Topock Project Executive Abstract

Document Title:

Groundwater Background Study, Steps 3 and 4: Revised Final Report of Results, PG&E Topock Compressor Station, Needles, California

Submitting Agency/Authored by: DTSC, DOI

Final Document? ☒ Yes ☐ No

Date of Document: November 6, 2009

Who Created this Document?: (i.e. PG&E, DTSC, DOI, Other)

PG&E

Priority Status: ☐ **HIGH** ☒ **MED** ☐ **LOW**
Is this time critical? ☒ Yes ☐ No

Type of Document:
☐ Draft ☒ Report ☐ Letter ☐ Memo

☐ Other / Explain:

Action Required:
☒ Information Only ☐ Review & Comment
Return to: ______________________

By Date:______________________
☐ Other / Explain:

What does this information pertain to?
- ☐ Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA)/Preliminary Assessment (PA)
- ☒ RCRA Facility Investigation (RFI)/Remedial Investigation (RI) (including Risk Assessment)
- ☐ Corrective Measures Study (CMS)/Feasibility Study (FS)
- ☐ Corrective Measures Implementation (CMI)/Remedial Action
- ☐ California Environmental Quality Act (CEQA)/Environmental Impact Report (EIR)
- ☐ Interim Measures
- ☐ Other / Explain:

Is this a Regulatory Requirement?
☒ Yes
☐ No
If no, why is the document needed?

What is the consequence of NOT doing this item? What is the consequence of DOING this item?

Completion of the Groundwater Background Study is an important milestone towards the completion of the corrective action project at this site.

Other Justification/s:
☐ Permit ☐ Other / Explain:

Brief Summary of attached document:

This groundwater background study was completed to assess the range of naturally occurring background concentrations of hexavalent chromium (Cr[VI]), total chromium (Cr[T]), and 17 other trace metals in groundwater near the PG&E Topock site and surrounding region. Six rounds of groundwater samples were collected from 25 wells near the PG&E Topock site over a 1-year period. Before calculating background concentrations, the final groundwater background study data set was selected after using statistics and geochemistry to evaluate the analytical data for redundant data caused by wells being near each other, possible multiple populations, and outliers.

The groundwater background concentrations were estimated using the method described in the technical memorandum, Preliminary Evaluation of Data for the Groundwater Background Study (CH2M HILL, 2006), which is consistent with the approach outlined in the approved Background Study Work Plan (CH2M HILL, 2004).

Based on statistical and geochemical review of the estimated background concentrations for sample independence and possible time trends, and comparison with published background concentrations for the same hydrogeologic province, the calculated UTLs (upper tolerance limit)/background concentrations for the 19 metals can be used to support the RFI/RI and risk assessment activities as well as assist the CMS/FS activities during the development of remedial action/corrective action goals. The limitations and caveats for use of the calculated UTLs for specific constituents, wells, or areas will be assessed and acknowledged, as appropriate for each application.

Written by: PG&E

Recommendations:

None.

How is this information related to the Final Remedy or Regulatory Requirements:

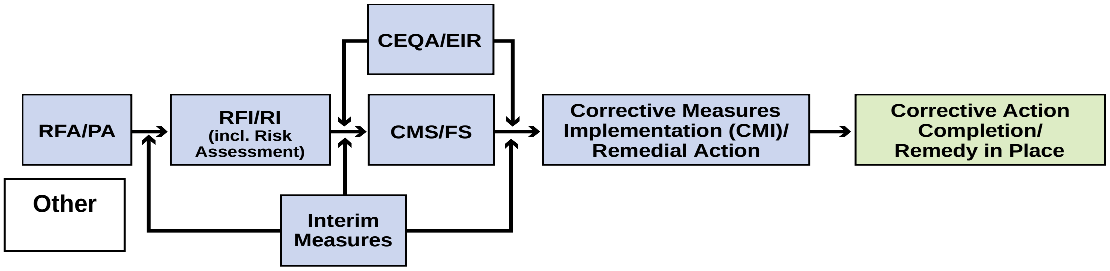
The calculated background concentrations for the 19 metals can be used to support the RFI/RI and risk assessment activities as well as assist the CMS/FS activities during the development of remedial action/corrective action goals.

Other requirements of this information?

The data in this report are used as input for the RFI/RI, the risk assessment, and the CMS/FS.

Related Reports and Documents:

Click any boxes in the Regulatory Road Map (below) to be linked to the Documents Library on the DTSC Topock Web Site (www.dtsc-topock.com).



Legend

RFA/PA – RCRA Facility Assessment/Preliminary Assessment

RFI/RI – RCRA Facility Investigation/CERCLA Remedial Investigation (including Risk Assessment)

CMS/FS – RCRA Corrective Measure Study/CERCLA Feasibility Study

CEQA/EIR – California Environmental Quality Act/Environmental Impact Report

Pacific Gas and Electric Company

Yvonne J. Meeks
Manager

Environmental Remediation
Gas Transmission & Distribution

Mailing Address
4325 South Higuera Street
San Luis Obispo, CA 93401

Location
6588 Ontario Road
San Luis Obispo, CA 93405

805.234.2257
Fax: 805.546.5232
E-Mail: Yjm1@Pge.Com

November 6, 2009

Mr. Aaron Yue
Project Manager
Geology Permitting and Corrective Action Branch
California Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, CA 90630

Pamela Innis
OEPC - Denver Region
P.O. Box 25007 (D-108)
Denver Federal Center, Bldg. 56
Denver, CO 80225-0007

Subject: Groundwater Background Study, Steps 3 and 4: Revised Final Report of Results, PG&E Topock Compressor Station, Needles, California

Dear Mr. Yue and Ms. Innis:

This letter transmits the *Groundwater Background Study Step 3 and 4: Revised Final Report of Results* for the Pacific Gas and Electric Company (PG&E) Topock Compressor Station site. This report incorporates changes to the *Groundwater Background Study Steps 3 and 4: Final Report of Results* report dated July 23, 2008, in response to the California Department of Toxic Substances Control (DTSC) letter dated October 26, 2009. The U.S Department of Interior (DOI) had previously approved the July 2008 Report on August 18, 2008. DTSC's October 26, 2009 comments and responses to those comments are presented in Appendix D2 of the report. Other changes that have been made include:

- Adding the word "Revised" to the report title where it appears in the report and title blocks of figures and tables.
- Minor editorial changes that are non-technical and do not affect the conclusions of the report.

No additional changes have been made to the report.

We are requesting approval from DTSC and DOI on this Revised Final Report in one week. As DTSC stated in its November 30, 2007 letter, the completion of the Groundwater Background Study is an important milestone towards the completion of the corrective action project at this site.

Do not hesitate to contact me at (805) 234-2257 with any questions or comments on the enclosed report.

Sincerely,

Yvonne Meeks

Yvonne Meeks
Topock Project Manager

cc: Chris Guerre/DTSC
Karen Baker/DTSC
Bob Doss/PG&E

Report

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station
Needles, California

Prepared for

California Department of Toxic Substances Control

November 6, 2009

On Behalf of

Pacific Gas and Electric Company

Prepared by

CH2MHILL

155 Grand Avenue, Suite 1000
Oakland, California 94612

Document Title: Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

Pacific Gas and Electric Company (PG&E) Topock Compressor Station, Needles, California

Site Name: Topock Compressor Station

Site Location: Needles, California

Prepared By: Pacific Gas and Electric Company Date: November 2009

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Approved Brian Schroth Date 11/6/09

Brian Schroth
CA Registered Professional Geologist #7423
CH2M HILL

Approved Christina Hong Date 11/6/09

Christina Hong
Site Project Manager
CH2M HILL

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Acronyms and Abbreviations

µg/L	microgram(s) per liter
µS/cm	microSiemen(s) per centimeter
$\delta^{18}O$	oxygen-18
$\delta^{2}H$	deuterium
‰	parts per thousand difference from isotope standard (applied to $\delta^{18}O$ and $\delta^{2}H$ values)
ADEQ	Arizona Department of Environmental Quality
Background Study Work Plan	*Work Plan for Assessing Background Metals Concentrations in Groundwater, PG&E Topock Compressor Station and Vicinity, Needles, California*
CMS/FS	corrective measure study/feasibility study
Cr(T)	total chromium
Cr(VI)	hexavalent chromium
DTSC	California Department of Toxic Substances Control
DOI	United States Department of Interior
mg/L	milligram(s) per liter
mV	millivolt(s)
MRL	method reporting limit
ORP	oxidation-reduction potential
PG&E	Pacific Gas and Electric Company
QA/QC	quality assurance/quality control
RASA	Regional Aquifer System Analysis
RCRA	Resource Conservation and Recovery Act
RFI/RI	RCRA facility investigation/remedial investigation
TDS	total dissolved solids
UPL	upper prediction limit
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit

1.0 Introduction

The purpose of the groundwater background study is to assess the range of naturally occurring background concentrations of hexavalent chromium (Cr[VI]), total chromium (Cr[T]), and other metals in groundwater near the Pacific Gas and Electric Company (PG&E) Topock site. The location of the PG&E Topock site is shown in Figure 1-1.

1.1 Background Study Steps

The *Work Plan for Assessing Background Metals Concentrations in Groundwater, PG&E Topock Compressor Station and Vicinity, Needles, California* (Background Study Work Plan), dated June 30, 2004 (CH2M HILL, 2004), and approved by the California Department of Toxic Substances Control (DTSC) on October 29, 2004, describes a process for identifying and evaluating potential background wells for sample collection and determining background metals concentrations in groundwater. The process includes the following four steps.

1. Selecting potential background wells
2. Selecting final background wells
3. Calculating background concentrations
4. Reviewing background concentrations

Step 1 involved field reconnaissance and a records search to identify existing wells for potential inclusion in the background study but did not involve any sample collection. Results of Step 1 were reported in a technical memorandum, *PG&E Topock Background Study, Step 1 Results* (CH2M HILL, 2005a). The Step 1 results were approved with conditions by DTSC in a letter dated April 6, 2005 (DTSC, 2005a). PG&E satisfied all DTSC approval conditions by excluding wells EPNG-1 and MTS-2 from the list of potential background wells, providing DTSC with well-specific sampling plans, providing DTSC with a sampling schedule and schedule for submittal of the Step 2 technical memorandum, and by addressing the issues and concerns raised by DTSC in the technical memorandum, *PG&E Topock Background Study, Step 2 Results* (CH2M HILL, 2005b).

Wells that were identified as potential background study wells in Step 1 were then sampled in May and July 2005. The analytical results of these first two sampling events were evaluated and used to select a final set of background study wells and analytes. This portion of the groundwater background study is referred to as Step 2. The results of Step 2 were reported in the technical memorandum, *PG&E Topock Background Study, Step 2 Results* (CH2M HILL, 2005b). In a letter dated October 11, 2005, DTSC provided approval with conditions of the final set of background wells and analytes in response to the Step 2 background study technical memorandum (DTSC, 2005b). This letter from DTSC will be referred to herein as the DTSC Step 2 Conditional Approval Letter. PG&E satisfied the approval conditions by excluding well Topock-3 from the final set of background wells, and by submitting the required data and information requested by DTSC in the technical memorandum, *Preliminary Evaluation of Data for the Groundwater Background Study* (CH2M HILL, 2006) at the completion of the sixth sampling event. A summary of this technical memorandum is provided in Section 2.2 of this report. Condition two of the DTSC Step 2 Conditional Approval Letter required that PG&E meet with DTSC to discuss the final background study data set and approach to calculating the background concentrations prior to preparation of the Step 3 Report. However, DTSC directed PG&E to proceed with the preparation of the Step 3 Report without this required meeting (DTSC, 2006). In addition, PG&E submitted a technical memorandum on November 11, 2005 (CH2M HILL, 2005c) to satisfy condition five of the DTSC Step 2 Conditional Approval Letter.

Step 3 of the groundwater background study involved the collection of four more rounds of samples (sampling events 3, 4, 5, and 6) from October 2005 through May 2006 from the final set of background wells.

After completion of the sixth sampling event, the background study data set was evaluated to identify appropriate statistical techniques for calculating background concentrations. As outlined in the approved work plan, this evaluation included a check for sample independence to determine if the samples are likely from one or more populations, statistical tests to identify outliers in the data set, and a review of geochemical data to identify wells or groups of wells that are geochemically distinct and therefore might not belong in the background data. PG&E submitted a technical memorandum, *Preliminary Evaluation of Data for the Groundwater Background Study* (CH2M HILL, 2006), providing the final background data set and the method used to calculate the background concentrations.

On January 26, 2007, PG&E submitted a report, *Groundwater Background Study Steps 3 and 4 Results* (CH2M HILL, 2007a), providing the calculated background concentrations of trace metals in groundwater using data from the six sampling events at the approved background study wells, and consistent with the approach outlined in the approved work plan. A subsequent supplemental submittal was made on March 1, 2007, providing revisions of two tables in the report (CH2M HILL, 2007b). Comments were received on the *Groundwater Background Study Steps 3 and 4 Results* from DTSC on November 30, 2007 (DTSC, 2007a) and the United States Department of Interior (DOI) on December 20, 2007 (DOI, 2007).

On January 14, 2008, PG&E submitted the *Revised Groundwater Background Study Step 3 and 4: Report of Results* (CH2M HILL, 2008a). As agreed with DTSC and DOI, the report was revised to address all but the following two comments:

1. The outlier evaluations documented in the *Revised Groundwater Background Study Step 3 and 4: Report of Results* were performed using the mean concentrations for each analyte and well. DTSC had requested an additional outlier evaluation for each constituent considering all the background data for that constituent, rather than each well's mean concentration for that constituent. This additional outlier evaluation was submitted on January 29, 2008 (CH2M HILL, 2008b).
2. The background study wells included in the *Revised Groundwater Background Study Step 3 and 4: Report of Results* were those selected and approved through Steps 1 and 2 of the groundwater background study. DOI's letter dated December 20, 2007 (DOI, 2007) indicated that the inclusion of three of the selected wells should be conditional on the results of the planned groundwater investigation in Arizona. If the results of the Arizona investigation conclude that the Arizona wells contain concentration of Cr(VI) above regional background levels on the Arizona side of the River, the decision to include the

three background study wells in the vicinity of the Arizona investigation in the background study would need to be re-evaluated.

In addition, as directed by DTSC in the November 30, 2007 letter, additional discussions of the issues of multiple populations, the use of a single upper tolerance limit (UTL) for each analyte and associated limitations, and the uses of UTLs in the Resource Conservation and Recovery Act (RCRA) facility investigation/remedial investigation (RFI/RI) and corrective measure study/feasibility study (CMS/FS) processes were documented in the cover letter to the report.

Comments were received on the *Revised Groundwater Background Study Steps 3 and 4: Report of Results* from DTSC on February 29, 2008 (DTSC, 2008) and DOI on June 13, 2008 (DOI, 2008a). These comments were incorporated into the July 23, 2008 *Groundwater Background Study Step 3 and 4: Final Report of Results* (CH2M HILL, 2008c).

DOI approved the July 23, 2008 *Groundwater Background Study Steps 3 and 4: Final Report of Results* on August 18, 2008 (DOI, 2008b). Comments were received on the report from DTSC on October 26, 2009 (DTSC, 2009). These DTSC comments have been incorporated into this *Groundwater Background Study Step 3 and 4: Revised Final Report of Results.*

1.2 Report Structure

This report provides the revised results of Steps 3 and 4 of the groundwater background study and incorporated changes in response to agencies comments as described above. Step 3 is calculating the background concentrations of Cr(VI), Cr(T), and other metals using the data from all six sampling events at the background wells. Step 4 is an evaluation of the background study data set to check for sample independence, possible time trends in concentrations of individual analytes from each well, and comparison of calculated background concentrations against other background studies carried out in the region.

The remainder of this report is organized as follows.

- Section 2.0 describes the process used to select the final background wells and analytes and presents the final background data set.
- Section 3.0 presents the methods used to calculate the groundwater background concentrations (UTL) and the results of these calculations.
- Section 4.0 presents a discussion of groundwater background study results with regard to the distribution of analytes and geochemical analysis.

In addition, Appendices A and B contain box-and-whisker and probability plots and an electronic version of the background data set, respectively. Appendix C contains the additional outlier evaluation requested by DTSC (CH2M HILL, 2008b) for each constituent. The evaluation considers all the background data for each constituent, rather than each well's mean concentration for each constituent. Appendix D contains responses to agency comments on the January 14, 2008 *Revised Groundwater Background Study Step 3 and 4: Report of Results* (CH2M HILL, 2008a), and the July 23, 2008 *Groundwater Background Study Step 3 and 4: Final Report of Results* (CH2M HILL, 2008c). As requested in DTSC's October 26, 2009 letter, the cover letter for the January 14, 2008 *Revised Groundwater Background Study Steps 3* *and 4: Report of Results* was included as Appendix E in this report. DTSC's October 26, 2009 comment letter is presented as Appendix F.

2.0 Background Study Data Set

2.1 Selection and Description of Background Wells

This section of the report outlines the process used to select the final set of background wells and analytes, and includes a summary of the final data set to be used to calculate the background concentrations. During Step 1 of the groundwater background study, a total of 41 wells were identified for the first two sampling rounds. This number was reduced to 36 wells after it was determined that five wells were either inappropriate or could not be sampled (CH2M HILL, 2005a). During Step 2 of the groundwater background study, results of the 36 samples were examined, and 25 wells were selected for the final background well set. Wells were excluded from the final background data set on the basis of (1) similarity of chemistry in samples from wells near each other (CH2M HILL, 2005b; DTSC, 2005b), (2) anthropogenic effects on sample chemistry (CH2M HILL, 2005b), and (3) one well that became inoperable and subsequently was removed from service (CH2M HILL, 2006). Descriptions of the evaluations and decisions made for each step of the well selection process can be found in the above referenced documents.

At the request of the Arizona Department of Environmental Quality (ADEQ), PG&E submitted a work plan in March 2007 (CH2M HILL, 2007c) to install wells on the Arizona side of the Colorado River to (1) assess chromium concentrations on the Arizona shore of the Colorado River, (2) assess chromium concentrations in the fluvial sediments beneath the Colorado River downstream from the chromium plume observed in the California floodplain, and (3) characterize the extent of geochemical conditions that limit hexavalent chromium mobility on the Arizona shore and beneath the Colorado River. The well locations in Arizona, installed in March - April 2008, are in the general vicinity of three selected background wells, PGE-9S, Sanders, and Topock-2. Initial sampling of the Arizona monitoring wells indicates that Cr(VI) concentrations above regional background levels do not exist in these Arizona wells, and therefore the use of the three selected background wells in Arizona is acceptable (DOI, 2008a). As discussed in Section 1.1, the inclusion of these three wells in the background data set will be re-evaluated if future samples from the Arizona wells are found to contain Cr(VI) above regional background levels.

For the final list of 25 wells, four additional rounds of samples were collected, resulting in a total of six sampling rounds from May 2005 through May 2006. The final background study wells are shown in Figure 2-1. Well construction and other information are provided in Table 2-1 (all tables and figures are located at the end of this report). Fourteen wells are in Arizona and 11 are in California. Collectively, the wells appear to represent the range of geologic and geochemical conditions of southern Mohave Valley groundwater. The New Farm Well, USFW-5, BOR-2, Sanders, and PGE-9S wells are screened in fluvial material derived from the Colorado River. It is not clear in what geologic material each of the three City of Needles wells (Needles MW-10, -11, and -12) is screened, as there are no well logs available. The proximity of these wells to the Colorado River suggests that they could be screened in either fluvial or alluvial material. The remaining 17 wells are screened in alluvial material derived primarily from the surrounding mountains.

The majority (19) of the wells are used as water supply wells for domestic, irrigation, or industrial purposes, and as a result, are selectively screened in low-to-medium total dissolved solids (TDS) zones of the alluvial aquifer (up to 1,600 milligrams per liter [mg/L]). Four wells in the groundwater background study, which are used as monitoring wells, are screened in naturally low-TDS zones: the shallow fluvial zone (BOR-2) and the shallow alluvium around the Topock site (MW-16, 17, and 18). Two wells screened in high-TDS groundwater zones (above 3,000 mg/L) were P-2 and PGE-9S. P-2 is a monitoring well in the high-TDS deep alluvium of the Topock site. PGE-9S was originally installed as a supply well for the compressor station, but the high TDS in this location prevented the well's use for water supply.

The Groundwater Background Study wells were sampled in May, July, November, and December 2005, and in February and May 2006. In some instances, certain wells were sampled a few weeks later than the rest because of the circumstances that prevented sampling during the planned sampling round. In the case of well Topock-2, a pump breakdown prevented a sample in the May 2006 round, and a subsequent sample collected in June 2006 showed anomalously high turbidity, likely the result of the well pump being started up after an extended idle period. The high turbidity in the sample is very likely the source of anomalously high concentrations of several analytes that did not correlate with duplicate samples. Because the anomalous concentrations were not considered representative of natural conditions, no trace metal or general chemistry data from the June 2006 sample from well Topock-2 were used in the background study data analysis and statistical evaluation, in accordance with the Background Study Workplan.

Samples were analyzed for the suite of analytes listed in Table 2-2. During each round, all quality assurance/quality control (QA/QC) criteria outlined in the Background Study Work Plan (CH2M HILL, 2004) were followed. DTSC was provided with six data quality evaluation reports, one for each sampling event, following the completion of the sixth sampling event. The data quality evaluation reports were presented in Attachment 4 of the technical memorandum, *Preliminary Evaluation of Data for the Groundwater Background Study*, (CH2M HILL, 2006).

2.2 Data Evaluation for Final Data Set Selection

The DTSC Step 2 Conditional Approval Letter required that PG&E conduct an initial data evaluation to include the following information.

1. Descriptive statistics for the data set.
2. An outline of potentially redundant data within the data set. Wells near each other could produce redundant data that could skew the background concentration estimates as a result of counting one well's data twice.
3. Evaluation of data set for multiple populations. Data could indicate that wells located in different locations or depths could represent more than one population, which might require that more than one background concentration be calculated for each metal.

4. Analysis for outlier concentrations or wells. Anomalously high concentrations of metals in some locations could be perceived as outliers (i.e., unrepresentative of natural background conditions in the region).
5. An outline of data set distribution before and after outlier removal.

Data from the six groundwater background study sampling events were examined to address DTSC's specific requests for data analysis. Potentially redundant data are addressed by statistical comparison of the wells in question (Section 2.2.1). A combination of geochemical analysis and statistical treatment is used to assess the data for outliers and potential multiple populations. The descriptive statistics and statistical outlier analysis can be found in Section 2.2.2. Section 2.2.3 provides a geochemical analysis and interpretation of the data, including the outliers generated by the statistical analysis.

After the statistical outlier analysis and geochemical interpretation, further adjustment to the background data set was made as directed by DTSC (DTSC, 2007a). The adjustment consisted of exclusion of data for selected constituents at selected wells, as detailed in Section 2.2.4. For brevity and clarity, where applicable, tables summarizing statistical results (at the end this report) will present results after DTSC-directed data exclusion, and also footnote results before the exclusion.

Conclusions from this data evaluation are presented in Section 2.3.

2.2.1 Wells in Proximity

The DTSC Step 2 Conditional Approval Letter noted the following three well pairs that could potentially produce redundant data that could skew the results of the groundwater background study: Needles MW-11 and Needles MW-12, GSWC-3 and GSWC-4, and Topock-2 and Topock-3. As required by DTSC, Topock-3 was dropped from the study, and data from the other two pairs were examined at the conclusion of data collection to evaluate redundancy. The pump in well GSWC-3 failed during the course of the data collection period and was not repaired or replaced by the well owner; therefore, this well was eliminated from the background study because of the lack of data. The remaining pair with a complete data set is the Needles MW-11/12 pair. This section includes a brief statistical analysis of the data from the Needles MW-11/12 pair.

For each of the dissolved metals, a Wilcoxon Rank Sum comparison was performed to evaluate if the chemistries are statistically similar or different. This is a non-parametric version of a comparison between the mean concentrations from each well. The results of this evaluation are provided in Table 2-3. Data in Table 2-3 indicate that Needles MW-11 concentrations are significantly more elevated than Needles MW-12 concentrations for arsenic, boron, chromium (total and hexavalent), molybdenum, potassium, selenium, and vanadium (at the 0.05 significance level). The Needles MW-12 concentrations are significantly higher for calcium, magnesium, manganese, and nickel.

These significant differences demonstrate that the chemistries from Needles MW-11 and Needles MW-12 are distinct. Thus, their proximity does not prevent each of these wells from providing useful representation of background conditions; therefore, both were recommended to be retained. Although the depths of the screened intervals for these wells are unknown, the total depth of Needles MW-11 is 60 feet deeper (280 feet deep) than

Needles MW-12 (220 feet deep). Wells screened at different depths can exhibit distinct water chemistry even though the wells have been installed near each another.

2.2.2 Statistical Outlier Analysis

The background data set was analyzed to identify outliers in the data set. The following sections describe the methods and results of this analysis.

Statistical Analysis. Groundwater samples were analyzed from six sampling events from May 2005 through June 2006. The total number of sample results per analyte is 150 (25 wells times six events).

Because elevated concentrations of metals in one or a few wells could have a significant influence on the magnitude of a background concentration, a statistical review of the elevated concentrations was performed. This review included both an outlier analysis (to determine whether any concentrations appear significantly different from the rest of the data set) using Rosner's or Dixon's test, and a mean rank evaluation to determine whether the most elevated concentrations appear clustered at any well. The latter analysis was performed by evaluating the patterns of the five most elevated concentrations for each analyte.

The mean concentrations for each analyte at each well were calculated for both of these statistical analyses. Thus, for each analyte, 25 mean concentrations were used instead of the 150 individual concentrations. The mean concentration is more often used to identify wells that appear different from the others. Because the mean concentrations of a specific analyte from an individual well in this study are typically more similar to one another than concentrations among wells, an outlier analysis of individual concentrations would list multiple concentrations from the well or wells with the highest concentrations, which would cloud the main objective of identifying wells with anomalous concentrations.

Field duplicate samples were collected during each sampling round in compliance with the QA/QC program. The results from these field duplicate samples were not included in the data set used for statistical analysis. Analytes reported as non-detect were assigned a value of one half the reporting limit for the purposes of statistical analysis.

As an initial data analysis tool, box-and-whisker and probability plots are often used to identify potential outliers. As directed by DTSC in the November 30, 2007 letter (DTSC, 2007a) and in a subsequent e-mail dated December 20, 2007 (DTSC, 2007b), the box-and-whisker and probability plots are provided in Appendix A for all analytes, except iodide (not detected), cadmium (not detected), mercury (not detected), oxygen-18 ($\delta^{18}O$), and deuterium ($\delta^{2}H$).

Prior to preparing the box-and-whisker plots and the probability plots, the following specific data were excluded:

- Sixth round data from Topock-2 (Section 2.1)
- Zinc data from PGE-09S (Section 2.2.3)
- All arsenic samples from the PGE-9S, Sanders, and Topock-2 wells (DTSC direction—DTSC, 2007a)

- All fluoride samples from the Sanders well (DTSC direction—DTSC, 2007a)
- May 19, 2005, samples for Cr(VI) and Cr(T) from the GSRV-2 well (DTSC direction—DTSC, 2007a)
- July 20, 2005, sample for iron from the PGE-9S well (DTSC direction—DTSC, 2007a)
- November 2, 2005 samples for lead in the Topock-2 well (DTSC direction—DTSC, 2007a)
- November 2, 2005 sample for lead in well MW-17 (DTSC direction—DTSC, 2007a)

It is important to note that the excluded data represent the upper range values for the constituents.

Box-and-whisker plots are constructed by assigning ends of the "box" to the first and third quartiles of the data set (these are the median values of the lower and upper 50 percent of the data set, respectively). The median of the full data set is designated as a line across the box. The "whiskers" are drawn to scale to either (1) the lowest and highest data value or (2) 1.5 times the interquartile range (third quartile value minus the first quartile value), whichever is smaller. Data points lying beyond the whisker length are considered box and whisker "outliers", although these are not necessarily expected to match those outliers identified by recognized statistical outlier tests. As requested by DTSC (DTSC, 2007b), the plots were prepared for all measured concentrations as opposed to the mean concentrations for each analyte (see Appendix A).

In addition to the box and whisker plots, probability plots were also prepared to support the outlier tests discussed below. The probability plots were prepared using the actual mean concentrations for the same list of constituents as the box-and-whisker plots. These plots present the actual concentrations (or transformation of the actual concentrations) versus the expected concentrations if the true distribution of the data (or transformed data) were normal. When the data are approximately distributed normally, the resulting plot will appear as a relatively straight line. When the data are skewed such that the more elevated values have a higher concentration than would be predicted with a normal distribution, the probability plot will curve upward on the right (more elevated concentration) side.

Whether or not the data are normally distributed, viewing the data in a probability plot offers a good view of the data since each value can be seen on the plot (similar values do not overlap). While probability plots can offer visual support to a mathematical outlier test, they can also serve as a useful qualitative tool for visually assessing whether elevated concentrations are unusual relative to the other concentrations. The probability plots for analytes with fewer than 25 percent detections offer the opportunity for this visual assessment, as discussed further below.

Rosner's/Dixon's Outlier Analysis. Outlier analyses were performed on the highest five mean concentrations for each analyte using a significance level of 0.05. In accordance with the United States Environmental Protection Agency (USEPA) guidance (USEPA, 2006), Rosner's test was applied when at least 25 samples were available. When fewer than 25 samples were available, Dixon's test was applied. These outlier tests are based on an assumption that the remaining concentrations represent a normal distribution (after the potential outlier is excluded).

Because the tests of normality for the non-outlier concentrations did not typically support assumptions of normality (as measured by the Shapiro-Wilke test using a significance level of 0.05), the data were transformed as suggested by USEPA guidance (USEPA, 2006). Three different transformations were considered for each potential outlier: the square root transformation, the cubic root transformation, and the natural logarithmic transformation. The logarithmic transformation is a standard transformation in environmental applications, while the square root and cubic root offer options appropriate for intermediate levels of skewness in the data. The data set for each analyte that best adhered to normality (either the untransformed data or one of the three transformed data sets) was used in the outlier testing.

As the percentage of detections decreases, testing for normality becomes less defensible. The absence of the ability to optimize the normality of the data via transformation reduces the defensibility of the mathematical outlier tests. A second, equally important, negative aspect of mathematical outlier testing with a low percent of detects is the artificially decreased estimate of the standard deviation (due to the substitution of a single proxy value, one-half the detection limit, for non-detects). This can lead to a large percentage of values (non-detects) with near-identical values which leads to identification of most or all detections as mathematical outliers.

Based on professional judgment, mathematical outlier tests were not attempted when there were fewer than 25 percent detections. Probability plots were reviewed for these analytes and qualitatively assessed. No outliers deemed worthy of exclusion were identified by this visual assessment.

Three parameters (deuterium, oxidation-reduction potential (ORP), and $\delta^{18}O$) had some negative values which complicated the transformations. Before applying the square root, cubic root, or logarithmic transformations to the data, a number was added to all values so that all were above zero. For deuterium, ORP, and $\delta^{18}O$, these values were 106, 211, and 14.2, respectively. The evaluation for these three parameters did not indicate a mathematical outlier.

Table 2-4 provides a summary of the analyte and well, where the mean concentration qualified as a statistical outlier on the basis of this evaluation. Per DTSC’s request, details of the Rosner’s/Dixon’s outlier analysis are provided in Table 2-5. This table presents the chosen transformation that promotes the best adherence to normality with the remaining concentrations (after the potential outlier is removed). It also provides, for each result, the Rosner or Dixon calculated statistic along with the critical value to which the statistic is compared. If the statistic is greater than the critical value, that result is considered a mathematical outlier. All results greater than that result are also considered mathematical outliers, even if their statistics did not surpass the critical value. Note that two or more elevated values can sometimes mask one another from being identified as mathematical outliers.

In assessing these results, it is important to note that these tests help indicate when elevated concentrations are unlikely to belong to the same population as the lower concentrations. These tests do not prove that these elevated concentrations are unworthy members of the background data set. Geochemical analysis in Section 2.2.3 addresses this issue.

Mean Rank Evaluation. A second method of evaluating potential outliers was to determine whether there were unusual patterns of the highest concentrations at any given well for multiple analytes. The five most elevated mean concentrations (Top 5) for each analyte were determined. The proportion of Top 5 occurrences were then calculated for each well. If a random distribution of data is assumed, then for each metal, there would be a 26.3 percent expectation (25 wells divided by the product of 19 trace metals times five elevated concentrations) that a given well would produce a Top 5 concentration. Wells were evaluated for their deviation from this statistical expectation.

The mean concentrations for each analyte and well for each trace metal and general chemistry parameters are listed at the end of this report. A matrix providing the mean ranks of the metal concentrations is provided in Table 2-6. A similar matrix for general chemistry analytes is provided in Table 2-7. The concentrations that ranked 1 through 5 for each trace metal in Table 2-8 were then used to determine the actual proportion of Top 5 concentration values for each well.

Because mean ranks were employed, a few analytes with equal concentrations (tied concentrations) did not have discrete concentrations for ranks 1, 2, 3, 4, and 5. This absence of discrete concentrations usually occurs when all the individual results are proxy values for nondetects (one-half the detection limit). For instance, dissolved cobalt has a 1- and a 2-ranked mean concentration, but the rest of the concentrations are ranked 14, the mean rank of the remaining tied concentrations (calculated from all nondetects). The absence of some ranks 1 through 5, when many concentrations are tied, is consistent with the intent of this evaluation. The Top 5-ranked mean concentrations represent potential indications of individual wells with multiple analytes bearing the most elevated concentrations. When five distinct Top 5 mean concentrations for a given analyte are not available, five individual wells would not be identified as having one of the five highest mean concentrations.

A summary of the analysis of the results in the trace metal mean rank evaluation is provided in Table 2-8. These results show that only well MW-17 had a statistically significant number of Top 5 concentrations. This well was found to be elevated in Top 5 metals, compared with the expected result from random data, at a 0.05 significance level. Had the number of Top 5 concentrations been one fewer (i.e. seven instead of eight), MW-17 would not be identified as an outlier. These results may suggest that well MW-17 may not be associated with a common source of metals. However, the latter exclusion of the November 2, 2005 lead value from this well, as described in Section 2.2.4 below, removes this well’s outlier status.

2.2.3 Geochemical Interpretation

In addition to statistical analysis, a preliminary assessment of hydrogeochemistry was performed to address comments in DTSC’s Step 2 conditional approval letter. Criteria for analytes or wells that may be excluded from a Groundwater Background Study cannot be defined based on statistics alone. They must be shown to be anomalous to the rest of the data based on mineralogy sources within a small area or relating to human sources (e.g., local contamination or well materials influence). Concentrations at the high or low end of a range help define the natural range but do not define anomalous data. A concentration above the 95 percent confidence limit means that the sample is one in 20 samples that would be expected in that range. The analyst must determine whether the concentration represents an exceptional environment or source that does not belong to a collection of natural background data. The following paragraphs describe how the data were evaluated to determine whether the results identified as outlier concentrations represent an exceptional environment or source.

2.2.3.1 General Geochemistry

Figure 2-3 is a Piper diagram of the mean concentration of major ion water chemistry for wells in the groundwater background study. In Figure 2-3, the wells are color-coded by geographic area. Although there is a wide range of chemistry in the region, there is at least some overlap between geographic groups. The variation forms a continuous region of the diamond plot area rather than isolated groupings.

Source minerals and rocks for the groundwater of the study region are a mixture of the following materials.

- Fluvial material of variable composition that has been transported great distances
- Alluvial material from the Chemehuevi and Sacramento Mountains generally having a dioritic composition (between granitic and mafic)
- Alluvial material derived from the Black Mountains to the east, which contain a mixture of volcanic rocks ranging from rhyolite to basalt (i.e., granitic to mafic)

The source rocks to the east are likely to be more mafic than those to the west, although the compositions do significantly overlap. Even within a given source material, mineralogy could be highly variable.

A Piper diagram of mean general chemistry concentrations grouped by geologic material is shown in Figure 2-4. The wells screened in fluvial material form a group in the upper area of the diamond-shaped Piper field. Because there are no logs available for the Needles MW-10, -11, and -12 wells, their geologic material is uncertain, but they are assumed to be fluvial wells on the basis of their isotopic signatures discussed as follows. Fluvial wells screened in deeper zones in the southern groundwater discharge area (PGE-9S and Sanders Well) are chemically more similar to those of the alluvial wells. Among the alluvial wells, most of those located in Arizona plot further to the left (more bicarbonate fraction) compared to the California alluvial samples (more chloride fraction), although three Arizona wells have similar chemistry to the California samples (ADOT New Well, EPNG-2, and Topock-2).

The stable isotopes, $\delta^{18}O$ and $\delta^{2}H$ for groundwater samples are plotted for the various geographic areas in Figure 2-5 and for the three geologic groups in Figure 2-6. As stated previously, the Needles MW-10, -11, and -12 wells are assumed to be fluvial wells based on their isotopic signatures. These and other fluvial wells screened in shallow zones are grouped with a lighter isotopic signature to the lower left side of Figure 2-6. This signature is typical of river water values for the area, and average river samples in the Topock site area are included in the figure for comparison. Fluvial wells screened in deeper zones in the southern groundwater discharge area (PGE-9S and Sanders Well) are isotopically heavier and chemically different, showing chemical signatures closer to those of the alluvial wells. These qualities indicate that groundwater from these wells is not influenced by the river as is evident in the other fluvial wells. Alluvial wells from the California and Arizona sides of the river show overlapping isotopic signatures, which suggest that although the source rocks are different on opposite sides of the valley, the isotopic signature of the groundwater is not affected. This overlap is further supported by the many non-plume wells (not shown in Figure 2-6 and not included in the background study) screened in the California alluvium that plot within the range of Arizona alluvial wells (for $\delta^{18}O$, -10.4 to -9.4 parts per thousand difference from the isotopic standard). Examples of the non-plume wells that fall in this range are CW-4M, OW-2S, OW-3M, MW-46-205, MW-33-150, MW-35-60, MW-40S, and MW-41D. These wells are scattered across the Topock site and are screened at various depths and therefore are not considered to be associated with a localized recharge source.

Although the California and Arizona wells appear similar based on stable isotopes, other parameters indicate local differences. For example, in the area surrounding wells Topock-2, Sanders Well, and PGE-9S, there could be some influence of hydrothermal activity, evidenced by elevated temperatures recorded in some samples from Topock-2. The somewhat higher concentrations of arsenic in this area appear to support the possible influence of hydrothermal activity (Figure 2-7).

2.2.3.2 Multiple Population Analysis

Available data indicate that there is a range of geochemical characteristics in the southern Mohave Valley. This observation is common in regional studies as there are variations in source rocks, local mineralogy, redox environments, biological activity, and other factors that can influence groundwater chemistry. Depending on the interpretation criteria used, the background study data may be viewed as belonging to a single population or may be split into separate populations on the basis of multiple factors. This section describes some potential multiple population scenarios that have been suggested by stakeholders in recent meetings and by DTSC in the November 30, 2007 comment letter (DTSC, 2007a).

General chemistry and isotopic analysis indicate that many of the fluvial samples have different chemical characteristics compared to alluvial samples. This is due to the influence of the Colorado River for the shallow fluvial groundwater. Alluvial groundwater at the site is fed primarily by local recharge. The alluvial water becomes mixed in varying proportions at varying distances from the river. In the shallow fluvial zone close to the river, the groundwater geochemistry is dominated by river water. Groundwater in the fluvial system near the river therefore has different chemical characteristics from the upgradient alluvial groundwater. This variation may be interpreted as a single aquifer with chemical evolution and mixing along the flowpath from upland alluvium to the fluvial system near the river. Alternatively, one may view the end members of this flow path as two separate populations of groundwater (DTSC, 2007a; DOI, 2007). The river-influenced fluvial groundwater is characterized by a mixed-ion general chemistry with relatively light isotopic signature. The upgradient alluvial groundwater is dominated by sodium and chloride, with heavier isotope values. However, there are a number of wells in the floodplain area where mixing occurs and the waters share characteristics from both fluvial and alluvial waters. The fluvial wells PGE-9S and Sanders are not influenced by the river due to their deeper screen depths, and these exceptions are supported by their chemistries being more similar to alluvial groundwater.

Redox conditions are also different between the two groups, with some exceptions. The Colorado River and associated wetlands contribute organic carbon to the sediment. Microorganisms use this carbon as a food source, and their metabolic activity creates localized reducing conditions. In fluvial material—that is geologically young enough to still contain carbon—reducing conditions influence the groundwater chemistry by reducing Cr(VI) to trivalent chromium and removing it from solution. In deep fluvial zones, the material is older, and in some areas, all the carbon appears to have been depleted. With no carbon source, microbial communities cannot proliferate, and some of these deep zones have returned to more oxidizing conditions. Alluvial materials in the study area are generally carbon-poor; therefore, wells screened in these materials mostly exhibit oxidizing conditions. The exception is in a few deep alluvial wells where old saline water is poorly circulated. The redox influence on water chemistry is shown on maps of dissolved iron concentration (Figure 2-8) and field-measured ORP (Figure 2-9). Elevated levels of iron are associated with strongly negative (i.e., reducing) ORP values, which is consistent with the geochemistry of iron. Where conditions are oxidizing, iron readily precipitates out of solution as an oxide.

Fluvial groundwater that shows river influence is characterized by the following.

- Light isotopic signature (δ^{18}O below -11.5 parts per thousand difference from the isotope standard (‰), δ^{2}H below -95‰)
- Relatively reducing conditions (absence of nitrate, presence of ammonia, dissolved manganese, and dissolved iron)
- Significantly greater concentrations (defined as greater than one standard deviation from the other group) of iron, manganese, ammonia, organic carbon, and alkalinity compared to alluvial wells

By contrast, the chemical characteristics of alluvial wells are as follows.

- Heavier isotopic signature (δ^{18}O above -11.0‰, δ^{2}H above -75‰)
- Oxidizing conditions (presence of nitrate, general absence of ammonia, manganese, iron)
- Significantly greater concentrations (defined as greater than one standard deviation from the other group) of chromium (Cr(VI) and Cr(T), and vanadium, along with higher temperature

The alluvial and fluvial groups may be described as representing two distinct populations, based on the bulleted differences listed above. The mean values of all remaining analytes in the two groups were within one standard deviation of each other.

Of the trace metals for which background concentrations will be calculated, only two were significantly different between the two groups: chromium and vanadium. These differences are driven more by the redox conditions than by alluvial vs. fluvial aquifer matrix. Chromium and vanadium are more prevalent in the oxidizing alluvial groundwater. Both metals exhibit low solubility in their reduced states, forming oxide or hydroxide minerals. The sixteen other trace metals do not have this redox sensitivity of solubility, therefore their concentrations are not significantly different between the two groups.

Another potentially distinct population may be interpreted as a geothermally influenced area immediately across the Colorado River from the Topock site. As discussed previously, the three wells in this area, PGE-9S, Sanders, and Topock-2, contain relatively elevated arsenic and some temperatures measured in Topock-2 have been above 35°C. About a half mile east of Topock-2, a non-Background Study well, MTS-2, has been documented as having water temperatures above 40°C (ADEQ, 2006).

In addition to geographic/geologic criteria, separate populations may be defined on the basis of depth because the Topock alluvial aquifer is stratified. The highest mean concentrations of Cr(VI) and Cr(T) in the groundwater background study are found at the MW-18 well. This well is screened at or near the water table as some of the other shallow, (non-background study) monitoring wells in the general vicinity such as OW-2S and OW-5S that have similar concentrations. Deeper wells in the area have much lower concentrations, suggesting the naturally elevated Cr(VI) concentrations are confined to shallow depth. A combination of hydraulic and geochemical data supports the designation of MW-18 as a background well. Note that MW-18 is one of 25 background wells approved (DTSC, 2005b), after completion of Step 2 of the background study, to be carried forward into the final steps of the study. Besides other wells with similar concentrations in the area mentioned above, more recent stable chromium isotope data show that isotope values for this well are consistent with other alluvial background wells (CH2M HILL, 2008e). Stable isotopes of oxygen and hydrogen in MW-18 samples are also consistent with other alluvial wells in the background study, as presented below, and with non-plume alluvial wells onsite (CH2M HILL, 2008d). Hydraulic head data from the Topock site monitoring well network describe groundwater gradients that place MW-18 upgradient from the nearest chromium plume edge and simulated plume flowpaths in the groundwater model run about 1,500 feet to the east of MW-18 (CH2M HILL, 2008d). It is this propensity of evidence that solidifies the designation of this well as representing natural concentrations of Cr(VI) in groundwater.

Other population distinctions may be made on the basis of total dissolved solids (TDS) or conservative ions such as sodium and chloride, which are directly related to TDS in the area. Wells PGE-9S and P-2 have significantly greater TDS concentrations than the remainder of the background study wells. However, this more likely reflects a bias of well construction rather than a distinct geochemical population. The remaining wells are used as water supply wells, and as such were deliberately constructed in zones of low TDS groundwater. Well P-2 was constructed as a monitoring well, and PGE-9S was a potential water supply well that was never used due to its high TDS. It is common to observe elevated TDS (>2,000 mg/L) in non-plume monitoring wells around the Topock site, and high TDS zones would be expected in offsite areas of similar hydrogeologic nature.

Having stated the above, the background concentrations were calculated from the pooled data set rather than calculated separately for each population. One of the defining goals of the DTSC-approved background study protocol was to consider a wide range of geologic and geochemical regimes in developing a background number that would truly be representative of the area as the whole. The development of multiple background concentrations would be subject to significant scientific uncertainty in categorizing well populations (and accommodating ranges of and changes to well chemistry), is not practical from a regulatory standpoint, and would hinder the progress towards selection and implementation of a final groundwater remedy at the site. Moreover, the data set collected for this study based on the approved work plan is aimed at identifying one background number for the entire study area, and additional data collection may well be necessary if background concentrations were to be calculated for two or more populations.

2.2.3.3 Outlier Interpretation

Although the statistical analysis identified some wells (e.g., PGE-9S, MW-17, Needles MW-12, and Sanders) with somewhat higher concentrations of some analytes, they were not considered to represent unique geochemical environments, anthropogenic sources, or QA/QC issues with sampling/analysis. These wells are scattered geographically and are in geologically variable materials that would be expected to produce variation in groundwater chemistry. In general, the aquifer beneath the Topock site contains the same variable material exhibited in the background study region. Discussion of specific examples and some exceptions follows.

The statistical analysis showed elevated concentrations of several general chemistry parameters (major ions and TDS) in PGE-9S compared with the other wells. However, monitoring wells on the Topock site (i.e., the California side of the river) show high TDS in deeper zones of the fluvial material, particularly in wells inside and outside the area of the Cr(VI) plume associated with the compressor station. For example, the deeper wells in well clusters MW-43, MW-52, and MW-53 have TDS values between 9,000 and 16,000 mg/L, which is higher than that of PGE-9S. These wells are outside of the plume and do not display isotopic characteristics of the plume. In addition, non-plume site monitoring wells screened in deep alluvial zones also consistently display elevated TDS that is naturally derived. Based on this evidence, deep zones of the alluvial aquifer contain high TDS, resulting in elevated levels of sodium, potassium, chloride, as well as many trace elements relative to the lower TDS wells in the region. Because the majority of background study wells are water supply wells, which have been deliberately screened in zones of low TDS, concentrations from wells PGE-9S and P-2 are at the high end of the range for this study. This does not indicate anomalous geologic environment, but that high TDS water is in the deep alluvial and fluvial aquifer zones.

An exception to this interpretation of elevated concentrations at PGE-9S is the case of zinc. The average concentration of this metal was 656 µg/L, which is eight times the next-highest average in the groundwater background study. Concentrations of zinc in regional wells, as well as in Topock site monitoring wells, are typically below 100 µg/L. Although concentrations above 100 µg/L are not rare, no well has consistently shown zinc levels this high, and the concentrations reported from PGE-9S are the highest recorded in the groundwater background study. It is unlikely that the zinc concentrations in PGE-9S represent natural occurrence. This well has been idle with an installed pump for the last 9 years. It is likely that the standpipe, pump column, and the pump itself have some galvanized (i.e., zinc-coated) parts, and although zinc is rust-resistant, the high TDS water in this well could still corrode the galvanic layer, resulting in zinc in solution or attached to colloids. This well also produced highly turbid samples. Some of the suspended colloids probably passed through when the samples were filtered. Based on these data, it is recommended that the zinc concentrations for PGE-9S be excluded from the background calculations.

2.2.4 Summary of Excluded Background Data

In addition to the exclusion of the sixth round of data from Topock-2 (Section 2.1) and the zinc data from PGE-09S (Section 2.2.3), additional adjustment was made to the background data set as directed by DTSC in the November 30, 2007 letter (DTSC, 2007a). Using box-and-whisker and probability plots, DTSC has identified additional outliers and directed the exclusion of the following data from the background data set:

- All arsenic samples from the PGE-9S, Sanders, and Topock-2 wells
- All fluoride samples from the Sanders well
- May 19, 2005, samples for Cr(VI) and Cr(T) from the GSRV-2 well
- July 20, 2005, sample for iron from the PGE-9S well
- November 2, 2005 samples for lead in the Topock-2 well
- November 2, 2005 sample for lead in well MW-17

All of these samples were therefore excluded from subsequent calculations or interpretation. It is important to note that the excluded data represent the upper range values for the constituents.

2.3 Final Background Study Data Set

Following removal of the excluded background data as described in Section 2.2.4, mean concentrations for trace metals and general chemistry parameters were recalculated and are presented in Table 2-9 and Table 2-10, respectively. As requested by DTSC, median concentrations are also provided in Tables 2-11 and 2-12. The resulting background data set was used to calculate summary statistics and UTL values for Cr(VI) and each of the 18 trace metals identified in Table 2-13 (19 metals in total). This data set is comprised of the six rounds of analytical data from the wells listed in Table 2-1, with the exception of the exclusions described in Section 2.2.4.

Summary statistics for each trace metal are listed in Table 2-13. These summary statistics include the mean, median, standard deviation, maximum detect, number of detects, number of samples, and percent detects. They also include the p-values for normality and lognormality (calculated with the Shapiro-Wilke test).

3.0 Background Concentrations

Background concentration estimates were calculated from the data set using the following statistical methods. Measured concentrations at individual wells are compared to background concentrations to gauge the likelihood that these individual concentrations could be considered within the concentration range of background. When measured concentrations are below background, they are assumed to be consistent with background concentrations. Any exceedance of the background concentrations can indicate either (1) the site concentration is more elevated than the range of concentrations expected from the overall background population, or (2) the site concentration is on par with elevated background concentrations, which would be expected in a small percentage of samples. Non-statistical interpretation, including geochemical and hydrogeologic considerations, would be employed to decide which of these two potential conclusions is correct.

A statistical value often used to estimate background concentration is the UTL, which represents an upper confidence bound on an upper percentile. Typically, a UTL is calculated as a 95 percent upper confidence bound on the 95th percentile (thus having 95 percent coverage), often called a 95/95 UTL. While no value can ensure a background threshold with 100 percent confidence, the 95/95 UTL does seek, with 95 percent confidence, to offer a value that at least 95 percent of background concentrations would fall below. This translates to one in 20 samples being expected to exceed the UTL. The lower the confidence level or percentile coverage, the lower the UTL value.

One could attempt to offer more protection against false positives (true background concentrations exceeding the UTL) by using a higher confidence level or estimating a more elevated percentile. The 95/95 UTL was chosen for this project due to its frequent use in environmental background studies (CH2M HILL, 2004).

Another statistical value used in some studies to estimate background concentration is the upper prediction limit (UPL, Gibbons, 1994). Typically, a UPL is calculated with 95% confidence that the next concentration (equivalent to the background population) compared to it would be less. Prediction limits in statistics are calculated with some specific number of future comparisons in mind (e.g., 1, 5, 20, and so forth) and increase as the number of future comparisons increases. The UPL used in environmental studies is typically calculated for the next concentration. As the number of site concentrations compared to this type of UPL grows, the number of false positives increases. Thus, the UPL tends to be a conservative threshold limit for most studies.

As mentioned previously, an exceedance of a UTL may simply indicate concentration consistent to the background population, but so elevated that such a value could only rarely be seen in the background sample concentrations. This issue is even more pronounced with a UPL when it is calculated based on the next concentration. On the other hand, it is difficult to know how many site concentrations will eventually be compared to the background concentration, so the calculation of an alternate UPL is problematic. For this reason, and due to its long history of use to estimate background concentration, the UTL (specifically, the

95/95 UTL) was recommended as the background concentration for this project (CH2M HILL, 2004).

The following procedure was used to calculate the UTLs using the final Groundwater Background Study data set.

1. Calculate mean concentrations for each well location, using the six rounds of samples, after removal of anomalous data (e.g., zinc in PGE-9S, sixth round of data from Topock-2, and others identified in Section 2.2.4).
2. Conduct a Shapiro-Wilke test for normality or lognormality for each analyte. Normal or lognormal UTLs will be used when the respective Shapiro-Wilke p-value is greater than 0.05. When both of the p-values for normality or lognormality are less than 0.05, a non-parametric UTL will be used.
3. Calculate UTL using the appropriate method for each analyte as described in Section 3.1.

3.1 Method for Calculation of Background Concentrations (UTLs)

UTLs have long been discussed as background concentrations for groundwater in USEPA guidance (USEPA, 2006). The theory and application of these tolerance intervals have been covered in other statistical resources (Hahn and Meeker, 1991; Mason et al., 1993). When calculating a UTL, the confidence of the interval and the elevated percentile to be estimated must be chosen. When using parametric (e.g., normal or lognormal) approaches, the background statistic has been calculated as a 95 percent/95 percent background UTL; that is, an upper-bound (with 95 percent confidence) of the 95th percentile of the distribution of each analyte in the data set. The calculation of the UTLs depends on the distributional assumption. When the Shapiro-Wilke p-value for normality is greater than 0.05, the normal UTL is calculated using the following equation.

$$UTL = \bar{x} + \left(K \times s\right) \tag{1}$$

Where:

$\bar{x}$ is the sample mean.
K is the tolerance factor.
s is the sample standard deviation.

For data sets that appear to be lognormally distributed, based on a Shapiro-Wilke p-value greater than 0.05, a lognormal UTL is calculated using the following equation.

$$UTL = e^{\bar{y}+\left(K \times s_x\right)} \tag{2}$$

Where:

$\bar{y}$ is the sample mean of the log-transformed sample data.
K is the tolerance factor.
s_x is the sample standard deviation of the log-transformed sample data.

For data sets that do not appear to be normally or lognormally distributed, non-parametric UTLs are calculated. A non-parametric UTL is computed by first ranking the concentrations and then choosing the lowest-ranked detected concentration that defines the 95th percentile with 95 percent confidence. For data sets with less than 59 concentrations, definition of the 95 percentile is not statistically possible with 95 percent confidence, even when the maximum concentration is assigned as the UTL. In this groundwater background study, the estimated percentile (95th or lower) associated with the highest concentration will be reported. This percentile is calculated using the following equation:

$$p = B_{0.95,n,1} \tag{3}$$

Where :

> B is a beta distribution defined by n (the number of sample results) and 1 (because the highest ranked concentration is being used).

3.2 Calculated Background Concentrations

Background concentrations for the southern Mohave Valley region were calculated using the approach described in Section 3.1 and as described in the technical memorandum, *Preliminary Evaluation of Data for the Groundwater Background Study (*CH2M HILL, 2006). Concentration means were calculated for each well location after exclusion of background data as identified in Section 2.2.4.

These background concentrations, calculated for each analyte as a UTL, or an upper-bound (with 95 percent confidence) of an elevated percentile of the background data, are listed in Table 3-1. As mentioned previously, when a parametric UTL was calculated (i.e., normal or lognormal UTL), the elevated percentile was the 95th. When a non-parametric UTL was calculated, the elevated percentile was based on the number of values available for the calculation. When 25 values were available, the non-parametric UTL is a 95 percent upper confidence bound of the 89th percentile. For zinc, where 24 values were available, the non-parametric UTL is a 95 percent upper confidence bound of the 88th percentile. Thus, there is a slightly higher opportunity for declaring a result to be in exceedance of background when a non-parametric UTL is calculated.

The probabilities of normality and lognormality for the data (using the Shapiro-Wilke test) are listed in Table 2-13. Table 2-13 also lists the mean, median, standard deviation, number of samples, and percent detects for each analyte.

Each calculated UTL should be considered a tentative background concentration, which means if concentrations above this value are found in the future, a closer examination of local geochemical environment should be performed to help determine whether the sample is natural or anthropogenic in nature. The underlying assumption of a 95/95 UTL statistic is that no more than one in twenty natural background samples falls above the UTL value, so that exceedances are not automatically assumed to be derived from anthropogenic sources. It is not anticipated that natural groundwater concentration ranges will change in the future. Therefore, no future alterations of the UTLs calculated by the methods presented in this report are anticipated.

4.0 Review of Background Concentrations

4.1 Sample Independence and Time Trends

The 25 wells sampled in the groundwater background study were selected to represent the range of geologic and geochemical conditions in groundwater of the southern Mohave Valley. As discussed in detail in Section 2.2.3.2, for the 19 trace metals studied, some of the data collected from these wells may be interpreted as representing distinct geochemical subareas. Despite this, it was concluded that each well location represents an independent, representative observation point for groundwater in the region.

According to the Background Study Work Plan (CH2M HILL, 2004), data for each of the 19 metals at each of the 25 wells was tested for time dependency using the Mann-Kendall test. This is a non-parametric method, so there are no distributional assumptions. Missing data values (non-detects) are easily handled, and irregularly spaced sampling intervals are permitted. This technique can be viewed as a non-parametric test for a zero slope in the linear regression of time-ordered data versus time.

The Mann-Kendall trend test was applied to the six concentrations from each well to help determine significant time trends occurred over the six events. Since the significance level used with this test was 0.05 (a typical level), one would expect completely random data to produce conclusions of significant increases or decreases in 5 percent of the cases. The percentage of significantly increasing cases with the actual background data appeared to be similar to what one would expect from random data. If the calculations are performed correctly, one anticipates identifying some significant increases, even from perfectly random data, (in about 0.05 or 5 percent of the total evaluations).

A total of 471 cases were tested using a 95 percent confidence level to test for significance of time trend during the course of the groundwater background study. The results are summarized in Table 4-1. Only 5 percent of the cases (21 out of 471 samples, see totals in Table 4-1) showed significant trends (either increasing or decreasing), which was expected given the 95 percent confidence level.

