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November 30, 2005

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Subject: Well Installation Work Plan for Interim Measures Performance Monitoring Program, PG&E Topock Compressor Station, Needles, California

Dear Mr. Shopay:

This letter transmits the *Well Installation Work Plan for Interim Measures Performance Monitoring Program*. The work plan is submitted for review in conformance with Condition 5 in DTSC's October 17, 2005 letter.

Please contact me at (805) 546-5243 if you have any questions on the work plan.

Sincerely,

Julie Eakins for Yvonne Meeks

cc. Kate Burger/ DTSC

Enclosure

Draft

Well Installation Work Plan for Interim Measures Performance Monitoring Program

PG&E Topock Compressor Station Needles, California

November 30, 2005

Prepared for

California Department of Toxic Substances Control

On behalf of

Pacific Gas and Electric Company

CH2MHILL
155 Grand Avenue, Suite 1000
Oakland, CA 94612

Draft

Well Installation Work Plan for Interim Measures Performance Monitoring Program

PG&E Topock Compressor Station
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This work plan was prepared under supervision of a California Certified Engineering Geologist:

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Project Hydrogeologist

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Acronyms and Abbreviations

µg/L	micrograms per liter
bgs	below ground surface
BLM	U.S. Bureau of Land Management
Cr(T)	total chromium
Cr(VI)	hexavalent chromium
DTSC	California Department of Toxic Substances Control
HNWR	Havasu National Wildlife Refuge
IDW	investigation-derived waste
IM	Interim Measure
IM-3	Interim Measure No. 3
PG&E	Pacific Gas and Electric Company
PVC	polyvinyl chloride

1.0 Introduction

Pacific Gas and Electric Company (PG&E) is implementing an Interim Measure (IM) to address chromium concentrations in groundwater at the Topock Compressor Station near Needles, California. The IM consists of groundwater extraction for hydraulic control of the plume boundaries near the Colorado River floodplain and management of extracted groundwater. The groundwater extraction, treatment, and injection systems are collectively referred to as Interim Measure No. 3 (IM-3). The IM-3 facilities include a groundwater extraction system, conveyance piping, a groundwater treatment plant, and an injection well field for the discharge of the treated groundwater. Figure 1-1 shows the location of the IM extraction, conveyance, treatment, and injection facilities.

In a letter dated February 14, 2005, the California Department of Toxic of Substances Control (DTSC) established the criteria for evaluating the performance of the IM. As defined by DTSC, the performance standard for this IM is to "establish and maintain a net landward hydraulic gradient, both horizontally and vertically, that ensures that hexavalent chromium concentrations at or greater than 20 micrograms per liter (µg/L) in the floodplain are contained for removal and treatment" (DTSC 2005a). The DTSC directive also defined the monitoring and reporting requirements for the IM. A draft *Performance Monitoring Plan for Interim Measures in the Floodplain Area* was submitted to DTSC on April 15, 2005 (CH2M HILL 2005a). The site monitoring, data evaluation, reporting, and response actions required under the February 2005 DTSC directive are collectively referred to as the IM Performance Monitoring Program for the floodplain area.

In a letter dated October 17, 2005, DTSC directed PG&E to prepare a well installation work plan that addresses modifications to the IM performance monitoring network (DTSC 2005b). Per DTSC direction, the work plan is to address hydraulic gradient well pairs for the expanded groundwater extraction system and additional plume characterization and delineation in the floodplain area to the north and northwest of the MW-34 well cluster.

This work plan has been prepared in compliance with DTSC's October 17 letter and describes the objectives, scope and rationale for modifications to the IM performance monitoring well network. The drilling program described in this work plan involves the installation of monitoring wells or monitoring well clusters at three locations on the western floodplain of the Colorado River near the PG&E Topock Compressor Station.

1.1 Project Background

The Topock Compressor Station is located in San Bernardino County, approximately 15 miles to the southeast of Needles, California (Figure 1-1). In February 1996, PG&E and DTSC entered into a Corrective Action Consent Agreement pursuant to Section 25187 of the California Health and Safety Code. Under the terms of that agreement, PG&E was directed to conduct a Resource Conservation and Recovery Act Facility Investigation and to implement corrective measures to address constituents of concern released in the Bat Cave Wash Area near the PG&E Topock Compressor Station. The primary constituents of concern

at Topock are hexavalent chromium (Cr[VI]) and total chromium (Cr[T]). The source was Cr(VI) salts historically used as a corrosion inhibitor in the station's cooling towers.

DTSC is the lead administering agency for the project. Assisting DTSC and PG&E with the planning and review of interim remedial measures are the members of the Topock Consultative Work Group, which was constituted under California's Site Designation Process. The Consultative Work Group consists of representatives from DTSC; the California Regional Water Quality Control Board, Colorado River Basin Region; the Metropolitan Water District of Southern California; the Arizona Department of Environmental Quality, the various federal agencies who own or manage adjacent property; and other project stakeholders.

In March 2004, as directed by the DTSC, PG&E began implementation of the Interim Measure. Components of the current IM-3 system include continuous groundwater extraction, piping, and conveyance of extracted groundwater to a treatment system; treatment of extracted groundwater using reduction-precipitation-filtration and reverse osmosis; and disposal of treated groundwater by injection wells. PG&E is currently pumping groundwater from one deep extraction well (TW-2D), located on a topographic bench along the station access road and above the Colorado River floodplain. The bench, referred to as the monitoring well MW-20 bench, is owned by the U.S. Bureau of Reclamation and is managed by the U.S. Bureau of Land Management (BLM). All well drilling sites proposed in this work plan are located in the floodplain area immediately east of the MW-20 bench on land maintained by BLM.

As part of the IM, groundwater and hydrogeologic investigations in the floodplain area were conducted by PG&E in April-May 2004 (Phase 1) and January-February 2005 (Phase 2). The results of the Phase 1 investigation are reported in the February 2005 Draft RCRA Facility Investigation/Remedial Investigation Report (CH2M HILL 2005b). The results of the Phase 2 investigation and associated installation of IM extraction well PE-1 are presented in separate well installation reports (CH2M HILL 2005c, 2005d). The results of these investigations and the floodplain wells that were installed have been incorporated in the IM Performance Monitoring Program and were used in preparing this work plan.

1.2 Objectives

As required by DTSC's October 17 letter, the primary objectives of the IM performance monitoring modifications drilling program are to address the hydraulic gradient well pairs for the expanded groundwater extraction system, and to collect data for further plume definition to the north and northwest of the MW-34 well cluster.

Accordingly, this work plan is organized as follows to address the additional drilling and well installation activities proposed for the IM performance monitoring network:

- Section 2 describes the existing IM performance monitoring program and summarizes the hydrogeologic framework and distribution of Cr(VI) in groundwater in the floodplain area.

- Section 3 describes the proposed modifications to the hydraulic monitoring network, activities to further delineate the Cr(VI) plume in the MW–34 / central floodplain area, and presents the scope of additional groundwater investigations in the floodplain.
- Section 4 describes the methods, procedures, and specifications for the drilling, groundwater sampling, monitoring well installation, and initial groundwater quality characterization for the proposed investigation sites.
- Section 5 describes the procedures for managing investigation-derived waste (IDW) and equipment decontamination associated with the field investigation.
- Section 6 outlines the approvals and approvals required from various agencies for the proposed field investigations in the floodplain area.
- Section 7 presents the implementation schedule and reporting activity for the IM performance monitoring drilling program.

2.0 Existing IM Performance Monitoring Data Summary

This section summarizes the existing IM performance monitoring network and summarizes the hydrogeologic framework and distribution of Cr(VI) in groundwater in the floodplain area, based on field investigations and monitoring data through October 2005. More complete presentation and discussion of the hydrogeologic conditions and groundwater quality data for the floodplain monitoring wells are included in the Phase 2 IM investigation report (CH2M HILL 2005c), and in recent IM performance monitoring reports (CH2M HILL 2005e, 2005f).

2.1 Performance Monitoring Well Network

The network of groundwater wells currently available for performance monitoring include four extraction wells and 49 monitoring wells in the floodplain and adjoining site area. Figure 2-1 shows the locations of wells used for the IM extraction, performance monitoring, and hydraulic gradient calculation. The wells are defined as:

- **Floodplain Wells**: MW-22, MW-27 cluster (3), MW-28 cluster (2), MW-29, MW-30 cluster (2), MW-32 cluster (2), MW-33 cluster (4), MW-34 cluster (3), MW-36 cluster (6), MW-39 cluster (6), MW-42 cluster (3), and MW-43 cluster (3).
- **Intermediate Wells**: MW-12, MW-19, MW-20 cluster (3), MW-21, MW-26, MW-31 cluster (2), MW-35 cluster (2), TW-2S, TW-2D.
- **Interior Wells**: MW-10, MW-25.

The two currently operational extraction wells, TW-2S and TW-2D, are located on the MW-20 bench (Figure 1-1). Two new extraction wells, TW-3D and PE-1, have been installed at DTSC's request to provide additional extraction system capacity. In March 2005, extraction well PE-1 was installed on the floodplain approximately 450 feet east of extraction well TW-2D (Figure 2-1). In late October 2005, extraction well TW-3D was installed approximately 15 feet west of well TW-2D, to serve as a supplemental extraction well for the IM system with a well completion similar to TW-2D.

2.1.1 Groundwater Monitoring Wells

The current network of groundwater wells used for performance monitoring includes 36 monitoring wells in the floodplain, nine wells in the MW-20 bench/Park Moabi Road area, and two monitoring wells in the interior plume area (MW-10, MW-25) (Figure 2-1). The majority of the performance monitoring wells used for hydraulic data and groundwater sampling are clusters consisting of two or three individual wells installed at one monitoring location.

2.1.2 Pressure Transducer Network

The current performance monitoring well network includes pressure transducer data collection at 49 groundwater wells and two river gauge stations (I-3, RRB). The data loggers typically record water level data at 30 minute intervals. The hydraulic monitoring data is used to prepare groundwater elevation contour maps for depth intervals in the aquifer in the floodplain area.

Hydraulic gradients are calculated each month between the following well/gradient pairs:

- MW-31-135 and MW-33-150 (northern gradient pair monitoring TW-2D)
- MW-20-130 and MW-34-80 (central gradient pair monitoring TW-2D)
- MW-20-130 and MW-42-65 (southern gradient pair monitoring TW-2D)

The location of the gradient wells pairs used in the current IM performance monitoring program are shown on Figure 2-1.

