Linda S. Adams
Secretary for
Environmental Protection

Department of Toxic Substances Control

Maureen F. Gorsen, Director
5796 Corporate Avenue
Cypress, California 90630

Arnold Schwarzenegge
Governor

November 3, 2006

Ms. Yvonne Meeks
Portfolio Manager – Site Remediation
Pacific Gas and Electric Company
4325 South Higuera Street
San Luis Obispo, CA 93401

ADDITIONAL BEDROCK INVESTIGATION BASED ON REVIEW OF BEDROCK TECHNICAL MEMORANDUM AT PACIFIC GAS AND ELECTRIC COMPANY (PG&E), TOPOCK COMPRESSOR STATION, NEEDLES, CALIFORNIA (EPA ID NO. CAT080011729)

Dear Ms. Meeks,

The Department of Toxic Substances Control (DTSC) has completed the evaluation of the *Technical Memorandum: Information Review of Groundwater Conditions in Bedrock Formation at PG&E's Topock Compressor Station* (Tech Memo) dated March 15, 2006. The Tech Memo was submitted in response to DTSC's letter dated January 6, 2006. DTSC requested for the Tech Memo to facilitate discussion and resolution of potential hexavalent chromium transport in bedrock raised by Consultative Workgroup members in their review of the February 2005 RCRA Facility Investigation/ Remedial Investigation (RFI/RI) report, and to facilitate preparation of the revised Volume 2 (Groundwater) RFI/RI Report.

Based on existing information, current interpretation, and the review of the Tech Memo, Dr. Kate Burger of the DTSC Geological Services Unit is recommending additional bedrock investigation. These recommendations are provided in the enclosed memorandum to Mr. Christopher Guerre dated July 20, 2006. Based on these recommendations, DTSC is requiring PG&E to prepare and submit a work plan no later than November 15, 2006, to proceed with the recommended investigations. It is DTSC's goal, at a minimum, to complete an aquifer test at PGE-07 well prior to initiation of the proposed Upland In-situ Pilot Test.

If you have any questions or comments with regards to this letter, please feel free to contact me at (714) 484-5439.

Sincerely,

Aaron Yue
Project Manager
Geology, Permitting and Corrective Action Branch

aky:110601B

Enclosure

cc: PG&E Topock Consultative Workgroup Members – Via e-mail

Department of Toxic Substances Control

Maureen F. Gorsen, Director
8800 Cal Center Drive
Sacramento, California 95826-3200

Linda S. Adams
Secretary for
Environmental
Protection

Arnold Schwarzenegger
Governor

MEMORANDUM

TO: Christopher Guerre, CHG
Project Manager
Hazardous Waste Management Program, Cypress Regional Office

FROM: Kate Burger, PG, PhD
Engineering Geologist, Northern California Geological Services Unit
Hazardous Waste Management Program, Sacramento Regional Office

DATE: July 20, 2006

SUBJECT: Recommendations Regarding Additional Bedrock Investigation
RCRA Facility Investigation, Pacific Gas and Electric Company,
Topock Compressor Station, Needles, San Bernardino County
Project No. 22120/540015-48/36-HWMP

DOCUMENT REVIEWED

Technical Memorandum, Information Review of Groundwater Conditions in Bedrock Formations at PG&E's Topock Compressor Station, Needles, California. Prepared by CH2M Hill. Dated March 15, 2006. (Technical Memorandum)

INTRODUCTION

The Northern California Geological Services Unit (GSU) of the Department of Toxic Substances Control (DTSC) has reviewed the above-referenced Technical Memorandum for the Pacific Gas and Electric Company (PG&E) Topock Compressor Station. Submitted in response to a DTSC letter dated January 6, 2006, the memorandum provides an informational review and evaluation of groundwater conditions in bedrock units at the PG&E Topock Compressor Station. DTSC intended that the memorandum supplement the bedrock-related discussions in the February 2005 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report and facilitate assessment of data gaps in the bedrock investigation. An additional bedrock investigation may have merit if review of the current information indicates that further characterization is required for:

1. bedrock stratigraphy;
2. hydraulic properties of the bedrock units;
3. groundwater flow conditions in the bedrock units;
4. defining the upper bedrock surface; and/or
5. nature and extent of chromium in bedrock.

