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November 15, 2004

Mr. Norman Shopay
Project Manager
California Department of Toxic Substances Control
Geology and Corrective Action Branch
700 Heinz Avenue
Berkeley, California 94720

Subject: Final Work Plan for Injection Well Installation on Parcel Number 650-151-06
Interim Measures No. 3, Pacific Gas and Electric Company, Topock Project

Dear Mr. Shopay:

This letter transmits the *Final Work Plan for Injection Well Installation on Parcel Number 650-151-06*. It provides a scope of work and schedule to install subsurface injection wells on Parcel 650-151-06 for Interim Measures No. 3 and to perform hydraulic tests and evaluations to determine if the injection wells will be capable of maintaining the projected anticipated maximum flow rate from the treatment system. This document serves as an updated work plan for injection well installation and hydrogeologic characterization in accordance with DTSC's Interim Measures No. 3 approval with conditions letter, dated June 30, 2004.

This work plan has been revised to address comments from DTSC dated November 2, 2004. All comments have been addressed, with the exception of Comment Number 3. Comment no. 3 states that PG&E should consider installation of a filter pack access tube and other long-term maintenance needs in the design of the injection well. If implemented, the filter pack access tube would need to be at least 3 inches in diameter in order to prevent clogging during use, and would require a significant redesign of the injection wells and an increase in the borehole size. Due to the limited area available for cuttings bins at the well sites, increasing the borehole size causes significant logistical difficulties. Filter pack access tubes are normally only installed on high capacity (greater than 1,500 gpm) municipal wells; because the injection wells will be used primarily for injection at relatively low flow rates with only occasional back flushing, a filter pack access tube is not considered warranted. Aspects of the well design that address long term maintenance needs include the use of louvered, stainless steel well screen to allow aggressive redevelopment and the installation of backwash pumps to periodically flush the wells.

The design of the injection wells has been revised because the results of recent drilling in the vicinity of the proposed injection wells suggest that the aquifer is deeper than originally estimated in this area. Accordingly the screen interval of the injection wells has been revised to 160 to 340 feet below ground surface, approximately 30 feet deeper than the original design. Screening the wells at this lower interval will minimize the chance of cross-

contaminating the deeper water containing high total dissolved solids with shallower water containing low total dissolved solids.

The November 2, 2004 comments also included a recommendation for an updated, stand-alone document that contains detailed procedures for investigation activities (drilling, well installation, aquifer testing, soil sampling), as well as a separate decontamination plan to support site investigation activities. PG&E will work with DTSC to develop an outline for a *Site Investigation Standard Procedures Plan* that will include standard operating procedures for these activities, including decontamination. PG&E has previously prepared a *Sampling and Analysis Plan for Groundwater and Surface Water Monitoring* that is currently under DTSC review.

As per direction in the received via e-mail from Norman Shopay on November 3, PG&E began drilling the pilot holes for the injection wells November 11, 2004. We plan to place the first well screen no earlier than the night of Tuesday, November 16. If you have any questions, please do not hesitate to call me.

Sincerely,

Terri Herson
for Yvonne Meeks

Enclosure

Final

Work Plan for Injection Well Installation on Parcel 650-151-06 PG&E Topock Compressor Station Needles, California

November 15, 2004

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

Final

Work Plan for Injection Well Installation on Parcel 650-151-06 PG&E Topock Compressor Station Needles, California

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On behalf of
Pacific Gas and Electric Company

This work plan was prepared under supervision of a California Certified Engineering Geologist,

Paul Bertucci, C.E.G.
Project Hydrogeologist

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Acronyms and Abbreviations

bgs	below ground surface
BLM	United States Bureau of Land Management
CACA	Corrective Action Consent Agreement
CRBRWQCB	California Regional Water Quality Control Board Colorado River Basin Region
Cr(T)	total chromium
Cr(VI)	hexavalent chromium
CWG	Topock Consultative Work Group
DTSC	California Department of Toxic Substances Control
gpm	gallons per minute
IDW	investigation-derived waste
µg/L	micrograms per liter
MWD	Metropolitan Water District of Southern California
PG&E	Pacific Gas and Electric Company
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
WDR	waste discharge requirements

1.0 Introduction

Pacific Gas and Electric Company (PG&E) is addressing chromium in groundwater at the Topock Compressor Station in Needles, California under the oversight of the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC). On July 8, 2004, PG&E submitted the *Summary of Proposed Project for Interim Measures No. 3* to manage increased volumes of extracted groundwater, in compliance with DTSC directives under Interim Measures No. 2 (CH2M HILL 2004a). In a letter dated June 30, 2004, DTSC approved with conditions the *Summary of Proposed Project for Interim Measures No. 3* (DTSC 2004a). The goal of Interim Measure No. 3 continues to be hydraulic control of the plume boundaries near the Colorado River to maintain a landward gradient. Interim Measure No. 3 includes construction of a larger treatment facility, piping to carry the water from the extraction wells to the treatment facility, and water management including reinjection of treated water.

On July 29, 2004, PG&E submitted an application and Report of Waste Discharge to the California Regional Water Quality Control Board Colorado River Basin Region (CRBRWQCB) for subsurface injection. October 13, 2004, CRBRWQCB issued waste discharge requirements (WDR) Order No. R7-2004-0103 specifying effluent limitations, prohibitions, specifications, and provisions for subsurface injection.

This work plan provides a scope of work and schedule to install and sample the planned injection wells, including aquifer evaluation and testing procedures to determine if injection wells will be capable of maintaining the projected anticipated maximum flow rate from the treatment system. This work plan has been revised to incorporate comments received from DTSC in a memorandum dated November 2, 2004 (DTSC 2004b).

Procedures for monitoring the performance and potential impacts from the proposed injection will be provided in a subsequent document. A related work plan for the installation and sampling of new observation wells in the immediate vicinity of the planned injection wells was submitted by PG&E on September 1, 2004 (CH2M HILL 2004b) and approved by the DTSC on September 3, 2004 (DTSC 2004c).

