Pacific Gas and Electric Company

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February 15, 2013

Ms. Patty Kouyoumdjian, Executive Officer
California Regional Water Quality Control Board, Lahontan Region
2501 Lake Tahoe Boulevard
South Lake Tahoe, California 96150

Subject: Response to Investigative Order No. R6V-2012-0060: Byproduct Plume Monitoring in IRZ Areas
Pacific Gas and Electric Company's Hinkley Compressor Station,
Hinkley, California

Dear Ms. Kouyoumdjian:

Pacific Gas and Electric Company (PG&E) is submitting the attached work plan for byproduct monitoring in the In-situ Reactive Zone (IRZ) Areas per the requirements of Board Order No. R6V-2012-0060 issued on December 21, 2012. On January 3, 2013, PG&E received an extension to submit the work plan on February 15, 2013.

The work plan presents two sampling and monitoring well installation layouts, both of which include sufficient data collection to determine impacts from the In-situ Reactive Zone (IRZ) byproducts. The first layout presents well locations explicitly prescribed by the December 21, 2012 order. The second layout presents well locations that meet the technical intent of the December 21, 2012 Order, as discussed during the collaborative manganese working group meetings held on December 20, 2012 and January 15 and February 13, 2013. The working group meetings were attended by the Lahontan Regional Water Quality Control Board (Regional Board) staff, a technical expert from the US Geological Survey, the Independent Review Panel (IRP) Manager, and Hinkley Community Advisory Committee members. PG&E is requesting approval from the Regional Board to proceed with the second sampling and monitoring well layout and sampling plan presented herein.

Please feel free to call me at (925) 818-9069 if you have any questions regarding the information presented in this letter.

Sincerely,

Kevin M. Sullivan

Enclosure: Response to Investigative Order No. R6V-2011-0060: Byproduct Plume Monitoring in IRZ Areas

ARCADIS

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MEMO

To:
Patty Z. Kouyoumdjian
Executive Officer
California Regional Water Quality Control Board, Lahontan Region (RWQCB)

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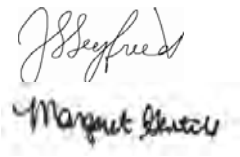
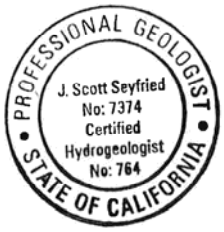
Ian Webster, Project Navigator
John Izbicki, USGS

From:
Scott Seyfried, P.G.
Margaret Gentile, Ph.D., P.E.





Date:
February 15, 2013

ARCADIS Project No.:
RC000699.0093

Subject:
Response to Investigative Order No. R6V-2012-0060: Byproduct Plume Monitoring in IRZ Areas, Pacific Gas and Electric Company (PG&E), Hinkley Compressor Station, San Bernardino County

1.0 Introduction

On December 21, 2012, the California Regional Water Quality Control Board, Lahontan Region (RWQCB) issued Investigative Order No. R6V-2012-0060 (the Order, RWQCB, 2012), requiring additional monitoring for byproducts associated with the In-Situ Reactive Zone (IRZ) system operating at the Pacific Gas and Electric (PG&E) property in Hinkley, California (Site). Specifically, the Order required the following:

- Submittal of a work plan to fully define the manganese plume in upper aquifer in the following areas (designated as Areas 1 through 5 on Figure 1A):
    - North: in the 1000-ft gap between wells EX-21 and EX-22 (Area 1)
    - West: in the 1300-ft gap between wells CA-MW-108 and SC-MW-13 (Area 2)
    - Southwest: in the 1900-ft gap between wells SA-MW-16 and MW-78 (Area 3)
    - South: in the 1100-ft gap between MW-78 and MW-39 (Area 4)
    - East: in the 1000-ft gap between wells SA-MW-25 and SC-MW-01 (Area 5).

- The work plan should propose IRZ monitoring points no more than 200 feet apart in the west to east direction and no more than 400 feet apart in the north to south direction.
- In addition, the work plan should propose a tracer test along the western IRZ boundaries.

This work plan is being submitted in accordance with the Order. The scope proposed in this work plan is preceded by a description of the current conceptual site model (CSM) for dissolved manganese in groundwater in the IRZ area and in the western area where manganese has been detected in domestic wells (Section 2). This work plan presents the objectives (Section 3) and proposed scope of work (Section 4) to address the Investigative Order requirements. Section 4 provides details regarding the proposed monitoring well locations, well construction, well development, tracer study, sampling and reporting.

2.0 Conceptual Site Model for Manganese in Groundwater

The following CSM focuses on the occurrence of manganese in groundwater both within the IRZ area and in the western area, where manganese has also been detected in some domestic wells. This CSM provides relevant background information and supports the rationale for the proposed scope of work. The CSM builds upon the information provided in the technical memorandum dated December 17, 2012 titled *Assessment of In-Situ Reactive Zone Treatment Byproducts* (ARCADIS, 2012). This information has been discussed and reviewed with Water Board staff, technical experts from the US Geological Survey (USGS), members of the Hinkley Community Advisory Committee (CAC), and the CAC's technical advisors in meetings on December 20, 2012 and further on January 15 and February 13, 2013. The area described in the following sections (Study Area) is approximately bounded by Alcudia Road to the north, Hinkley Road to the west, Dixie Road to the east, and Highcrest Road to the south (Figure 2).

Figure 2 is a schematic representation of manganese in groundwater that illustrates the following key components of the CSM:

- Groundwater flow directions governing the transport of dissolved manganese.
- The extent of dissolved manganese in groundwater associated with the IRZ system.
- The presence of dissolved manganese associated with deeper aquifer materials in the western area.

For reference, the extent of the hexavalent chromium plume, defined by 3.1 micrograms per liter (µg/L), is also shown.

2.1 Lithology

The Site is underlain by fluvial and alluvial sediments consisting of interbedded sand, silt and clay deposits, which are underlain by a lacustrine clay interval or weathered bedrock and bedrock. Bedrock

features are observed at the ground surface in some areas, and shallow bedrock is noted in the vicinity of these surface features. Alluvial materials are likely associated with alluvial fans and with nearby surficial bedrock features (Haley & Aldrich, 2010). Fluvial sediments include deposits of the ancestral Mojave River. The lithology of the fluvial and alluvial deposits in the western area is variable due to the variety of fluvial and alluvial depositional environments. As a result, the grain size distribution of these sediments can vary from coarse to fine over short distances, both laterally and vertically.