In the case of Cr(VI), MW-18 was the only well that showed a significant increase with time. However, this well has been sampled numerous times before the groundwater background study and the earlier data were used to check the trend. Figure 4-1 shows all existing data for Cr(VI) in MW-18, and the apparent increase during the groundwater background study is shown to be within the range of previous measurements. The natural fluctuation of Cr(VI) concentrations in this well appears to have been in an upward trend during the groundwater background study but is not likely a long-term trend. This well will continue to be monitored as part of the groundwater monitoring program for the Topock site. As discussed in detail in Section 2.2.3.2, a combination of hydraulic and geochemical data supports the designation of MW-18 as a background well.

In the case of arsenic, the only well showing a significantly increasing trend is USFW-5. Concentrations of arsenic observed in this well range from 3.4 to 4.2 µg/L, just above the reporting limit of 1 µg/L. Although the increasing trend was statistically significant, the total net increase of 0.8 µg/L (4.2 minus 3.4) is well within expected laboratory analytical precision.

Based on geochemical analysis and statistical time trend analysis, the current data are considered representative of the region and independent in space and time at a 95 percent confidence level. However, based on DTSC's comment in the November 30, 2007 letter (DTSC, 2007a), monitoring wells MW-16 and MW-17 are proposed to be sampled for trace metals on a semiannual basis to monitor for any trends in natural trace metal concentrations.

In addition, DTSC suggested that MW-15 be considered for monitoring (DTSC, 2007a). This well is not recommended for monitoring for the purpose of this study because it was previously excluded in the DTSC-approved work plan (CH2M HILL, 2004) due to its location down gradient of the old evaporation ponds area.

Based on geochemical analysis and statistical time trend analysis, collection of any additional data for the groundwater background study is not merited. The current data are representative of the region and independent in space and time at a 95 percent confidence level.

4.2 Comparison with Published Data

Recent studies of trace metal groundwater chemistry in this region are available in the technical literature. Two published studies are considered representative of this geographic/geologic terrain. One is ADEQ's groundwater quality study of the Sacramento Valley (ADEQ, 2001), which is the groundwater basin immediately to the east of Mohave Valley. The second is a broad study of southwestern U.S. groundwater basins by the United States Geological Survey, named the Southwest Alluvial Basins, Regional Aquifer-System Analysis (RASA) study (Robertson, 1991). This study incorporates 72 basins in central and southern Arizona, southeastern California and Nevada, and western New Mexico. The basins share common geologic and hydrologic characteristics and Mohave Valley is included. These two studies provide a broad comparison of regional trace element data with data collected during the Groundwater Background Study.

In addition, there are two other published studies in this region that focused solely on Cr(VI) concentrations. One is a survey of naturally occurring Cr(VI) in the western Mojave Desert, California, encompassing wells between 80 and 200 miles west/southwest of the Topock site (Ball and Izbicki, 2004). The other is an early survey of elevated naturally occurring Cr(VI) in Paradise Valley, north of Phoenix, Arizona (Robertson, 1975).

Table 4-2 compares mean and UTL values from the groundwater background study with concentrations published in the two previous trace metal in groundwater studies (ADEQ, 2001; Robertson, 1991). With the exception of aluminum, the mean values for the groundwater background study are within one standard deviation of the means for the RASA study. The mean aluminum concentrations calculated for the groundwater background study used 25 µg/L for non-detected results because the method reporting limit

(MRL) was 50 µg/L. The RASA study used a much lower MRL to report a mean of 9.8 µg/L. Therefore, it was assumed that the larger mean value for the groundwater background study is an artifact of a higher MRL. The highest aluminum concentration observed in the groundwater background study (164 µg/L in a sample from Needles MW-11) is within the reported range for aluminum in the RASA study. Fewer metals were reported in ADEQ's study, and only mean values are available, but the groundwater background study concentrations are generally consistent with those of Sacramento Valley. Total dissolved chromium concentrations are markedly lower in the groundwater background study, with the calculated UTL lower than the published mean concentration for Sacramento Valley. This may be due to the fact that Sacramento Valley is surrounded by more mafic rock formations that contribute to the groundwater chemistry. The term mafic refers to rocks richer in pyroxene and/or olivine minerals, which tend to contain higher chromium impurity than most common rock-forming minerals. The alluvial materials in the Topock area are derived from metadiorite, which is considered intermediate on the mafic scale. However, Robertson (1975) concluded that localized geochemical conditions are more responsible for determining Cr(VI) concentrations in groundwater than the chromium content of the source rocks.

The Mojave Desert, California, study (Ball and Izbicki, 2004) included groundwater samples from a range of source rocks, from granitic (low end of the mafic scale) to the mafic Pelona Schist. Hexavalent chromium concentrations ranged from less than 0.1 µg/L to 60 µg/L, with the higher concentrations in the more mafic areas, as expected. Concentrations in granitic rocks, less mafic than the metadiorites near the Topock site, ranged up to 36 µg/L. The Paradise Valley study (Robertson, 1975) was focused on a relatively rare case of very high natural Cr(VI) concentrations (up to 220 µg/L).

The mean metal concentrations and calculated UTLs in the groundwater background study appear to be consistent with published concentrations in groundwater within the same hydrogeologic province.

5.0 Conclusions

This groundwater background study was completed to assess the range of naturally occurring background concentrations of Cr(VI), Cr(T), and 17 other trace metals in groundwater near the PG&E Topock site and surrounding region. Six rounds of groundwater samples were collected from 25 wells near the PG&E Topock site over a 1-year period. Before calculating background concentrations, the final groundwater background study data set was selected after using statistics and geochemistry to evaluate the analytical data for redundant data caused by wells being near each other, possible multiple populations, and outliers. The data set used to calculate the background concentrations was developed from six rounds of sampling from the 25 wells listed in Table 2-1, with the exception of the excluded data identified in Section 2.2.4.

The groundwater background concentrations were estimated using the method described in the technical memorandum, *Preliminary Evaluation of Data for the Groundwater Background Study* (CH2M HILL, 2006), which is consistent with the approach outlined in the Background Study Work Plan (CH2M HILL, 2004). This method involved calculating the UTL for each of the 19 metals after calculating the mean concentration for each well location. The UTL was calculated using either a normal, lognormal, or non-parametric distribution after conducting a Shapiro-Wilke p-value test. The calculated UTLs are listed in Table 3-1.

Based on statistical and geochemical review of the estimated background concentrations for sample independence and possible time trends, and comparison with published background concentrations for the same hydrogeologic province, the calculated UTLs (background concentrations) for the 19 metals can be used to support the RFI/RI and risk assessment activities as well as assist the CMS/FS activities during the development of remedial action/corrective action goals.

In response to DTSC’s comments in the November 30, 2007 letter (DTSC, 2007a), monitoring wells MW-16 and MW-17 are proposed to be monitored for trace metals semiannually to monitor for any trends in natural trace metal concentrations.

The calculated UTLs are deemed tentative background concentrations, which means that if concentrations above this value are found in the future, a closer examination of the local geochemical environment would be necessary to determine whether the sample is natural or anthropogenic in nature. During preparation of the RFI/RI, risk assessment, and CMS/FS, the use of the background groundwater concentrations determined through calculation of UTLs for the study area as a whole will be evaluated, noting that the calculated UTLs may not be appropriate for all constituents in all portions of the site or at all depths. The limitations and caveats for use of the calculated UTLs for specific constituents, wells, or areas will be assessed and acknowledged, as appropriate for each application.

6.0 References

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Tables

TABLE 2-1

Well and Geology Information

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results
PG&E Compressor Station and Vicinity, Needles, California

Common Well ID or Mapped ID	Location Description	State	Current Well Owner	Well Use / Remarks	Date Installed	Boring Depth (ft)	Well Depth (ft)	Well Screen Length (ft)	Well Screen Interval (ft)	Depth to Water (ft)[1]	Well Diameter (in)	Depth to Bedrock (ft)	Driller's Log or Geologic Log Available	Well Construction Log Available	Hydrogeologic Unit Monitored
ADOT New Well	Needle Mountain, AZ	AZ	Arizona Department of Transportation	Industrial/ Municipal Supply	11/18/1999	530	530	200	330-530	220	8	NE	Driller's Log	Yes	Alluvial Well
Sanders	I-40 at the CA/AZ border	AZ	Brown Investments	Domestic	1/1/1984		230	Unk.	Unk.	12	3	NE	No	No	Fluvial Well
Topock-2	East of Golden Shores Marina	AZ	City of Needles	Industrial/ Municipal Supply	9/1/1980	150	150	40	100-140	53	12	Unk.	No	No	Alluvial Well
EPNG-2	EPNG	AZ	El Paso Natural Gas	Industrial/ Municipal Supply	10/7/1990	500	500	160	322-482	240	10.75/ 8	Unk.	Driller's Log	Yes	Alluvial Well
GSWC-1	Golden Shores	AZ	Golden Shores Water Company	Industrial/ Municipal Supply	1/16/1962	250	250	Unk.	Unk.	140	8	Unk.	No	No	Alluvial Well
GSWC-2	Golden Shores	AZ	Golden Shores Water Company	Industrial/ Municipal Supply	2/26/1965	500	500	unk.	unk.	270	12	Unk.	No	No	Alluvial Well
GSWC-4	Golden Shores	AZ	Golden Shores Water Company	Industrial/ Municipal Supply	10/26/1999	610	610	170	352-522	258	12	NE	Driller's Log	Yes	Alluvial Well
PGE-9S	I-40 at the CA/AZ border	AZ	Pacific Gas and Electric	Industrial/ Municipal Supply	4/22/1997	100	100	70	30-100	5.72	12	104	Both Logs	Yes	Fluvial Well
Langmaack	Golden Shores	AZ	Richard and Maria Langmaack	Domestic	1/1/1979	240	240	Unk.	Unk.	190	6	Unk.	No	No	Alluvial Well
GSRV-2	Catfish Paradise	AZ	RPGS LLC	Domestic	2/9/2000	245	245	40	205-245	60	8	NE	Driller's Log	Yes	Alluvial Well
TMLP-2	East of EPNG	AZ	Topock Mesa Limited Partnership	Monitoring/ Piezometer	3/4/1996	880	880	80	750-880	Artesian	2	159	Driller's Log	No	Alluvial Well
BOR-2	Havasu Nat Wild Ref	AZ	U.S. Bureau of Reclamation	Monitoring/ Piezometer	12/6/1989	35	30.48	5	30-35	16.18	2	NE	Driller's Log	Yes	Fluvial Well
New Farm Well	Havasu Nat Wild Ref	AZ	Havasu Nat Wild Ref	Irrigation	4/3/1995	116	116	60	56-116	9	16	NE	Driller's Log	Yes	Fluvial Well
USFW-5	Havasu Nat Wild Ref	AZ	U.S. Fish and Wildlife	Domestic	11/15/2002	75	75	5	70-75	21	5	NE	Driller's Log	Yes	Fluvial Well
CA Agriculture Station	Agriculture Check Station	CA	California Department of Food and Agriculture Plant Inspection, Pest Exclusion Branch - Needles Inspection Station	Domestic	7/1/1965	Unk.	202	Unk.	Unk.	150	6	Unk.	No	No	Alluvial Well
Needles MW-10	Bush and "K" St. Needles	CA	City of Needles	Industrial/ Municipal Supply	Unk.	Unk.	180	100	80-180	14	10	Unk.	No	No	Unknown; Assumed Fluvial Well
Needles MW-11	Needles Golf Course	CA	City of Needles	Industrial/ Municipal Supply	Unk.	Unk.	280	Unk.	Unk.	Unk.	18	Unk.	No	No	Unknown; Assumed Fluvial Well
Needles MW-12	Needles Golf Course	CA	City of Needles	Industrial/ Municipal Supply	Unk.	Unk.	220	Unk.	Unk.	Unk.	Unk.	Unk.	No	No	Unknown; Assumed Fluvial Well

TABLE 2-1

Well and Geology Information

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Compressor Station and Vicinity, Needles, California

Common Well ID or Mapped ID	Location Description	State	Current Well Owner	Well Use / Remarks	Date Installed	Boring Depth (ft)	Well Depth (ft)	Well Screen Length (ft)	Well Screen Interval (ft)	Depth to Water (ft)[1]	Well Diameter (in)	Depth to Bedrock (ft)	Driller's Log or Geologic Log Available	Well Construction Log Available	Hydrogeologic Unit Monitored
Lily Hill	**1501 Lily Hill Dr. #36 Needles**	**CA**	**Mountain View Rentals (aka Terrace View), LLC**	**Irrigation**	**11/28/1997**	**225**	**225**	**5**	**220-225**	**175**	**5**	**NE**	**Driller's Log**	**Yes**	**Alluvial Well**
Tayloe	**National Old Trails Rd and Hwy 95, South of Needles**	**CA**	**John Tayloe**	**Domestic**	**4/1/1969**	**Unk.**	**394**	**40**	**360-400**	**280**	**6**	**Unk.**	**No**	**No**	**Alluvial Well**
MW-16	**On-site**	**CA**	**Pacific Gas and Electric**	**Monitoring/ Piezometer**	**4/10/1998**	**218**	**218.1**	**20**	**198-218**	**201.57**	**4**	**NE**	**Both Logs**	**Yes**	**Alluvial Well**
MW-17	**On-site**	**CA**	**Pacific Gas and Electric**	**Monitoring/ Piezometer**	**5/18/1998**	**151**	**150.5**	**20.5**	**130-150.5**	**133.8**	**4**	**NE**	**Both Logs**	**Yes**	**Alluvial Well**
MW-18	**On-site**	**CA**	**Pacific Gas and Electric**	**Monitoring/ Piezometer**	**4/8/1998**	**110**	**110**	**20**	**85-105**	**88.9**	**4**	**NE**	**Both Logs**	**Yes**	**Alluvial Well**
P-2	**New Ponds site**	**CA**	**Pacific Gas and Electric**	**Monitoring/ Piezometer**	**8/28/1986**	**249**	**258**	**10**	**238.5-248.5**	**170.98**	**4**	**NE**	**Geologic Log**	**Yes**	**Alluvial Well**
PMM-Supply	**Park Moabi**	**CA**	**Park Moabi Marina**	**Industrial/ Municipal Supply**	**3/1/1961**	**190**	**180**	**129**	**28-42/65-180**	**22.5**	**10**	**Unk.**	**Driller's Log**	**No**	**Alluvial Well**

Notes:

1. Depth to water based on field measurements or water depths noted on logs.

Unk. = Unknown

NE = not encountered

TABLE 2-2

Background Study Analyte List

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Compressor Station and Vicinity, Needles, California

Analytical Methods for Metals	
Analyte	**Analytical Method**
Dissolved Aluminum	SW6020A
Dissolved Antimony	SW6010B/SW7000 series
Dissolved Arsenic	SW6010B/SW7000 series
Dissolved Barium	SW6010B/SW7000 series
Dissolved Beryllium	SW6010B/SW7000 series
Dissolved Cadmium	SW6010B/SW7000 series
Hexavalent Chromium	SW7199
Dissolved Chromium	SW6010B/SW7000 series
Dissolved Cobalt	SW6010B/SW7000 series
Dissolved Copper	SW6010B/SW7000 series
Dissolved Lead	SW6010B/SW7000 series
Dissolved Manganese	SW6010B/SW7000 series
Dissolved Mercury	SW7470A
Dissolved Molybdenum	SW6010B/SW7000 series
Dissolved Nickel	SW6010B/SW7000 series
Dissolved Selenium	SW6010B/SW7000 series
Dissolved Silver	SW6010B/SW7000 series
Dissolved Thallium	SW6010B/SW7000 series
Dissolved Vanadium	SW6010B/SW7000 series
Dissolved Zinc	SW6010B/SW7000 series
Analytical Methods for Additional Parameters	
Alkalinity	EPA 310.1
Boron	SW6010B / SW7000 series
Bromide	SW6010B / SW7000 series
Calcium	SW6010B / SW7000 series
Chloride	EPA 300
Deuterium	CFIRM
Dissolved Organic Carbon	EPA 415.1/SM 5310 B-D
Total Organic Carbon	EPA 415.1/SM 5310 B-D
Fluoride	EPA 300
Iodide	SW6010B / SW7000series
Dissolved Iron	SW6010B / SW7000series
Magnesium	SW6010B / SW7000series
Ammonia	EPA 350.2
Nitrate	EPA 300
Total Kjeldahl nitrogen	EPA 351.4
Oxygen 18	CFIRM

TABLE 2-2

Background Study Analyte List

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Compressor Station and Vicinity, Needles, California

Analyte	**Analytical Method**
pH	EPA 150.1
Potassium	SW6010B / SW7000 series
Silica	SW6010B / SW7000 series
Sulfate	EPA 300.0
Sodium	SW6010B / SW7000 series
Total Suspended Solids	EPA 160.1
Total Dissolved Solids	EPA 160.1

Notes:

SM = Standard Methods SW 846 Update III EPA -EPA 600 series for chemical analysis of water and wastes

TABLE 2-3

Needles MW-11 (A) versus Needles MW-12 (B)
Two-tailed Wilcoxon Rank Sum Comparisons
Groundwater Background Study Steps 3 and 4: Revised Final Report of Results
PG&E Topock Compressor Station and Vicinity, Needles, California

Parameter	Probability that the Observed Differences Would Occur Purely by Chance	Statistical Decision with 0.05 Signficance Level	Mean A	Mean B	Median A	Median B	A Detection Frequency	B Detection Frequency	Percent Detects
Aluminum	0.422	< 25% Detects	48.2	25.0	25.0	25.0	1/6	0/6	8
Antimony	1.000	0% Detects	1.0	1.0	1.0	1.0	0/6	0/6	0
Arsenic	0.017	A > B	6.3	3.6	6.1	3.6	6/6	6/6	100
Barium	0.054	ns	27.6	32.1	27.6	31.5	6/6	6/6	100
Beryllium	1.000	0% Detects	0.5	0.5	0.5	0.5	0/6	0/6	0
Boron	0.017	A > B	0.5	0.4	0.5	0.4	6/6	6/6	100
Cadmium	1.000	0% Detects	0.5	0.5	0.5	0.5	0/6	0/6	0
Calcium	0.017	B > A	107.0	153.0	107.0	153.0	6/6	6/6	100
Chromium	0.012	A > B	2.8	0.5	2.8	0.5	6/6	0/6	50
Cobalt	0.203	< 25% Detects	0.5	0.7	0.5	0.5	0/6	2/6	17
Copper	0.875	ns	3.5	4.8	3.9	4.0	6/6	6/6	100
Hexavalent chromium	0.014	A > B	2.4	0.2	2.4	0.1	6/6	0/6	50
Iron	1.000	0% Detects	0.1	0.1	0.1	0.1	0/6	0/6	0
Lead	0.477	ns	0.7	1.3	0.5	0.5	1/6	2/6	25
Magnesium	0.023	B > A	46.0	61.2	45.7	61.4	6/6	6/6	100
Manganese	0.017	B > A	16.7	592.0	18.6	585.0	6/6	6/6	100
Mercury	1.000	0% Detects	0.1	0.1	0.1	0.1	0/6	0/6	0
Molybdenum	0.017	A > B	17.0	11.2	16.8	11.1	6/6	6/6	100
Nickel	0.014	B > A	0.6	10.6	0.5	3.9	1/6	6/6	58
Potassium	0.017	A > B	13.0	9.4	12.5	9.5	6/6	6/6	100
Selenium	0.012	A > B	4.0	0.5	3.9	0.5	6/6	0/6	50
Silver	1.000	0% Detects	0.5	0.5	0.5	0.5	0/6	0/6	0
Sodium	0.121	ns	328.0	294.0	327.0	303.0	6/6	6/6	100
Thallium	0.422	< 25% Detects	0.5	0.6	0.5	0.5	0/6	1/6	8
Vanadium	0.017	A > B	10.7	5.6	10.7	5.5	6/6	6/6	100
Zinc	0.528	ns	17.4	19.6	11.5	18.4	3/6	5/6	67

Notes:

ns = no significant difference

TABLE 2-4

Summary of Statistical Outliers Results (at 0.05 significance level)

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

Parameter	Location
Metals	
Arsenic	PGE-09S
Arsenic	Sanders
Nickel	Needles MW-12
Nickel	MW-16
Selenium	MW-17
Vanadium	Sanders
Zinc	PGE-09S
General Chemistry	
Chloride	PGE-09S
Chloride	P-2
Potassium	PGE-09S
Specific conductance	PGE-09S
Specific conductance	P-2
Sodium	PGE-09S
Total dissolved solids	PGE-09S
Total dissolved solids	P-2
Total organic carbon	PGE-09S
Total organic carbon	BOR-2
Total organic carbon	Needles MW-12
Total organic carbon	New Farm Well
Turbidity	PGE-09S
Turbidity	MW-16
Turbidity	BOR-2

TABLE 2-5

Details on Mathematical Outlier Testing for Background Data

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

Parameter	Number of Samples When Potential Outlier Removed	Sample ID	Transformation	Transformed Result	Original Result	Rosner's Critical Value	Rosner's Statistic	Dixon's Critical Value	Dixon's Statistic	Exceeds Critical Value?	Result Identified as Mathematical Outlier?
Trace Metals											
Arsenic	24	PGE-09S	Logarithm	3.652	38.5	2.82	2.170	--	--	no	yes
Arsenic	23	Sanders	Cubic Root	3.230	33.7	2.8	2.904	--	--	yes	yes
Arsenic	22	BOR-2	Square Root	4.167	17.4	2.78	2.323	--	--	no	no
Arsenic	21	Lily Hill	Square Root	3.645	13.3	2.76	1.993	--	--	no	no
Arsenic	20	Topock-2	None	12.340	12.3	2.73	2.542	--	--	no	no
Barium	24	PMM-Supply	Logarithm	5.050	156.0	2.82	1.910	--	--	no	no
Barium	23	P-2	Cubic Root	5.299	148.8	2.8	2.332	--	--	no	no
Barium	22	PGE-09S	Cubic Root	4.939	120.5	2.78	2.147	--	--	no	no
Barium	21	EPNG-2	Square Root	9.566	91.5	2.76	1.767	--	--	no	no
Barium	20	ADOT New Well	Square Root	9.248	85.5	2.73	1.748	--	--	no	no
Chromium	24	MW-18	Square Root	5.835	34.1	2.82	2.060	--	--	no	no
Chromium	23	GSRV-2	Square Root	5.391	29.1	2.8	2.024	--	--	no	no
Chromium	22	Langmaack	Square Root	4.706	22.2	2.78	1.786	--	--	no	no
Chromium	21	TMLP-2	Square Root	4.642	21.6	2.76	1.930	--	--	no	no
Chromium	20	MW-17	Square Root	3.708	13.7	2.73	1.400	--	--	no	no
Copper	24	MW-17	Logarithm	1.966	7.1	2.82	1.663	--	--	no	no
Copper	23	Lily Hill	Logarithm	1.856	6.4	2.8	1.618	--	--	no	no
Copper	22	Langmaack	Logarithm	1.793	6.0	2.78	1.648	--	--	no	no
Copper	21	ADOT New Well	Logarithm	1.590	4.9	2.76	1.425	--	--	no	no
Copper	20	Needles MW-12	Logarithm	1.569	4.8	2.73	1.495	--	--	no	no
Hexavalent chromium	24	MW-18	Square Root	5.638	31.8	2.82	2.064	--	--	no	no
Hexavalent chromium	23	GSRV-2	Square Root	5.204	27.1	2.8	2.040	--	--	no	no
Hexavalent chromium	22	Langmaack	Square Root	4.544	20.7	2.78	1.831	--	--	no	no
Hexavalent chromium	21	TMLP-2	Square Root	4.125	17.0	2.76	1.714	--	--	no	no
Hexavalent chromium	20	MW-17	Square Root	3.708	13.8	2.73	1.555	--	--	no	no
Molybdenum	24	Sanders	Logarithm	3.591	36.3	2.82	2.289	--	--	no	no
Molybdenum	23	Topock-2	Logarithm	3.111	22.4	2.8	1.745	--	--	no	no
Molybdenum	22	CA Agriculture Station	Logarithm	3.083	21.8	2.78	1.863	--	--	no	no
Molybdenum	21	MW-17	Logarithm	2.910	18.4	2.76	1.712	--	--	no	no
Molybdenum	20	PGE-09S	Logarithm	2.876	17.8	2.73	1.819	--	--	no	no
Nickel	24	Needles MW-12	Logarithm	2.359	10.6	2.82	2.676	--	--	no	yes
Nickel	23	MW-16	Logarithm	2.210	9.1	2.8	3.074	--	--	yes	yes
Nickel	22	Langmaack	Logarithm	1.359	3.9	2.78	2.577	--	--	no	no
Nickel	21	MW-17	Logarithm	1.033	2.8	2.76	2.471	--	--	no	no
Nickel	20	BOR-2	Logarithm	0.604	1.8	2.73	1.935	--	--	no	no
Selenium	24	MW-17	Cubic Root	2.346	12.9	2.82	3.207	--	--	yes	yes
Selenium	23	GSWC-1	Cubic Root	1.655	4.5	2.8	1.884	--	--	no	no

TABLE 2-5

Details on Mathematical Outlier Testing for Background Data

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

Parameter	Number of Samples When Potential Outlier Removed	Sample ID	Transformation	Transformed Result	Original Result	Rosner's Critical Value	Rosner's Statistic	Dixon's Critical Value	Dixon's Statistic	Exceeds Critical Value?	Result Identified as Mathematical Outlier?
Selenium	22	Needles MW-11	Cubic Root	1.590	4.0	2.78	1.848	--	--	no	no
Selenium	21	Sanders	Cubic Root	1.492	3.3	2.76	1.657	--	--	no	no
Selenium	20	Lily Hill	Cubic Root	1.441	3.0	2.73	1.604	--	--	no	no
Vanadium	24	Sanders	None	59.917	59.9	2.82	3.644	--	--	yes	yes
Vanadium	23	MW-16	None	32.383	32.4	2.8	2.424	--	--	no	no
Vanadium	22	GSWC-4	None	22.017	22.0	2.78	1.477	--	--	no	no
Vanadium	21	Lily Hill	None	20.483	20.5	2.76	1.378	--	--	no	no
Vanadium	20	GSWC-1	None	19.733	19.7	2.73	1.372	--	--	no	no
Zinc	24	PGE-09S	Logarithm	6.486	655.9	2.82	3.650	--	--	yes	yes
Zinc	23	Sanders	Logarithm	4.352	77.7	2.8	2.106	--	--	no	no
Zinc	22	MW-17	Logarithm	4.286	72.7	2.78	2.281	--	--	no	no
Zinc	21	Tayloe	Logarithm	4.250	70.1	2.76	2.610	--	--	no	no
Zinc	20	CA Agriculture Station	Logarithm	3.864	47.7	2.73	2.314	--	--	no	no
General Chemistry Parameters											
Alkalinity	24	PGE-09S	Cubic Root	8.008	513.5	2.82	3.284	--	--	yes	yes
Alkalinity	23	Sanders	Cubic Root	6.042	220.6	2.8	1.681	--	--	no	no
Alkalinity	22	BOR-2	Square Root	14.457	209.0	2.78	1.729	--	--	no	no
Alkalinity	21	Needles MW-12	Square Root	14.021	196.6	2.76	1.691	--	--	no	no
Alkalinity	20	New Farm Well	Cubic Root	5.739	189.0	2.73	1.668	--	--	no	no
Alkalinity	24	PGE-09S	Logarithm	6.241	513.5	2.82	2.729	--	--	no	no
Alkalinity	23	Sanders	Cubic Root	6.407	263.0	2.8	1.959	--	--	no	no
Alkalinity	22	Needles MW-12	Cubic Root	6.194	237.7	2.78	1.872	--	--	no	no
Alkalinity	21	BOR-2	Square Root	14.457	209.0	2.76	1.725	--	--	no	no
Alkalinity	20	Needles MW-11	Square Root	14.283	204.0	2.73	1.820	--	--	no	no
Boron	24	PGE-09S	Logarithm	0.374	1.5	2.82	2.425	--	--	no	no
Boron	23	Sanders	Logarithm	-0.043	1.0	2.8	2.112	--	--	no	no
Boron	22	Topock-2	Logarithm	-0.474	0.6	2.78	1.561	--	--	no	no
Boron	21	CA Agriculture Station	Logarithm	-0.493	0.6	2.76	1.657	--	--	no	no
Boron	20	Needles MW-11	Logarithm	-0.611	0.5	2.73	1.569	--	--	no	no
Calcium	24	PGE-09S	Logarithm	5.991	400.0	2.82	2.546	--	--	no	no
Calcium	23	P-2	Logarithm	5.586	266.7	2.8	2.415	--	--	no	no
Calcium	22	Needles MW-12	Logarithm	5.030	153.0	2.78	1.864	--	--	no	no
Calcium	21	MW-17	Logarithm	4.814	123.2	2.76	1.661	--	--	no	no
Calcium	20	New Farm Well	Logarithm	4.735	113.8	2.73	1.668	--	--	no	no
Chloride	24	PGE-09S	Logarithm	8.251	3833.3	2.82	2.932	--	--	yes	yes
Chloride	23	P-2	Cubic Root	11.439	1496.7	2.8	3.452	--	--	yes	yes
Chloride	22	Topock-2	Cubic Root	7.091	356.6	2.78	1.550	--	--	no	no
Chloride	21	PMM-Supply	Cubic Root	6.892	327.3	2.76	1.508	--	--	no	no

TABLE 2-5

Details on Mathematical Outlier Testing for Background Data

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

Parameter	Number of Samples When Potential Outlier Removed	Sample ID	Transformation	Transformed Result	Original Result	Rosner's Critical Value	Rosner's Statistic	Dixon's Critical Value	Dixon's Statistic	Exceeds Critical Value?	Result Identified as Mathematical Outlier?
Chloride	20	Needles MW-11	Cubic Root	6.692	299.7	2.73	1.457	--	--	no	no
Deuterium	25	MW-17	None	-58.583	-58.6	2.82	1.265	--	--	no	no
Deuterium	24	Tayloe	None	-60.633	-60.6	2.8	1.190	--	--	no	no
Deuterium	23	MW-16	None	-63.317	-63.3	2.78	1.060	--	--	no	no
Deuterium	22	CA Agriculture Station	None	-64.133	-64.1	2.76	1.053	--	--	no	no
Deuterium	21	MW-18	None	-65.083	-65.1	2.73	1.038	--	--	no	no
Dissolved organic carbon	24	PGE-09S	Logarithm	2.039	7.7	2.82	2.593	--	--	no	no
Dissolved organic carbon	23	BOR-2	Logarithm	1.549	4.7	2.8	2.339	--	--	no	no
Dissolved organic carbon	22	New Farm Well	Logarithm	1.375	4.0	2.78	2.430	--	--	no	no
Dissolved organic carbon	21	Needles MW-12	Logarithm	1.113	3.0	2.76	2.369	--	--	no	no
Dissolved organic carbon	20	GSRV-2	Logarithm	0.928	2.5	2.73	2.403	--	--	no	no
Dissolved oxygen	24	GSRV-2	None	7.648	7.6	2.82	2.047	--	--	no	no
Dissolved oxygen	23	CA Agriculture Station	None	7.547	7.5	2.8	2.212	--	--	no	no
Dissolved oxygen	22	Lily Hill	None	6.523	6.5	2.78	1.485	--	--	no	no
Dissolved oxygen	21	Langmaack	None	6.402	6.4	2.76	1.471	--	--	no	no
Dissolved oxygen	20	Needles MW-12	None	6.262	6.3	2.73	1.435	--	--	no	no
Fluoride	24	Sanders	Logarithm	1.864	6.5	2.82	1.958	--	--	no	no
Fluoride	23	ADOT New Well	Cubic Root	1.593	4.0	2.8	1.875	--	--	no	no
Fluoride	22	Topock-2	Cubic Root	1.559	3.8	2.78	1.957	--	--	no	no
Fluoride	21	EPNG-2	Square Root	1.888	3.6	2.76	2.256	--	--	no	no
Fluoride	20	MW-16	Square Root	1.552	2.4	2.73	1.646	--	--	no	no
Magnesium	24	PGE-09S	Logarithm	5.035	153.7	2.82	2.420	--	--	no	no
Magnesium	23	BOR-2	Logarithm	4.246	69.9	2.8	1.860	--	--	no	no
Magnesium	22	Needles MW-12	Logarithm	4.114	61.2	2.78	1.889	--	--	no	no
Magnesium	21	P-2	Logarithm	3.961	52.5	2.76	1.897	--	--	no	no
Magnesium	20	Needles MW-11	Logarithm	3.829	46.0	2.73	1.934	--	--	no	no
Manganese	24	PGE-09S	Logarithm	7.182	1315.0	2.82	2.098	--	--	no	no
Manganese	23	Needles MW-12	Logarithm	6.383	591.7	2.8	2.023	--	--	no	no
Manganese	22	New Farm Well	Logarithm	6.208	496.5	2.78	2.203	--	--	no	no
Manganese	21	USFW-5	Logarithm	5.700	298.8	2.76	2.293	--	--	no	no
Manganese	20	BOR-2	Logarithm	5.537	254.0	2.73	2.630	--	--	no	no
Nitrate as Nitrogen	24	GSWC-1	None	4.403	4.4	2.82	1.800	--	--	no	no
Nitrate as Nitrogen	23	MW-18	None	3.842	3.8	2.8	1.517	--	--	no	no
Nitrate as Nitrogen	22	MW-17	None	3.695	3.7	2.78	1.512	--	--	no	no
Nitrate as Nitrogen	21	TMLP-2	None	3.592	3.6	2.76	1.544	--	--	no	no
Nitrate as Nitrogen	20	Lily Hill	None	3.573	3.6	2.73	1.665	--	--	no	no
Oxidation reduction potential	25	Lily Hill	None	343.833	343.8	2.82	2.550	--	--	no	no
Oxidation reduction potential	24	GSRV-2	None	193.333	193.3	2.8	1.493	--	--	no	no

Parameter	Number of Samples When Potential Outlier Removed	Sample ID	Transformation	Transformed Result	Original Result	Rosner's Critical Value	Rosner's Statistic	Dixon's Critical Value	Dixon's Statistic	Exceeds Critical Value?	Result Identified as Mathematical Outlier?
Oxidation reduction potential	23	MW-18	None	135.833	135.8	2.78	0.987	--	--	no	no
Oxidation reduction potential	22	EPNG-2	None	135.167	135.2	2.76	1.025	--	--	no	no
Oxidation reduction potential	21	ADOT New Well	None	123.167	123.2	2.73	0.946	--	--	no	no
Oxygen 18	25	MW-17	None	-7.867	-7.9	2.82	1.708	--	--	no	no
Oxygen 18	24	Tayloe	None	-8.433	-8.4	2.8	1.474	--	--	no	no
Oxygen 18	23	CA Agriculture Station	None	-8.950	-9.0	2.78	1.218	--	--	no	no
Oxygen 18	22	MW-16	None	-9.083	-9.1	2.76	1.195	--	--	no	no
Oxygen 18	21	PMM-Supply	None	-9.233	-9.2	2.73	1.159	--	--	no	no
Potassium	24	PGE-09S	Logarithm	2.960	19.3	2.82	2.829	--	--	yes	yes
Potassium	23	Needles MW-11	Logarithm	2.561	13.0	2.8	2.340	--	--	no	no
Potassium	22	MW-17	Logarithm	2.329	10.3	2.78	1.947	--	--	no	no
Potassium	21	P-2	Logarithm	2.321	10.2	2.76	2.167	--	--	no	no
Potassium	20	Needles MW-12	Square Root	3.069	9.4	2.73	2.428	--	--	no	no
Sodium	24	PGE-09S	Logarithm	7.870	2616.7	2.82	3.259	--	--	yes	yes
Sodium	23	P-2	Cubic Root	8.823	686.8	2.8	2.773	--	--	no	no
Sodium	22	Sanders	Square Root	18.890	356.8	2.78	1.785	--	--	no	no
Sodium	21	Needles MW-11	Square Root	18.111	328.0	2.76	1.733	--	--	no	no
Sodium	20	Needles MW-12	Square Root	17.146	294.0	2.73	1.597	--	--	no	no
Soluble silica	24	Sanders	Logarithm	3.880	48.4	2.82	2.418	--	--	no	no
Soluble silica	23	Needles MW-11	Logarithm	3.651	38.5	2.8	1.746	--	--	no	no
Soluble silica	22	GSRV-2	Logarithm	3.536	34.3	2.78	1.335	--	--	no	no
Soluble silica	21	Lily Hill	Logarithm	3.534	34.3	2.76	1.416	--	--	no	no
Soluble silica	20	GSWC-4	Logarithm	3.522	33.9	2.73	1.464	--	--	no	no
Specific conductance	24	PGE-09S	Logarithm	9.642	15400.0	2.82	3.310	--	--	yes	yes
Specific conductance	23	P-2	Square Root	73.110	5345.0	2.8	3.282	--	--	yes	yes
Specific conductance	22	Needles MW-12	Square Root	50.431	2543.3	2.78	1.778	--	--	no	no
Specific conductance	21	Needles MW-11	Square Root	48.905	2391.7	2.76	1.763	--	--	no	no
Specific conductance	20	Sanders	Square Root	46.458	2158.3	2.73	1.608	--	--	no	no
Sulfate	24	PGE-09S	Logarithm	6.789	887.8	2.82	1.828	--	--	no	no
Sulfate	23	MW-17	Logarithm	6.540	692.2	2.8	1.760	--	--	no	no
Sulfate	22	Needles MW-12	Logarithm	6.321	556.0	2.78	1.699	--	--	no	no
Sulfate	21	Needles MW-11	Logarithm	6.082	438.0	2.76	1.597	--	--	no	no
Sulfate	20	BOR-2	Cubic Root	7.399	405.0	2.73	1.966	--	--	no	no
Temperature	24	Topock-2	None	35.700	35.7	2.82	1.761	--	--	no	no
Temperature	23	TMLP-2	None	33.333	33.3	2.8	1.359	--	--	no	no
Temperature	22	EPNG-2	None	32.267	32.3	2.78	1.185	--	--	no	no
Temperature	21	GSWC-2	None	31.833	31.8	2.76	1.145	--	--	no	no
Temperature	20	GSWC-4	None	31.583	31.6	2.73	1.148	--	--	no	no

TABLE 2-5
Details on Mathematical Outlier Testing for Background Data
Groundwater Background Study Steps 3 and 4: Revised Final Report of Results
PG&E Topock Compressor Station and Vicinity, Needles, California

Parameter	Number of Samples When Potential Outlier Removed	Sample ID	Transformation	Transformed Result	Original Result	Rosner's Critical Value	Rosner's Statistic	Dixon's Critical Value	Dixon's Statistic	Exceeds Critical Value?	Result Identified as Mathematical Outlier?
Total dissolved solids	24	PGE-09S	Logarithm	9.048	8501.7	2.82	3.187	--	--	yes	yes
Total dissolved solids	23	P-2	Cubic Root	14.654	3146.7	2.8	2.978	--	--	yes	yes
Total dissolved solids	22	Needles MW-12	Square Root	40.249	1620.0	2.78	1.960	--	--	no	no
Total dissolved solids	21	Needles MW-11	Square Root	38.708	1498.3	2.76	1.953	--	--	no	no
Total dissolved solids	20	MW-17	None	1363.333	1363.3	2.73	2.167	--	--	no	no
Total organic carbon	24	PGE-09S	Logarithm	2.014	7.5	2.82	2.779	--	--	no	yes
Total organic carbon	23	BOR-2	Logarithm	1.520	4.6	2.8	2.698	--	--	no	yes
Total organic carbon	22	Needles MW-12	Logarithm	1.048	2.9	2.78	2.477	--	--	no	yes
Total organic carbon	21	New Farm Well	Logarithm	0.990	2.7	2.76	2.878	--	--	yes	yes
Total organic carbon	20	USFW-5	Logarithm	0.502	1.7	2.73	2.484	--	--	no	no
Turbidity	24	PGE-09S	Logarithm	4.012	55.3	2.82	2.934	--	--	yes	yes
Turbidity	23	MW-16	Logarithm	3.012	20.3	2.8	2.817	--	--	yes	yes
Turbidity	22	BOR-2	Logarithm	2.920	18.5	2.78	3.485	--	--	yes	yes
Turbidity	21	New Farm Well	Logarithm	1.007	2.7	2.76	2.090	--	--	no	no
Turbidity	20	USFW-5	Logarithm	0.989	2.7	2.73	2.381	--	--	no	no
pH	24	Topock-2	None	9.642	7.9	2.82	1.934	--	--	no	no
pH	23	Tayloe	None	73.110	7.9	2.8	2.069	--	--	no	no
pH	22	Langmaack	None	50.431	7.8	2.78	1.451	--	--	no	no
pH	21	EPNG-2	None	48.905	7.8	2.76	1.493	--	--	no	no
pH	20	TMLP-2	None	46.458	7.8	2.73	1.535	--	--	no	no

TABLE 2-6

Details of Mean Ranks Evaluation for Mean Concentrations of Trace Metals

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

Location	**Aluminum**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Cobalt**	**Copper**	**Hexavalent chromium**	**Lead**	**Mercury**	**Molybdenum**	**Nickel**	**Selenium**	**Silver**	**Thallium**	**Vanadium**	**Zinc**
ADOT New Well	1	14	14	5	14	13	13	14	4	12	20	13	12	7	19	17	15	14	6
BOR-2	16	14	3	9	14	13	24	14	25	24	20	13	20	5	23	17	15	23	11
CA Agriculture Station	2	14	21	20	14	13	17	14	22	17	20	13	3	25	7	17	15	11	5
EPNG-2	5	14	17	4	14	13	10	14	14	9	20	13	13	25	15	17	15	12	7
GSRV-2	19	1	13	11	1	13	2	14	21	2	20	13	17	22	12	1	1	10	25
GSWC-1	7	14	9	17	14	13	6	14	8	6	6	13	14	10	2	2	15	6	20
GSWC-2	23	14	8	12	14	13	14	14	6	14	7	13	15	17	10	6	15	8	23
GSWC-4	23	14	7	15	14	13	8	14	13	7	11	13	16	12	16	3	15	3	19
Langmaack	9	14	11	23	14	13	3	14	3	3	12	13	25	3	9	4	15	9	13
Lily Hill	8	14	4	10	14	13	12	14	2	13	5	13	7	6	6	17	3	4	12
MW-16	11	14	6	21	14	13	9	14	16	8	20	13	8	2	13	17	15	2	24
MW-17	23	14	24	18	14	13	5	14	1	5	2	13	4	4	1	8	15	21	3
MW-18	10	14	25	7	14	13	1	14	19	1	20	13	24	13	6	17	15	20	15
Needles MW-10	6	14	19	24	14	13	21	14	23	24	20	13	11	20	17	17	15	19	18
Needles MW-11	3	14	10	22	14	13	16	14	9	16	10	13	6	23	3	17	15	15	16
Needles MW-12	23	14	20	19	14	13	24	2	5	21	4	13	9	1	23	17	2	18	14
New Farm Well	18	14	15	8	14	13	24	14	20	24	20	13	18	19	23	17	15	25	21
P-2	23	14	22	2	14	13	15	14	15	15	13	13	20	16	11	17	15	13	10
PGE-09S	23	14	1	3	14	13	24	1	7	19	8	13	5	8	23	17	15	22	1
PMM-Supply	15	14	23	1	14	13	11	14	17	11	9	13	22	15	14	7	15	16	8
Sanders	12	14	2	14	14	13	19	14	10	20	20	13	1	9	4	17	4	1	2
TMLP-2	13	14	12	25	14	13	4	14	24	4	20	13	21	21	18	17	15	6	22
Tayloe	14	14	16	13	14	13	18	14	12	18	3	13	10	19	8	17	15	17	4
Topock-2	4	14	5	6	14	13	7	14	11	10	1	13	2	11	20	5	15	7	17
USFW-5	18	14	18	16	14	13	20	14	18	24	20	13	23	14	23	17	15	25	9

TABLE 2-7

Details of Mean Ranks Evaluation for Mean Concentrations of General Chemistry Parameters

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

Location	Alkalinity	Boron, dissolved	Bromide	Calcium, dissolved	Chloride	Deuterium	Dissolved Organic Carbon	Fluoride	Iodide	Iron, dissolved	Magnesium, dissolved	Manganese, dissoved	N-Ammonia	N-Nitrate	N-Total Kjeldahl Nitrogen	Oxygen 18	pH	Potassium, dissolved	Soluble silica	Sodium, dissolved	Specific conductance	Sulfate	Total Dissolved Solids
ADOT New Well	20	6	14	18	10	16	18	2	14	18	22	15	14	14	20	17	8	14	16	11	12	18	18
BOR-2	4	17	14	10	13	25	2	22	14	2	2	5	2	23	1	24	13	15	17	9	13	5	6
CA Agriculture Station	19	4	14	12	8	4	17	12	14	18	13	11	14	16	3	3	12	16	11	8	11	9	9
EPNG-2	18	8	14	19	11	17	25	4	14	18	20	24	14	13	20	17	4	13	14	12	8	19	19
GSRV-2	8	23	14	15	22	9	5	7	14	10	14	14	14	8	7	13	7	19	4	24	23	22	22
GSWC-1	15	13	14	17	21	6	16	15	14	18	12	25	14	1	6	6	14	10	9	21	22	16	20
GSWC-2	14	14	14	21	18	13	14	17	14	18	17	21	14	19	4	8	21	18	8	19	21	21	21
GSWC-4	9	16	14	24	23	12	13	14	14	5	19	23	14	16	20	11	10	21	5	22	18	24	23
Langmaack	13	20	14	23	24	7	21	19	14	18	16	16	14	6	14	9	3	17	7	23	24	23	24
Lily Hill	7	10	14	14	15	18	22	10	14	18	9	9	14	5	20	18	18	7	4	13	17	12	15
MW-16	17	12	14	22	12	3	9	5	14	18	23	17	14	9	9	4	23	23	19	10	16	13	17
MW-17	24	15	14	4	17	1	10	9	14	18	10	10	14	3	5	1	20	3	25	7	6	2	5
MW-18	21	18	14	9	6	5	23	21	14	18	15	20	14	2	20	7	22	6	18	14	10	15	12
Needles MW-10	10	22	14	11	19	22	8	20	14	8	8	7	14	23	20	23	6	22	15	18	15	7	14
Needles MW-11	5	6	14	6	5	25	6	11	14	18	5	8	14	17	20	25	18	2	2	4	4	4	4
Needles MW-12	3	10	14	3	9	21	4	16	14	18	3	2	14	20	12	22	24	5	12	5	3	3	3
New Farm Well	6	21	14	5	16	23	3	25	14	4	6	3	14	23	8	22	16	12	21	17	14	6	8
P-2	25	7	1	2	2	11	19	8	14	18	4	22	14	11	11	10	19	4	22	2	2	10	2
PGE-09S	1	1	14	1	1	19	1	23	14	1	1	1	1	23	2	19	25	1	10	1	1	1	1
PMM-Supply	22	20	14	8	4	10	20	6	14	7	11	18	14	7	14	5	15	9	23	15	7	20	10
Sanders	2	2	14	13	7	15	11	1	1	18	21	6	14	11	20	15	11	25	1	3	5	11	7
TMLP-2	16	11	14	20	14	2	24	18	14	18	24	19	14	18	10	2	5	24	20	17	25	17	25
Tayloe	12	25	14	25	25	8	12	13	14	9	18	13	14	4	20	14	2	11	6	25	20	25	13
Topock-2	23	3	14	16	3	14	15	3	14	6	25	12	14	12	20	12	1	8	13	6	9	14	11
USFW-5	11	24	14	7	20	20	7	25	14	3	7	4	14	23	20	20	9	20	24	20	19	8	16

TABLE 2-8

Summary of Mean Rank Evaluation Results For Trace Metals (Top Five)

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

Location	Number of Mean Concentrations Ranked in the Top Five	Number of Mean Concentrations Evaluated (19 Metals)	Probability that the Number of Top Five Concentrations Would Occur by Chance	Is this Probability Significant at the 0.05 Level
ADOT New Well	3	19	0.777	
BOR-2	2	19	0.911	
CA Agriculture Station	3	19	0.777	
EPNG-2	2	19	0.911	
GSRV-2	6	19	0.213	
GSWC-1	3	19	0.777	
GSWC-2	0	19	0.997	
GSWC-4	2	19	0.911	
Langmaack	5	19	0.383	
Lily Hill	6	19	0.213	
MW-16	2	19	0.911	
MW-17	8	19	0.039	Yes
MW-18	2	19	0.911	
Needles MW-10	0	19	0.997	
Needles MW-11	2	19	0.911	
Needles MW-12	5	19	0.383	
New Farm Well	0	19	0.997	
P-2	1	19	0.976	
PGE-09S	5	19	0.383	
PMM-Supply	1	19	0.976	
Sanders	6	19	0.213	
TMLP-2	2	19	0.911	
Tayloe	2	19	0.911	
Topock-2	5	19	0.213	
USFW-5	0	19	0.997	

TABLE 2-9

Mean Concentrations for Trace Metals from Each Well

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, Califorina

Location	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Hexavalent chromium	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
ADOT New Well	55.8	1.0	5.5	85.5	0.5	0.5	7.7	0.5	4.9	7.4	0.5	0.1	10.0	1.5	0.7	0.5	0.5	11.5	38.5
BOR-2	30.2	1.0	17.4	67.0	0.5	0.5	0.5	0.5	0.8	0.1	0.5	0.1	5.6	1.8	0.5	0.5	0.5	0.7	21.7
CA Agriculture Station	54.7	1.0	3.2	31.8	0.5	0.5	2.3	0.5	1.5	1.9	0.5	0.1	21.8	0.5	2.9	0.5	0.5	14.3	47.7
EPNG-2	46.9	1.0	5.0	91.5	0.5	0.5	10.6	0.5	2.3	8.7	0.5	0.1	9.0	0.5	1.3	0.5	0.5	13.8	30.1
GSRV-2	29.2	1.2	5.6	57.2	0.7	0.5	27.8[1]	0.5	1.5	25.0[2]	0.5	0.1	6.6	0.6	1.7	2.1	0.9	16.3	9.3
GSWC-1	40.5	1.0	7.0	41.2	0.5	0.5	13.4	0.5	4.3	12.7	1.2	0.1	7.4	1.2	4.5	1.5	0.5	19.7	13.5
GSWC-2	25.0	1.0	8.0	50.2	0.5	0.5	5.9	0.5	4.7	5.0	1.0	0.1	7.3	0.7	1.8	0.7	0.5	18.9	13.0
GSWC-4	25.0	1.0	8.1	46.5	0.5	0.5	10.9	0.5	2.4	10.1	0.7	0.1	7.1	1.0	1.1	1.1	0.5	22.0	14.8
Langmaack	36.8	1.0	6.1	25.2	0.5	0.5	22.2	0.5	6.0	20.7	0.6	0.1	3.6	3.9	1.8	1.1	0.5	18.3	20.0
Lily Hill	40.0	1.0	13.3	59.2	0.5	0.5	7.8	0.5	6.4	7.4	1.3	0.1	14.6	1.6	2.99	0.5	0.6	20.5	21.1
MW-16	34.0	1.0	9.5	29.3	0.5	0.5	10.7	0.5	2.0	8.8	0.5	0.1	12.7	9.1	1.7	0.5	0.5	32.4	12.3
MW-17	25.0	1.0	1.5	35.6	0.5	0.5	13.7	0.5	7.1	13.8	0.5[3]	0.1	18.4	2.8	12.9	0.6	0.5	4.5	72.7
MW-18	35.0	1.0	1.0	70.2	0.5	0.5	34.1	0.5	1.6	31.8	0.5	0.1	4.8	0.9	2.99	0.5	0.5	4.8	19.3
Needles MW-10	42.2	1.0	3.7	20.7	0.5	0.5	0.6	0.5	1.4	0.1	0.5	0.1	10.3	0.6	1.0	0.5	0.5	5.2	15.8
Needles MW-11	48.2	1.0	6.3	27.6	0.5	0.5	2.8	0.5	3.5	2.4	0.7	0.1	17.0	0.6	4.0	0.5	0.5	10.7	17.4
Needles MW-12	25.0	1.0	3.6	32.1	0.5	0.5	0.5	0.7	4.8	0.2	1.3	0.1	11.2	10.6	0.5	0.5	0.6	5.6	19.6
New Farm Well	29.8	1.0	5.4	69.0	0.5	0.5	0.5	0.5	1.6	0.1	0.5	0.1	6.1	0.6	0.5	0.5	0.5	0.5	13.4
P-2	25.0	1.0	2.2	149.0	0.5	0.5	3.4	0.5	2.1	2.9	0.6	0.1	5.6	0.8	1.8	0.5	0.5	11.9	22.3
PGE-09S	25.0	1.0	NC[5]	121.0	0.5	0.5	0.5	0.8	4.4	0.5	1.0	0.1	17.8	1.4	0.5	0.5	0.5	0.7	NC[6]
PMM-Supply	30.8	1.0	1.7	156.0	0.5	0.5	9.5	0.5	1.8	7.7	0.7	0.1	5.4	0.9	1.6	0.6	0.5	9.4	28.7
Sanders	33.1	1.0	NC[5]	48.7	0.5	0.5	0.7	0.5	3.5	0.4	0.5	0.1	36.3	1.2	3.3	0.5	0.6	59.9	77.7
TMLP-2	32.3	1.0	5.9	15.9	0.5	0.5	21.6	0.5	0.9	17.0	0.5	0.1	5.5	0.6	0.7	0.5	0.5	19.7	13.2
Tayloe	31.1	1.0	5.2	48.9	0.5	0.5	0.8	0.5	2.7	0.6	1.9	0.1	10.8	0.6	2.1	0.5	0.5	8.0	70.1
Topock-2[5]	48.0	1.0	NC[5]	79.4	0.5	0.5	12.7	0.5	3.0	7.9	0.5[4]	0.1	22.4	1.0	0.6	1.1	0.5	19.6	17.2
USFW-5	29.8	1.0	3.9	44.7	0.5	0.5	0.7	0.5	1.8	0.1	0.5	0.1	5.0	0.9	0.5	0.5	0.5	0.5	23.5
Percent Detects	76	4	100	100	4	0	84	8	100	84	52	0	100	92	80	32	16	92	100

Notes:

All concentrations in ug/L (micrograms per liter).

[1] Cr(T) concentration from the May 19, 2005 event was excluded from the background study dataset as directed by DTSC (DTSC, 2007a).
Prior to exclusion, mean Cr(T) concentration at GSRV-2 was 29.1 ug/L (CH2M HILL, 2007b).

[2] Cr(VI) concentration from the May 19, 2005 event was excluded from the background study dataset as directed by DTSC (DTSC, 2007a).
Prior to exclusion, mean Cr(VI) concentration at GSRV-2 was 27.1 ug/L (CH2M HILL, 2007b).

[3] Pb concentration from the November 2, 2005 event was excluded from the background study dataset as directed by DTSC (DTSC, 2007a).
Prior to exclusion, mean Pb concentration at MW-17 was 9.82 ug/L (CH2M HILL, 2007b).

[4] Pb concentrations from the Nov 2, 2005 and June 30, 2006 events were excluded from the background study dataset as directed by DTSC (DTSC, 2007a).
Prior to exclusion, mean Pb concentration at Topock-2 was 11.5 ug/L (CH2M HILL, 2007b).

[5] All Topock-2 results from the sixth event (June 2006) were excluded from the background data set (see Section 2.1).

NC[5] - Mean concentrations not calculated since all As concentrations were excluded from the background data set as directed by DTSC (DTSC, 2007a).
Prior to exclusion, mean As concentrations were 38.5 ug/L for PGE-09S, 33.7 ug/L for Sanders, and 12.3 ug/L for Topock-2 (CH2M HILL, 2007b).

NC[6] - Mean concentrations not calculated since all Zn concentrations were excluded from the background data set (see Section 2.2.3).
Prior to exclusion, mean Zn concentration was 656 ug/L for PGE-09S (CH2M HILL, 2007b).