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 (CACA) pursuant to Section 25187 of the California Health and Safety Code. Under the terms of the CACA, PG&E was directed to conduct a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) 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 (CWG), constituted under California's Site Designation Process, and consisting of representatives of DTSC, the CRBRWQCB, Metropolitan Water District of Southern California (MWD), the various federal agencies who own or manage adjacent property, and other project stakeholders.

As directed by the DTSC under Interim Measures No. 2, PG&E is currently pumping groundwater from one deep extraction well (TW-2D), located on a 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 United States Bureau of Reclamation and is managed by the United States Bureau of Land Management (BLM). PG&E began pumping from this location in March 2004 and is currently pumping at a rate of approximately 70 gallons per minute (gpm).

PG&E is currently working on Interim Measures No. 3 under the oversight of DTSC and the CWG. Due to the influence of the Colorado River stage on groundwater levels, extracting groundwater at higher rates is required under Interim Measures No. 3. To gain the space needed to accommodate higher pumping rates and the associated higher volume of extracted water, PG&E is seeking to expand and relocate the groundwater treatment operation to property recently purchased from MWD (San Bernardino County Assessor's Parcel 650-151-06). The primary components of Interim Measures No. 3 include additional groundwater extraction from well TW-2 and/or additional wells, piping, and conveyance of extracted groundwater to a treatment system; treatment of extracted groundwater using reduction-precipitation-filtration and reverse osmosis; and management of treated groundwater water.

One proposed alternative for management of treated groundwater is injection of the treated groundwater. The proposed injection well field is located near the southwest corner of Parcel 650-151-06. This work plan addresses the construction, testing, and sampling of the injection wells.

1.2 Project Objectives

The primary objective of this project is to install up to 10 wells at proposed injection areas on Parcel 650-151-06. The injection wellfield is designed to accept up to 200 gpm of treated groundwater from the Interim Measures No. 3 treatment plant (the peak design flow of injected water is 135 gpm; an additional 65 gpm has been added as a contingency). To meet these objectives, the injection wells will be installed, sampled, and tested.

Existing wells on Parcel 650-151-06 include MW-13 and MW-18. Both of these wells are relatively shallow wells that penetrate only the upper portion of the aquifer. Chromium is detected in the shallow wells on and near Parcel 650-151-06 at low concentrations that may represent natural background. In addition, Well MW-37D, located in Bat Cave Wash near the eastern boundary of Parcel 650-151-06, is the nearest deep monitoring well. Chromium concentrations in MW-37D have approached 1 milligram per liter. The initial observation wells are currently being drilled on Parcel 650-151-06. These wells will be used to:

- Obtain additional data on the distribution of chromium in the aquifer.
- Better define the hydrogeology of the deeper aquifer zone beneath Parcel 650-151-06.

Following injection well installation, hydraulic testing will be conducted to provide data on the capacity of each well and the hydraulic properties of the aquifer. It is necessary to test the capacity of each injection well to verify the wellfield can accept the 200-gpm design flow of treated groundwater. The hydraulic testing will also be used to provide estimates of aquifer properties for improving the calibration of the groundwater model.

The injection well program also includes observation wells that will monitor changes in water levels and water quality during the operation of the injection wells. These observation wells are currently being installed and will be used to monitor injection to prevent elevated groundwater levels.

1.3 Overview of Project Activities

Three general areas have been identified on Parcel 650-151-06 that are suitable for installation of injection wells. The two primary areas are identified as the East Mesa and the West Mesa, as shown on Figure 1-2. These areas were selected based on the topography of the site and represent areas of relatively flat ground that can be made accessible to drilling equipment with only minor grading. A third area (Center Mesa, Figure 1-2), that is relatively flat but not easily accessible, has been identified as a contingency area that would be used only if hydrogeologic conditions turn out to be unfavorable for injection wells on one or both of the primary areas.

The injection well drilling program will involve drilling, development, and testing of up to 10 injection wells on Parcel 650-151-06. Because there are no data on the hydraulic properties of the aquifer at Parcel 650-151-06, it is not possible to estimate the capacity of an injection well. If aquifer properties are found to be favorable, fewer than 10 injection wells will be needed to meet the design capacity. Each injection well will be tested soon after it is drilled. Injection well drilling will continue until the total capacity of the wellfield is at least 200 gpm (135 gpm design flow plus a 50-percent safety factor). The proposed locations for the initial group of five injection wells, currently accessible to drilling equipment, are shown on Figure 1-2.

2.0 Well Design and Installation

2.1 Site Preparation

An observation well drilling program is currently underway on Parcel 650-151-06 (DTSC 2004b). Site preparation for the observation well installation program involved grading existing roadways and grading paths for equipment access where no roadways exist. Prior to moving equipment onto Parcel 650-151-06, the drilling sites and the access routes were surveyed for biological and cultural resources, and mitigation measures have already been established to protect these resources during the drilling activities.

It is anticipated that the primary route of access for equipment to Parcel 650-151-06 will be the former route of US Highway 66. This road was in passable condition except for two locations where culverts had been washed out. In these locations, rough, one-lane detours previously had been graded and built to allow traffic to cross the stream adjacent to the washed out culverts. Fill was placed on these detours to allow passage the drilling equipment associated with the present observation well drilling. No additional fill is needed to allow access for the injection well drilling equipment.

Access to the Center Mesa area would require construction of approximately 150 feet of roadway either across the face of a slope or along the top of a narrow ridge. This would result in additional modification of the landscape; therefore, drilling is only proposed on the Center Mesa if sufficient injection capacity cannot be developed on the East and West Mesas. A separate plan showing details of the proposed roadway onto the Center Mesa will be submitted for approval prior if it becomes evident that drilling is likely to occur there.

2.2 Injection Wells

Injection wells will be drilled and tested sequentially. The number of injection wells ultimately drilled will be determined by the capacity of the wells. Once a sufficient number of wells have been installed to accommodate the design flow of 135 gpm plus a 50-percent excess safety factor, the injection well drilling will be considered complete.