Throughout much of the Site, a lacustrine clay interval (the blue clay) is encountered beneath the unconsolidated alluvial and fluvial deposits, at approximately 140 to 170 feet below ground surface (bgs). The blue clay unit thins toward the west, and is absent in the far west (Stantec, 2012).

2.2 Groundwater Occurrence and Flow

Groundwater beneath the study area is encountered at depths of approximately 75 to 90 feet bgs. Saturated sediments beneath the water table to the blue clay (bedrock) are considered the Upper Aquifer. The blue clay unit is an effective hydraulic barrier or aquitard between the unconfined Upper Aquifer and the confined/semi-confined Lower Aquifer. The blue clay unit has impeded the downward migration of chromium, such that chromium may be present in the deeper portion of the Upper Aquifer, and not encountered in the Lower Aquifer, with the exception of a limited area near MW-23C, near Mountain View Road and Santa Fe Avenue. Bedrock is encountered at fairly shallow depths in the western area and forms the base of the Upper Aquifer (Stantec, 2012).

The inferred Lockhart Fault projection shown on Figure 2 is drawn as reported by the United States Geological Survey (USGS). The fault has no obvious surface expression and is likely concealed beneath alluvial materials (Stantec, 2012). There may be a buried physical expression of the Lockhart Fault in bedrock; Stantec noted a relatively low bedrock surface elevation in borings for two monitoring wells (MW-160 and MW-167) (Stantec, 2012). Historical groundwater elevation data in the Hinkley Valley suggest the presence of a partial barrier to groundwater flow along the Lockhart Fault's inferred projection.

Groundwater within the Upper and Lower Aquifers generally flows from south to north. Within the IRZ area, groundwater generally flows to the north and northwest (Figures 2 and 3). To the west, groundwater flow direction and gradients are consistent with the surface topography; wells in this western area screened at or below the water table indicate that groundwater flows to the northeast (Figures 2 and 3).

Upward vertical hydraulic gradients between the deep and shallow zones of the Upper Aquifer are present in some areas in the west and within the IRZ area in the west. For example, upward hydraulic gradients were noted in several of the western area wells in the area between Serra Road and Fairview Road and between Aquarius Road and Frontier Road (Stantec, 2012). Upward gradients between the deep and shallow zones of the Upper Aquifer are also encountered along the western boundary of the IRZ area, e.g.

within well pairs along Fairview Road. Downward gradients within the Upper Aquifer are otherwise generally encountered within the IRZ treatment area.

2.3 Nature and Extent of Dissolved Manganese in Groundwater

Dissolved manganese has been detected in Site monitoring wells and in nearby domestic wells located west of the Site, as shown on Figures 2 and 3.

Manganese dissolution is known to occur within the IRZ area. The geochemical conditions that are promoted within the IRZ in order to reduce hexavalent chromium to trivalent chromium also create an environment that encourages naturally-occurring manganese to dissolve. The spatial distribution in manganese concentrations associated with the IRZ area is monitored on a quarterly basis using a network of over 200 monitoring wells (Figure 1). These data are currently used as the basis for defining the extent of dissolved manganese in groundwater as a result of IRZ operations, as documented over time in the December 17 technical memorandum (ARCADIS, 2012). The threshold concentration of 0.39 milligrams per liter (mg/L) shown on Figures 1 through 3 has been used for Site permitting purposes as indicative of IRZ-generated manganese, based on baseline manganese concentrations.

As shown on Figures 2 and 3, dissolved manganese generated in the IRZ area migrates to the north/northwest, following the direction of groundwater flow. This groundwater ultimately flows toward the remedial pumping center north of Highway 58. Downgradient of the IRZ area, the geochemical conditions of the groundwater changes to its background (oxic) conditions. In this oxic redox state, manganese is not stable in the dissolved phase, and tends to precipitate out of the water. As a result, concentrations of manganese tend to decrease downgradient of the IRZ system.

Elevated concentrations of dissolved manganese are also present in groundwater in the western area of the Site (Figures 2 and 3). Historical groundwater manganese concentrations, groundwater flow, lithology and geochemical data indicate that this manganese is background (Figure 2). Groundwater in the western area flows to the northeast toward the IRZ area, as indicated by arrows on Figure 2 and groundwater elevation contours on Figure 3. In the western area, manganese detections generally occur in monitoring wells screened in the deeper portion of the Upper Aquifer in close proximity to or within the blue clay or weathered bedrock (Figure 2). The deep Upper Aquifer groundwater is typically less oxic, indicating the presence of reducing conditions and potential reduction of manganese minerals or persistence of dissolved manganese.

In addition, deeper manganese may migrate upwards to shallower depths as a result of upward hydraulic gradients between the deep and shallow zones of the Upper Aquifer. For example, in the area between Serra Road and Fairview Road and between Aquarius Road and Frontier Road (Figure 3), the deeper manganese detections occur in areas with upward gradients between the deep and shallow zone of the Upper Aquifer (Stantec, 2012).

Anthropogenic activities other than the IRZ systems may also cause a change in redox conditions and associated increase in dissolved manganese in groundwater. For example, dairy farms and other concentrated animal operations can lead to localized anaerobic conditions in groundwater and increased manganese dissolution.

3.0 Objectives

The objectives for the scope of work proposed in this work plan are as follows:

- Install additional monitoring wells in compliance with the Order
- Conduct tracer tests to evaluate the distribution and migration of IRZ injection solution along the western IRZ boundaries.

These objectives will be met through the installation and monitoring of 6 to 14 proposed monitoring wells and the completion of a tracer test, as described below.

4.0 Scope of Work

4.1 Monitoring Well Installation and Sampling Plan

4.1.1 Monitoring Well Locations

Two potential well layouts are shown on Figures 1A and 1B. Figure 1A presents the wells suggested by the Order language, and Figure 1B presents PG&E's alternate proposal that we believe meets the technical intent and goals of the Order. A total of 6 to 14 monitoring wells pairs will be installed and three existing monitoring wells will be used to fulfill the requirements of the Order, as shown on Figures 1A and 1B. Each of the new monitoring well pairs will include one well screened in the shallow zone of the Upper Aquifer and one well screened in the deep zone of the Upper Aquifer.