TABLE 2-10

Mean Concentrations for General Chemistry Parameters from Each Well

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

Location	Alkalinity	Boron, Dissolved	Bromide	Calcium, Dissolved	Chloride	Deuterium	Dissolved Organic Carbon	Fluoride	Iodide	Iron, Dissolved	Magnesium, Dissolved	Manganese, Dissolved	N-Ammonia	N-Nitrate	N-Total Kjeldahl Nitrogen	Oxygen-18	pH	Potassium, Dissolved	Silica, Soluble	Sodium, Dissolved	Specific conductance	Sulfate	Total dissolved solids
Units	mg/L	mg/L	mg/L	mg/L	mg/L	0/00	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	00/00	pH Units	mg/L	mg/L	mg/L	µS/cm	mg/L	mg/L
ADOT New Well	85.8	0.5	0.3	39.0	209.0	-73.1	0.8	4.0	0.3	0.1	5.9	2.0	0.3	1.9	0.3	-10.4	7.7	5.5	24.9	178.0	1390	68.3	627.0
BOR-2	209.0	0.2	0.3	80.1	151.0	-101.0	4.7	0.4	0.3	1.6	69.9	254.0	0.5	0.2	1.1	-12.9	7.6	5.5	23.8	230.0	1370	405.0	1180.0
CA Agriculture Station	88.6	0.6	0.3	62.3	258.0	-64.1	0.8	1.4	0.3	0.1	16.8	3.1	0.3	1.8	0.6	-9.0	7.6	5.5	29.2	242.0	1600	213.0	926.0
EPNG-2	91.3	0.5	0.3	38.4	196.0	-74.6	0.6	3.6	0.3	0.1	7.5	0.7	0.3	1.9	0.3	-10.4	7.8	5.5	25.4	174.0	1910	65.6	602.0
GSRV-2	159.0	0.2	0.3	44.0	50.9	-68.9	2.5	2.0	0.3	0.1	15.2	2.8	0.3	3.0	0.4	-10.0	7.7	5.2	34.3	63.5	685	38.8	388.0
GSWC-1	124.0	0.3	0.3	40.6	78.0	-66.1	0.8	0.9	0.3	0.1	17.0	0.5	0.3	4.4	0.4	-9.4	7.6	6.5	32.3	90.5	749	88.4	498.0
GSWC-2	127.0	0.3	0.3	31.0	99.1	-69.9	0.8	0.8	0.3	0.1	12.1	1.2	0.3	1.6	0.4	-9.5	7.5	5.4	32.9	103.0	787	58.9	469.0
GSWC-4	156.0	0.2	0.3	25.9	48.9	-69.5	0.8	0.9	0.3	0.1	9.1	0.7	0.3	1.8	0.3	-9.9	7.6	4.8	33.9	83.9	1090	34.6	372.0
Langmaack	142.0	0.2	0.3	30.0	47.0	-67.2	0.7	0.8	0.3	0.1	12.7	2.0	0.3	3.2	0.3	-9.8	7.8	5.4	33.0	67.1	605	36.3	352.0
Lily Hill	160.0	0.4	0.3	49.7	134.0	-81.5	0.7	1.7	0.3	0.1	20.3	7.5	0.3	3.6	0.3	-11.2	7.5	7.2	34.3	172.0	1120	180.0	755.0
MW-16	99.9	0.3	0.3	30.3	184.0	-63.3	1.5	2.4	0.3	0.1	5.6	1.5	0.3	2.9	0.3	-9.1	7.4	4.2	22.6	214.0	1200	130.0	669.0
MW-17	70.3	0.2	0.3	123.0	102.0	-58.6	1.0	1.8	0.3	0.1	18.5	3.5	0.3	3.7	0.4	-7.9	7.5	10.3	18.4	278.0	1930	692.0	1360.0
MW-18	83.6	0.2	0.3	86.2	285.0	-65.1	0.7	0.5	0.3	0.1	13.8	2.1	0.3	3.8	0.3	-9.4	7.5	7.8	23.3	170.0	1670	89.0	847.0
Needles MW-10	146.0	0.2	0.3	74.2	94.5	-98.3	1.5	0.7	0.3	0.1	26.7	34.2	0.3	0.3	0.3	-12.8	7.7	4.4	25.2	144.0	1240	262.0	787.0
Needles MW-11	204.0	0.5	0.3	107.0	300.0	-102.0	2.1	1.6	0.3	0.1	46.0	16.7	0.3	1.7	0.3	-13.5	7.5	13.0	38.5	328.0	2390	438.0	1500.0
Needles MW-12	238.0	0.4	0.3	153.0	250.0	-97.5	3.0	0.8	0.3	0.1	61.2	592.0	0.3	0.7	0.3	-12.5	7.4	9.4	28.6	294.0	2540	556.0	1620.0
New Farm Well	189.0	0.2	0.3	114.0	106.0	-98.8	4.0	0.3	0.3	0.5	36.4	497.0	0.3	0.3	0.3	-12.5	7.5	5.6	22.1	145.0	1320	317.0	955.0
P-2	50.6	0.5	1.2	267.0	1500.0	-69.2	0.7	1.9	0.3	0.1	52.5	0.8	0.3	2.5	0.3	-9.8	7.5	10.2	21.7	687.0	5350	202.0	3150.0
PGE-09S	514.0	1.5	0.3	400.0	3830.0	-85.1	7.7	0.4	0.3	3.9[1]	154.0	1320.0	0.7	0.2	1.1	-11.4	7.2	19.3	29.8	2620.0	15400	888.0	8500.0
PMM-Supply	80.0	0.2	0.3	89.3	327.0	-69.0	0.7	2.2	0.3	0.1	17.8	1.4	0.3	3.1	0.3	-9.2	7.5	6.6	21.1	161.0	1910	63.8	906.0
Sanders	263.0	1.0	0.3	54.8	283.0	-72.2	1.0	NC	0.8	0.1	6.8	99.8	0.3	2.5	0.3	-10.3	7.6	3.4	48.4	357.0	2160	184.0	1130.0
TMLP-2	143.0	0.1	0.3	23.3	25.4	-68.5	0.8	1.2	0.3	0.1	10.0	2.8	0.3	3.6	0.3	-10.1	7.8	6.2	33.7	57.2	547	15.9	280.0
Tayloe	107.0	0.3	0.3	34.7	138.0	-60.6	0.7	0.8	0.3	0.1	5.5	1.3	0.3	1.6	0.3	-8.4	7.9	3.9	22.5	145.0	959	87.1	793.0
Topock-2 [2]	79.4	0.6	0.3	41.3	357.0	-70.2	0.8	3.8	0.3	0.1	5.4	3.1	0.3	2.0	0.3	-9.9	7.9	7.1	25.5	288.0	1880	99.0	896.0
USFW-5	145.0	0.1	0.3	89.5	80.0	-97.3	1.7	0.3	0.3	0.5	30.6	299.0	0.3	0.3	0.3	-12.4	7.7	5.0	19.7	101.0	1020	234.0	701.0

Notes:

NC - Mean concentration for fluoride was not calculated as all fluoride concentrations were excluded from the background data set as directed by DTSC (DTSC, 2007a). Prior to exclusion, the mean fluoride concentration for Sanders was 6.5 mg/L (CH2M HILL, 2007a).

[1] Iron concentration from the July 20, 2005 event was excluded from the background data set as directed by DTSC (DTSC, 2007a). Prior to exclusion, the mean iron concentration for PGE-09S was 5.6 mg/L (CH2M HILL, 2007a).

[2] All Topock-2 results from the sixth event (June 2006) were excluded from the background data set (see Section 2.1).

TABLE 2-11

Median Concentrations for Trace Metals from Each Well

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, Califorina

Location	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Hexavalent chromium	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
ADOT New Well	43.1	1.0	5.6	83.4	0.5	0.5	7.8	0.5	2.9	8.2	0.5	0.1	10.1	0.5	0.5	0.5	0.5	11.5	32.4
BOR-2	25.0	1.0	17.7	56.7	0.5	0.5	0.5	0.5	0.5	0.1	0.5	0.1	5.8	1.2	0.5	0.5	0.5	0.5	5.5
CA Agriculture Station	40.6	1.0	3.3	31.8	0.5	0.5	2.6	0.5	1.5	2.3	0.5	0.1	21.0	0.5	2.9	0.5	0.5	14.7	29.2
EPNG-2	39.3	1.0	5.1	89.6	0.5	0.5	10.5	0.5	1.5	8.8	0.5	0.1	8.7	0.5	1.2	0.5	0.5	13.5	22.0
GSRV-2	25.0	1.0	5.5	57.7	0.5	0.5	27.9[1]	0.5	0.8	25.3[2]	0.5	0.1	6.6	0.5	1.5	0.5	0.5	17.4	8.4
GSWC-1	25.0	1.0	7.2	41.9	0.5	0.5	13.5	0.5	4.5	12.7	1.2	0.1	7.4	0.9	4.4	0.5	0.5	19.7	13.1
GSWC-2	25.0	1.0	8.0	50.9	0.5	0.5	6.1	0.5	2.0	5.3	0.5	0.1	7.3	0.5	1.9	0.5	0.5	19.0	5.0
GSWC-4	25.0	1.0	8.1	43.5	0.5	0.5	11.5	0.5	1.9	10.4	0.5	0.1	7.0	0.5	1.1	0.5	0.5	21.5	13.9
Langmaack	25.0	1.0	6.3	25.9	0.5	0.5	21.6	0.5	3.0	21.0	0.5	0.1	3.6	0.5	1.9	0.5	0.5	18.5	15.9
Lily Hill	25.0	1.0	15.3	59.9	0.5	0.5	8.9	0.5	3.7	8.9	0.5	0.1	13.9	0.5	2.8	0.5	0.5	22.9	23.4
MW-16	25.0	1.0	9.6	29.4	0.5	0.5	10.5	0.5	1.4	8.5	0.5	0.1	12.8	8.7	1.7	0.5	0.5	31.9	13.1
MW-17	25.0	1.0	1.6	35.6	0.5	0.5	12.6	0.5	5.2	13.9	0.5[3]	0.1	18.9	1.7	13.0	0.5	0.5	4.0	72.5
MW-18	25.0	1.0	1.1	68.9	0.5	0.5	36.2	0.5	0.8	33.4	0.5	0.1	4.7	0.5	3.1	0.5	0.5	4.3	16.6
Needles MW-10	25.0	1.0	3.7	20.7	0.5	0.5	0.5	0.5	1.2	0.1	0.5	0.1	10.3	0.5	1.1	0.5	0.5	5.2	5.0
Needles MW-11	25.0	1.0	6.1	27.6	0.5	0.5	2.8	0.5	3.9	2.4	0.5	0.1	16.8	0.5	3.9	0.5	0.5	10.7	11.5
Needles MW-12	25.0	1.0	3.6	31.5	0.5	0.5	0.5	0.5	4.0	0.1	0.5	0.1	11.1	3.9	0.5	0.5	0.5	5.5	18.4
New Farm Well	25.0	1.0	5.4	69.2	0.5	0.5	0.5	0.5	1.4	0.1	0.5	0.1	6.1	0.5	0.5	0.5	0.5	0.5	7.8
P-2	25.0	1.0	2.2	148.0	0.5	0.5	3.4	0.5	2.1	3.0	0.5	0.1	5.8	0.6	1.8	0.5	0.5	11.8	22.0
PGE-09S	25.0	1.0	NC[5]	112.0	0.5	0.5	0.5	0.5	1.9	0.5	0.5	0.1	18.0	1.5	0.5	0.5	0.5	0.5	NC[6]
PMM-Supply	25.0	1.0	1.6	151.0	0.5	0.5	10.0	0.5	1.5	9.0	0.5	0.1	5.4	0.5	1.6	0.5	0.5	9.4	25.6
Sanders	25.0	1.0	NC[5]	47.5	0.5	0.5	0.5	0.5	3.6	0.4	0.5	0.1	37.2	0.8	3.2	0.5	0.5	61.8	81.8
TMLP-2	25.0	1.0	6.0	14.6	0.5	0.5	22.1	0.5	0.5	18.6	0.5	0.1	5.5	0.5	0.5	0.5	0.5	20.0	5.0
Tayloe	25.0	1.0	5.3	48.2	0.5	0.5	0.5	0.5	2.3	0.5	2.0	0.1	10.6	0.5	2.1	0.5	0.5	7.8	71.9
Topock-2[5]	25.0	1.0	NC[5]	72.6	0.5	0.5	11.0	0.5	3.5	7.4	0.5[4]	0.1	22.1	0.5	0.5	0.5	0.5	19.1	12.4
USFW-5	25.0	1.0	3.9	46.0	0.5	0.5	0.5	0.5	1.7	0.1	0.5	0.1	5.1	0.5	0.5	0.5	0.5	0.5	5.0

Notes:

All concentrations in ug/L (micrograms per liter).

[1] Cr(T) concentration from the May 19, 2005 event was excluded from the background study dataset as directed by DTSC (DTSC, 2007a).
Prior to exclusion, median Cr(T) concentration at GSRV-2 was 28.3 ug/L (CH2M HILL, 2007b).

[2] Cr(VI) concentration from the May 19, 2005 event was excluded from the background study dataset as directed by DTSC (DTSC, 2007a).
Prior to exclusion, median Cr(VI) concentration at GSRV-2 was 25.4 ug/L (CH2M HILL, 2007b).

[3] Pb concentration from the November 2, 2005 event was excluded from the background study dataset as directed by DTSC (DTSC, 2007a).
Prior to exclusion, median Pb concentration at MW-17 was 0.5 ug/L (CH2M HILL, 2007b).

[4] Pb concentrations from the Nov 2, 2005 and June 30, 2006 events were excluded from the background study dataset as directed by DTSC (DTSC, 2007a).
Prior to exclusion, median Pb concentration at Topock-2 was 0.5 ug/L (CH2M HILL, 2007b).

[5] All Topock-2 results from the sixth event (June 2006) were excluded from the background data set (see Section 2.1).

NC[5] - Median concentrations not calculated since all As concentrations were excluded from the background data set as directed by DTSC (DTSC, 2007a).

NC[6] - Median concentrations not calculated since all Zn concentrations were excluded from the background data set (see Section 2.2.3).

TABLE 2-12

Median Concentrations for General Chemistry Parameters from Each Well

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

Location	Alkalinity	Boron, Dissolved	Bromide	Calcium, Dissolved	Chloride	Deuterium	Dissolved Organic Carbon	Fluoride	Iodine	Iron, Dissolved	Magnesium, Dissolved	Manganese, Dissolved	N-Ammonia	N-Nitrate	N-Total Kjeldahl Nitrogen	Oxygen 18	pH	Potassium, Dissolved	Silica, Soluble	Sodium, Dissolved	Specific conductance	Sulfate	Total dissolved solids
Units	mg/L	mg/L	mg/L	mg/L	mg/L	0/00	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	00/00	pH Units	mg/L	mg/L	mg/L	µS/cm	mg/L	mg/L
ADOT New Well	86.7	0.6	0.3	39.3	209.0	-73.0	0.5	4.0	0.3	0.1	5.9	2.2	0.3	1.9	0.3	-10.6	7.8	5.6	24.5	179.0	1200	68.4	615.0
BOR-2	201.0	0.2	0.3	78.8	78.4	-101.0	3.3	0.3	0.3	1.4	35.9	273.0	0.4	0.3	0.9	-12.9	7.6	5.2	24.2	113.0	1200	206.0	785.0
CA Agriculture Station	89.2	0.6	0.3	60.8	260.0	-63.9	0.5	1.4	0.3	0.1	16.5	3.0	0.3	1.8	0.3	-9.0	7.8	5.4	28.7	237.0	1610	214.0	930.0
EPNG-2	91.4	0.5	0.3	37.6	195.0	-74.2	0.5	3.6	0.3	0.1	7.4	0.5	0.3	2.0	0.3	-10.4	7.7	5.4	25.1	171.0	1150	65.9	578.0
GSRV-2	157.0	0.2	0.3	44.4	50.9	-69.7	0.5	2.0	0.3	0.1	15.1	0.5	0.3	3.1	0.3	-10.1	7.6	5.3	37.8	63.4	593	38.1	373.0
GSWC-1	125.0	0.3	0.3	40.2	77.5	-67.0	0.5	0.9	0.3	0.1	17.2	0.5	0.3	4.5	0.3	-9.4	7.7	6.4	32.3	90.5	728	89.2	480.0
GSWC-2	127.0	0.2	0.3	31.2	98.8	-68.8	0.5	0.9	0.3	0.1	12.1	0.9	0.3	1.6	0.3	-9.6	7.7	5.4	33.3	104.0	772	58.9	450.0
GSWC-4	154.0	0.2	0.3	25.7	48.1	-69.5	0.5	0.9	0.3	0.1	9.0	0.5	0.3	1.9	0.3	-9.9	7.8	4.7	33.6	83.1	584	34.6	363.0
Langmaack	140.0	0.2	0.3	29.8	46.8	-68.5	0.5	0.8	0.3	0.1	12.8	1.6	0.3	3.1	0.3	-9.8	7.8	5.4	31.5	67.2	566	36.2	348.0
Lily Hill	141.0	0.3	0.3	25.7	50.6	-75.0	0.5	1.7	0.3	0.1	8.6	1.1	0.3	4.1	0.3	-10.4	7.7	4.9	32.9	110.0	892	61.7	428.0
MW-16	98.6	0.3	0.3	30.3	180.0	-63.9	1.6	2.4	0.3	0.1	5.8	1.6	0.3	2.8	0.3	-9.0	7.3	4.1	23.2	213.0	1220	127.0	670.0
MW-17	53.6	0.2	0.3	123.0	102.0	-58.4	0.8	1.8	0.3	0.1	18.5	3.9	0.3	3.8	0.3	-7.9	7.6	10.3	19.0	280.0	1880	694.0	1370.0
MW-18	82.8	0.2	0.3	83.8	272.0	-65.5	0.5	0.6	0.3	0.1	14.0	1.5	0.3	3.8	0.3	-9.3	7.5	7.7	23.5	171.0	1540	84.6	800.0
Needles MW-10	143.0	0.2	0.3	74.9	94.9	-98.3	1.4	0.7	0.3	0.1	27.1	32.2	0.3	0.3	0.3	-12.7	7.8	4.4	26.0	143.0	1250	262.0	783.0
Needles MW-11	207.0	0.5	0.3	107.0	302.0	-102.0	1.5	1.7	0.3	0.1	45.7	18.6	0.3	1.7	0.3	-13.5	7.5	12.5	40.3	327.0	2440	436.0	1510.0
Needles MW-12	240.0	0.4	0.3	153.0	254.0	-97.0	2.9	0.8	0.3	0.1	61.4	585.0	0.3	0.7	0.3	-12.4	7.4	9.5	29.7	303.0	2560	556.0	1640.0
New Farm Well	193.0	0.2	0.3	117.0	108.0	-99.0	2.7	0.3	0.3	0.5	37.0	508.0	0.3	0.3	0.3	-12.4	7.5	5.8	22.3	149.0	1390	317.0	988.0
P-2	50.4	0.5	0.3	265.0	1490.0	-69.7	0.5	1.9	0.3	0.1	52.0	0.5	0.3	2.6	0.3	-9.7	7.6	10.4	23.0	680.0	5170	206.0	3150.0
PGE-09S	508.0	1.5	0.3	412.0	3890.0	-85.2	7.4	0.3	0.3	3.8[1]	154.0	1250.0	0.7	0.3	0.9	-11.4	7.2	19.3	28.0	2650.0	15800	899.0	8620.0
PMM-Supply	81.9	0.2	0.3	86.8	318.0	-65.5	0.5	2.3	0.3	0.1	17.4	1.1	0.3	3.1	0.3	-9.1	7.6	6.6	21.3	159.0	1610	62.8	895.0
Sanders	260.0	0.9	0.3	50.4	266.0	-72.3	0.8	NC	0.3	0.1	6.0	122.0	0.3	2.5	0.3	-10.1	7.5	3.5	46.4	355.0	1920	176.0	1070.0
TMLP-2	147.0	0.1	0.3	22.9	25.3	-68.6	0.5	1.2	0.3	0.1	10.0	2.6	0.3	3.6	0.3	-10.2	7.8	6.2	35.2	57.9	444	15.9	270.0
Tayloe	108.0	0.4	0.3	34.6	137.0	-60.5	0.5	0.8	0.3	0.1	5.4	0.5	0.3	1.7	0.3	-8.4	8.0	3.8	22.7	145.0	965	86.6	558.0
Topock-2 [2]	77.4	0.6	0.3	41.5	378.0	-72.0	0.5	3.8	0.3	0.1	5.6	2.5	0.3	1.9	0.3	-9.9	7.9	7.5	25.5	293.0	1800	102.0	960.0
USFW-5	146.0	0.1	0.3	88.7	79.3	-96.5	1.7	0.3	0.3	0.5	30.9	302.0	0.3	0.3	0.3	-12.2	7.8	5.0	16.2	100.0	1050	236.0	701.0

Notes:

NC - Mean concentration for Fluoride was not calculated as all Fluoride concentrations were excluded from the background data set as directed by DTSC (DTSC, 2007a).

[1] Iron concentration from the July 20, 2005 event was excluded from the background data set as directed by DTSC (DTSC, 2007a).

[2] All Topock-2 results from the sixth event (June 2006) were excluded from the background data set (see Section 2.1).

Table 2-13

Summary Statistics After Data Exclusion[1]

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

Parameter	Units	Mean	Median	Standard Deviation	Number of Detects	Number of Samples	Percent Detects	Normality p-value	Lognormality p-value	Distribution	Elevated Percentile Estimated by UTL (with 95% confidence)	UTL [3,4]
Aluminum	ug/L	35.1	32.3	9.5	18	25	72	0.010	0.042	Nonparametric	89	55.8
Antimony	ug/L	1.0	1.0	0.0	1	25	4	0.000	0.000	Nonparametric	89	1.22
Arsenic	ug/L	5.9	5.5	3.8	22	22	100	0.010	0.499	Lognormal	95	24.3
Barium	ug/L	60.1	48.9	37.1	25	25	100	0.004	0.977	Lognormal	95	195
Beryllium	ug/L	0.5	0.5	0.0	1	25	4	0.000	0.000	Nonparametric	89	0.663
Cadmium	ug/L	0.5	0.5	0.0	0	25	0	--	--	Nonparametric	89	NA[2]
Chromium	ug/L	8.9	7.7	9.3	21	25	84	0.001	0.005	Nonparametric	89	34.1
Cobalt	ug/L	0.5	0.5	0.1	2	25	8	0.000	0.000	Nonparametric	89	0.843
Copper	ug/L	3.1	2.4	1.8	24	25	96	0.034	0.589	Lognormal	95	10.5
Hexavalent chromium	ug/L	7.7	7.4	8.5	19	25	76	0.001	0.004	Nonparametric	89	31.8
Lead	ug/L	0.7	0.5	0.4	11	25	44	0.000	0.000	Nonparametric	89	1.91
Mercury	ug/L	0.1	0.1	0.0	0	25	0	0.000	0.000	Nonparametric	89	NA[2]
Molybdenum	ug/L	11.3	9.0	7.6	25	25	100	0.001	0.378	Lognormal	95	36.3
Nickel	ug/L	1.8	0.9	2.5	22	25	88	0.000	0.001	Nonparametric	89	10.6
Selenium	ug/L	2.2	1.7	2.5	20	25	80	0.000	0.097	Lognormal	95	10.3
Silver	ug/L	0.7	0.5	0.4	8	25	32	0.000	0.000	Nonparametric	89	2.13
Thallium	ug/L	0.5	0.5	0.1	4	25	16	0.000	0.000	Nonparametric	89	0.908
Vanadium	ug/L	14.0	11.9	12.6	23	25	92	0.000	0.002	Nonparametric	89	59.9
Zinc	ug/L	27.2	19.8	19.9	24	24	100	0.000	0.024	Nonparametric	88	77.7

Notes:

[1] Outliers from GSRV-2, PGE-09S, Sanders, Topock-2, and MW-17 were removed from the background data set (see Section 2.2.4).

[2] Any detection above the reporting limits used in the study will be viewed as an exceedance of background.

[3] 95% upper confidence limit of the elevated percentile.

[4] Potential limitations for use of these UTLs are described in Appendix E and prior background study documents such as DTSC's November 30, 2007 letter (DTSC, 2007a).

Table 3-1

Calculated Upper Tolerance Limits for Trace Metals[1]

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results
PG&E Topock Compressor Station and Vicinity, Needles, California

Parameter	Units	Elevated Percentile Estimated by UTL (with 95% confidence)	UTL [3,5]
Aluminum	ug/L	89	55.8
Antimony	ug/L	89	1.22
Arsenic	ug/L	95	24.3[4]
Barium	ug/L	95	195
Beryllium	ug/L	89	0.663
Cadmium	ug/L	89	NA[2]
Chromium	ug/L	89	34.1
Cobalt	ug/L	89	0.843
Copper	ug/L	95	10.5
Hexavalent chromium	ug/L	89	31.8
Lead	ug/L	89	1.91[4]
Mercury	ug/L	89	NA[2]
Molybdenum	ug/L	95	36.3
Nickel	ug/L	89	10.6
Selenium	ug/L	95	10.3
Silver	ug/L	89	2.13
Thallium	ug/L	89	0.908
Vanadium	ug/L	89	59.9
Zinc	ug/L	88	77.7

Notes:

[1] Outliers from GSRV-2, PGE-09S, Sanders, Topock-2, and MW-17 were removed from the background data set (see Sections 2.2.3 and 2.2.4).

[2] Any detection above the method reporting limit (MRP) used in the study will be viewed as an exceedance of background.

[3] 95% upper confidence limit of the elevated percentile.

[4] Prior to the exclusion (DTSC, 2007a), the UTLs for arsenic and lead were 42.8 and 11.5 ug/L, respectively.

[5] Potential limitations for use of these UTLs are described in Appendix E and prior background study documents such as DTSC’s November 30, 2007 letter (DTSC, 2007a).

Table 4-1

Significance of Time Trend During Course of Background Study

Groundwater Background Study Steps 3 and 4: Revised Final Report of Results

PG&E Topock Compressor Station and Vicinity, Needles, California

	Counts					Percentages			
Parameter	No Significant Trend	Significantly Decreasing	Significantly Increasing	All Non-detects	Total	No Significant Trend	Significantly Decreasing	Significantly Increasing	All Non-detects
Aluminum	18	0	0	7	25	72%	0%	0%	28%
Antimony	1	0	0	24	25	4%	0%	0%	96%
Arsenic	20	1	1	0	22	91%	5%	5%	0%
Barium	21	3	1	0	25	84%	12%	4%	0%
Beryllium	1	0	0	24	25	4%	0%	0%	96%
Cadmium	0	0	0	25	25	0%	0%	0%	100%
Chromium	21	0	0	4	25	84%	0%	0%	16%
Cobalt	2	0	0	23	25	8%	0%	0%	92%
Copper	19	5	0	1	25	76%	20%	0%	4%
Hexavalent chromium	17	1	1	6	25	68%	4%	4%	24%
Lead	11	0	0	14	25	44%	0%	0%	56%
Mercury	0	0	0	25	25	0%	0%	0%	100%
Molybdenum	23	0	2	0	25	92%	0%	8%	0%
Nickel	22	0	0	3	25	88%	0%	0%	12%
Selenium	20	0	0	5	25	80%	0%	0%	20%
Silver	8	0	0	17	25	32%	0%	0%	68%
Thallium	4	0	0	21	25	16%	0%	0%	84%
Vanadium	20	1	2	2	25	80%	4%	8%	8%
Zinc	21	3	0	0	24	88%	13%	0%	0%
Sum	249	14	7	201	471	53%	3%	1%	43%
Sum without All Nondetects	249	14	7		270	92%	5%	3%	

TABLE 4-2
Topock Background Study Metal Concentrations Compared to Published Metal Concentrations within Region
Groundwater Background Study Steps 3 and 4: Revised Final Report of Results
PG&E Compressor Station and Vicinity, Needles, California

Analyte	Topock Background Study Mean	Topock Background Study UTL	ADEQ[1] Sacramento Valley Study Mean	RASA[2] Program Mean	RASA[2] Program Standard Deviation	RASA[2] Program Range	RASA[2] Program: Number of Samples Collected
Aluminum	35.1	55.80	NM	9.80	20.10	0-300	363
Antimony	1.0	1.22	> 90% below MRL	NM	NM	NM	NM
Arsenic	5.9	24.30	14.00	15.70	31.60	0-1,300	467
Barium	60.1	195	> 90% below MRL	95.90	464.70	0-8,100	314
Beryllium	0.5	0.66	> 90% below MRL	0.00	0.00	0-2	296
Cadmium	100% below MRL	100% below MRL	> 90% below MRL	0.00	0.00	0-0.2	336
Chromium	8.9	34.10	42.00	10.30	30.70	0-300	436
Cobalt	0.5	0.84	NM	0.10	0.70	0-6	298
Copper	3.1	10.50	21.00	2.30	7.40	0-70	369
Hexavalent chromium	7.7	31.80	NM	NM	NM	NM	NM
Lead	0.7	1.91	> 90% below MRL	3.10	10.90	0-110	371
Mercury	100% below MRL	100% below MRL	> 90% below MRL	0.10	0.20	0-0.2	387
Molybdenum	11.3	36.30	NM	7.70	16.60	0-150	347
Nickel	1.8	10.60	> 90% below MRL	NM	NM	NM	NM
Selenium	2.2	10.30	NM	1.90	3.10	0-30	434
Silver	0.7	2.13	> 90% below MRL	NM	NM	NM	NM
Thallium	0.5	0.91	> 90% below MRL	NM	NM	NM	NM
Vanadium	14.0	59.90	NM	18.50	19.00	0-130	293
Zinc	27.2	77.70	9.00	57.50	189.70	0-2,900	379

Notes:
1) ADEQ Open File Report June 2001. "Ambient Ground Water Quality of the Sacramento Valley Basin: A 1999 Baseline Study."
2) RASA = Regional Aquifer-System Analyis (Robertson 1991); zero mean values not explained, but are assumed to indicate >50% below MRL
3) NM = Not measured; MRL = Method Reporting Limit; Zero values in RASA range are as reported (no detection limit provided)
4) All concentrations in µg/L
5) The study of Ball and Izbicki (2004) conducted in the Mojave Desert, CA reported a range in Cr(VI) from <0.1 to 60 ug/L with a median of 5.5 ug/L, and Robertson (1975) reported a Cr(VI) range of <10 to 220 ug/L in Paradise Valley, AZ. See text for further description.

Figures

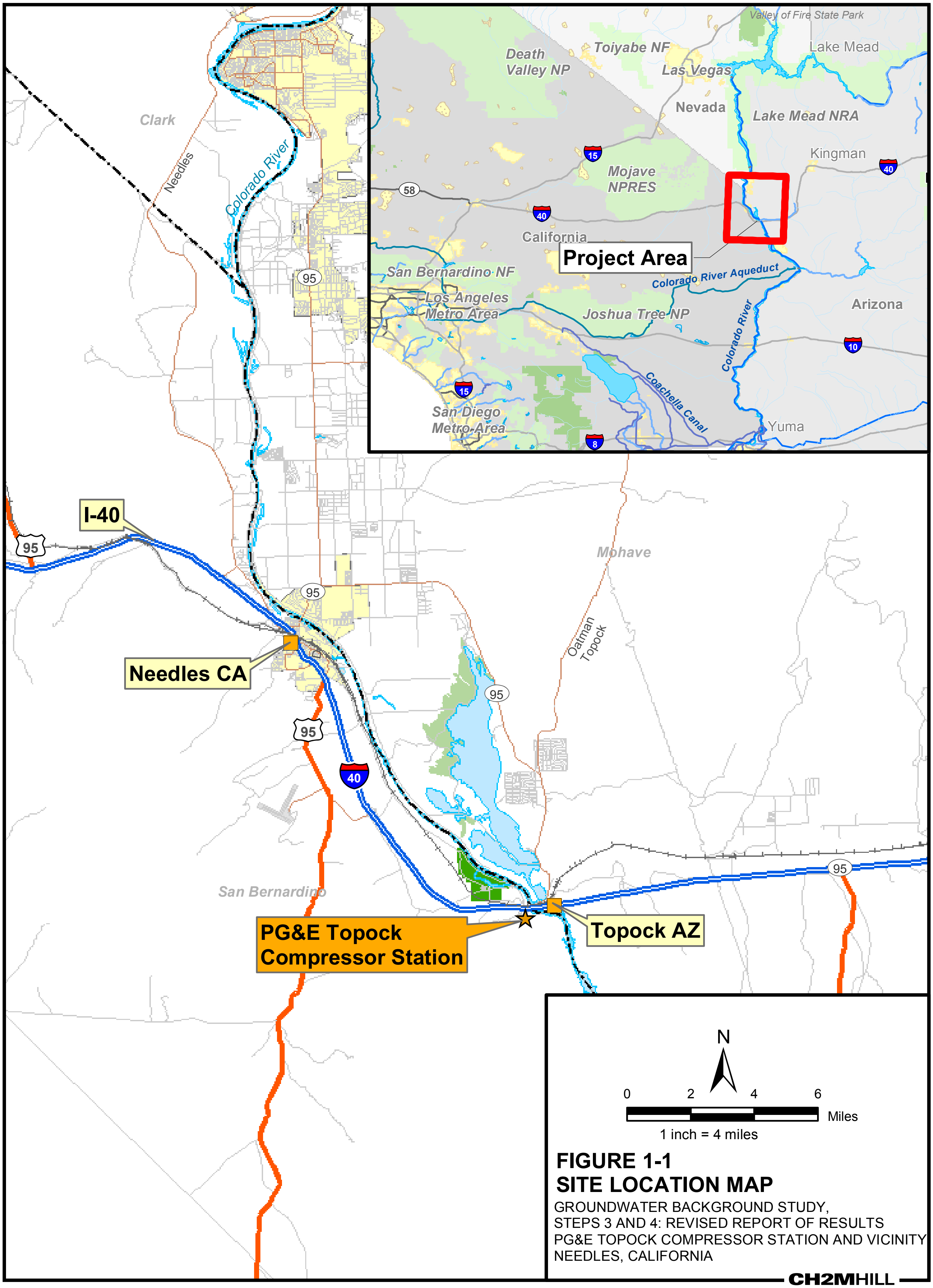

FIGURE 1-1
SITE LOCATION MAP

GROUNDWATER BACKGROUND STUDY,
STEPS 3 AND 4: REVISED REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

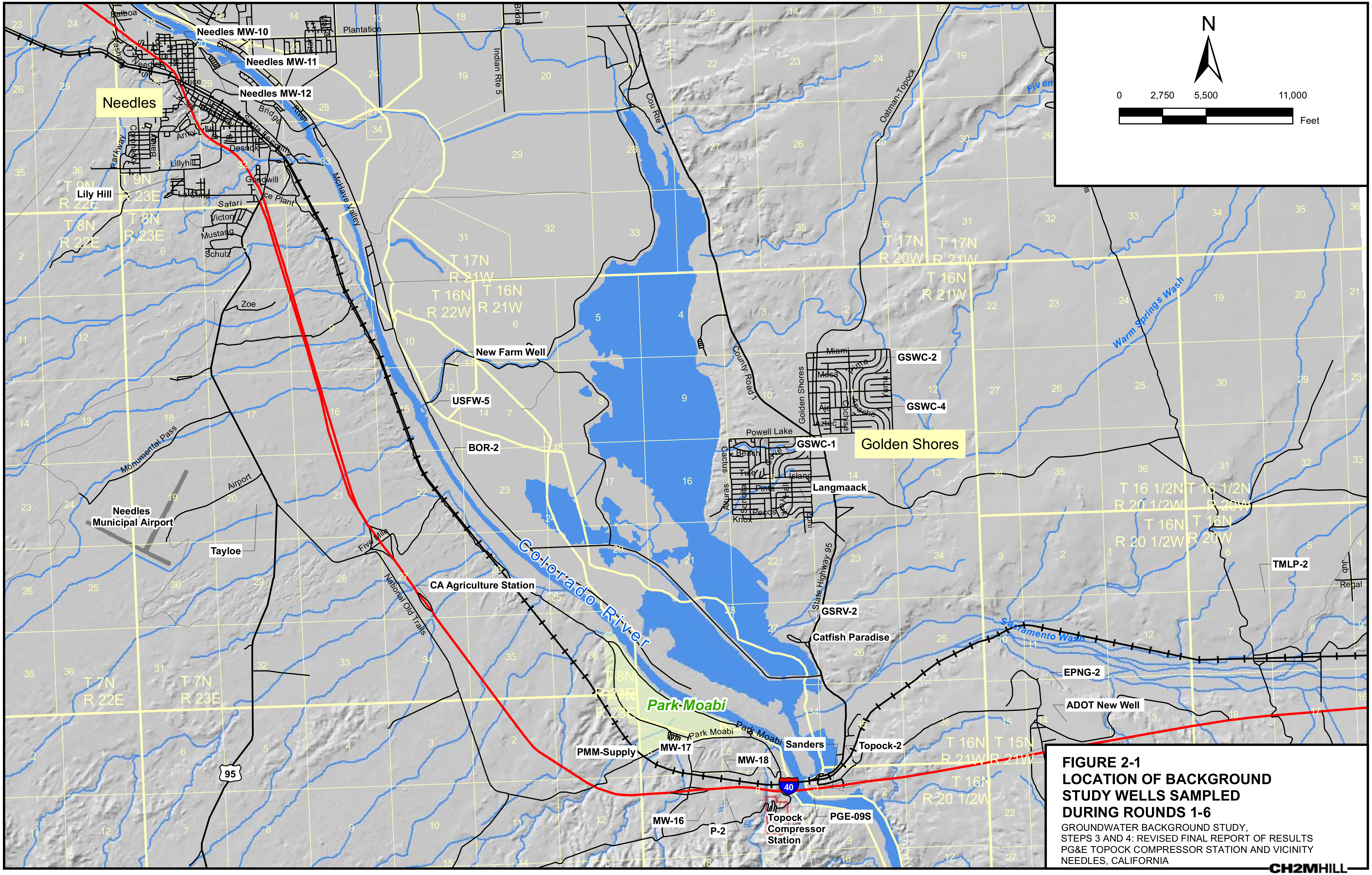

FIGURE 2-1
LOCATION OF BACKGROUND STUDY WELLS SAMPLED DURING ROUNDS 1-6

GROUNDWATER BACKGROUND STUDY,
STEPS 3 AND 4: REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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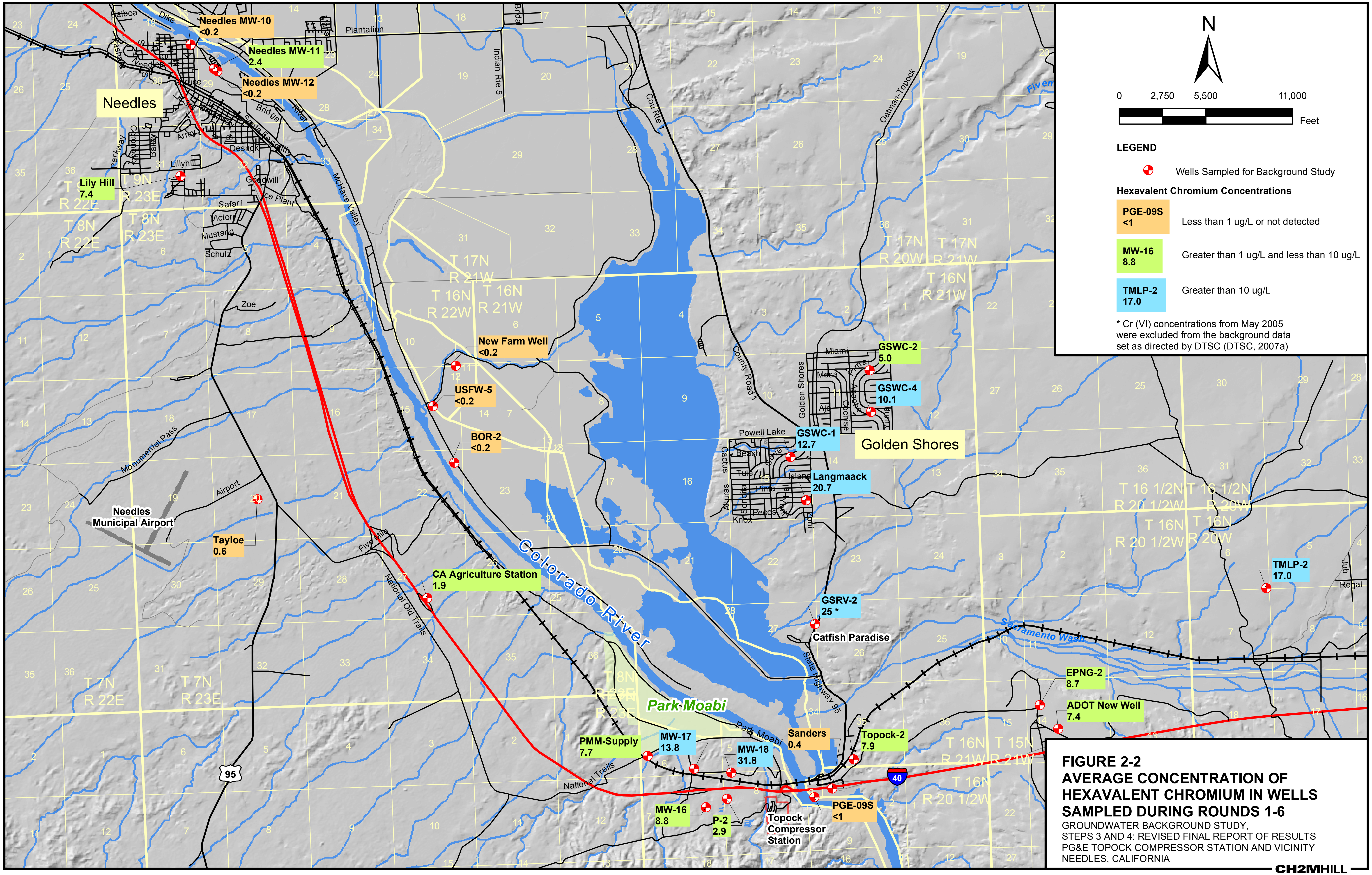

LEGEND

● Wells Sampled for Background Study

Hexavalent Chromium Concentrations

PGE-09S <1	Less than 1 ug/L or not detected
MW-16 8.8	Greater than 1 ug/L and less than 10 ug/L
TMLP-2 17.0	Greater than 10 ug/L

* Cr (VI) concentrations from May 2005 were excluded from the background data set as directed by DTSC (DTSC, 2007a)

FIGURE 2-2
AVERAGE CONCENTRATION OF HEXAVALENT CHROMIUM IN WELLS SAMPLED DURING ROUNDS 1-6

GROUNDWATER BACKGROUND STUDY,
STEPS 3 AND 4: REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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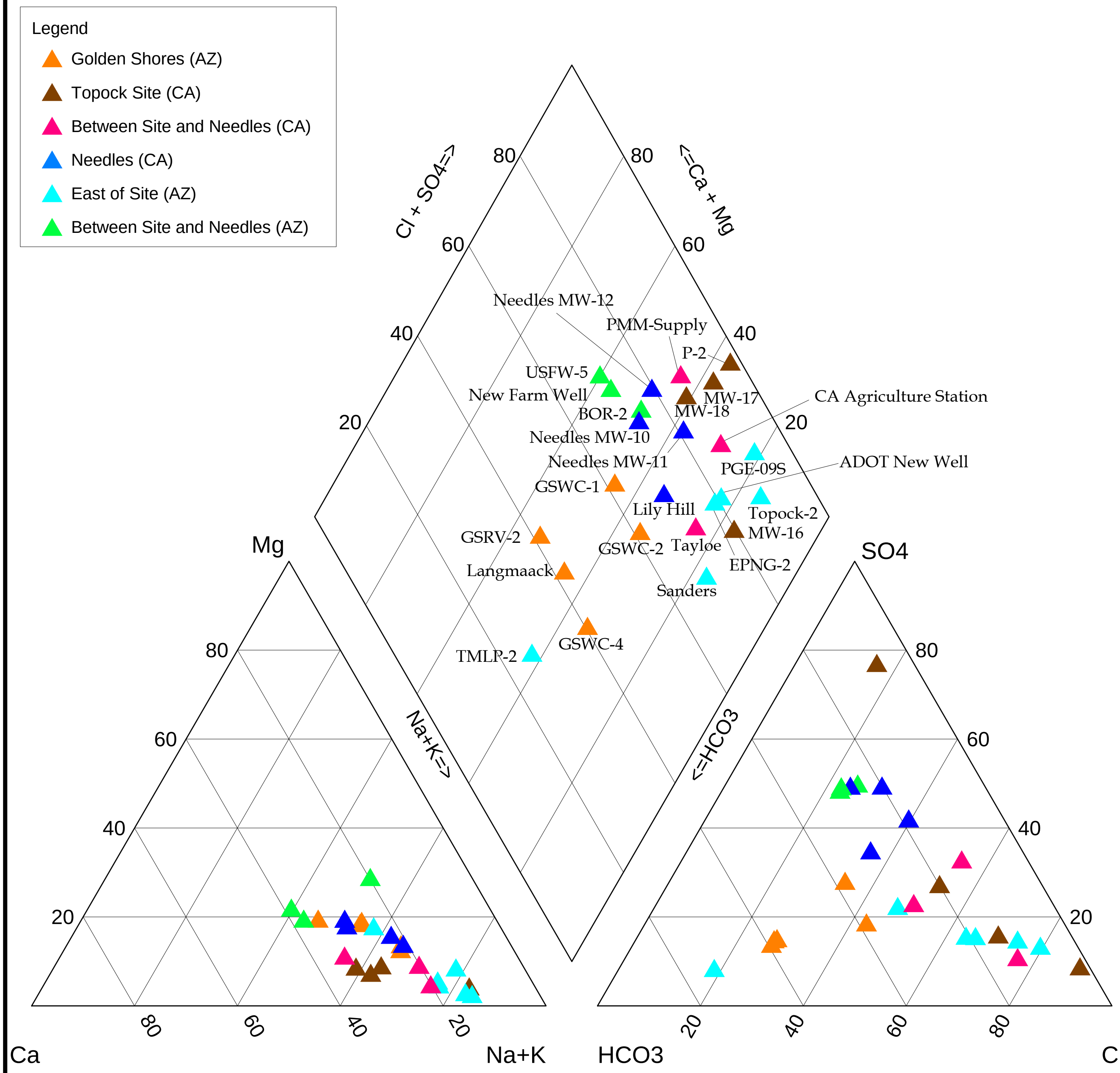

FIGURE 2-3
PIPER DIAGRAM OF MEAN CONCENTRATIONS FROM BACKGROUND WELLS IN DIFFERENT PORTIONS OF STUDY AREA

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

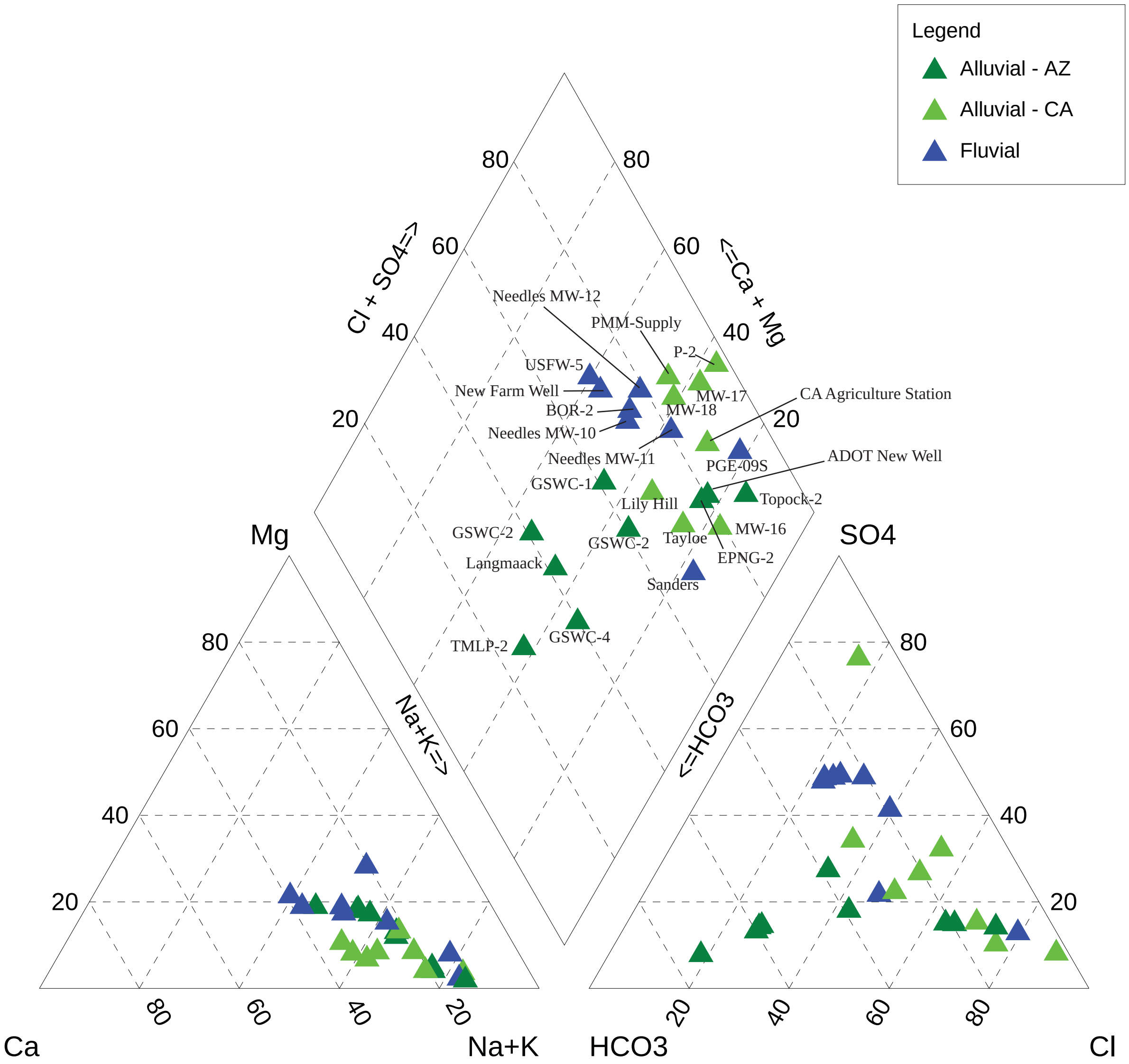

FIGURE 2-4
PIPER DIAGRAM OF MEAN CONCENTRATIONS FROM BACKGROUND WELLS SCREENED IN DIFFERENT GEOLOGIC MATERIALS

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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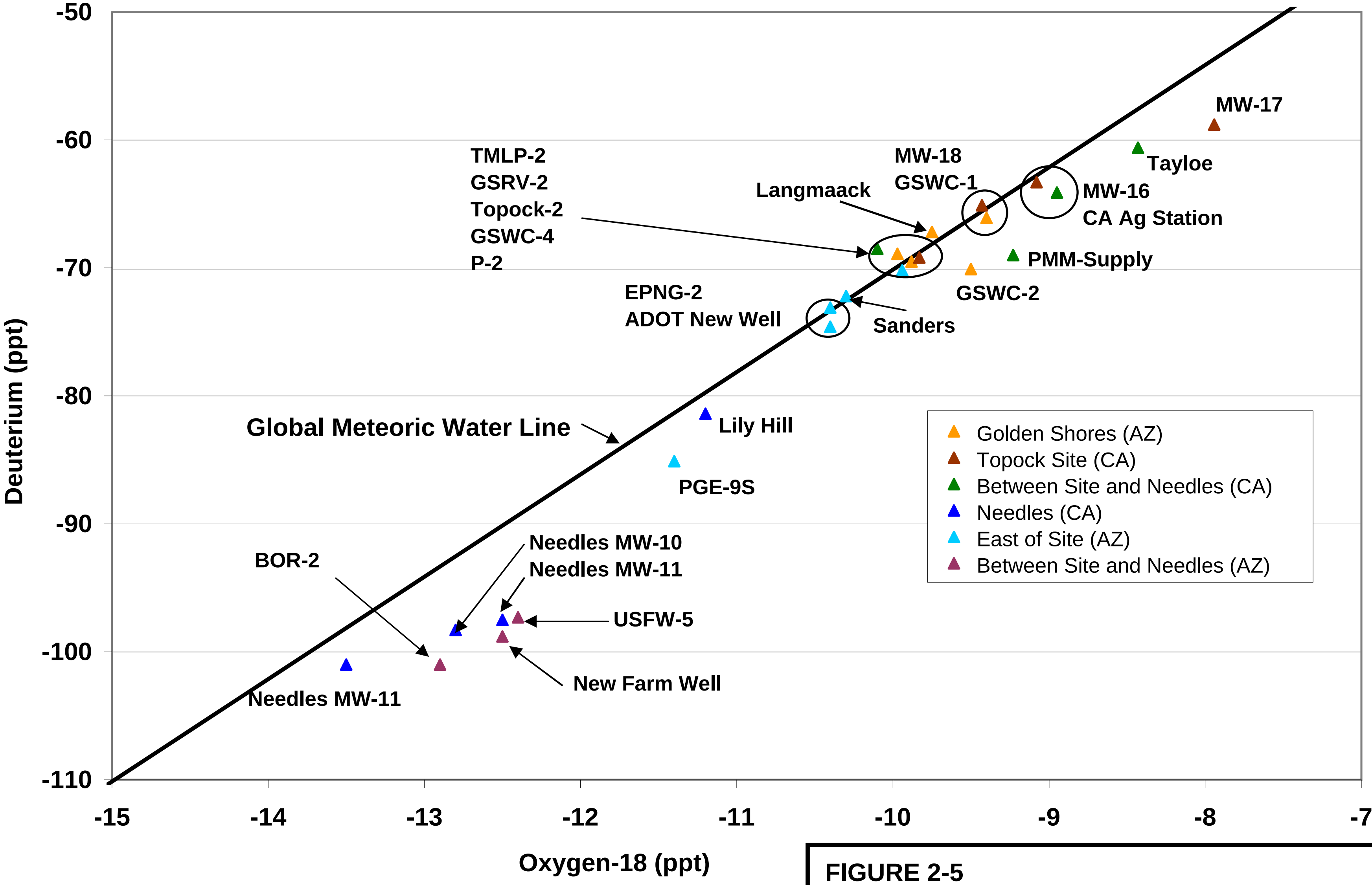

FIGURE 2-5
SCATTER PLOT OF MEAN CONCENTRATIONS OF STABLE ISOTOPES FROM BACKGROUND WELLS IN DIFFERENT PORTIONS OF STUDY AREA

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

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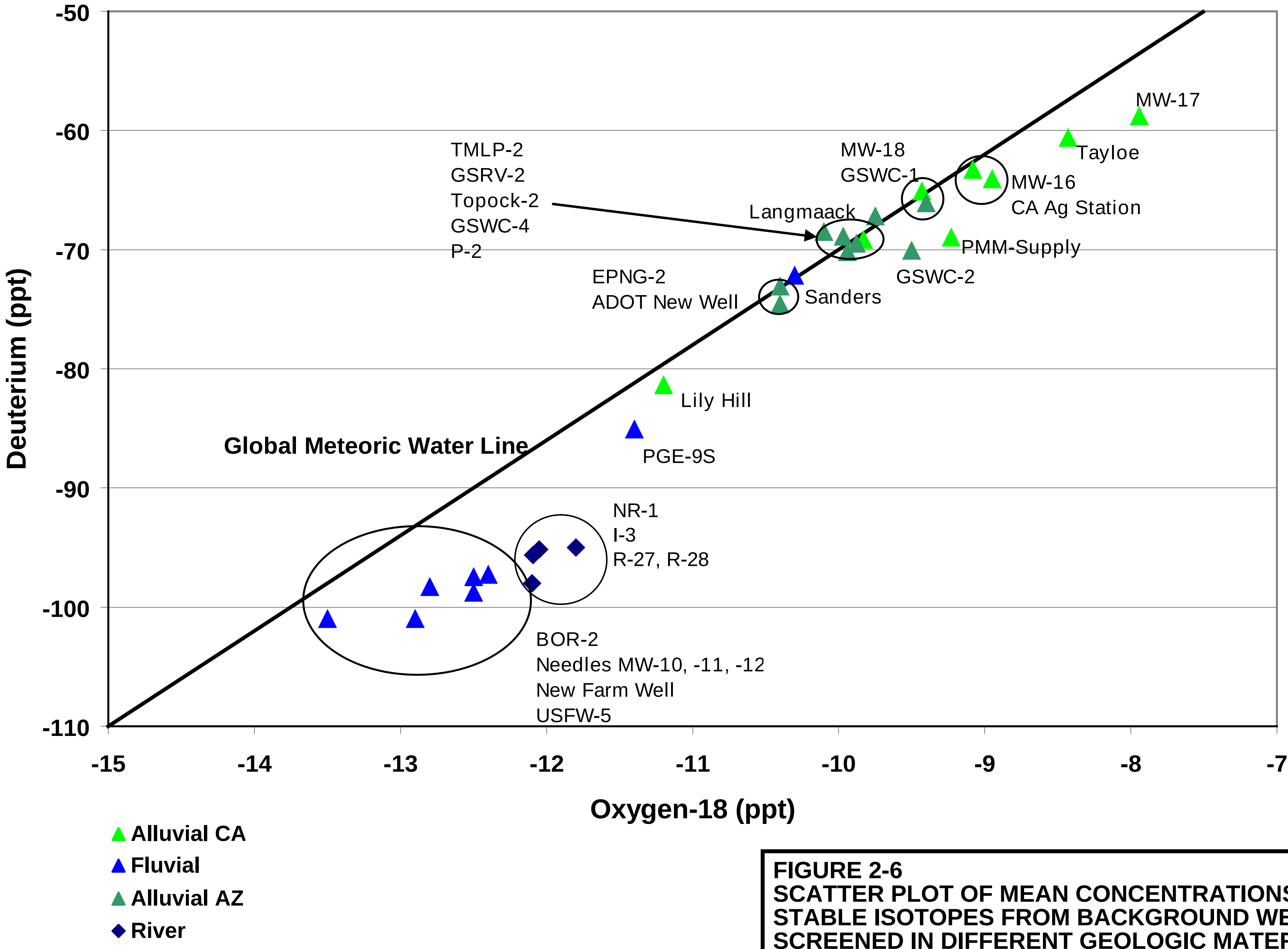

Note: Needles Wells Geology Unknown, Assumed Fluvial

FIGURE 2-6
SCATTER PLOT OF MEAN CONCENTRATIONS OF STABLE ISOTOPES FROM BACKGROUND WELLS SCREENED IN DIFFERENT GEOLOGIC MATERIALS
GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