Mud rotary drilling methods will be used for injection well drilling. Mud rotary is the most commonly used method for the installation of larger-diameter production wells and was used successfully to install the TW-1 and TW-2 wells at the Topock site. Attempts to recover core during the mud rotary drilling at the TW-1 and TW-2 wells were largely unsuccessful, due to the presence of cobbles. Coring slows down the drilling process considerably. If nearby observation wells were successful in penetrating the total depth of the alluvial aquifer, coring will not be performed during injection well drilling. If the nearby observation wells were not able to penetrate the entire thickness of the alluvial aquifer, coring will be attempted in the portion of the aquifer below the bottom of the deepest nearby observation well while drilling a pilot hole.

In addition to the drilling rig, a large support/water truck and one or more 4-wheel drive pickup trucks will be used for crew and equipment and material transfer to the drill site. Short-term material storage in the area will be necessary to accommodate the drilling operations. Materials to be stored at the well site include drilling equipment and well construction materials (casing, sand, bentonite, cement grout, etc.).

Cuttings and excess core generated from drilling the borings will be transferred to lined, steel roll-off soil bins temporarily staged at the drilling site. The water produced from well development will be contained in lined bins or tanks at the drill site. Disposal procedures for the investigation-derived waste (IDW) are discussed in Section 4.0.

The following sections describe the well design and the drilling, logging, construction, and sampling activities for the planned injection wells.

2.2.1 Injection Well Design

Each injection well will be installed and constructed to an approximate depth of 300 feet below ground surface (bgs), the estimated lowest depth of permeable deposits in the alluvial aquifer. The injection wells will be constructed using a combination of mild steel blank casing and type 304 stainless-steel louvered well screen separated by a mechanical coupling device. Final depths and quantities of material will be determined by the on-site CH2M HILL representative following drilling of a pilot hole. During the current observation well drilling effort, select samples of core from the saturated alluvial aquifer will be submitted for grain-size analysis. The grain-size analysis data will be used to design the gravel pack and screen size for the injection wells. PG&E will confer with DTSC regarding gravel pack and screen size prior to well construction.

Injection of treated water will be through drop tubes installed in the well casing. Drop tubes will be designed so that positive pressure is maintained in them at all times. Until the wells are installed and tested, the number and diameter of the drop tubes can not be determined.

A drawing of a typical injection well and associated details is presented on Figure 2-1. Assuming a water table at 95 feet bgs and a final well depth of 340 feet bgs, the basic injection well design consists of:

- Six-inch-diameter mild steel blank casing from 2 feet above ground surface to 145 feet bgs. The well casing will be fabricated in lengths not less than 20 feet.
- Mechanical coupler to connect mild steel to stainless-steel at approximately 145 feet bgs.
- Six-inch diameter type 304 stainless-steel blank casing from 145 to 160 feet bgs.
- Six-inch-diameter type 304 stainless-steel, louvered screen from 160 feet to 330 feet bgs, 0.06-inch slot (size is currently assumed for bidding purposes only). The well casing will be fabricated in lengths of 20 feet and not less than 10 feet.
- Six-inch-diameter type 304 stainless-steel blank casing (well sump) from 330 to 340 feet bgs.
- A 6-inch-diameter type 304 stainless-steel bull nose to be located at a well depth of about 340 feet bgs.

- Drop tube injection piping.
- Centralizers spaced every 50 feet beginning at 100 feet bgs.
- Gravel pack (Silica Resources or equivalent) from 340 to 153 feet bgs (7 feet above the screened interval after surge-settling).
- Transition sand interval from 153 to 150 feet bgs, consisting of Monterey #30 sand.
- Cement grout seal from 150 to 0 feet bgs.

2.2.2 Injection Well Drilling and Installation

This section describes the work necessary to drill, construct, and develop each of the injection wells. The boreholes will be drilled using direct circulation mud-rotary drilling methods. Equipment needed for mud-rotary drilling typically includes a large drilling rig, a pipe truck, a water truck, a mud screen/shaker table, and two or more large bins or tanks for cuttings and waste drilling mud.

For each of the wells (assuming a water table at 95 feet bgs and 340-foot well depth), the drilling and construction will include, but not be limited to:

1. Performing mobilization, demobilization, and site cleanup.
2. Drilling a 6-inch-diameter pilot hole to a maximum of 20 feet into bedrock and collect core samples from the bottom portion of the pilot hole as directed by the CH2M HILL on-site representative.
3. Drilling a 24-inch-diameter borehole to a depth of approximately 25 feet.
4. Providing and installing a 20-inch-diameter conductor casing and sanitary seal in the 24-inch-diameter borehole.
5. Keeping a written log of strata encountered during drilling and a written daily record of work progress, crew present, and equipment and materials used.
6. Drilling a 12-inch-diameter borehole (or reaming a pilot borehole) to approximately 340 feet bgs (or as specified by the CH2M HILL on-site representative).
7. Running geophysical logs in the open borehole (pilot hole or reamed borehole).
8. Providing and installing approximately 170 feet of 6-inch-diameter, louvered, stainless-steel well screen with 10-foot blank casing sump, 15 feet of stainless-steel blank casing (above the screened interval), and associated appurtenances in the well. The slot size will be determined from sieve analysis results from wellfield drilling investigations.
9. Providing and installing approximately 145 feet of 6-inch-diameter steel well casing, with appurtenances, in the well.
10. Providing and installing approximately 187 feet of gravel pack in the well. The type, size, gradation, and uniformity of gravel will be determined by the on-site CH2M HILL representative depending on field conditions determined by the pilot borehole. The gravel pack is assumed to be size 8 x 16. The gravel pack will be placed in the well bore annulus in accordance with AWWA A100-90, Section 6.7 and Section A.2 (Method of

Installation and Gravel-Pack Installation Methods). Before gravel placement, the contractor will make adequate preparations for continuous circulation of clear water. The fluid properties will be approved by CH2M HILL. Clear water will be circulated while installing the pack. Circulation will be continuous until the pack is fully in place. The method of gravel placement will be by hydraulically pumping the gravel through tremie pipe from the bottom of the annulus upward. The rate of gravel placement will not exceed 1.5 feet per minute, as measured by a sounding line, and placement will proceed without interruption until completion.