2.2 Hydrogeology of Floodplain Area

The wells screened in the unconsolidated alluvial fan and fluvial deposits, which comprise the Alluvial Aquifer, have been separated into three depth intervals to present groundwater quality and groundwater level data. The depth intervals of the Alluvial Aquifer, designated upper, middle, and lower, are based on grouping the monitoring wells screened at common elevations and do not represent distinct hydrostratigraphic units or separate aquifer zones.

The Alluvial Aquifer depth intervals and hydrogeologic setting in the floodplain is shown on Figure 2-2, a cross section extending east from the MW-20 (IM extraction wells) to the MW-34 well cluster and the Colorado River (the location of the cross section is shown on Figure 2-1). For the purposes of performance monitoring, the depth interval concept is useful for presenting and evaluating lateral gradients, while minimizing effects of vertical gradients and observing the influence of pumping from partially penetrating wells. It should be noted, however, that these divisions do not correspond to any lithostratigraphic layers within the aquifer. The floodplain aquifer is considered to be hydraulically undivided.

Figure 2-3 shows structure elevation contours on the Miocene bedrock surface that underlies the floodplain area. The map shows the boring locations and elevations of the top of the cemented, hard Miocene sedimentary rock formation (also referred to as the Miocene conglomerate unit). It should be noted that some of the drilling investigations in the floodplain area have encountered an interval of weathered conglomerate formation that overlies the hard, cemented Miocene bedrock surface depicted on Figure 2-3.

2.3 Chromium Distribution in Floodplain Area

The groundwater monitoring wells in the floodplain area are sampled for Cr(VI), Cr(T), and field water quality parameters under quarterly, monthly, and biweekly schedules, in accordance with the approved groundwater monitoring plan and DTSC directives. Figure 2-4 presents a plan view of the October 2005 Cr(VI) results for wells in the upper, middle, and lower depth intervals of the Alluvial Aquifer. Figure 2-4 also shows the

approximate locations of the 20 µg/L and 50 µg/L Cr(VI) contour lines in groundwater within each depth interval. The California drinking water standard for Cr(T) is 50 µg/L.

Figure 2-5 presents Cr(VI) concentrations for floodplain monitoring wells on a north-south oriented cross section that parallels the Colorado River. The location of cross section B is shown on Figure 2-1. The cross section posts the groundwater Cr(VI) concentration results for sampling events conducted in March, July, and October 2005, and shows the inferred distribution of Cr(VI) in groundwater in the plane of this cross section. As shown on Figure 2-5, Cr(VI) concentrations above 20 µg/L are found in the deep interval of the aquifer in the vicinity of well MW-34-100. At the MW-33 well cluster, Cr(VI) concentrations ranged from 18.6 µg/L (mid-depth interval) to 5.6 µg/L (base of the lower interval). Cr(VI) was not detected above analytical reporting limits in any of the upper, middle, or lower depth wells in the southern well clusters MW-27 and MW-43 during the sampling events performed in March through October 2005.

3.0 Proposed IM Performance Monitoring Modifications

This work plan is focused on 1) expanding the performance monitoring system for the IM extraction system by adding additional gradient control well pairs associated with well PE-1 and 2) providing further characterization of the chromium distribution in the area north of the MW-34 well cluster.

3.1 Gradient Control Well Pairs for Performance Monitoring

Per DTSC letter of February 14, 2005, the successful performance of the IM pumping is measured by achieving a minimum landward gradient of 0.001 feet per foot in a set of three gradient control well pairs centered on the TW-2 pumping location. Gradient control wells are all completed in the deep portion of the aquifer, where Cr(VI) concentrations are most prevalent. When the PE-1 well is brought on line, it will create a second, smaller cone of depression in the floodplain. To continue to assess IM performance based on gradient control wells, new gradient control well pairs will be needed that are appropriately located to measure the gradients in the vicinity of PE-1.

Groundwater model simulations were conducted to evaluate the gradient that will likely exist when both TW-2D and PE-1 are pumping. The model projected groundwater contours with TW-2D pumping 90 gpm and PE-1 pumping 40 gpm are shown on Figure 3-1. Dashed lines on Figure 3-1 denote the existing and proposed new gradient control well pairs, and show the relative alignment of those well pairs in relation to the projected groundwater contours. Ideally, well pairs should be oriented in a line perpendicular to the groundwater level contours to more accurately measure the gradient. Well pairs not aligned perpendicular to the contours will indicate a smaller than actual gradient, and therefore provide a more conservative measure of IM success.

As shown on Figure 3-1, two new wells and two existing wells are proposed to measure the gradient associated with pumping at PE-1. A new well (MW-45, Site B) will be installed approximately 15 feet from PE-1 to provide the central gradient control well for all three well pairs associated with PE-1. A new well (MW-44, Site A) will be installed approximately 170 feet north of PE-1 to provide the northern gradient control pair (with new well MW-45). Ideally, MW-44 would be located in the vegetated area further to the east to align the well pair with the gradient. However, this would involve significant cutting of riparian vegetation and could significantly delay the approval of the project. Consequently, the location for MW-44 is a compromise that is intended to achieve adequate measurement of the gradient without damaging sensitive habitat. If actual gradients created by pumping PE-1 are different than model projections, MW-44 may not be appropriately located to measure the gradients produced by PE-1 pumping. In this event, the central and southern PE-1 gradient control pairs would be used for evaluating the gradients induced by PE-1 pumping.

A third well (MW-46, Site C) is proposed for a location approximately 480 feet east of the TW-2D pumping center (Figure 3-1) to provide additional hydraulic gradient control for performance monitoring. The MW-46 location is selected to supplement the existing performance monitoring wells at the MW-28 cluster. Well MW-28-90, screened at the top of the lower depth interval, is currently the only well used for the deeper gradient control in this area. Accordingly, a deeper monitoring well in this area is proposed to provide additional performance data for gradient control in the lower depth interval.

Existing wells MW-34-100 and MW-27-85 paired with the new MW-45 well will provide central and southern gradient control well pairs for measuring gradients associated with pumping at PE-1. These two well pairs are optimally aligned with the projected groundwater gradients.

With PE-1 pumping, the existing northern and southern gradient control well pairs associated with TW-2 will still be usable. These well pairs comprise MW-33-150/MW-31-135 and MW-42-65/MW-20-130. The northern and southern TW-2 well pairs are slightly off-axis to the gradient because they include wells at the MW-20 and MW-31 locations which are not very close to the pumping center. When well TW-3D begins pumping, consideration should be given to using well TW-2D as the central gradient control well for both MW-33-150 and MW-42-65. This would provide a more accurate measure of the hydraulic gradient around the TW-3D pumping center because the well pairs would be better aligned with the gradient.

3.2 Chromium Distribution in MW-34 Area

A second objective of the current scope of work involves additional characterization of the chromium distribution north and northwest of well MW-34-100. Chromium concentrations in well MW-34-100 have gradually increased over the last several months, from about 400 µg/L to over 700 µg/L. At the MW-34 cluster, Cr(VI) is only present in the deepest well. MW-34-80 screened only 20 feet above MW-34-100 has not shown detectable concentrations of Cr(VI) since March 2004. There is a slight bedrock ridge located in the vicinity of PE-1 that may provide some geologic control on the distribution of Cr(VI) in the deepest portion of the aquifer (Figures 2-2 and 2-3). If this ridge does exert geologic control, the Cr(VI) plume may be confined to the deeper portion of the aquifer in the area north of MW-34-100 where the bedrock is deeper.

Wells at Sites A and C shown on Figures 3-1 and 3-2 are proposed to provide characterization of the distribution of Cr(VI) in the area north of MW-34-100. Site A is located in an area where the Cr(VI) plume could be present in the deep portion of the aquifer around the end of the bedrock ridge. Well MW-44 will be used for hydraulic monitoring for gradient control and further characterization of Cr(VI) distribution.

Site C is located near the MW-28 well cluster. The deep screened interval at well MW-28-90 is at 70 to 90 feet bgs, near the contact between the fluvial and the alluvial sediments. The MW-28-90 screen was placed, in consultation with DTSC, in what was determined to be the deepest permeable zone of the aquifer at this location. Because the drilling met refusal before encountering the hard, unweathered Miocene conglomerate bedrock unit, questions have been raised about the possible presence of a permeable zone between the screened interval of MW-28-90 and the hard bedrock. Drilling at Site C (MW-46) is proposed to

provide additional characterization of the deepest portion of the aquifer, and to augment the MW-28 well cluster.

3.3 Proposed Groundwater Investigation and Well Installation

The scope of work described here includes well installation at three locations. The drilling locations, labeled Sites A, B, and C, are shown on Figure 3-2, along with the proposed access routes and staging areas. Table 3-1 provides the objectives, rationale, and general number of wells at each location. Screened intervals in all wells will be 10 feet in length. This work plan provides general target depths for screened intervals. The actual screened interval depths will be chosen based on review of the lithologic core logs from the pilot borings and the results from the depth specific sampling. The target depth intervals for depth specific sampling and well screens for drilling Sites A and C are shown on hydrogeologic section B (Figure 3-3).

Depth specific sampling will be conducted using an Isoflow® groundwater sampling system. This characterization method was used in the January-February 2005 floodplain drilling program (CH2M HILL 2005c). Samples will be collected using a submersible pump attached to a packer. The packer will be set at the bottom of the drive casing and the pump will draw water from an open section of borehole below the drive casing. Using this method, it is possible to purge and sample a vertically-discrete section of the aquifer during drilling. Field parameters will be measured to determine the electrical conductivity and oxidation reduction potential of the water. A water sample will be collected and analyzed for hexavalent chromium using the HACH onsite laboratory at the IM-3 treatment plant. Water levels will be measured during purging to provide a comparison of relative permeability throughout the borehole. The data from the Isoflow® samples will be used in conjunction with the lithologic logs to select screened intervals for the wells, in consultation with DTSC.

Site A – A total of three well screens will be installed at Site A (to be designated MW-44). The proposed general depth intervals for the well screens and the approximate depths of Isoflow® samples are shown on Figure 3-3. Two of the well screens will be located in the deep portion of the aquifer. The target depths for these screens are just above bedrock, and at a depth similar to MW-34-100. These target depths may be adjusted based on a review of Isoflow® sample results and lithologic logs in consultation with DTSC. A mid-depth well will be installed at Site A at an elevation approximately coincident with MW-34-55. The deepest well screen and the mid-depth well screen at Site A will be installed as nested wells in a common borehole. The upper screen in the deep portion of the aquifer will be installed in a separate borehole.