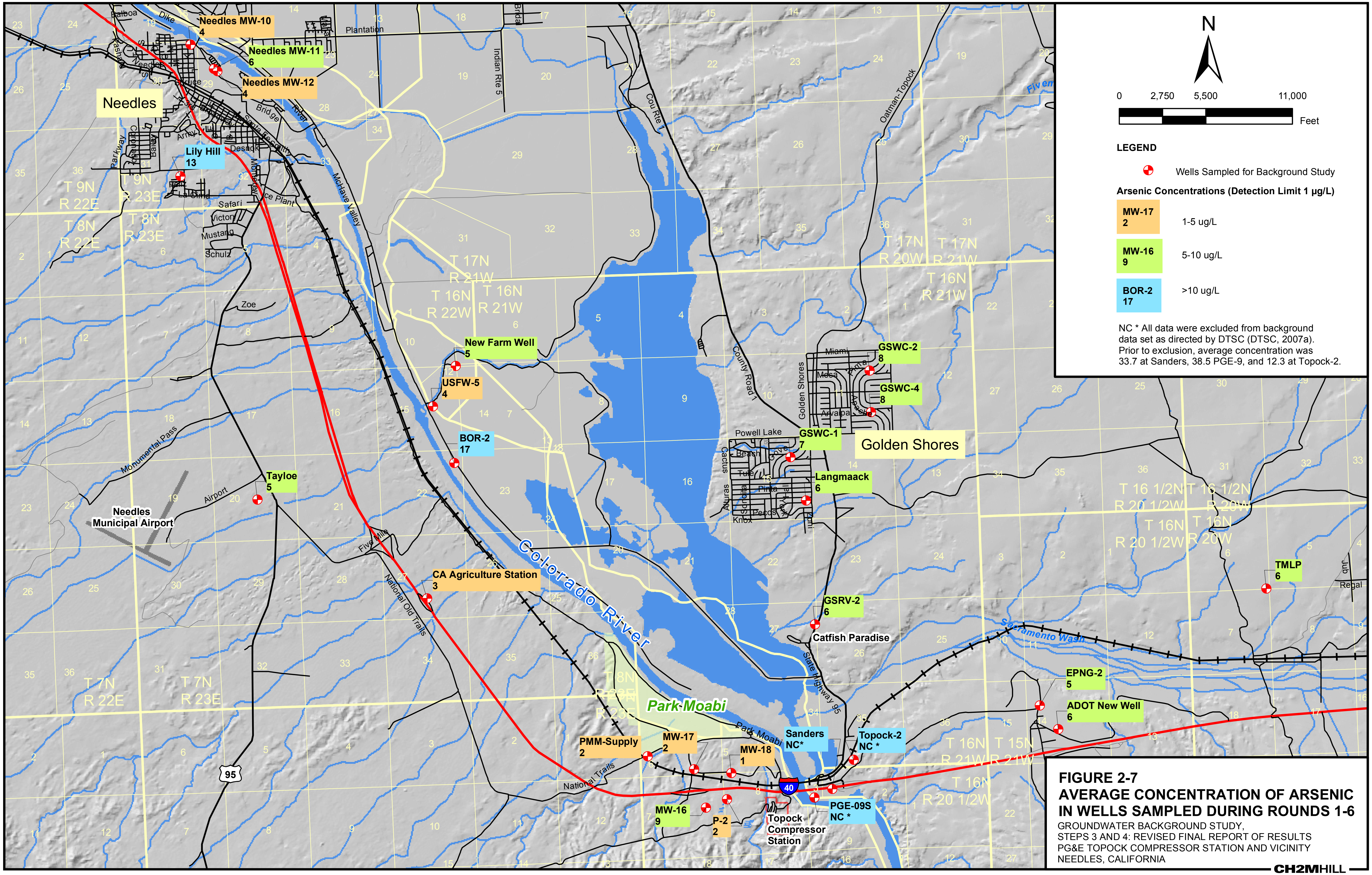

FIGURE 2-7
AVERAGE CONCENTRATION OF ARSENIC IN WELLS SAMPLED DURING ROUNDS 1-6

GROUNDWATER BACKGROUND STUDY,
STEPS 3 AND 4: REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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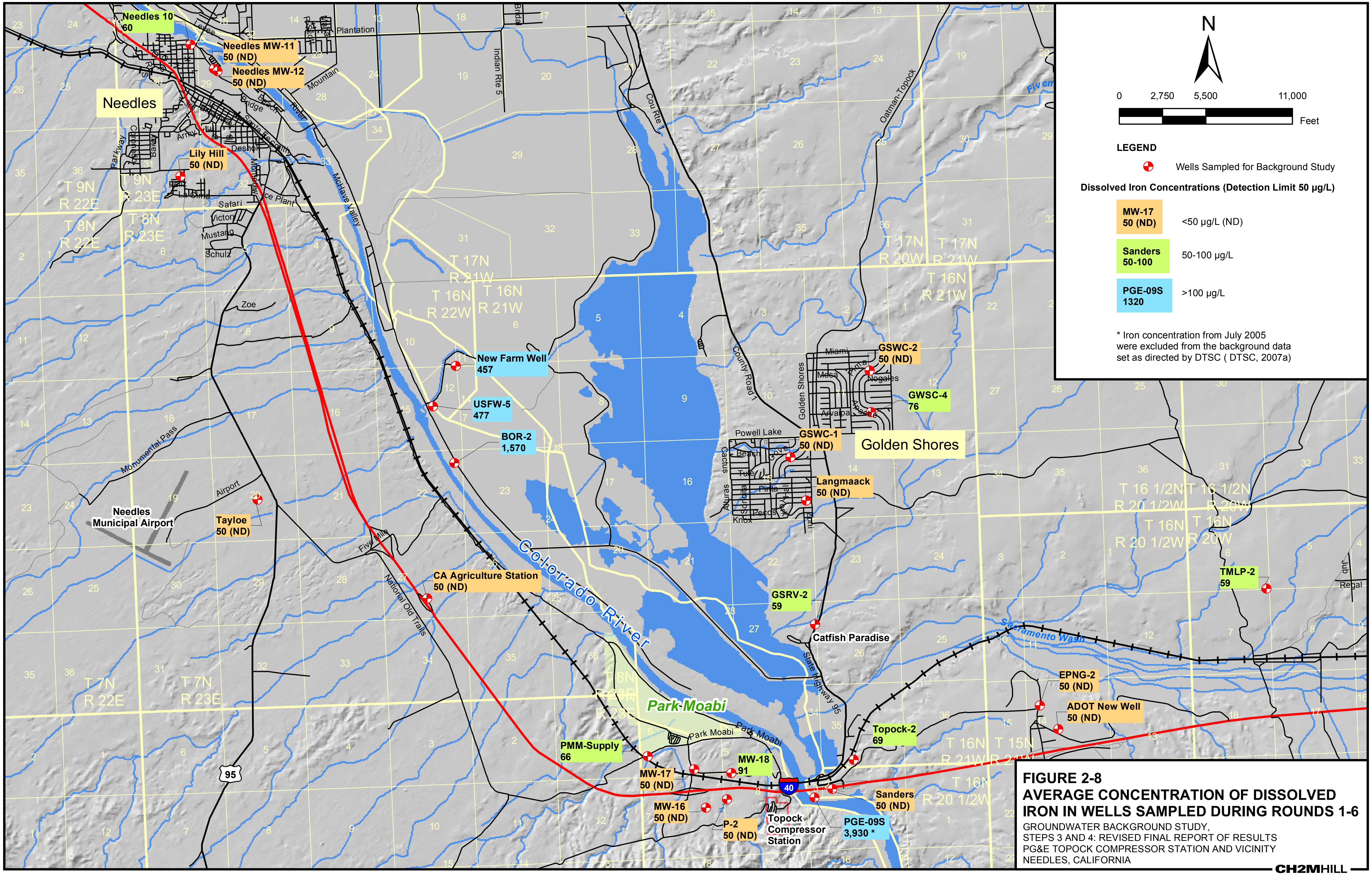

FIGURE 2-8
AVERAGE CONCENTRATION OF DISSOLVED IRON IN WELLS SAMPLED DURING ROUNDS 1-6

GROUNDWATER BACKGROUND STUDY,
STEPS 3 AND 4: REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

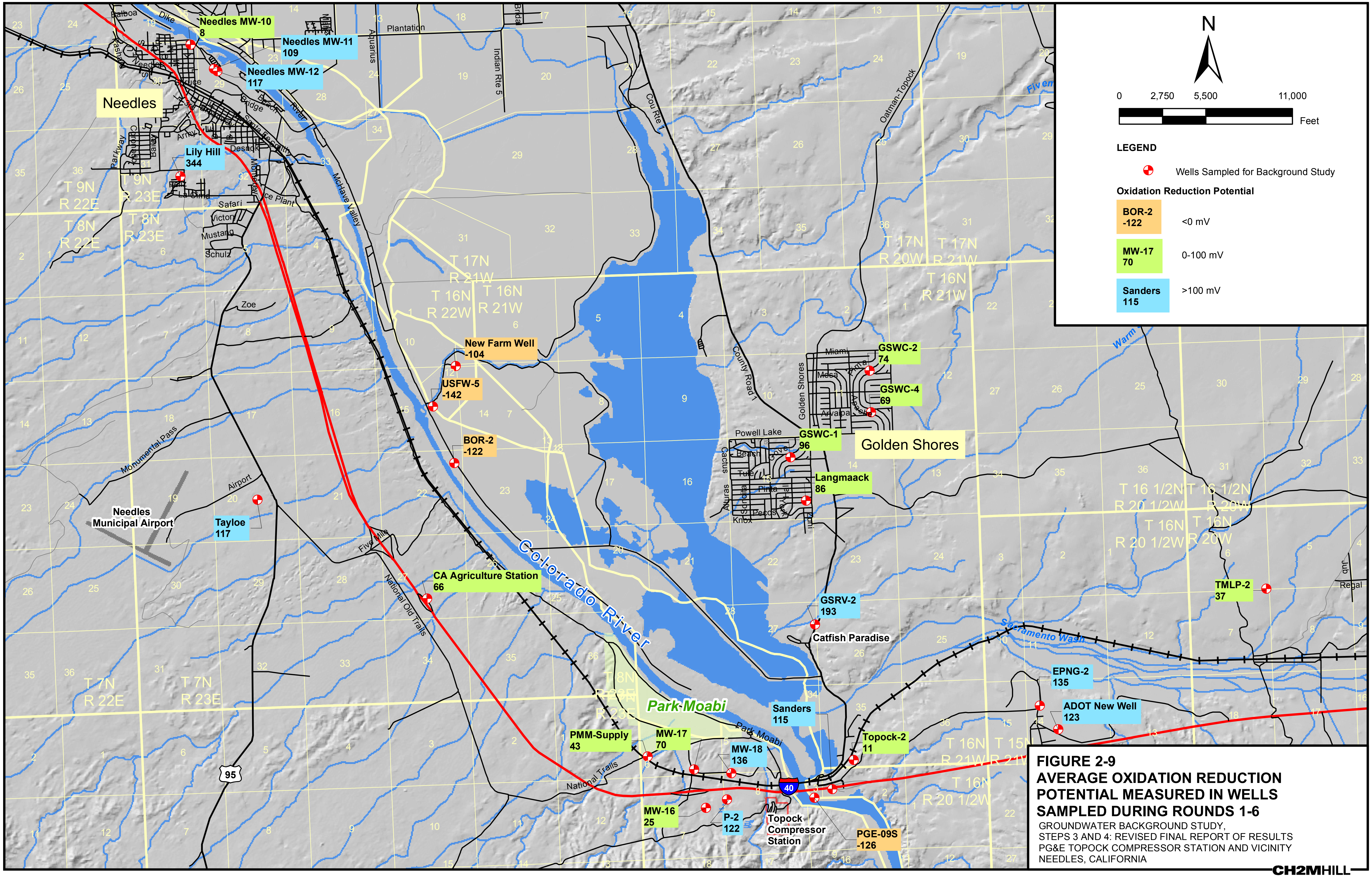

FIGURE 2-9
AVERAGE OXIDATION REDUCTION POTENTIAL MEASURED IN WELLS SAMPLED DURING ROUNDS 1-6

GROUNDWATER BACKGROUND STUDY,
STEPS 3 AND 4: REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

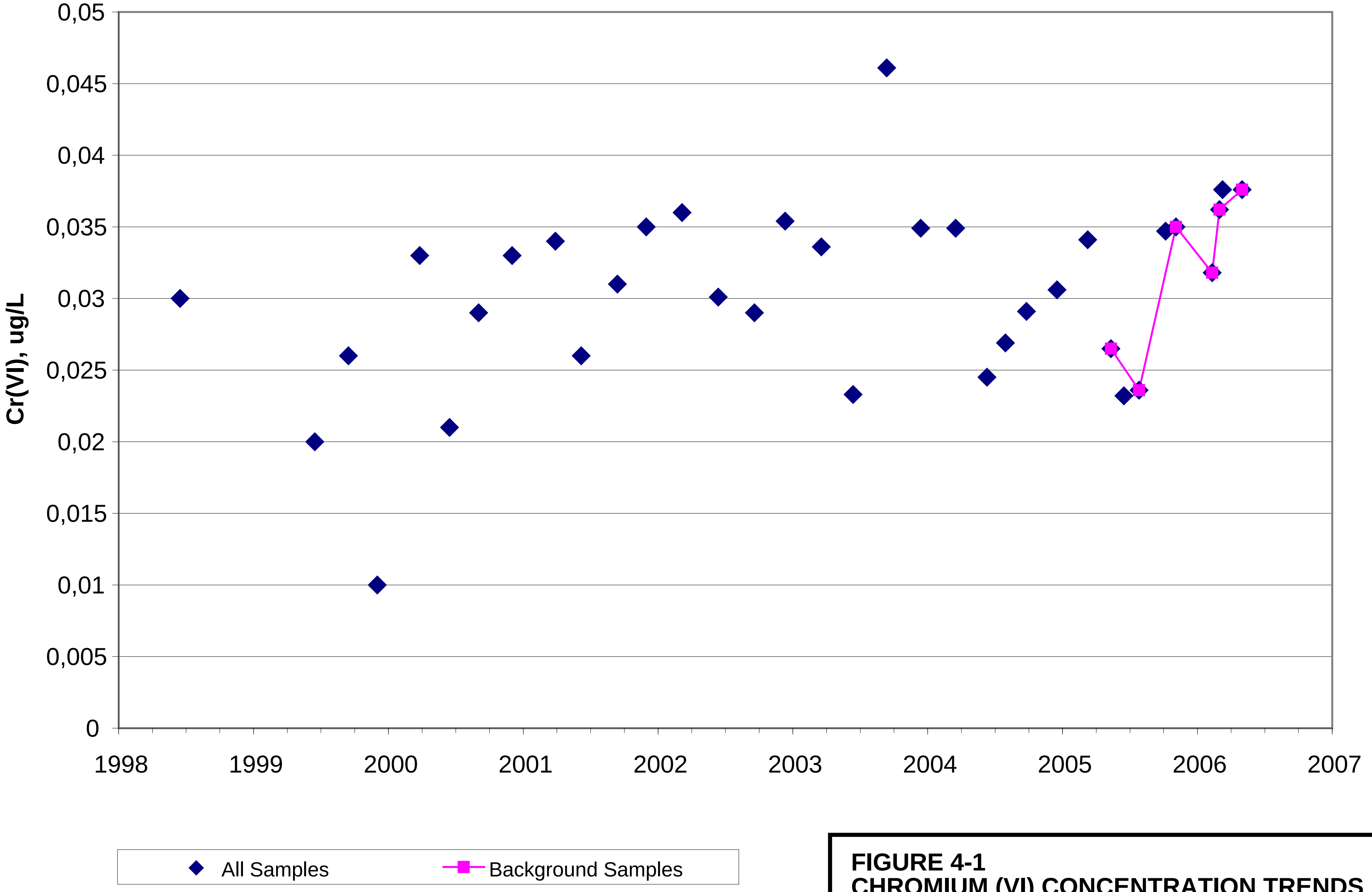

FIGURE 4-1
CHROMIUM (VI) CONCENTRATION TRENDS IN WELL MW-18

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

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Appendix A
Box-and-Whisker and Probability Plots

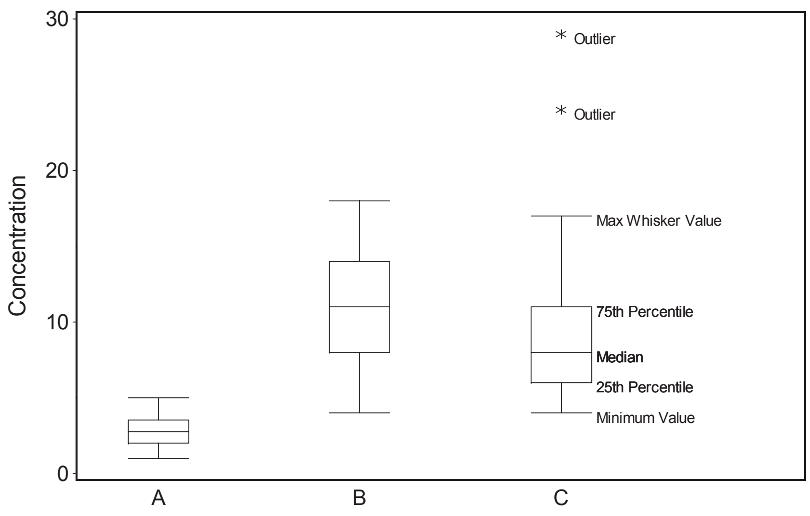
Box and whisker plots present information on the central tendency, variability, and skewness for a sample data set by sketching the center 50% of the concentrations with a box, and then illustrating the typical tail regions of the distribution with whiskers. For atypical concentrations that extend further from the center than the whiskers, individual data symbols are plotted. Specifically, these box and whisker plots are constructed as follows:

- The height of the box represents the interquartile range (IQR). The IQR is the distance between the 25th and the 75th percentiles.
- The horizontal line in the box interior represents the median.
- The vertical lines issuing from the box extend to the minimum and maximum measured values (as long as these minimum and maximum values do not extend further from the box than a distance of 1.5 times the interquartile range).
- Individual data symbols are used for concentrations that exceed the whiskers.

These principles are presented in the example plots shown in Figure 1. The upper and lower edges of the box and the ends of the whiskers all represent actual measured concentrations in the sample data set. Specifically for Data Group C, the 25th percentile, 75th percentile, and median are all labeled as part of the box. In this plot the overall minimum value overall serves as the end of the whisker since it is within a distance of 1.5 x IQR from the box. The maximum value (and the next to the largest value), however, are further from the box than a distance of 1.5 x IQR. Thus, they are labeled as outliers. The third largest overall value, that represents the largest value within a distance of 1.5 x IQR, serves as the end of the upper whisker.

Thus the lengths of the upper and lower whiskers will vary independently based on the location of the value furthest from the center that is still within 1.5 x IQR. Note in Figure 1 that the upper and lower whiskers (particularly for data group C) are not always similar lengths for a given plot. Furthermore, if the only points which fall outside the box extend further from the box than 1.5 x IQR, then no whisker will appear at all. (The whisker will have zero length.) If all of the sample results equal the same value, then the box and whiskers all collapse into a single horizontal line.

Figure 1: Example Box and Whisker Plots



Various interpretations are possible by examining these box and whisker plots. For example, if extensive overlap exists between the box plots from different data groups, such as between data groups B and C, then the measurements from each group, on average, are very similar. Conversely, little overlap, as seen between data group A and the other two, suggests that the measurements from the groups are, on average, quite different.

Also, if the data appears balanced about the median, as it does with data groups A and B, then the data is symmetrically distributed. If, on the other hand, the lower whisker and distance from the lower box edge to the median are shorter than the upper whisker and the distance from the median to the upper edge, then the distribution is said to be positively skewed. This is the case with the plot for data group C. Thus a box and whisker plot can help suggest the type of distribution that exists. For example, a normal distribution is symmetrical (neither positively nor negatively skewed), whereas a lognormal distribution is highly positively skewed.

The presence of outlying measurements that are plotted with individual symbols (measured concentrations which fall outside the span of the lower and upper whiskers) does suggest that these concentrations will be influential in any statistical calculations. Since these values are particularly influential, it is appropriate to ensure that they are not the result of a transcription error, drawn from a sample location distinct from the site of interest, or of questionable quality based on a data validation study. They definitely do not, however, indicate that these results should automatically be removed (without assignable cause) from the data set. For instance, the presence of measurements exceeding the end of the upper whisker may simply be additional evidence of positively skewed distribution.

BOX AND WHISKER PLOT LEGEND
GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

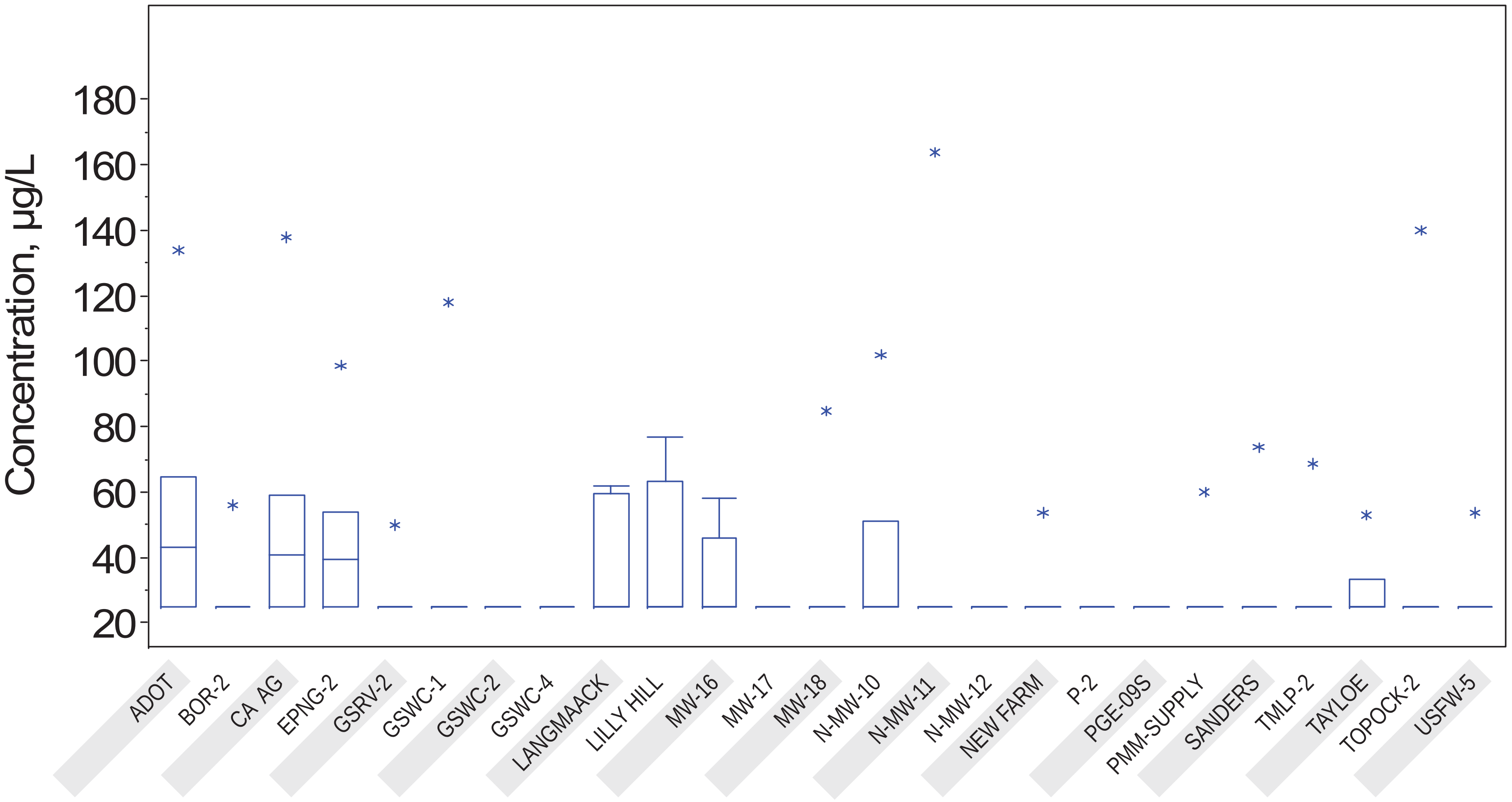


FIGURE A-1
BOX AND WHISKER PLOT FOR DISSOLVED ALUMINUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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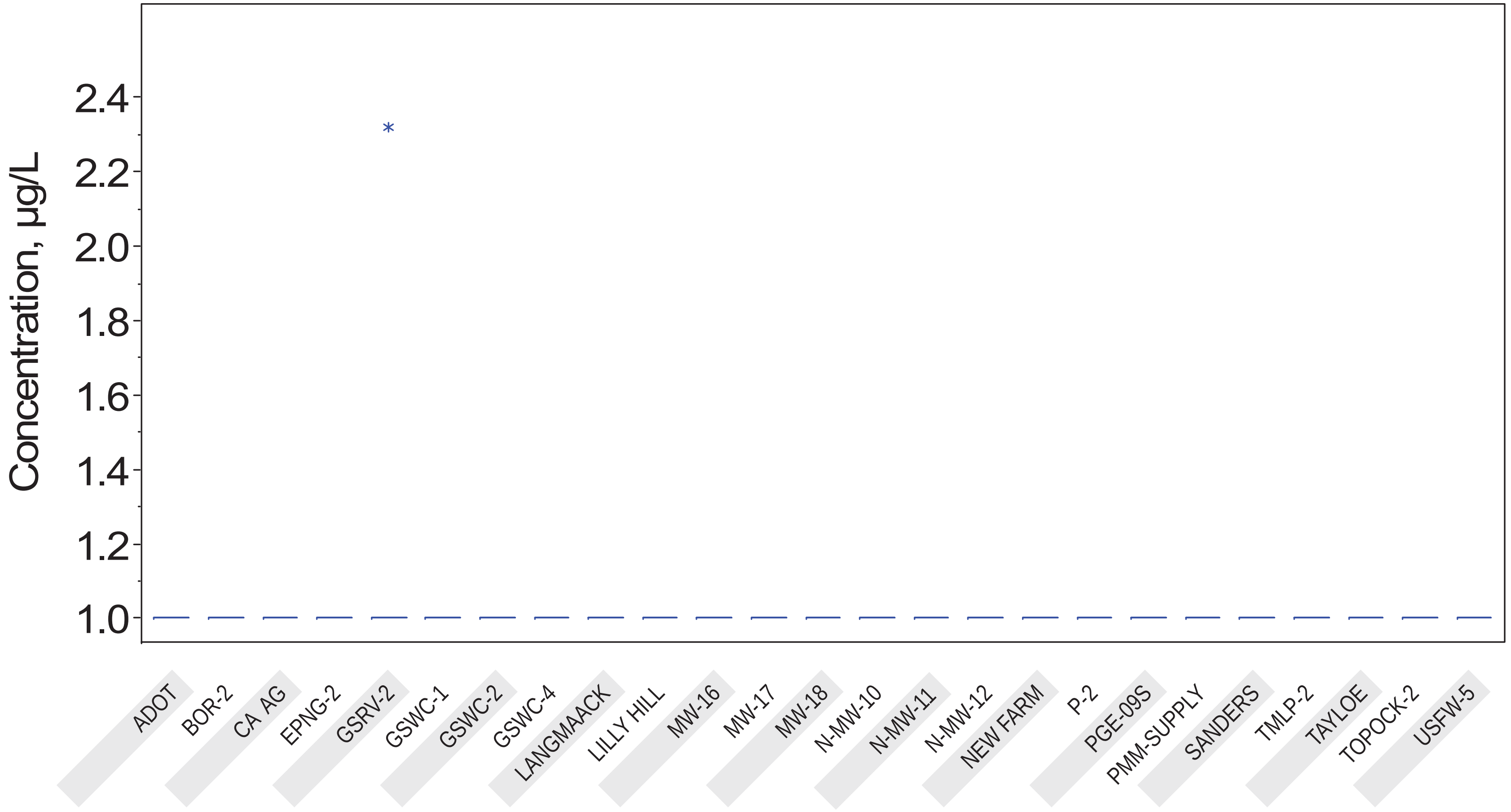

FIGURE A-2
BOX AND WHISKER PLOT FOR DISSOLVED ANTIMONY

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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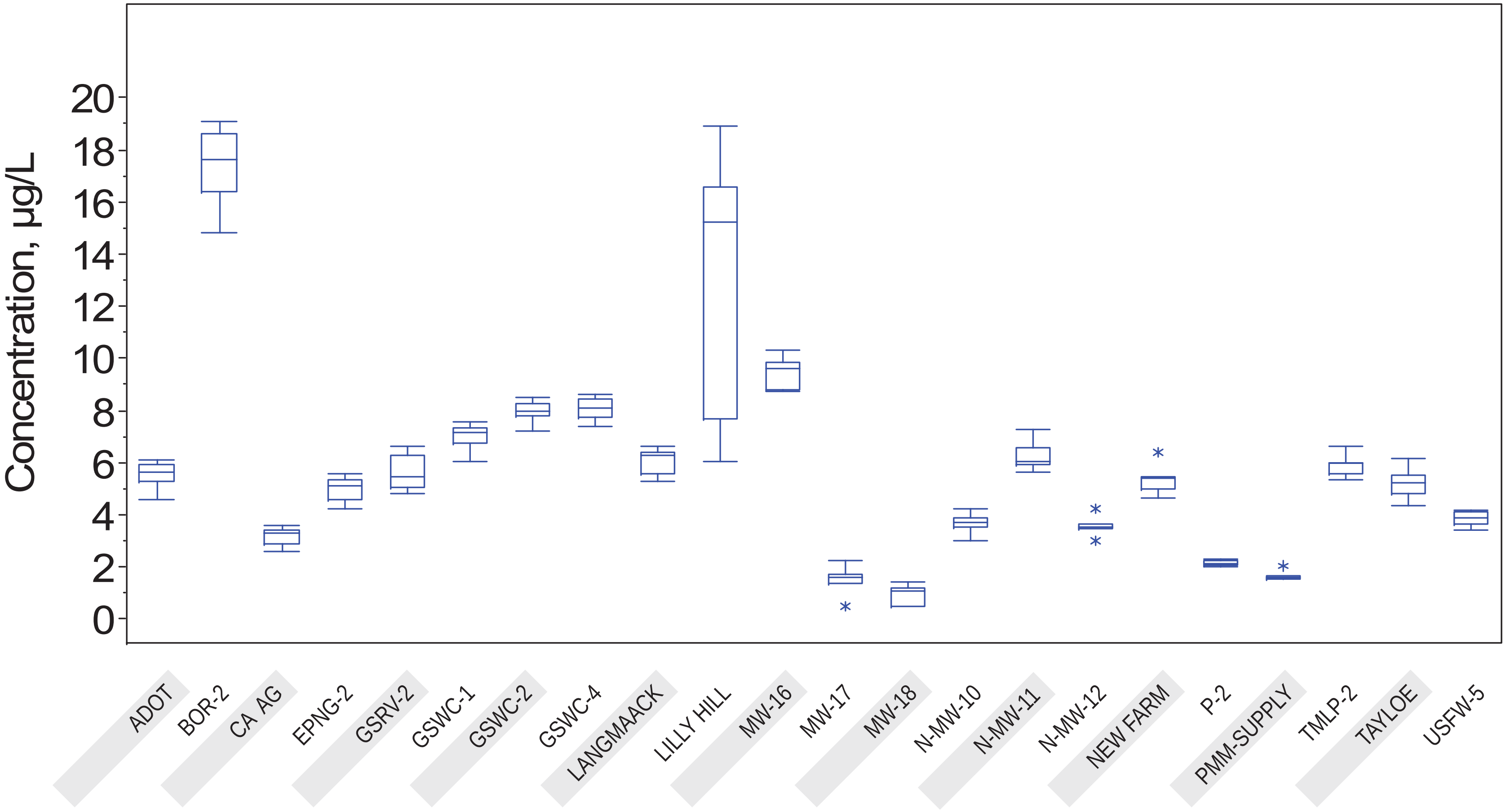

NOTE:
Prior to preparing this box and whisker plot, the dissolved arsenic concentrations from PGE-09S, Sanders, and Topock-2 were excluded from the background study dataset as directed by DTSC.

FIGURE A-3
BOX AND WHISKER PLOT FOR DISSOLVED ARSENIC

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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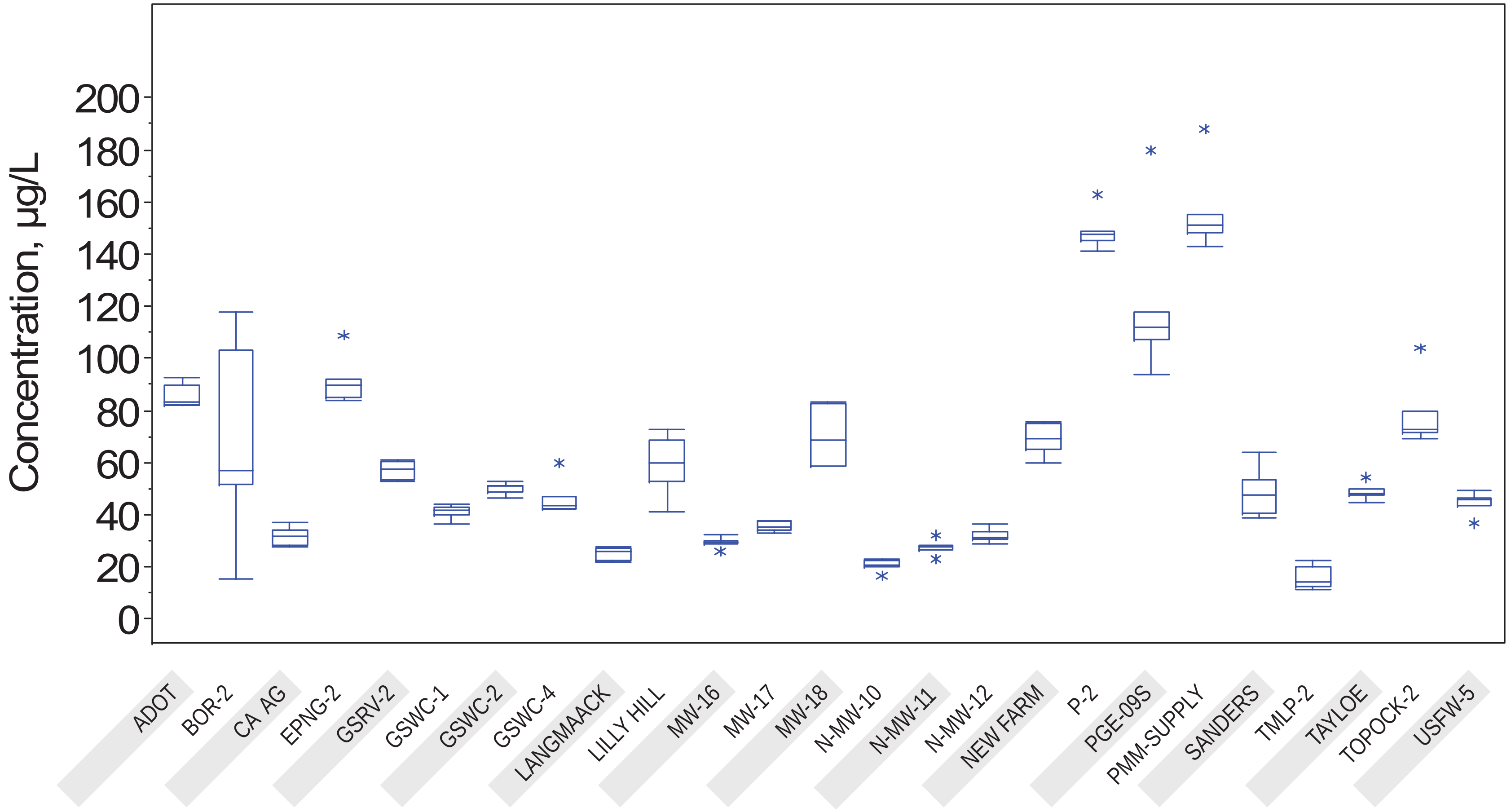

FIGURE A-4
BOX AND WHISKER PLOT
FOR DISSOLVED BARIUM
GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

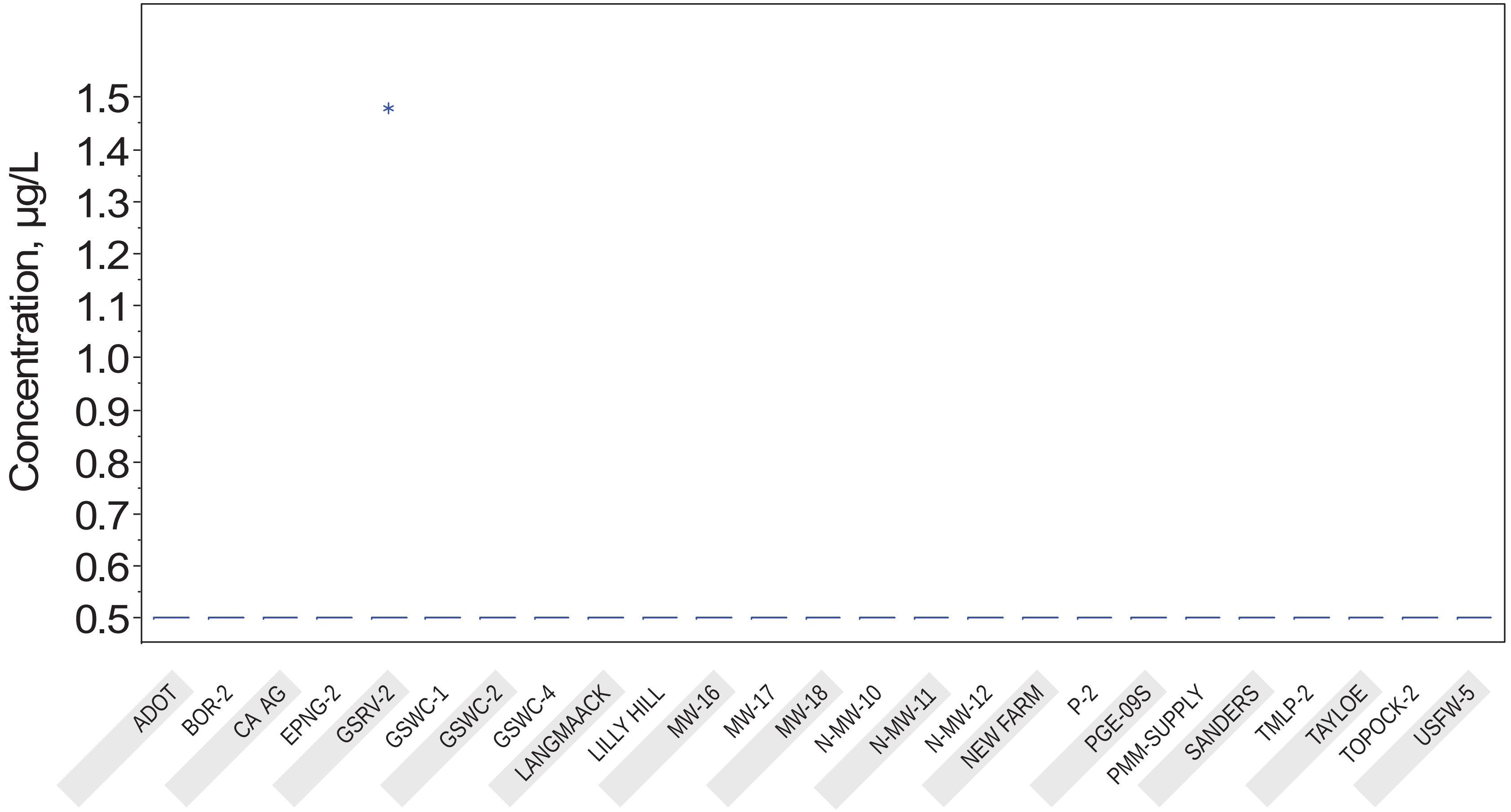

FIGURE A-5
BOX AND WHISKER PLOT FOR DISSOLVED BERYLLIUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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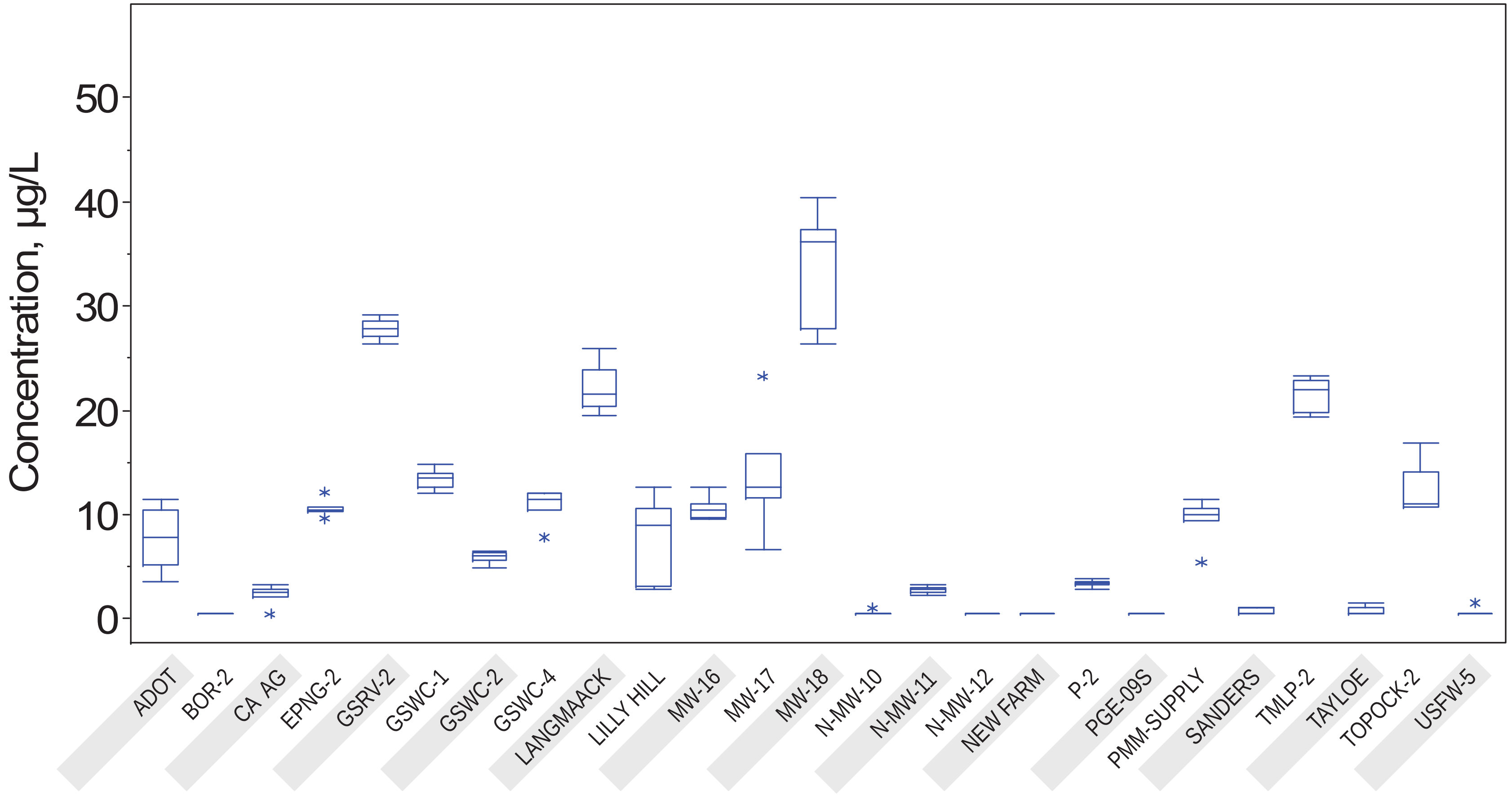

NOTE:
Prior to preparing this box and whisker plot, the dissolved chromium concentration from GSRV-2 from the May 19, 2005 event was excluded from the background study dataset as directed by DTSC. The dissolved chromium concentration from Topock-2 from the sixth event (June 30, 2006) was also excluded from the background data set (see Section 2.1).

FIGURE A-6
BOX AND WHISKER PLOT FOR DISSOLVED CHROMIUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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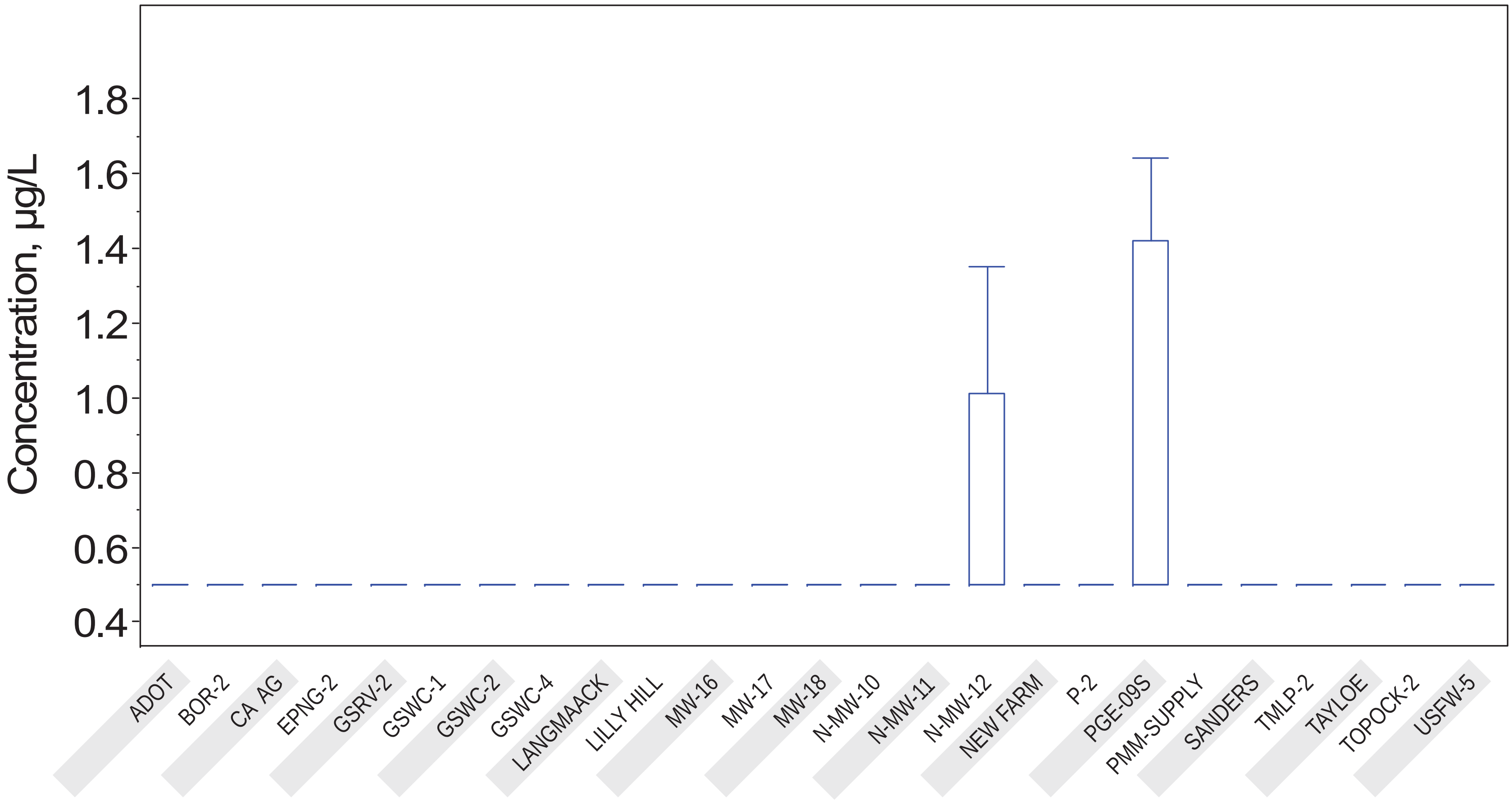


FIGURE A-7
BOX AND WHISKER PLOT FOR DISSOLVED COBALT

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

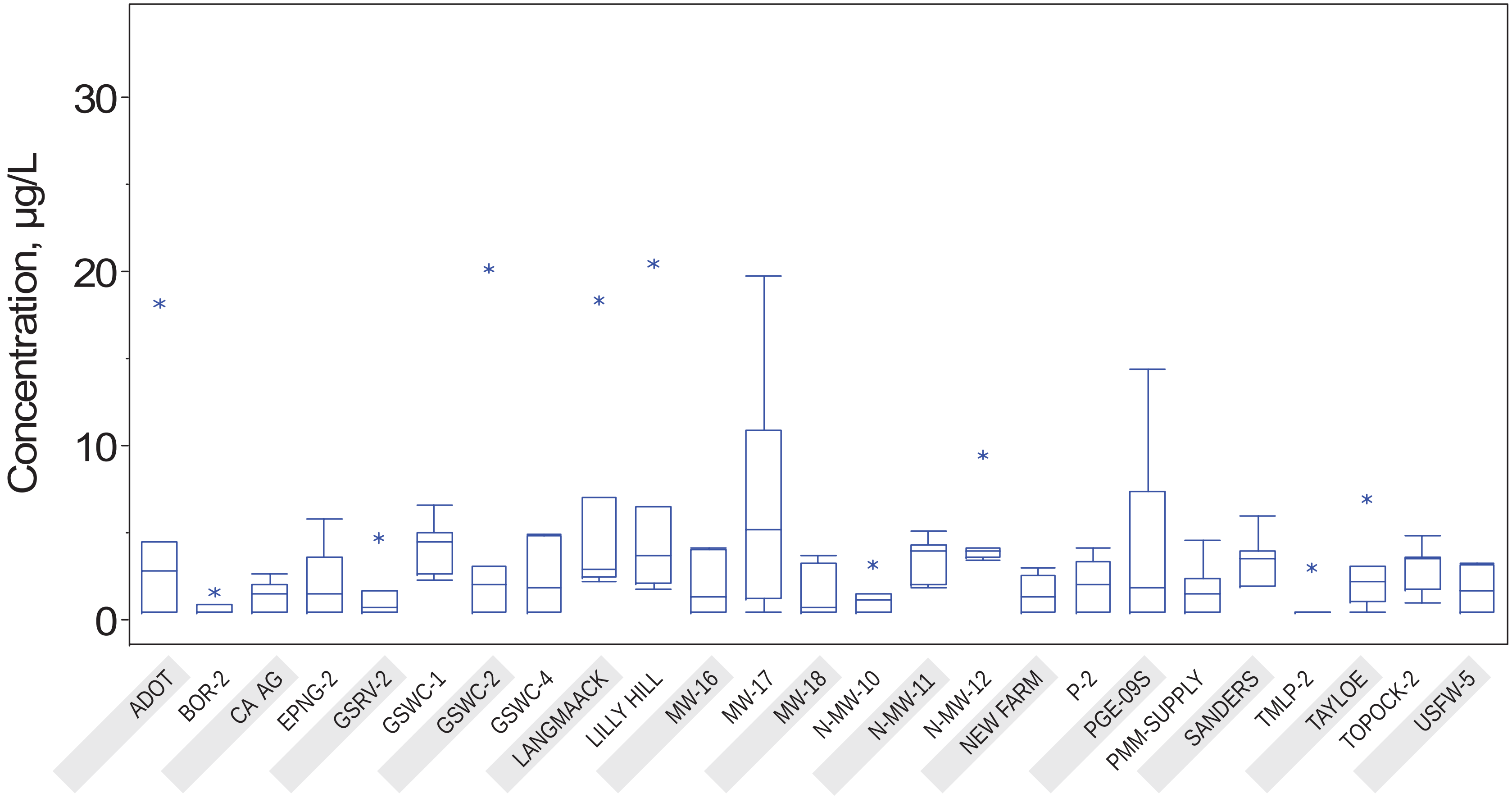
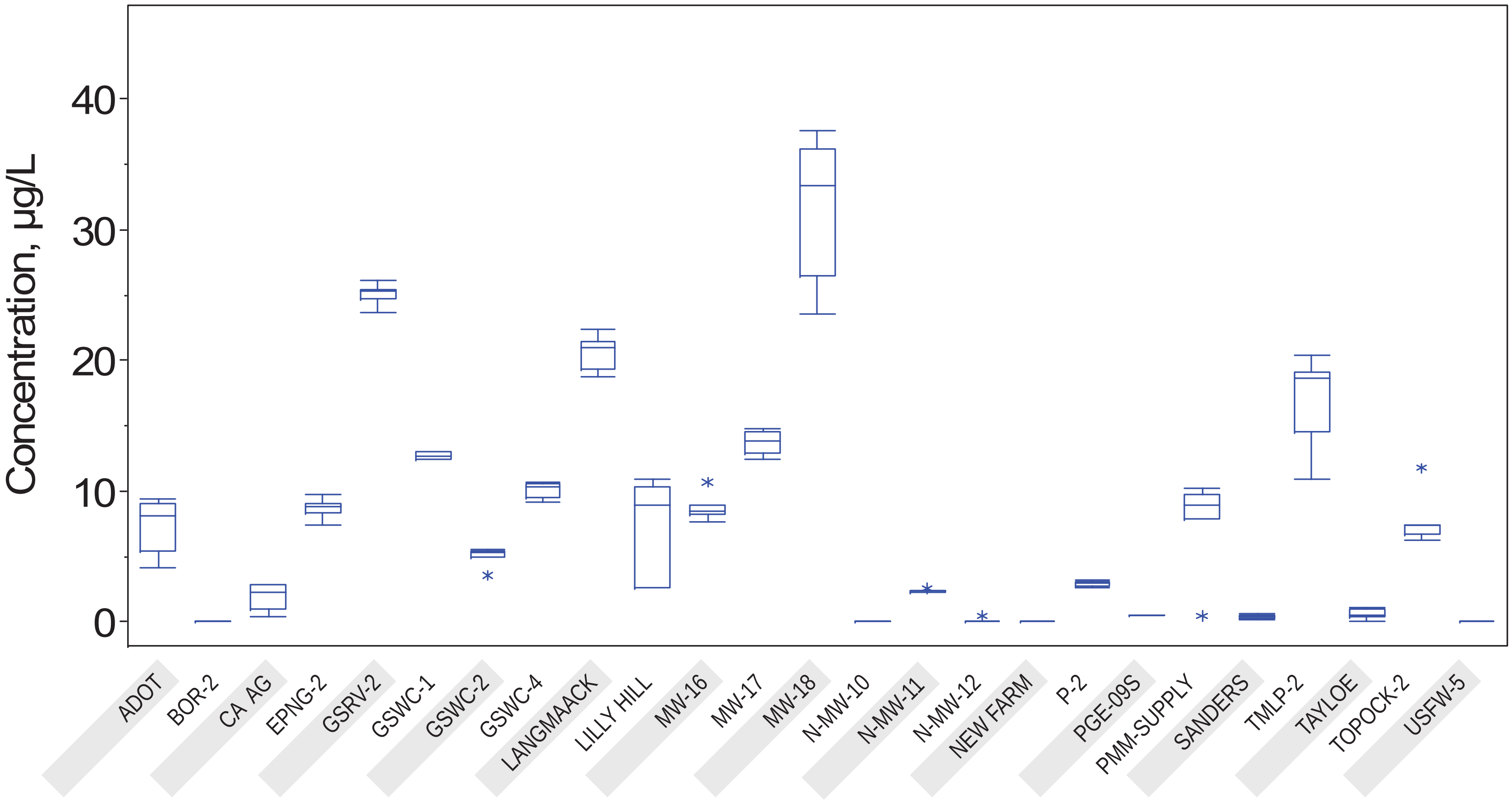


FIGURE A-8
BOX AND WHISKER PLOT FOR DISSOLVED COPPER

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

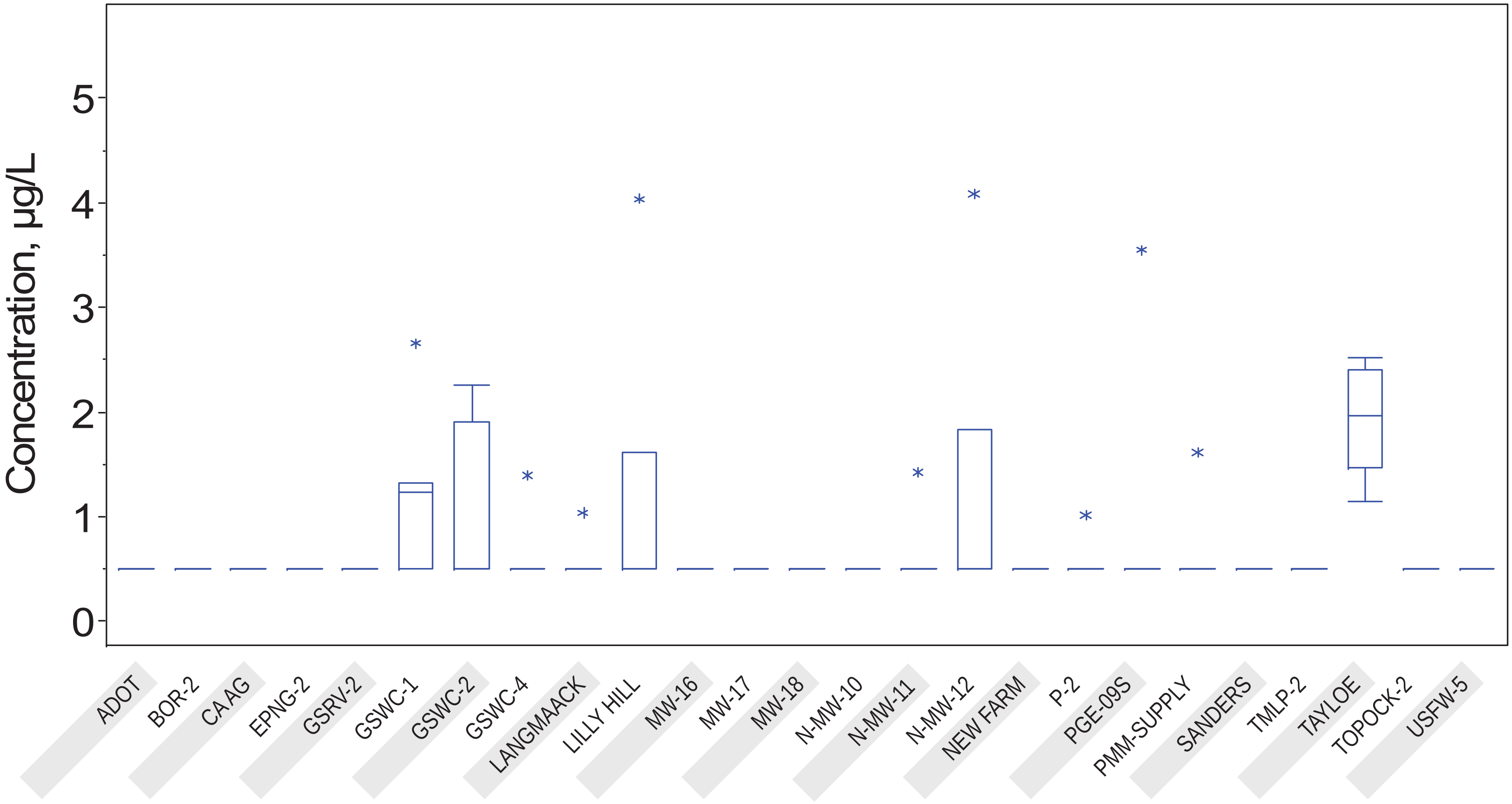


NOTE:
Prior to preparing this box and whisker plot, the dissolved hexavalent chromium concentration from GSRV-2 from the May 19, 2005 event was excluded from the background study dataset as directed by DTSC. The dissolved hexavalent chromium concentration from Topock-2 from the sixth event (June 30, 2006) was also excluded from the background data set (see Section 2.1).

FIGURE A-9
BOX AND WHISKER PLOT FOR DISSOLVED HEXAVALENT CHROMIUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL



NOTE:
Prior to preparing this box and whisker plot, the dissolved lead concentrations from MW-17 and Topock-2 from the November 2, 2005 event were excluded from the background study dataset as directed by DTSC. The dissolved lead concentration from Topock-2 from the sixth event (June 30, 2006) was also excluded from the background data set (see Section 2.1).