11. Providing and installing a transition interval of graded sand (finer than the filter-pack), followed by approximately 150 feet of annular cement grout seal in the well. The cement grout will be a mixture of not more than 188 pounds of sand to one 94-pound sack of Portland cement (two parts sand to one part cement, by weight) and about 7 gallons of potable water. This is equivalent to a "10.3 sack mix." The cement will meet the requirements, including the latest revisions, of ASTM C150, Standard Specification for Portland Cement. Type I or II or an approved equivalent and any additives will meet the requirements, including the latest revisions of Standard Specifications for Chemical Admixtures for Concrete. Additives must be approved by CH2M HILL.
12. Developing the completed well by mechanical surging with double-surge block and simultaneous air lifting.
13. Providing and installing a pump for development and test pumping and an access pipe for automatic water level measuring devices.
14. Further developing the well by pumping and surging with a test pump to be supplied by the contractor.
15. Separating and properly disposing of drill cuttings and development sediments from associated liquids.
16. Restoring the well site to its original condition.

Mud Rotary Drilling

Maintaining proper drilling fluid properties during drilling operations is critical and warrants additional attention. A Baroid-certified mud engineer or equivalent will be retained by the contractor to develop a drilling mud program and provide recommendations on adjusting the drilling fluid properties while protecting the water yielding properties of the aquifer. Upon approval by the CH2M HILL on-site representative, the contractor will add materials as recommended by the mud specialist. Organic drilling additives will not be used. All drilling fluid additives will be mixed with the makeup water using a jet/hopper mud mixer approved by a CH2M HILL representative. The drilling fluid will possess such characteristics as are required to adequately maintain the walls of the borehole to prevent caving of the walls as drilling progresses and to permit recovery of representative samples of drill cuttings.

Drilling fluid properties will be maintained to deposit only a thin (maximum of 2/32 of an inch), easily-removable filter cake on the face of the borehole. The drilling fluid properties will be maintained as follows:

1. Weight: Not to exceed 8.7 pounds per gallon.
2. Viscosity: Not to exceed 34 seconds per quart.
3. Sand Content: Not to exceed 2 percent.
4. Total Solids Content: Not to exceed 7 percent.
5. Thirty-minute Water Loss: Not to exceed 15 cc.

Equipment for measuring fluid properties will be immediately available at the drill site. Drilling fluid properties, including fluid weight, viscosity, water loss, sand content, and total solids content, will be checked at a minimum of:

1. Every 100 feet of depth drilled.
2. Every 12 hours of circulation when not drilling
3. As directed by the CH2M HILL representative. All drilling fluid test equipment and test procedures will be equal to those given in the American Petroleum Institute's Recommended Practice 13B-1, Recommended Practice Standard Procedure for Field Testing Water-Based Drilling Fluids.

The contractor will provide a circulation system that will minimize the recirculation of drill cuttings. The system will include settling tanks of adequate size (at least three borehole volumes), a sampling trough, a shaker table, and a desanding-desilting system. The system will be designed to facilitate the retrieval of representative samples from the discharge with a minimum of recirculation of material. The mud tank system will be equipped with a shaker table and a desander-desilter system with a minimum of four cones, capable of handling the capacity of the system. The desander-desilter system will have a pump capable of supplying a minimum of 40 pounds per square inch per cone at 80 gpm per cone minimum.

The mud properties will be managed to prevent formation of excessive filter cake on the borehole walls. Prior to placement of the gravel pack, the borehole walls will be cleaned by thinning the mud with potable water.

Well Development

Within 48-hours following well construction and annular seal placement, the injection wells will be developed using a surge block, bailer, submersible pump, and air-lifting. 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.

2.2.3 Downhole Geophysical and Spinner Logging

Geophysical logging will be conducted in every injection well. Logging will be conducted in the mud-filled borehole prior to the construction of the well. The suite of logs that will be run in the open boreholes will include spontaneous potential, natural gamma ray, resistivity, induction, and a caliper log. If geophysical logging is conducted in the pilot borehole rather than in the reamed well bore, a caliper log will not be necessary.

The purpose of the geophysical logging is to confirm the contact depth of the bedrock formation, assess the hydrogeologic characteristics of the alluvial aquifer, and assist in well screen selection. The geophysical logs will also be used to support the site conceptual hydrogeologic model.

Following well development, a downhole spinner velocity log will be run in each injection well to assess which portions of the screened interval are more transmissive. The results of the spinner log will be used for further hydraulic characterization of the injection wellfield and to support the site hydrogeologic/groundwater model.

2.2.4 Injection Well Initial Sampling

Following well development and as part of the hydraulic testing activity (described below), the new injection wells will be purged and sampled for initial water quality characterization and to assess receiving water quality. The sampling activity will follow the procedures, analytical methods, reporting limits, and quality control plan used for the Topock groundwater monitoring program as described in the Sampling and Analysis Plan, Groundwater and Surface Water Monitoring (CH2M HILL 2004c).

Samples from the new injection wells will be analyzed for Cr(VI), Cr(T), total dissolved solids, specific conductance, and cations/anions (chloride, sulfate, alkalinity, carbonate/bicarbonate, nitrate, and general minerals). Field water quality parameters (temperature, pH, specific conductance, oxidation-reduction potential, and turbidity) will also be measured. The results of the initial well sampling will be incorporated with the groundwater sampling data collected from the nearby (within 60 feet) observation well clusters (CH2M HILL 2004b) to support the baseline water quality assessment of the injection wellfield.

Additional baseline water quality data will also be collected as part of the installation of the injection wellfield compliance groundwater monitoring system, as required by WDR No. R7-2004-0103. A separate compliance monitoring plan providing sampling and analysis details will be submitted to DTSC and the CRBRWQCB.

The samples from the injection wells will be used to determine the baseline water quality for total dissolved solids and common anions/cations. Samples from long-screen injection wells reflect the average water quality in the aquifer. In order to avoid potential plugging of the injection wells, the injected water will be adjusted to approximately match the quality of the water in the injection well.