Area 1

Area 1 is located in the north in the 1000-ft space between wells EX-21 and EX-22.

Manganese has previously been detected above the threshold concentration of 0.39 mg/L in the CA-MW-500 series row monitoring wells located southeast of Area 1 at CA-MW-504 and CA-MW-505. To delineate the downgradient extent of this area of elevated manganese, monitoring wells CA-MW-601, CA-MW-602, and CA-MW-603 were sited and installed in the directly downgradient direction (as described in the manganese mitigation work plan dated May 2, 2012). The hydraulic gradient in this area indicates that the general northwest groundwater flow direction from the Central Area IRZ shifts northward towards the remedial pumping centers north of Highway 58 (Figure 3).

The Order requires additional monitoring wells in Area 1 to the west of the CA-MW-600 series monitoring wells to fill the space that is not currently monitored between EX-21 and EX-22. Additional monitoring wells in this area would confirm that the finger of manganese detected at CA-MW-504 and CA-MW-505 did not migrate west of the CA-MW-600 series wells. Figure 1A shows four monitoring wells (A, B, C, and D) in Area 1, using a 200 foot spacing between wells. The immediate installation of this density of monitoring wells is not necessary to confirm that groundwater with elevated manganese did or did not migrate further west than expected. The most critical location in this potential data gap is on the eastern side of the gap. Accordingly, the alternative well layout proposed by PG&E in Figure 1B includes a first well (D), as shown in the figure. If this well were to detect the westward migration of manganse at concentrations above the threshold concentration, additional wells A, B, and C would be installed sequentially from east to west to delineate the manganese concentrations above the threshold.

Area 2

Area 2 is located west in the 1,300-ft gap between wells CA-MW-108 and SC-MW-13. Area 2 includes new monitoring wells pairs E and F. Figure 1A and 1B show locations E1, F1 and E2, F2. Locations E1 and F1 are the preferred locations for these wells proposed by individuals at the Manganese Working Group meeting on February 13, 2013. However biological and access surveys will need to be completed to determine if these locations are feasible. An initial biological survey has been completed at locations E2 and F2, and they will be used if locations if E1 and F1 are not feasible.

Area 3

Area 3 is located southwest in the 1,900-ft gap between wells SA-MW-16 and MW-78. Area 3 includes existing monitoring well pair SA-MW-26S/D and new monitoring wells pairs G and H.

Area 4

Area 4 is located south in the 1,100-ft gap between wells MW-78S and MW-39. Area 4 includes new monitoring wells pairs I, J, K, L and M, as shown on Figure 1A. PG&E proposes that this density of monitoring is not necessary for the monitoring of potential manganese migration upgradient of injection locations, as discussed during the Manganese Working Group meeting on February 13, 2013. Existing wells MW-17, MW-78, and SA-MW-27 will be added to the manganese monitoring program, per the Order, and MW-39 will be added as well. These wells are currently used to define the hexavalent chromium plume. Since the manganese plume falls well within the extent of the chromium plume, and the chromium plume has not been pulled southward to these wells on a sustained basis, it is extremely unlikely that the manganese plume has been or is likely to be pulled this far to the south. Gradients are monitored in this area and have continually shown a dominant northward direction. By adding the four wells above to the by-product monitoring program, they should provide an adequate warning system for future potential southward migration of manganese. Accordingly, the alternative well layout proposed by

PG&E in Figure 1B does not include new monitoring well locations in Area 4 and does include sampling of MW-17, MW-39, MW-78, and SA-MW-27.

Area 5

Area 5 is located east in the 1,000-ft gap between SA-MW-25 and SC-MW-01. Area 5 includes existing monitoring well MW-03A, and new monitoring well pair N.

As specified in the Order, the proposed IRZ monitoring points will be no more than 200 feet apart from each other in the west to east direction, and no more than 400 feet apart from each other in the south to north direction, with the exception of SA-MW-26S/D and location F2 and the alternative layouts described above. Monitoring well pair SA-MW-26S/D is slightly more than 400 feet south of SA-MW-16S/D. This location is proposed to take advantage of an existing well pair in the network. Monitoring location F2 is more than 400 feet north of SC-MW-13 in order to remain on PGE property, should access to other properties be difficult to obtain.

An initial biological survey was conducted of the monitoring well locations proposed in this work plan, with the exception of E1 and F1 proposed at the February 13, 2013 meeting. The findings from this initial survey indicate that that these locations are feasible. Some areas, e.g. Area 1, will require construction of new access roads. Immediately prior to construction of the monitoring wells and access road(s), a thorough biological survey will be conducted. There is a possibility that the presence of endangered species, such as a burrowing owl, could cause delays in construction or modifications to the locations shown in this plan.

4.1.2 Monitoring Well Construction

New shallow and deep zone monitoring wells will be installed using hollow stem augers. It is anticipated that a 10-inch diameter borehole will be advanced to approximately 110 to 120 feet below ground surface (bgs) for the shallow zone monitoring wells, and an 8-inch diameter borehole will be advanced to a maximum depth of 145 feet bgs or until blue clay is encountered, whichever occurs first, for the deep zone monitoring wells. The deep zone monitoring wells will be constructed first, followed by the shallow zone monitoring wells. Soil samples will be collected near-continuously during installation of the deep zone monitoring well, from approximately 85 feet bgs (depth to groundwater) to approximately 150 feet bgs or until the blue clay is encountered, whichever occurs first. Shallow zone monitoring wells will be constructed of 4-inch Schedule 80 PVC casing and 0.010-inch PVC slotted screen, and the deep zone monitoring wells will be constructed of 2.5-inch Schedule 80 PVC casing and 0.010-inch PVC slotted screen. Additionally, plastic centralizers will be installed on the well casings every 20 feet during well construction.

The paired monitoring wells will be screened within the shallow and deep portions of the upper aquifer. The specific screened intervals will be determined during the installation process based on lithologic information collected from soil cores. The shallow screen will be set approximately 5 feet above and at least 10 feet below encountered groundwater. Deep zone monitoring wells will be constructed with a 10 to 20 foot screen interval that will target more permeable materials. The bottom of the deeper monitoring well screen will be at least 5 feet above the drilled depth or blue clay, whichever occurs first. The well screen for both the shallow and deep zone monitoring wells will be surrounded by a silica sand pack to two feet above the top of the screen interval, and then overlain by approximately 40 feet of bentonite pellets hydrated for approximately 2 hours. Neat cement grout will then be backfilled from the top of the bentonite at approximately 50 feet to just below the ground surface. Actual screen depths, lengths, slot sizes, and backfill materials may vary based on field findings and lithology during construction.