FIGURE A-10
BOX AND WHISKER PLOT
FOR DISSOLVED LEAD
GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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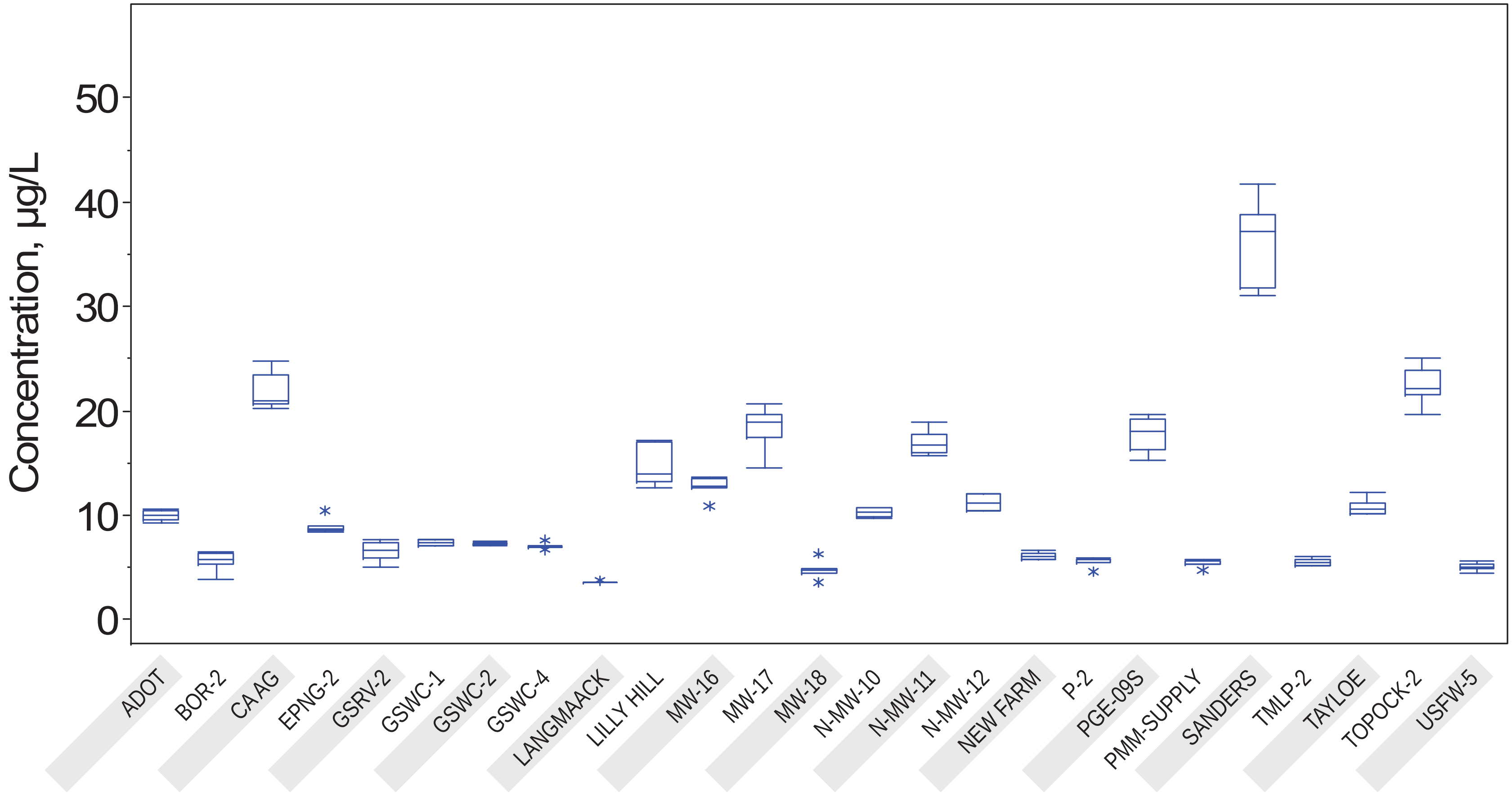

FIGURE A-11
BOX AND WHISKER PLOT FOR DISSOLVED MOLYBDENUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

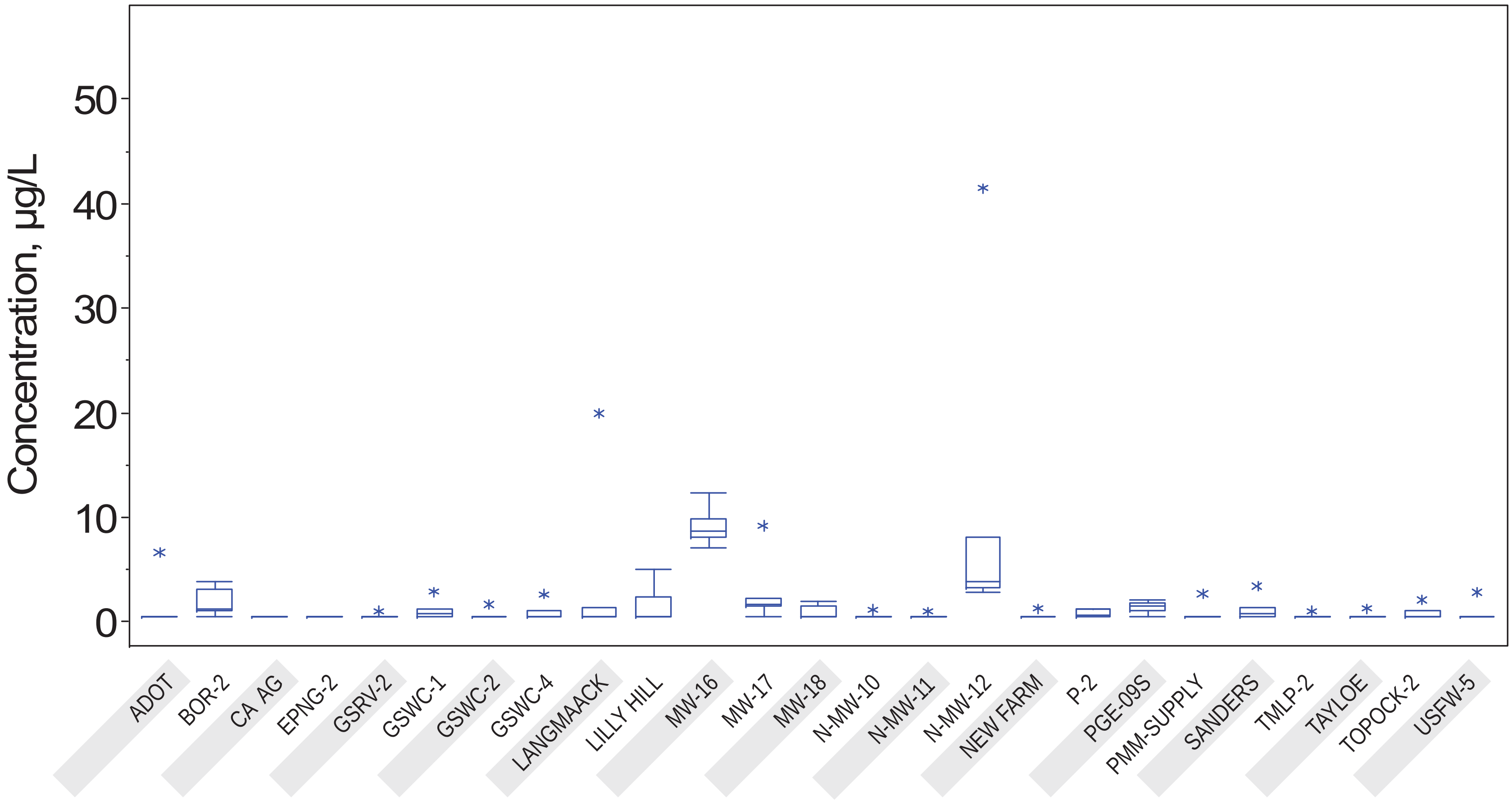

FIGURE A-12
BOX AND WHISKER PLOT FOR DISSOLVED NICKEL

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

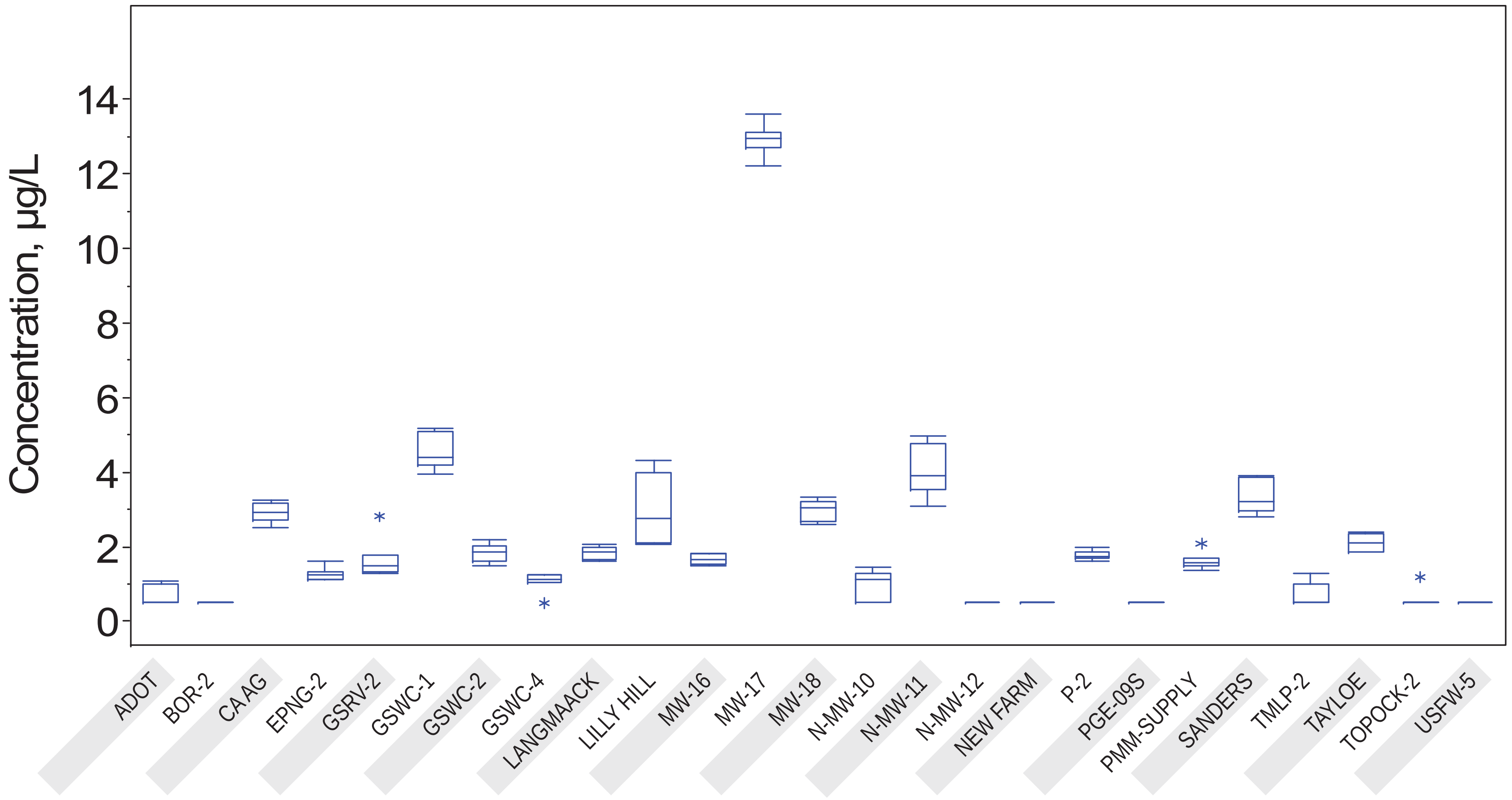

FIGURE A-13
BOX AND WHISKER PLOT FOR DISSOLVED SELENIUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

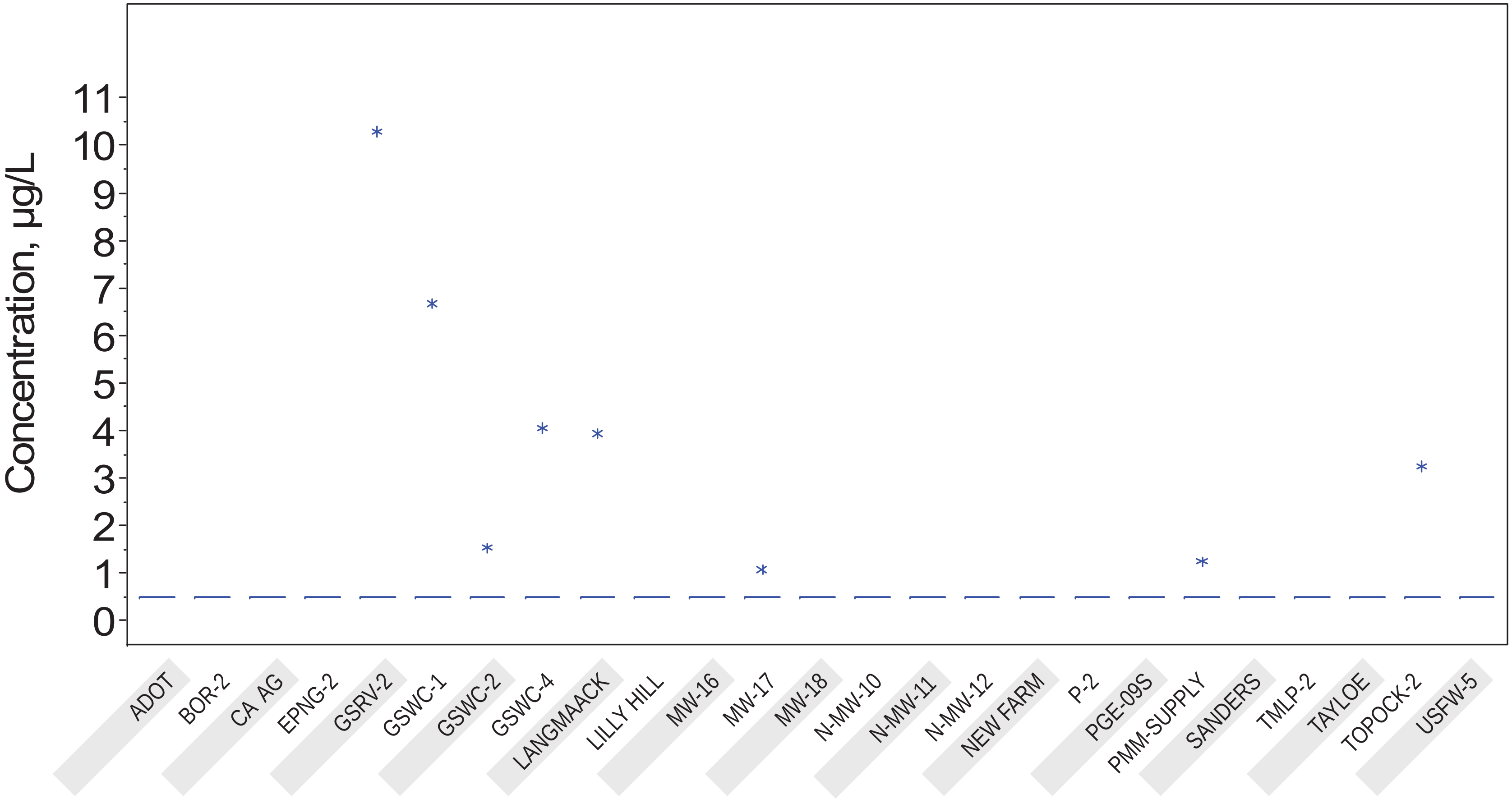

FIGURE A-14
BOX AND WHISKER PLOT FOR DISSOLVED SILVER

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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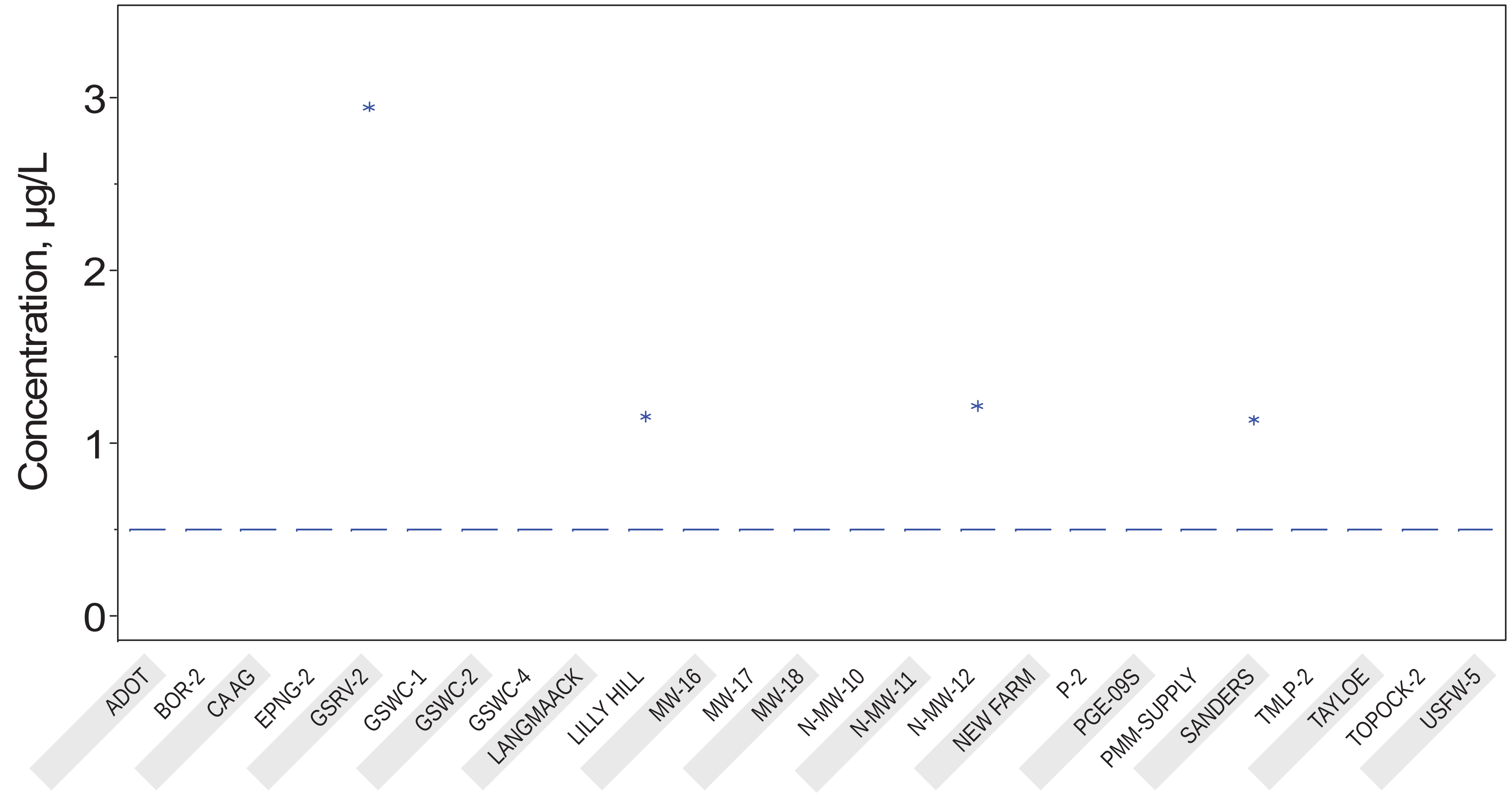

FIGURE A-15
BOX AND WHISKER PLOT
FOR DISSOLVED THALLIUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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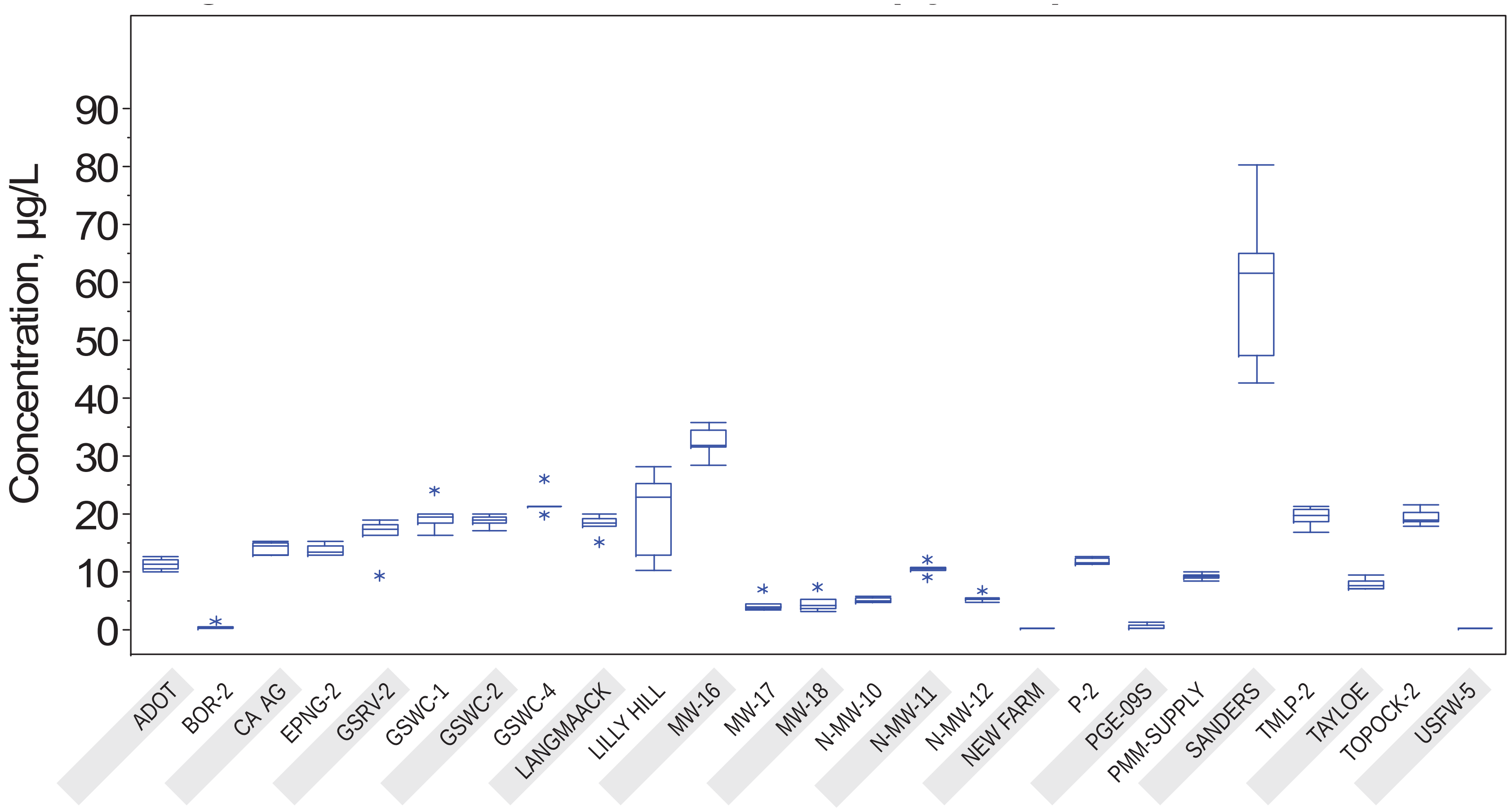

FIGURE A-16
BOX AND WHISKER PLOT FOR DISSOLVED VANADIUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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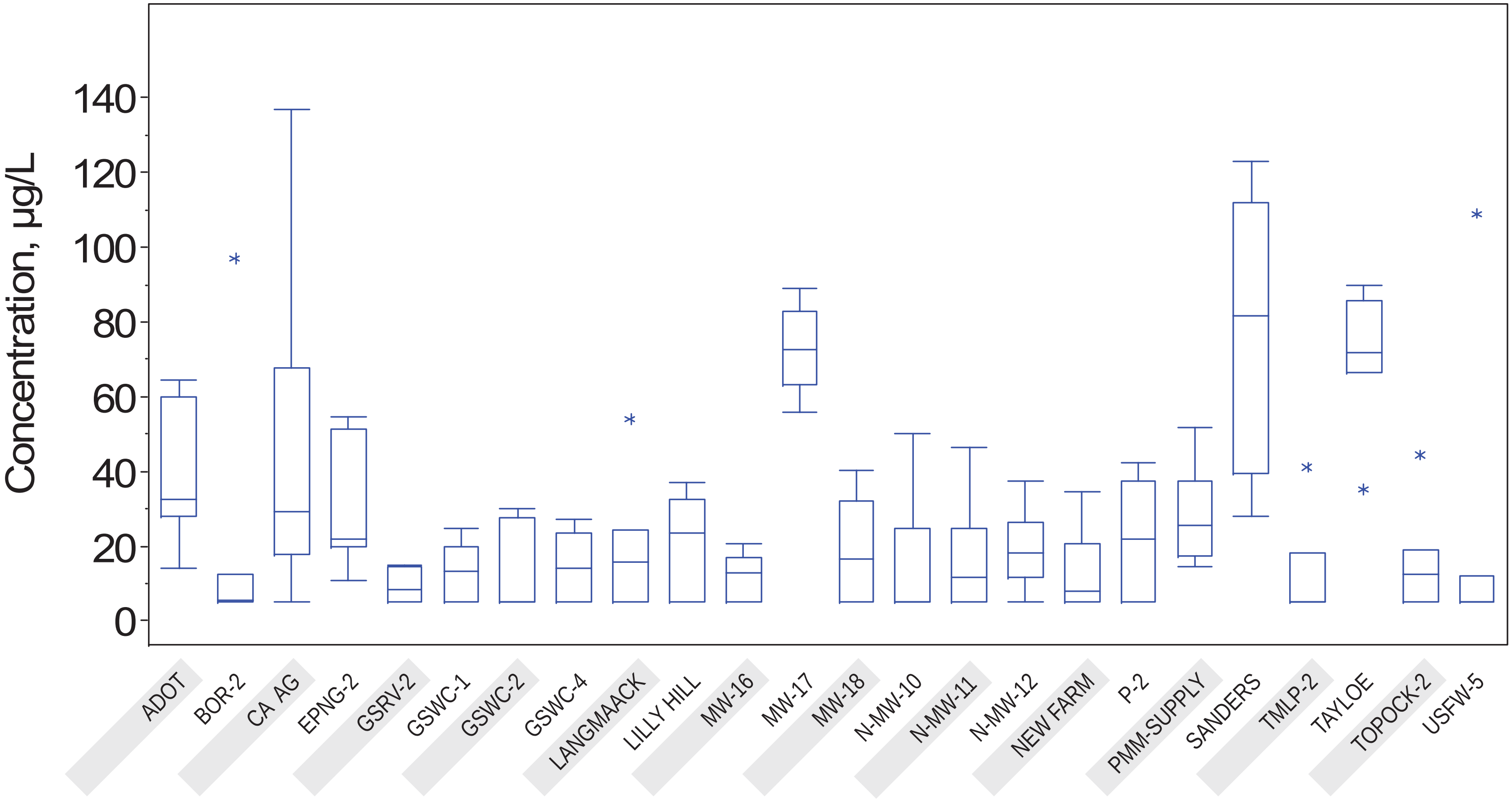

NOTE:
Prior to preparing this box and whisker plot, the dissolved zinc concentrations from PGE-09S were excluded from the background study dataset (see Section 2.2.2). The dissolved zinc concentration from Topock-2 from the sixth event (June 30, 2006) was also excluded from the background data set (see Section 2.1).

FIGURE A-17
BOX AND WHISKER PLOT
FOR DISSOLVED ZINC
GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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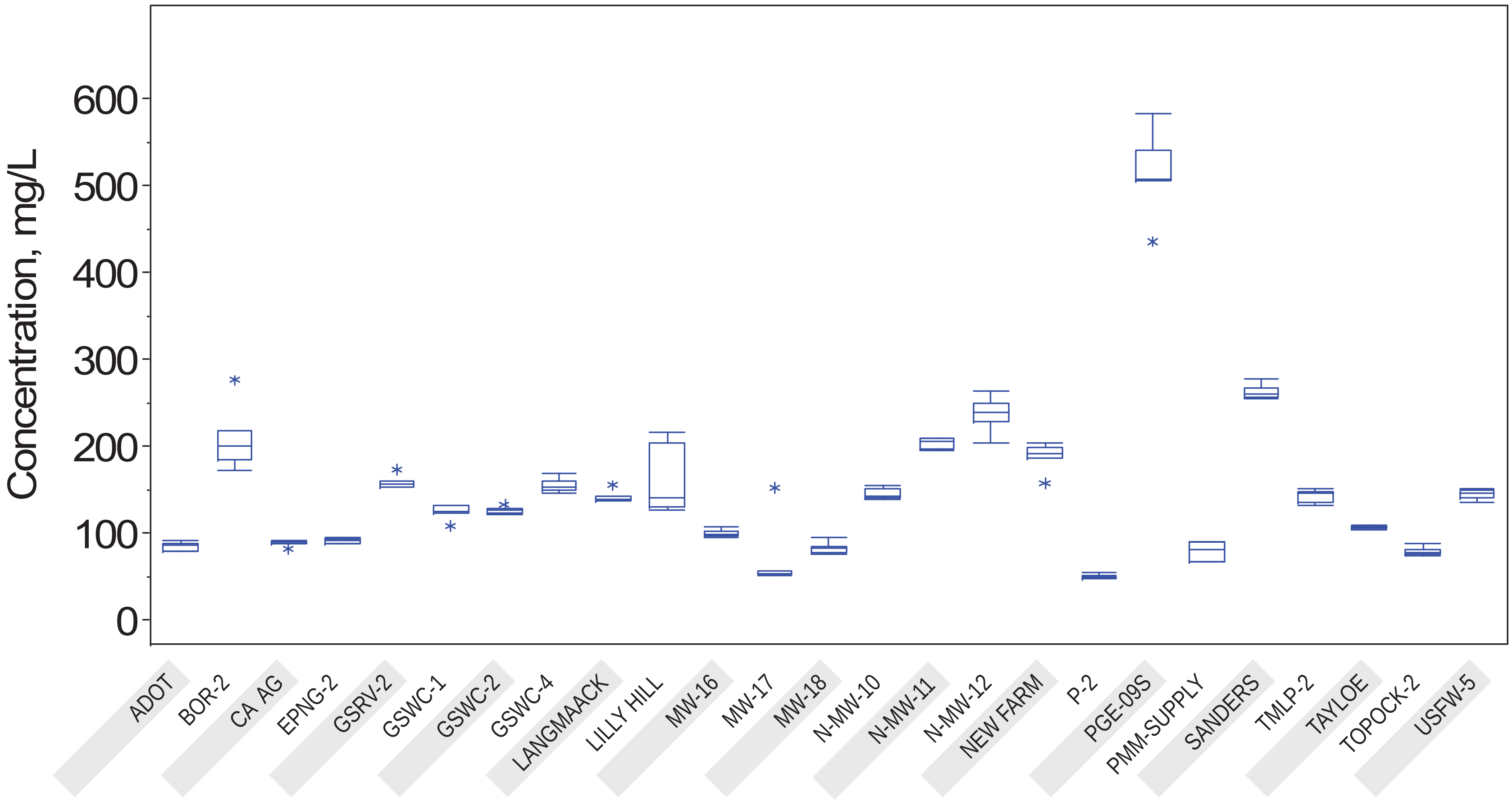

FIGURE A-18
BOX AND WHISKER PLOT FOR TOTAL ALKALINITY

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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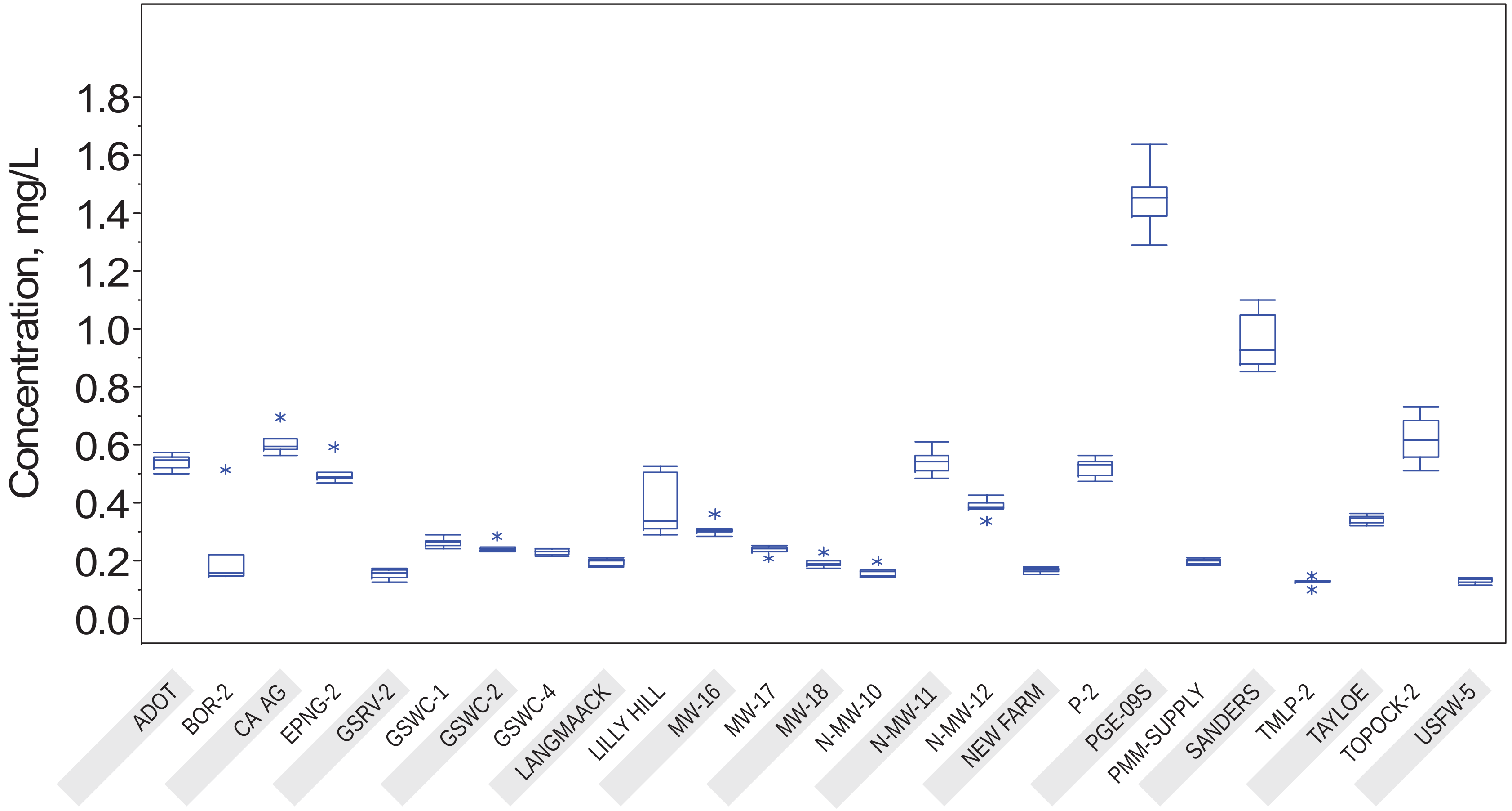

FIGURE A-19
BOX AND WHISKER PLOT FOR DISSOLVED BORON

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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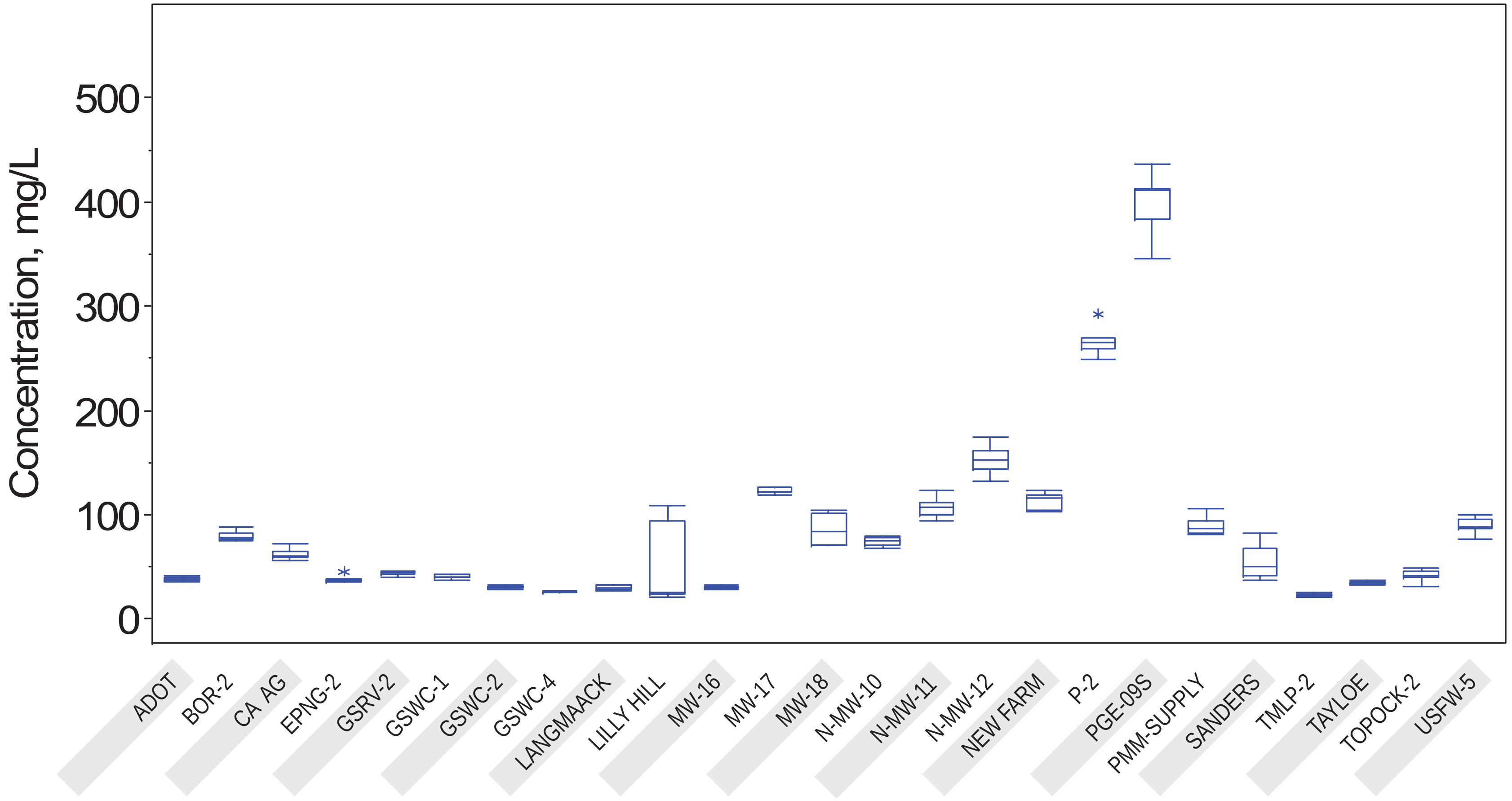

FIGURE A-20
BOX AND WHISKER PLOT FOR DISSOLVED CALCIUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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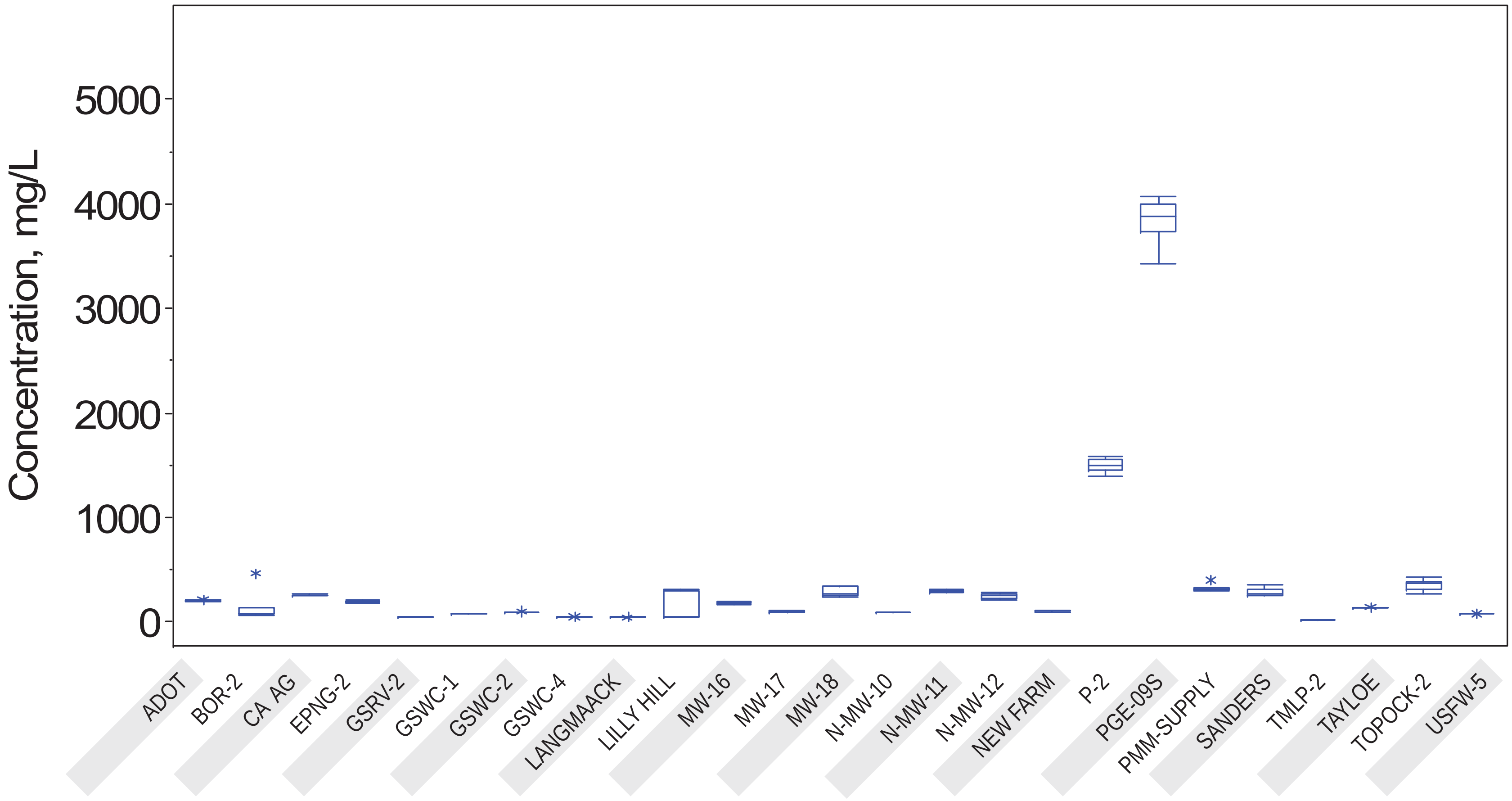

FIGURE A-21
BOX AND WHISKER PLOT FOR CHLORIDE

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

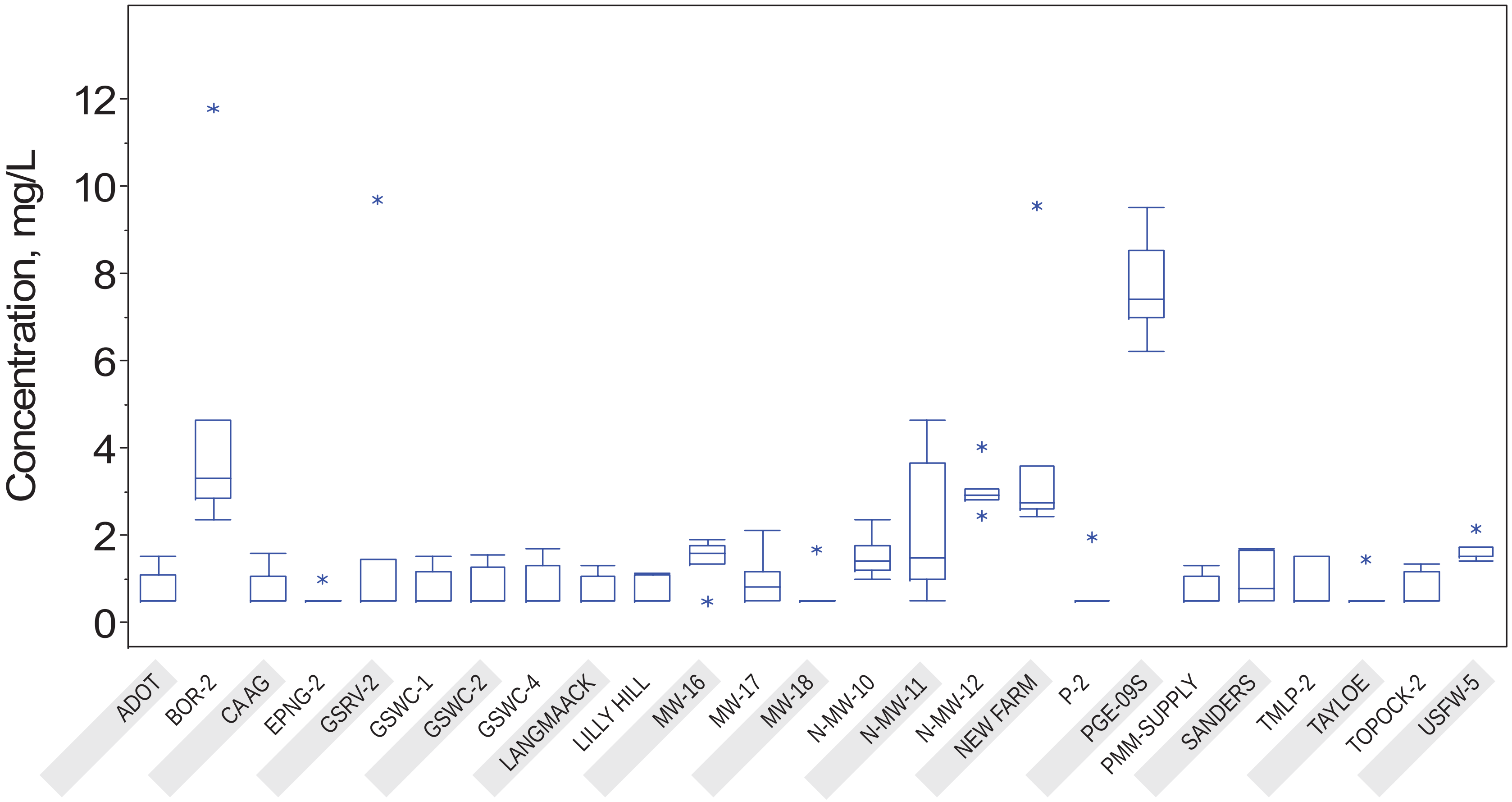

FIGURE A-22
BOX AND WHISKER PLOT FOR DISSOLVED ORGANIC CARBON

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

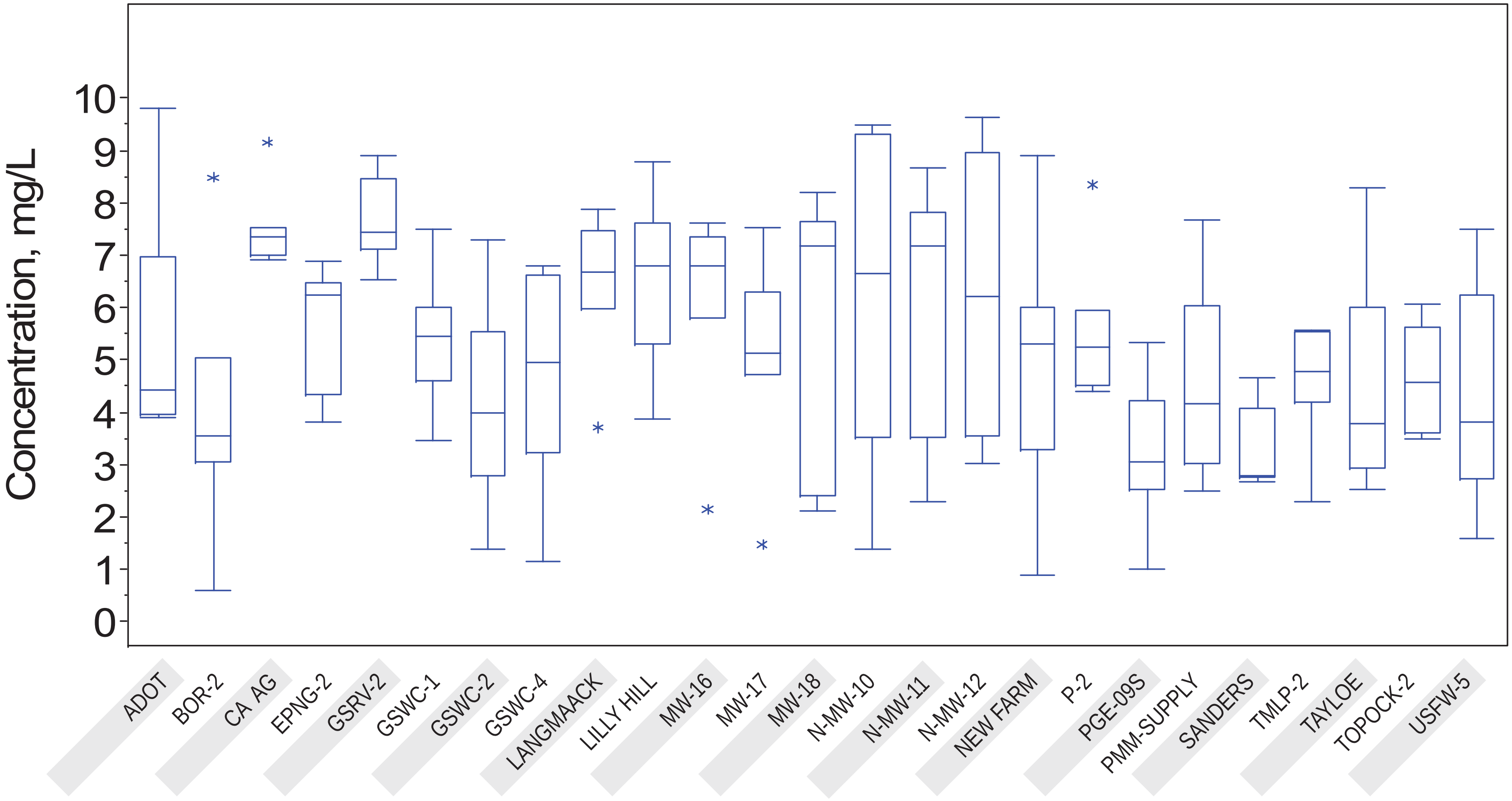

FIGURE A-23
BOX AND WHISKER PLOT FOR DISSOLVED OXYGEN

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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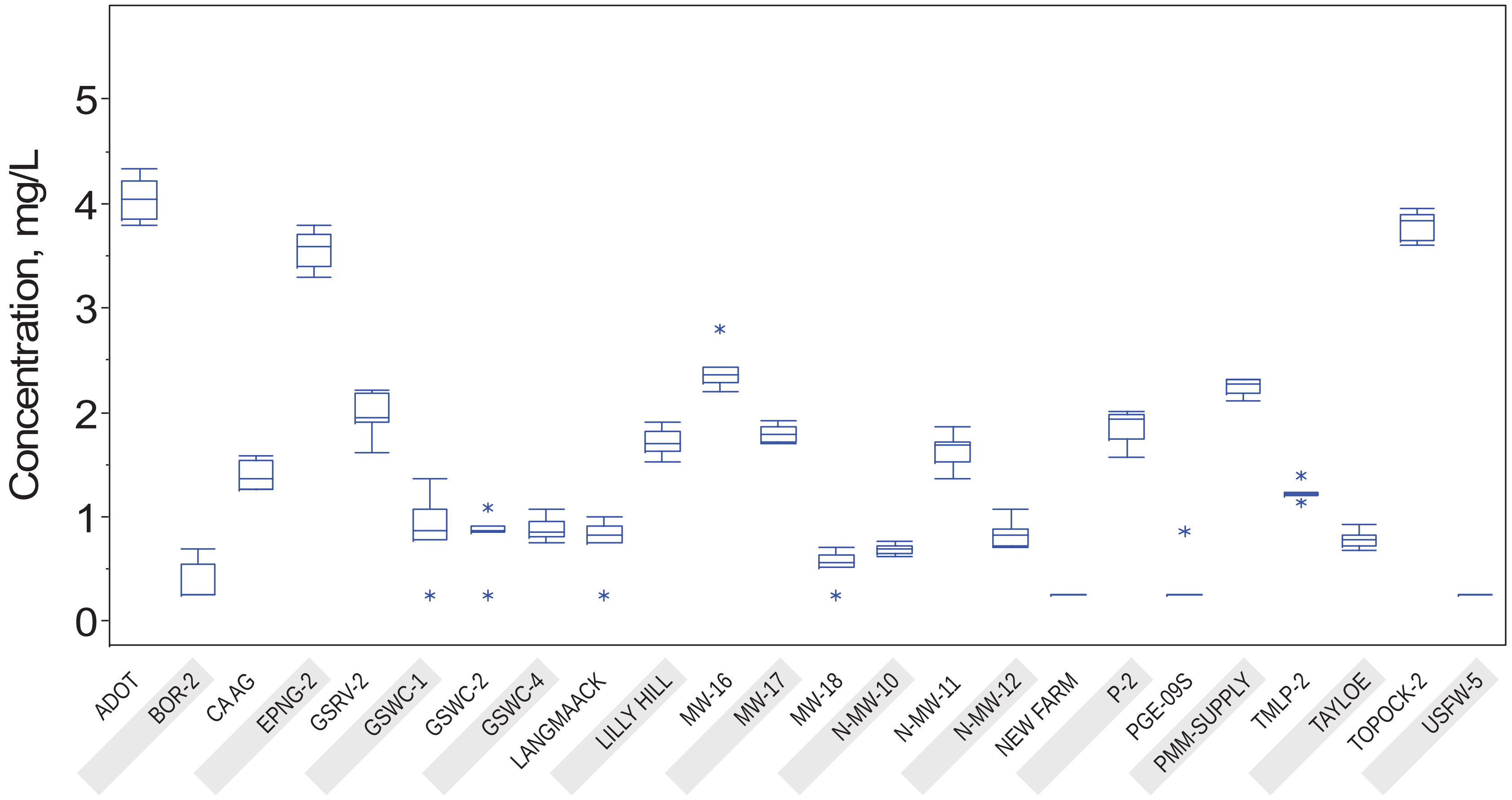
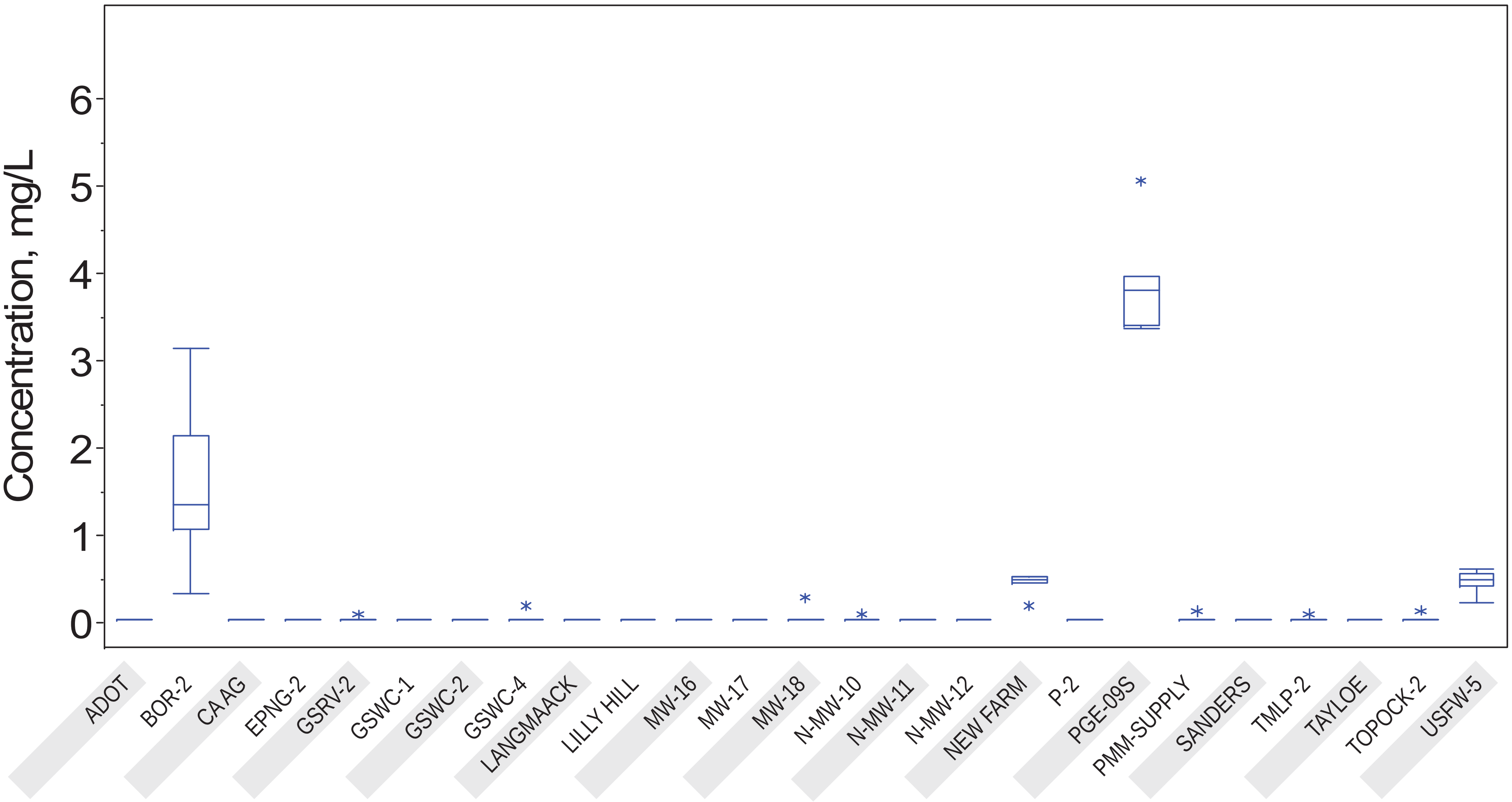


NOTE:
Prior to preparing this box and whisker plot, the dissolved fluoride concentrations from Sanders were excluded from the background study dataset as directed by DTSC.