The GSU focus for this memorandum is to comment on whether the existing data adequately addresses these investigation objectives and to provide recommendations for further investigation. If you have questions, please contact me at (916) 255-6537.

DTSC provided the Technical Memorandum to the Geo/Hydro Technical Workgroup (TWG) on March 17, 2006 and discussed the bedrock investigation with TWG members in an April 18, 2006 meeting. DTSC received comments on the Technical Memorandum from the U.S. Geological Survey (USGS), Hargis+Associates (on behalf of the Fort Mojave Indian Tribe), and GeoTrans (on behalf of the Arizona Department of Environmental Quality (ADEQ)). The following comments and recommendations consider the stakeholder comments on the February 2005 RFI Report and comments received on the Technical Memorandum.

BEDROCK STRATIGRAPHY

For the purposes of the RFI, the stratigraphy should be defined to the extent that the water-bearing units that may be impacted by site activities are adequately characterized.

In the February 2005 RFI Report and subsequent site characterization reports, PG&E has defined the bedrock units for the Topock Compressor Station in a manner consistent with existing geologic studies in the region. According to published studies, bedrock formations are generally considered to be rocks that are Miocene or older in age. As summarized in Table 1 of the Technical Memorandum, these studies typically describe the bedrock units as igneous and metamorphic crystalline rocks, volcanic rocks, and consolidated/cemented sedimentary rocks.

As stated in Section 1.2 of the Technical Memorandum, PG&E is defining the bedrock units as "all rocks that are older than, and unconformably underlie, the Fanglomerate of Metzger and Loeltz." Based on this definition, PG&E has identified two bedrock units for the site:

Pre-Tertiary metamorphic and igneous bedrock: primarily metadiorite, gneiss, and granitic rocks. The crystalline bedrock is exposed in the Chemehuevi Mountains south of the site. This unit was penetrated by borings and wells at the Old Evaporation Ponds, and in wells MW-24BR and PGE-08.

Middle Miocene conglomerate bedrock: conglomerate to gravelly sandstone, 10 to 30 percent silt and clay, usually reddish-brown. Locally includes megabreccia (inferred landslide deposits). The Miocene conglomerate unconformably overlies the Pre-Tertiary crystalline bedrock and generally has a structural dip up to 40 degrees to the northeast. The unit formed by alluvial deposition resulting from Miocene-age mountain block extension faulting and uplift. The unit is exposed south of the site and has been penetrated by 32 borings. Most of these borings penetrated less than ten feet into the unit. Greater than 20 feet of the Miocene conglomerate was penetrated at PGE-07, PGE-08, TW-1, TW-2, MW-23, MW-24BR, MW-33, MW-48 and MW-50.

In investigation reports subsequent to the February 2005 RFI Report and in recent discussions, PG&E has referred to a "reworked Miocene conglomerate", a reddish-brown unit consisting of locally-derived materials from the Miocene conglomerate. The dip of these locally-derived materials is consistent with the Oldest Alluvium (5 degrees). This terminology has led to some confusion as to whether the reworked Miocene conglomerate should be considered to be a bedrock unit. PG&E has clarified that the reworked Miocene conglomerate is part of the unit referred to as the Oldest Alluvium which unconformably overlies the Miocene conglomerate. The Oldest Alluvium is equivalent to the Fanglomerate unit defined by Metzger and Loeltz (1973) and is estimated to be of Late Miocene to Pliocene age.

Preliminary discussions suggest that the Arizona Topock Groundwater Study may apply an alternate interpretation of bedrock units in the site vicinity. This alternate definition of bedrock is largely derived from use of driller's logs to define the Arizona stratigraphy and the occurrence of thicker sequences of younger stratigraphic units in Arizona that are interpreted to exhibit bedrock characteristics. The possibility of an alternate definition of bedrock units does not seem relevant to the PG&E RFI activities until such time as a nature and extent investigation *in the Miocene conglomerate or Pre-Tertiary crystalline bedrock* extends into Arizona.