Upon completion of well installation, Well Completion Reports will be prepared and submitted to the California Department of Water Resources.

4.1.3 Monitoring Well Development

The monitoring wells will be developed no sooner than 48 hours after completion. The newly installed wells will be developed to remove fines and establish hydraulic connection with the aquifer formation. Well development will consist of surging the well, removing fines by bailing, and purging the water column with a submersible pump (while recording water quality parameters until stable readings are achieved).

Initial groundwater samples will be collected from each well after the well has been developed.

4.1.4 Monitoring Well Sampling

The new and existing monitoring well pairs will be added to the IRZ manganese monitoring program to provide an additional level of monitoring for byproducts generated by the IRZ. The manganese monitoring program wells will be sampled quarterly for hexavalent chromium and dissolved manganese. Results from the quarterly sampling events will be presented in the quarterly *Monitoring Report for the In Situ Reactive Zone and Northwest Freshwater Injection Project*. In addition, the quarterly report will include maps showing the extent of the manganese plumes for the shallow and deep zones of the upper aquifer separately. The quarterly reports will also include potentiometric maps of the IRZ area.

4.2 Tracer Study Work Plan

4.2.1 Background

Through the course of IRZ implementation, several tracer studies using non-toxic eosine and fluorescein dyes have been conducted to evaluate injection solution distribution and migration. Tracer studies

conducted to date included pilot testing and start-up testing in the Central Area from 2006 to 2008, hydraulic testing in the Source Area in 2007, start-up testing in the South Central Re-Injection Area in 2009, and other pilot study activities. Table 1 presents a summary of tracer injections and Figure 4 shows the monitoring well locations where tracer was detected through May 2010, when the majority of tracer data collection ended.

Data collected from these studies indicate that tracer travels along the direction of groundwater flow that is indicated by groundwater elevation contours. In the SCRIA, tracer was detected in monitoring wells downgradient and within the radius of influence of injection wells, but tracer was not detected laterally from injection points to the west in monitoring wells along Fairview Road or Summerset Drive.

4.2.2 Methods and Procedures

In accordance with the Water Board Order, a tracer study will be conducted along the western boundary of the Source Area IRZ to evaluate injection solution distribution and migration in areas where monitoring well network gaps have been identified. As highlighted in green on Figure 1A and Figure 1B, the tracer study is proposed in the vicinity of the southern set of six injection wells in the Source Area IRZ. The tracer study will be initiated following the installation of monitoring wells along Fairview Road. The tracer study well network will be comprised of the following:

- **Injection wells:** Tracer will be applied to the subsurface through injection wells. The injection wells include existing source area remediation wells SA-RW-11, SA-RW-12, and SA-RW-13. Injection wells SA-RW-11, SA-RW-12, and SA-RW-13 are currently configured to inject across the shallow and deep units, consistent with historic operations.
- **Downgradient monitoring wells:** These are wells that are not intended to be directly influenced during the injection, but rather through post-injection ambient groundwater flow. The downgradient monitoring wells include existing source area monitoring wells, MW-01, SA-SM-05S/D, SA-SM-04S/D, SA-SM-08S/D, SA-SM-11S/D.
- **Up- and Side-gradient monitoring wells:** Tracer is not expected to be detected in these wells following the injection. The purpose of these wells is to evaluate the potential for ambient groundwater to migrate west and potentially impact the nearby domestic wells . Side-gradient monitoring wells include new monitoring well pair G and H, and existing source area monitoring well and SA-MW-26S/D. Up-gradient monitoring well MW-17 is also included.

4.2.3 Injections

During initial operation of the southern set of the six injection wells (SA-RW-11, SA-RW-12, SA-RW-13, SA-RW-14, SA-RW-15, and SA-RW-16) from June 2008 to April 2011, the average total flow rate of 15 to 30 gallons per minute (gpm), generally using a combination of three injection wells in operation at a time. Flowrates have declined over time due to well fouling. SA-RW-11 and SA-RW-12 are currently operating

at a flowrate of less than1 gpm and SA-RW-13 is currently operating at a flowrate of 11 gpm. Prior to the tracer study, mechanical and chemical rehabilitation will be conducted to maximize flowrates for the study.

The tracer (fluorescein dye) will be injected into each of the identified injection wells in discreet pulses, similar to how ethanol is currently injected, to achieve an average concentration of 1 mg/L. The tracer injection will include 4 injection pulses over a two week period.

4.2.4 Sampling and Reporting

Prior to injection of the tracer, groundwater samples will be collected for fluorescein from the identified downgradient, upgradient and side-gradient monitoring wells to establish background conditions.

Following completion of the tracer injection, sampling will be conducted in the identified downgradient, up-gradient and side-gradient monitoring well and analyzed for fluorescein on a quarterly basis during routine quarterly monitoring events. Downgradient wells will be sampled for fluorescein until dye concentrations are less than one percent of the injected concentration. Up- and side-gradient monitoring wells will be sampled until any dye detected decreases. If dye does not arrive at up- and side-gradient monitoring wells within two years, sampling will be discontinued. Results from the tracer sampling will be presented in the quarterly *Monitoring Report for the In Situ Reactive Zone and Northwest Freshwater Injection Project.*

4.3 Schedule

Task/Milestone	Duration (approximate)	Schedule (after RWQCB approval)
Biological clearance survey and release to construction	4 weeks	6 weeks
Construction of monitoring wells	2 months	3.5 months
Baseline sampling of tracer study monitoring wells	1 week	4.5 months
Well rehabilitation	2 weeks	3 months
Tracer Study Injections	2 weeks	6 months
Completion of tracer study	2 years	Approximately 2.5 years

There is a possibility that the biological survey conducted prior to construction reveals the presence of endangered species, such as a burrowing owl. This could cause delays in construction and completion of this plan.

5.0 References

ARCADIS 2012. *Assessment of In-Situ Reactive Zone Treatment Byproducts*, PG&E Hinkley Compressor Station, Hinkley, California. Technical memorandum. December 17.