3.0 Injection Well Hydraulic Testing

The principal objective of hydraulic testing at each injection site will be to estimate the sustainable injection capacity for the constructed well. Given schedule and water disposal constraints, long-term hydraulic testing for the purpose of improving the model will be a lower priority. CH2M HILL will take full advantage of all observed hydraulic data from the short-term tests and update hydraulic property distribution accordingly. It is anticipated that the MLU software (Hemker 1999) will be used to analyze the hydraulic data. This software was previously used to analyze the aquifer test data from the TW-2 extraction wells.

Step-drawdown testing will be performed in the injection wells immediately following development. The pumping rates will be varied at approximately half-hour intervals, with three to four pumping intervals. Each step-drawdown test is estimated to produce up to 20,000 gallons of water and last for up to 4 hours. The pumped water be contained in one or more tanks on Parcel 650-151-06 near the well site. The injection well and nearby monitoring wells will be outfitted with pressure transducers to measure water levels before, during, and following the step-drawdown tests.

The water pumped from each injection well during the step test will be analyzed for chromium. Assuming that chromium concentrations in the extracted water are less than the WDR R7-2004-0103 maximum daily effluent discharge limitations of 16 micrograms per liter (µg/L) Cr(VI) and 50 µg/L Cr(T), the water from the step test will be injected back into the injection well at a constant rate until the tank is empty. The rate of injection will be estimated from the step-drawdown test data. Groundwater levels will be measured in the injection well and in nearby monitoring wells, and these data will be used to estimate the capacity of the injection well and hydraulic properties of the aquifer.

A longer-term pumping test for the injection wells will not be feasible until conveyance and treatment systems are in place. As stated above, the main purpose of this hydraulic testing is to evaluate injection capacity. If estimated properties indicate a need for longer-term testing, plans will be made to perform this work after the conveyance and treatment systems are operational. If the initial hydraulic testing and startup of the injection wells are not sufficient to characterize the aquifer properties of the wellfield, a separate letter work plan proposing longer-term testing will be submitted at a future date.

4.0 Waste Management

Several types of waste materials will be generated during the drilling, development, and testing of the monitoring and injection wells. IDW materials that will be generated include groundwater, drill cuttings, drilling mud, and incidental trash. Drill cuttings and drilling mud may potentially contain chromium, although during previous drilling operations at the Topock site, these materials had non-detectable concentrations of chromium. The incidental trash will consist of empty paper and plastic bags, cardboard boxes, wooden pallets, and miscellaneous debris.

Water generated during drilling and development activity will be contained in temporary storage tanks on Parcel 650-151-06 and transferred by truck to storage tanks in PG&E's operations area for characterization, treatment, or disposal at a permitted waste disposal facility. Temporary storage tanks will be provided with secondary containment berms to contain any leaks or spills. Based on available data, it is anticipated that groundwater from the proposed wells on Parcel 650-151-06 will not contain chromium in concentrations above the 50 μg/L California maximum contaminant level for drinking water.

Drilling 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 drill sites during the drilling and sampling activities. After sampling and characterization, all cuttings bins will be removed from the staging area for ultimate disposition by PG&E at an appropriate licensed facility. The cuttings will be screened for chromium, the main chemical of concern for the site. If the cuttings are characterized as a hazardous waste, they will be transported off site for disposal at a permitted hazardous waste disposal facility. It is estimated that the soil IDW bins temporarily staged on Parcel 650-151-06 will not remain in excess of 45 days.

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

5.0 Schedule and Reporting

The schedule for the installation of the initial group of up to five injection wells is provided on Table 5-1 below. The schedule would be shortened considerably if the initial injection wells drilled are found to be capable of handling the design flows. This work will be conducted during normal daylight hours except during the reaming or drilling of the 12-inch well bore and construction of the well. To minimize mud intrusion into the formation that would occur if the mud-filled borehole was allowed to stand overnight, a 24-hour-per-day work schedule will be implemented during drilling of the 12-inch well bore and installation of the well casing, screen, and gravel pack.

Following completion of the fieldwork, a summary report will be prepared to document the well installation and the results of sampling and testing of the injection wells. The report will include the drilling, well completion, and geophysical logs; well development and initial sampling records and results; spinner velocity logging data; and results and evaluation of the short-term hydraulic tests. The investigation report will be submitted approximately 5 weeks following the completion of the short-term hydraulic tests. The results of drilling, logging, and water quality analyses will also be provided to DTSC and project stakeholders in periodic interim data releases while the well installation and testing program is performed.

TABLE 5-1
Injection Well Drilling Program Schedule
Work Plan for Injection Well Installation on Parcel 650-151-06, Topock Compressor Station

Activity	Duration	Start	Finish
DTSC / BLM Review of Draft Work Plan	5 days	9/27/04	10/01/04
Revise Draft Work Plan and Submit Final to DTSC and BLM	8 days	11/3/04	11/10/04
Injection Well Drilling and Testing (up to five injection wells)	10 weeks	11/11/04	1/21/05
Drilling and Testing Report (up to five injection wells)	5 weeks	1/21/05	2/25/05

6.0 Permits and Approvals Required

Table 6-1 provides a listing of all permits and approvals that have been identified as applicable to the installation and operation of the injection wells on Parcel 650-151-06. To expedite the schedule, permits, cultural and natural resource surveys and approvals have been obtained for the initial group of five injection wells. All applicable and necessary permits/approvals will be documented prior to moving drilling equipment to the site.

TABLE 6-1
Permits, Approvals, and Certifications for Injection Wells
Work Plan for Injection Well Installation on Parcel 650-151-06, PG&E Topock Compressor Station

Agency	Permits, Approval, Certifications, etc.
Federal BLM	Action Memorandum authorizing Interim Measures No. 3 activities on BLM land
State Water Resources Control Board/ Colorado River Basin Regional Water Quality Control Board	Notice of Intent and Storm Water Pollution Prevention Plan for Construction Activities; coverage under statewide general permit
United States Army Corps of Engineers	404 Permit
Regional Water Quality Control Board	401 Certification
United States Fish & Wildlife Service	USFWS, Section 7 Consultation
California Department of Fish and Game	CDFG 1600 Agreement
State Historic Preservation Office	Section 106 Consultation
San Bernardino County	Grading Permits and Well Permits
Regional Water Quality Control Board	Waste Discharge Requirement
MWD	Permission for access to perform work on the property

7.0 References

California Department of Toxic Substances Control (DTSC). 2004a. Letter. "Approval of *Summary of Proposed Project for Interim Measures No. 3."* June 30.