For the purposes of the PG&E RFI, the hydrostratigraphic units should be defined for the immediate site vicinity and, if appropriate, should then be expanded to fit a larger scale hydrogeologic context. GSU considers the PG&E definition of bedrock units to be appropriate for the conceptual hydrogeologic model at the Topock Compressor Station.

BEDROCK SURFACE

The conceptual hydrogeologic model for the Topock Compressor Station considers the top of the Miocene conglomerate to be a hydraulic boundary for the Alluvial Aquifer. Because the topography of this surface has the potential to affect groundwater flow and plume transport in the Alluvial Aquifer, the RFI needs to collect data to prepare an adequately detailed structural contour map of this surface.

As noted by several reviewers, the February 2005 RFI Report lacks a structural contour map of the top of the Miocene conglomerate. Since issuing the report, PG&E has provided several updates to the map. The Technical Memorandum includes a structural contour map depicting data collected through March 2005. However, in the report entitled Interim Measures 2006 Well Drilling Investigation Report (dated June 30, 2006), PG&E has provided an update to the map using data collected by the 2006 drilling activities. This latest version of the structural contour map is included as Figure 1 of this memorandum.

In the upland areas of the site, Figure 1 shows a steeply dipping bedrock surface adjacent to the Chemehuevi Mountains that is likely controlled by the Chemehuevi detachment fault. Further northward in the upland area, the surface flattens out and dips toward the north northwest. The most prominent feature is a bedrock ridge in the floodplain area that has a north-south orientation. The bedrock surface drops off

sharply toward the east and north, likely as a result of river downcutting (although structural control of the bedrock surface cannot be eliminated).

GSU has the following recommendations regarding the structural contour map of the top of the Miocene conglomerate.

- PG&E should revise Figure 1 of this memorandum to show the estimated configuration of bedrock beneath the river channel. For the revision, PG&E should use the results of the USGS geophysical survey, geotechnical borings for the Interstate 40 bridge, and bedrock elevation data near the railroad bridge.

- If the nature and extent investigation of the Alluvial Aquifer extends beneath the river or into Arizona, as possible, the investigation should extend to bedrock and the structural contour map should be updated to reflect the new data.

HYDRAULIC CHARACTERIZATION OF BEDROCK UNITS

The Topock Compressor Station is located at the terminus of the Mohave Valley where Pre-Tertiary crystalline bedrock outcrops to the south (Chemehuevi Mountains) and west (Sacramento Mountains) to create hydraulic barriers to groundwater flow. Groundwater flowing southward within the Mohave Groundwater Basin is forced upward and toward the river as the bedrock becomes shallower and the valley narrows. Unlike the southerly flow direction in the northern portions of the Mohave Valley, groundwater in the immediate vicinity of the Topock Compressor Station (immediately against the low permeability Pre-Tertiary bedrock) flows north to northeasterly toward the river under low hydraulic gradients.

Consistent with the regional hydrogeologic framework, the conceptual hydrogeologic model for the site also includes upward hydraulic gradients from the bedrock units to the Alluvial Aquifer. Upward gradients between these units can be measured at two locations. Quarterly water level measurements at the MW-24 well cluster indicate a persistent upward gradient between the bedrock and lower Alluvial Aquifer (0.003 to 0.006 feet per foot). Vertical gradient estimates will shortly be available between well MW-12 (Alluvial Aquifer) and new well MW-48 (Miocene conglomerate). Upward hydraulic gradients are also suggested by the lack of chromium detections in these bedrock wells which are downgradient of the primary discharge points for chromium to the Alluvial Aquifer.