Haley & Aldrich 2010. *Feasibility Study*, Pacific Gas and Electric Company Hinkley Compressor Station, Hinkley, California. August 30.

Lahontan Regional Water Quality Control Board (RWQCB) 2012. *Investigative Order No. R6V-2012-0060. Byproduct Plume Monitoring in IRZ Areas*, Pacific Gas and Electric Company (PG&E), Hinkley Compressor Station, San Bernardino County (Board Order No. R6V-2010-0014. December 21.

Stantec 2012. *Preliminary Reporting of Geology and Hydrology for Investigations in the Western Area*, Pacific Gas and Electric Company's Hinkley Compressor Station. November 19.

6.0 Attachments

Tables

Table 1 Fluorescein and Eosine Tracer Study Summary

Figures

Figure 1A Monitoring Well Locations Per Board Order No. R6V-2012-0060 and Tracer Study Locations

Figure 1B PG&E Proposed Monitoring Well and Tracer Study Locations

Figure 2 Manganese Conceptual Site Model

Figure 3 Plan View of Groundwater Flow and Manganese

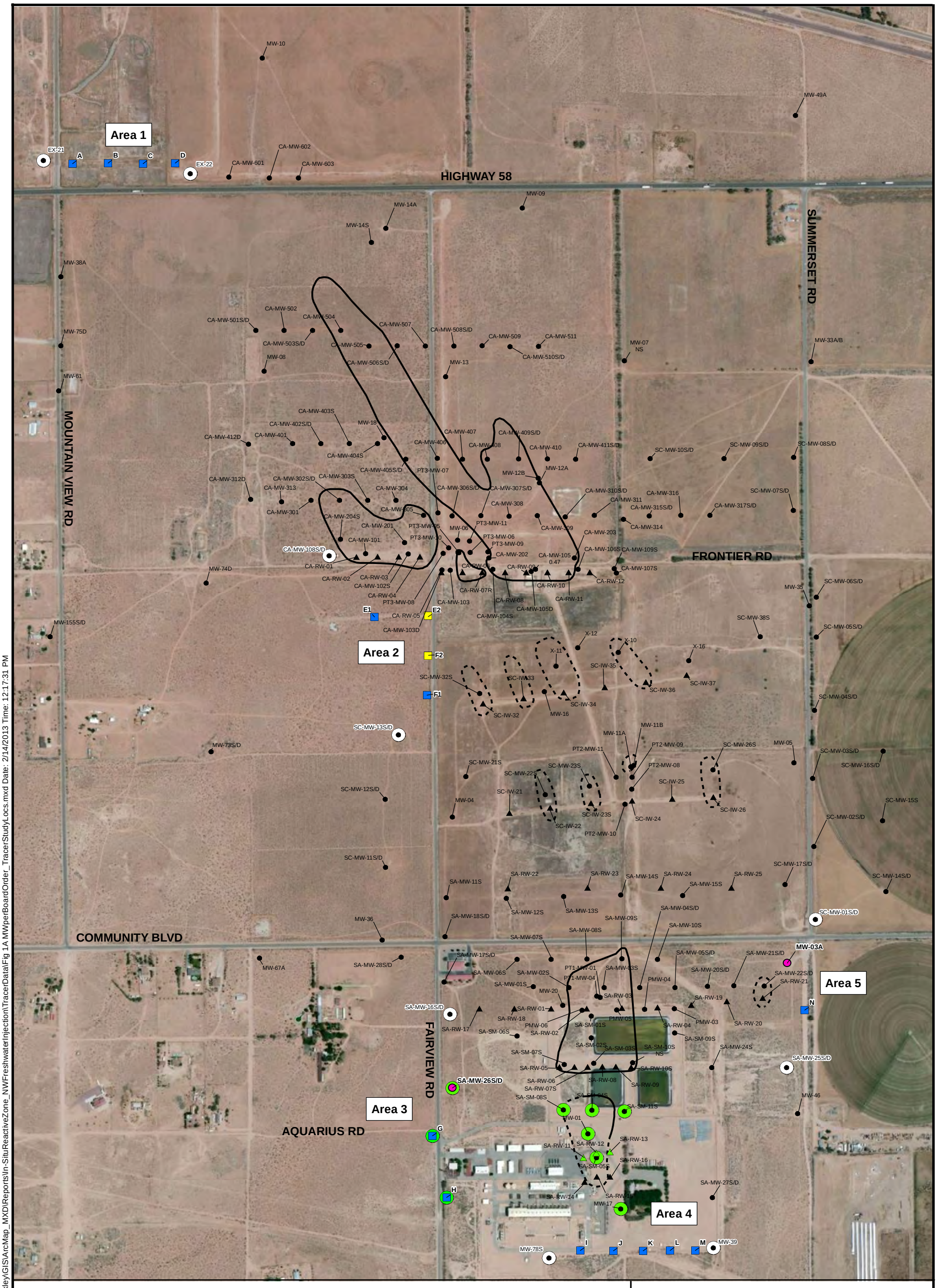
Figure 4 Tracer Study Results through May 2010

Table 1. Fluorescein and Eosine Tracer Study Summary

Study	Injection Location	Date of Injection	Tracer	Amount of Tracer	Average Injection Concentration (ppb)
Source Area Hydraulic Test					
	SA-RW-10	10/23/07-10/24/07	Fluorescein	2.2 lbs	12,800
Central Area Pilot Test					
	PT3-IW-01	11/29/06-12/21/06	Fluorescein	4 L	15,000
Central Area Start-up					
	CA-RW-03	12/10/07- 12/14/07	Fluorescein	0.1 lbs	153
	CA-RW-07	12/10/07- 12/14/07	Fluorescein	0.1 lbs	78
	CA-RW-11	12/10/07- 12/14/07	Fluorescein	0.1 lbs	81
	CA-RW-06	3/25/08-4/5/08	Fluorescein	2.1 lbs	766
	CA-RW-07	3/25/08-4/5/08	Eosine	2.9 lbs	774
South Central Re-Injection Area Start-up					
	SC-IW-22	11/19/09- 1/4/10	Eosine	3.3 lbs	862
	SC-IW-24	11/19/09- 1/4/10	Eosine	5.9 lbs	741
	SC-IW-26	11/19/09- 1/4/10	Eosine	5.3 lbs	864
	SC-IW-32	11/19/09- 1/4/10	Eosine	2.2 lbs	579
	SC-IW-34	11/19/09- 1/4/10	Eosine	5.0 lbs	746
	SC-IW-36	11/19/09- 1/4/10	Eosine	5.0 lbs	745
Infiltration Gallery Pilot Test					
	Infiltration Gallery	11/16/09-12/3/09	Eosine	0.3 lbs	731
Direct Push Pilot Near SA-MW-15					
	IP-1, IP-2, IP-3	10/13/09- 10/16/09	Fluorescein	0.2 lbs	5,719