FIGURE A-24
BOX AND WHISKER PLOT FOR FLUORIDE

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL



NOTE:
Prior to preparing this box and whisker plot, the dissolved iron concentration from PGE-09S from the July 20, 2005 event was excluded from the background study dataset as directed by DTSC. The dissolved iron concentration from Topock-2 from the sixth event (June 30, 2006) was also excluded from the background data set (see Section 2.1).

FIGURE A-25
BOX AND WHISKER PLOT FOR DISSOLVED IRON

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

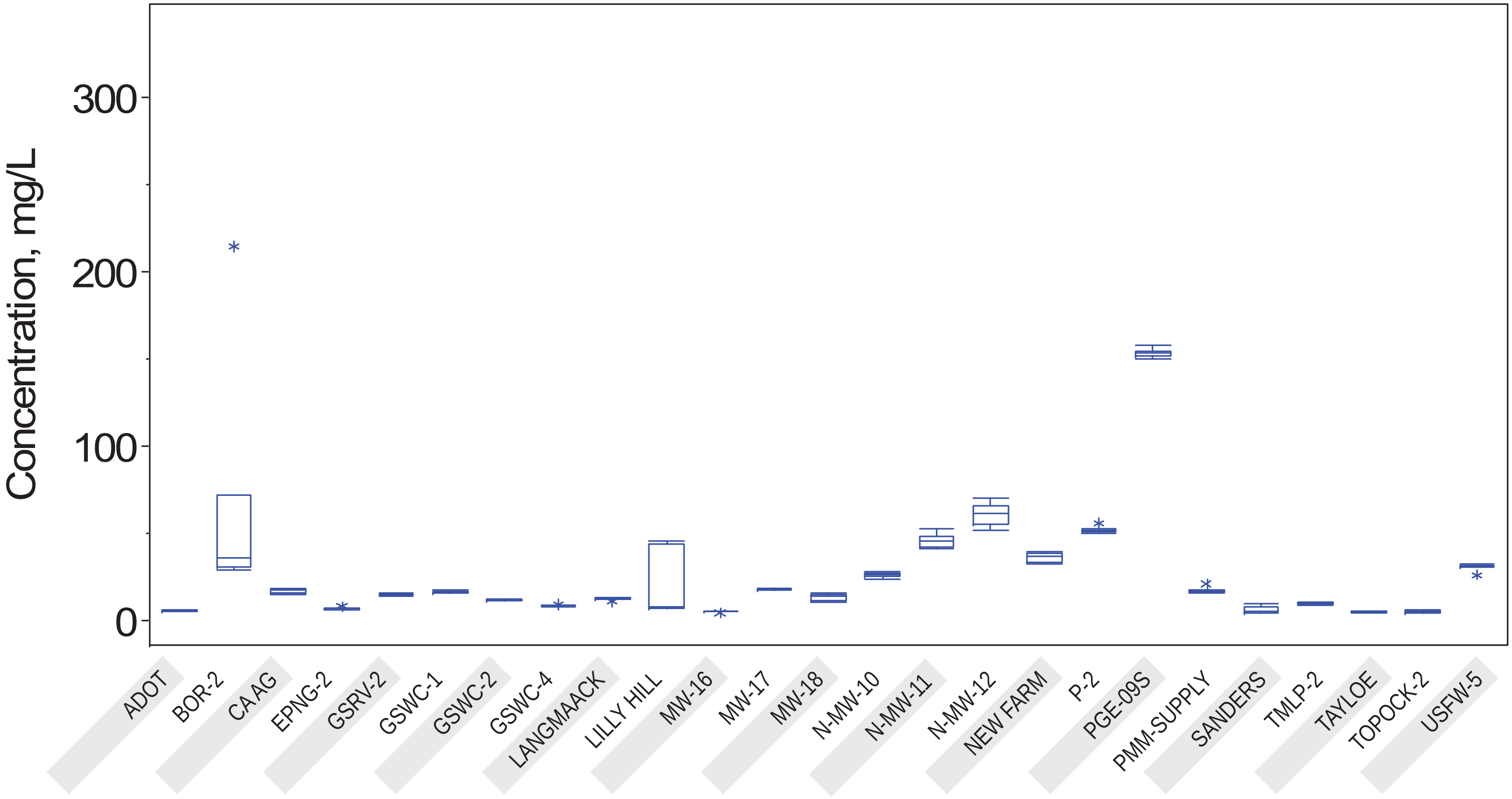


FIGURE A-26
BOX AND WHISKER PLOT FOR DISSOLVED MAGNESIUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

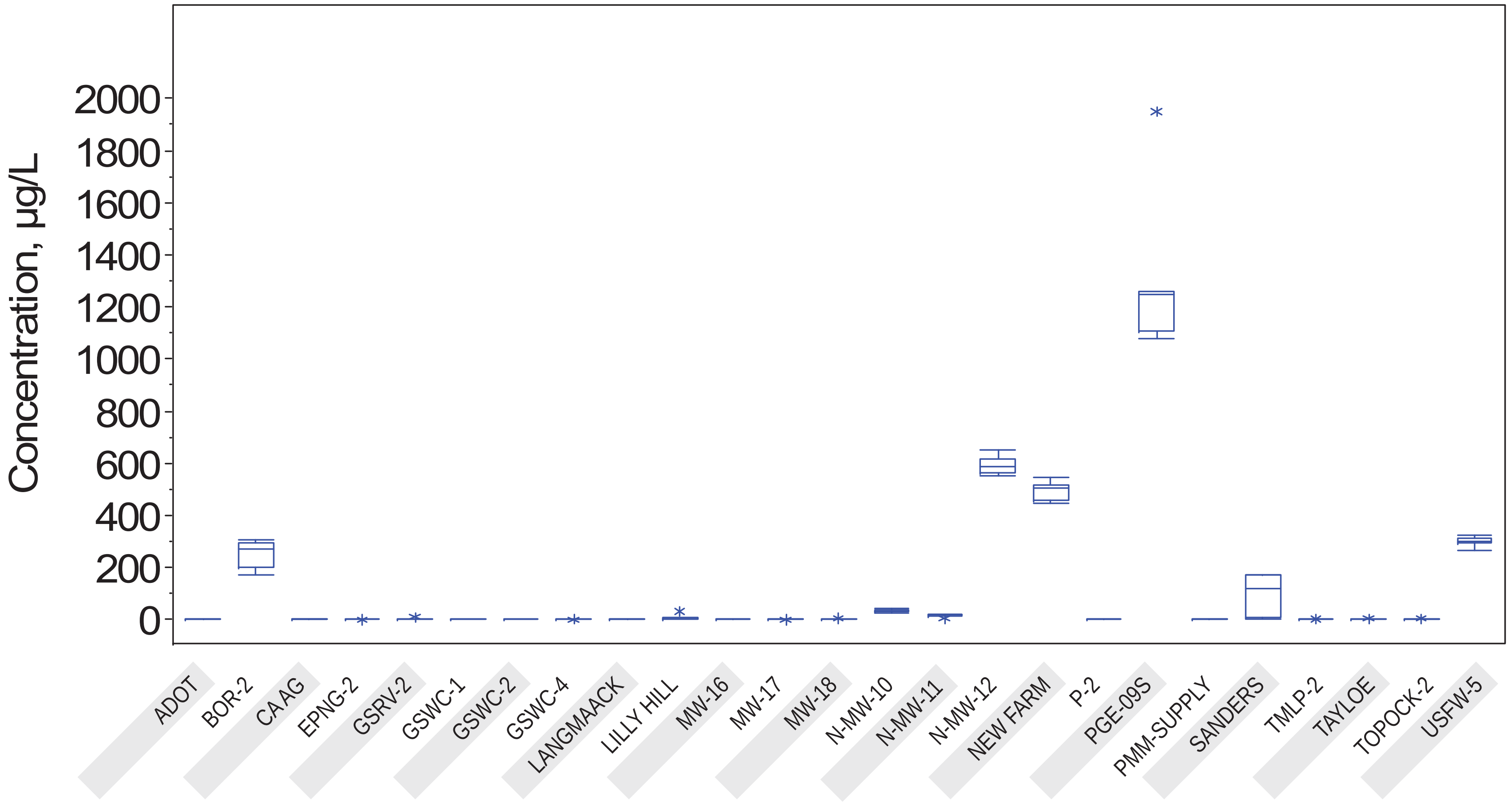


FIGURE A-27
BOX AND WHISKER PLOT FOR DISSOLVED MANGANESE

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

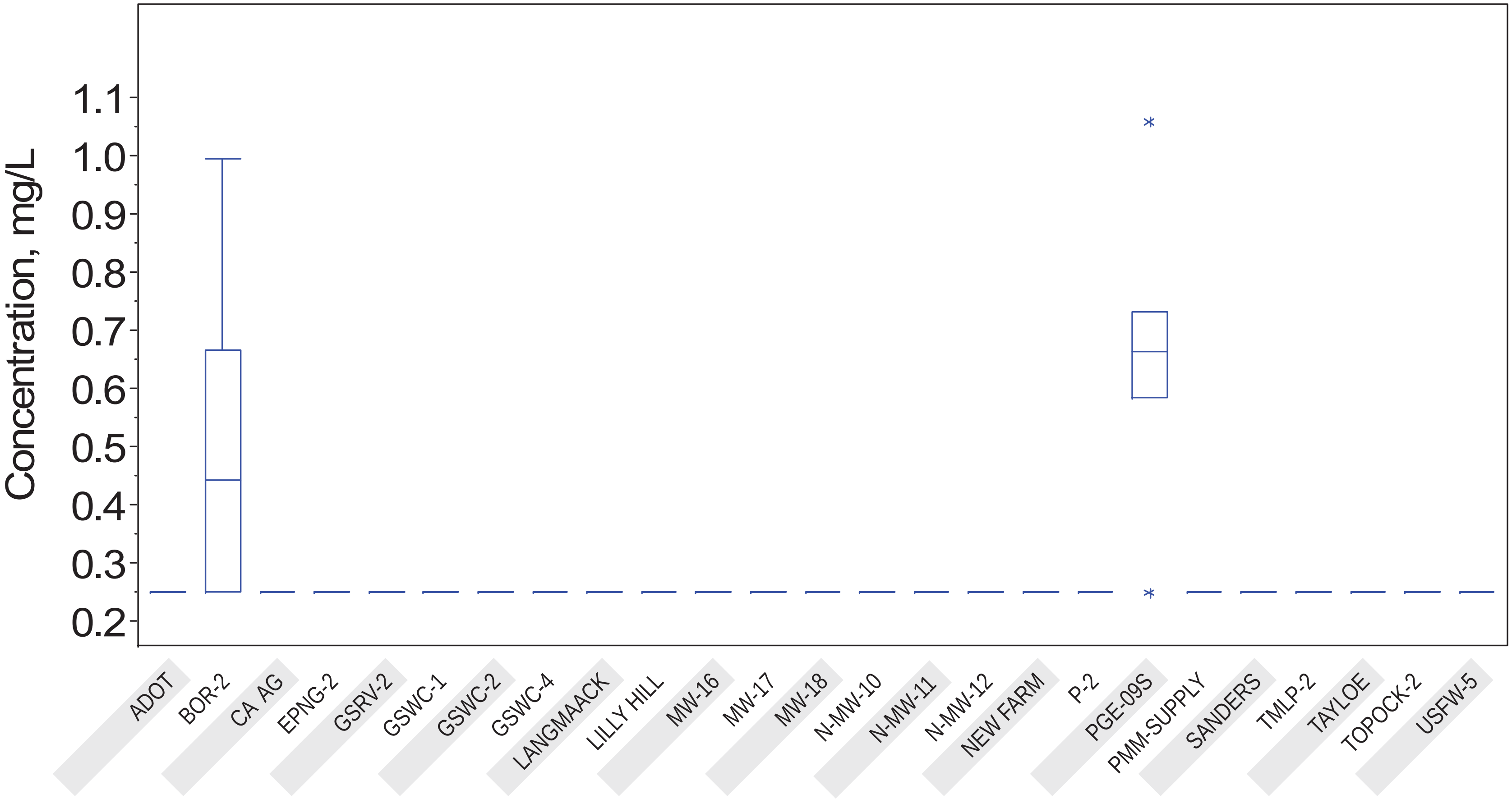


FIGURE A-28
BOX AND WHISKER PLOT FOR N-AMMONIA

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

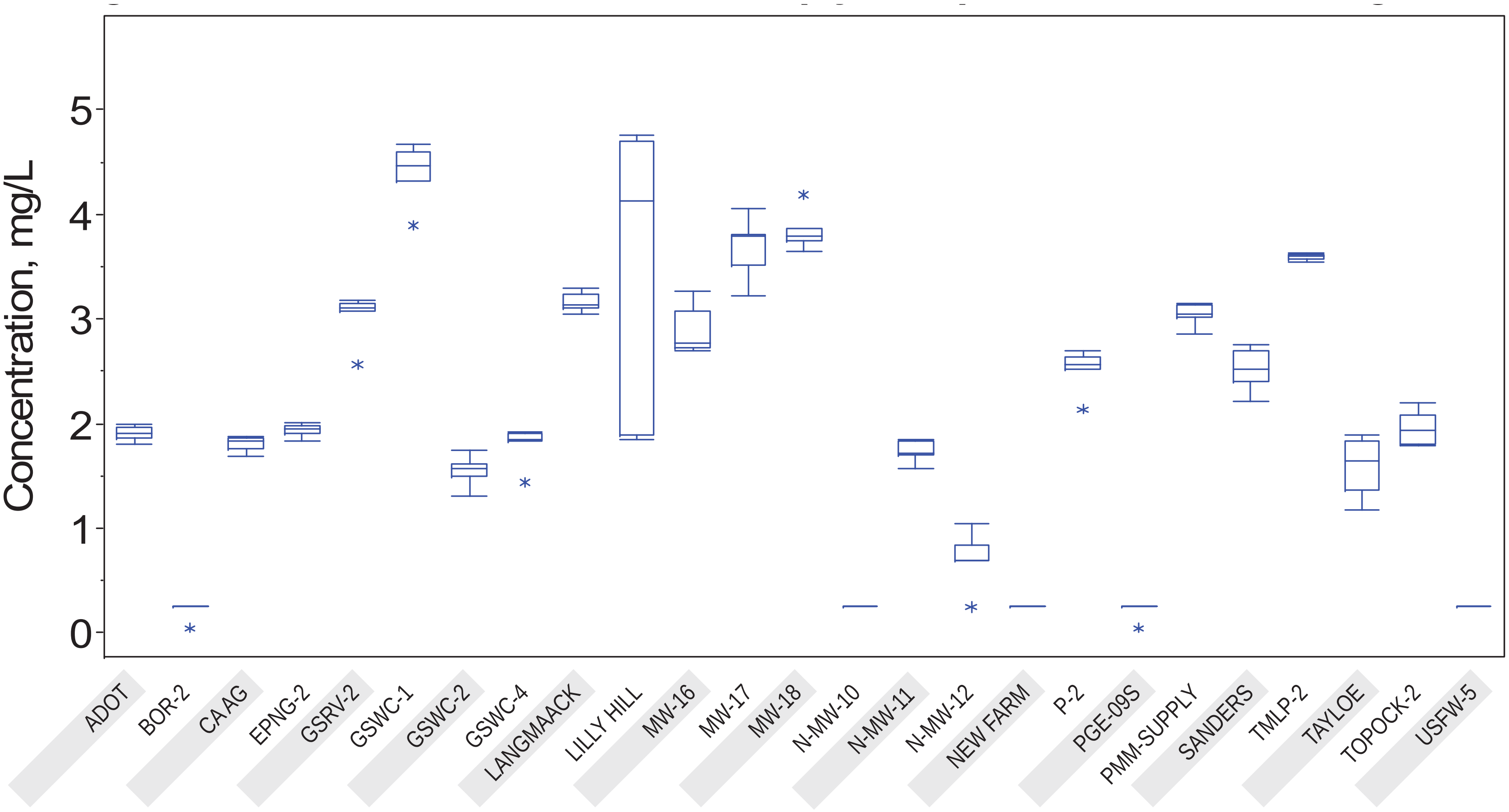


FIGURE A-29
BOX AND WHISKER PLOT FOR N-NITRATE

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

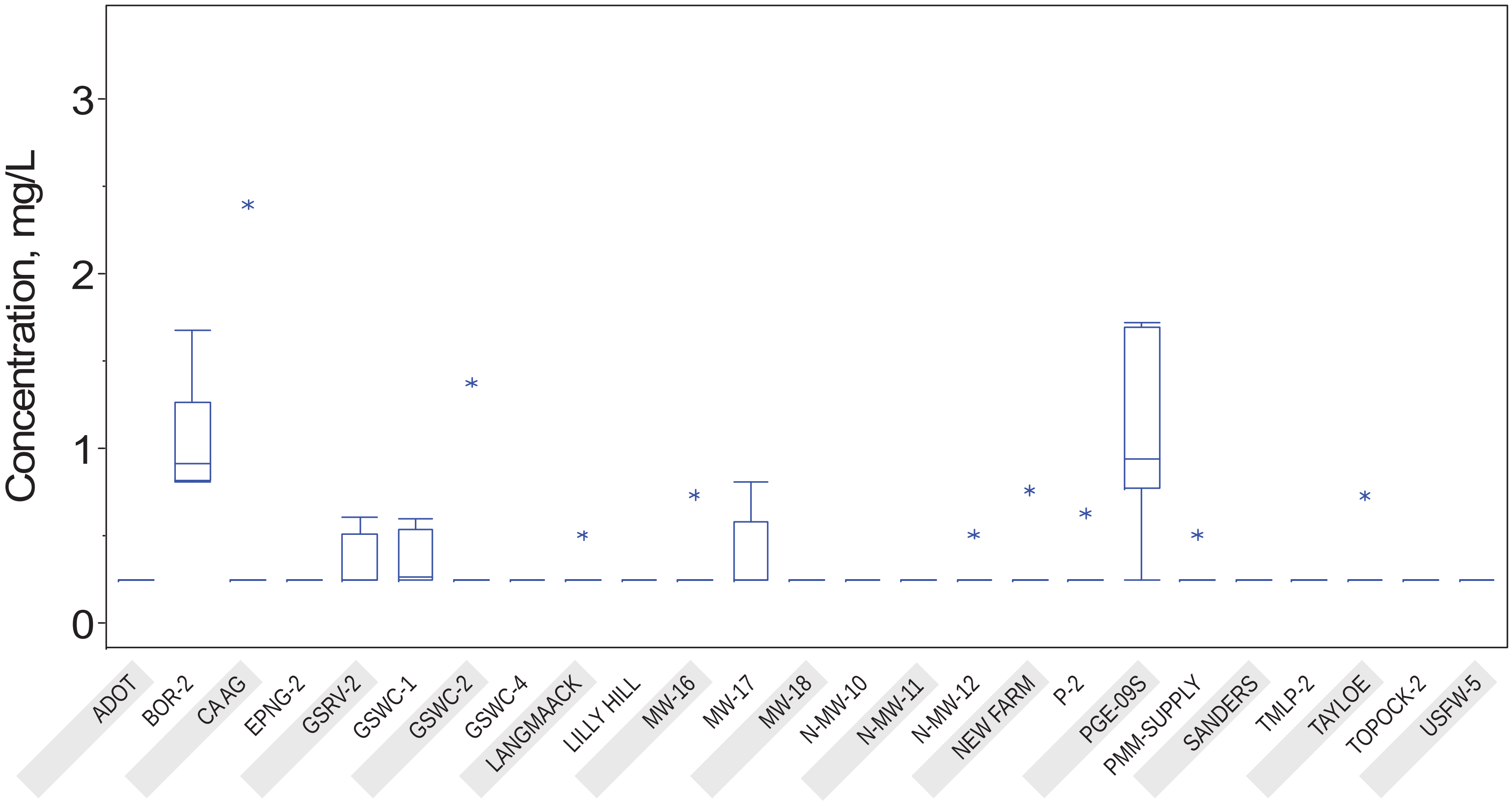


FIGURE A-30
BOX AND WHISKER PLOT FOR N-TOTAL KJELDAHL NITROGEN

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

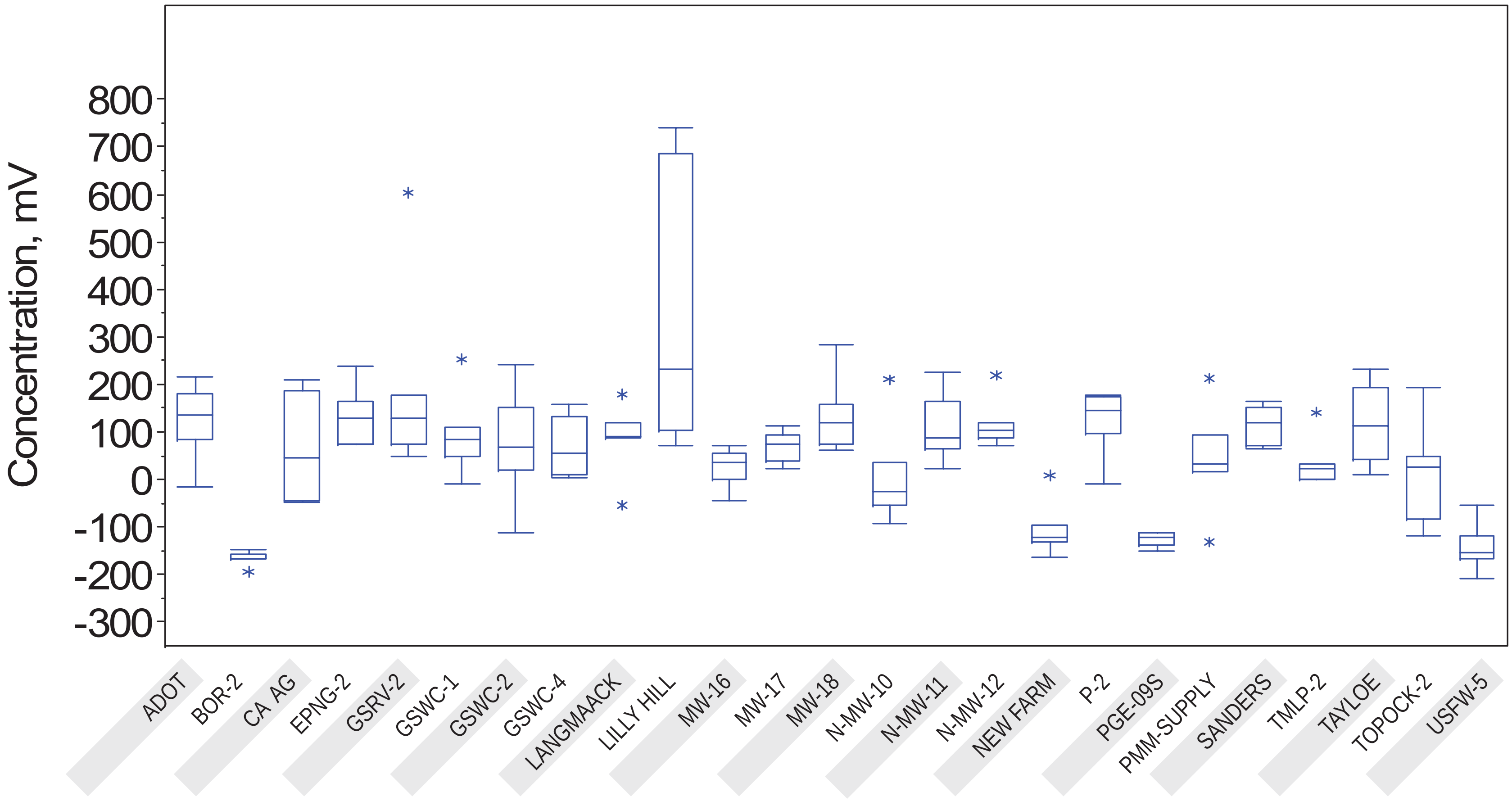


FIGURE A-31
BOX AND WHISKER PLOT FOR OXIDATION REDUCTION POTENTIAL

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

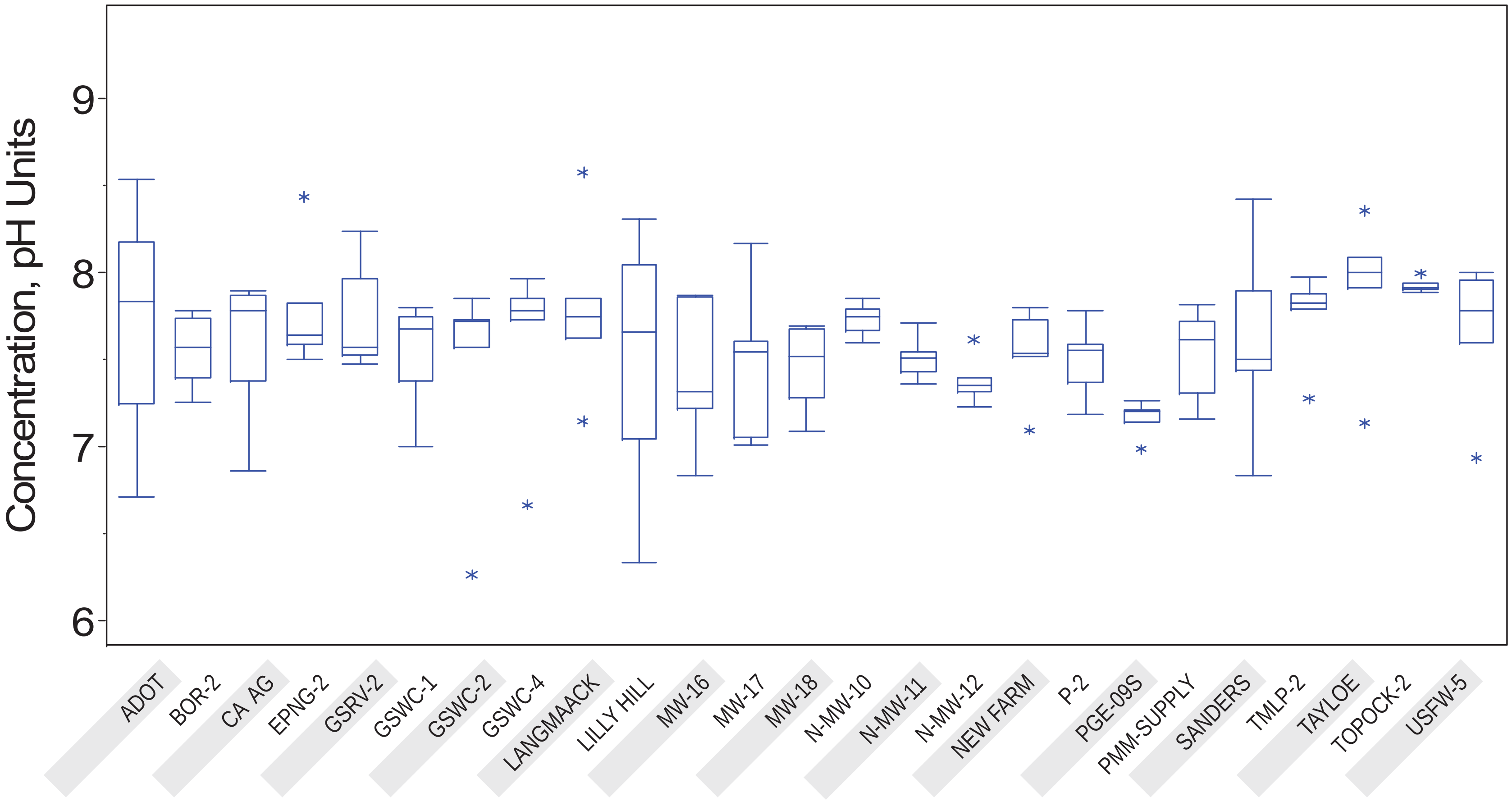


FIGURE A-32
BOX AND WHISKER PLOT FOR pH

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

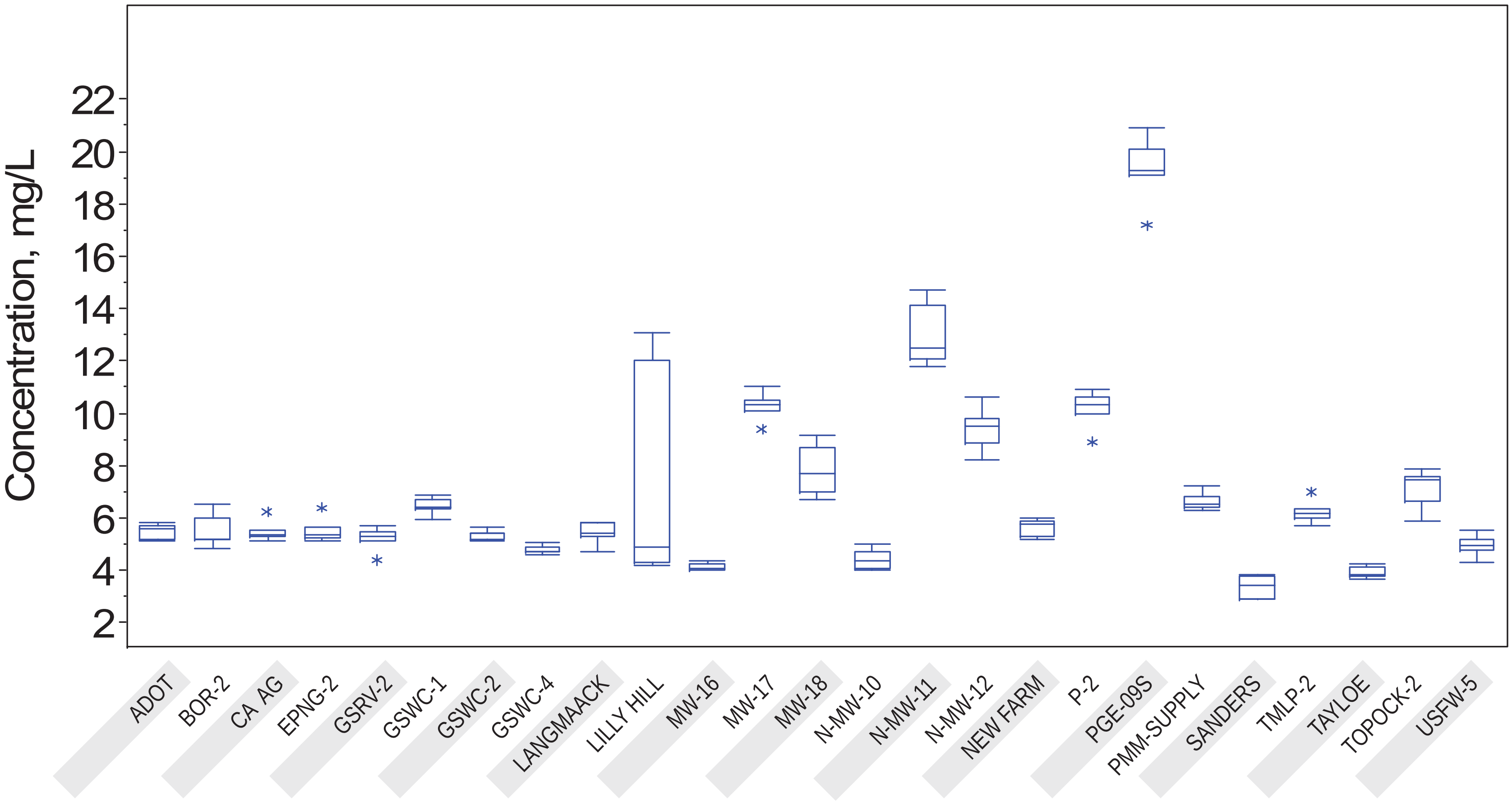


FIGURE A-33
BOX AND WHISKER PLOT FOR DISSOLVED POTASSIUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

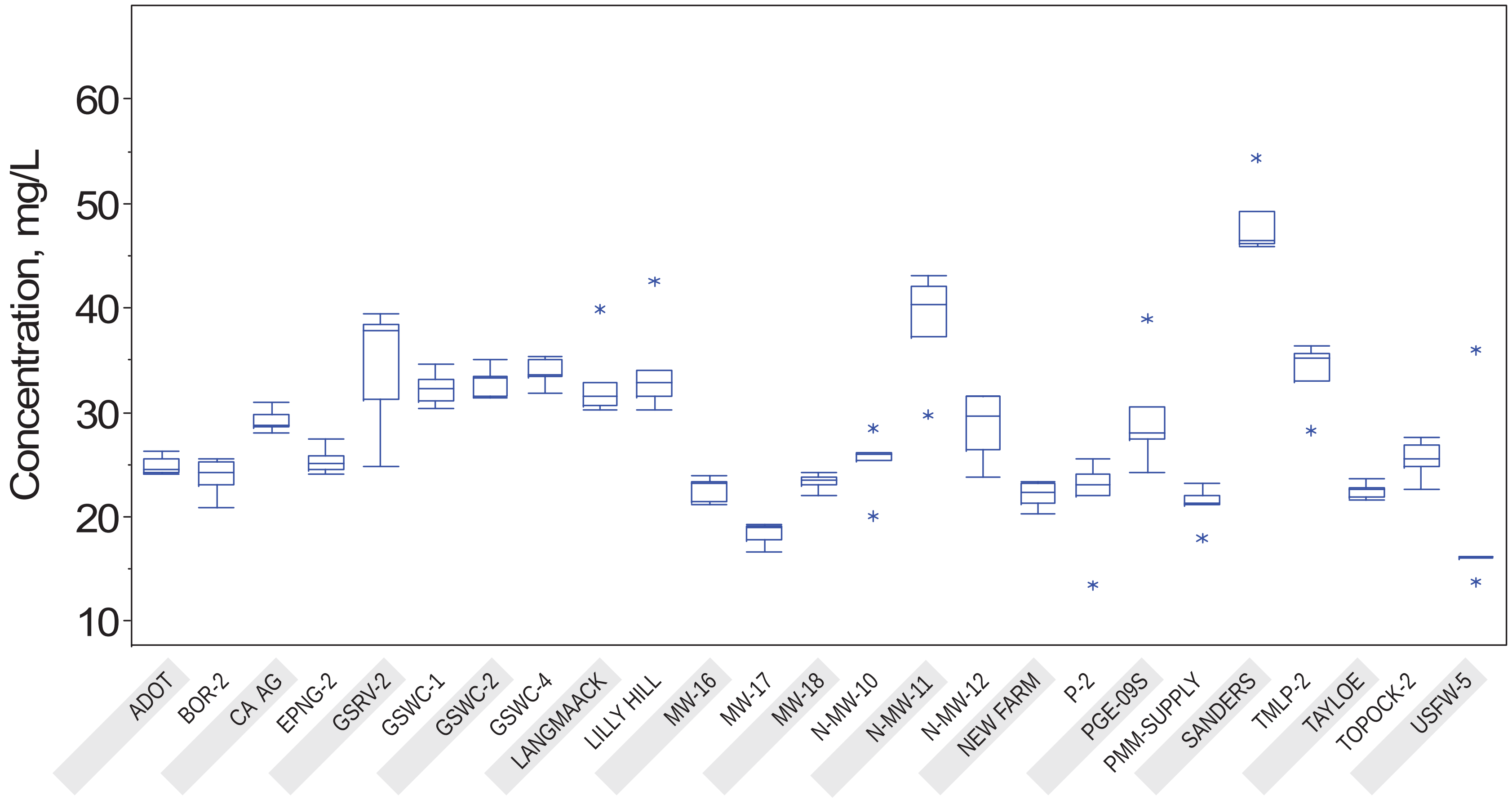


FIGURE A-34
BOX AND WHISKER PLOT FOR SOLUBLE SILICA

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

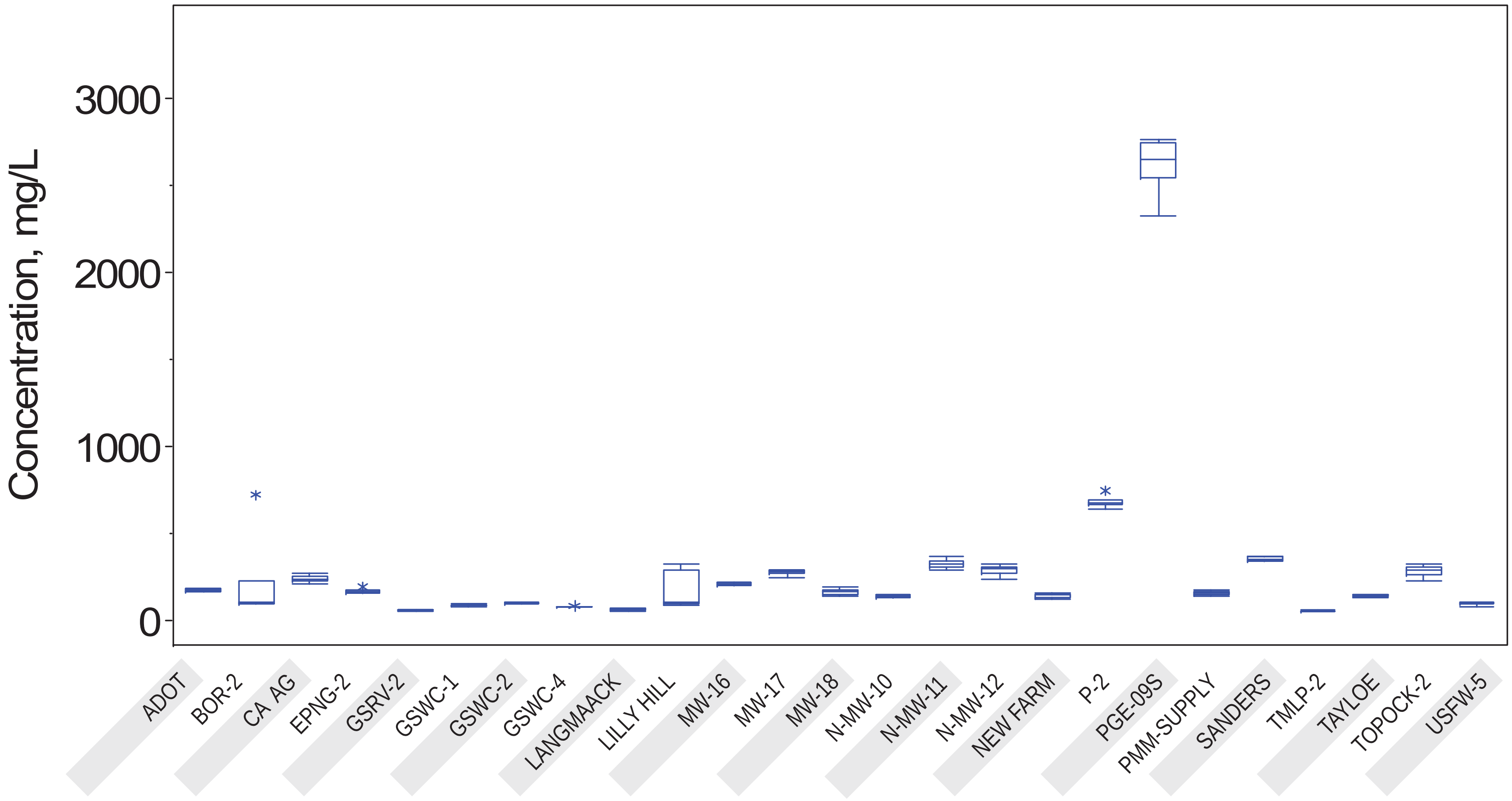


FIGURE A-35
BOX AND WHISKER PLOT
FOR DISSOLVED SODIUM

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

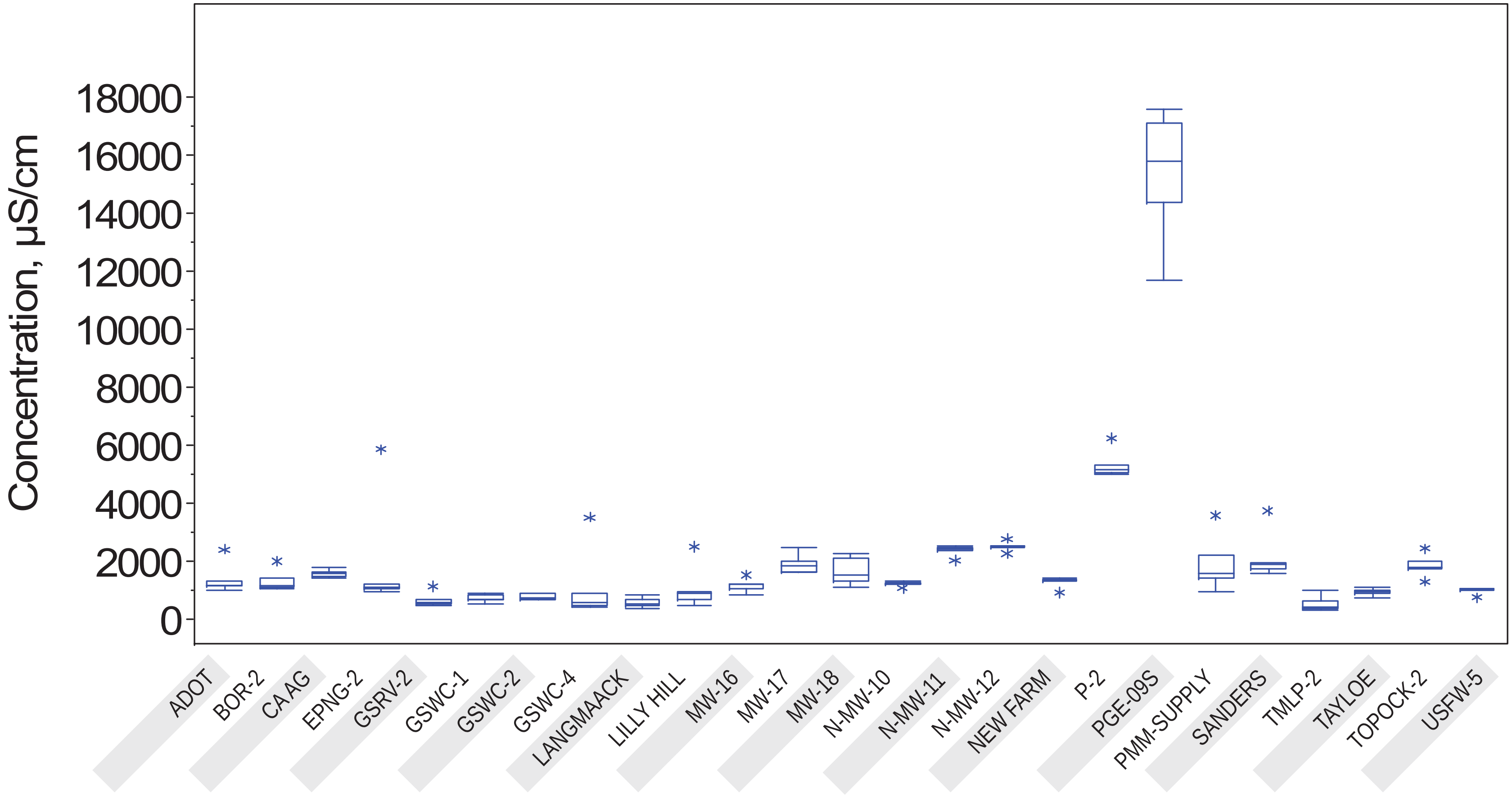


FIGURE A-36
BOX AND WHISKER PLOT FOR SPECIFIC CONDUCTANCE

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

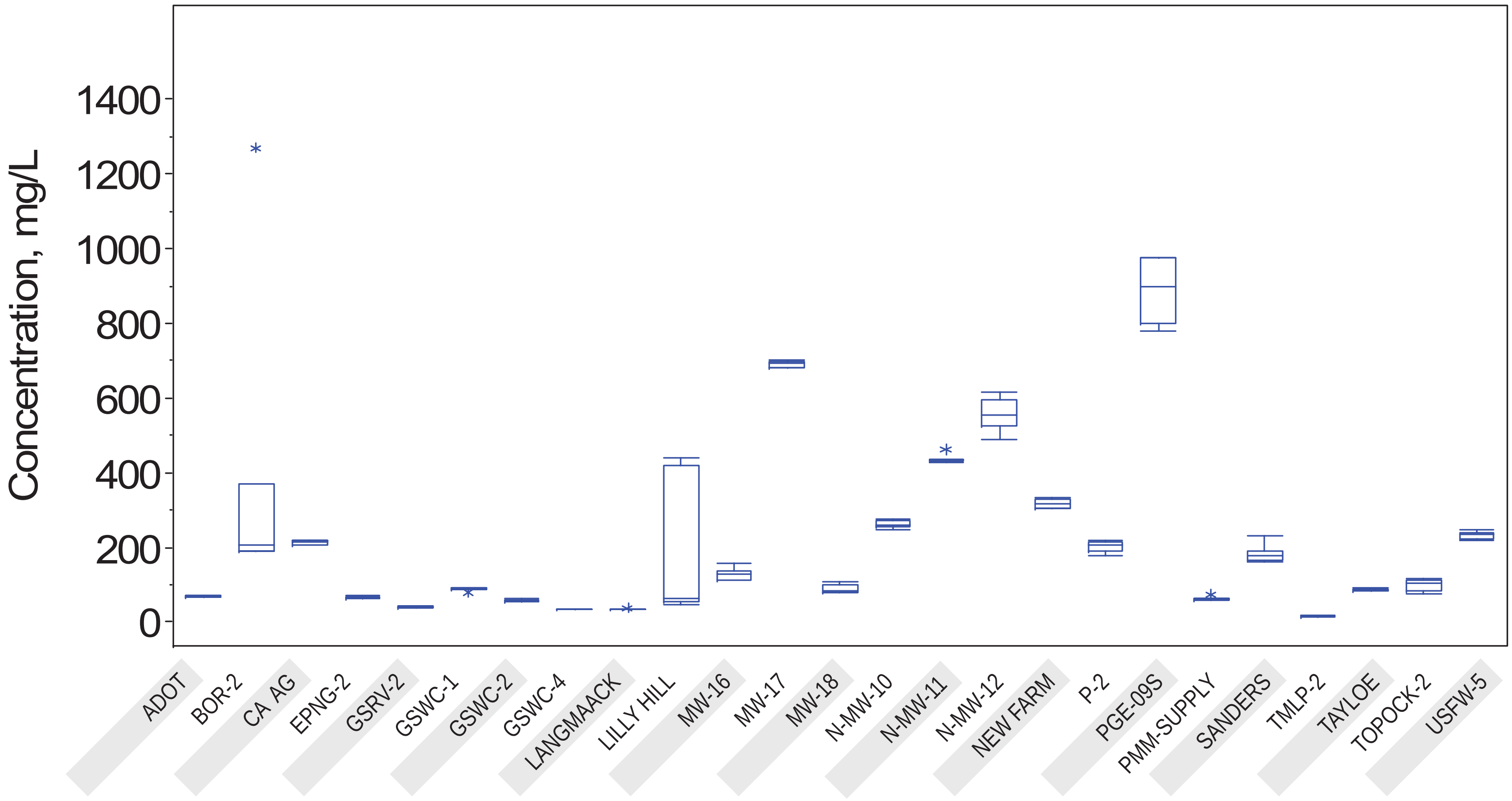


FIGURE A-37
BOX AND WHISKER PLOT FOR SULFATE

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

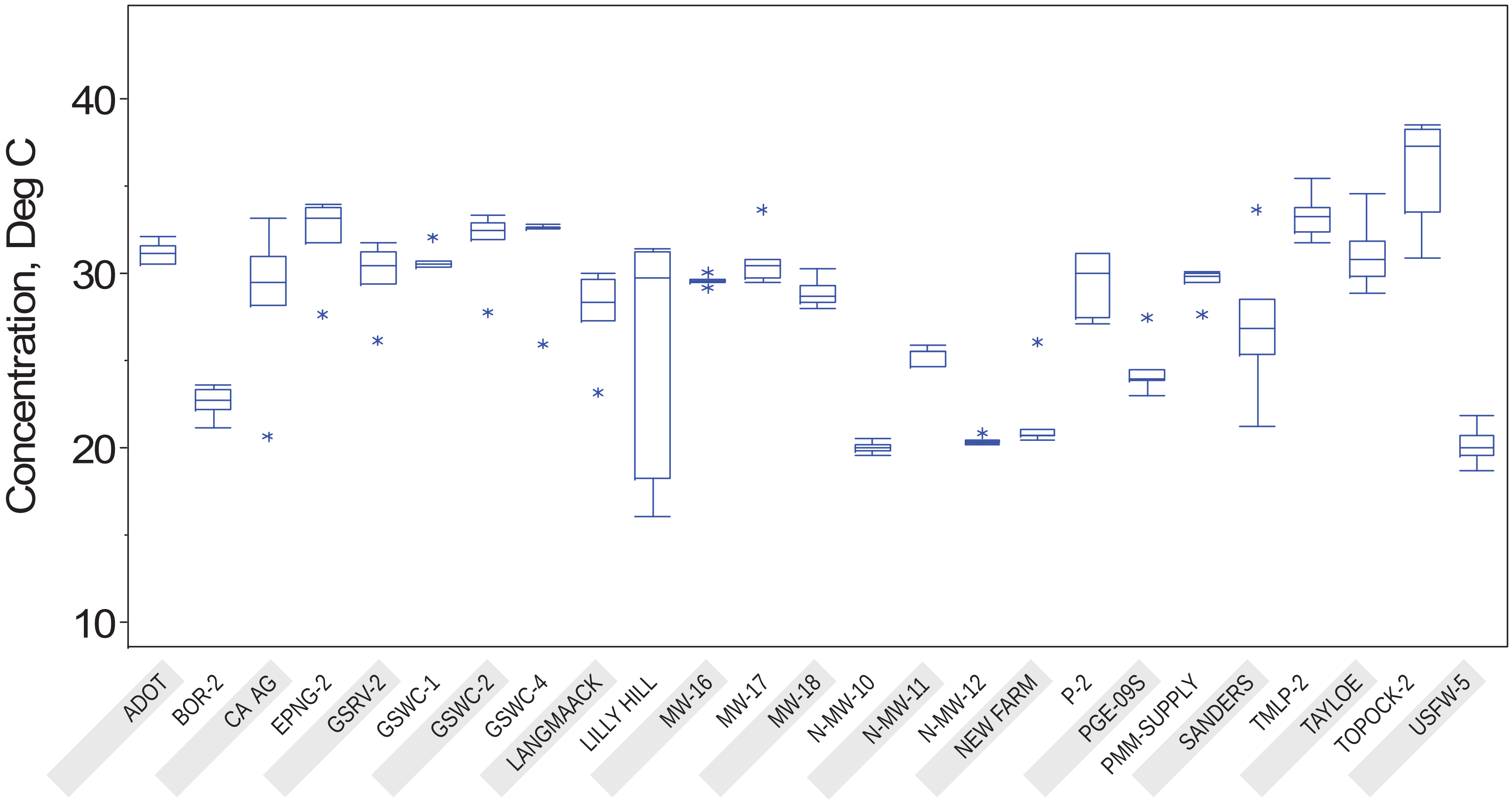


FIGURE A-38
BOX AND WHISKER PLOT FOR TEMPERATURE

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

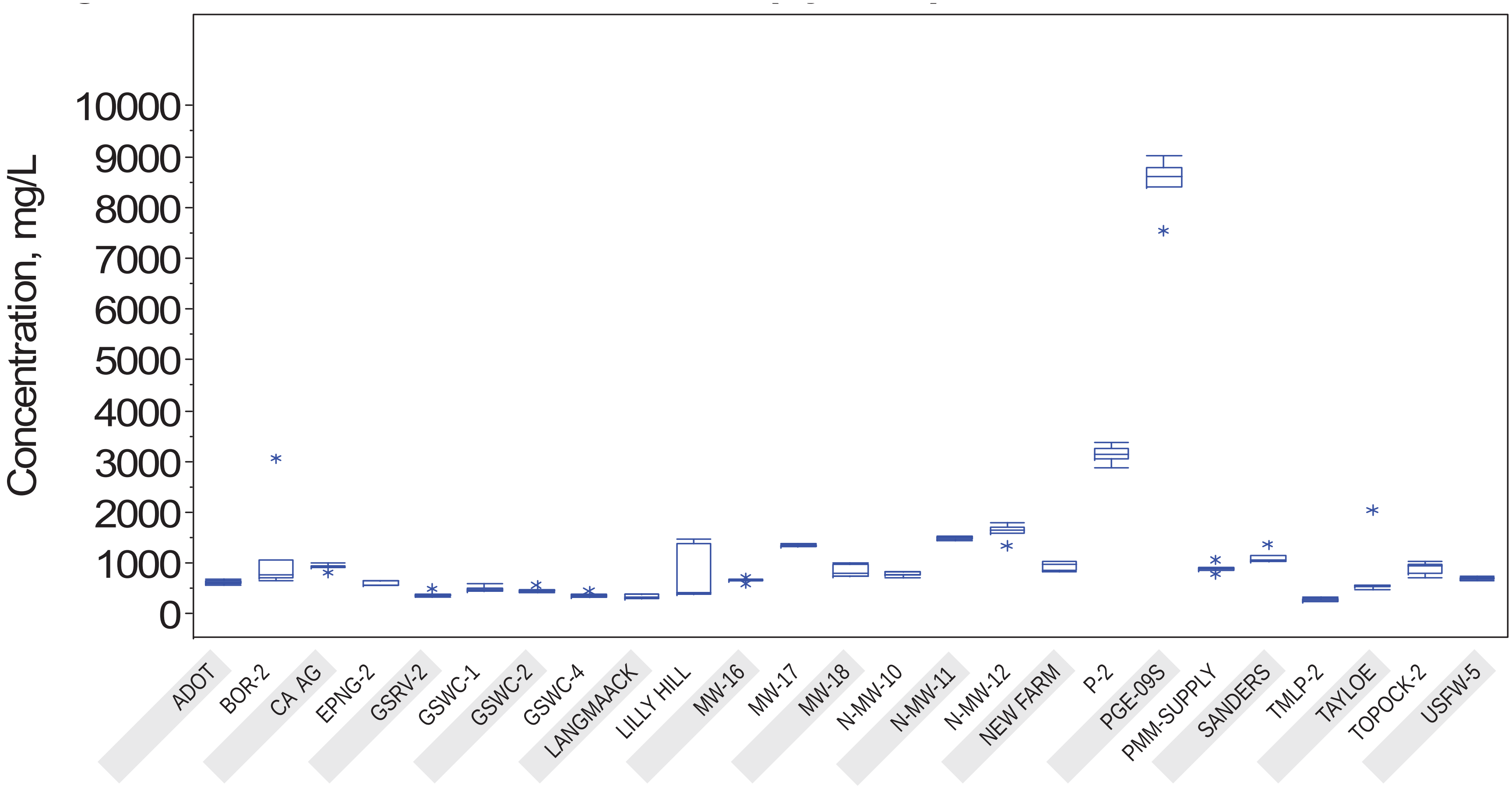


FIGURE A-39
BOX AND WHISKER PLOT FOR TOTAL DISSOLVED SOLIDS

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

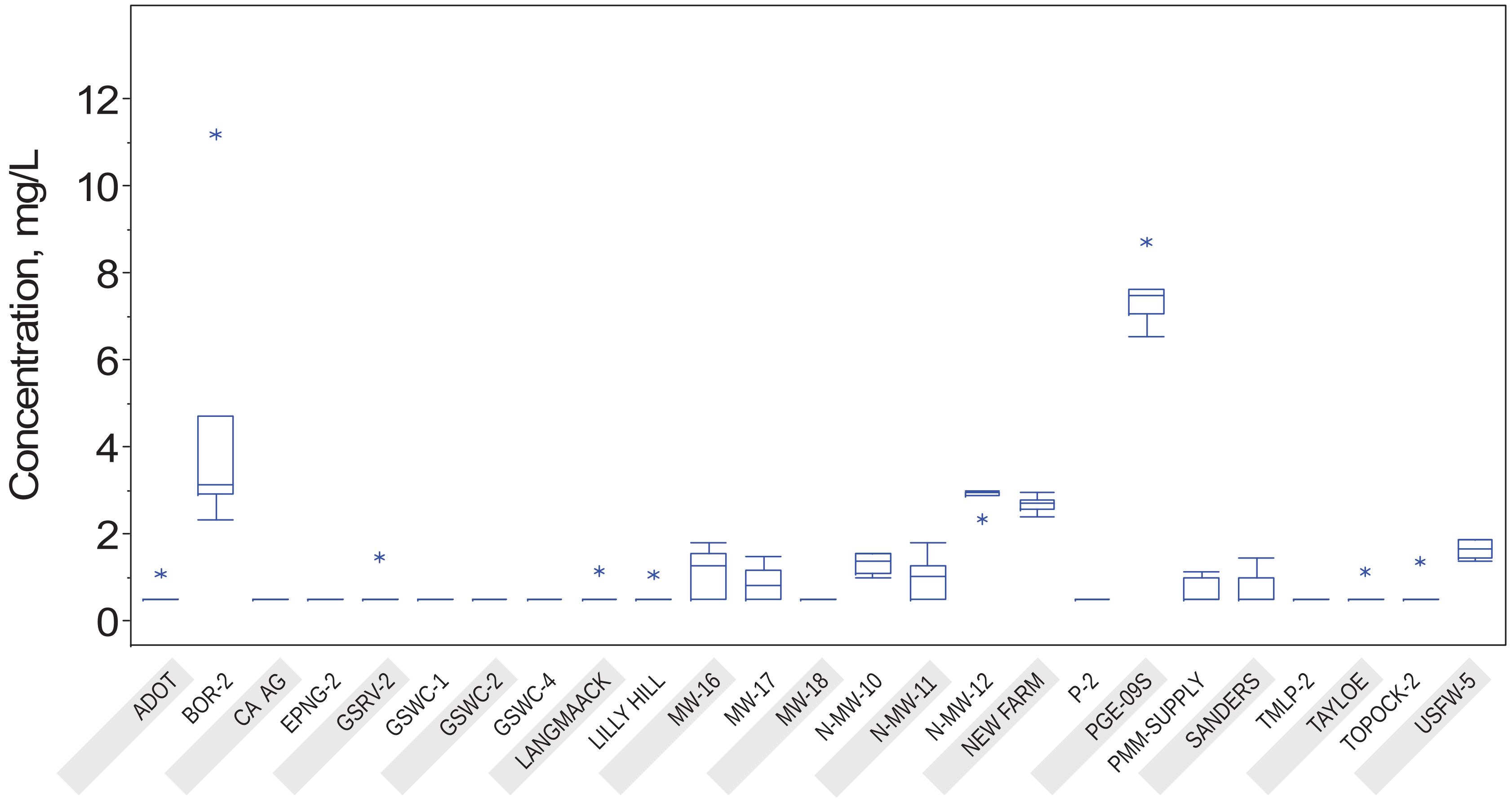


FIGURE A-40
BOX AND WHISKER PLOT FOR TOTAL ORGANIC CARBON

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

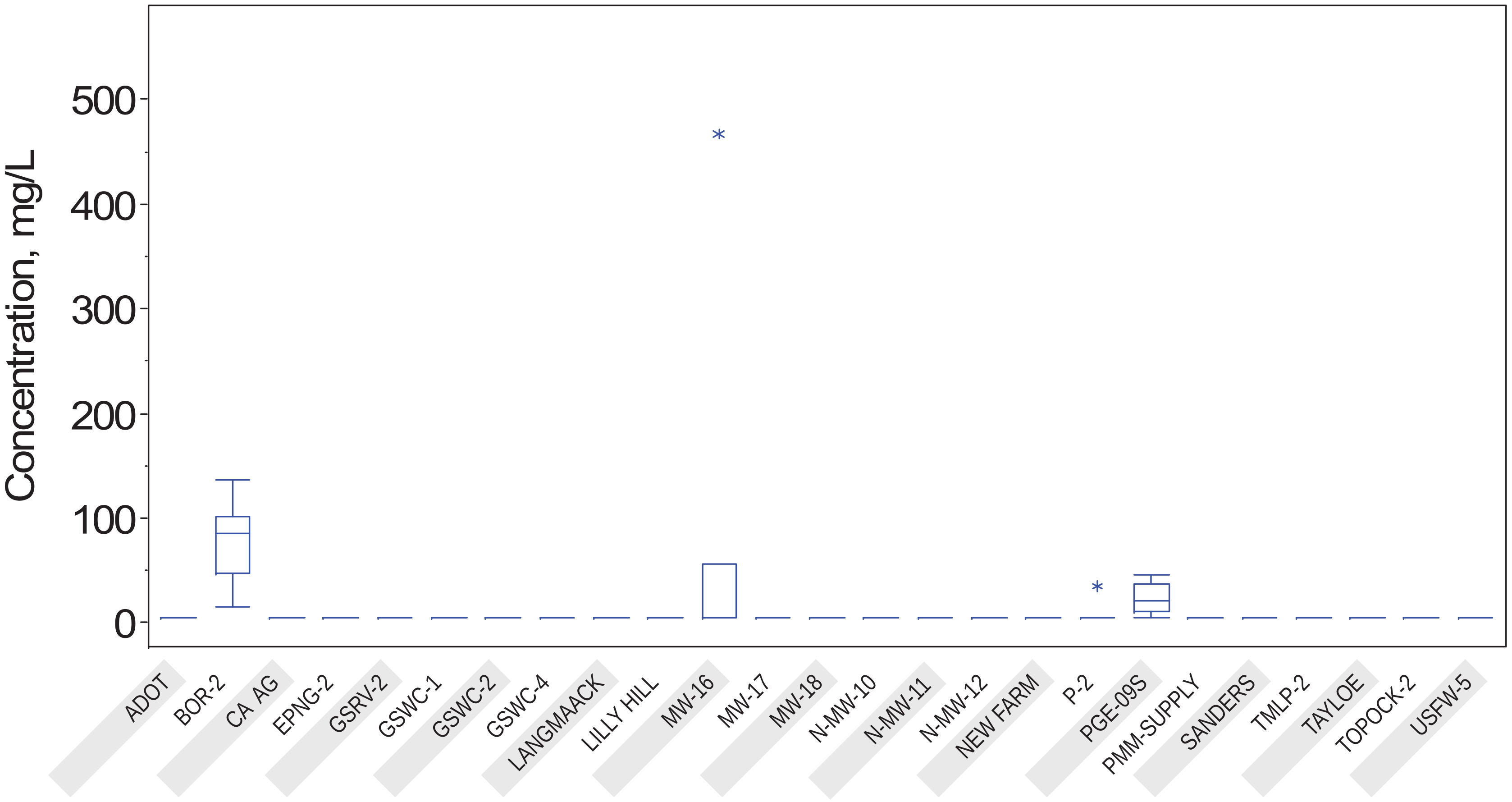


FIGURE A-41
BOX AND WHISKER PLOT
FOR TOTAL SUSPENDED SOLIDS

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

CH2MHILL

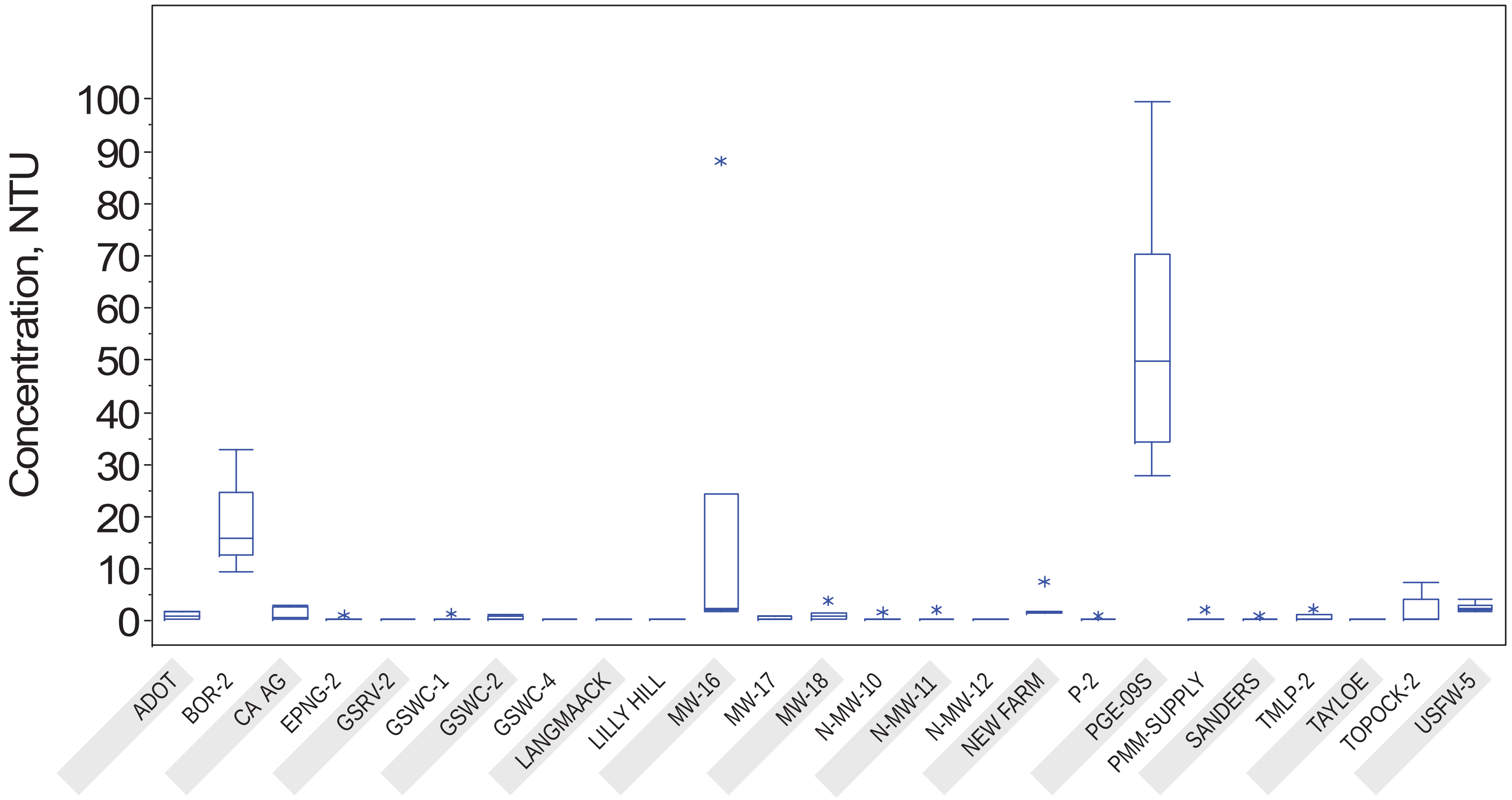


FIGURE A-42
BOX AND WHISKER PLOT FOR TURBIDITY

GROUNDWATER BACKGROUND STUDY, STEPS 3 AND 4:
REVISED FINAL REPORT OF RESULTS
PG&E TOPOCK COMPRESSOR STATION AND VICINITY
NEEDLES, CALIFORNIA