The Miocene conglomerate and Pre-Tertiary crystalline bedrock are often described as shattered, sheared, and highly fractured, as a result of detachment faulting and crustal extension during Miocene time. Published studies (Howard et al. 1997; John 1987) and observations of bedrock units in the vicinity of the Topock Compressor Station characterize the bedrock units as moderately fractured. Despite the discontinuities caused by the tectonic activity, bedrock units in the Mohave Groundwater Basin are described as relatively impermeable (Metzger and Loeltz 1973), as is further evidenced by limited water resource development in these formations. Published studies report that the Pre-Tertiary crystalline bedrock has small yields (up to 5 gallons per minute)

from fractures and weathered zones. The published studies do not discuss the Miocene conglomerate as a potential source of groundwater for the region.

Hydraulic property data that has been collected in the vicinity of the Topock Compressor Station during the RFI and earlier investigations is summarized below.

Miocene conglomerate. The upper portion of the Miocene conglomerate has been penetrated by 32 borings at the Topock Compressor Station and is usually found to be moist to dry. The draft lithologic log for boring MW-48 describes the unit as slightly moist to moist, except in the vicinity of two identified fracture zones. A rising head slug test conducted in well MW-23 had an estimated hydraulic conductivity of 1.5×10^{-5} centimeters per second (cm/sec) (Ecology & Environment 2002). The two monitoring wells completed in the Miocene Conglomerate, MW-23 and MW-48, generally take several hours to recharge after purging. Although the Miocene conglomerate has been described as "shattered" in some core descriptions for the site, this consistency is a result of the sonic drilling method rather than an indication of *in situ* conditions.

Pre-Tertiary bedrock. A rising head slug test in well MW-24BR had an estimated hydraulic conductivity of 9.7×10^{-7} cm/sec (Ecology & Environment 2002). PG&E reports that this well takes several days to recover after a three casing volume purge. In their comments on the February 2005 RFI Report, several stakeholders have cited an estimated transmissivity for Pre-Tertiary bedrock of 10,000 gallons per day per foot (gpd/ft) as evidence of greater water-transmitting characteristics than the unit description would imply. The Technical Memorandum is critical of this estimate (based on the 1969 Dames and Moore test conducted in former injection well PGE-08) for two reasons. First, the test duration was too short to accurately assess the hydraulic properties of fractured rock. Second, the transmissivity value was derived using an inappropriate data analysis method (i.e., porous media method instead of a fractured rock method). In the April 18, 2006 TWG meeting, CH2M Hill indicated that it is not feasible to use the data to derive a modified transmissivity estimate because of the short test duration. It is also not possible to estimate hydraulic properties from the operational performance of well PGE-08 because limited records were kept during injection.

The available site-specific hydraulic data for the bedrock units is limited and generally represents very localized portions of these units. Of particular concern is the fact that the existing data do not assess the water transmissive properties of fracture or fault zones. Characterization of the fracture connectivity would be particularly challenging because of the difficulty of locating fracture zones with vertical borings. Although lineament analyses have been performed in the site vicinity, there is no surface expression of bedrock fracture zones to guide siting of borings and wells. Some stakeholders have raised the possibility of unmapped faults as potential conduits for groundwater flow. Identification of unmapped faults is also problematic because the features would be covered by younger overburden. Surface geophysical techniques are unlikely to be effective because of low contrast in seismic wave velocity between the Oldest Alluvium and the bedrock units. Of all the possible investigation options, the

most meaningful endeavor might be an aquifer test in well PGE-08 to assess the water transmissive properties associated with the crystalline bedrock and the Chemehuevi detachment fault. A downhole camera survey prior to an aquifer test could be useful to evaluate the characteristics of the crystalline bedrock in the uncased portion of the well.

Based on the current conceptual hydrogeologic model for the site, GSU is not recommending additional investigation (i.e., boreholes, well installation, geophysical surveys, downhole fracture density and orientation surveys in well PGE-08) solely to supplement the hydraulic property data set for bedrock units. GSU believes that there is little chance that this resource-intensive effort would yield data useful for selecting a final remedy. GSU is recommending that additional hydraulic data be obtained by conducting aquifer tests in existing wells completed in the Miocene conglomerate and Pre-Tertiary bedrock (i.e., PGE-07, PGE-08, MW-48). An aquifer test at well PGE-08 may provide the most effective assessment of the *current* transmissivity of the crystalline bedrock.