Notes

L	liter
lbs	pounds
ppb	parts per billion



Legend

- Monitoring Wells
- IRZ Recirculation Wells
- Proposed Monitoring Well
- Alternative Monitoring Well Location
- Existing Monitoring Well to be Used for Manganese Delineation Program
- Injection Well to be used for Tracer Study
- Monitoring Well to be used for Tracer Study Monitoring
- Wells referred to in Board Order No. R6V-2012-0060 to define areas requiring new monitoring wells
- Dissolved manganese concentrations exceeding threshold concentration of 0.39 mg/L Fourth Quarter 2012

Note:
Imagery accessed through BING Maps Aerial via ArcGIS Online Layer Packages by ESRI (12/1/2010) (c) 2010 Microsoft Corporation and its data suppliers accessed on 02/04/2013 through ArcGIS 10.

mg/L- milligrams per liter

N

0 360 720

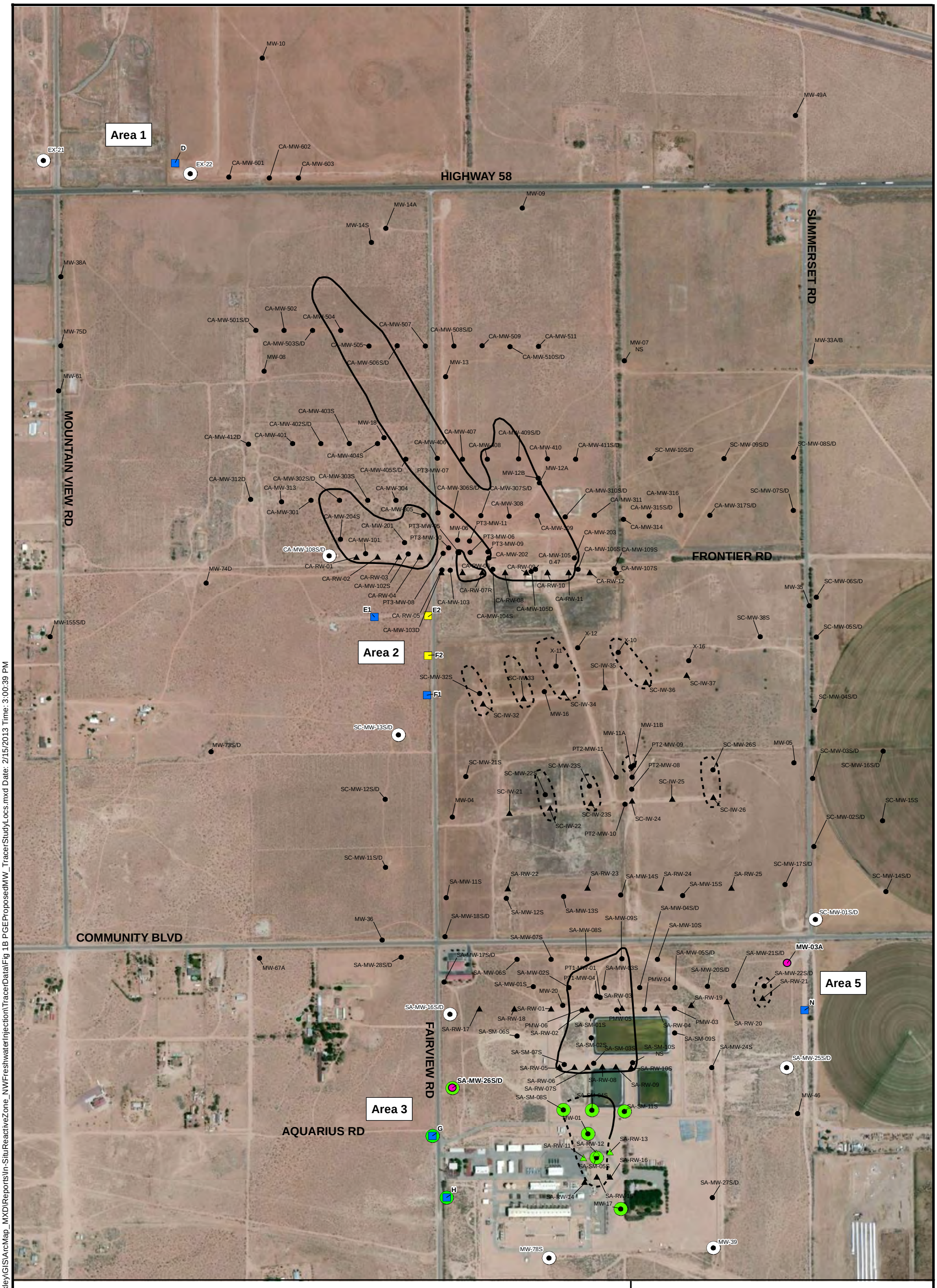
Feet

FIGURE 1A
MONITORING WELL LOCATIONS PER BOARD ORDER NO. R6V-2012-0060 AND TRACER STUDY LOCATIONS

PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY, CALIFORNIA

ARCADIS

Drafter: BCG Path: I:\RC000699.0001_PGE_Hinkley\GIS\ArcMap_MXD\Reports\In-SituReactiveZone_NWFreshwaterInjection\TracerData\Fig 1A MWperBoardOrder_TracerStudyLocs.mxd Date: 2/14/2013 Time: 12:17:31 PM



Legend

- Monitoring Wells
- IRZ Recirculation Wells
- Proposed Monitoring Well
- Alternative Monitoring Well Location
- Existing Monitoring Well to be Used for Manganese Delineation Program
- Injection Well to be used for Tracer Study
- Monitoring Well to be used for Tracer Study Monitoring
- Wells referred to in Board Order No. R6V-2012-0060 to define areas requiring new monitoring wells
- Dissolved manganese concentrations exceeding threshold concentration of 0.39 mg/L Fourth Quarter 2012