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Appendix B
Electronic Background Data Set on CD

Appendix C

Additional Outlier Evaluation

APPENDIX C

Additional Outlier Evaluation

In the June 2, 2007 and November 30, 2007 GSU memorandum, DTSC requested additional outlier evaluation be performed for each constituent's expanded dataset using individual data (rather than the mean concentration for each constituent per well). In response to DTSC's request, PG&E performed the additional outlier evaluation and submitted three tables summarizing the evaluation results to DTSC on January 29, 2008 (CH2M HILL, 2008b). These tables are included in this appendix as:

- Table C-1 – Non-parametric analysis of variance (ANOVA) Considering Influence of Well
- Table C-2 – Details on Mathematical Outlier Testing for Individual Data
- Table C-3 – Comparison of Outliers

In the February 28, 2008 GSU memorandum, General Comment 3 - Outliers, DTSC requested that an expanded data set outlier evaluation utilizing the information contained in the January 29, 2008 transmittal be included in the Final Background Study Report. In response to the GSU comment, this appendix was prepared to present and discuss the results of this additional outlier evaluation.

Outlier Evaluation Results

The box-and-whisker plots (Appendix A) illustrate graphically that the variability among wells is much more significant than the variability among samples from each well. This visual observation is bolstered by a non-parametric ANOVA evaluation (see Table C-1) for all constituents with at least 25 percent detects. (An arbitrary limit of 25 percent was chosen to avoid evaluation of those cases dominated by proxy concentrations for non-detects.) With this analysis, a low calculated probability indicates a significant contribution by between-well differences relative to within-well differences. All of these were well below a typical significance level of 0.05 and most were below 0.00005 (extremely small). These findings reinforced the decision that the individual data could not be interpreted as independent results.

Note that when individual data are tested for outliers, the most elevated values often have similar concentrations from the same well that can potentially mask each other's values from being identified as outliers. Masking could occur in this study where there are several values in the same elevated range, so that the statistical significance of any one of those values is diminished. If there are enough values in the elevated range, individual samples will not be identified as outliers.

A detailed table of this evaluation is presented in Table C-2. The list of outliers identified using individual data is compared to the list of outliers identified using each well's mean concentration in Table C-3. The comparison of outliers shows that the outlier analysis using mean well concentration (as presented in this report) is more conservative than that using the individual well data. Further, the mean concentrations can be defended as independent values whereas the individual values are clearly not independent from other values from the same well.

Conclusions

Based on the results presented above, the outlier analysis and practice of using mean concentrations (from each well) in the statistical calculations as shown in the report continues to be recommended as the most appropriate choice for representing this data set for statistical analysis.

TABLE C-1
Nonparametric ANOVA Considering Influence of Well

Parameter	Percent Detects	Calculated Probability*
Alkalinity, total as $CaCO_3$	100	<0.000005
Arsenic	98	<0.000005
Barium	100	<0.000005
Boron	100	<0.000005
Calcium	100	<0.000005
Chloride	100	<0.000005
Chromium	71	<0.000005
Copper	70	0.00056
Deuterium	100	<0.000005
Dissolved organic carbon	52	<0.000005
Dissolved oxygen	100	0.01741
Fluoride	83	<0.000005
Hexavalent chromium	75	<0.000005
Magnesium	100	<0.000005
Manganese	71	<0.000005
Molybdenum	99	<0.000005
Nickel	36	<0.000005
Nitrate as Nitrogen	79	<0.000005
Oxidation reduction potential	100	<0.000005
Oxygen 18	100	<0.000005
pH	100	0.006541
Potassium	100	<0.000005
Selenium	69	<0.000005
Sodium	100	<0.000005
Soluble silica	100	<0.000005
Specific Conductance	100	<0.000005
Sulfate	100	<0.000005
Temperature	100	<0.000005
Total dissolved solids	100	<0.000005
Total organic carbon	38	<0.000005
Turbidity	37	<0.000005
Vanadium	85	<0.000005
Zinc	67	<0.000005

* A low probability indicates the variability between wells is more significant than the random variability within the wells.

Only analytes with greater than 25% detection rate were evaluated.

TABLE C-2
Details on Mathematical Outlier Testing for Individual Data

Parameter	Number of Samples When Potential Outlier Removed	Well	Sample Date	Transformed Result	Transformation	Original Result	Rosner's Critical Value	Rosner's Statistic	Exceeds Critical Value?	Result Identified as Mathematical Outlier?
Alkalinity, bicarb. as $CaCO_3$	149	PGE-09S	7/20/2005	24.145	Square Root	583	3.52	3.133		yes
Alkalinity, bicarb. as $CaCO_3$	148	PGE-09S	5/3/2006	23.259	Square Root	541	3.51	3.034		yes
Alkalinity, bicarb. as $CaCO_3$	147	PGE-09S	12/20/2005	22.539	Square Root	508	3.51	2.961		yes
Alkalinity, bicarb. as $CaCO_3$	146	PGE-09S	10/31/2005	22.517	Square Root	507	3.51	3.060		yes
Alkalinity, bicarb. as $CaCO_3$	145	PGE-09S	2/21/2006	506.000	None	506	3.51	4.976	yes	yes
Alkalinity, bicarb. as $CaCO_3$	140	Needles MW-12	12/20/2005	263.000	None	263	3.5	2.314		
Alkalinity, total as $CaCO_3$	149	PGE-09S	7/20/2005	6.368	Logarithm	583	3.52	2.943		
Alkalinity, total as $CaCO_3$	148	PGE-09S	5/3/2006	6.293	Logarithm	541	3.51	2.892		
Alkalinity, total as $CaCO_3$	147	PGE-09S	12/20/2005	6.230	Logarithm	508	3.51	2.857		
Alkalinity, total as $CaCO_3$	146	PGE-09S	10/31/2005	6.229	Logarithm	507	3.51	2.947		
Alkalinity, total as $CaCO_3$	145	PGE-09S	2/21/2006	6.227	Logarithm	506	3.51	3.046		
Alkalinity, total as $CaCO_3$	140	Needles MW-12	12/20/2005	6.407	Cubic Root	263	3.5	2.035		
Arsenic	149	PGE-09S	2/21/2006	3.910	Logarithm	49.9	3.52	2.454		
Arsenic	148	Sanders	5/2/2006	3.813	Logarithm	45.3	3.51	2.403		
Arsenic	147	PGE-09S	5/3/2006	3.809	Logarithm	45.1	3.51	2.455		
Arsenic	146	PGE-09S	10/31/2005	3.664	Logarithm	39	3.51	2.343		
Arsenic	145	PGE-09S	12/20/2005	3.643	Logarithm	38.2	3.51	2.372		
Arsenic	140	Sanders	7/25/2005	3.026	Cubic Root	27.7	3.5	2.943		
Barium	149	PMM-Supply	11/2/2005	5.236	Logarithm	188	3.52	2.209		
Barium	148	PGE-09S	7/20/2005	5.193	Logarithm	180	3.51	2.180		
Barium	147	P-2	5/4/2006	5.094	Logarithm	163	3.51	2.054		
Barium	146	PMM-Supply	7/21/2005	5.043	Logarithm	155	3.51	2.004		
Barium	145	PMM-Supply	5/1/2006	5.030	Logarithm	153	3.51	2.017		
Barium	140	P-2	5/13/2005	4.990	Logarithm	147	3.5	2.138		
Boron	149	PGE-09S	7/20/2005	0.495	Logarithm	1.64	3.52	2.631		
Boron	148	PGE-09S	5/3/2006	0.399	Logarithm	1.49	3.51	2.549		
Boron	147	PGE-09S	2/21/2006	0.392	Logarithm	1.48	3.51	2.606		
Boron	146	PGE-09S	5/11/2005	0.358	Logarithm	1.43	3.51	2.620		
Boron	145	PGE-09S	12/20/2005	0.329	Logarithm	1.39	3.51	2.645		
Boron	140	Sanders	12/20/2005	-0.121	Logarithm	0.886	3.5	2.139		
Calcium	149	PGE-09S	5/3/2006	6.078	Logarithm	436	3.52	2.627		
Calcium	148	PGE-09S	2/21/2006	6.023	Logarithm	413	3.51	2.625		
Calcium	147	PGE-09S	10/31/2005	6.021	Logarithm	412	3.51	2.695		
Calcium	146	PGE-09S	12/20/2005	6.019	Logarithm	411	3.51	2.771		
Calcium	145	PGE-09S	7/20/2005	5.948	Logarithm	383	3.51	2.753		
Calcium	140	P-2	7/26/2005	5.572	Logarithm	263	3.5	2.529		
Chloride	149	PGE-09S	5/11/2005	8.311	Logarithm	4070	3.52	2.968		
Chloride	148	PGE-09S	5/3/2006	8.294	Logarithm	4000	3.51	3.055		
Chloride	147	PGE-09S	10/31/2005	8.287	Logarithm	3970	3.51	3.161		
Chloride	146	PGE-09S	2/21/2006	8.243	Logarithm	3800	3.51	3.243		
Chloride	145	PGE-09S	12/20/2005	8.227	Logarithm	3740	3.51	3.363		
Chloride	140	P-2	3/21/2006	7.307	Logarithm	1490	3.5	2.911		
Chromium	149	MW-18	11/3/2005	6.356	Square Root	40.4	3.52	2.396		
Chromium	148	MW-18	5/1/2006	6.116	Square Root	37.4	3.51	2.300		
Chromium	147	MW-18	3/1/2006	6.025	Square Root	36.3	3.51	2.292		
Chromium	146	MW-18	2/9/2006	6.008	Square Root	36.1	3.51	2.332		
Chromium	145	GSRV-2	5/19/2005	5.941	Square Root	35.3	3.51	2.341		
Chromium	140	GSRV-2	12/22/2005	5.206	Square Root	27.1	3.5	2.046		
Copper	149	Lily Hill	5/1/2006	3.020	Logarithm	20.5	3.52	2.390		
Copper	148	GSWC-2	7/22/2005	3.006	Logarithm	20.2	3.51	2.431		
Copper	147	MW-17	5/19/2005	2.986	Logarithm	19.8	3.51	2.469		

TABLE C-2
Details on Mathematical Outlier Testing for Individual Data

Parameter	Number of Samples When Potential Outlier Removed	Well	Sample Date	Transformed Result	Transformation	Original Result	Rosner's Critical Value	Rosner's Statistic	Exceeds Critical Value?	Result Identified as Mathematical Outlier?
Copper	146	Langmaack	12/19/2005	2.640	Cubic Root	18.4	3.51	3.361		
Copper	145	ADOT New Well	11/3/2005	2.630	Cubic Root	18.2	3.51	3.489		
Copper	140	MW-17	11/2/2005	2.685	Square Root	7.21	3.5	2.242		
Deuterium	149	Tayloe	12/20/2005	-54.000	None	-54	3.52	1.538		
Deuterium	148	MW-17	3/1/2006	-54.800	None	-54.8	3.51	1.501		
Deuterium	147	MW-17	12/22/2005	-55.000	None	-55	3.51	1.504		
Deuterium	146	GSWC-1	12/19/2005	-57.000	None	-57	3.51	1.382		
Deuterium	145	MW-18	3/1/2006	-57.600	None	-57.6	3.51	1.354		
Deuterium	140	MW-16	3/1/2006	-59.200	None	-59.2	3.5	1.307		
Dissolved organic carbon	148	BOR-2	12/21/2005	2.468	Logarithm	11.8	3.52	2.814		
Dissolved organic carbon	147	GSRV-2	5/4/2006	2.273	Logarithm	9.71	3.51	2.670		
Dissolved organic carbon	146	New Farm Well	2/21/2006	2.258	Logarithm	9.56	3.51	2.728		
Dissolved organic carbon	145	PGE-09S	7/20/2005	2.254	Logarithm	9.53	3.51	2.807		
Dissolved organic carbon	144	PGE-09S	10/31/2005	2.145	Logarithm	8.54	3.51	2.757		
Dissolved organic carbon	139	Needles MW-11	5/2/2006	1.668	Cubic Root	4.64	3.5	2.716		
Dissolved oxygen	147	ADOT New Well	5/2/2006	9.820	None	9.82	3.52	2.043		
Dissolved oxygen	146	Needles MW-12	2/22/2006	9.620	None	9.62	3.51	1.988		
Dissolved oxygen	145	Needles MW-10	2/22/2006	9.470	None	9.47	3.51	1.953		
Dissolved oxygen	144	Needles MW-10	7/21/2005	9.300	None	9.3	3.51	1.907		
Dissolved oxygen	143	Needles MW-10	5/2/2006	9.190	None	9.19	3.51	1.886		
Dissolved oxygen	138	Lily Hill	2/22/2006	8.790	None	8.79	3.5	1.844		
Fluoride	149	Sanders	5/2/2006	1.992	Cubic Root	7.91	3.52	2.845		
Fluoride	148	Sanders	3/1/2006	1.941	Cubic Root	7.31	3.51	2.770		
Fluoride	147	Sanders	11/3/2005	1.875	Cubic Root	6.59	3.51	2.638		
Fluoride	146	Sanders	5/18/2005	1.834	Cubic Root	6.17	3.51	2.575		
Fluoride	145	Sanders	7/25/2005	1.785	Cubic Root	5.69	3.51	2.478		
Fluoride	140	Topock-2	6/22/2005	1.574	Cubic Root	3.9	3.5	1.951		
Hexavalent chromium	149	MW-18	5/1/2006	6.132	Square Root	37.6	3.52	2.376		
Hexavalent chromium	148	GSRV-2	5/19/2005	6.107	Square Root	37.3	3.51	2.415		
Hexavalent chromium	147	MW-18	3/1/2006	6.017	Square Root	36.2	3.51	2.416		
Hexavalent chromium	146	MW-18	11/3/2005	5.916	Square Root	35	3.51	2.409		
Hexavalent chromium	145	MW-18	2/9/2006	5.639	Square Root	31.8	3.51	2.285		
Hexavalent chromium	140	GSRV-2	11/2/2005	4.970	Square Root	24.7	3.5	2.032		
Magnesium	149	BOR-2	12/21/2005	5.371	Logarithm	215	3.52	2.825		
Magnesium	148	PGE-09S	5/3/2006	5.063	Logarithm	158	3.51	2.561		
Magnesium	147	PGE-09S	2/21/2006	5.043	Logarithm	155	3.51	2.607		
Magnesium	146	PGE-09S	7/20/2005	5.037	Logarithm	154	3.51	2.671		
Magnesium	145	PGE-09S	10/31/2005	5.030	Logarithm	153	3.51	2.741		
Magnesium	140	Needles MW-12	12/20/2005	4.193	Logarithm	66.2	3.5	1.987		
Manganese	149	PGE-09S	7/20/2005	7.576	Logarithm	1950	3.52	2.205		
Manganese	148	PGE-09S	12/20/2005	7.139	Logarithm	1260	3.51	2.080		
Manganese	147	PGE-09S	5/3/2006	7.139	Logarithm	1260	3.51	2.118		
Manganese	146	PGE-09S	10/31/2005	7.115	Logarithm	1230	3.51	2.150		
Manganese	145	PGE-09S	2/21/2006	7.012	Logarithm	1110	3.51	2.151		
Manganese	140	Needles MW-12	7/21/2005	6.340	Logarithm	567	3.5	2.074		
Molybdenum	149	Sanders	5/2/2006	3.731	Logarithm	41.7	3.52	2.563		
Molybdenum	148	Sanders	11/3/2005	3.658	Logarithm	38.8	3.51	2.505		
Molybdenum	147	Sanders	7/25/2005	3.619	Logarithm	37.3	3.51	2.499		
Molybdenum	146	Sanders	12/20/2005	3.611	Logarithm	37	3.51	2.549		
Molybdenum	145	Sanders	3/1/2006	3.459	Logarithm	31.8	3.51	2.336		
Molybdenum	140	CA Agriculture Station	5/1/2006	3.153	Logarithm	23.4	3.5	1.964		

TABLE C-2
Details on Mathematical Outlier Testing for Individual Data

Parameter	Number of Samples When Potential Outlier Removed	Well	Sample Date	Transformed Result	Transformation	Original Result	Rosner's Critical Value	Rosner's Statistic	Exceeds Critical Value?	Result Identified as Mathematical Outlier?
Nickel	149	Needles MW-12	5/2/2006	3.726	Logarithm	41.5	3.52	4.037	yes	yes
Nickel	148	Langmaack	12/19/2005	2.996	Logarithm	20	3.51	3.478		
Nickel	147	MW-16	11/3/2005	2.518	Logarithm	12.4	3.51	3.087		
Nickel	146	MW-16	12/22/2005	2.281	Logarithm	9.79	3.51	2.920		
Nickel	145	MW-17	12/22/2005	2.224	Logarithm	9.24	3.51	2.950		
Nickel	140	MW-16	5/13/2005	1.959	Logarithm	7.09	3.5	3.183		
Nitrate as Nitrogen	149	Lily Hill	11/3/2005	4.750	None	4.75	3.52	2.045		
Nitrate as Nitrogen	148	Lily Hill	7/25/2005	4.700	None	4.7	3.51	2.042		
Nitrate as Nitrogen	147	GSWC-1	2/20/2006	4.670	None	4.67	3.51	2.055		
Nitrate as Nitrogen	146	GSWC-1	5/1/2006	4.600	None	4.6	3.51	2.037		
Nitrate as Nitrogen	145	GSWC-1	12/19/2005	4.490	None	4.49	3.51	1.986		
Nitrate as Nitrogen	140	MW-17	5/9/2006	4.060	None	4.06	3.5	1.790		
Oxidation reduction potential	148	Lily Hill	5/1/2006	741	None	741	3.52	4.723	yes	yes
Oxidation reduction potential	147	Lily Hill	12/20/2005	685	None	685	3.51	4.725	yes	yes
Oxidation reduction potential	146	GSRV-2	5/19/2005	604	None	604	3.51	4.492	yes	yes
Oxidation reduction potential	145	MW-18	5/1/2006	282	None	282	3.51	2.028		
Oxidation reduction potential	144	GSWC-1	2/20/2006	254	None	254	3.51	1.816		
Oxidation reduction potential	139	Needles MW-11	2/22/2006	227	None	227	3.5	1.701		
Oxygen 18	149	MW-17	5/9/2006	-7.400	None	-7.4	3.52	1.919		
Oxygen 18	148	MW-17	3/1/2006	-7.700	None	-7.7	3.51	1.761		
Oxygen 18	147	MW-17	12/22/2005	-7.800	None	-7.8	3.51	1.722		
Oxygen 18	146	MW-17	7/26/2005	-7.900	None	-7.9	3.51	1.682		
Oxygen 18	145	Tayloe	7/25/2005	-7.900	None	-7.9	3.51	1.705		
Oxygen 18	140	CA Agriculture Station	11/3/2005	-8.500	None	-8.5	3.5	1.414		
pH	149	Langmaack	2/21/2006	8.58	None	741	3.52	2.567		
pH	148	ADOT New Well	5/2/2006	8.54	None	685	3.51	2.529		
pH	147	EPNG-2	5/2/2006	8.44	None	604	3.51	2.324		
pH	146	Sanders	5/2/2006	8.42	None	282	3.51	2.322		
pH	145	Tayloe	5/2/2006	8.36	None	254	3.51	2.207		
pH	140	Tayloe	12/20/2005	8.09	None	227	3.5	1.605		
Potassium	149	PGE-09S	5/11/2005	3.040	Logarithm	20.9	3.52	2.960		
Potassium	148	PGE-09S	12/20/2005	3.001	Logarithm	20.1	3.51	2.964		
Potassium	147	PGE-09S	10/31/2005	2.960	Logarithm	19.3	3.51	2.961		
Potassium	146	PGE-09S	2/21/2006	2.955	Logarithm	19.2	3.51	3.052		
Potassium	145	PGE-09S	5/3/2006	2.950	Logarithm	19.1	3.51	3.152		
Potassium	140	Needles MW-11	2/22/2006	2.534	Logarithm	12.6	3.5	2.363		
Selenium	149	MW-17	11/2/2005	2.610	Logarithm	13.6	3.52	2.577		yes
Selenium	148	MW-17	7/26/2005	2.573	Logarithm	13.1	3.51	2.602		yes
Selenium	147	MW-17	12/22/2005	2.573	Logarithm	13.1	3.51	2.673		yes
Selenium	146	MW-17	5/9/2006	2.549	Logarithm	12.8	3.51	2.723		yes
Selenium	145	MW-17	3/1/2006	2.333	Cubic Root	12.7	3.51	3.794	yes	yes
Selenium	140	Needles MW-11	11/3/2005	2.179	Square Root	4.75	3.5	2.231		
Sodium	149	PGE-09S	5/3/2006	7.927	Logarithm	2770	3.52	3.307		yes
Sodium	148	PGE-09S	2/21/2006	7.919	Logarithm	2750	3.51	3.440		yes
Sodium	147	PGE-09S	5/11/2005	7.905	Logarithm	2710	3.51	3.581	yes	yes
Sodium	146	PGE-09S	12/20/2005	7.859	Logarithm	2590	3.51	3.702	yes	yes
Sodium	145	PGE-09S	10/31/2005	7.844	Logarithm	2550	3.51	3.883	yes	yes
Sodium	140	P-2	12/21/2005	6.537	Logarithm	690	3.5	2.488		
Soluble silica	125	Sanders	12/20/2005	3.996	Logarithm	54.4	3.38	2.629		
Soluble silica	124	Sanders	11/3/2005	3.667	Cubic Root	49.3	3.38	2.535		
Soluble silica	123	Sanders	7/25/2005	3.593	Cubic Root	46.4	3.38	2.322		

TABLE C-2
Details on Mathematical Outlier Testing for Individual Data

Parameter	Number of Samples When Potential Outlier Removed	Well	Sample Date	Transformed Result	Transformation	Original Result	Rosner's Critical Value	Rosner's Statistic	Exceeds Critical Value?	Result Identified as Mathematical Outlier?
Soluble silica	122	Sanders	3/1/2006	3.588	Cubic Root	46.2	3.37	2.364		
Soluble silica	121	Sanders	5/18/2005	6.775	Square Root	45.9	3.37	2.493		
Soluble silica	116	Langmaack	2/21/2006	6.317	Square Root	39.9	3.35	2.025		
Specific Conductance	147	PGE-09S	2/21/2006	9.776	Logarithm	17600	3.51	5.183	yes	yes
Specific Conductance	146	PGE-09S	12/20/2005	9.747	Logarithm	17100	3.51	5.577	yes	yes
Specific Conductance	145	PGE-09S	10/31/2005	9.680	Logarithm	16000	3.51	5.862	yes	yes
Specific Conductance	144	PGE-09S	5/11/2005	9.655	Logarithm	15600	3.51	6.558	yes	yes
Specific Conductance	143	PGE-09S	5/3/2006	9.575	Logarithm	14400	3.51	7.200	yes	yes
Specific Conductance	138	P-2	11/30/2005	8.558	Logarithm	5210	3.5	4.003	yes	yes
Sulfate	149	BOR-2	12/21/2005	7.147	Logarithm	1270	3.52	2.195		
Sulfate	148	PGE-09S	5/3/2006	6.883	Logarithm	976	3.51	1.980		
Sulfate	147	PGE-09S	10/31/2005	6.882	Logarithm	975	3.51	2.013		
Sulfate	146	PGE-09S	2/21/2006	6.841	Logarithm	935	3.51	2.007		
Sulfate	145	PGE-09S	12/20/2005	6.759	Logarithm	862	3.51	1.960		
Sulfate	140	MW-17	3/1/2006	6.542	Logarithm	694	3.5	1.894		
Temperature	149	Topock-2	7/21/2005	38.500	None	38.5	3.52	2.204		
Temperature	148	Topock-2	6/22/2005	38.300	None	38.3	3.51	2.206		
Temperature	147	Topock-2	11/2/2005	37.300	None	37.3	3.51	2.037		
Temperature	146	TMLP-2	5/1/2006	35.500	None	35.5	3.51	1.683		
Temperature	145	Tayloe	5/16/2005	34.600	None	34.6	3.51	1.509		
Temperature	140	Sanders	5/2/2006	33.700	None	33.7	3.5	1.386		
Total dissolved solids	149	PGE-09S	10/31/2005	9.108	Logarithm	9030	3.52	3.203		yes
Total dissolved solids	148	PGE-09S	2/21/2006	9.081	Logarithm	8790	3.51	3.295		yes
Total dissolved solids	147	PGE-09S	5/3/2006	9.066	Logarithm	8660	3.51	3.414		yes
Total dissolved solids	146	PGE-09S	12/20/2005	9.056	Logarithm	8570	3.51	3.557	yes	yes
Total dissolved solids	145	PGE-09S	5/11/2005	9.037	Logarithm	8410	3.51	3.708	yes	yes
Total dissolved solids	140	P-2	7/26/2005	8.046	Logarithm	3120	3.5	2.643		
Total organic carbon	149	BOR-2	12/21/2005	2.416	Logarithm	11.2	3.52	3.207		
Total organic carbon	148	PGE-09S	7/20/2005	2.167	Logarithm	8.73	3.51	3.014		
Total organic carbon	147	PGE-09S	10/31/2005	2.029	Logarithm	7.61	3.51	2.940		
Total organic carbon	146	PGE-09S	5/3/2006	2.022	Logarithm	7.55	3.51	3.031		
Total organic carbon	145	PGE-09S	2/21/2006	2.008	Logarithm	7.45	3.51	3.125		
Total organic carbon	140	BOR-2	5/11/2005	1.112	Logarithm	3.04	3.5	2.253		
Turbidity	149	PGE-09S	2/21/2006	4.599	Logarithm	99.4	3.52	3.490		yes
Turbidity	148	MW-16	5/13/2005	4.480	Logarithm	88.2	3.51	3.561	yes	yes
Turbidity	147	PGE-09S	5/11/2005	4.251	Logarithm	70.2	3.51	3.547	yes	yes
Turbidity	146	PGE-09S	10/31/2005	4.004	Logarithm	54.8	3.51	3.508		yes
Turbidity	145	PGE-09S	5/3/2006	3.809	Logarithm	45.1	3.51	3.504		yes
Turbidity	140	MW-16	7/26/2005	3.199	Logarithm	24.5	3.5	3.789	yes	yes
Vanadium	149	Sanders	5/2/2006	8.961	Square Root	80.3	3.52	3.393		
Vanadium	148	Sanders	3/1/2006	8.075	Square Root	65.2	3.51	2.990		
Vanadium	147	Sanders	11/3/2005	7.987	Square Root	63.8	3.51	3.040		
Vanadium	146	Sanders	12/20/2005	7.733	Square Root	59.8	3.51	2.983		
Vanadium	145	Sanders	7/25/2005	6.899	Square Root	47.6	3.51	2.520		
Vanadium	140	MW-16	12/22/2005	31.800	None	31.8	3.5	2.571		
Zinc	149	PGE-09S	5/11/2005	7.534	Logarithm	1870	3.52	3.857	yes	yes
Zinc	148	PGE-09S	2/21/2006	6.838	Logarithm	933	3.51	3.469		
Zinc	147	PGE-09S	7/20/2005	6.485	Logarithm	655	3.51	3.309		
Zinc	146	PGE-09S	10/31/2005	5.568	Logarithm	262	3.51	2.582		
Zinc	145	PGE-09S	12/20/2005	5.440	Cubic Root	161	3.51	2.838		
Zinc	140	Sanders	3/1/2006	4.688	Cubic Root	103	3.5	2.364		

TABLE C-3
Comparison of Outliers

Outliers Determined from Individual Data Evaluation

Analyte	Well	Date
Nickel	Needles MW-12	5/2/2006
Oxidation reduction potential	Lily Hill	5/1/2006
Oxidation reduction potential	Lily Hill	12/20/2005
Oxidation reduction potential	GSRV-2	5/19/2005
Selenium	MW-17	11/2/2005
Selenium	MW-17	7/26/2005
Selenium	MW-17	12/22/2005
Selenium	MW-17	5/9/2006
Selenium	MW-17	3/1/2006
Sodium	PGE-09S	5/3/2006
Sodium	PGE-09S	2/21/2006
Sodium	PGE-09S	5/11/2005
Sodium	PGE-09S	12/20/2005
Sodium	PGE-09S	10/31/2005
Specific Conductance	PGE-09S	2/21/2006
Specific Conductance	PGE-09S	12/20/2005
Specific Conductance	PGE-09S	10/31/2005
Specific Conductance	PGE-09S	5/11/2005
Specific Conductance	PGE-09S	5/3/2006
Specific Conductance	P-2	11/30/2005
Total dissolved solids	PGE-09S	10/31/2005
Total dissolved solids	PGE-09S	2/21/2006
Total dissolved solids	PGE-09S	5/3/2006
Total dissolved solids	PGE-09S	12/20/2005
Total dissolved solids	PGE-09S	5/11/2005
Turbidity	PGE-09S	2/21/2006
Turbidity	MW-16	5/13/2005
Turbidity	PGE-09S	5/11/2005
Turbidity	PGE-09S	10/31/2005
Turbidity	PGE-09S	5/3/2006
Turbidity	MW-16	7/26/2005
Zinc	PGE-09S	5/11/2005

Outliers Determined from Well Averages

For comparison (from Final Background Study, Steps 3 and 4: Report of Results)

Analyte	Well
Arsenic	PGE-09S
Arsenic	Sanders
Chloride	PGE-09S
Chloride	P-2
Nickel	Needles MW-12
Nickel	MW-16
Potassium	PGE-09S
Selenium	MW-17
Sodium	PGE-09S
Specific conductance	PGE-09S
Specific conductance	P-2
Total dissolved solids	PGE-09S
Total dissolved solids	P-2
Total organic carbon	PGE-09S
Total organic carbon	BOR-2
Total organic carbon	Needles MW-12
Total organic carbon	New Farm Well
Turbidity	PGE-09S
Turbidity	MW-16
Turbidity	BOR-2
Vanadium	Sanders
Zinc	PGE-09S

Appendix D
Response to Comments

Appendix D1

Agency Comments on the Revised Groundwater Background Study Step 3 and 4: Report of Results, January 14, 2008

TABLE D-1
Response to DTSC Comments on the *Revised Groundwater Background Study Step 3 and 4: Report of Results*
PG&E Topock Compressor Station, Needles, California

Comment Number	Comment (DTSC's February 29, 2008 Letter including GSU Memorandum dated February 28, 2008)	Response to Comment
General Comment 1	**Topic 2 – Potential Limitations for Use of the Groundwater Background Study:** The cover letter to the Revised Report discusses limitations anticipated when utilizing the results of the groundwater background study during preparation of the RCRA Facility Investigation/Remedial Investigation (RFI/RI), risk assessment, and Corrective Measure Study/Feasibility Study (CMS/FS). Topic 2 indicates that the use of the background groundwater concentrations will be evaluated, noting that they may not be appropriate for all constituents in all portions of the site or at all depths. Based on this statement, it is uncertain what actual levels will be used in the RFI/RI, risk assessment, or CMS/FS. Due to this uncertainty, PG&E should provide, either in a revision to the Revised Report or in a separate submittal, a summary of the proposed background/alternate levels and presentation of the associated decision logic. Preferably, the summary would be submitted in advance of the associated work plan or report to ensure this issue is appropriately addressed in a timely manner.	A conference call was held on March 11, 2008 between PG&E and DTSC to clarify this comment. PG&E understands that a high level of detail and a great amount of specificity would be needed to satisfy the agency's comment and gain acceptance of the response. Attaining such level of detail and specificity would necessitate performing the actual risk assessment and evaluating the remedial action objectives for the actual CMS/FS. Therefore, to address this comment appropriately and efficiently, PG&E proposes to maintain the same approach outlined in Section 5.0 of the report, which is to evaluate the use of the background groundwater concentrations determined through calculation of UTLs for the study area as a whole during preparation of the RFI/RI, risk assessment, and CMS/FS. The limitations and caveats for use of the calculated UTLs for specific constituents, wells, or areas will be assessed and acknowledged, as appropriate for each application.
General Comment 2	**Extreme values:** Outliers for trace metals have been evaluated using formal outlier tests, box-and-whisker plots, and probability plots. The assessment identified both data that has been excluded from the background data, and data that appears to represent extreme values for the Mojave Valley region. The following metals either contained value(s) that were identified as outliers and/or exhibit data points on probability and box-and-whisker plots that are suggestive of outliers: arsenic (BOR-2, Lilly Hill), molybdenum (Sanders), nickel (MW-16, Needles MW-12), selenium (MW-17), and vanadium (Sanders). These data were retained in the background data set, but represent extreme values. The GSU remains concerned that these extreme values strongly influence the Upper Tolerance Limit (UTL) calculated for the background data for the site. When establishing constituents of potential concern and delineating the groundwater plume, PG&E should, at a minimum, be cautious and judicious regarding the use of the UTLs in the assessment.	As explained in Section 2.2.2, box-and-whisker "outliers" are not true outliers in the statistical sense, but are visual indicators of values that might warrant further examination. The rigorous statistical outlier tests described in the report represent this further examination, and the nickel, selenium, and vanadium values cited in the comment were in fact identified as statistical outliers (see Table 2-4). The arsenic values from BOR-2 and Lily Hill were not identified as statistical outliers after data from the sixth sampling event from Topock-2 were excluded. As recommended by DTSC in comments to the Step 2 report, a geochemical interpretation is necessary following the statistical analysis to interpret the apparent outliers. The arsenic, selenium, and vanadium values were within expected ranges for this geologic province, as shown in Table 4-2. Nickel was not assessed in the RASA study, and the ADEQ study found 90% of nickel concentrations below an unspecified reporting limit. Nickel concentrations are considered representative of what would be expected in a variety of steel-cased, water supply wells using the approved sampling techniques of this study (see response to Specific Comment 6 below).

TABLE D-1
Response to DTSC Comments on the *Revised Groundwater Background Study Step 3 and 4: Report of Results*
PG&E Topock Compressor Station, Needles, California

Comment Number	Comment (DTSC's February 29, 2008 Letter including GSU Memorandum dated February 28, 2008)	Response to Comment
	The case of arsenic exemplifies the GSU's concerns. Arsenic from wells BOR-2 and Lilly Hill were identified as outliers (CH2M Hill, 2007), and exhibit outlier tendencies as illustrated by box-and-whisker and probability plots. The regional UTL presented in the Revised Report is 24.3 ug/L. Delineating the plume or selecting constituents of potential concern for risk assessments using only the arsenic UTL appears inappropriate for the Topock site after reviewing the entire Topock site data set. The Topock data indicates that routine detections of arsenic are less than 5 ug/L and that chromium contaminated portions of the plume range from 5 to 14 ug/L (excluding contaminated well MW-12). Well BOR-2 (mean arsenic concentration of 17.4 ug/L) is influenced by fluvial water and reducing conditions (see Figure 2-6 of the Revised Report) and represents a geochemical environment where arsenic, like iron, can persist. Well Lilly Hill (mean arsenic concentration of 13.3 ug/L) exhibited unusual well chemistry that had isotopic signatures fluctuating widely from fluvial to alluvial. Based on evaluation of site data and the extreme values within the regional background data set, the GSU would anticipate that a lower site specific arsenic background concentration would be derived for plume delineation and selection of constituents of potential concern.	With regard to comment in the second paragraph, it is acknowledged in the report that multiple background populations may be interpreted for the region, including areas within and away from the influence of the Colorado River. However, samples that may fall into the river-influenced population (such as BOR-2) or may represent a mixed water (as was described for Lily Hill in the comment) do not warrant exclusion from the dataset as presented in the report. The range of arsenic concentrations is interpreted to represent the natural variation of the region as a whole.
General Comment 3	**Outliers - Individual Outlier Analysis Tables:** On January 29, 2008, CH2M Hill provided an email to DTSC that included tabulated outlier statistics utilizing individual sampling event data, rather than each well's mean concentration as was performed in the Revised Report. An expanded data set outlier evaluation utilizing information contained in the January 29, 2008 transmittal should be included in the next revision.	Appendix C has been added to the report and provides a description of the expanded outlier analysis and an explanation of the observed differences between the expanded (i.e., individual sample) analysis and the mean concentration analysis.
Specific Comment 1	**Cover Letter, Topic 3 - Rationale for a Single (rather than Multiple) Background Concentrations for the Topock Groundwater Study:** The discussion includes comments suggesting that assessing multiple populations was not envisioned as an objective of the background study process. Please note that comments from Kate Burger (DSTC, 2005) clearly discussed outlier screening and the potential to identify multiple groundwater populations that would necessitate the calculation of a different background concentrations for each population. Alternate language is suggested for the next revision.	The discussion under Topic 3 of the Cover Letter refers to the original objective of the Background Study, as stated in the June 20, 2004 Work Plan (CH2M HILL, 2004), which is to define an upper threshold concentration for total chromium, Cr(VI), and other metals in groundwater at the Topock site. However, the same discussion also acknowledged that some DTSC and DOI reviewers have suggested the derivation of separate background concentrations for various portions of the site, This acknowledgement of comments made by DTSC reviewers includes, but is not limited to, Dr. Burger's comment in

TABLE D-1
Response to DTSC Comments on the *Revised Groundwater Background Study Step 3 and 4: Report of Results*
PG&E Topock Compressor Station, Needles, California

Comment Number	Comment (DTSC's February 29, 2008 Letter including GSU Memorandum dated February 28, 2008)	Response to Comment
		the Conditional Approval of Step 2 Report (October 11, 2005). PG&E believes that this adequately addresses DTSC's Specific Comment 1, and, therefore, no changes will be made. A point of note is in the 2005 Conditional Approval of Step 2 Report. Dr. Burger requested that PG&E provide an evaluation of multiple populations and outliers to assist DTSC with its review and approval of the background data set. PG&E responded to Dr., Burger's request in Section 2.2.3.2 (Multiple Population Analysis) of the January 14, 2008 Revised Background Study Report.
Specific Comment 2	**Section 2.1, Selection and Description of Background Wells:** The beginning of the second paragraph on page 2-1 indicates that PG&E submitted the Arizona groundwater well workplan at the request of DTSC. The sentence should indicate that the workplan was requested by the Arizona Department of Environmental Quality (ADEQ), not DTSC.	Changes to text have been made to incorporate this comment.
Specific Comment 3	**Section 2.1, Selection and Description of Background Wells:** The third paragraph on page 2-1 indicates that 14 background wells are located in California and that 11 are in Arizona. The sentence should indicate that there are 11 background wells in California and 14 in Arizona.	Changes to text have been made to incorporate this comment.
Specific Comment 4	**Section 2.1, Selection and Description of Background Wells:** The second paragraph on page 2-2 indicates that the June 2006 groundwater sample from well Topock-2 could not be used for the study due to anomalously high turbidity. First, the paragraph should clarify that no data (metals, general minerals, etc.) from the June 2006 Topock-2 sampling event were used for the background study or any of the statistical assessments or calculations. Additionally, the sentence within the paragraph should be revised to clarify that, more important than elevated turbidity, the June 2006 Topock-2 data could not be used for the study due to anomalously high concentrations for several metals that did not correlate with duplicate samples.	Changes to the text have been made to indicate that no data were used from the last sampling event at this well, and that the turbidity was the likely cause of the anomalously high concentrations of some metals that did not correlate with duplicate samples.
Specific Comment 5	**Section 2.2.2, Statistical Outlier Analysis:** The fourth and/or fifth paragraphs on page 2-4 discussing box-and-whisker plots should clarify that the some plots do not include the excluded data (e.g., arsenic, chromium, hexavalent chromium, fluoride, lead, zinc, etc.) as	A paragraph was added to clarify that specific data were excluded prior to preparing the plots. The horizontal axis label for the box-and-whisker plot for arsenic (Figure A-3) was corrected to remove PGE-09S, Sanders, and Topock-2. The

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	indicated in Section 2.2.4 and on Table 2-9 of the Revised Report (this should also be stated on the plots themselves). Additionally, the box-and-whisker plots for arsenic and zinc (Figures A-3 and A-17 respectively) should be revised as the x-axis still contains labels for the excluded wells and, therefore, mislabels the data. Similarly, the text should be revised to indicate that some probability plots contained in Appendix B do not include excluded data. Those plots in Appendix B that do not include excluded data will need to be revised and specify which data is excluded.	horizontal axis label for the box-and-whisker plot for zinc (Figure A-17) was corrected to remove PGE-09S. Footnotes regarding excluded data were also added to the applicable figures in Appendix A. Note that all figures (A-series and B-series) are included in Appendix A and not in Appendix B.
Specific Comment 6	**Section 2.2.2, Statistical Outlier Analysis, Fifth Paragraph, Page 2-4:** All eight outliers (asterisks) identified in Figure A-14 for silver (Appendix A) were detected during a November 2, 2005 sampling event. Silver was not detected anytime else during any of the other background well sampling events. All samples analyzed for silver on November 2, 2005 (11 analyses) detected silver except for one duplicate sample. As the isolated silver detections are highly suggestive of a sampling methodology or laboratory data quality problem, it is recommended that the November 2, 2005 silver data be excluded from the background data set. Also recall that anomalously high lead concentrations from the November 2, 2005 sampling event have already been excluded from the background data set.	There is no observational evidence to justify removing the silver values. They were not identified as statistical outliers. It is not uncommon to occasionally observe trace metal concentrations that appear to be anomalously high. This is very commonly the result of colloidal material passing through the filters. The fact that the higher concentrations are not consistently observed supports this idea, since colloid quantities and sizes are highly variable. This effect is suspected in many of the background study samples for a variety of metals, but because these kinds of values would be expected in future samples, the occasional colloid breakthrough is considered a normal artifact of sampling and should be represented in the calculated background concentrations.
	Figure A-31 contains an anomalously elevated ORP measurement for well GSRV-2 that was previously identified in DTSC's November 30, 2007 letter. It is recommended that the ORP outlier be removed from the data set. This modification would require editing Figure A-31 and Figure 2-9 among other things.	It is agreed that the ORP value is anomalously high. ORP is a field-measured parameter that can vary significantly, and should only be used as a general indicator of redox conditions, rather than a precise measurement. With this in mind, the value has been left in the report for completeness, since there is no documentation of equipment malfunction for that measurement. If it were removed, Figure 2-9 would still show an oxidizing condition (blue color code) at this well, so interpretation of the data would not change.
	Box-and-whisker plots for Figures A-32 and A-36 are inappropriately plotted and will need to be revised.	Figures A-32 and A-36 have been revised to reflect field pH and specific conductance values (instead of lab pH and specific conductance) collected starting with the 2nd sampling event. Lab pH and specific conductance were only measured during the 1st sampling event. Corresponding tables (Tables 2-5, 2-7, 2-10, and 2-12) were also revised to reflect this change.

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	PG&E should also consider exclusion of the zinc outliers identified in Figure A-17. Four of the five outliers were obtained from the questionable November 2005 sampling event.	There is no evidence of questionable conditions or sample quality control issues associated with the November 2005 sampling event. We cannot find justification to remove values that appear to be higher than others in box-and-whisker plots (see response to General Comment 2).
Specific Comment 7	**Section 2.2.2, Statistical Outlier Analysis, Rosner's/Dixon's Outlier Analysis:** The third paragraph on page 2-5 indicates that when fewer than 25 samples were available, Dixon's test was applied. Table 2-5 indicates that Dixon's test was only used for ORP measurements utilizing 21 samples even though 25 mean ORP values exist as indicated in Appendix A (Figure A-31) and Appendix B (Electronic Version of Background Data Set on CD). The Revised Report should be revised to include text discussing why Dixon's test was utilized for ORP measurements and should consider, if necessary, alternatives to allow application of Rosner's test to ORP measurements. Additionally, Figure B-23 (Probability Plot for ORP) only utilizes 17 transformed concentrations and does not utilize the 25 mean concentrations. It appears that Figure B-23 should be revised. A footnote should be included on the revised figure if it is appropriate to not include the total 25 concentrations.	Dixon's outlier test was originally applied to ORP due to the lower number of results available to the test (21 as opposed to 25). The lower sample size was due to an error caused by negative numbers which impacted the transformation. An approach was developed, when transforming the data for the outlier test, to add a value to all results that would cause all values to be positive. For ORP, the selected value was 211 since the most negative value was 210. As a result, the Rosner's test is now applied to ORP. No mathematical outliers were identified for ORP as a result of the Rosner's test. Table 2-5 and Figure B-23 have been revised to reflect this change. Text was added to explain this approach.
Specific Comment 8	**Section 2.2.2, Statistical Outlier Analysis, Rosner's/Dixon's Outlier Analysis:** The last paragraph on page 2-5 introduces Table 2-4 which summarizes outliers identified by Rosner's test. Table 2-4 was compared to the equivalent table (Table 2-6) from the original report (CH2M Hill, 2007). The older table from the CH2M Hill, 2007 report contains six more outliers: Arsenic for BOR-2, Topock-2, and Lily Hill; Copper for Topock-2; Alkalinity for PGE-9S; and Turbidity for Topock-2. PG&E will need to discuss the discrepancies between the two tables and amend the Revised Report if necessary. Please note that it appears that the old outlier table included the excluded June 2006 groundwater sample data from well Topock-2.	After data for the sixth event (June 30, 2006) for Topock-2 were excluded from the data set, the six outliers cited in the comment ceased to be statistical outliers. However, they were inadvertently left in Table 2-6 of the January 2007 draft report (after the exclusion of the sixth event was discussed). Table 2-4 of the current report correctly discusses the outliers for the data set. No change in the report will be made.
Specific Comment 9	**Section 2.2.2, Statistical Outlier Analysis, Mean Rank Evaluation:** Table 2-8 was compared to the equivalent table (Table 2-9) from the original report (CH2M Hill, 2007). The older table compared the "Top Five" mean concentrations for dissolved metals (26 constituents evaluated) instead of trace metals (19 constituents evaluated) and determined additional outliers. The text should indicate why this	The 26 constituents evaluated in the January 2007 draft report included both trace metals (19 total) and common metals used in general chemistry analysis (7 total). The seven general chemistry metals were boron, calcium, iron, magnesium, manganese, potassium, and sodium. They were inadvertently included in the trace metal outlier analysis presented in Table 2-

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	change was selected over the original methodology.	9 of the January 2007 draft report. Table 2-8 of the current report correctly presents the information. No changes to the text will be made.
Specific Comment 10	**Section 2.2.3.1, General Geochemistry, Figures 2-3 and 2-4 Piper diagrams:** PG&E should double check and make sure that well data from Tayloe and TMLP-2 were not transposed on the figures. General mineral data were switched between these two wells in a summary table in the original report (CH2M Hill, 2007) and, therefore, concern exists that the data table error could also have propagated to the figures.	The data were checked, and general chemistry data for the two wells were not transposed on Figures 2-3 and 2-4. No changes to the report were made in response to this comment.
Specific Comment 11	**Section 2.2.3.1, General Geochemistry:** The first paragraph on page 2-8 of the Revised Report indicates that alluvial wells from the California and Arizona sides of the river show overlapping isotopic signatures. However, if Figure 2-5 is corrected (see Specific Comment 12 below), then the Arizona wells cluster on the figure and appear isotopically lighter than alluvial California background wells. The United States Department of the Interior (DOI) had previously mentioned this issue in its February 28, 2007 letter. The Revised Report will need to be corrected to incorporate this previously identified issue.	After the correction described in Specific Comment 12, there is still significant overlap between AZ and CA alluvial wells - P-2, MW-18, and PMM Supply all fall within the range of the AZ alluvial wells. Also, non-plume, site alluvial monitoring wells show strong overlap with the AZ alluvial wells. Text has been appended to explain these points.
Specific Comment 12	**Figures 2-5 and 2-6:** The same errors still remain on these figures even after they were identified for revision in previous agency reviews (i.e., appropriately labeling Needles MW-12 and switching labels for Tayloe/TMLP-2). PG&E will need to refer to DOI's and DTSC's 2007 comments and revise the figure.	The errors have been corrected in Figure 2-5 and Figure 2-6.
Specific Comment 13	**2.2.4 Summary of Excluded Background Data:** The last bullet on page 2-11 has cited the wrong date for the excluded lead sample at MW-17. The correct date is November 2, 2005. The second to the last bullet on page 2-11 should eliminate reference to the June 30, 2006 lead data as it was already excluded (Section 2.1) with the sixth round of Topock-2 data. The last paragraph on page 2-6 also refers to an incorrect date for the excluded lead sample at MW-17 and should also be revised.	Changes to the text have been made to incorporate this comment.
Specific Comment 14	**Table 2-9:** A footnote should be added to this table indicating that the data from the June 2006 Topock-2 sampling event were not used in	A footnote was added to Table 2-9 as requested. In addition, for consistency, a similar footnote was also added to Tables 2-10,

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	calculating any of the results displayed within the table.	2-11, and 2-12. The footnote reads as follows: "All Topock-2 results from the sixth event (June 2006) were excluded from the background data set (see Section 2.1)."
Specific Comment 15	**3.0 Background Concentrations:** Footnotes describing or referencing potential limitations of the regional background concentrations should be included on both Tables 2-13 and 3-1.	A footnote was added to Table 2-13 and Table 3-1, as requested. The footnote reads as follows: "Potential limitations for use of these UTLs are described in prior background study documents such as the cover letter to the January 14 revised background study report (CH2M HILL, 2008a) and DTSC's November 30, 2007 letter (DTSC, 2007a)."
Specific Comment 16	**Section 4.1, Sample Independence and Time Trends:** The first paragraph on page 4-1 indicates that for the 19 trace metals studied, there were no connections between higher metal concentrations and the geographic area, geologic parent material, or general chemistry type (e.g., TDS, sodium percentage). However, this is not consistent with findings elsewhere in the Revised Report (e.g., Section 2.2.3.2). A revision is necessary and should discuss or make reference to the sections of the document (e.g., Section 2.2.3.2) discussing populations/subpopulations within the data set that exhibit differences in metal concentrations (e.g., fluvial and alluvial groups; shallow versus deep alluvial waters; potential geothermal area with elevated metals in the Topock Marina area).	Changes to the text have been made to incorporate this comment.
Specific Comment 17	**Appendix B, Electronic Version of Background Data Set on CD:** Inappropriate data have been pasted into the row for the June 30, 2006 Topock-2 data. It appears that duplicate sample data has been inserted instead of the original data. Page 2-4, paragraph 3 of the Revised Report indicates that the results from duplicate samples were not included in the data set used for statistical analysis. The original data, not the duplicate, should be reinserted into the data set with the understanding that it is excluded from any statistical calculations. The entire Appendix B data set should be reviewed to ensure that other inappropriate insertions have not been made.	The following changes to Appendix B have been made to incorporate this comment: • Duplicate samples were removed from the data set. • Data excluded from statistical analysis were highlighted in yellow. • Wells excluded from Background Study after Step 2 were highlighted in orange.