NATURE AND EXTENT OF CHROMIUM IN BEDROCK

When evaluating the nature and extent of chromium in the bedrock units, it is important to keep in mind that there are two plausible mechanisms for chromium to enter the bedrock units. The first mechanism is the direct injection of chromium-containing wastewater into the Pre-Tertiary crystalline bedrock via well PGE-08. The second mechanism consists of the downward migration of chromium within the Alluvial Aquifer into the Miocene conglomerate.

Fate and Transport of Chromium in Wastewater Discharged to PGE-08

As summarized in the February 2005 RFI Report and the Technical Memorandum, approximately 29,400,000 gallons of chromium-containing wastewater were injected into well PGE-08 between June 1970 and February 1974. Injection pressures are reported to have been as high as 400 pounds per square inch (psi). During this time, PG&E was conducting a two-step treatment process[1] which is thought to have reduced the chromium concentration to less than 1 milligram per liter (mg/L) prior to injection. Based on the historical facility operations described in the February 2005 RFI Report, GSU estimates that less than one percent of the chromium mass discharged between 1951 and 1974 was injected into well PGE-08. During this timeframe, the majority of chromium mass was discharged to the Alluvial Aquifer.

Groundwater chemistry data collected from wells completed in Pre-Tertiary bedrock indicate highly reducing conditions. Water chemistry data for well PGE-08 and well MW-24BR indicate that *in situ* groundwater conditions in this bedrock unit are very

[1] The first step in the treatment process was to reduce hexavalent chromium to trivalent chromium in the chromium reduction tank by injecting the wastewater with sulfur dioxide gas to maintain a pH between 2.9 and 3.2. The second treatment step was to transfer the water to the precipitation tank where it was injected with sodium hydroxide to raise the pH to between 6.7 and 7.2. Poly Floc II and ferric sulfate were also used during the second step to enhance chromium removal.

negative (approximately -300 millivolts). The reducing conditions in bedrock are also indicated by the detection of sulfide in wells PGE-08 and MW-24BR at average concentrations of 1.3 and 0.5 mg/L, respectively, in four sampling events between 1998 and 2004. TWG members have discussed that ferrous iron minerals in the crystalline bedrock may be contributing to the reducing conditions, although mineral surface area in contact with groundwater may limit the significance of this geochemical process. If representative of groundwater conditions at the time of injection, these geochemical conditions would have converted any remaining hexavalent chromium to the essentially immobile trivalent chromium.

During the April 18, 2006 meeting, TWG members had a lengthy discussion of the possible fate of the injected wastewater.

Trapped in Fractures Near Well. One possible fate is that the injected wastewater is trapped in fractures in the vicinity of the well. However, the volume of injected wastewater is hard to reconcile with the probable fracture porosity. Meeting participants discussed that some fractures may have opened up under the high pressures used for injection and that these fractures would not be open to the well under non-injection conditions. Hence, additional investigations (e.g., new borings or wells adjacent to PGE-08, fracture density surveys, fracture orientation surveys, flow meter surveys) may not be effective for identifying the fractures that received most of the wastewater.

Discharged to Alluvial Aquifer. Another possible fate is that the injected wastewater may have followed a path of least resistance and migrated upward to the Alluvial Aquifer. Under this scenario, the discharged wastewater may have entered the Alluvial Aquifer within the currently mapped extent of the chromium plume. PG&E had identified well PGE-07 as a potential monitoring point to evaluate the effect of injection into well PGE-08 on the groundwater chemistry within the Alluvial Aquifer. PG&E obtained total dissolved solids (TDS) and specific conductivity profiles within well PGE-07 on 24 occasions between December 1972 and August 1980 (TES 1995). The profiles were collected at inconsistent time increments which make it difficult to interpret the arrival of a wastewater injection front. Hence, it does not appear that the PGE-07 data can be used to support evaluation of this potential fate. Without a useable data set, it does not seem worthwhile to further evaluate this potential fate.