Site B – One well screen will be installed at Site B (MW-45). The screened interval in this well will be just above the bedrock, similar to extraction well PE-1. The purpose of the well at Site B is to provide water level data for gradient determination. Isoflow® sampling was conducted in the nearby well PE-1, approximately 15 feet away from Site B. Cr(VI) was not detected in any of the six Isoflow® samples collected from PE-1 (CH2M HILL 2005d). No Isoflow® sampling is planned for the boring at Site B.

Site C – One or two well screens will be installed for hydraulic monitoring in the deep portion of the aquifer at Site C (MW-46). The target depth for screens and proposed

Isoflow® sampling depths at this location are shown on Figure 3-3. The number of well screens installed will depend on the geologic conditions encountered. In nearby well MW-28, the deep section of the borehole encountered stiff, weathered Miocene conglomerate that did not appear to be water bearing. If similar conditions are encountered in the deep portion of the borehole at Site C, a single screen may be installed in the overlying alluvium. If a substantial thickness of permeable alluvium is encountered, two well screens will be installed. The target geologic formation for well screens at Site C is the alluvium that underlies the fluvial materials.

Further details about proposed well installation and sampling methodologies are provided in Section 4.

4.0 Drilling, Sampling and Well Installation

4.1 Site Preparation, Materials Staging, and Equipment Access

The proposed access routes and equipment staging areas for this field investigation are shown on Figure 3-2. The drilling equipment access routes on the floodplain are based on the approved access routes described in the final Technical Memorandum addressing access routes for site monitoring activities (CH2M HILL 2005g). The Technical Memorandum summarizes sampling access routes and proposed mitigation measures for the floodplain that were reviewed and field surveyed with representatives of BLM and the Havasu National Wildlife Refuge (HNWR) in June and July 2005. In addition to the primary equipment access route shown on Figure 3-2, a secondary contingency access route is proposed for the Site A and Site B drilling locations. This contingency access route, would be used if other construction, operation, or testing activities in the central floodplain associated with the piping of PE-1 or In-Situ Pilot Study preclude access to these sites from the north.

For all proposed drilling sites shown on Figure 3-2, it is anticipated that no clearing of vegetation will be needed to allow access for drilling equipment. Prior to mobilization of drilling equipment, the proposed access routes and drilling sites will be field-checked and clearly delineated by PG&E, BLM, and CH2M HILL If modifications to the access routes or minor clearing vegetation are needed, additional surveys will be conducted to ensure that no sensitive habitat will be impacted. All field activities associated with the equipment access and well drilling for this project will be coordinated with BLM to ensure the protection of cultural and biological resources.

Site preparation shall take place prior to execution of drilling and monitoring well installation tasks. Site preparation shall include identifying and avoiding biologically and/or culturally sensitive areas and site hazards, to the extent possible. The drill rig shall be cleaned before mobilization to each site and following completion of drilling at each site if visible grease, oil, or other contamination is evident on the equipment. After the drill rig has mobilized into place, short-term staging areas will be established. Plastic sheeting will be laid on the ground surface in the staging areas to keep the drilling materials and equipment clean and to minimize impacts to the ground surface from the drilling materials and equipment. Materials to be stored at the well site include drilling equipment and well construction materials (e.g., casing, sand, bentonite, and grout). Locations of staging areas are shown on Figure 3-2. Additional materials may be stored on PG&E Topock Compressor Station property.

4.2 Drilling and Sampling Activities

Drilling and well installations shall conform to state and local regulations. CH2M HILL will obtain authorizations and applications required for drilling and well installation. Utility clearances will also be obtained prior to commencement of drilling. The drilling, core/borehole logging, and well construction will be performed under the supervision of a

California Professional Geologist. The drilling and well installation activities will be conducted in accordance with methods and standard operating procedures in the *Topock Program Sampling, Analysis and Field Procedures Manual* (CH2M HILL 2005h).

The methods, equipment, and procedures for drilling, logging, and depth specific groundwater sampling are described below. The methods and procedures are based on the successful implementation and experience from the prior drilling programs conducted in the floodplain area in 2005 (CH2M HILL 2005c, 2005d).

4.2.1 Rotosonic Drilling Method

Drilling will be accomplished using the rotosonic drilling technique, which involves advancing a rotating and vibrating drill head or core barrel through the subsurface. This method produces a continuous core from the land surface to target drilling depths (ranging from 40 to 130 feet below ground surface [bgs]), generates minimal drilling wastes, and typically can drill through gravel, cobble, and softer bedrock formations. The continuous core obtained from sonic drilling will facilitate the core logging, sampling, and core preservation requirements for the IM Phase 2 drilling program (CH2M HILL 2005c).

4.2.2 All-terrain Rig with Rotosonic Method

The monitoring wells planned for the floodplain area will require use of track-mounted all-terrain rotosonic drilling equipment. This type of drilling equipment was previously used to install monitoring wells on the floodplain in April and May 2004 and January to March 2005.

To support the all-terrain drilling rig, a tracked or balloon-tired forklift and one or more all-terrain vehicles will be used to transport crew, equipment, and materials from staging areas near the roadways to the drill sites on the floodplain. The forklift will also be used to transport cuttings and excess core generated from drilling the soil borings to lined, steel roll-off soil bins that will be temporarily stored, with permission of the BLM, at staging areas located at the MW-35 area adjacent to Park Moabi Road and on the MW-20 bench (see Figure 3-2). Disposal procedures for the investigation-derived waste (IDW) are discussed in Section 5.

4.2.3 Core Logging

Lithologic descriptions will be logged under the supervision of a California Registered Geologist at each soil boring based on visual inspection of the retrieved core. The field log will document the following information at each soil boring:

- Unique soil boring or well identification
- Purpose of the soil boring (e.g., monitoring well)
- Location in relation to an easily identifiable landmark
- Names of the drilling subcontractor and logger
- Start and finish dates and times
- Drilling method
- If applicable, types of drilling fluids and depths at which they were used
- Diameters of surface casing, casing type, and methods of installation
- Depth at which saturated conditions were first encountered

- Lithologic descriptions (based on the Unified Soil Classification System)
- Sampling-interval depths
- Zones of caving or heaving
- Depth at which drilling fluid was lost and the volume lost
- Changes in drilling fluid properties
- Drilling rate
- Drilling rig reactions, such as chatter, rod drops, and bouncing

Consistent with the Phase 2 IM drilling investigation (CH2M HILL 2005c), the results of the continuous core logging of the pilot borings will be summarized in grain-size core plots for the hydrogeologic characterization and to assist in selecting well screen intervals.

4.2.4 Depth-Specific Groundwater Sampling

Groundwater samples will be collected at discrete depths from the deep boreholes, at Sites A and C (MW-44 and MW-46). The Isoflow® sampler or equivalent will be used for groundwater sample collection. Samples will be collected from a 10-foot open borehole, at 20-foot intervals. Where feasible, a sample will also be collected from the zone just above the bedrock. Table 4-1 summarizes the proposed target sampling depths for depth specific groundwater sampling.

Depth specific samples will be obtained from an open section of borehole below the drive casing either by bailing or by pumping using the Isoflow® vertical aquifer profiling system, a special sampling system designed by the drilling contractor, Prosonic. The sampling pump incorporates a packer that is placed in the bottom of the temporary casing to isolate the open hole below the casing. Attached below the packer is a submersible pump enclosed in a short section of well screen. By using a packer to hydraulically isolate the sampling interval from the water standing in the temporary casing above, the purge volumes can be minimized and representative samples can be obtained from a discrete section of the borehole. An alternative to the hydraulic packer equipped Isoflow® tool, a mechanical "segregation-block" may be used on the Isoflow® pump assembly. The advantage of this method is that the water level response inside the sonic casing can be measured during borehole purging to assess the relative permeability of the open borehole interval (see Section 4.2.5).

Purging will involve pumping one to three borehole volumes from the open borehole interval being sampled and monitoring the field parameters (temperature, pH, electrical conductivity, and oxidation-reduction potential). After the field parameters have stabilized and at least one borehole volume has been removed, groundwater samples will be collected for Cr(VI) analysis. The Cr(VI) analyses will be conducted at the onsite field laboratory currently set up at the IM-3 treatment plant using the HACH colorimetric method. A sufficient quantity of sample will be collected and filtered in the field so that confirmation samples can be sent to a certified laboratory if Cr(VI) is detected in any of the grab samples. Because the time of field sample collection and screening precludes laboratory analysis of these samples within the Cr(VI) 24-hour holding time, the confirmation samples will be run for Cr(T) only. All groundwater grab samples will be filtered in the field prior to preservation and analysis.

4.2.5 Water Level Measurements during Borehole Groundwater Sampling

Additional characterization of the Alluvial Aquifer is proposed as part of the depth specific sampling activity. The Isoflow® sampling system can be configured with a casing "segregation-block" (as opposed to an inflatable packer) to allow the measurement of water levels during 10-foot open hole intervals for qualitative assessment of aquifer permeability. The recording of drawdown response for each zone purged may allow for distinguishing low, medium, and higher permeability zones within the boreholes tested. Drawdown will be measured during pumping with an electronic sounder. Pumping rate will be measured by timing the filling of a bucket or measuring the depth of water in the purge tank. An estimate of specific capacity will be obtained that can provide a relative measure of the permeability of the borehole at the depth of the sample. This is considered screening level data for use in selecting more permeable zones for well screens. It is not considered suitable for more quantitative purposes such as model calibration.

4.2.6 Cased-Well Geophysical Logging

Following installation, cased-well geophysical logging (natural gamma ray and induction) will be conducted in the deep monitoring wells constructed at Site A (MW-44) and Site C (MW-46). This type of geophysical survey provides formation characteristics of the aquifer intervals and can be used for hydrogeologic interpretation and water quality characterization. It may also be useful for selecting the screened interval in the mid depth well at Site A.

4.3 Well Construction Requirements and Specifications

Monitoring wells will be installed and developed sequentially. The design approach for the new performance monitoring wells is outlined in Section 3.3. Table 4-1 provides a summary of the target intervals for depth specific groundwater sampling and well installation at the three drilling sites.

A cluster of three monitoring wells (mid-depth and lower interval completions) are planned at Site A (MW-44). As described in Section 3.3 and Table 4-1, a single-boring, nested well design is proposed for installing the deep and shallow monitoring wells at the MW-44 location. The middle well at this cluster would be installed in a separate boring drilled within 15 feet of the MW-44 pilot boring. A single-completion monitoring well will be installed at Site B (MW-45) to serve as the gradient monitoring well adjacent to extraction well PE-1. At the third location Site C (MW-46), up to two monitoring wells (separate boring well-pair) will be installed in the lower interval of the aquifer.