TABLE D-2
Response to DOI Comments on the *Revised Groundwater Background Study Step 3 and 4: Report of Results*
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Comment Number	**Comment (DOI's June 13, 2008 Letter)**	**Response to Comment**
General Comment 1	The subject report does not describe the known or potential limitations with using regional groundwater background concentrations when applying them in decision-making documents. The use of the regional groundwater background concentrations must be evaluated by PG&E and presented to CA DTSC and DOI on a case by case basis prior to the issuance of all decision-making documents (e.g. the RFI/RI, RA and CMS/FS).	Comment acknowledged. No changes to this report will be made.
General Comment 2	Since initial sampling indicates that Cr(VI) concentrations above regional background levels do not exist in the recently completed groundwater wells in Arizona, DOI accepts the use of the three wells in Arizona as originally proposed. If elevated Cr(VI) is detected, this decision will need to be revisited.	Section 2.1 was modified to acknowledge this conclusion.
Specific Comment 1	Page 3-3, Section 3.2, 4th paragraph – The paragraph states that the background UTLs should be considered a tentative concentration and that there may be results that exceed these in the future. This implies that background UTLs may be recalculated when concentrations are recorded that exceed these values. DOI does not agree with the ongoing recalculation of background UTLs. Please clarify.	Text was added in Section 3.2 to clarify this comment.
Specific Comment 2	Page 4-1, Section 4.1, 5th paragraph – The paragraph suggests that the Cr(VI) in well MW-18 may not be naturally occurring. Please clarify. Also, please clarify how it was determined that the Cr(VI) concentrations were within the ranges of previous studies.	Text was added to Section 2.2.3.2 (Multiple Population Analysis) to clarify this comment.

Appendix D2
DTSC Comments on the Groundwater Background Study Steps 3 and 4: Final Report of Results, July 23, 2008

TABLE D-3
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PG&E Topock Compressor Station, Needles, California

Comment Number	Comment (DTSC's February 29, 2008 Letter including GSU Memorandum dated February 28, 2008)	Response to Comment	GSU Response (DTSC's October 26, 2009 Letter)	PG&E's Response to GSU Response
General Comment 1	**Topic 2 – Potential Limitations for Use of the Groundwater Background Study:** The cover letter to the Revised Report discusses limitations anticipated when utilizing the results of the groundwater background study during preparation of the RCRA Facility Investigation/Remedial Investigation (RFI/RI), risk assessment, and Corrective Measure Study/Feasibility Study (CMS/FS). Topic 2 indicates that the use of the background groundwater concentrations will be evaluated, noting that they may not be appropriate for all constituents in all portions of the site or at all depths. Based on this statement, it is uncertain what actual levels will be used in the RFI/RI, risk assessment, or CMS/FS. Due to this uncertainty, PG&E should provide, either in a revision to the Revised Report or in a separate submittal, a summary of the proposed background/alternate levels and presentation of the associated decision logic. Preferably, the summary would be submitted in advance of the associated work plan or report to ensure this issue is appropriately addressed in a timely manner.	A conference call was held on March 11, 2008 between PG&E and DTSC to clarify this comment. PG&E understands that a high level of detail and a great amount of specificity would be needed to satisfy the agency's comment and gain acceptance of the response. Attaining such level of detail and specificity would necessitate performing the actual risk assessment and evaluating the remedial action objectives for the actual CMS/FS. Therefore, to address this comment appropriately and efficiently, PG&E proposes to maintain the same approach outlined in Section 5.0 of the report, which is to evaluate the use of the background groundwater concentrations determined through calculation of UTLs for the study area as a whole during preparation of the RFI/RI, risk assessment, and CMS/FS. The limitations and caveats for use of the calculated UTLs for specific constituents, wells, or areas will be assessed and acknowledged, as appropriate for each application.	It is noted that the background limitations were only briefly mentioned during preparation of the RFI/RI, risk assessment, and CMS/FS. In fact, some new to the project were not aware of any background limitations after reviewing the July 23, 2008 Background Report. Therefore, for completeness, it is requested that the Cover Letter attached to the January 14, 2008 Draft Background Report be included as an appendix (Appendix E) to the Final Background Report.	As requested by DTSC, the cover letter to the January 14, 2008 Groundwater Background Study Report has been attached to this report as Appendix E.
General Comment 2	**Extreme values:** Outliers for trace metals have been evaluated using formal outlier tests, box-and-whisker plots, and probability plots. The assessment identified both data that has been excluded from the background data, and data that appears to represent extreme values for the Mojave Valley region. The following metals either contained value(s) that were identified as outliers and/or exhibit data points on probability and box-and-whisker plots that are suggestive of outliers: arsenic (BOR-2, Lilly Hill), molybdenum (Sanders), nickel (MW-16, Needles MW-12), selenium (MW-17), and vanadium (Sanders). These data were retained in the background data set, but represent extreme values. The GSU remains concerned that these extreme values strongly influence the Upper Tolerance Limit (UTL) calculated for the background data for the site. When establishing constituents of potential concern and delineating the groundwater plume, PG&E should, at a minimum, be cautious and judicious regarding the use of the UTLs in the assessment. The case of arsenic exemplifies the GSU's concerns. Arsenic from wells BOR-2 and Lilly Hill were identified as outliers (CH2M Hill, 2007), and exhibit outlier tendencies as illustrated by box-and-whisker and probability plots. The regional UTL presented in the Revised Report is 24.3 ug/L. Delineating the plume or selecting constituents of potential concern for risk assessments using only the arsenic UTL appears inappropriate for the Topock site after reviewing the entire Topock site data set. The Topock data indicates that routine detections of arsenic are less than 5 ug/L and that chromium contaminated portions of the plume range from 5 to 14 ug/L (excluding contaminated well MW-12). Well BOR-2 (mean arsenic concentration of 17.4 ug/L) is influenced by fluvial water and reducing conditions (see Figure 2-6 of the Revised Report) and represents a geochemical environment where arsenic, like iron, can persist. Well Lilly Hill (mean arsenic concentration of 13.3 ug/L) exhibited unusual well chemistry that had isotopic signatures fluctuating widely from fluvial to alluvial. Based on evaluation of site data and the extreme values within the regional background data set, the GSU would anticipate that a lower site specific arsenic background concentration would be derived for plume delineation and selection of constituents of potential concern.	As explained in Section 2.2.2, box-and-whisker "outliers" are not true outliers in the statistical sense, but are visual indicators of values that might warrant further examination. The rigorous statistical outlier tests described in the report represent this further examination, and the nickel, selenium, and vanadium values cited in the comment were in fact identified as statistical outliers (see Table 2-4). The arsenic values from BOR-2 and Lily Hill were not identified as statistical outliers after data from the sixth sampling event from Topock-2 were excluded. As recommended by DTSC in comments to the Step 2 report, a geochemical interpretation is necessary following the statistical analysis to interpret the apparent outliers. The arsenic, selenium, and vanadium values were within expected ranges for this geologic province, as shown in Table 4-2. Nickel was not assessed in the RASA study, and the ADEQ study found 90% of nickel concentrations below an unspecified reporting limit. Nickel concentrations are considered representative of what would be expected in a variety of steel-cased, water supply wells using the approved sampling techniques of this study (see response to Specific Comment 6 below). With regard to comment in the second paragraph, it is acknowledged in the report that multiple background populations may be interpreted for the region, including areas within and away from the influence of the Colorado River. However, samples that may fall into the river-influenced population (such as BOR-2) or may represent a mixed water (as was described for Lily Hill in the comment) do not warrant exclusion from the dataset as presented in the report. The range of arsenic concentrations is interpreted to represent the natural variation of the region as a whole.	The response is acknowledged and modification to this portion of the Revised Report is not required. Please note, however, that concerns regarding extreme values as outlined in the original comment above still persist.	The process of data evaluation, described in the agency-approved workplan, was followed by (a) conducting a rigorous statistical outlier analysis and (b) conducting a geochemical evaluation of the outlier data to evaluate whether the statistical outliers are within the expected range for the regional geochemical environment. This process was approved by the regulatory authorities, including DTSC. The final background dataset was the result of this process, with the exception of deletion of additional data that DTSC specifically requested be excluded (as described in Section 2.2.4 of the report).
General Comment 3	**Outliers - Individual Outlier Analysis Tables:** On January 29, 2008, CH2M Hill provided an email to DTSC that included tabulated outlier	Appendix C has been added to the report and provides a description of the expanded outlier analysis and an explanation	The response is acknowledged and modification to this portion of the Report is not required. The Revised	PG&E agrees that box-and-whisker plots provide visual indications of potential outliers

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	statistics utilizing individual sampling event data, rather than each well's mean concentration as was performed in the Revised Report. An expanded data set outlier evaluation utilizing information contained in the January 29, 2008 transmittal should be included in the next revision.	of the observed differences between the expanded (i.e., individual sample) analysis and the mean concentration analysis.	Report states that *"The box-and-whisker plots (Appendix A) illustrate graphically that the variability among wells is much more significant than the variability among samples from each well."* This is not the case for all the data. While it is agreed that this is often the case, it is the uncommon occurrences that should be sought out and evaluated for the purposes of outlier analysis. For example, arsenic data presented in Appendix A box-and-whiter plot Figure A-3 clearly shows that arsenic data from wells BOR-2 and Lilly Hill are anomalous compared to the rest of the data set (note that Sanders and PGE-09S data are already excluded in Figure A-3) and, therefore, the variability among a few individual wells is more significant than the variability among all the rest of the wells. Also see response to General Comment 2 regarding arsenic.	such as the arsenic samples described in the GSU response. As per DTSC's comment, such potential outliers were then evaluated using statistical outlier testing which did not identify these as true outliers. The original point of the January 29, 2008 email was that outlier analysis among averaged values at each well is statistically more defensible (due to lack of location-redundant data) and provides a more conservative UTL analysis.
Specific Comment 1	**Cover Letter, Topic 3 - Rationale for a Single (rather than Multiple) Background Concentrations for the Topock Groundwater Study:** The discussion includes comments suggesting that assessing multiple populations was not envisioned as an objective of the background study process. Please note that comments from Kate Burger (DSTC, 2005) clearly discussed outlier screening and the potential to identify multiple groundwater populations that would necessitate the calculation of a different background concentrations for each population. Alternate language is suggested for the next revision.	The discussion under Topic 3 of the Cover Letter refers to the original objective of the Background Study, as stated in the June 20, 2004 Work Plan (CH2M HILL, 2004), which is to define an upper threshold concentration for total chromium, Cr(VI), and other metals in groundwater at the Topock site. However, the same discussion also acknowledged that some DTSC and DOI reviewers have suggested the derivation of separate background concentrations for various portions of the site. This acknowledgement of comments made by DTSC reviewers includes, but is not limited to, Dr. Burger's comment in the Conditional Approval of Step 2 Report (October 11, 2005). PG&E believes that this adequately addresses DTSC's Specific Comment 1, and, therefore, no changes will be made. A point of note is in the 2005 Conditional Approval of Step 2 Report. Dr. Burger requested that PG&E provide an evaluation of multiple populations and outliers to assist DTSC with its review and approval of the background data set. PG&E responded to Dr., Burger's request in Section 2.2.3.2 (Multiple Population Analysis) of the January 14, 2008 Revised Background Study Report.	The response is acknowledged and modification to this portion of the Revised Report is not required. The intent of the original DTSC comment was to acknowledge that outlier screening and evaluating multiple groundwater populations was envisioned and communicated to PG&E as early as 2005 and, therefore, was considered an objective of the background study early on in the process. Inclusion of the Cover Letter in the Revised Report, as per General Comment 1, will aid in supporting PG&E's response to this comment.	Per DTSC General Comment 1, the cover letter to the January 14, 2008 Groundwater Background Study Report has been attached to this report as Appendix E.
Specific Comment 2	**Section 2.1, Selection and Description of Background Wells:** The beginning of the second paragraph on page 2-1 indicates that PG&E submitted the Arizona groundwater well workplan at the request of DTSC. The sentence should indicate that the workplan was requested by the Arizona Department of Environmental Quality (ADEQ), not DTSC.	Changes to text have been made to incorporate this comment.		
Specific Comment 3	**Section 2.1, Selection and Description of Background Wells:** The third paragraph on page 2-1 indicates that 14 background wells are located in California and that 11 are in Arizona. The sentence should indicate that there are 11 background wells in California and 14 in Arizona.	Changes to text have been made to incorporate this comment.		
Specific Comment 4	**Section 2.1, Selection and Description of Background Wells:** The second paragraph on page 2-2 indicates that the June 2006 groundwater sample from well Topock-2 could not be used for the study due to anomalously high turbidity. First, the paragraph should clarify that no data (metals, general minerals, etc.) from the June 2006	Changes to the text have been made to indicate that no data were used from the last sampling event at this well, and that the turbidity was the likely cause of the anomalously high concentrations of some metals that did not correlate with		

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	Topock-2 sampling event were used for the background study or any of the statistical assessments or calculations. Additionally, the sentence within the paragraph should be revised to clarify that, more important than elevated turbidity, the June 2006 Topock-2 data could not be used for the study due to anomalously high concentrations for several metals that did not correlate with duplicate samples.	duplicate samples.		
Specific Comment 5	**Section 2.2.2, Statistical Outlier Analysis:** The fourth and/or fifth paragraphs on page 2-4 discussing box-and-whisker plots should clarify that the some plots do not include the excluded data (e.g., arsenic, chromium, hexavalent chromium, fluoride, lead, zinc, etc.) as indicated in Section 2.2.4 and on Table 2-9 of the Revised Report (this should also be stated on the plots themselves). Additionally, the box-and-whisker plots for arsenic and zinc (Figures A-3 and A-17 respectively) should be revised as the x-axis still contains labels for the excluded wells and, therefore, mislabels the data. Similarly, the text should be revised to indicate that some probability plots contained in Appendix B do not include excluded data. Those plots in Appendix B that do not include excluded data will need to be revised and specify which data is excluded.	A paragraph was added to clarify that specific data were excluded prior to preparing the plots. The horizontal axis label for the box-and-whisker plot for arsenic (Figure A-3) was corrected to remove PGE-09S, Sanders, and Topock-2. The horizontal axis label for the box-and-whisker plot for zinc (Figure A-17) was corrected to remove PGE-09S. Footnotes regarding excluded data were also added to the applicable figures in Appendix A. Note that all figures (A-series and B-series) are included in Appendix A and not in Appendix B.		
Specific Comment 6	**Section 2.2.2, Statistical Outlier Analysis, Fifth Paragraph, Page 2-4:** All eight outliers (asterisks) identified in Figure A-14 for silver (Appendix A) were detected during a November 2, 2005 sampling event. Silver was not detected anytime else during any of the other background well sampling events. All samples analyzed for silver on November 2, 2005 (11 analyses) detected silver except for one duplicate sample. As the isolated silver detections are highly suggestive of a sampling methodology or laboratory data quality problem, it is recommended that the November 2, 2005 silver data be excluded from the background data set. Also recall that anomalously high lead concentrations from the November 2, 2005 sampling event have already been excluded from the background data set.	There is no observational evidence to justify removing the silver values. They were not identified as statistical outliers. It is not uncommon to occasionally observe trace metal concentrations that appear to be anomalously high. This is very commonly the result of colloidal material passing through the filters. The fact that the higher concentrations are not consistently observed supports this idea, since colloid quantities and sizes are highly variable. This effect is suspected in many of the background study samples for a variety of metals, but because these kinds of values would be expected in future samples, the occasional colloid breakthrough is considered a normal artifact of sampling and should be represented in the calculated background concentrations.	The GSU disagrees with PG&E's response regarding silver outliers pictured in Figure A-14 and believes there is compelling reason to doubt the infrequent silver background detections that occurred only for samples analyzed on November 2, 2005. Additionally, site specific evidence supporting that colloids are a cause of the silver detections simply does not exist. However, as this issue currently has no impact on the project, revision of Revised Report is not required.	PG&E agrees that this issue has no impact on the project. We also agree that no site-specific evidence exists whether colloidal effects influence or do not influence the values; this was offered as a possible explanation based on previous experience. There is also no evidence that there were any laboratory issues for the November 2, 2005 samples. This possibility was examined soon after those results were received and based on the lack of evidence the samples could not be excluded.
	Figure A-31 contains an anomalously elevated ORP measurement for well GSRV-2 that was previously identified in DTSC's November 30, 2007 letter. It is recommended that the ORP outlier be removed from the data set. This modification would require editing Figure A-31 and Figure 2-9 among other things.	It is agreed that the ORP value is anomalously high. ORP is a field-measured parameter that can vary significantly, and should only be used as a general indicator of redox conditions, rather than a precise measurement. With this in mind, the value has been left in the report for completeness, since there is no documentation of equipment malfunction for that measurement. If it were removed, Figure 2-9 would still show an oxidizing condition (blue color code) at this well, so interpretation of the data would not change.	With regard to the highly elevated and anomalous ORP outlier, the GSU is surprised that additional steps were not enacted to assess the anomalous data other than for reviewing documentation for equipment malfunction. For instance, another reading with a back up instrument would have been warranted to confirm suspect field data. However, as this issue currently has no impact on the project, revision of Revised Report is not required.	PG&E agrees that this issue also has no impact on the project. Standard field sampling procedures were followed in collecting all field measurements, in accordance with the approved work plan. The standard procedure for a daily-calibrated instrument was followed for this and all Background Study and Groundwater Monitoring Program sampling events.
	Box-and-whisker plots for Figures A-32 and A-36 are inappropriately plotted and will need to be revised.	Figures A-32 and A-36 have been revised to reflect field pH and specific conductance values (instead of lab pH and specific conductance) collected starting with the 2nd sampling event. Lab pH and specific conductance were only measured during the 1st sampling event. Corresponding tables (Tables 2-5, 2-7, 2-10, and 2-12) were also revised to reflect this change.		
	PG&E should also consider exclusion of the zinc outliers identified in Figure A-17. Four of the five outliers were obtained from the questionable November 2005 sampling event.	There is no evidence of questionable conditions or sample quality control issues associated with the November 2005 sampling event. We cannot find justification to remove values that appear to be higher than others in box-and-whisker plots (see response to General Comment 2).		

TABLE D-3
Response to DTSC Comments on the *Groundwater Background Study Step 3 and 4: Final Report of Results, July 23, 2008*
PG&E Topock Compressor Station, Needles, California

Comment Number	Comment (DTSC's February 29, 2008 Letter including GSU Memorandum dated February 28, 2008)	Response to Comment	GSU Response (DTSC's October 26, 2009 Letter)	PG&E's Response to GSU Response
Specific Comment 7	**Section 2.2.2, Statistical Outlier Analysis, Rosner's/Dixon's Outlier Analysis:** The third paragraph on page 2-5 indicates that when fewer than 25 samples were available, Dixon's test was applied. Table 2-5 indicates that Dixon's test was only used for ORP measurements utilizing 21 samples even though 25 mean ORP values exist as indicated in Appendix A (Figure A-31) and Appendix B (Electronic Version of Background Data Set on CD). The Revised Report should be revised to include text discussing why Dixon's test was utilized for ORP measurements and should consider, if necessary, alternatives to allow application of Rosner's test to ORP measurements. Additionally, Figure B-23 (Probability Plot for ORP) only utilizes 17 transformed concentrations and does not utilize the 25 mean concentrations. It appears that Figure B-23 should be revised. A footnote should be included on the revised figure if it is appropriate to not include the total 25 concentrations.	Dixon's outlier test was originally applied to ORP due to the lower number of results available to the test (21 as opposed to 25). The lower sample size was due to an error caused by negative numbers which impacted the transformation. An approach was developed, when transforming the data for the outlier test, to add a value to all results that would cause all values to be positive. For ORP, the selected value was 211 since the most negative value was 210. As a result, the Rosner's test is now applied to ORP. No mathematical outliers were identified for ORP as a result of the Rosner's test. Table 2-5 and Figure B-23 have been revised to reflect this change. Text was added to explain this approach.		
Specific Comment 8	**Section 2.2.2, Statistical Outlier Analysis, Rosner's/Dixon's Outlier Analysis:** The last paragraph on page 2-5 introduces Table 2-4 which summarizes outliers identified by Rosner's test. Table 2-4 was compared to the equivalent table (Table 2-6) from the original report (CH2M Hill, 2007). The older table from the CH2M Hill, 2007 report contains six more outliers: Arsenic for BOR-2, Topock-2, and Lily Hill; Copper for Topock-2; Alkalinity for PGE-9S; and Turbidity for Topock-2. PG&E will need to discuss the discrepancies between the two tables and amend the Revised Report if necessary. Please note that it appears that the old outlier table included the excluded June 2006 groundwater sample data from well Topock-2.	After data for the sixth event (June 30, 2006) for Topock-2 were excluded from the data set, the six outliers cited in the comment ceased to be statistical outliers. However, they were inadvertently left in Table 2-6 of the January 2007 draft report (after the exclusion of the sixth event was discussed). Table 2-4 of the current report correctly discusses the outliers for the data set. No change in the report will be made.	The response is acknowledged and modification to this portion of the Revised Report is not requested. It is understandable that removal of Topock 2 data (including elevated values) would affect outlier identification for well Topock 2, but its affect on outlier identification at other wells is not anticipated (e.g., arsenic for wells BOR-2 and Lily Hill). Moreover, PG&E has previously concluded that arsenic at wells BOR-2 and Lily Hill were statistical outliers (CH2M Hill, 2007, Table 2-6). Identification of arsenic at wells BOR-2 and Lily Hill as statistical outliers/extreme values is significant as discussed in General Comment 2.	The statistical methods used to determine outliers in the 2008 Background Study Report were those described in the approved work plan and the methods determined that arsenic in the wells of the GSU response were not outliers. The concentrations were within the range expected of fluvial groundwater in this region.
Specific Comment 9	**Section 2.2.2, Statistical Outlier Analysis, Mean Rank Evaluation:** Table 2-8 was compared to the equivalent table (Table 2-9) from the original report (CH2M Hill, 2007). The older table compared the "Top Five" mean concentrations for dissolved metals (26 constituents evaluated) instead of trace metals (19 constituents evaluated) and determined additional outliers. The text should indicate why this change was selected over the original methodology.	The 26 constituents evaluated in the January 2007 draft report included both trace metals (19 total) and common metals used in general chemistry analysis (7 total). The seven general chemistry metals were boron, calcium, iron, magnesium, manganese, potassium, and sodium. They were inadvertently included in the trace metal outlier analysis presented in Table 2-9 of the January 2007 draft report. Table 2-8 of the current report correctly presents the information. No changes to the text will be made.		
Specific Comment 10	**Section 2.2.3.1, General Geochemistry, Figures 2-3 and 2-4 Piper diagrams:** PG&E should double check and make sure that well data from Tayloe and TMLP-2 were not transposed on the figures. General mineral data were switched between these two wells in a summary table in the original report (CH2M Hill, 2007) and, therefore, concern exists that the data table error could also have propagated to the figures.	The data were checked, and general chemistry data for the two wells were not transposed on Figures 2-3 and 2-4. No changes to the report were made in response to this comment.		
Specific Comment 11	**Section 2.2.3.1, General Geochemistry:** The first paragraph on page 2-8 of the Revised Report indicates that alluvial wells from the California and Arizona sides of the river show overlapping isotopic signatures. However, if Figure 2-5 is corrected (see Specific Comment 12 below), then the Arizona wells cluster on the figure and appear isotopically lighter than alluvial California background wells. The United States Department of the Interior (DOI) had previously mentioned this issue in its February 28, 2007 letter. The Revised Report will need to be corrected to incorporate this previously	After the correction described in Specific Comment 12, there is still significant overlap between AZ and CA alluvial wells - P-2, MW-18, and PMM Supply all fall within the range of the AZ alluvial wells. Also, non-plume, site alluvial monitoring wells show strong overlap with the AZ alluvial wells. Text has been appended to explain these points.	The response is acknowledged and modification of the Revised Report is not required. It is noted that significant overlap does not exist in the data pictured in Figure 2-6 in that the isotopically lightest wells are located in California. An unbiased evaluation of the data would also include assessment of non-plume, site alluvial monitoring wells that do not exhibit overlap of stable isotope data.	The point of the original response was that isotope data for alluvial groundwater on the CA side unaffected by site activity overlaps with alluvial groundwater on the AZ side. While outside the scope of the background study, PG&E offered the information that had non-plume, site alluvial groundwater data been included, this overlap would have been more evident. Further discussion of non-plume,

TABLE D-3
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PG&E Topock Compressor Station, Needles, California

Comment Number	Comment (DTSC's February 29, 2008 Letter including GSU Memorandum dated February 28, 2008)	Response to Comment	GSU Response (DTSC's October 26, 2009 Letter)	PG&E's Response to GSU Response
	identified issue.			alluvial wells that did not exhibit overlap was not included, not to bias the discussion, but because it was outside the scope of the background study, and would not have any impact on the project. The CA-side samples that showed a light signature from the Background Study plot on the light end of the non-industrial isotopic signature range as presented in the RFI/RI Volume 2 Report.
Specific Comment 12	**Figures 2-5 and 2-6:** The same errors still remain on these figures even after they were identified for revision in previous agency reviews (i.e., appropriately labeling Needles MW-12 and switching labels for Tayloe/TMLP-2). PG&E will need to refer to DOI's and DTSC's 2007 comments and revise the figure.	The errors have been corrected in Figure 2-5 and Figure 2-6.	The color coding for the Tayloe and Langmaack wells on Figure 2-5 are incorrect and it is requested that the final be revised appropriately.	Figure has been corrected. The color coding for the Tayloe well was incorrect, and has been corrected from blue to green. The color coding for the Langmaack well was correct. An arrow connecting the well label and the data point has been added for clarity.
Specific Comment 13	**2.2.4 Summary of Excluded Background Data:** The last bullet on page 2-11 has cited the wrong date for the excluded lead sample at MW-17. The correct date is November 2, 2005. The second to the last bullet on page 2-11 should eliminate reference to the June 30, 2006 lead data as it was already excluded (Section 2.1) with the sixth round of Topock-2 data. The last paragraph on page 2-6 also refers to an incorrect date for the excluded lead sample at MW-17 and should also be revised.	Changes to the text have been made to incorporate this comment.		
Specific Comment 14	**Table 2-9:** A footnote should be added to this table indicating that the data from the June 2006 Topock-2 sampling event were not used in calculating any of the results displayed within the table.	A footnote was added to Table 2-9 as requested. In addition, for consistency, a similar footnote was also added to Tables 2-10, 2-11, and 2-12. The footnote reads as follows: "All Topock-2 results from the sixth event (June 2006) were excluded from the background data set (see Section 2.1)."		
Specific Comment 15	**3.0 Background Concentrations:** Footnotes describing or referencing potential limitations of the regional background concentrations should be included on both Tables 2-13 and 3-1.	A footnote was added to Table 2-13 and Table 3-1, as requested. The footnote reads as follows: "Potential limitations for use of these UTLs are described in prior background study documents such as the cover letter to the January 14 revised background study report (CH2M HILL, 2008a) and DTSC's November 30, 2007 letter (DTSC, 2007a)."	It is recommended that the footnote be changed to read as follows: "Potential limitations for use of these UTLs are described in Appendix E and prior background study documents such as the cover letter to the January 14 revised background study report (CH2M HILL, 2008a) and DTSC's November 30, 2007 letter (DTSC, 2007a)." Also see response to General Comment 1.	The footnote text has been revised as requested to state: "Potential limitations for use of these UTLs are described in Appendix E and prior background study documents such as DTSC's November 30, 2007 letter (DTSC, 2007a)." The cover letter to the January 14, 2008 Groundwater Background Study Report has been attached to this report as Appendix E.
Specific Comment 16	**Section 4.1, Sample Independence and Time Trends:** The first paragraph on page 4-1 indicates that for the 19 trace metals studied, there were no connections between higher metal concentrations and the geographic area, geologic parent material, or general chemistry type (e.g., TDS, sodium percentage). However, this is not consistent with findings elsewhere in the Revised Report (e.g., Section 2.2.3.2). A revision is necessary and should discuss or make reference to the sections of the document (e.g., Section 2.2.3.2) discussing populations/subpopulations within the data set that exhibit differences in metal concentrations (e.g., fluvial and alluvial groups; shallow versus deep alluvial waters; potential geothermal area with elevated metals in the Topock Marina area).	Changes to the text have been made to incorporate this comment.		
Specific Comment 17	**Appendix B, Electronic Version of Background Data Set on CD:** Inappropriate data have been pasted into the row for the June 30, 2006 Topock-2 data. It appears that duplicate sample data has been inserted instead of the original data. Page 2-4, paragraph 3 of the	The following changes to Appendix B have been made to incorporate this comment: • Duplicate samples were removed from the data set. • Data excluded from statistical analysis were highlighted in		

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PG&E Topock Compressor Station, Needles, California

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	Revised Report indicates that the results from duplicate samples were not included in the data set used for statistical analysis. The original data, not the duplicate, should be reinserted into the data set with the understanding that it is excluded from any statistical calculations. The entire Appendix B data set should be reviewed to ensure that other inappropriate insertions have not been made.	yellow. • Wells excluded from Background Study after Step 2 were highlighted in orange.		
New GSU Specific Comment 18			Page 2-10, Second to Last Paragraph: The following sentence should be changed to be consistent with language planned for the CMS/FS Report, "*Both metals exhibit low solubility ~~are insoluble~~ in their reduced states, forming oxide or hydroxide minerals.*"	The specific text change has been made.

Appendix E
Cover Letter for the January 14, 2008 Revised Groundwater Background Study Step 3 and 4: Report of Results

Pacific Gas and Electric Company

Yvonne Meeks
Manager

Environmental Remediation
Gas T&D Department

Mailing Address
4325 South Higuera Sreet
San Luis Obispo, CA 93401
Location
6588 Ontario Road
San Luis Obispo, CA 93405
Tel: (805) 234-2257
Email: yjm1@pge.com

January 14, 2008

Mr. Aaron Yue
Project Manager
Geology Permitting and Corrective Action Branch
California Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, CA 90630

Subject: **Revised Groundwater Background Study, Steps 3 and 4: Report of Results PG&E Topock Compressor Station, Needles, California**

Dear Mr. Yue:

This letter transmits the *Revised Groundwater Background Study Step 3 and 4: Report of Results* for the Pacific Gas and Electric Company (PG&E) Topock Compressor Station site. This report incorporates changes to the *Groundwater Background Study Steps 3 and 4 Results* report dated January 26, 2007, in response to the California Department of Toxic Substances Control (DTSC's) letter dated November 30, 2007, and the U.S Department of Interior's (DOI's) letter dated December 20, 2007. As agreed with DTSC and DOI, this revised report does not address two comments:

1. The outlier evaluations documented in this *Revised Groundwater Background Study Step 3 and 4: Report of Results* were performed using the mean concentrations for each analyte and well, for the reasons described in Section 2.2. DTSC has requested an additional outlier evaluation for each constituent considering all the measured concentrations for that constituent, rather than each well's mean concentration for that constituent. This additional outlier evaluation will be performed and the results will be reported separately from this report at a future date.
2. The background study wells included in this *Revised Groundwater Background Study Step 3 and 4: Report of Results* were those selected and approved through Steps 1 and 2 of the groundwater background study. DOI's letter dated December 20, 2007 indicates that the inclusion of three of the selected wells should be conditional on the results of the planned groundwater investigation in Arizona. If chromium is found above regional background levels on the Arizona side of the River, the decision to include the three wells in the vicinity of the Arizona investigation in the background study would need to be re-evaluated.

The remaining comments in DTSC's November 30, 2007 letter and DOI's December 20 letter are addressed in the *Revised Groundwater Background Study Step 3 and 4: Report of Results.* As directed by DTSC in the November 30, 2007 letter, the following three discussion topics are presented in this letter:

Topic 1 - Future Uses of the Groundwater Background Study Results

As discussed in the approved work plan[1], the objective of the background study is to define an upper threshold background concentration for total chromium, hexavalent chromium and other inorganic constituents in groundwater at the Topock site. The upper threshold concentration represents the upper concentration of the constituent in natural groundwater not affected by contamination and is referred to as a background concentration. These concentrations are reported in the form of statistical upper tolerance limits (UTLs). The UTL is an EPA-recommended, and widely accepted, statistical method for determining a background value from a set of data. The UTL represents a value that 95 percent of the population will fall below with 95 percent confidence.

The background study will be used during the Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) processes to:

- Support the RCRA Facility Investigation/Remedial Investigation (RFI/RI) and risk assessment activities at the Topock site and to provide a basis by which the list of constituents of potential concern (COPCs) can be evaluated and, if necessary, revised. For site characterization, this would include using the background concentrations to help distinguish the nature and extent of site-related contamination vs. naturally occurring levels of inorganic constituents. For COPC evaluation, the background concentrations can be used as points of comparison so that assessment is focused on those constituents that are elevated above naturally occurring levels. For risk assessment, background concentrations can be used to help identify the site-related chemicals so that they can be evaluated in the risk assessment, and those that contribute most significantly to risk can be identified. Background concentrations can also be useful in communicating risk to the public, putting site-related risks in perspective by comparing those risks to risks associated with background conditions at the site.
- Assist with the Corrective Measures Study/Feasibility Study (CMS/FS) activities at the Topock site during the development of remedial action/corrective action goals. Consistent with the National Contingency Plan, remedial action goals are derived based on two threshold criteria: overall protection of human health and the environment, and compliance with Applicable, or Relevant and Appropriate, Requirements (ARARs). Background concentrations may be used during the risk assessment process to develop remedial goals, particularly if the risk assessment indicates that risk-based remedial goals are lower than naturally occurring background levels. Background concentrations are also cited in certain chemical-specific ARARs, such as California's groundwater and vadose zone protection standards that are applicable to RCRA hazardous waste interim status treatment, storage and disposal facilities[2].

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[1] Work Plan for Assessing Background Metals Concentrations in Groundwater, PG&E Topock Compressor Station and Vicinity, Needles, California. June 2004.

[2] U.S. Department of the Interior Preliminary Determination of Applicable, or Relevant and Appropriate, Requirements for the Pacific Gas and Electric Company Topock CERCLA Site

Topic 2 - Potential Limitations for Use of the Groundwater Background Study

As has been discussed with DTSC and DOI and noted in DTSC's November 30 letter and DOI's December 20 letter, the data collected for this study may be interpreted to represent two or more populations based on geochemical or geological distinctions. During preparation of the RFI/RI, risk assessment, and CMS/FS, the use of the background groundwater concentrations determined through calculation of UTLs for the study area as a whole will be evaluated, noting that the calculated UTLs may not be appropriate for all constituents in all portions of the site or at all depths.

Examples of populations or subpopulations that could be separated out from the background data set are discussed below:

- Groundwater in fluvial material that is influenced by the Colorado River vs. groundwater in alluvial material away from the river's influence. The latter is typically geochemically oxidizing whereas the former is relatively reducing, and this difference is expressed by differences in concentrations of several chemical parameters, including nitrate, ammonia, and oxidation-reduction potential. Section 2.2 of the *Revised Groundwater Background Study Step 3 and 4: Report of Results* identifies which inorganic constituents are dominant in the fluvial and alluvial waters and which are detected at low frequency.
- Groundwater in the alluvial aquifer is stratified and shows distinct differences from shallow to deep zones. For example, shallow alluvial groundwater in the area around well MW-18 and the Interim Measure No. 3 injection field contain hexavalent chromium, Cr(VI), concentrations that are greater than concentrations found in deeper wells in the same area, coupled with relatively low dissolved solids and major ion concentrations. Although these relatively elevated Cr(VI) concentrations are naturally occurring, they may be interpreted as representing a distinct geochemical zone that is not found elsewhere. It is common to observe shallow alluvial wells in non-plume areas of the Topock Site with relatively lower dissolved solids concentrations and more oxidizing conditions than in deeper alluvial wells. Consistent with the geochemical environment of the shallow zone, Cr(VI) concentrations in shallow wells also tend to be greater than in deeper wells.
- Three background study wells located immediately across the Colorado River from the site contain relatively higher concentrations of arsenic and fluoride, and may represent another distinct geochemical environment. Slightly elevated groundwater temperature has been observed in samples from one of these wells. These observations suggest there may be localized geothermal influences in this area. At DTSC's request, arsenic concentrations from these three wells and fluoride concentrations from one of these wells were excluded from the data set.

These groupings are subject to interpretation, and are described in Section 2.2 of the *Revised Groundwater Background Study Step 3 and 4: Report of Results*.

As required by DTSC's November 30th letter, a total of 30 analyses have been removed from the background study database that had been used to calculate UTLs for the *Groundwater Background Study Steps 3 and 4 Results* report dated January 26, 2007. Using box-and-whisker and probability plots, these analyses were interpreted by DTSC as being non-representative of the database as a whole. The deletion of these 30 analyses from the background study data set has resulted in changes in the UTLs for lead and arsenic.

Topic 3 - Rationale for a Single (rather than Multiple) Background Concentrations for the Topock Groundwater Study

The approach to and design of the groundwater background study was documented in the approved work plan and study results (Phase 1, Phase 2, Phase 3/4 results). The definition of the background groundwater study area is the unconsolidated alluvial aquifer of the Mohave Groundwater Basin stretching from the Topock site in the south to Needles in the north (approximately 15 miles north of the Topock Site) and from the edge of the alluvial aquifer along the mountain front in the west to several miles east of the site in Arizona. Over 150 wells in the study area were evaluated during Step 1 of the background study. During Step 2 of the background study, 36 wells were sampled and screened for inclusion in the final data set. Factors considered in including the final set of wells included whether the groundwater general chemistry is consistent with the southern Mohave Valley groundwater general chemistry; whether a potential anthropogenic source may affect the concentrations of metals in groundwater; and whether the well was located within a cluster of other background wells which could cause a geographic bias. And as documented in the *Revised Groundwater Background Study Step 3 and 4: Report of Results,* outlier and geochemical evaluations were performed during Step 3 to maximize the representativeness of the groundwater background study data to the Topock site. One of the defining goals of the DTSC-approved background study protocol was to consider a wide range of geologic and geochemical regimes in developing a background number that would truly be representative of the area as a whole. The Cr(VI) concentrations found in the background study are consistent with those reported in other published studies in the region.

PG&E believes that the results of the groundwater background study are appropriate for completion of the RFI/RI and CMS/FS, are not overly conservative, and may actually underestimate the natural range in background values due to the number of upper end data points eliminated during Step 2 and Step 3. Although there is scatter in the dataset, this is expected in natural geochemical environments.

The derivation of separate background concentrations for various portions of the site has been suggested by some DTSC and DOI reviewers. PG&E believes that the development of multiple background concentrations would be subject to significant scientific uncertainty in categorizing well populations (and accommodating ranges of and changes to well chemistry), is not practical from a regulatory standpoint, and would hinder rather than advance the progress toward selection and implementation of a final groundwater remedy at the site. Moreover, the dataset collected for this study based on the approved work plan is aimed at identifying one background number for the entire study area. More specifically:

- Under a multiple population approach, the dynamic nature of groundwater flowing under the influence of current or future extraction/injection remedies could result in wells being shifted from one population to the other over time – resulting in a complex and potentially conflicting regulatory framework with no commensurate benefits.
- The methodology for defining which wells are associated with which population would be arbitrary and would be difficult to apply in practice. The boundaries of the datasets

would be indistinct, with individual wells falling partly in several different populations, depending on which constituent was being considered.

- Developing multiple populations would significantly delay proceeding to the final remedy as various aspects of the approach are challenged by stakeholders and/or further background study data collection is necessary to address an issue that was not the objective of the approved Background Study workplan.

Do not hesitate to contact me at (805) 234-2257 with any questions or comments on this information or the enclosed report.

Sincerely,

Yvonne Meeks

Yvonne Meeks
Topock Project Manager

cc: Chris Guerre/DTSC
Karen Baker/DTSC
Kris Doebbler/DOI

Appendix F
DTSC October 26, 2009 Letter

Department of Toxic Substances Control

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

Linda S. Adams
Secretary for
Environmental Protection

Arnold Schwarzenegger
Governor

TO: Aaron Yue
Project Manager
Geology, Permitting & Corrective Action Branch

FROM: Chris Guerre, CHG
Senior Engineering Geologist
Geological Services Unit

DATE: October 26, 2009

SUBJECT: Revised Groundwater Background Study, Steps 3 and 4
PG&E Topock Compressor Station, Needles, California
PCA 22120 WP 540015-48/36 WR 840315

DOCUMENTS REVIEWED

Groundwater Background Study, Steps 3 and 4: Final Report of Results PG&E Topock Compressor Station, Needles, California (Revised Report). The Revised Report is dated July 23, 2008 and was prepared by CH2M Hill on behalf of Pacific Gas and Electric Company (PG&E).

INTRODUCTION

The Geological Services Unit (GSU) with the Department of Toxic Substances Control (DTSC) has evaluated PG&E's responses to agency comments contained in Appendix D of the Revised Report and associated modifications to the document. The Revised Report contains calculations and evaluation of naturally occurring groundwater background metal concentrations, including chromium. Background metal concentrations were calculated in the Revised Report using 25 wells: 11 in California and 14 in Arizona that are reported to represent groundwater conditions within the southern Mojave Valley. Eight of the wells are reported to be screened in fluvial materials, while the remaining 17 wells are identified as being screened in alluvial materials.

Based on the GSU review, it is recommended that PG&E modify the Revised Report so that it addresses the following comments: General Comment 1 and Specific Comments 12 and 15, and new Specific Comment 18. With the exception of the last comment, the numbering system utilized in Appendix D of the Revised Report was employed in this memorandum. Questions regarding this memorandum should be directed to Chris Guerre at (714) 484-5422 or by email at cguerre@dtsc.ca.gov.

GSU RESPONSE TO COMMENTS

DTSC General Comment 1, Topic 2 – Potential Limitations for Use of the Groundwater Background Study: The cover letter to the Revised Report discusses limitations anticipated when utilizing the results of the groundwater background study during preparation of the RCRA Facility Investigation/Remedial Investigation (RFI/RI), risk assessment, and Corrective Measure Study/Feasibility Study (CMS/FS). Topic 2 indicates that the use of the background groundwater concentrations will be evaluated, noting that they may not be appropriate for all constituents in all portions of the site or at all depths. Based on this statement, it is uncertain what actual levels will be used in the RFI/RI, risk assessment, or CMS/FS. Due to this uncertainty, PG&E should provide, either in a revision to the Revised Report or in a separate submittal, a summary of the proposed background/alternate levels and presentation of the associated decision logic. Preferably, the summary would be submitted in advance of the associated work plan or report to ensure this issue is appropriately addressed in a timely manner.

PG&E Response: A conference call was held on March 11, 2008 between PG&E and DTSC to clarify this comment. PG&E understands that a high level of detail and a great amount of specificity would be needed to satisfy the agency's comment and gain acceptance of the response. Attaining such level of detail and specificity would necessitate performing the actual risk assessment and evaluating the remedial action objectives for the actual CMS/FS. Therefore, to address this comment appropriately and efficiently, PG&E proposes to maintain the same approach outlined in Section 5.0 of the report, which is to evaluate the use of the background groundwater concentrations determined through calculation of UTLs for the study area as a whole during preparation of the RFI/RI, risk assessment, and CMS/FS. The limitations and caveats for use of the calculated UTLs for specific constituents, wells, or areas will be assessed and acknowledged, as appropriate for each application.

GSU Response: It is noted that the background limitations were only briefly mentioned during preparation of the RFI/RI, risk assessment, and CMS/FS. In fact, some new to the project were not aware of any background limitations after reviewing the July 23, 2008 Background Report. Therefore, for completeness, it is requested that the Cover Letter attached to the January 14, 2008 Draft Background Report be included as an appendix (Appendix E) to the Final Background Report.

General Comment 2, Extreme values: Outliers for trace metals have been evaluated using formal outlier tests, box-and-whisker plots, and probability plots. The assessment identified both data that has been excluded from the background data, and data that appears to represent extreme values for the Mojave Valley region. The following metals either contained value(s) that were identified as outliers and/or exhibit data points on probability and box-and-whisker plots that are suggestive of outliers: arsenic (BOR-2, Lilly Hill), molybdenum (Sanders), nickel (MW-16, Needles MW-12), selenium (MW-17), and vanadium (Sanders). These data were retained in the background data set, but represent extreme values. The GSU remains concerned that these extreme values strongly influence the Upper Tolerance Limit (UTL) calculated for the background data for the site. When establishing constituents of potential concern and delineating the groundwater plume, PG&E should, at a minimum, be cautious and judicious regarding the use of the UTLs in the assessment.

The case of arsenic exemplifies the GSU's concerns. Arsenic from wells BOR-2 and Lilly Hill were identified as outliers (CH2M Hill, 2007), and exhibit outlier tendencies as illustrated by box-and-whisker and probability plots. The regional UTL presented in the Revised Report is 24.3 ug/L. Delineating the plume or selecting constituents of potential concern for risk assessments using only the arsenic UTL appears inappropriate for the Topock site after reviewing the entire Topock site data set. The Topock data indicates that routine detections of arsenic are less than 5 ug/L and that chromium contaminated portions of the plume range from 5 to 14 ug/L (excluding contaminated well MW-12). Well BOR-2 (mean arsenic concentration of 17.4 ug/L) is influenced by fluvial water and reducing conditions (see Figure 2-6 of the Revised Report) and represents a geochemical environment where arsenic, like iron, can persist. Well Lilly Hill (mean arsenic concentration of 13.3 ug/L) exhibited unusual well chemistry that had isotopic signatures fluctuating widely from fluvial to alluvial. Based on evaluation of site data and the extreme values within the regional background data set, the GSU would anticipate that a lower site specific arsenic background concentration would be derived for plume delineation and selection of constituents of potential concern.

<u>PG&E Response:</u> As explained in Section 2.2.2, box-and-whisker "outliers" are not true outliers in the statistical sense, but are visual indicators of values that might warrant further examination. The rigorous statistical outlier tests described in the report represent this further examination, and the nickel, selenium, and vanadium values cited in the comment were in fact identified as statistical outliers (see Table 2-4). The arsenic values from BOR-2 and Lily Hill were not identified as statistical outliers after data from the sixth sampling event from Topock-2 were excluded.

As recommended by DTSC in comments to the Step 2 report, a geochemical interpretation is necessary following the statistical analysis to interpret the apparent outliers. The arsenic, selenium, and vanadium values were within expected ranges for this geologic province, as shown in Table 4-2. Nickel was not assessed in the RASA study, and the ADEQ study found 90% of nickel concentrations below an unspecified reporting limit. Nickel concentrations are considered representative of what would be expected in a variety of steel-cased, water supply wells using the approved sampling techniques of this study (see response to Specific Comment 6 below).

With regard to comment in the second paragraph, it is acknowledged in the report that multiple background populations may be interpreted for the region, including areas within and away from the influence of the Colorado River. However, samples that may fall into the river-influenced population (such as BOR-2) or may represent a mixed water (as was described for Lily Hill in the comment) do not warrant exclusion from the dataset as presented in the report. The range of arsenic concentrations is interpreted to represent the natural variation of the region as a whole.

GSU Response: The response is acknowledged and modification to this portion of the Revised Report is not required. Please note, however, that concerns regarding extreme values as outlined in the original comment above still persist.

General Comment 3, Outliers - Individual Outlier Analysis Tables: On January 29, 2008, CH2M Hill provided an email to DTSC that included tabulated outlier statistics utilizing individual sampling event data, rather than each well's mean concentration as was performed in the Revised Report. An expanded data set outlier evaluation utilizing information contained in the January 29, 2008 transmittal should be included in the next revision.

PG&E Response: Appendix C has been added to the report and provides a description of the expanded outlier analysis and an explanation of the observed differences between the expanded (i.e., individual sample) analysis and the mean concentration analysis.

GSU Response: The response is acknowledged and modification to this portion of the Report is not required. The Revised Report states that "*The box-and-whisker plots (Appendix A) illustrate graphically that the variability among wells is much more significant than the variability among samples from each well.*" This is not the case for all the data. While it is agreed that this is often the case, it is the uncommon occurrences that should be sought out and evaluated for the purposes of outlier analysis. For example, arsenic data presented in Appendix A box-and-whiter plot Figure A-3 clearly shows that arsenic data from wells BOR-2 and Lilly Hill are anomalous compared to the rest of the data set (note that Sanders and PGE-09S data are already excluded in Figure A-3) and, therefore, the variability among a few individual wells is more significant than the variability among all the rest of the wells. Also see response to General Comment 2 regarding arsenic.

Specific Comment 1 – Cover Letter, Topic 3 - Rationale for a Single (rather than Multiple) Background Concentrations for the Topock Groundwater Study: The discussion includes comments suggesting that assessing multiple populations was not envisioned as an objective of the background study process. Please note that comments from Kate Burger (DSTC, 2005) clearly discussed outlier screening and the potential to identify multiple groundwater populations that would necessitate the calculation of a different background concentrations for each population. Alternate language is suggested for the next revision.

PG&E Response: The discussion under Topic 3 of the Cover Letter refers to the original objective of the Background Study, as stated in the June 20, 2004 Work Plan (CH2M HILL, 2004), which is to define an upper threshold concentration for total chromium, Cr(VI), and other metals in groundwater at the Topock site.

However, the same discussion also acknowledged that some DTSC and DOI reviewers have suggested the derivation of separate background concentrations for various portions of the site, This acknowledgement of comments made by DTSC reviewers includes, but is not limited to, Dr. Burger's comment in the Conditional Approval of Step 2 Report (October 11, 2005). PG&E believes that this adequately addresses DTSC's Specific Comment 1, and, therefore, no changes will be made.

A point of note is in the 2005 Conditional Approval of Step 2 Report. Dr. Burger requested that PG&E provide an evaluation of multiple populations and outliers to assist DTSC with its review and approval of the background data set. PG&E responded to Dr., Burger's request in Section 2.2.3.2 (Multiple Population Analysis) of the January 14, 2008 Revised Background Study Report.

GSU Response: The response is acknowledged and modification to this portion of the Revised Report is not required. The intent of the original DTSC comment was to acknowledge that outlier screening and evaluating multiple groundwater populations was envisioned and communicated to PG&E as early as 2005 and, therefore, was considered an objective of the background study early on in the process. Inclusion of the Cover Letter in the Revised Report, as per General Comment 1, will aid in supporting PG&E's response to this comment.

Specific Comment 6 - Section 2.2.2, Statistical Outlier Analysis, Fifth Paragraph, Page 2-4: All eight outliers (asterisks) identified in Figure A-14 for silver (Appendix A) were detected during a November 2, 2005 sampling event. Silver was not detected anytime else during any of the other background well sampling events. All samples analyzed for silver on November 2, 2005 (11 analyses) detected silver except for one duplicate sample. As the isolated silver detections are highly suggestive of a sampling methodology or laboratory data quality problem, it is recommended that the November 2, 2005 silver data be excluded from the background data set. Also recall that anomalously high lead concentrations from the November 2, 2005 sampling event have already been excluded from the background data set.

Figure A-31 contains an anomalously elevated ORP measurement for well GSRV-2 that was previously identified in DTSC's November 30, 2007 letter. It is recommended that the ORP outlier be removed from the data set. This modification would require editing Figure A-31 and Figure 2-9 among other things.

Box-and-whisker plots for Figures A-32 and A-36 are inappropriately plotted and will need to be revised.

PG&E should also consider exclusion of the zinc outliers identified in Figure A-17. Four of the five outliers were obtained from the questionable November 2005 sampling event.

PG&E Response: There is no observational evidence to justify removing the silver values. They were not identified as statistical outliers. It is not uncommon to occasionally observe trace metal concentrations that appear to be anomalously high. This is very commonly the result of colloidal material passing through the filters. The fact that the higher concentrations are not consistently observed supports this idea, since colloid quantities and sizes are highly variable. This effect is suspected in many of the background study samples for a variety of metals, but because these kinds of values would be expected in future samples, the occasional colloid breakthrough is considered a normal artifact of sampling and should be represented in the calculated background concentrations.

It is agreed that the ORP value is anomalously high. ORP is a field-measured parameter that can vary significantly, and should only be used as a general indicator of redox conditions, rather than a precise measurement. With this in mind, the value has been left in the report for completeness, since there is no documentation of equipment malfunction for that measurement. If it were removed, Figure 2-9 would still show an oxidizing condition (blue color code) at this well, so interpretation of the data would not change.

Figures A-32 and A-36 have been revised to reflect field pH and specific conductance values (instead of lab pH and specific conductance) collected starting with the 2nd sampling event. Lab pH and specific conductance were only measured during the 1st sampling event. Corresponding tables (Tables 2-5, 2-7, 2-10, and 2-12) were also revised to reflect this change.

There is no evidence of questionable conditions or sample quality control issues associated with the November 2005 sampling event. We cannot find justification to remove values that appear to be higher than others in box-and-whisker plots (see response to General Comment 2).

GSU Response: The GSU disagrees with PG&E's response regarding silver outliers pictured in Figure A-14 and believes there is compelling reason to doubt the infrequent silver background detections that occurred only for samples analyzed on November 2, 2005. Additionally, site specific evidence supporting that colloids are a cause of the silver detections simply does not exist. However, as this issue currently has no impact on the project, revision of Revised Report is not required.

With regard to the highly elevated and anomalous ORP outlier, the GSU is surprised that additional steps were not enacted to assess the anomalous data other than for reviewing documentation for equipment malfunction. For instance, another reading with a back up instrument would have been warranted to confirm suspect field data. However, as this issue currently has no impact on the project, revision of Revised Report is not required.

Specific Comment 8 - Section 2.2.2, Statistical Outlier Analysis, Rosner's/Dixon's Outlier Analysis: The last paragraph on page 2-5 introduces Table 2-4 which summarizes outliers identified by Rosner's test. Table 2-4 was compared to the equivalent table (Table 2-6) from the original report (CH2M Hill, 2007). The older table from the CH2M Hill, 2007 report contains six more outliers: Arsenic for BOR-2, Topock-2, and Lily Hill; Copper for Topock-2; Alkalinity for PGE-9S; and Turbidity for Topock-2. PG&E will need to discuss the discrepancies between the two tables and amend the Revised Report if necessary. Please note that it appears that the old outlier table included the excluded June 2006 groundwater sample data from well Topock-2.

PG&E Response: After data for the sixth event (June 30, 2006) for Topock-2 were excluded from the data set, the six outliers cited in the comment ceased to be statistical outliers. However, they were inadvertently left in Table 2-6 of the January 2007 draft report (after the exclusion of the sixth event was discussed).

Table 2-4 of the current report correctly discusses the outliers for the data set. No change in the report will be made.

GSU Response: The response is acknowledged and modification to this portion of the Revised Report is not requested. It is understandable that removal of Topock 2 data (including elevated values) would affect outlier identification for well Topock 2, but its affect on outlier identification at other wells is not anticipated (e.g., arsenic for wells BOR-2 and Lily Hill). Moreover, PG&E has previously concluded that arsenic at wells BOR-2 and Lily Hill were statistical outliers (CH2M Hill, 2007, Table 2-6). Identification of arsenic at wells BOR-2 and Lily Hill as statistical outliers/extreme values is significant as discussed in General Comment 2.

Specific Comment 11 - Section 2.2.3.1, General Geochemistry: The first paragraph on page 2-8 of the Revised Report indicates that alluvial wells from the California and Arizona sides of the river show overlapping isotopic signatures. However, if Figure 2-5 is corrected (see Specific Comment 12 below), then the Arizona wells cluster on the figure and appear isotopically lighter than alluvial California background wells. The United States Department of the Interior (DOI) had previously mentioned this issue in its February 28, 2007 letter. The Revised Report will need to be corrected to incorporate this previously identified issue.

PG&E Response: After the correction described in Specific Comment 12, there is still significant overlap between AZ and CA alluvial wells - P-2, MW-18, and PMM Supply all fall within the range of the AZ alluvial wells. Also, non-plume, site alluvial monitoring wells show strong overlap with the AZ alluvial wells. Text has been appended to explain these points.

GSU Response: The response is acknowledged and modification of the Revised Report is not required. It is noted that significant overlap does not exist in the data pictured in Figure 2-6 in that the isotopically lightest wells are located in California. An unbiased evaluation of the data would also include assessment of non-plume, site alluvial monitoring wells that do not exhibit overlap of stable isotope data.

Specific Comment 12, Figures 2-5 and 2-6: The same errors still remain on these figures even after they were identified for revision in previous agency reviews (i.e., appropriately labeling Needles MW-12 and switching labels for Tayloe/TMLP-2). PG&E will need to refer to DOI's and DTSC's 2007 comments and revise the figure.

PG&E Response: The errors have been corrected in Figure 2-5 and Figure 2-6.

GSU Response: The color coding for the Tayloe and Langmaack wells on Figure 2-5 are incorrect and it is requested that the final be revised appropriately.

Specific Comment 15, 3.0 Background Concentrations: Footnotes describing or referencing potential limitations of the regional background concentrations should be included on both Tables 2-13 and 3-1.

PG&E Response: A footnote was added to Table 2-13 and Table 3-1, as requested. The footnote reads as follows: "Potential limitations for use of these UTLs are described in prior background study documents such as the cover letter to the January 14 revised background study report (CH2M HILL, 2008a) and DTSC's November 30, 2007 letter (DTSC, 2007a)."

GSU Response: It is recommended that the footnote be changed to read as follows: "Potential limitations for use of these UTLs are described in Appendix E and prior background study documents such as the cover letter to the January 14 revised background study report (CH2M HILL, 2008a) and DTSC's November 30, 2007 letter (DTSC, 2007a)." Also see response to General Comment 1.

New GSU Specific Comment 18: Page 2-10, Second to Last Paragraph: The following sentence should be changed to be consistent with language planned for the CMS/FS Report, "*Both metals exhibit low solubility ~~are insoluble~~ in their reduced states, forming oxide or hydroxide minerals.*"

REFERENCES

CH2M Hill, January 26, 2007. Groundwater Background Study, Steps 3 and 4 Results PG&E Topock Compressor Station, Needles, California.