_____. 2004b. Memorandum. "DTSC Geological Services Unit comments on Draft Work Plan for Injection Well Installation on Parcel 650-151-06, dated September 27, 2004." November 2.

_____. 2004c. Letter. "Conditional Approval of Observation Well Installation Work Plan, dated September 1, 2004." September 3.

CH2M HILL. 2004a. *Summary of Proposed Project for Interim Measures Number 3*. July 8.

_____. 2004b. Technical Memorandum: *Revised-Final Field Activities Summary for Observation Well Installation and Groundwater Characterization under IM No. 3.* September 1.

_____. 2004c. *Sampling and Analysis Plan, Groundwater and Surface Water Monitoring, PG&E Topock Compressor Station, Needles, California.* July 14.

Hemker, C.J. 1999. Transient well flow in vertically heterogeneous aquifers. *Journal of Hydrology*. 225:1-18.

Figures

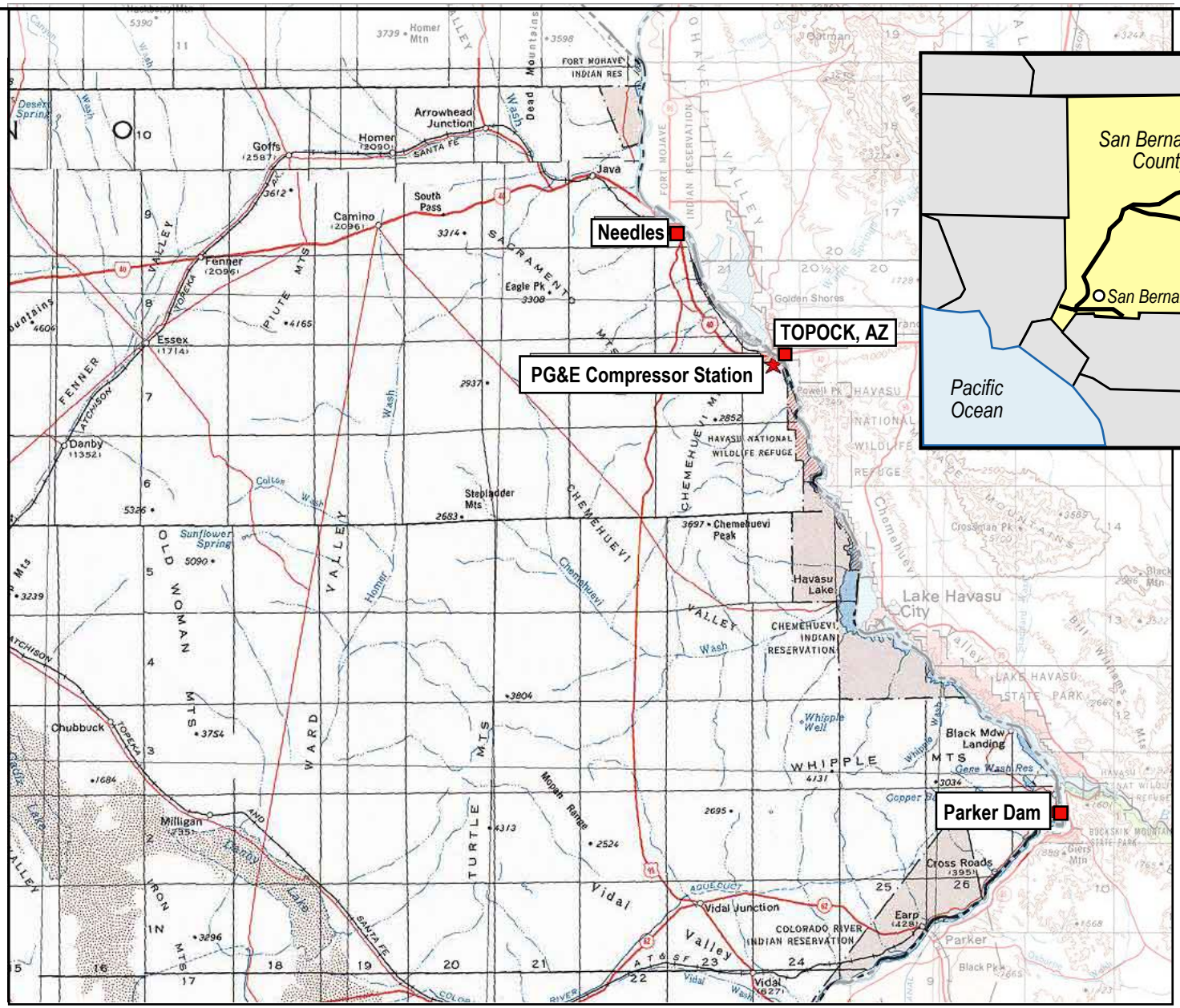

Figure 1.1
Site Location Map

WORK PLAN FOR INJECTION WELL INSTALLATION ON PARCEL
650-151-06 TOPOCK COMPRESSOR STATION,
NEEDLES, CALIFORNIA

CH2MHILL

315994.PS.07.IW_Figure 1-1 SiteLocMap-Final_9/23/04_ccc

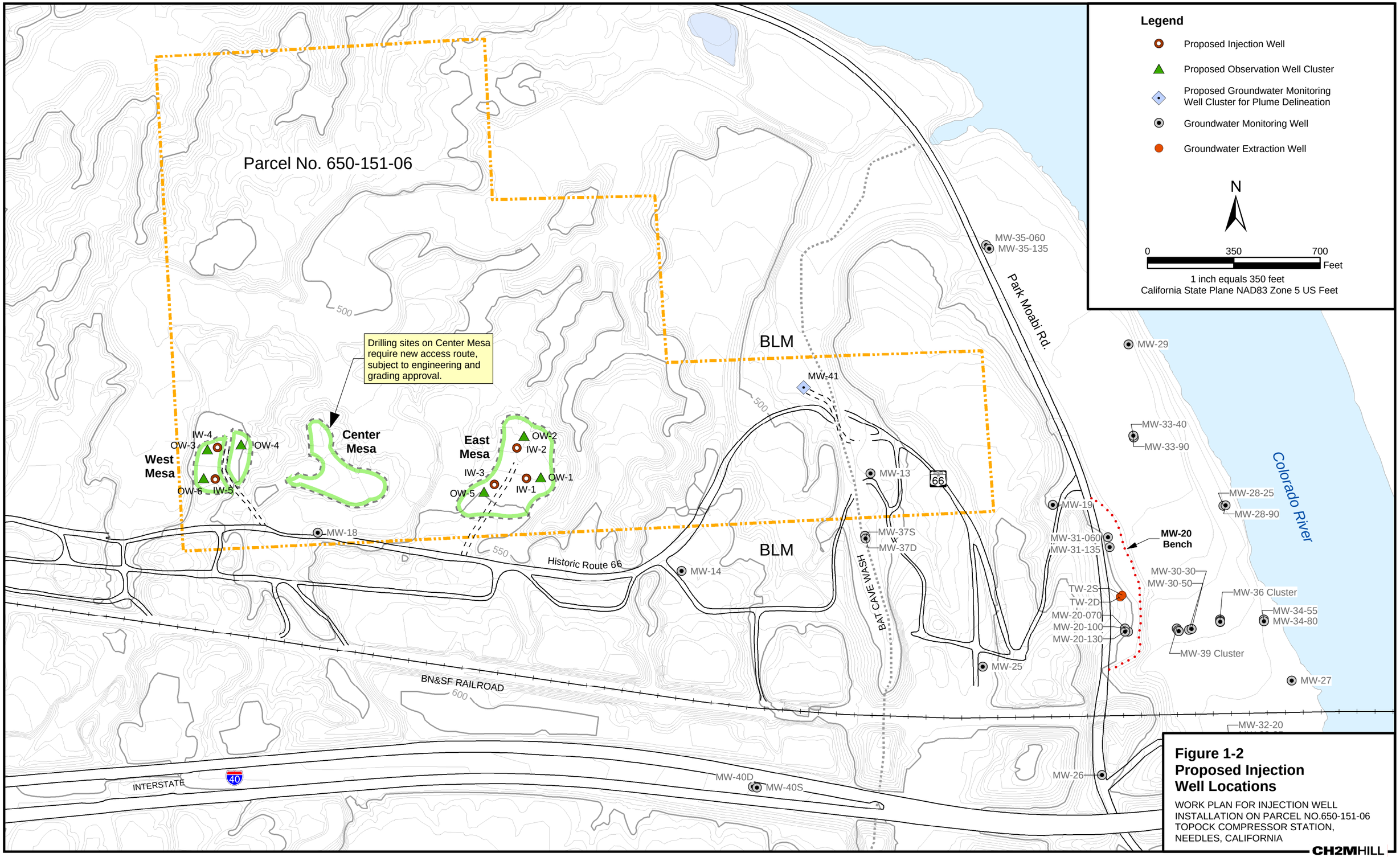

Figure 1-2
Proposed Injection Well Locations

WORK PLAN FOR INJECTION WELL INSTALLATION ON PARCEL NO.650-151-06
TOPOCK COMPRESSOR STATION,
NEEDLES, CALIFORNIA

CH2MHILL