Note:
Imagery accessed through BING Maps Aerial via ArcGIS Online Layer Packages by ESRI (12/1/2010) (c) 2010 Microsoft Corporation and its data suppliers accessed on 02/04/2013 through ArcGIS 10.

mg/L- milligrams per liter

N

0 360 720

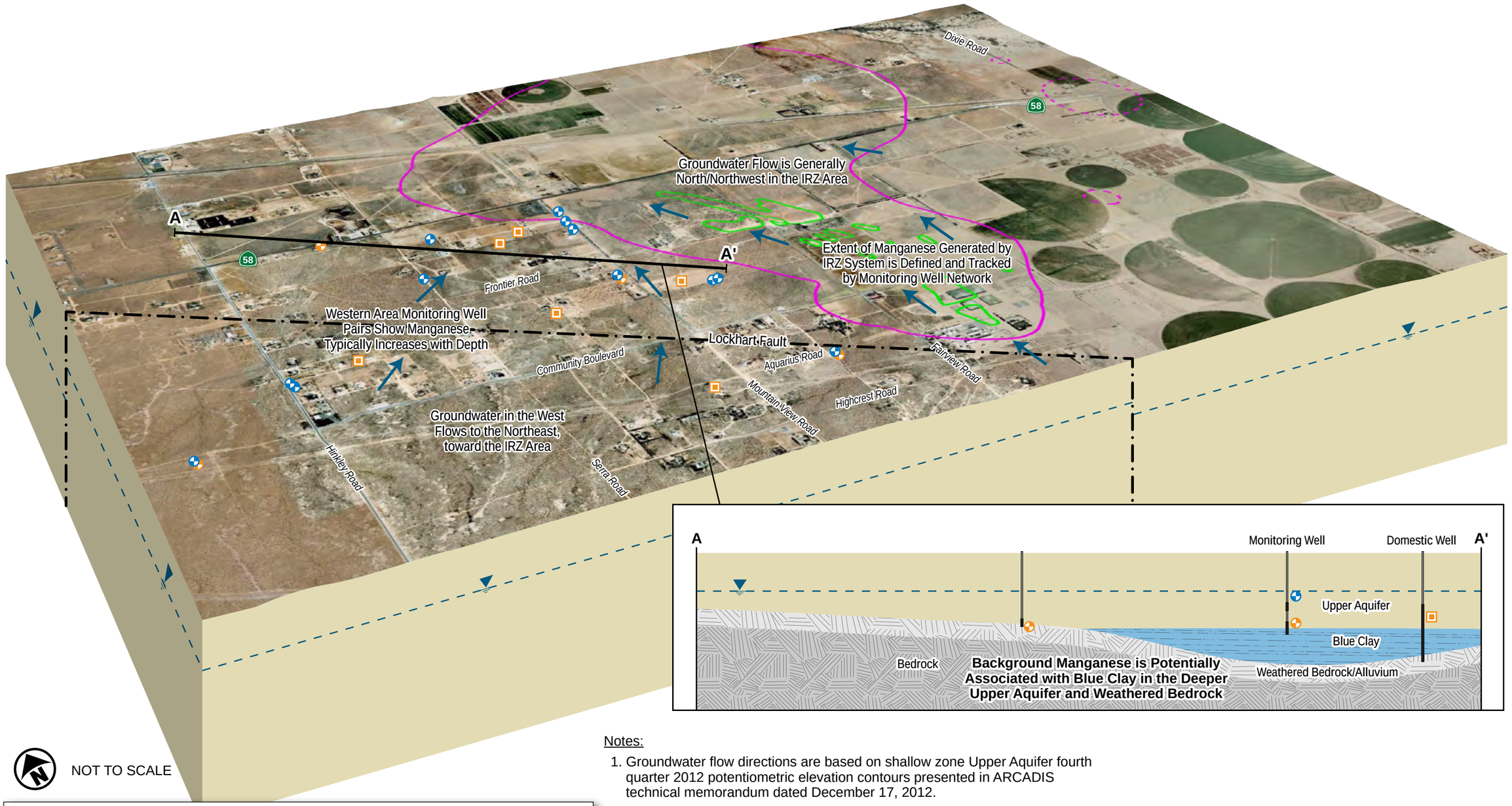
Feet

FIGURE 1B
PG&E PROPOSED MONITORING WELL AND TRACER STUDY LOCATIONS

PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY, CALIFORNIA

ARCADIS

Drafter: BCG Path: I:\RC000699.0001_PGE_Hinkley\GIS\ArcMap_MXD\Reports\In-SituReactiveZone_NWFreshwaterInjection\TracerData\Fig 1B PGEProposedMW_TracerStudyLocs.mxd Date: 2/15/2013 Time: 3:00:39 PM



NOT TO SCALE

LEGEND

- Inferred Groundwater Flow Direction
- Water Table
- 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, Third Quarter 2012
- Dissolved Manganese Concentrations in IRZ Monitoring Network greater than 0.39 mg/L

Western Area Wells

- Mn > 0.05 mg/L
- Mn < 0.05 mg/L
- Domestic Well with Manganese Detected

Notes:

1. Groundwater flow directions are based on shallow zone Upper Aquifer fourth quarter 2012 potentiometric elevation contours presented in ARCADIS technical memorandum dated December 17, 2012.
2. Cr(VI) contour based on data collected third quarter 2012 and presented in ARCADIS technical memorandum dated December 17, 2012.
3. Manganese contours are based on data collected fourth quarter 2012 and presented in ARCADIS technical memorandum dated December 17, 2012.
4. Cr(T) = total dissolved chromium
5. Cr(VI) = hexavalent chromium
6. IRZ = In-situ Reactive Zone
7. Mn = Manganese
8. mg/L = milligrams per liter

FIGURE 2
MANGANESE
CONCEPTUAL SITE MODEL
PACIFIC GAS AND ELECTRIC COMPANY
COMPRESSOR STATION, HINKLEY, CALIFORNIA

CITY:Highlands Ranch DIV/GROUP:(ENV/GIS) DB: Brianna Griffith
Path: I:\RC000699.0001_PGE_Hinkley\GIS\ArcMap_MXD\Reports\In-SituReactiveZone_NWFreshwaterInjection\TracerData\Fig 3 PlanView_GWFlowMn.mxd Date: 2/15/2013 Time: 2:37:31 PM