Migrated Eastward Along Detachment Fault. Another potential fate is that the injected wastewater intersected the fault zone at the base of the Chemehuevi Mountains and migrated eastward. Although the Technical Memorandum cites examples of faults elsewhere in the Mojave Desert that act as barriers to groundwater flow, no evaluation of the effect of the Chemehuevi detachment fault on groundwater flow in the vicinity of the Topock Compressor Station has been conducted. This scenario could be evaluated by conducting a clean water injection test in well PGE-08 that attempts to simulate the hydraulic conditions during injection. An injection test has obvious drawbacks, including: insufficient operational records to replicate wastewater injection; fractures in the bedrock unit may not

respond in the same manner as during wastewater injection; injection could push any residual wastewater outward; and injection could alter bedrock geochemistry.

Potential for Downward Migration from Alluvial Aquifer to Bedrock Units

Several lines of evidence suggest limited potential for downward migration of chromium from the Alluvial Aquifer into the Miocene conglomerate. First, the regional hydrogeologic setting indicates that groundwater is moving upward and toward the Colorado River at the terminus of the Mohave Groundwater Basin. Vertical gradients measured at the MW-24 well cluster indicate a consistently upward hydraulic gradient from the bedrock to the Alluvial Aquifer. Second, groundwater in bedrock at the MW-24 well cluster does not contain detectable chromium. If there were significant downward migration of chromium into the bedrock units in the vicinity of the former percolation bed, one would expect to see some evidence of it at this well cluster. Finally, the Miocene conglomerate appears to act as a hydraulic boundary for the Alluvial Aquifer. The matrix of the conglomerate is dry to moist at the contact between this unit and the Alluvial Aquifer. Wells completed in the Miocene conglomerate have low water yield during purging and sampling, even when completed across known fractures. Hence, if the Alluvial Aquifer chromium plume were entering into the Miocene conglomerate, it would have to be migrating along a continuous fracture or unrecognized fault[2] and against the hydraulic gradient.

POTENTIAL FOR FRACTURES OR FAULTS TO ACT AS CONDUITS FOR CHROMIUM PLUME MIGRATION TOWARD COLORADO RIVER

Several stakeholders have expressed concern that fracture zones or faults may act as conduits for eastward chromium migration. There are two mechanisms by which the chromium plume may be entering structural conduits. First, wastewater injected into well PGE-08 may be migrating eastward along the Chemehuevi detachment fault or other fracture zones in the crystalline bedrock. Second, if the plume intersects an unmapped fault or fracture zone, the chromium plume in the Alluvial Aquifer may flow downward into the Miocene conglomerate. The latter scenario seems unlikely given the regional hydrogeologic setting.

If a chromium plume is migrating eastward along a structural conduit, the next point to consider is the fate of the plume if it were to migrate beneath the Colorado River. Some questions to consider include:

- Is the transmissive length of the fault or fracture zone long enough for continued plume migration into Arizona? If there is an abrupt change in transmissivity, the plume would tend to migrate upward.
- Does the fault or fracture truncate against the thick sequence of fluvial sediments in the river channel? If so, the tendency would be for the plume to discharge to the fluvial sediments.

[2] The Chemehuevi detachment fault lies to the south of the chromium plume in the Alluvial Aquifer.

- Do the regional hydraulic gradients drive the plume to migrate upward into the more transmissive fluvial sediments within the Colorado River channel?

GSU does not believe that any amount of additional investigation can fully allay stakeholder concerns that an unrecognized fault or fracture zone is allowing eastward chromium plume migration in the Miocene conglomerate. However, GSU does not believe it to be realistic that the plume would migrate downward against the regional hydraulic gradient. In addition, further investigation to identify these zones seems to be an impossible task because these features lack a surface expression and the features cannot be discriminated using surface geophysical techniques.

Further evaluation of the potential for the Chemehuevi detachment fault to transmit wastewater injected into PGE-08 may have merit to support final remedy evaluation, although any assessment would not be able to duplicate the conditions during active injection. If a prolonged aquifer test in well PGE-08 does not show a response in other bedrock wells or in Alluvial Aquifer wells, GSU suggests that no further evaluation would be necessary for this potential conduit.