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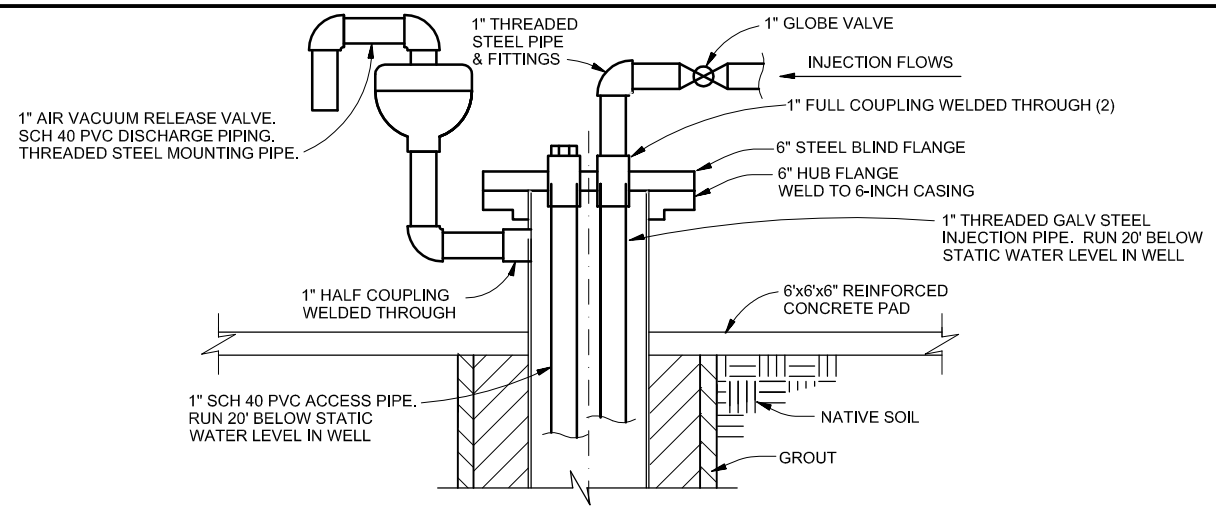
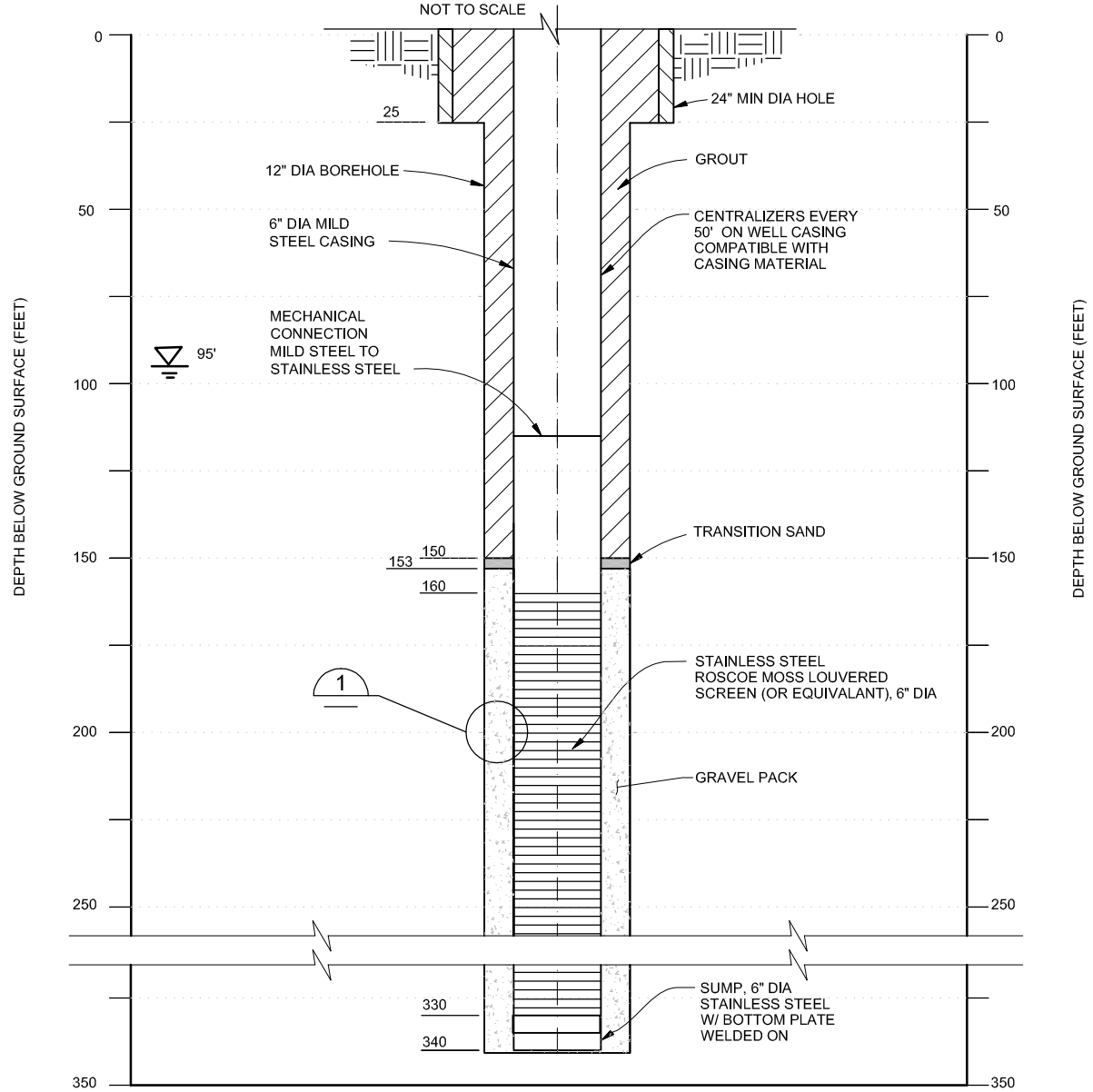


WELLHEAD DETAIL

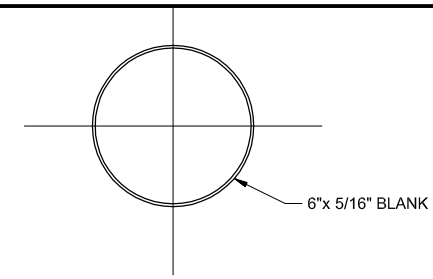
NOTE: DRILLERS ARE NOT RESPONSIBLE FOR WELLHEAD CONSTRUCTION

NOT TO SCALE

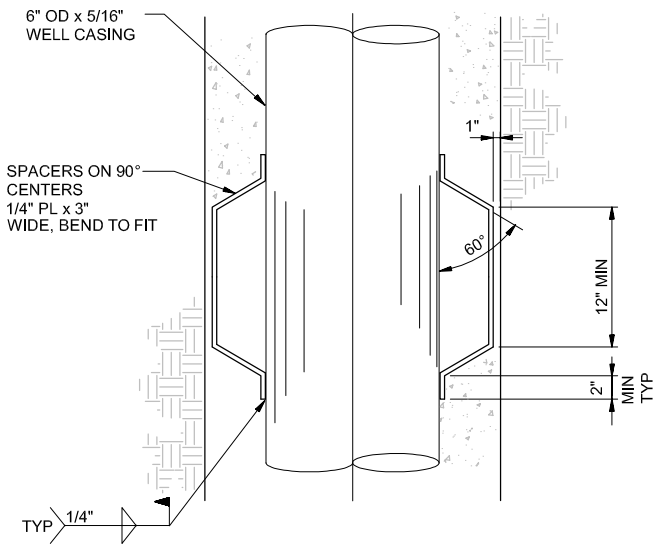


PRELIMINARY WELL CONSTRUCTION RECOMMENDATION

HORIZONTAL NOT TO SCALE



PLAN VIEW



CENTRALIZER DETAIL 1

NTS

REVISION 1 – 11/15/04

PACIFIC GAS & ELECTRIC CO.
TOPOCK COMPRESSOR STATION
INTERIM MEASURES NO. 3

FIGURE 2-1
SCHEMATIC DIAGRAM OF IM-3 INJECTION WELL
PG&E PARCEL 650-151-06

SHEET	
DWG	
DATE	9/24/04
PROJ	315994

File name: IM3_IWconst_detail2.dwg 15-Nov-2004