The final well screen intervals selected in consultation with DTSC based on the lithologic log and results of the depth specific groundwater sampling. Consistent with the existing floodplain wells, the new monitoring wells will be identified by the well number (e.g., MW-44) followed by the bottom depth of the well screen, rounded to the nearest 5 feet (e.g., MW-44-65, screened to a depth of 65 feet bgs).

4.3.1 Well Casing and Screen

All new performance monitoring wells will be constructed with Schedule 40 PVC casing and 10 feet length of factory-slotted well screen. Two-inch diameter PVC wells will be installed for all lower interval monitoring wells, depths anticipated to range from approximately 100 to 160 feet bgs (Table 4-1). The shallowest monitoring well to be installed at the MW-44 location will be constructed of one-inch diameter Schedule 40 casing in a nested well completion with the deeper well. Casing requirements are as follows:

- All casing will be new, unused, and decontaminated
- Glue will not be used to join casing, and casings will be joined only with compatible threads that will not interfere with the planned use of the well
- All PVC will conform to ASTM Standard F 480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System)
- The casing will be straight and plumb.

Well screen requirements are as follows:

- All requirements that apply to casing will also apply to well screen, except for strength requirements
- All well screens will be factory slotted, with slot size of 0.020 inch.

The bottom of the screen of the shallow and middle-depth wells will be capped with a threaded blank end-cap (sediment trap).

4.3.2 Borehole Completion Materials

The annular space will be filled with a filter pack, a bentonite seal, or casing grout between the well casing and the borehole wall. In middle and/or shallow interval wells more than 50 feet deep, at least two stainless steel centralizers will be used, one at the bottom and one at the top of the screen.

Filter Pack

The filter pack will consist of No. 3 silica sand (consistent with other monitoring wells completed in the Alluvial Aquifer) and will extend from the bottom of the hole to approximately 2 feet above the top of the well screen. The top of the sand pack will be sounded to verify its depth during placement. Additional filter pack will be placed as required to return the level of the pack to 2 feet above the screen. A minimum 1-foot-thick layer of fine sand will be placed above the No. 3 sand filter pack to minimize the potential for the bentonite slurry (seal) material to invade the filter pack adjacent to the top of the well screen during well construction.

The contractor will record the volume of the filter pack emplaced in the well. Potable water may be used, with the approval of the field geologist, to emplace the filter pack, as long as no contaminants are introduced to the subsurface.

Bentonite Seal and Annular Grout

The bentonite seal requirements are as follows:

- The bentonite seal will consist of at least 2 feet of bentonite between the filter pack and the casing grout
- Only 100 percent sodium bentonite will be used
- Bentonite chips or pellets will be hydrated with potable water if the transition seal is not below the water table, otherwise a bentonite slurry (1 gallon water for 2 pounds bentonite) will be used.

The casing grout requirements are as follows:

- The casing grout will extend from the top of the bentonite seal to ground surface
- The grout will be either a 30 percent solids bentonite grout or a cement mixture in the following proportions:
  - 94 pounds of neat Type I or II Portland or American Petroleum Institute Class A cement
  - Not more than 4 pounds of 100 percent sodium bentonite powder
  - Not more than 8 gallons of potable water
- All grout will be pumped into place using a tremie pipe
- The expected volume of each ingredient in the grout mixture will be pre-calculated and documented

San Bernardino County should be notified at least 2 hours prior to grouting to provide them the opportunity to have a representative onsite during grouting.

4.3.3 Shallow Well MW-44 Construction Requirements

Well shallowest well at MW-44, constructed of 1-inch PVC casing and screen, will be completed in the same borehole (and within the same surface completion) as the deeper 2-inch well at MW-44. The deep well will have the same well screen and filter pack requirements as the other proposed wells. However, because shallower MW-44 well will be part of a double-well completion, the following describes the special requirements applying to this well:

- The casing grout will extend from the top of the deeper MW-44 well bentonite seal to 6 feet below the shallower MW-44 bottom of screen.
- Four feet of bentonite pellets or medium chips will be placed above the casing grout (alternatively, for expediency, medium chips may be used instead of casing grout between the deep and shallow MW-44 well screens).
- One foot of fine sand will be place as transition sand will be placed above the pellet seal.

- The filter pack for shallower MW-44 well will be placed from one foot below to not more than two feet above the shallow MW-44 screen.
- One foot of transition sand will be placed above the shallow MW-44 well filter pack, and a one-foot bentonite pellet seal will be placed above the transition sand.

4.3.4 Surface Completion Requirements

Surface completions for all wells installed in this program will consist of above-ground, steel, locking wellhead monument. A watertight expanding rubber seal type locking cap will be provided for each well. The wellhead monument (steel stovepipe) completion will be placed over the casing and cap and seated in a 3-foot by 3-foot by 4-inch-thick concrete pad. The ground surface will be freed of grass and scoured to a depth of 4 inches before setting the concrete pad. The diameter of the sleeve or stovepipe will be at least 4 inches greater than the diameter of the casing. The concrete pad will be sloped away from the well sleeve. The identity of the well will be permanently marked on the casing cap and the protective sleeve.

All wells will be secured as soon as possible after drilling by using corrosion-resistant locks. The locks will be keyed for opening with one master key.

4.3.5 Well Development

Within 24 to 72 hours following well construction and annular seal placement, the monitoring wells will be developed using a combination of surge block, bailer, and pumping. During development, temperature, pH, specific conductance, and turbidity will be measured using field instruments. Well development will continue until field parameters stabilize and turbidity is reduced to less than 50 nephelometric turbidity units. The purge water produced during well development will be collected in portable tanks or drums at the drill site and transferred to cuttings bins or storage tanks in the staging area. Disposal procedures for the IDW are discussed in Section 5.

4.3.6 Well Surveying and Completion Diagram

Following surface completion, all new monitoring wells will be surveyed for well datum elevation and location. In addition to the lithologic core logs to be prepared for all pilot borings (Section 4.2.3), a well completion diagram will be prepared for each monitoring well installed. It will include the following information:

- Well identification
- Drilling method
- Installation date(s)
- Elevations of ground surface and the measuring point
- Total boring depth
- Lengths and descriptions of the screen and casing

- Lengths and descriptions of the filter pack, bentonite seal, casing grout, and any back filled material
- Depth to groundwater in the constructed well.

4.4 Initial Groundwater Sampling

All new IM performance monitoring wells shall be sampled within approximately 10 days after well development using a temporary adjustable-rate submersible pump (2-inch wells) and peristaltic pump (1-inch well). The wells will be purged and sampled using the casing-volume method purge rates be selected to obtain representative groundwater samples from the aquifer zone and be consistent with the existing monitoring wells in the floodplain.

The groundwater samples collected from the new monitoring wells will be analyzed for Cr(VI), dissolved Cr(T), total dissolved solids, specific conductance, chloride, sulfate, alkalinity, carbonate/bicarbonate, nitrate, calcium, magnesium, potassium, sodium, and stable isotopes oxygen 18 and deuterium. Field water quality parameters (temperature, pH, specific conductance, oxidation-reduction potential, dissolved oxygen, and turbidity) will also be measured and recorded.

Initial groundwater sampling activities will follow the procedures, analytical methods, reporting limits, and quality control plan described in the *Topock Program Sampling, Analysis, and Field Procedures Manual*, dated March 2005 (CH2M HILL 2005h). The Cr(VI) and Cr(T) samples will be filtered in the laboratory before analysis consistent with prior IM field investigations and the groundwater monitoring program.

Following initial sampling, the new wells will be incorporated in the Topock groundwater monitoring program and hydraulic monitoring (pressure transducer) network used for the IM performance monitoring program.

5.0 Waste Management and Decontamination

5.1 Waste Management

Several types of waste materials will be generated during the drilling, development, and sampling of the performance monitoring wells. IDW materials that will be generated include groundwater, drill cuttings, and incidental trash.

Water generated during drilling, development, and sampling activities will be collected in bins or portable storage tanks temporarily located on the MW-20 bench. Secondary containment will be set-up at the drilling area for the portable storage tanks or bins. Water generated from the monitoring well installations will be introduced to the IM-3 treatment facility, or transported offsite to a permitted disposal facility.

Drill cuttings include the fragments of rock and soil that are removed to create the borehole. The cuttings will be contained in lined roll-off bins at the staging areas during the drilling and sampling activities (see Figure 3-2). After sampling and characterization, all cuttings bins will be removed from the staging areas for disposal in a permitted offsite disposal facility. It is estimated that the soil IDW bins temporarily stored in the staging areas will not remain in excess of 45 days.

Incidental trash will be collected at the end of each drilling shift and hauled from the drill site to an appropriate offsite disposal facility.

5.2 Equipment Decontamination

The back of the track-mounted drilling rig and all down-hole drilling tools will be decontaminated prior to arrival at the site and subsequent to finishing the well installation. Decontamination will be accomplished by steam cleaning the core barrel, drill stem, drive casing, and back of the drilling rig. With BLM approval, the pre- and post-mobilization steam cleaning will be conducted on a temporary decontamination pad (lined plastic-sheeting) located on the MW-20 bench (Figure 3-2). Rinsate from the decontamination operation will be collected on the containment pad and transferred to the cuttings bin or purge water tanks located on the north end of the MW-20 bench. The decontamination rinsate will be managed along with the cuttings or purge water. Between borings, the sonic well casing, core barrel, and down-hole tools will be steam-cleaned at the temporary decontamination pad on the MW-20 bench or on the PG&E Topock Compressor Station property.

6.0 Approvals and Authorizations

Table 6-1 summarizes the anticipated approvals and authorizations applicable to the drilling and installation of new IM performance monitoring wells on the BLM-managed floodplain at the Topock site, subject to agency concurrence. Refer to Figure 3-1 for the locations and proposed access routes to the drilling sites addressed in this work plan. All applicable and necessary approvals and authorizations will be documented prior to moving drilling equipment to the drilling sites.

The project area lies within a larger area of significant cultural, biological, and tribal sacred site resources and all activities outlined in this workplan will be conducted in a manner which recognizes and respects these resources. In addition, the Colorado River itself is of spiritual and cultural importance to local tribes. All field work will be planned and conducted in a manner which recognizes the importance of these resources. It is anticipated that mitigation measures identified for previously authorized activities (i.e., stipulations listed by the BLM Lake Havasu Field Office Action Memorandum 3) remain in effect, subject to further BLM/DTSC direction. Because cultural resources surveys have been conducted and have not identified any cultural resources within or near the project area, it is anticipated that an onsite cultural resources monitor will not be required during the well construction and completion activities described in this work plan. Prior to the start of any ground-disturbing activities, a qualified biologist will be conduct a 'pre-activity' survey. If no significant biological resources are found at that time, an on-site biological monitor will not be required during the outlined activities.

