treatment facilities included in Alternative 4C-3 and 4C-5. Relevant mitigation measures from Section 3.11, *Aesthetics*, would also apply to any new water supply centralized treatment facilities and would likely be able to reduce impacts to a less than significant level.
- **Physical Effects of Socioeconomic Changes.** Construction of new water supply facilities would not be expected to require acquisition of property containing existing residents or other structures and thus would not have the potential for the creation of blighted conditions due to abandoned structures.

As PG&E develops and defines plans for alternative water supplies, the Water Board will be required to evaluate the specific environmental impacts from proposed replacement water methods. The mitigation above will be applied as appropriate. In most cases, it is considered possible that the identified mitigation will reduce secondary physical impacts to a less than significant level.

As described throughout this document, the EIR has followed a conservative scaling approach to disclose potential worst-case effects of the remedial actions overall. It is distinctly possible that this approach may overstate the actual environmental effects that will occur in implementing the project. Given that the alternative water supply method has not been fully defined at this time, additional CEQA analysis of the specific impacts may be necessary at the time that the method is defined and designed.