Legend

- Domestic well in western area with no manganese detected in samples collected by community members, the Water Board and/or PG&E
- Domestic well in western area with manganese detected in samples collected by community members, the Water Board and/or PG&E
- Western monitoring well with dissolved manganese greater than 0.5 milligrams per liter
- Western monitoring well with dissolved manganese less than 0.5 milligrams per liter
- Monitoring wells in shallow zone of upper aquifer
- Monitoring wells in deep zone of upper aquifer
- Potentiometric Elevation Contours in Shallow Zone of Upper Aquifer Fourth Quarter 2012, Dashed Where Inferred (feet above mean sea level, 5 ft contour interval)
- Dissolved manganese concentrations in IRZ monitoring network greater than 0.39 milligrams per liter (mg/L), Fourth Quarter 2012
- Topographic Contours
- IRZ Location
- PG&E Property

Notes:
-Locations approximate and based on limited information in some cases

N

0 2,300 4,600

SCALE IN FEET

FIGURE 3
PLAN VIEW OF GROUNDWATER FLOW AND MANGANESE

PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY, CALIFORNIA

ARCADIS

HIGHWAY 58

MOUNTAIN VIEW RD

SUMMERSET RD

FAIRVIEW RD

COMMUNITY BLVD

CA-MW-501S
CA-MW-502
CA-MW-503S
CA-MW-503D
CA-MW-504
CA-MW-505
CA-MW-506S
CA-MW-506D
CA-MW-507
CA-MW-508S
CA-MW-509
CA-MW-510S
CA-MW-511

CA-MW-412S
CA-MW-412D
CA-MW-401
CA-MW-402S
CA-MW-402D
CA-MW-403S
CA-MW-403D
CA-MW-404S
CA-MW-404D
CA-MW-405S
CA-MW-405D
CA-MW-313
CA-MW-312D
CA-MW-301
CA-MW-302S
CA-MW-302D
CA-MW-303S
CA-MW-303D
CA-MW-304
CA-MW-305
CA-MW-204S
CA-MW-108S
CA-MW-108D
CA-RW-01*
CA-MW-101
CA-RW-02
CA-RW-03
CA-RW-04
CA-MW-201
CA-MW-102S
CA-MW-102D
PT3-MW-05
PT3-MW-01
PT3-MW-08
MW-06
PT3-MW-02
PT3-EX-01
PT3-MW-06
PT3-MW-03
PT3-EX-02
PT3-MW-04
PT3-IW-03
PT3-IW-02
PT3-IW-01
CA-MW-202
CA-RW-05
CA-MW-103
CA-RW-06
CA-RW-07
CA-MW-104S
CA-MW-104D
CA-RW-08
CA-MW-105
CA-MW-203
CA-RW-09
CA-RW-10
CA-RW-11
CA-RW-12
CA-MW-106S
CA-MW-106D
CA-MW-107S
CA-MW-107D
CA-MW-406
CA-MW-407
CA-MW-408
CA-MW-409S
CA-MW-410
CA-MW-411S
PT3-MW-07
CA-MW-306S
CA-MW-306D
CA-MW-307S
CA-MW-307D
CA-MW-308
CA-MW-309
CA-MW-310S
CA-MW-310D
CA-MW-311
CA-MW-314
CA-MW-315S
CA-MW-316
CA-MW-317S
SC-MW-10S
SC-MW-10D
SC-MW-09S
SC-MW-09D
SC-MW-08S
SC-MW-08D
SC-MW-07S
SC-MW-07D
SC-MW-06S
SC-MW-06D
MW-35
SC-MW-38S
SC-MW-38D
SC-MW-05S
SC-MW-05D
X-12
X-10
X-16
SC-IW-37
SC-IW-36
MW-16
SC-MW-32S
SC-IW-32
SC-IW-33
SC-IW-35
SC-IW-34
SC-MW-04S
SC-MW-04D
SC-MW-13S
SC-MW-13D
MW-11B
PT2-MW-09
PT2-MW-08
PT2-MW-11
PT2-MW-10
SC-IW-24
PT2-MW-06
PT2-MW-05
SC-MW-26S
SC-MW-26D
SC-IW-26
SC-IW-23
SC-IW-25
PT2-MW-03
PT2-MW-04
PT2-MW-01
SC-MW-21S
SC-MW-22S
SC-IW-21
SC-IW-22
MW-04
MW-05
SC-MW-16S
SC-MW-16D
SC-MW-03S
SC-MW-03D
SC-MW-15S
SC-MW-15D
SC-MW-02S
SC-MW-02D
SC-MW-12S
SC-MW-12D
SC-MW-11S
SC-MW-11D
SA-MW-15S
IP-2
IP-3
IP-1
SC-MW-14S
SC-MW-14D
SC-MW-01S
SC-MW-01D

SA-SM-01D
SA-RW-03
SA-SM-02S
SA-SM-02D
SA-RW-07*
SA-RW-06*
SA-RW-05*
SA-SM-10S
SA-SM-10D
SA-RW-10
SA-RW-08*
SA-RW-09*
SA-RW-12*
SA-RW-11*
SA-RW-13*
SA-RW-14*
SA-RW-16*
SA-RW-15*

Central Area

South Central Re-Injection Area

Infiltration Gallery Pilot

Direct Push Pilot

Source Area

Legend

- Injection Well
- Extraction Well
- Monitoring Well

Maximum Eosine/Fluorescein Concentrations 2006 to May 2010

- <0.5 ppb
- 0.5-5 ppb
- >5 ppb
- Tracer injection location

Notes
* Injection due to recirculation
ppb - parts per billion

N

0 360 720
Feet

FIGURE 4
TRACER STUDY RESULTS THROUGH MAY 2010

PACIFIC GAS AND ELECTRIC COMPANY
HINKLEY, CALIFORNIA

ARCADIS

Drafter: BCG Path: I:\RC000699.0001_PGE_Hinkley\GIS\ArcMap_MXD\Reports\In-SituReactiveZone_NWFreshwaterInjection\TracerData\Fig 4 MaxTracer_ThroughMay2010.mxd Date: 2/11/2013 Time: 4:22:00 PM