7.0 Schedule and Reporting

The schedule for the drilling and installation of the additional IM performance monitoring wells is provided in Table 7-1. The implementation schedule is subject to obtaining approvals and authorizations from DTSC, BLM, and other agencies. The investigation field work will be conducted during daylight hours.

Following completion of the fieldwork, a summary report will be prepared to document the well installation and the results of initial sampling of the new IM performance monitoring wells. The report will include the drilling, depth specific groundwater sampling, well completion, well development, and initial groundwater sampling results and records. The field activities summary report will be submitted approximately 6 weeks after the completion of the initial well sampling.

8.0 References

California Department of Toxic Substances Control (DTSC). 2005a. Letter to PG&E. "Criteria for Evaluating Interim Measures Performance Requirements to Hydraulically Contain Chromium Plume in Floodplain Area." February 14.

_____. 2005b. Letter to PG&E. "Conditional Approval of Final Installation Work Plan and Design Plan for Conveyance Piping and Power Supply for Extraction Well TW-3D, Pacific Gas and Electric Company, Topock Compressor Station". October 17.

CH2M HILL. 2005a. Draft Performance Monitoring Plan for Interim Measures in the Floodplain Area, *PG&E Topock Compressor Station, Needles, California.* April 15.

_____. 2005b. *Draft RCRA Facility Investigation / Remedial Investigation Report, Topock Compressor Station.* February 28.

_____. 2005c. *Interim Measure Phase 2 Monitoring Well Installation Report, PG&E Topock Compressor Station, Needles, California.* May 2.

_____. 2005d. *Groundwater Extraction Well PE-1 Installation Report, PG&E Topock Compressor Station, Needles, California.* March 31.

_____. 2005e. *Performance Monitoring Report for September 2005, PG&E Topock Compressor Station, Needles, California.* October 14.

_____. 2005f. *Performance Monitoring Report for October 2005 and Quarterly Performance Evaluation, August through October 2005, PG&E Topock Compressor Station, Needles, California.* November 30.

_____. 2005g. Technical Memorandum: *PG&E Topock Project: Review of Access Routes for Groundwater and Surface Water Data Collection Locations, and Proposed Mitigation Measures.* September 14.

_____. 2005h. *Topock Program Sampling, Analysis, and Field Procedures Manual, Revision 1, PG&E Topock Compressor Station, Needles, California.* March 31.

Tables

TABLE 3-1
Proposed Drilling and Well Installation Activities
Well Installation Work Plan for IM Performance Monitoring Program
PG&E TopockCompresor Station

Drill Site ID Location	Objective	Proposed Activities	Rationale
Site A (MW-44)	Gradient Monitoring Well Pair	Continous-core hydrogeologic logging	New well required for PE-1 performance monitoring
170' north of PE-1	Delineation & Characterization	Depth-discrete groundwater sampling	Delineate plume limit northwest of MW-34-100
		Install 3 monitoring wells (mid-depth & lower intervals)	
		Initial water quality characterization	
		Incorporate wells in hydraulic monitoring network	
Site B (MW-45)	Gradient Monitoring Well Pair	Selected-core hydrogeologic logging	New well required for PE-1 performance monitoring
15' east of PE-1		Install 1 monitoring well (lower interval)	
		Initial water quality characterization	
		Incorporate well in hydraulic monitoring network	
Site C (MW-46)	Hydraulic Gradient Control	Continous-core hydrogeologic logging	New well needed for better control on gradient mapping in lower aquifer interval
90' west of MW-28	Delineation & Characterization	Depth-discrete groundwater sampling	
		Install 1 to 2 monitoring wells (lower interval)	
		Initial water quality characterization	
		Incorporate wells in hydraulic monitoring network	

NOTES:

See Figures 3-1 and 3-2 for location of proposed drilling sites.

TABLE 4-1
Drilling and Sampling Plan
Well Installation Work Plan for IM Performance Monitoring Program
PG&E TopockCompresor Station

Drill Site ID Location	Approximate Surface Elevation feet MSL	Estimated Depth Miocene Bedrock feet bgs	Core Logging and Sampling - Pilot Hole			Proposed Well Installations	
			Target Drilling Depth feet bgs	Interval for Core Log & Archive feet bgs	Intervals Targeted for Groundwater Grab Sampling feet bgs	Alluvial Aquifer Completion	Well Construction
Site A (MW-44) 170' north of PE-1	467	120	130	20 - total depth	46 - 56 66 - 76 86 - 96 106 - 116 total depth	 Mid-Depth Interval Lower Interval Base Lower Interval	 1" PVC - 10' screen 2" PVC - 10' screen 2" PVC - 10' screen
Site B (MW-45) 15' east of PE-1	470	95	105	70 - total depth	no sampling location characterized	Lower Interval	2" PVC - 10' screen
Site C (MW-46) 90' west of MW-28	472	160	170	20 - total depth	46 - 56 66 - 76 86 - 96 106 - 116 126 - 136 146 - 156 total depth	 Lower Interval Base Lower Interval install 2nd well pending groundwater grab sample results	 2" PVC - 10' screen 2" PVC - 10' screen

NOTES:

1. See Figure 3-2 for proposed locations for drilling sites and Figure 3-3 for target intervals for depth-specific groundwater sampling and screen selection
2. Depth-specific groundwater grab samples to be collected from 10-foot open-borehole intervals using Isoflow ™ system
   Target intervals are listed for general planning and subject to drilling conditions.
3. Groundwater grab samples will be analyzed for Cr(VI) with IM-3 treatment plant laboratory (HACH analytical method) and field water quality parameters.
   Supplemental groundwater samples (field-filtered and preserved) will be collected for Cr(T) laboratory analysis if confirmation of Cr(VI) HACH method results is required.
4. Well screen intervals will be selected in consultation with DTSC based on core log and results of groundwater grab sampling.

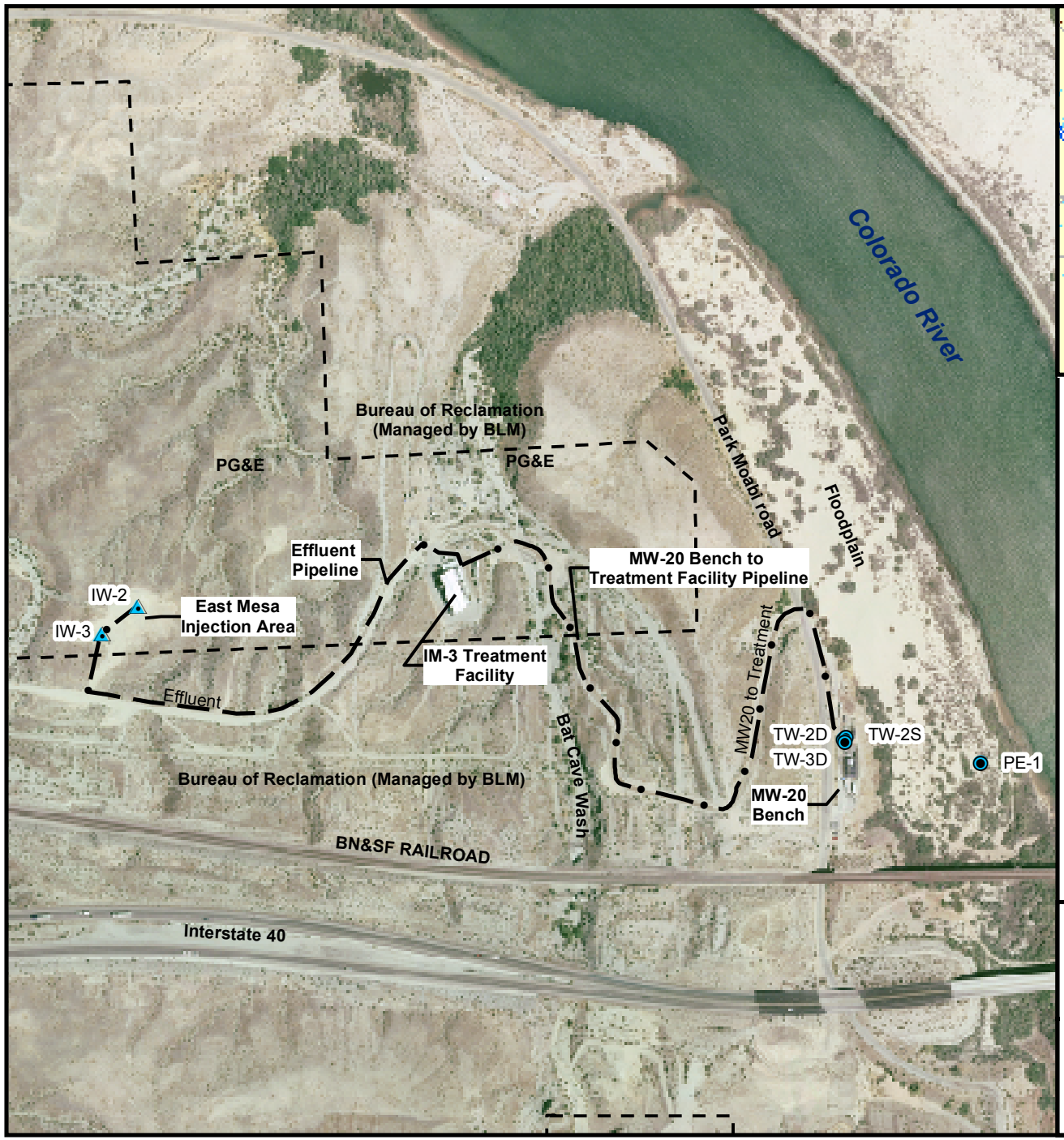
TABLE 6-1
Approvals and Authorizations for Additional Performance Monitoring Wells
Well Installation Work Plan for IM Performance Monitoring Program
PG&E Topock Compressor Station, Needles, California

Agency	Approvals and Authorizations
U.S. Bureau of Land Management	BLM Action Memorandum dated March 3, 2004 authorized additional groundwater wells. Approval letter from BLM Lake Havasu Field Office required, subject to consultations with tribes, SHPO, and USFWS (see below).
California DTSC	CEQA compliance will be determined based on review of the proposed activities described in this work plan.
California Department of Fish and Game	Streambed Alteration Agreement required pursuant to Fish and Game Code Section 1600 et seq.
U. S. Fish and Wildlife Service	BLM to consult with USFWS in accordance with Section 7 of the Endangered Species Act.
State Historic Preservation Office	May include Tribal consultation followed by SHPO consultation.
San Bernardino County	Well drilling approvals

TABLE 7-1
Project Implementation Schedule
Well Installation Work Plan for IM Performance Monitoring Program
PG&E Topock Compressor Station, Needles, California

Activity	Duration
Site Preparation and Driller Mobilization	Within 10 days of DTSC and BLM approvals
Drilling, Hydrogeologic Characterization, and Well Installation (total six wells at three drilling sites)	4 weeks
Initial Groundwater Sampling (six wells)	2 days
Field Activities Summary Report	6 weeks from completion of initial groundwater sampling

Figures



N

0 550 1,100 Feet

1 inch equals 550 feet

LEGEND

PG&E Property Line

Existing IM Extraction Well

Existing IM Injection Well

Notes: Location map shows Interim Measures No.3 (IM-3) wells as of of November 2005. Aerial photography taken May 2005.