RECOMMENDATIONS REGARDING ADDITIONAL BEDROCK INVESTIGATION

When considering the possible approaches for further bedrock investigation at this site, GSU believes that one should be cognizant that:
(1) the majority of chromium mass was discharged to the Alluvial Aquifer (only a fraction of a percent was injected into the Pre-Tertiary crystalline bedrock), and
(2) significant chromium migration into the Miocene conglomerate seems implausible.
From this perspective, GSU views extensive investigation efforts that entail additional deep bedrock drilling and well installation to be an imprudent use of resources.

Based on this review, GSU offers the following recommendations for additional bedrock investigation. These recommendations focus on efforts that have the greatest likelihood of supporting the evaluation of potential remedies during the CMS.

1. Conduct a long-term pumping test in well PGE-08 to evaluate the transmissivity of the Chemehuevi detachment fault and communication with other bedrock wells and Alluvial Aquifer wells. In addition to existing wells in the vicinity of well PGE-08, the observation wells should include wells in the Arizona floodplain (see ADEQ comments).

2. Obtain groundwater quality samples at periodic intervals during the PGE-08 aquifer test. Use the data to conduct geochemical modeling to evaluate the potential fate of chromium in the crystalline bedrock.

3. Conduct aquifer tests in wells MW-48 and PGE-07 to further characterize the hydraulic properties of the bedrock.

4. Conduct flow meter surveys and/or spinner logging within PGE-07 and PGE-08 to evaluate vertical hydraulic gradients within the bedrock units. PGE-07 will require

retrofitting prior to this survey because the well is screened in both the Oldest Alluvium and the Miocene conglomerate.[3]

5. Evaluate the existing downhole camera survey of well PGE-07 to verify whether the well is screened in Miocene conglomerate or crystalline bedrock. Consider conducting a downhole camera survey in well PGE-08.

6. Revise the structural contour map of the top of the Miocene conglomerate to show the estimated configuration of bedrock beneath the river channel. Existing data from the USGS geophysical survey, geotechnical borings for the Interstate 40 bridge, and bedrock elevation data near the railroad bridge can be used for the revision. If additional investigation is conducted beneath the Colorado River channel or in Arizona, as feasible, extend the boreholes to the top of the Miocene conglomerate and update the structural contour map.

REFERENCES

CH2M Hill. 2005. Draft RCRA Facility Investigation and Remedial Investigation Report, PG&E Topock Compressor Station, Needles, California. February.

Dames & Moore. 1969. Proposed System for Waste Water Disposal, Topock Compressor Station Near Needles, California. Prepared for Pacific Gas and Electric Company. August 19.

Ecology and Environment. 2002. Hydrogeological Testing Results, Pacific Gas and Electric Company, Topock Compressor Station, Needles, California.

Howard, K.A., B.E. John, and J.E. Nielson. 1997. Preliminary Geologic Map of the Eastern and Northern Parts of the Topock 7.5-minute Quadrangle, Arizona and California, United States Geological Survey Open-File report 95-534.

John, B.E. 1987. Geologic Map of the Chemehuevi Mountains area, San Bernardino County, California and Mohave County, Arizona, United States Geological Survey Open-File Report 87-666.

Metzger, D.G. and O.J. Loeltz. 1973. Geohydrology of the Needles Area, Arizona, California, Nevada. United States Geological Survey Professional Paper 486-J.

Technical and Ecological Services (TES). 1995. Topock Compressor Station, Bat Cave Wash, Background Geologic, Hydrogeologic, and Water Quality Information. October 1995.

Peer Reviewed By: Alfredo Zanoria, CHG, CEG

[3] At DTSC's request, PG&E has submitted a technical memorandum (dated February 24, 2006) regarding a potential retrofit of this well.