FIGURE 1-1
LOCATIONS OF IM-3 GROUNDWATER EXTRACTION, CONVEYANCE, AND TREATMENT FACILITIES

WELL INSTALATION WORK PLAN FOR
IM PERFORMANCE MONITORING PLAN
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

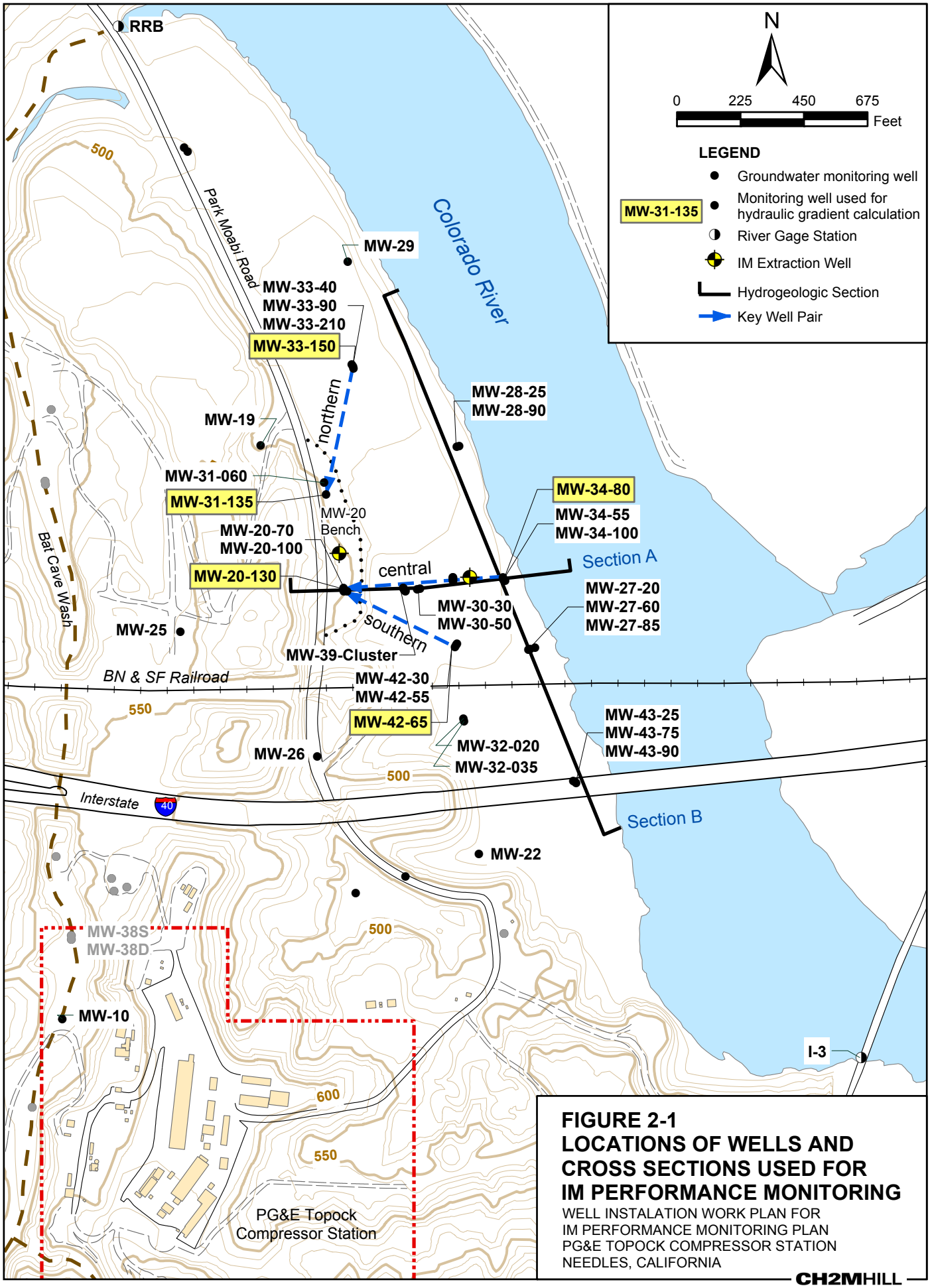


FIGURE 2-1
LOCATIONS OF WELLS AND CROSS SECTIONS USED FOR IM PERFORMANCE MONITORING

WELL INSTALATION WORK PLAN FOR
IM PERFORMANCE MONITORING PLAN
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

BAO \\ZINFANDEL\PROJ\PACIFICGASELECTRICCO\TOPOCKPROGRAM\GIS\MXD\2005\IMPM_WELLS_SECTIONS_8X11.MXD
IMPM_WELLS_SECTIONS_8X11.PDF 11/30/2005 10:18:25

West

East
Section A

TW-2S
TW-2D
projected: 140'

TW-3D
projected: 130'

MW-20 Cluster

MW-39 Cluster

MW-30-30
MW-30-50

MW-36 Cluster

PE-1
projected: 20'

MW-34-55
MW-34-80
MW-34-100

Colorado River

static water level (no pumping)

ALLUVIAL AQUIFER

Upper Depth Interval

Middle Depth Interval

Lower Depth Interval

Approximate geologic contact between alluvial fan (west) and fluvial deposits (east)

132'

157'

180'

67'

118'

108'

105'

116'

?

Miocene Conglomerate (Bedrock)

Elevation (feet above MSL)

550
500
450
400
350
300
250

0
100
200
300
400
500
600
700

Distance (feet)

Current (Nov. 2005) Extraction:
TW-2D at approx 95 gpm.
TW-3D to be operational and
supplement TW-2D pumping Dec. 2005.

True-Scale (No Vertical Exaggeration)

water level
well screen
Top of cemented Miocene bedrock formation
boring depth (feet) 103

Notes:
See Figure 2-1 for cross-section location

FIGURE 2-2
EAST-WEST FLOODPLAIN HYDROGEOLOGIC SECTION A

WELL INSTALLATION WORK PLAN
FOR IM PERFORMANCE MONITORING PROGRAM
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

G:\PACIFICGASELECTRICCO\TOPOCKPROGRAM\GINT\INPUT\GINT_WORK_FILE_TYPES\GDW\X-SECTIONS\WORK_PLAN\WORK_PLAN_SEC-A_TRUESCALE.GDW;

N

0 300 600

Feet

LEGEND

- Monitoring Well (Deep Boring)
- Exploration Boring
- Groundwater Supply or Test Well
- Groundwater Extraction Well
- Bedrock elevation contour, dashed where inferred
- 436 — Elevation of Top Miocene Conglomerate (cemented bedrock formation) feet above mean sea level (MSL)
- (est) 330 — Bedrock elevation estimated

Colorado River

River elevation typically ranges from 453 to 457 feet MSL

Park Moabi Road

Bat Cave Wash

BN & SF Railroad

Interstate 40

Miocene Bedrock at Surface

PG&E

PG&E

PG&E Topock Compressor Station

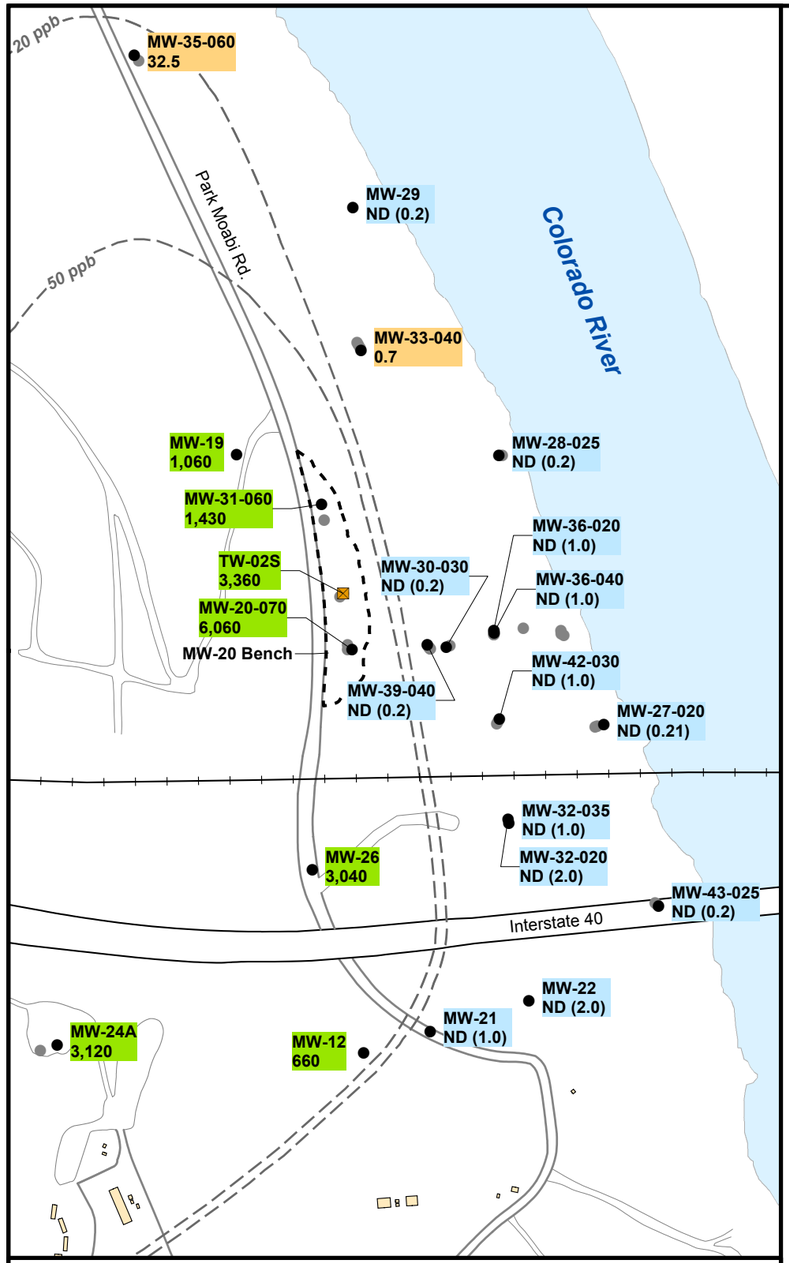
MW-35-135 (est) 245
MW-41D 177
MW-37D 284
MW-19 (est) 310
MW-28-90 (est) 305
MW-31-135 (est) 330
MW-20 Bench
TW-2D 347
MW-20-130 (est) 350
MW-39-100 357
MW-36-100 369
MW-34-100 361
PE-1 378
PE-1A 378
MW-27-85 372
PE-1B 381
MW-25 (est) 320
MW-32-35 424
MW-26 (est) 370
MW-43-90 369
MW-40D 325
MW-22 446
MW-21 450
MW-12 436
MW-23 504
MW-38D 338
TW-1 350
XMW-9 475

200 225 250 275 300 325 350 375 400 425 450 475

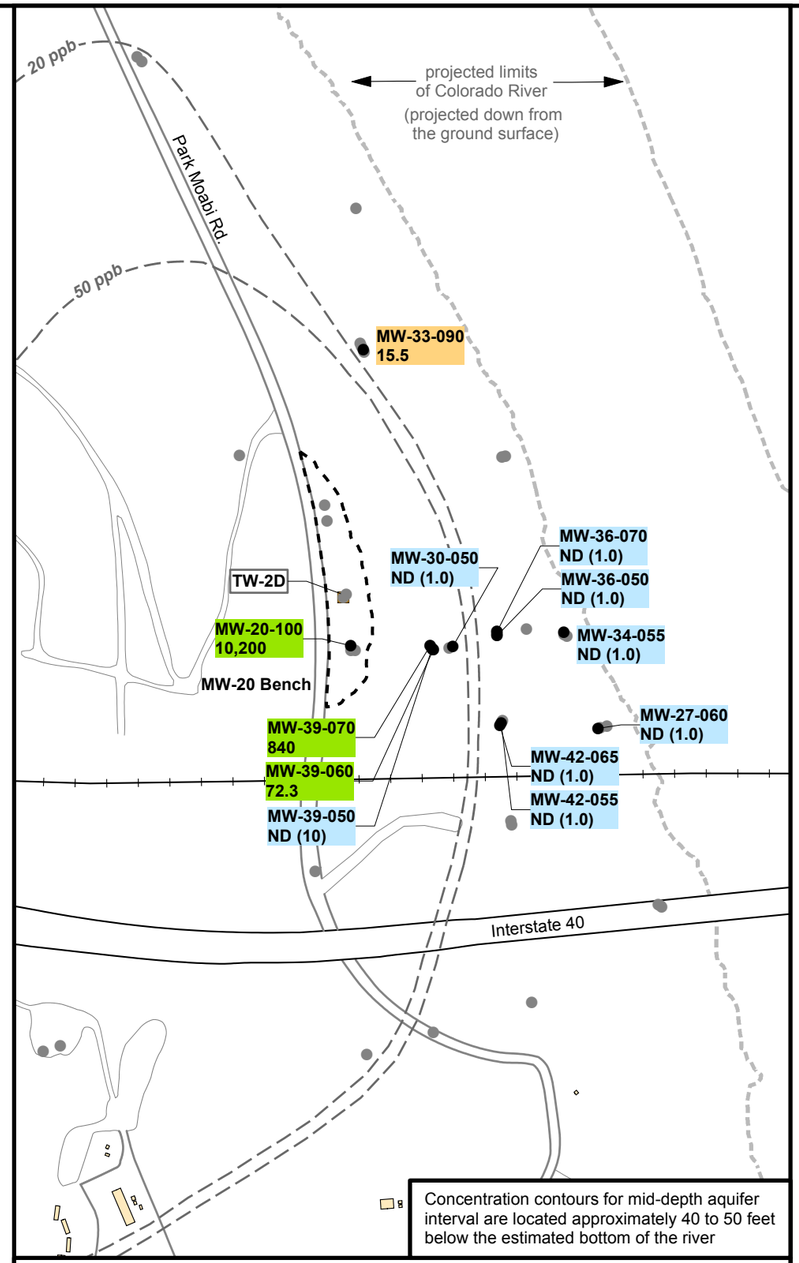
FIGURE 2-3
ELEVATION CONTOUR MAP FOR TOP OF MIOCENE BEDROCK

WELL INSTALATION WORK PLAN FOR
IM PERFORMANCE MONITORING PLAN
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

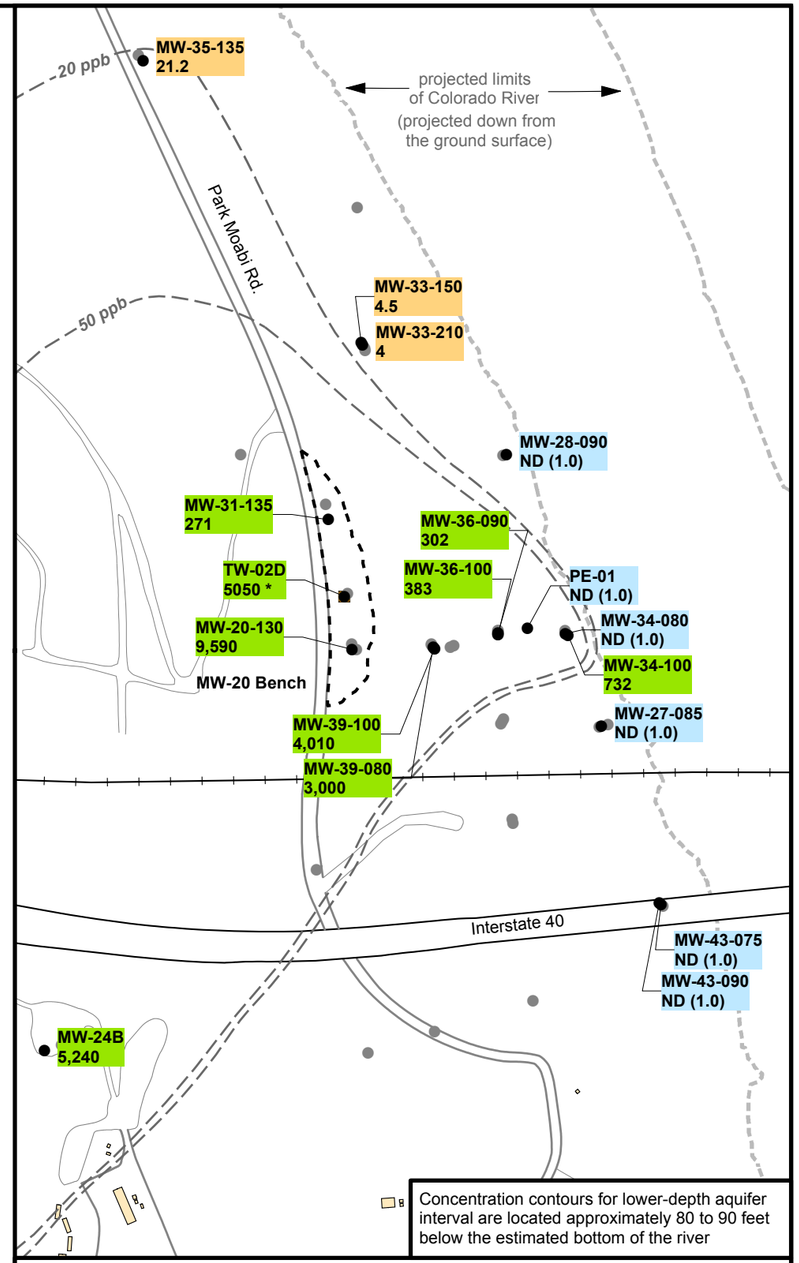
CH2MHILL



Shallow Wells (Upper Depth Interval)



Intermediate Wells (Middle Depth Interval)



Deep Wells (Lower Depth Interval)

ND (1) Not detected at listed reporting limit (ppb)

41 Less than 50 ppb

3,810 Greater than 50 ppb

— · 50 — · Inferred Cr(VI) concentration contour

Notes:
Results plotted are from primary samples for monitoring event.
Results marked * are from the June 2005 sampling event. All other results are from the October 2005 quarterly sampling event.

Hexavalent Chromium Concentrations in Groundwater
October 2005 Quarterly Sampling Event

Concentrations in micrograms per liter (µg/L)
equivalent to parts per billon (ppb)
ND = not detected at listed reporting limit.

N

0 400 800 Feet

1 inch equals 400 feet

FIGURE 2-4
CR(VI) CONCENTRATIONS IN ALLUVIAL AQUIFER, OCTOBER 2005

WELL INSTALATION WORK PLAN FOR
IM PERFORMANCE MONITORING PLAN
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

North

South
Section B

MW-33 wells
projected 200' onto line of section

MW-33-40
MW-33-90
MW-33-150
MW-33-210

Cross-Section Parallel to the Colorado River

BN & SF
Railroad

I-40
Bridge

MW-28-25
MW-28-90
projected: 40'

MW-34-55
MW-34-80
MW-34-100

MW-27-20
MW-27-60
MW-27-85

MW-43-25
MW-43-75
MW-43-90

water table (average 454' MSL)

Upper Depth Interval

Middle Depth Interval

Lower Depth Interval

ALLUVIAL AQUIFER

Oldest Alluvium (Toa)

Approximate geologic contact between alluvial fan and fluvial deposits

Miocene Conglomerate (Bedrock)

MW-33-40	MW-28-25	MW-34-55	MW-27-20	MW-43-25
ND (1.0)	ND (0.2)	ND (1.0)	ND (0.2)	ND (0.2)
ND (1.0)*	ND (0.2)	ND (1.0)	ND (0.2)	ND (0.2)*
0.7	ND (0.2)	ND (1.0)	ND (0.21)	ND (0.2)
18.6	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
16.1	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
15.5	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
ND (1.0)		ND (1.0)	ND (2.0)	ND (1.0)
5.2		ND (1.0)	ND (1.0)	ND (2.0)
4.5		426	ND (1.0)	ND (1.0)
1.4		617		
5.6		732		
4.0				
237'	148'	116'	107'	97'

20 50 500

Elevation (feet above MSL)

560 540 520 500 480 460 440 420 400 380 360 340 320 300 280 260 240

-200 0 200 400 600 800 1,000 1,200 1,400 1,600 1,800

Distance (feet)

water level

well screen

Top of cemented Miocene bedrock formation

boring depth (feet)

Mar-05
July-05
Oct-05

103'

50 Inferred Hexavalent Chromium concentration contour

Hexavalent Chromium concentration in micrograms per liter (ug/L) equivalent to parts per billion (ppb)

ND (1)	Not detected at listed reporting limit (ppb)
42	Less than 50 ppb
3,810	Greater than 50 ppb

Notes:
See Figure 2-1 for cross-section location.
Results marked * are from June 2005 sampling events.

FIGURE 2-5
CR(VI) CONCENTRATIONS
FLOODPLAIN CROSS-SECTION B
MARCH, JULY, AND OCTOBER 2005

WELL INSTALLATION WORK PLAN
FOR IM PERFORMANCE MONITORING PROGRAM
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

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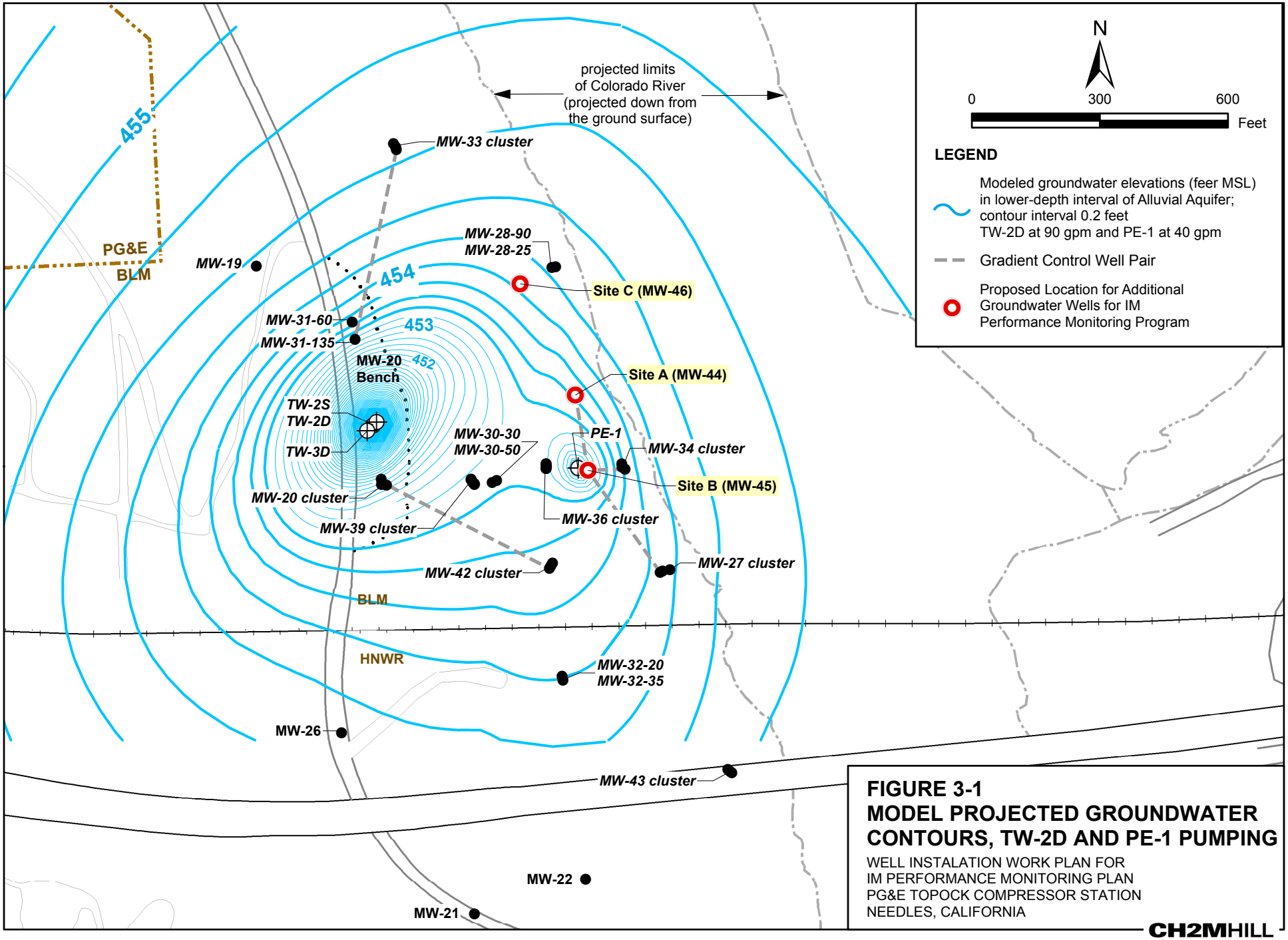

FIGURE 3-1
MODEL PROJECTED GROUNDWATER CONTOURS, TW-2D AND PE-1 PUMPING

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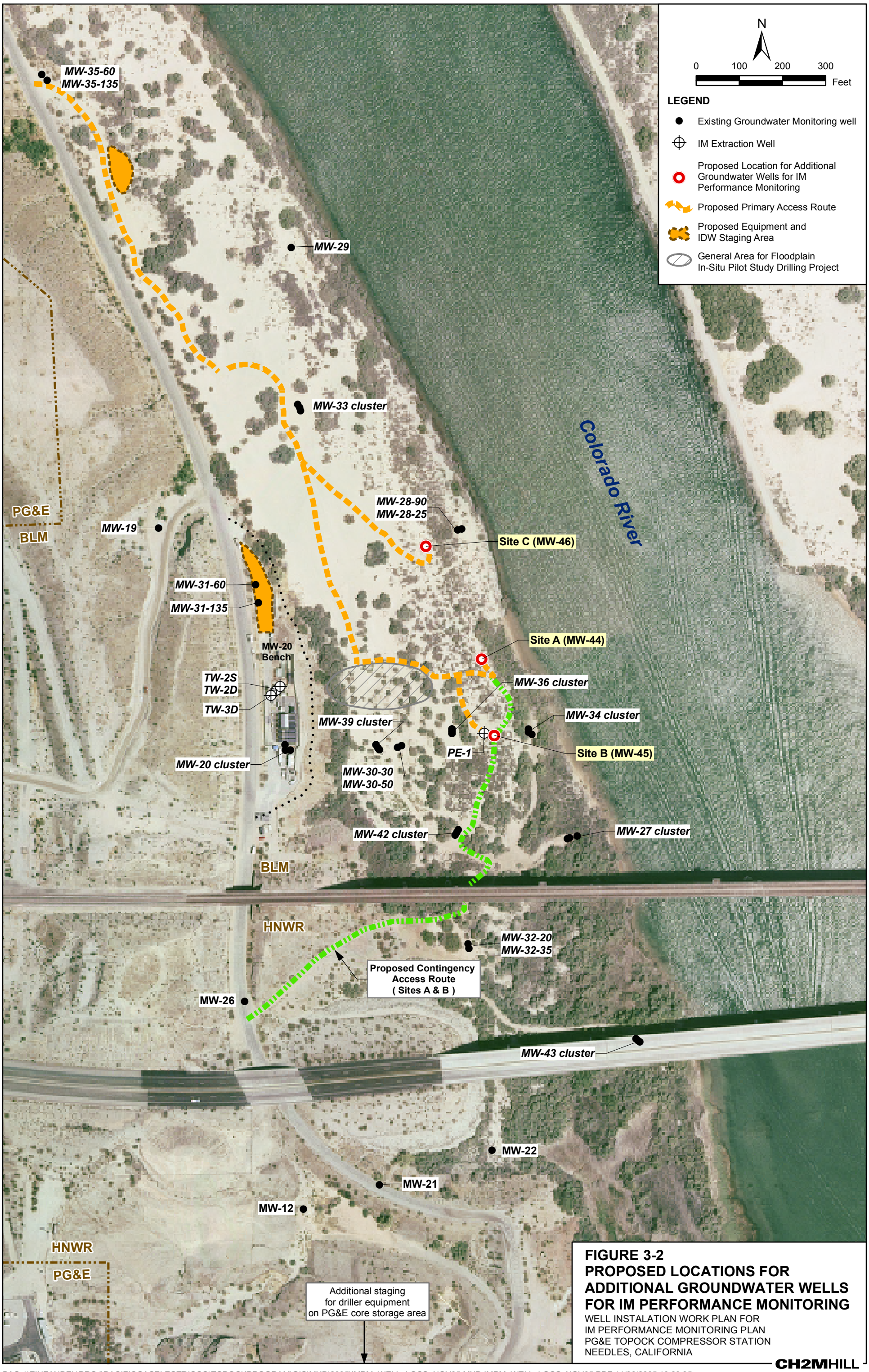

FIGURE 3-2
PROPOSED LOCATIONS FOR ADDITIONAL GROUNDWATER WELLS FOR IM PERFORMANCE MONITORING

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North

South
Section B

Cross-Section Parallel to the Colorado River

MW-33 wells
projected 200' onto line of section

MW-33-40
MW-33-90
MW-33-150
MW-33-210

Site C
projected 90' onto line of section

Proposed
MW-46
(1 to 2 wells)

MW-28-25
MW-28-90

projected: 40'

Site A

Proposed
MW-44
(3 wells)

MW-34-55
MW-34-80
MW-34-100

BN & SF
Railroad

MW-27-20
MW-27-60
MW-27-85

I-40
Bridge

MW-43-25
MW-43-75
MW-43-90

water table (average 455' MSL)

Upper Depth
Interval

Middle Depth
Interval

Lower Depth
Interval

ALLUVIAL AQUIFER

Oldest Alluvium (Toa)

Approximate geologic contact
between alluvial fan
and fluvial deposits

20
50
500

237'
148'
170'
target
130'
target
116'
107'
97'

Miocene Conglomerate (Bedrock)

Elevation (feet above MSL)

560 540 520 500 480 460 440 420 400 380 360 340 320 300 280 260 240

-200 0 200 400 600 800 1,000 1,200 1,400 1,600 1,800

Distance (feet)

water level
Inferred Hexavalent Chromium Contour — 50
well screen
Top of cemented Miocene bedrock formation
boring depth (feet) — 103'

Proposed Characterization Boring and New Wells

Target interval for installing performance monitoring well(s) (10-foot screen)

Approximate Intervals Targeted for Groundwater Isoflow Sampling

target drilling depth — 130' target

FIGURE 3-3
PROPOSED LOCATIONS FOR ADDITIONAL PERFORMANCE MONITORING WELLS AT SITE A AND SITE C

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