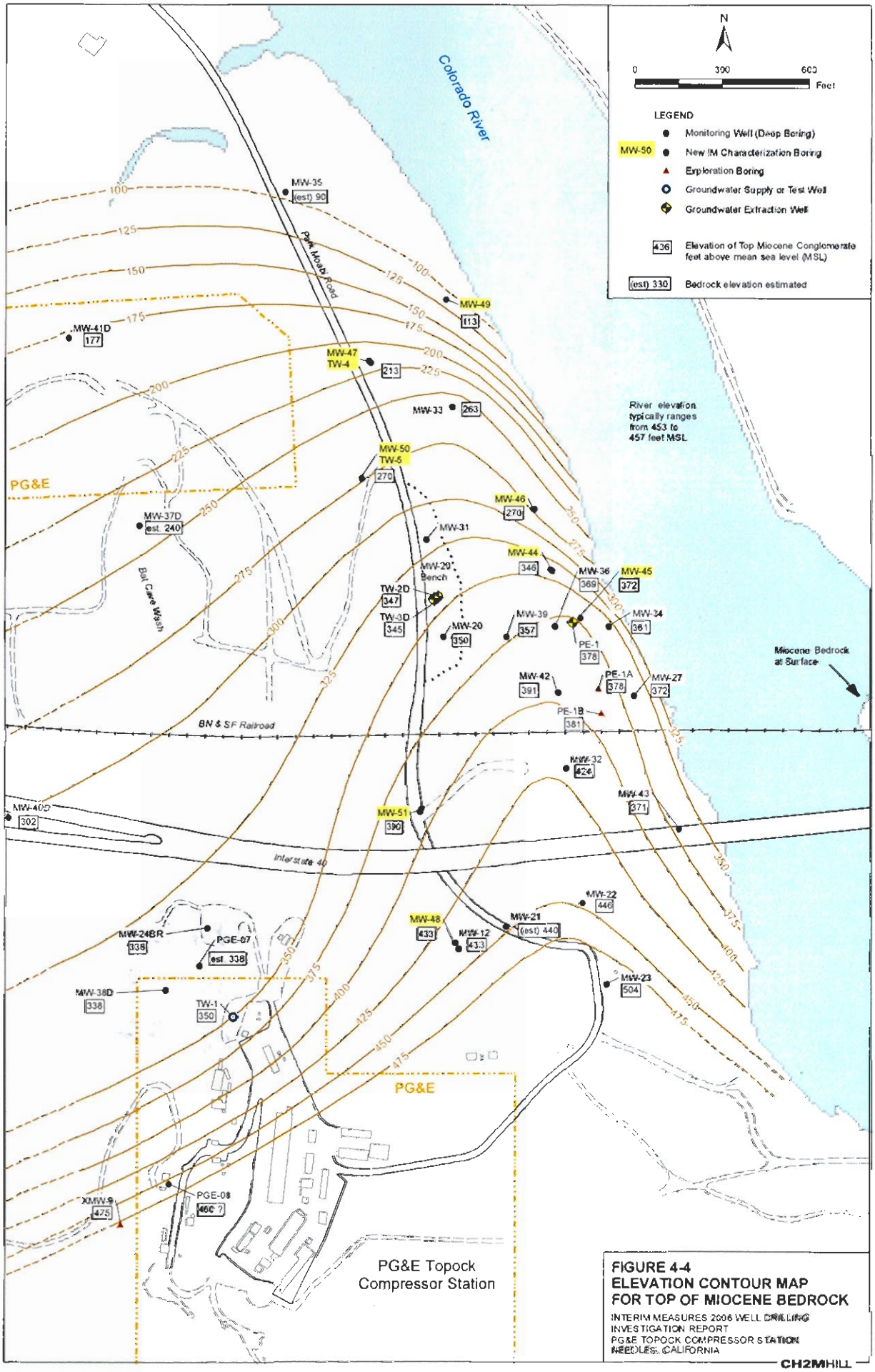

FIGURE 4-4
ELEVATION CONTOUR MAP FOR TOP OF MIOCENE BEDROCK
INTERIM MEASURES 2006 WELL DRILLING INVESTIGATION REPORT
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL