Draft Operations and Maintenance Manual
Volume 2

Sampling and Monitoring Plan Intermediate (60%) Design Submittal for the Final Groundwater Remedy, PG&E Topock Compressor Station, Needles, California

Prepared for
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Acronyms and Abbreviations

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
ADEQ	Arizona Department of Environmental Quality
AOC	Area of Concern
AutoDV	automated data validation
BOD	Basis of Design
CACA	Corrective Action Consent Agreement
CD	Consent Decree
CFR	Code of Federal Regulations
CoC	chain of custody
COC	chemical of concern
COPC	chemical of potential concern
Cr(III)	trivalent chromium
Cr(T)	total chromium
Cr(VI)	hexavalent chromium
CSM	conceptual site model
DO	dissolved oxygen
DOI	U.S. Department of the Interior
DQO	data quality objective
DTSC	California Department of Toxic Substances Control
ELAP	California Environmental Laboratory Accreditation Program
Fe(II)	ferrous iron
Fe(III)	ferric iron
FWPTS	Freshwater Pre-Injection Treatment System
HI	hazard index
HNWR-1	Havasu National Wildlife Refuge Well No. 1
IRL	Inner Recirculation Loop
IRZ	In-situ Reactive Zone
LCS	laboratory control sample
mg/L	milligrams per liter
Mn	manganese
MS	matrix spike
MSD	matrix spike duplicate

MWD	Metropolitan Water District
NELAP	National Environmental Laboratory Accreditation Program
NTH IRZ	National Trails Highway In-Situ Reactive Zone
O&M	operation and maintenance
ORP	oxidation reduction potential
P&ID	piping and instrumentation diagram
PG&E	Pacific Gas and Electric Company
ppb	parts per billion
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAOs	Remedial Action Objectives
RD/RA	Remedial Design/Remedial Action
S(II-)	sulfide
SOP	Standard Operating Procedure
SWMU	Solid Waste Management Unit
TCS	Topock Compressor Station
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
TWG	Technical Working Group
UNLV	University of Las Vegas
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey

1.0 Introduction

In a coordinated effort, the United States Department of the Interior (DOI) and the California Department of Toxic Substance Control (DTSC) selected the final groundwater remedy to address chromium in groundwater at Solid Waste Management Unit (SWMU) 1/Area of Concern (AOC) 1 and AOC 10 (DOI 2010 and DTSC 2011). When the selected final groundwater remedy is implemented, the current groundwater monitoring programs will be replaced by a new Corrective Measure/Remedial Action Monitoring Program with the focus of evaluating the performance of the remedy to attain the remedial action objectives (RAOs) and to comply with applicable or relevant and appropriate requirements (ARARs). The monitoring program will have several components: compliance monitoring, process control monitoring, and constituents of potential concern (COPCs) monitoring.

1.1 Compliance Monitoring During Remedy Implementation

The RAOs for the groundwater remedy are:

1. Prevent ingestion of groundwater as a potable water source having hexavalent chromium (Cr[VI]) in excess of the regional background concentration of 32 micrograms per liter (µg/L).
2. Prevent or minimize migration of total dissolved chromium (Cr[T]) and Cr(VI) in groundwater to ensure concentrations in surface water do not exceed water quality standards that support the designated beneficial uses of the Colorado River (11 µg/L Cr[VI]).
3. Reduce the mass of Cr(T) and Cr(VI) in groundwater at the site to achieve compliance with ARARs in groundwater. This RAO will be achieved through cleanup goal of regional background of 32 µg/L of Cr(VI).
4. Ensure that the geographic location of the target remediation area does not permanently expand following completion of the remedial action.

Compliance monitoring will focus on evaluating the groundwater remedy with regard to these RAOs. RAO 1, relating to prevention of ingestion of contaminated groundwater, will be met primarily through institutional controls. The Compliance Monitoring Program is designed to assess the groundwater remedy with regard to RAOs 2, 3, and 4, relating to controlling migration and reducing mass to an adequate degree.

1.2 Process Control Monitoring During Remedy Implementation

Process control monitoring is conducted to assess the extent that the groundwater remedy is functioning as designed. The process control monitoring will focus on issues such as assessing carbon dosing to maintain an effective In-situ Reactive Zone (IRZ) and the generation and attenuation of in-situ by-products.

In addition, water level monitoring will also be conducted to assess the adequacy of gradient control measures. Although gradient control is not an RAO in itself, maintaining groundwater gradients in certain areas, such as the freshwater injection barrier and the East Ravine Extraction Wells, will enhance plume control and plume remediation.

In above-ground support systems, process control monitoring involves sampling from pipes and tanks to monitor changes in water quality for extracted water that will be treated, amended and/or re-injected and to monitor the effectiveness of the carbon amendment system.

1.2.1 Summary of In Situ Remediation Chemistry

IRZ components of the design involve biologically-mediated treatment of Cr(VI). This section summarizes the in situ processes and chemical reactions within and downgradient of the IRZ that form the basis for the monitoring requirements of this system.

IRZ treatment is achieved through the stimulation of native microorganisms by the delivery of a degradable source of organic carbon, providing an electron donor for microbial growth. The goal of this process is to provide a sufficient quantity of electron donor to overcome the aquifer’s supply of aerobic electron acceptors (primarily oxygen and nitrate) so that Cr(VI) will be reduced by microbes (i.e., used as an electron acceptor) to its trivalent form (Cr[III]). Cr(VI) is relatively soluble (present in solution at neutral pH as the chromate anion, CrO_4^{2-}); whereas Cr (III) is relatively insoluble and precipitates out of solution as Cr(III)-hydroxide and mixed metal-hydroxide phases.

The utilization of electron acceptors in the system will generally be governed by the principles of thermodynamic equilibrium and redox kinetics. Dissolved oxygen (DO) and nitrate are thermodynamically more favorable electron acceptors than Cr(VI), while Cr(VI) is thermodynamically a more favorable electron acceptor than manganese oxides, iron oxides, and sulfate. However, given the relative availability of the electron acceptors and spatial heterogeneities of the subsurface aquifer environment, many of these reactions can occur simultaneously under field conditions. For example, iron and manganese reduction can proceed concurrently and sulfate reduction can begin before iron oxides are depleted, depending on the strength of the reducing environment. The strength of the reducing environment can be tuned by adjusting the concentration of organic carbon injected. This can help minimize the reduction of manganese, iron, and sulfate while still achieving adequate Cr(VI) reduction and removal. However, in order to create a reducing environment sufficient for the sustained removal of Cr(VI), some manganese, iron, and sulfate reduction will occur. Some iron reduction is actually desirable, as it provides stored Cr(VI) reduction capacity within the aquifer. These principles are discussed in more detail in Appendix B of the Basis of Design Report/60% Design Submittal (the 60% BOD Report).

The oxidation-reduction (redox) reactions fostered in the IRZ may temporarily mobilize certain naturally-occurring metals within the treatment zone, including iron, manganese, arsenic, and barium. Reduction of insoluble manganese(III/IV)-oxides generates manganese(II), which is soluble. Similarly, reduction of iron(III)-oxides releases ferrous iron (Fe[II]), which in the process releases arsenic that was adsorbed and coprecipitated within the iron oxides. Barium, which may be largely present in the soil as barite ($BaSO_4$), can be released during sulfate reduction. Although the release of manganese, arsenic, and iron will be unavoidable, the system will be operated to limit sulfate reduction, which will substantially limit—and likely avoid—the release of barium. The concentrations of these by-products will attenuate downgradient of the treatment zone through various reactions, including sorption, reoxidation, and precipitation/coprecipitation, as discussed in more detail in Appendix B of the 60% BOD Report.

Monitoring will be performed to assess the performance of the treatment remedy. Total organic carbon (TOC), Cr(VI), DO, nitrate, and sulfate will be monitored within the treatment zone to assess the effectiveness of organic carbon distribution. The concentrations of by-products (manganese, iron, arsenic, and barium) will also be monitored within, and downgradient of, the treatment zone to assess by-product generation and attenuation.

1.2.2 Adaptive Operations Approach

In the field, variations in Cr(VI) concentration distributions, lithology and hydrogeology will be encountered. To deal with the uncertainty in these parameters in implementation, the remedial system was designed to be flexible and the remedy will be implemented with an adaptive operational strategy. During system installation and baseline sampling, additional data will be collected that will refine the current conceptual model. Where appropriate, the data may be used to refine the design, for example of remedial well screens and perhaps locations. The data will also be used to update the solute transport model and refine remedy projections. During remedy implementation, monitoring data will be collected and used to guide the operations of the system, including changes in operational flowrates, injection parameters, and potentially well locations. This monitoring program provides a plan for data collection, interpretation, and guidance for adapting operations as the remedy is implemented.

2.0 Monitoring Goals and Data Quality Objectives

The Compliance Monitoring Program and Process Control Monitoring Program are described in more depth in this section. The monitoring goals and data quality objectives (DQOs) for the remedy establish the process elements and decision points that will be considered during remedy implementation. These objectives guide data collection to assess operations of the remedial components and to optimize the remedial performance. This monitoring plan establishes the following components for each of the DQOs, as summarized in Table 2.1-1 (tables are located at the end of each section):

- Problem statements and decision statements (Section 2)
- Inputs to the decisions and study area boundaries (Sections 3 and 4)
- Decision rules (Section 2)
- Limits of decision errors and optimization of design for data collection (Sections 3 and 4)

For the remedy, the decision rules are effectively an adaptive operations framework that outlines how the data collected will be used to make operational adjustments. The DQOs and decision rules/operations framework dovetail with the Contingency Plan, presented in Volume 3 of this Operation and Maintenance (O&M) Manual. The Contingency Plan includes a failure modes analysis that anticipates potential operational issues that may occur with the remedy. The DQOs guide the adaptive operations elements to mitigate for these operational issues. Mitigations identified in the failure modes analysis that are not covered by design or adaptive operations may require additional contingency actions, as outlined in the plan.

2.1 Remedy Compliance Monitoring Program

The goal of the Compliance Monitoring Program will be to assess the operation of the remedy with regard to RAOs 2, 3, and 4. The program will involve periodic monitoring of groundwater collected from within and outside of the Cr(VI) plume (see Figure 2.1-1; figures are located at the end of each section) and from surface water sampling locations along the Colorado River (Figure 2.1-2). New monitoring well locations are being proposed to supplement the existing network and are highlighted on Figure 2.1-3. The RAOs and DQOs for compliance monitoring are described in detail below and summarized in Table 2.1-1. Note that RAO 1, which involves prevention of the ingestion of water with elevated Cr(VI), requires no action within the Compliance Monitoring Program described here, since the proper institutional controls will be used to meet this RAO.

Compliance DQO-1 (RAO 2): Prevent or minimize migration of Cr(T) and Cr(VI) in groundwater to ensure concentrations in surface water do not exceed water quality standards that support the designated beneficial uses of the Colorado River (11 µg/L Cr[VI]).

RAO 2 will be satisfied during remedy operation by the in-situ treatment of Cr(VI) in groundwater; the treatment will minimize and prevent Cr(VI) and Cr(T) from reaching the Colorado River. Surface water sampling will be conducted to assess remedy performance regarding this objective. The surface water sampling locations are shown on Figure 2.1-2 and listed in Table 2.1-2. As part of the Compliance Monitoring Program, surface water samples will be collected periodically from the Colorado River from multiple locations upstream, midstream, and downstream of the zone where treated groundwater discharges to the river. Although RAO 2 is specifically intended to address Cr(VI), the IRZ by-products arsenic and manganese will also be monitored. The surface water quality criteria for Cr(VI) is 11 µg/L and 150 µg/L for arsenic (Source: Table 2 of the Record of Decision [ROD], ARAR #3, Federal Water Pollution Control Act. 33 USC 1251-1387, 40 CFR 131.38). There are no surface water quality criteria for Cr(T) and manganese. Elevated concentrations of Cr(VI), manganese, and arsenic can be potentially attributed to the Topock site if midstream and/or downstream surface water concentrations show statistically significant increases above upstream concentrations observed during the same sampling event.

If Cr(VI), arsenic, or manganese concentrations increase in surface water samples and are attributable to the Topock site, operational changes will be implemented per the process control decision rules outlined in Section 3.

If Cr(VI), arsenic, or manganese concentrations do not return to baseline as a result of the operational adjustments, the recommendations in the Contingency Plan measures (see Volume 3) will be implemented.

Compliance DQO-2 (RAO 3): Reduce the mass of Cr(T) and Cr(VI) in groundwater at the site to achieve compliance with ARARs in groundwater. This RAO will be achieved through cleanup goal of regional background of 32 µg/L of Cr(VI).

To assess remedy performance with regard to RAO 3, groundwater samples will be collected periodically from the compliance monitoring program well network inside the plume (the network is described in Section 3). The compliance monitoring wells inside the plume are shown in Figure 2.1-1 and listed in Table 2.1-3 according to their intended function within the monitoring program.

As part of the data quality objectives for RAO 3, wells located within the plume boundary (defined by the current 32 µg/L Cr(VI) plume boundary) will be monitored for Cr(VI), and concentration trends will be reviewed to assess progress toward this RAO. Cr(VI) concentration trends will be evaluated and model projections compared to baseline estimates. If the plume remediation timeframes are lengthened, operational changes will be evaluated and implemented to the remediation system, as presented in the process control decision rules/operational framework in Section 2.2 and in the Contingency Plan. Data will also be evaluated to determine when the appropriate time for monitored natural attenuation arises.

Compliance DQO-3 (RAO 4): Ensure that the geographic location of the target remediation area does not permanently expand following completion of the remedial action.

To assess remedy performance with regard to RAO 4, groundwater samples will be collected periodically from the Compliance Monitoring Program well network outside the plume, according to the DQOs for this RAO, as described in Section 3. The compliance monitoring wells outside the plume are shown in Figure 2.1-1 and listed in Table 2.1-3. The data collected will be analyzed to ensure that the concentrations of Cr(VI) and remedy by-products, specifically manganese and arsenic, do not permanently increase outside of the baseline Cr(VI) plume.

Upgradient of the plume, if concentrations of Cr(VI), manganese, or arsenic increase above anticipated concentrations, operational adjustments for the Inner Recirculation Loop (IRL) injections and freshwater injections will be considered and groundwater modeling will be used to assess effects of the considered operational changes. Based on the modeling assessment, the need for additional data collection and the benefits and timing of the operational adjustments will be reviewed and changes presented and implemented if warranted. The Process Control Monitoring Program and decision rules/operational framework are outlined in Section 2.2. If operational adjustments are implemented, the effects will be assessed in the context of the overall plume remediation using the field data and re-calibrated groundwater modeling projections.

If Cr(VI) concentrations show an increasing trend downgradient of the National Trails Highway In-situ Reactive Zone (NTH IRZ) compliance wells located outside of the baseline Cr(VI) plume in the floodplain, operational adjustments will be considered as outlined in Section 2.2.1 and in the Contingency Plan. Similarly, if by-product concentrations increase beyond expectations downgradient of the NTH IRZ in compliance wells located outside of the baseline Cr(VI) plume in the floodplain, operational adjustments will be considered as outlined in Section 2.2.1.

2.2 Process Control Monitoring Program

The objective of the Process Control Monitoring Program will be to assess the extent to which the groundwater remedy is functioning as designed based on the DQOs. The process control monitoring network is shown in Figure 2.2-1.

2.2.1 National Trails Highway In-situ Reactive Zone (NTH IRZ)

NTH IRZ DQO-1: The carbon substrate amendment system must be working to amend the organic carbon substrate into the recirculated groundwater.

To evaluate the effectiveness of the carbon substrate amendment system, samples will be collected from the MW-20 Bench and Transwestern Bench distribution systems and analyzed for TOC. Samples will be collected from sampling ports located in each forcemain following the location where organic carbon substrate is added and passes through a static mixer. Samples will also be collected from injection vaults. If TOC concentrations do not match the target mixing concentrations for a given injection, troubleshooting will be conducted to identify and repair any problems with the carbon amendment system.

During system start-up, samples will be collected frequently, approximately weekly or biweekly, until data suggest that the amendment system is working properly. Once the system operations are verified, sampling frequency will be reduced to quarterly or semi-annually from select injection well vaults, as needed to ensure proper system operation.

NTH IRZ DQO-2: The NTH IRZ must be complete and maintain Cr(VI) treatment over time.

The decision rules/operational framework for the NTH IRZ is shown on Figure 2.2-2. Operation of the NTH IRZ will involve extraction of groundwater from NTH IRZ Extraction Wells, amendment with organic carbon substrate, and re-injection into NTH IRZ Injection Wells to generate an IRZ to treat Cr(VI). DQO-2 for the NTH IRZ is to ensure that the IRZ has been sufficiently established in the subsurface as a result of the IRZ system operations.

To evaluate this objective, monitoring data from dose response wells, located in proximity to the NTH IRZ Injection Wells, will be collected. The dose response wells are shown on Figure 2.2-1 and identified on Table 2.1-2. The details of the sampling program for these wells are presented in Section 4. In general, the following primary monitoring data will be collected and used for decision making:

- TOC: The distribution of TOC is the primary mode of generating reducing conditions for treatment of Cr(VI) in groundwater.
- Dissolved iron: Dissolved iron is a Cr(VI) reductant that is generated under iron reducing conditions stimulated by the injection of organic carbon. If dissolved iron is distributed in the aquifer where TOC is not, Cr(VI) reducing conditions will still be established. As such, dissolved iron serves as a secondary indicator of the establishment of an IRZ.
- Cr(VI): the presence or absence of Cr(VI) in groundwater will also serve as a direct indicator of whether Cr(VI) treatment at a given location is occurring or necessary.

The process for evaluating the data collected from the monitoring wells and making operational adjustments according to the decision rules/operational framework is presented in a flowchart on Figure 2.2-2. As detailed on Figure 2.2-2, a combination of TOC, dissolved iron, and Cr(VI) data from dose response monitoring wells will be evaluated to determine if the IRZ has been established. TOC concentrations will be compared to the target concentration range established based on experience, pilot testing results, and solute transport modeling, provided in Table 2.2-1. The anticipated concentrations vary with distance from injection points, with higher concentrations anticipated close to injection points and lower concentrations anticipated further from injection points. If TOC concentrations are within the anticipated range, then operations will continue. If TOC concentrations are below the anticipated range, Cr(VI) and dissolved iron data will also be evaluated. If dissolved iron is above baseline and Cr(VI) is treated to less than 32 parts per billion (ppb), then the IRZ operation will be considered successful. If TOC concentrations are below the anticipated range, dissolved iron does not increase above baseline, and Cr(VI) is not treated, operational adjustments will be considered, as shown on Figure 2.2-2.

In addition, downgradient Cr(VI) concentrations will be evaluated, as shown on Figure 2.2-2. If Cr(VI) concentrations are not decreasing within expectations outlined in Table 2.2-1, then operational adjustments will be considered as shown on Figure 2.2-2.

Short-term operational adjustments that may be made to improve TOC distribution and establishment of the IRZ include adjustment of the TOC injection concentration, dosing frequency or duration, injection and extraction rates, target injection intervals, or river bank extraction rates. Increasing the injection concentration and adjusting the dosing parameters would be implemented if data indicate that injected water is reaching the location, but there is not sufficient carbon remaining in solution to establish Cr(VI)-reducing conditions. A decrease in nitrate without increase in TOC or dissolved iron is an indication of this case. If injected water is not reaching the monitoring location as indicated by a lack of change in Cr(VI), nitrate and dissolved metals, an increase in flow rate could be used to improve distribution. The targeted treatment intervals may need to be adjusted if it appears that some intervals within a given injection location require more reagent distribution than others or if some intervals are already completely treated while others are not. River bank extraction rates may be adjusted if the hydraulic gradient being induced downgradient of the IRZ is preventing lateral distribution at the injection points. Adjustments to the river bank extraction rates would have to be balanced with the evaluation of the extraction for performance, as outlined in Section 2.2.2.

If short-term operational adjustments are not sufficient to improve the performance of the NTH IRZ, long-term operational changes such as adding the provisional injection wells and changing reagents will be considered. The addition of provisional injection wells would decrease the required TOC injection concentration to achieve complete distribution. Selection of a carbon substrate with slower degradation rates could increase the distribution distances. If long-term operational changes are not sufficient to improve the performance of the NTH IRZ, further contingency measures will be implemented (see Contingency Plan in Volume 3).

It is anticipated that the IRZ operations will be cycled; for example the IRZ would be operated for six months to establish reducing conditions and then will be turned off for 18 months during which time residual reducing capacity generated during injections will continue to treat Cr(VI) in groundwater. The decision process for turning the IRZ operations on and off is illustrated starting on Box 27 of Figure 2.2-2. Residual reducing capacity could potentially be stored during injections as reduced iron from iron reduction, sulfide from sulfate reduction, or as biomass from microbial growth. For dose response wells, dissolved iron concentrations, Cr(VI) concentrations below 32 μg/L, and other redox indicators such as nitrate and sulfate will be used to evaluate the establishment and maintenance of an adequate reducing capacity within the treatment zone. If these parameters collected from dose response wells indicate reducing conditions have been established, IRZ operations will be shut down and monitoring of these parameters will continue. As the data indicate that reducing conditions are lost, e.g., through a decrease in dissolved iron concentrations, an increase in Cr(VI) concentrations, or an increase in other redox indicators such as nitrate, the IRZ operations will be resumed. The monitoring data will provide information all along the IRZ, and it is possible that treatment may be complete and operations will be shut down in some areas, while additional treatment and operation will be needed in other areas.

NTH IRZ DQO-3: By-product generation and migration from the NTH IRZ must be controlled.

The decision rules/operational framework for the NTH IRZ by-product evaluation is also shown on Figure 2.2-2. DQO-3 for the NTH IRZ is to ensure that by-product generation from the NTH IRZ is adequately controlled. To evaluate this objective, monitoring data from dose response wells will be used to evaluate the generation of by-products within the IRZ, while monitoring wells located dowgradient of the IRZ in the mid-floodplain and monitoring wells located proximal to the river bank extraction system will be used to monitor by-product attenuation and migration. By-product data collection will include sampling for dissolved arsenic, dissolved manganese, dissolved iron, and dissolved barium, as detailed in Section 4.

By-product concentration data will be compared to the anticipated concentration range and timing based on solute transport modeling as presented in Table 2.2-1. If by-product concentrations are above the anticipated range, operational adjustments will be made.

Short-term operational adjustments that may be made to improve by-product generation and migration include adjustment of the TOC injection concentration, dosing frequency or duration, injection and extraction rates, target injection intervals, or river bank extraction rates. Decreasing the injection TOC concentration and adjusting the dosing parameters could decrease the generation of the by-products. Adjustments to the TOC injections to minimize by-product generation would have to be balanced with maintaining Cr(VI) treatment, as outlined in NTH IRZ DQO-2. River bank extraction rates may be adjusted if the hydraulic gradient downgradient being induced is having detrimental influence on downgradient by-product migration. Adjustments to the river bank extraction rates would have to be balanced with the evaluation of the extraction for performance, as outlined in Section 2.2.2.

If short-term operational adjustments are not sufficient to improve by-product generation and migration from the NTH IRZ, long-term operational changes such as adding the provisional injection wells will be considered. The addition of provisional injection wells would decrease the required TOC injection concentrations and decrease by-product generation.

If short-term and long-term operational adjustments are not sufficient to improve by-product generation and migration from the NTH IRZ, the river bank extraction system operation may be adjusted to ensure that by-products do not cause unacceptable impacts to the river, as indicated in box 17 on the operational flowchart in Figure 2.2-2. The DQOs to evaluate operation of the river bank extraction system are presented in Section 2.2.2.

NTH IRZ DQO-4: Extraction on the north end of the NTH IRZ will be conducted to control Cr(VI) with the NTH and river bank extraction systems.

The decision rules/operational framework for the NTH northern extraction is shown on Figure 2.2-3. On the northern end of the NTH IRZ, potential migration of Cr(VI) in groundwater will be controlled via extraction, rather than the establishment of an IRZ. On this end of the NTH IRZ, data will be collected to assess the ability of extraction to control Cr(VI) migration. This objective will be assessed through evaluation of data collected from northern NTH IRZ extraction monitoring wells, the extraction wells themselves, and the surface water sampling locations. The monitoring well and surface water sampling locations are listed on Table 2.1-2 and shown on Figures 2.2-1 and 2.1-2, and the sampling programs are detailed in Sections 3 and 4.

The analytical and water level data collected will be used to adjust the flow model and a lines-of-evidence approach will be used to evaluate the hydraulic control of the Cr(VI) plume, as discussed in further detail in Section 4.4. The river bank extraction system operation will also be evaluated and adjusted to address control of the Cr(VI) plume. If it is assessed that control is not likely to be achieved, operational adjustments to the extraction rates of the northern NTH IRZ extraction wells or River Bank Extraction Wells will be considered, as detailed on Figure 2.2-3. If operational adjustments do not adequately enhance the likelihood of Cr(VI) plume control, the installation of provisional wells will be considered. The Contingency Plan will be implemented if performance is not improved by the operational adjustments or addition of provisional wells.

NTH IRZ DQO-5: Extraction will be conducted to minimize extraction of organic carbon and reduced metal by-products, e.g. iron and manganese.

The decision rules/operational framework for evaluating extracted water quality from the NTH IRZ is shown on Figure 2.2-2. The extraction of residual organic carbon substrate or reduced metals, such as iron and manganese, from NTH IRZ Extraction Wells may increase the potential for fouling of the NTH IRZ Injection Wells receiving the extracted water. Extraction wells IRZ-9 and IRZ-23 are the most likely to extract organic carbon or reduced metal by-products, given their proximity to the IRZ Injection Wells. Samples will be collected from the extraction wells and analyzed for organic carbon, iron, and manganese, among other water quality parameters, as outlined in Section 4.2.

Operational adjustments to address extracted organic carbon or reduced metals caused by injections in nearby injection wells include reducing TOC injection concentrations and changing injection or extraction flow rates, as detailed on Figure 2.2-2. By reducing TOC injection concentrations, the organic carbon substrate may be consumed before reaching the extraction well. Decreasing the injection flow rates or extraction flow rates would decrease the lateral hydraulic gradient and reduce the potential for extraction of water with residual organic carbon or reduced metal by-products by the extraction wells. Extraction wells may also need to be taken off-line for variable periods of time to control these impacts, or to maintain the well. These operational adjustments, including the shutdown of any given injection or extraction well, would be coupled with an assessment of the strength of the IRZ and Cr(VI) treatment in that area per NTH IRZ DQO-2. However, it is anticipated that if treated water is being extracted, the IRZ would be established in the area and continued operation would not be needed. In addition, the overall flow balance of the system will be considered when adjusting the injection and extraction flows to ensure that carbon distribution is still occurring in areas that need treatment.

2.2.2 Inner Recirculation Loop (IRL)

The intent of the IRL is to increase the hydraulic gradient toward the NTH IRZ.

IRL DQO-1: Inner loop recirculation will be operated to facilitate flushing of the Cr(VI) plume through the NTH IRZ.

The process for evaluating the development of hydraulic gradients to facilitate Cr(VI) plume flushing is illustrated on the right-hand side of the flow diagram in Figure 2.2-4. Data will be compared to the anticipated concentration range and timing based on solute transport modeling as presented in Table 2.2-1.

The hydraulic gradient will be evaluated through analysis of water levels collected across the site, particularly at IRL injection dose response wells where water level mounding is anticipated and at extraction wells where groundwater drawdown is anticipated. Observed hydraulic gradients will be compared to anticipated gradients as simulated with flow modeling that will be periodically updated as field data are collected. In addition, Cr(VI) concentration changes from IRL injection downgradient monitoring wells will be compared to anticipated concentration changes and timeframes predicted from solute transport modeling, as summarized in Table 2.2-1. If the change in hydraulic gradient and the changes in downgradient monitoring well Cr(VI) concentration trends are not within expectations, short-term adjustments to improve performance, such as increasing injection rates or adjusting the flow balance across the IRL, will be considered for implementation. Changes to freshwater injection rates will be considered in concert with changes to River Bank Extraction Well flow rates (see Section 2.2.4). Longer-term changes may include installation of additional injection wells, such as provisional well IRL-5. An increase in injection rates in a given well or the addition of a well will require either decreasing injection rates in other wells or increased extraction rates from the River Bank Extraction Wells or freshwater source and may require additional extraction capacity. The changes will be made and flow rates will be balanced across the system to optimize the hydraulic gradient across the system. If the desired hydraulic gradients cannot be achieved and Cr(VI) concentrations are not declining within expectations such that the remedy duration is projected to be of an unacceptable duration, the Contingency Plan will be implemented.

IRL DQO-2: Cr(VI) in groundwater extracted from the River Bank Extraction Well system must be treated if levels exceed the target Cr(VI) concentration.

The process for evaluating data and making operational changes to the IRL carbon injections is presented on the left-hand side of Figure 2.2-4. If Cr(VI) is present in groundwater extracted from the River Bank Extraction Wells at a blended concentration that exceeds the target clean-up level of 32 μg/L, the recirculated groundwater will be amended with carbon substrate and process control monitoring will be conducted to enhance treatment. Cr(VI) concentration data will be collected from the extracted groundwater. If the Cr(VI) concentration in the extracted water is greater than 32 ppb, then the carbon amendment system will be turned on or continue to operate if already on. If the Cr(VI) concentration is less than 32 μg/L, the carbon amendment system will be turned off or remain off.

If the carbon amendment system is active, data will be collected from the IRL injection dose response monitoring wells, listed in Table 2.1-2 and shown on Figure 2.2-1, to evaluate Cr(VI) treatment and by-product generation. If TOC concentrations are less than anticipated and Cr(VI) is not treated to less than 32 μg/L in samples collected from dose response wells, then operational adjustments such as increasing TOC injection concentrations or changing dosing parameters will be made. If by-product concentrations are above the anticipated range, the TOC concentration will be decreased or dosing parameters will be adjusted.

The process for evaluating extracted water quality data is presented on the left-hand side of Figure 2.2-4. If concentrations of reduced metals are elevated and it is affecting injection well performance (see O&M Manual Volume 1, Section 4 for details on evaluating injection well performance), then adjustments will be made to improve injection well performance. Short-term operational changes that will be considered include increasing the backwashing and chemical rehabilitation frequency, and adjusting extraction rates or the flow balance if concentrations of fouling constituents vary among wells. Adjustments of the extraction rates would have to be weighed against the hydraulic control needs and performance of the River Bank Extraction Wells as discussed in IRL DQO-3, below. The addition of low concentrations of TOC to maintain a slightly reduced water chemistry signature in the injection well may also be applied; this will be coupled with the complementary monitoring associated with TOC addition as described in the previous paragraph. If injection well maintenance becomes unacceptably costly or burdensome due to the re-injection of reduced metals, treatment for removal of those metals prior to re-injection may be considered.

IRL DQO-3: Control migration of Cr(VI).

IRL DQO-4: Control the migration of by-products in the deeper units.

The decision rules/operational framework for the River Bank Extraction Wells are shown on Figure 2.2-5. As discussed in the NTH IRZ objectives section (Section 2.2.1), Cr(VI) and by-product concentration trends will be monitored in floodplain process control monitoring wells. Cr(VI) and by-products data from the river bank extraction monitoring well network and surface water sampling network will be used to evaluate the adequacy of the system's control of the Cr(VI) plume and by-product migration. The monitoring well and surface water sampling locations are listed on Table 2.1-2 and shown on Figure 2.2-1, and the sampling programs are detailed in Sections 3 and 4.

The analytical and water level data collected will be used to adjust the flow model and a lines-of-evidence approach will be used to evaluate the control of Cr(VI) and/or by-products, as discussed in further detail in Section 4.4. If control of Cr(VI) and by-products in the deeper units is assessed as not likely to be achieved, operational adjustments will be made, as shown on Figure 2.2-5. Operations may be improved by adjusting extraction rates or taking further contingency measures, such as adding additional extraction wells (see Volume 3, Contingency Plan). If it is determined from the evaluation of concentrations and hydraulic control evaluation that control for Cr(VI) is needed in the shallow unit, extraction from intervals in the shallow unit will be considered as part of contingency plan implementation. If extraction rates need to be increased, the IRL injection system may need to be modified to accommodate increased injection rates. Wells may be rehabilitated or the flow balance adjusted in the short term; and provisional injection wells can be added in the long term if additional injection capacity is necessary. If operational adjustments do not result in adequate control of the Cr(VI), additional contingency measures may be implemented.

IRL DQO-5: The naturally-occurring reducing rind will be monitored for changes in water quality.

Geochemical parameters indicative of reducing conditions in the floodplain reducing rind include low DO, low oxidation reduction potential (ORP), dissolved manganese and iron concentrations above detection limits, dissolved arsenic, and potentially low concentrations of dissolved nitrate. These analytes will be monitored to assess the character of the reducing rind during remedy operations. The data will be monitored over time to assess changes in the groundwater quality. Trends will also be evaluated in light of other various factors that could cause changes. For instance, implementation of the remedy will involve changes to the flow regime (flow rates and directions) within the floodplain, which may cause shifts in the steady state concentrations of redox indicators. In addition, baseline analyte concentrations within floodplain monitoring wells are highly variable. The entire dataset will be considered when evaluating the overall impact to the reducing rind, and multiple lines of investigation will be evaluated to understand the data trends. The presence and effectiveness of the engineered reducing zone will also be considered when evaluating changes to the natural reducing zone. If broad changes to the reducing conditions occur, further investigations may be warranted.

2.2.3 Topock Compressor Station (TCS) Recirculation Loop

TCS DQO-1: TCS injection wells will be operated to treat Cr(VI) in groundwater beneath the TCS.

The decision rules/operational framework for the TCS Injection Wells is shown on Figure 2.2-6. To evaluate treatment of Cr(VI) in groundwater beneath the TCS, data will be collected from the TCS Recirculation Loop dose response monitoring wells, listed in Table 2.1-2 and shown on Figure 2.2-1. If TOC concentrations are less than anticipated and Cr(VI) is not treated to less than 32 µg/L in samples collected from dose response wells, than operational adjustments such as increasing TOC injection concentrations or changing dosing parameters will be considered. If by-product concentrations are above the anticipated range, consideration will be given to decreasing the TOC concentration or adjusting the dosing parameters.

In addition, the TCS injection wells will only be operated if the freshwater injection at FW-02 is operating at an effective injection rate to control potential Cr(VI) or in-situ by-product migration from the TCS injections.

TCS DQO-2: TCS Recirculation Loop Transwestern Bench Extraction Wells will be operated to remove Cr(VI) mass from the high concentration area in the vicinity of the TCS and control migration toward the East Ravine.

The decision rules/operational framework for the TCS Recirculation Loop Transwestern Bench extraction are shown on Figure 2.2-7. To optimize the extraction of Cr(VI) from the Transwestern Bench extraction system, data will be collected from the extracted groundwater and the Transwestern Bench monitoring well network, listed in Table 2.1-2 and shown on Figure 2.2-1. Multiple lines of evidence will be used to evaluate and optimize the hydraulic control of the Transwestern Bench extraction system, as outlined in Section 4.4 and shown on Figure 2.2-7. If additional control is need, operational changes will be made such as increasing extraction rates or adding provisional extraction wells. If these changes are not sufficient, additional contingency actions will be considered.

TCS DQO-3: East Ravine Extraction Wells will be operated to remediate Cr(VI) and control migration towards the river.

The decision rules/operational framework for the TCS Recirculation Loop East Ravine extraction system is shown on Figure 2.2-8. Analytical data collected from East Ravine Extraction Wells, monitoring wells and surface water sampling locations, as well as water level data collected from the East Ravine extraction monitoring well network, will be used to adjust the flow model. These sampling locations are listed in Table 2.1-2. A lines-of-evidence approach will be used to evaluate the potential migration of Cr(VI), as discussed in further detail in Section 4.4. If hydraulic control is assessed to be inadequate, increasing extraction rates in the short term will be considered. If operational adjustments do not result in adequate control of the Cr(VI), the additional contingency measures may be implemented. If operational adjustments do not result in hydraulic control of the Cr(VI) plume, the Contingency Plan will be implemented.

If extraction rates are increased, the IRL injection system may need to be modified to accommodate increased injection rates. Wells may be rehabilitated or the flow balance adjusted in the short term; and provisional injection wells can be added in the long term if additional injection capacity is necessary.

2.2.4 Freshwater Injection

Freshwater DQO-1: Freshwater injections will be operated to facilitate flushing of the Cr(VI) plume through the NTH IRZ and to contain carbon-amended water and in-situ by-products from the IRL.

The process for evaluating the development of hydraulic gradients to facilitate Cr(VI) plume flushing is illustrated on Figure 2.2-9. Water level data will be collected across the site, and IRL injection downgradient monitoring will be used to assess Cr(VI) concentration changes. Data collected will be compared to model output, and if necessary the model will be adjusted to better reflect field data. The model will then be used to project remedial timeframes, and the need for adjustments will be considered in the light of projected changes to the remedial timeframe or weaknesses in the remediation system. If needed, operational adjustments to the freshwater injections including increasing injection rates or adjusting the flow balance in the short term, as well as additional contingency measures such as adding injection wells, will be considered for implementation. Increasing injection rates in a given well will require either decreasing injection rates in other wells or increasing the extraction rate from the freshwater source. Changes to freshwater injection rates will be considered in concert with changes to River Bank Extraction Well flow rates (see Section 2.2.2).

Arsenic and manganese concentrations will be compared to expected concentrations in the IRL by-product monitoring wells, as summarized in Table 2.2-1. If concentration trends are not within expectations, short-term adjustments will be considered for implementation, similar to those listed above.

Table 2.1-1
Data Quality Objectives
Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan
Revised Basis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy
PG&E Topock Compressor Station, Needles, California

	1. State the Problem	**2. Decision Statements**	**3. Inputs to the Decision**	**4. Study Area Boundaries**	**5. Decision Rules**	**6. Limits of Decision Errors**	**7. Optimize the Design for Data Collection**
COMPLIANCE							
1) Surface Water (RAO 2)	The remedy must be implemented in compliance with RAO 2 (prevent or minimze migration of total chromium and hexavalent chromium to ensure concentrations in surface water do not exceed water quality standards).	Modify operations or remedy components to meet the RAO?	Surface water sampling results	Surface water sampling location network.	If Cr(VI), arsenic, or manganese concentrations increase in surface water samples and are attributable to the Topock site, operational changes will be implemented per the process control decision rules. If Cr(VI), arsenic, or manganese concentrations do not return to baseline as a result of the operationalal adjustments, the contingency plan will be implemented.	Limit decision error through: - Collection of samples upriver and downriver of potentially affected areas to accurately attribute concentration changes to the Topock site. - Quarterly to semi-annual data collection throughout the lifetime of remedy operations.	See Section 3
2) Inside the Plume (RAO 3)	The remedy must be implemented in compliance with RAO 3 (Reduce the mass of total chromium and hexavalent chromium in groundwater at the site to achieve compliance with ARARs in groundwater.)	Modify operations or remedy components to meet the RAO?	hexavalent chromium concentration data from monitoring wells in the interior of the plume.	Interior of the plume	If hexavalent chromium concentrations are not decreasing within expected timeframes, operational changes (potentially including the addition of provisional IRZ wells) will be implemented per the process control decision rules. If operational changes do not improve the hexavalent chromium concentration trends, the contingency plan will be implemented.	Limit decision error through: - Groundwater monitoring at multiple points distributed laterally and vertically across plume, spanning a range in anticipated cleanup timeframes. - Monitoring with a frequency consistent with anticipated cleanup timeframes.	See Section 3
3) Ouside the Plume (RAO 4)	The remedy must be implemented in compliance with RAO 4 (the target remediation area does not permanently expand following completion of the remedial action)	Modify operations or remedy components to meet the RAO?	hexavalent chromium and byproduct concentration data from monitoring wells outside of the baseline plume	Outside of the Plume	If Cr(VI), arsenic or manganese concentrations increase and persist above long term expectations outside the baseline hexavalent chromium plume, operational changes will be implemented per the process control decision rules. If operational changes do not improve the Cr(VI), arsenic or manganese concentrations outside the baseline hexavalent chromium plume, the contingency plan will be implemented.	Limit decision error through: - Collection of samples from outside of the baseline hexavalent chromium plume. - Sampling frequency based on anticipated arrival times of water affected by various components of the remedy. - Quarterly collection of water level data to assess hydraulic performance, ensuring plume control. - Comparison of Cr(VI) and byproduct dynamics with solute transport model predictions to assess performance.	See Section 3

Table 2.1-1
Data Quality Objectives
Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan
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PG&E Topock Compressor Station, Needles, California

	1. State the Problem	**2. Decision Statements**	**3. Inputs to the Decision**	**4. Study Area Boundaries**	**5. Decision Rules**	**6. Limits of Decision Errors**	**7. Optimize the Design for Data Collection**
PROCESS CONTROL							
National Trails Highway In-Situ Reactive Zone (NTH IRZ)							
1	The carbon substrate amendment system must be working to amend the organic carbon substrate into the recirculated groundwater.	Is the carbon amendment system working properly?	Organic carbon samples collected from the MW-20 Bench and Transwestern Bench distribution systems.	Distribution systems.	If carbon amendment systems are not delivering desired TOC concentrations, troubleshooting and repair, if needed, will be conducted.	Limit decision error through: - Collection of samples at key system locations. - Monthly data collection at start-up to ensure system is working properly and routine sampling thereafter.	See Section 4
2	The NTH IRZ must be complete and maintain hexavalent chromium treatment over time.	Modify operations of the NTH IRZ? Start or stop NTH IRZ recirculation and organic carbon injections? Modify the NTH IRZ design? Modify the monitoring well layout?	Organic carbon, Cr(VI), and dissolved metals analytical data from NTH IRZ dose response and downgradient monitoring wells.	Floodplain (NTH IRZ dose response and downgradient monitoring wells)	See decision rules/operational framework in Figure 2.2-2. If operational adjustments in Figure 2.2-2 are not sufficient to control hexavalent chromium migration in the Floodplain, refer to inner recirculation loop riverbank extraction decision rules on Figure 2.2-5	Limit decision error through: - Placement of monitoring well locations at the weak points of the IRZ (mid-point between injection locations) and downgradient. - Collection of a variety of parameters to evaluate establishment of hexavalent chromium reducing conditions. - Monthly to quarterly sampling during start-up and operational changes.	See Section 4
3	Byproduct generation and migration from the NTH IRZ must be controlled.	Modify NTH IRZ operations based on byproduct concentration trends? Modify NTH IRZ design based on byproduct concentration trends?	Organic carbon and byproduct concentration data collected from dose response wells, downgradient monitoring wells, and Riverbank extraction monitoring wells located in the Floodplain.	Floodplain downgradient of NTH IRZ (NTH IRZ dose response wells, downgradient monitoring wells, and Riverbank extraction monitoring wells)	See decision rules/operational framework in Figure 2.2-2. If operational adjustments in Figure 2.2-2 are not sufficient to control by-product generation and migration, refer to inner recirculation loop riverbank extraction decision rules on Figure 2.2-5	Limit decision error through: - Placement of monitoring wells at a variety of locations lateral and downgradient of injection wells. - Design sampling frequency to ensure observation of concentration changes, based on anticipated timeframe for concentration changes.	See Section 4
4	Extraction on the north end of the NTH IRZ will be conducted to control hexavalent chromium with the NTH and Riverbank extraction systems.	Should extraction operations be modified to control hexavalent chromium migration on the north end of the NTH IRZ?	hexavalent chromium and water level data from monitoring wells on the north end of the NTH. Groundwater modeling catpure estimates. Surface water sampling hexavalent chromium data.	North end of the NTH IRZ (Northern extraction monitoring wells)	See decision rules/operational framework in Figure 2.2-3.	Limit decision error through: - A multiple lines of evidence performance assessment. - Use of existing and additional monitoring wells for data collection. - Monthly to quarterly data collection at start-up to ensure system is working properly.	
5	Extraction will be conducted to minimize extraction of TOC and reduced metal by-products, e.g. iron and manganese.	Should operations be adjusted to minimize extraction of treated metals?	Water quality data collected from the NTH IRZ extraction wells	NTH IRZ	See decision rules/operational framework in Figure 2.2-2.	Limit decision error through: - Water quality monitoring at each NTH IRZ extraction well. - Quarterly or more frequent monitoring initially to evaluate extracted water quality.	See Section 4

Table 2.1-1
Data Quality Objectives
Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan
Revised Basis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy
PG&E Topock Compressor Station, Needles, California

	1. State the Problem	**2. Decision Statements**	**3. Inputs to the Decision**	**4. Study Area Boundaries**	**5. Decision Rules**	**6. Limits of Decision Errors**	**7. Optimize the Design for Data Collection**
Inner Recirculation Loop (IRL)							
1	Inner loop recirculation will be operated to facilitate flushing of the hexavalent chromium plume through the NTH IRZ.	Should inner recirculation loop injection well operations be modified to facilitate flushing of the hexavalent chromium plume?	Water level data and hexavalent chromium concentration data from across the site	Project Area	See decision rules/operational framework in Figure 2.2-4.	Limit decision error through: - Placement of monitoring wells within the plume in locations to collect data on flushing of hexavalent chromium concentration trends. - Sampling collection frequency based on solute transport modeling predictions. - Evaluation of timeframe predictions based on model re-calibrated with installation and operational data.	See Section 4
2	Hexavalent chromium in groundwater extracted from the Riverbank extraction well system must be treated if levels exceed the target hexavalent chormium concentration.	Does water extracted from the Riverbank contain hexavalent chromium above background and require treatment? If hexavalent chromium treatment is required, should carbon-amended injection well operations be modified to ensure hexavalent chromium treatment? Are constituents in extracted water degrading injection well performance?	Water quality analytical data from samples collected from Riverbank extracted water. Organic carbon, Cr(VI), and dissolved metals analytical data from dose response wells. Injection well performance.	Riverbank Extraction Monitoring Wells and Extraction Wells Inner Recirculation Loop Dose Response Wells	See decision rules/operational framework in Figure 2.2-4.	Limit decision error through: - Collection of water quality data from individual extraction wells and from the combined stream. - Monitoring in the immediate vicinity of injection wells to ensure injected water is treated adequately. - Monthly to quarterly data collection at start-up, followed by continued quarterly monitoring to quickly address water quality changes.	See Section 4
3	Control migration of Cr(VI).	Should operations of Riverbank extraction wells be modified to prevent hexavalent chromium from entering the river? Are currently operating screen intervals of the Riverbank extraction wells sufficient to prevent hexavalent chromium from entering the river?	Water level data from NTH IRZ Riverbank extraction monitoring wells. Groundwater modeling. Surface water sampling hexavalent chromium data.	Focus on Riverbank extraction monitoring network and surface water sampling locations. Data from sitewide water level monitoring may also be used.	See decision rules/operational framework in Figure 2.2-5.	Limit decision error through: - A multiple lines of evidence performance assessment. - Use of existing and additional monitoring wells for data collection.	See Section 4

Table 2.1-1
Data Quality Objectives
Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan
Revised Basis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy
PG&E Topock Compressor Station, Needles, California

	1. State the Problem	2. Decision Statements	3. Inputs to the Decision	4. Study Area Boundaries	5. Decision Rules	6. Limits of Decision Errors	7. Optimize the Design for Data Collection
4	Control the migration of by-products in the deeper units.	Should operations of Riverbank extraction wells be modified to prevent in-situ byproducts in the river? Are currently operating screen intervals of the Riverbank extraction wells sufficient to prevent an increase in the concentrations of byproducts entering the river?	Water level data from NTH IRZ Riverbank extraction monitoring wells Groundwater modeling. Surface water sampling byproduct data.	Focus on Riverbank extraction monitoring network and surface water sampling locations. Data from sitewide water level monitoring may also be used.	See decision rules/operational framework in Figure 2.2-5.	Limit decision error through: - A multiple lines of evidence performance assessment. - Use of existing and additional monitoring wells for data collection.	
5	The naturally-occurring reducing rind will be monitored for changes in water quality	Do changes in the water quality parameters in the rind warrant additional investigation?	Geochemical data and water levels from fluvial monitoring wells	Floodplain Fluvial Aquifer	See section 2.2.2	Limit decision error through: - Assessing multiple geochemical lines of evidence for assessing reducing rind impacts.	See Section 4
Topock Compressor Station (TCS) Recirculation Loop							
1	TCS injection wells will be operated to treat hexavalent chromium in groundwater beneath the compressor station	Should TCS loop injection well operations be modified to promote better hexavalent chromium treatment?	Organic carbon, Cr(VI), and dissolved metals analytical data from monitoring wells downgradient of of the injection wells.	TCS loop dose response and downgradient monitoring wells	See decision rules/operational framework in Figure 2.2-6.	Limit decision error through: - Monitoring of dose response wells to ensure system is working properly.	See Section 4
2	TCS loop Transwestern bench extraction wells will be operated to remove hexavalent chromium mass from the high concentration area in the vicinity of the TCS and control migration toward the East Ravine.	Should extraction system operations or configuration be changed to optimize hexavalent chromium migration control?	hexavalent chromium analytical and water level data from TCS loop embayment extraction monitoring wells Groundwater modeling.	TCS Loop Transwestern bench extraction monitoring wells	See decision rules/operational framework in Figure 2.2-7.	Limit decision error through: - Assessment and optimization of extration effectivenss through multiple lines of evidence.	See Section 4
3	East Ravine extraction wells will be operated to remediate hexavalent chromium and control migration towards the river	Should extraction system operations or configuration be changed to optimize hexavalent chromium treament and migration control?	hexavalent chromium analytical data from East Ravine monitoring and extraction wells Water level data from monitoring well network Surface water sampling hexavalent chromium data.	TCS Loop East Ravine extraction monitoring wells	See decision rules/operational framework in Figure 2.2-8.	Limit decision error through: - A multiple lines of evidence evaluation of plume control.	See Section 4

Table 2.1-1
Data Quality Objectives
Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan
Revised Basis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy
PG&E Topock Compressor Station, Needles, California

	1. State the Problem	2. Decision Statements	3. Inputs to the Decision	4. Study Area Boundaries	5. Decision Rules	6. Limits of Decision Errors	7. Optimize the Design for Data Collection
Freshwater Injection							
1	Freshwater injections will be operated to facilitate flushing of the hexavalent chromium plume through the NTH IRZ and to contain carbon-amended water and in-situ by-products from the inner recirculation loop	Should freshwater injection well operations be modified to facilitate flushing of the hexavalent chromium plume and inner recirculation loop carbon-amended injection water?	Water level data from across the site and analytical data from freshwater injection observation wells	Project Area	See decision rules/operational framework in Figure 2.2-9.	Limit decision error through: - Placement of monitoring wells within the plume in locations to collect data on flushing of hexavalent chromium concentration trends. - Sampling collection frequency based on solute transport modeling predictions. - Evaluation of timeframe predictions based on model re-calibrated with installation and operational data.	See Section 4

Table 2.1-2

Monitoring Program Wells and Surface Water Sampling Points

Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan

Revised BEsis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy

PG&E Topock Compressor Station, Needles, California

	Compliance Monitoring			**Process Control Monitoring**														**Analyte Sampling Frequencies**													
	Location relative to Chromium plume			**National Trails Highway In-Situ Reactive Zone**					**Inner Recirculation Loop (IRL)**				**Topock Compressor Station (TCS) Loop**																		
Location ID	Outside Plume	Inside Plume	Surface Water	Dose Response Wells[1]	Downgradient Monitoring Wells	RiverBEnk and Northern NTH Extraction Wells	RiverBEnk Extraction Monitoring Wells	Northern NTH IRZ Extraction Monitoring Wells	Dose Response Wells[1]	Downgradient Monitoring Well	Byproduct Monitoring Well	Water Level Monitoring Well (for IRL and Freshwater Injections)	Dose Response Wells[1]	Downgradient Monitoring Well	Transwestern Bench and East Ravine Extraction Wells	Transwestern Bench Extraction Monitoring Wells	East Ravine Extraction Monitoring Wells	**Hexavalent Chromium**	**Total Chromium**	**Total Organic Carbon**	**Dissolved Arsenic**	**Dissolved Manganese**	**Dissolved Iron**	**Dissolved BErium**	**Nitrate**	**Molyb-denum**	**Selen-ium**	**Sulfate**	**Total Dissolved Solids**	**Alkalinity**	**Cations/ Anions**
Existing Monitoring Wells																															
CW-01D	X											X						A	A												
CW-01M	X											X						A	A												
CW-02D	X										X	X						SA	SA	SA[3]	SA	SA	SA	SA	As needed	A		As needed	As needed	As needed	As needed
CW-02M	X										X	X						SA	SA	SA[3]	SA	SA	SA	SA	As needed			As needed	As needed	As needed	As needed
CW-03D	X										X	X						SA	SA	SA[3]	SA	SA	SA	SA	As needed	A		As needed	As needed	As needed	As needed
CW-03M	X										X	X						SA	SA	SA[3]	SA	SA	SA	SA	As needed	A		As needed	As needed	As needed	As needed
CW-04D	X											X						A	A												
CW-04M	X											X						A	A												
MW-10		X										X						A	A						A	A					
MW-11		X										X						BE	BE												
MW-12		X										X				X		Q	SA						A	A	A				
MW-13	X									X		X						SA	SA		SA	SA	SA	SA[3]	SA			As needed	As needed	As needed	As needed
MW-14	X								X			X						Q	Q (yr), SA	Q[3]	Q	Q	Q	Q	Q[3]			As needed	As needed	As needed	As needed
MW-15	X											X						BE	BE												
MW-19		X										X						BE	BE												
MW-20-070		X		X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q			M(yr), Q	As needed	As needed	As needed
MW-20-100		X		X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q			M(yr), Q	As needed	As needed	As needed
MW-20-130		X		X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	A	A	M(yr), Q	As needed	As needed	As needed
MW-21	X			X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	As needed[2]			M(yr), Q	As needed	As needed	As needed
MW-22					X		X					X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	A	A	A	M(yr), Q	As needed	As needed	As needed
MW-23-060	X											X					X	Q	SA						A	A	A				
MW-23-080	X											X					X	Q	SA						A	A	A				
MW-24A												X													A	A	A				
MW-24B		X										X						BE	BE						A	A	A				
MW-24BR	X											X						Q	Q												
MW-25		X										X						BE	BE												
MW-26		X		X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	A	A	M(yr), Q	As needed	As needed	As needed
MW-27-020	X						X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-27-060	X						X					X						Q	SA	Q	Q	Q	Q	Q	As needed			As needed	As needed	As needed	As needed
MW-27-085	X						X					X						Q	SA	Q	Q	Q	Q	Q	As needed			As needed	As needed	As needed	As needed
MW-28-025	X						X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-28-090	X						X					X						Q	SA	Q	Q	Q	Q	Q	Q	A	A	As needed	As needed	As needed	As needed
MW-29	X						X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-30-030	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-30-050	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-31-060		X										X						BE	BE												
MW-31-135	X											X						BE	BE												
MW-32-020	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-32-035	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-33-040	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed

	Compliance Monitoring			**Process Control Monitoring**														**Analyte Sampling Frequencies**													
	Location relative to Chromium plume			**National Trails Highway In-Situ Reactive Zone**					**Inner Recirculation Loop (IRL)**				**Topock Compressor Station (TCS) Loop**																		
Location ID	Outside Plume	Inside Plume	Surface Water	Dose Response Wells[1]	Downgradient Monitoring Wells	RiverBEnk and Northern NTH Extraction Wells	RiverBEnk Extraction Monitoring Wells	Northern NTH IRZ Extraction Monitoring Wells	Dose Response Wells[1]	Downgradient Monitoring Well	Byproduct Monitoring Well	Water Level Monitoring Well (for IRL and Freshwater Injections)	Dose Response Wells[1]	Downgradient Monitoring Well	Transwestern Bench and East Ravine Extraction Wells	Transwestern Bench Extraction Monitoring Wells	East Ravine Extraction Monitoring Wells	**Hexavalent Chromium**	**Total Chromium**	**Total Organic Carbon**	**Dissolved Arsenic**	**Dissolved Manganese**	**Dissolved Iron**	**Dissolved BErium**	**Nitrate**	**Molyb-denum**	**Selen-ium**	**Sulfate**	**Total Dissolved Solids**	**Alkalinity**	**Cations/ Anions**
MW-33-090	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-33-150	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-33-210	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-34-055	X						X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-34-080	X						X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-34-100		X					X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-35-060	X							X				X						Q	SA						A	A	A	As needed	As needed	As needed	As needed
MW-35-135		X						X				X						Q	SA						A	A	A	As needed	As needed	As needed	As needed
MW-36-020	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-36-040	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-36-050	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-36-070	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-36-090	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-36-100		X			X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-37D		X								X		X						SA	SA		SA	SA	SA	SA[3]	Q	A	A	As needed	As needed	As needed	As needed
MW-37S	X									X		X						SA	SA		SA	SA	SA	SA[3]	Q	A	A	As needed	As needed	As needed	As needed
MW-38D		X										X						BE	BE												
MW-38S		X										X						BE	BE												
MW-39-040	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-39-050	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-39-060	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-39-070	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-39-080	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-39-100		X			X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-40D		X										X						BE	BE												
MW-40S	X											X						BE	BE												
MW-41D	X									X		X						SA	SA		SA	SA	SA	SA[3]	As needed			As needed	As needed	As needed	As needed
MW-41M	X									X		X						SA	SA		SA	SA	SA	SA[3]	Q			As needed	As needed	As needed	As needed
MW-41S	X									X		X						SA	SA		SA	SA	SA	SA[3]	Q			As needed	As needed	As needed	As needed
MW-42-030	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-42-055	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-42-065	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-43-025	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-43-075	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-43-090	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-44-070	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-44-115		X			X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-44-125		X			X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-45-095		X					X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-46-175		X			X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed

Table 2.1-2

Monitoring Program Wells and Surface Water Sampling Points

Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan

Revised BEsis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy

PG&E Topock Compressor Station, Needles, California

	Compliance Monitoring			**Process Control Monitoring**														**Analyte Sampling Frequencies**													
	Location relative to Chromium plume			**National Trails Highway In-Situ Reactive Zone**					**Inner Recirculation Loop (IRL)**				**Topock Compressor Station (TCS) Loop**																		
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MW-46-205	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	A	A	A	As needed	As needed	As needed	As needed
MW-47-055	X			X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q			M(yr), Q	As needed	As needed	As needed
MW-47-115	X			X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q			M(yr), Q	As needed	As needed	As needed
MW-49-135	X						X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-49-275	X						X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
MW-49-365	X						X					X						Q	SA	Q	Q	Q	Q	Q	As needed			As needed	As needed	As needed	As needed
MW-50-095	X											X						SA	A												
MW-50-200		X										X						BE	BE						A	A	A				
MW-51		X		X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	A	A	M(yr), Q	As needed	As needed	As needed
MW-52D	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-52M	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-52S	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-53D	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-53M	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-53S	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed[2]			As needed	As needed	As needed	As needed
MW-54-085	X						X					X						A	A		A	A	A	A	As needed			As needed	As needed	As needed	As needed
MW-54-140	X						X					X						A	A		A	A	A	A	As needed			As needed	As needed	As needed	As needed
MW-54-195	X						X					X						A	A		A	A	A	A	As needed			As needed	As needed	As needed	As needed
MW-55-045	X						X					X						A	A		A	A	A	A	As needed			As needed	As needed	As needed	As needed
MW-55-120	X						X					X						A	A		A	A	A	A	As needed			As needed	As needed	As needed	As needed
MW-56D	X						X					X					X	A	A		A	A	A	A	As needed			As needed	As needed	As needed	As needed
MW-56M	X						X					X					X	A	A		A	A	A	A	As needed			As needed	As needed	As needed	As needed
MW-56S	X						X					X					X	A	A		A	A	A	A	As needed			As needed	As needed	As needed	As needed
MW-57-050		X										X					X	Q	SA												
MW-57-070		X										X					X	Q	SA							A					
MW-57-185	X											X					X	Q	SA							A					
MW-58-065	X											X					X	Q	SA							A					
MW-58-115	X											X					X	Q	SA							A					
MW-58-205	X											X					X	Q	SA							A					
MW-59-100		X										X				X		Q	SA							A					
MW-60-125		X										X						BE	BE							A					
MW-61-110		X										X					X	Q	SA							A					
MW-62-065		X										X					X	Q	SA							A					
MW-62-110		X										X					X	Q	SA							A					
MW-62-190	X											X					X	Q	SA							A					
MW-63-065	X											X					X	Q	SA							A					
MW-64-150	X											X					X	Q	SA							A					
MW-64-205	X											X					X	Q	SA							A					
MW-64-260												X														A					
MW-65-160		X										X						SA	A							A					
MW-65-225		X										X						A	A							A					

Table 2.1-2
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Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan
Revised BEsis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy
PG&E Topock Compressor Station, Needles, California

	Compliance Monitoring			**Process Control Monitoring**														**Analyte Sampling Frequencies**													
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MW-66-165		X										X	X					Q	Q (yr), SA	Q	Q	Q	Q	Q	Q	A		As needed	As needed	As needed	As needed
MW-66-230		X										X	X					Q	Q (yr), SA	Q	Q	Q	Q	Q	Q	A		As needed	As needed	As needed	As needed
MW-66BR-270	X											X						A	A												
MW-67-185		X										X		X		X		Q	SA	SA	SA	SA	SA	SA	SA	A		As needed	As needed	As needed	As needed
MW-67-225		X										X		X		X		Q	SA	SA	SA	SA	SA	SA	SA	A		As needed	As needed	As needed	As needed
MW-67-260		X										X		X		X		SA	SA	SA	SA	SA	SA	SA	SA	A		As needed	As needed	As needed	As needed
MW-68-180		X										X				X		Q	SA							A					
MW-68-240		X										X				X		Q	SA							A					
MW-68BR-280												X				X		Q	SA												
MW-69-195		X										X						BE	BE							A					
MW-70-105	X											X					X	Q	SA							A					
MW-71-35	X			X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	A		M(yr), Q	As needed	As needed	As needed
MW-72-80		X										X					X	Q	SA							A					
MW-73-80		X										X					X	Q	SA							A					
MW-74-240	X											X						A	A							A					
OW-01D	X											X						SA	SA												
OW-01M	X											X						SA	SA												
OW-01S	X											X						SA	SA												
OW-02D	X											X						SA	SA												
OW-02M	X											X						SA	SA												
OW-02S	X											X						SA	SA							A					
OW-05D	X											X						SA	SA												
OW-05M	X											X						SA	SA												
OW-05S	X											X						SA	SA												
PT-5D		X			X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
PT-5M	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
PT-5S	X				X		X					X						Q	SA	Q	Q	Q	Q	Q	As needed			As needed	As needed	As needed	As needed
PT-8D		X										X						BE	BE												
PT-9D		X										X						BE	BE												
PT-9M		X										X						BE	BE												
PT-9S		X										X						BE	BE												

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	Location relative to Chromium plume			**National Trails Highway In-Situ Reactive Zone**					**Inner Recirculation Loop (IRL)**				**Topock Compressor Station (TCS) Loop**																		
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Proposed monitoring Wells																															
A	X							X				X						Q	SA									As needed	As needed	As needed	As needed
B	X							X				X						Q	SA									As needed	As needed	As needed	As needed
C		X		X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	As needed[2]			M(yr), Q	As needed	As needed	As needed
D		X		X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	As needed[2]			M(yr), Q	As needed	As needed	As needed
E		X		X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	As needed[2]			M(yr), Q	As needed	As needed	As needed
F		X		X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	As needed[2]			M(yr), Q	As needed	As needed	As needed
G		X		X								X						M(yr), Q	Q (yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	M(yr), Q	A	A	A	M(yr), Q	As needed	As needed	As needed
H		X			X		X					X						Q	SA	Q	Q	Q	Q	Q	Q			As needed	As needed	As needed	As needed
I	X										X	X						SA	SA	SA[3]	SA	SA	SA	SA	As needed			As needed	As needed	As needed	As needed
J	X										X	X						SA	SA	SA[3]	SA	SA	SA	SA	As needed			As needed	As needed	As needed	As needed
K		X										X				X		Q	SA												
L		X										X						BE	BE												
M		X								X		X						SA	SA		SA	SA	SA	SA[3]	As needed			As needed	As needed	As needed	As needed
N		X										X						BE	BE												
O	X						X					X						Q(yr), SA	Q (yr), SA	Q	Q	Q	Q	Q	As needed			As needed	As needed	As needed	As needed
P	X								X			X						Q	Q (yr), SA	Q[3]	Q	Q	Q	Q	Q[3]			As needed	As needed	As needed	As needed
Q	X								X			X						Q	Q (yr), SA	Q[3]	Q	Q	Q	Q	Q[3]			As needed	As needed	As needed	As needed
R		X								X		X						SA	SA		SA	SA	SA	SA[3]	As needed			As needed	As needed	As needed	As needed
S	X											X						A	A												
Extraction Wells																															
IRZ-1						X												M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
IRZ-5						X												M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
IRZ-9						X												M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
IRZ-23						X												M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
RB-1						X												M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
RB-2						X												M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
RB-3						X												M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
RB-4						X												M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
RB-5						X												M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
TWB-1															X			M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
TWB-2															X			M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
ER-1															X			M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
ER-2															X			M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
ER-3															X			M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
ER-4															X			M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed
ER-6															X			M(Q), Q		M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q	M(Q), Q					As needed	As needed	As needed

Table 2.1-2

Monitoring Program Wells and Surface Water Sampling Points

Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan

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Surface Water Sampling Locations																															
C-NR4 (River channel)			X				X											Q	SA		Q	Q			A	A	A				
C-NR3 (River channel)			X				X											Q	SA		Q	Q			A	A	A				
C-NR1 (River channel)			X				X											Q	SA		Q	Q			A	A	A				
C-CON (River channel)			X				X											Q	SA		Q	Q			A	A	A				
C-MAR (River channel)			X				X											Q	SA		Q	Q			A	A	A				
C-R27 (River channel)			X				X											Q	SA		Q	Q			A	A	A				
C-BNS (River channel)			X				X											Q	SA		Q	Q			A	A	A				
C-R-22A (River channel)			X				X										X	Q	SA		Q	Q			A	A	A				
C-I-3 (River channel)			X				X										X	Q	SA		Q	Q			A	A	A				
C-TAZ (River channel)			X				X										X	Q	SA		Q	Q			A	A	A				
RBB (Shoreline)			X				X											Q	SA		Q	Q			A	A	A				
R-19 (Shoreline)			X				X											Q	SA		Q	Q			A	A	A				
R-28 (Shoreline)			X				X											Q	SA		Q	Q			A	A	A				
R-63 (Shoreline)			X				X										X	Q	SA		Q	Q			A	A	A				
SW-1 (East Ravine)			X				X										X	Q	SA		Q	Q			A	A	A				
SW-2 (East Ravine)			X				X										X	Q	SA		Q	Q			A	A	A				

Notes:

Sampling program will be re-evaluated after two years of operation.

[1] Dose Response Wells are defined as within the carbon footprint as predicted by the fate and transport model.

2 BEseline data inidicates no detectable nitrate.

[3] If associated injection well is amended with carbon

Frequencies:

T: Potentially monitored continuously via transducer

M: Monthly

Q: Quarterly

SA: Semi-Annually

A: Annually

BE: Biennially

(yr): Frequency for the first year/month/quarter, frequency reduction to be considered thereafter

Table 2.1-3

Compliance Monitoring Program

Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan[1]

Revised Basis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy

PG&E Topock Compressor Station, Needles, California

Well ID	Process Control Monitoring Well Category	Currently-Anticipated Timeframe for Cr(VI) Concentration Changes[2]	Analyte Sampling Frequencies[3]			
			Cr(VI)	Cr(T)	Dissolved Byproducts	Water Levels
Compliance Monitoring Wells: Outside Plume						
A	Northern NTH Extraction	---	Q	SA	---	Q
B	Northern NTH Extraction	---	Q	SA	---	Q
I	IRL By-Product	---	SA	SA	SA (Mn, As)	Q
J	IRL By-Product	---	SA	SA	SA (Mn, As)	Q
O	Riverbank Extraction	---	Q(yr), SA	Q(yr), SA	Q(yr), SA (Mn, As)	Q
P	IRL Dose Response	---	Q	Q(yr), SA	---	Q
Q	IRL Dose Response	---	Q	Q(yr), SA	---	Q
S	Water Level Monitoring	---	A[4]	A[4]	---	Q
CW-01D	Water Level Monitoring	---	A[4]	A[4]	---	Q
CW-01M	Water Level Monitoring	---	A[4]	A[4]	---	Q
CW-02D	IRL By-Product	---	SA[4]	SA[4]	SA (Mn, As)	Q
CW-02M	IRL By-Product	---	SA[4]	SA[4]	SA (Mn, As)	Q
CW-03D	IRL By-Product	---	SA[4]	SA[4]	SA (Mn, As)	Q
CW-03M	IRL By-Product	---	SA[4]	SA[4]	SA (Mn, As)	Q
CW-04D	Water Level Monitoring	---	A[4]	A[4]	---	Q
CW-04M	Water Level Monitoring	---	A[4]	A[4]	---	Q
MW-13	IRL Downgradient	---	SA	SA	---	Q
MW-14	IRL Dose Response	---	Q	Q(yr), SA	---	Q
MW-15	Water Level Monitoring	---	BE[5]	BE[5]	---	Q
MW-21	NTH IRZ Dose Response	---	M(yr), Q	Q(yr), SA	---	Q
MW-23-060	East Ravine Extraction	---	Q	SA	---	Q
MW-23-080	East Ravine Extraction	---	Q	SA	---	Q
MW-24BR	Water Level Monitoring	---	Q[5]	Q[5]	---	Q
MW-27-020	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
MW-27-060	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
MW-27-085	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
MW-28-025	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
MW-28-090	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
MW-29	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
MW-30-030	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-30-050	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-31-135	Water Level Monitoring	---	BE[7]	BE[7]	---	Q
MW-32-20	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-32-35	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-33-040	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-33-090	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-33-150	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-33-210	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-34-055	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
MW-34-080	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
MW-35-60	Northern NTH Extraction	---	Q	SA	---	Q
MW-36-020	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-36-040	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-36-050	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-36-070	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-36-090	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-37S	IRL Downgradient	---	SA	SA	---	Q
MW-39-040	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-39-050	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-39-060	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-39-070	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-39-080	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-40S	Water Level Monitoring	---	BE[5]	BE[5]	---	Q
MW-41D	IRL Downgradient	---	SA	SA	---	Q
MW-41M	IRL Downgradient	---	SA	SA	---	Q
MW-41S	IRL Downgradient	---	SA	SA	---	Q
MW-42-030	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-42-055	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-42-065	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-43-025	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-43-075	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-43-090	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-44-070	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-46-205	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-47-055	NTH IRZ Dose Response	---	M(yr), Q	Q(yr), SA	---	Q
MW-47-115	NTH IRZ Dose Response	---	M(yr), Q	Q(yr), SA	---	Q
MW-49-135	Riverbank Extraction	---	Q	SA	Q(yr), SA (Mn, As)	Q
MW-49-275	Riverbank Extraction	---	Q	SA	Q(yr), SA (Mn, As)	Q
MW-49-365	Riverbank Extraction	---	Q	SA	Q(yr), SA (Mn, As)	Q
MW-50-095	Water Level Monitoring	---	SA[5]	A[5]	---	Q
MW-52D	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-52M	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-52S	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-53D	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-53M	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q

Well ID	Process Control Monitoring Well Category	Currently-Anticipated Timeframe for Cr(VI) Concentration Changes[2]	Analyte Sampling Frequencies[3]			
			Cr(VI)	Cr(T)	Dissolved Byproducts	Water Levels
MW-53S	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
MW-54-085	Riverbank Extraction	---	A	A	Q(yr), SA (Mn, As)	Q
MW-54-140	Riverbank Extraction	---	A	A	Q(yr), SA (Mn, As)	Q
MW-54-195	Riverbank Extraction	---	A	A	Q(yr), SA (Mn, As)	Q
MW-55-045	Riverbank Extraction	---	A	A	Q(yr), SA (Mn, As)	Q
MW-55-120	Riverbank Extraction	---	A	A	Q(yr), SA (Mn, As)	Q
MW-56D	Riverbank and ER Extraction	---	A	A	Q(yr), SA (Mn, As)	Q
MW-56M	Riverbank and ER Extraction	---	A	A	Q(yr), SA (Mn, As)	Q
MW-56S	Riverbank and ER Extraction	---	A	A	Q(yr), SA (Mn, As)	Q
MW-57-185	TWB and ER Extraction	---	Q	SA	---	Q
MW-58-065	ER Extraction	---	Q	SA	---	Q
MW-58-115	ER Extraction	---	Q	SA	---	Q
MW-58-205	ER Extraction	---	Q	SA	---	Q
MW-63-065	East Ravine Extraction	---	Q	SA	---	Q
MW-66BR-270	Water Level Monitoring	---	A[6]	A[6]	---	Q
MW-70-105	ER Extraction	---	Q	SA	---	Q
MW-71-35	NTH IRZ Dose Response	---	M(yr), Q	Q(yr), SA	---	Q
MW-74-240	Water Level Monitoring	---	A[6]	A[6]	---	Q
OW-01D	Water Level Monitoring	---	SA[4]	SA[4]	---	Q
OW-01M	Water Level Monitoring	---	SA[4]	SA[4]	---	Q
OW-01S	Water Level Monitoring	---	SA[4]	SA[4]	---	Q
OW-02D	Water Level Monitoring	---	SA[4]	SA[4]	---	Q
OW-02M	Water Level Monitoring	---	SA[4]	SA[4]	---	Q
OW-02S	Water Level Monitoring	---	SA[4]	SA[4]	---	Q
OW-05D	Water Level Monitoring	---	SA[4]	SA[4]	---	Q
OW-05M	Water Level Monitoring	---	SA[4]	SA[4]	---	Q
OW-05S	Water Level Monitoring	---	SA[4]	SA[4]	---	Q
PT-5M	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
PT-5S	NTH IRZ Downgradient	---	Q	SA	Q (Mn, As)	Q
Compliance Monitoring Wells: Inside Plume						
C	NTH IRZ Dose Response	< 6 months	M(yr), Q	Q(yr), SA	---	Q
D	NTH IRZ Dose Response	< 6 months	M(yr), Q	Q(yr), SA	---	Q
E	NTH IRZ Dose Response	< 6 months	M(yr), Q	Q(yr), SA	---	Q
F	NTH IRZ Dose Response	< 6 months	M(yr), Q	Q(yr), SA	---	Q
G	NTH IRZ Dose Response	< 6 months	M(yr), Q	Q(yr), SA	---	Q
H	NTH IRZ Downgradient	< 6 months	Q	SA	---	Q
K	TWB Extraction	20-30 years	Q	SA	---	Q
L	Water Level Monitoring	20-30 years	BE[7]	BE[7]	---	Q
M	IRL Downgradient	10-20 years	SA	SA	---	Q
N	Water Level Monitoring	~ 30 years	BE[7]	BE[7]	---	Q
R	IRL Downgradient	0.5-2 years	SA	SA	---	Q
MW-10	Water Level Monitoring	2-10 years	A[7]	A[7]	---	Q
MW-11	Water Level Monitoring	10-20 years	BE[7]	BE[7]	---	Q
MW-12	TWB Extraction	20-30 years	Q	SA	---	Q
MW-19	Water Level Monitoring	10-20 years	BE[7]	BE[7]	---	Q
MW-20-070	NTH IRZ Dose Response	< 6 months	M(yr), Q	SA	---	Q
MW-20-100	NTH IRZ Dose Response	< 6 months	M(yr), Q	SA	---	Q
MW-20-130	NTH IRZ Dose Response	< 6 months	M(yr), Q	SA	---	Q
MW-24B	Water Level Monitoring	20-30 years	BE[7]	BE[7]	---	Q
MW-25	Water Level Monitoring	20-30 years	BE[7]	BE[7]	---	Q
MW-26	NTH IRZ Dose Response	< 6 months	M(yr), Q	Q(yr), SA	---	Q
MW-31-060	Water Level Monitoring	20-30 years	BE[7]	BE[7]	---	Q
MW-34-100	Riverbank Extraction	20-30 years	Q	SA	---	Q
MW-35-135	Northern NTH Extraction	2-10 years	Q	SA	---	Q
MW-36-100	NTH IRZ Downgradient	2-10 years	Q	SA	---	Q
MW-37D	IRL Downgradient	2-10 years	SA	SA	---	Q
MW-38D	Water Level Monitoring	10-20 years	BE[7]	BE[7]	---	Q
MW-38S	Water Level Monitoring	10-20 years	BE[7]	BE[7]	---	Q
MW-39-100	NTH IRZ Downgradient	2-10 years	Q	SA	---	Q
MW-40D	Water Level Monitoring	10-20 years	BE[7]	BE[7]	---	Q
MW-44-115	NTH IRZ Downgradient	2-10 years	Q	SA	---	Q
MW-44-125	NTH IRZ Downgradient	2-10 years	Q	SA	---	Q
MW-45-095	Riverbank Extraction	2-10 years	Q	SA	---	Q
MW-46-175	NTH IRZ Downgradient	2-10 years	Q	SA	---	Q
MW-50-200	Water Level Monitoring	20-30 years	BE[7]	BE[7]	---	Q
MW-51	NTH IRZ Dose Response	< 6 months	M(yr), Q	Q(yr), SA	---	Q
MW-57-050	TWB and ER Extraction	~ 30 years	Q	SA	---	Q
MW-57-070	TWB and ER Extraction	~ 30 years	Q	SA	---	Q
MW-59-100	TWB Extraction	~ 30 years	Q	SA	---	Q
MW-60-125	Water Level Monitoring	~ 30 years	BE[7]	BE[7]	---	Q
MW-61-110	East Ravine Extraction	~ 30 years	Q	SA	---	Q
MW-62-065	East Ravine Extraction	~ 30 years	Q	SA	---	Q
MW-62-110	East Ravine Extraction	~ 30 years	Q	SA	---	Q
MW-65-160	Water Level Monitoring	0.5-2 years	SA[4]	A[4]	---	Q
MW-65-225	Water Level Monitoring	2-10 years	A[4]	A[4]	---	Q
MW-66-165	TCS Dose Response	< 6 months	Q	Q(yr), SA	---	Q

Table 2.1-3
Compliance Monitoring Program
Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan[1]
Revised Basis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy
PG&E Topock Compressor Station, Needles, California

Well ID	Process Control Monitoring Well Category	Currently-Anticipated Timeframe for Cr(VI) Concentration Changes[2]	Analyte Sampling Frequencies[3]			
			Cr(VI)	Cr(T)	Dissolved Byproducts	Water Levels
MW-66-230	TCS Dose Response	< 6 months	Q	Q(yr), SA	---	Q
MW-67-185	TCS Downgradient and TWB Extraction	2-10 years	Q	SA	---	Q
MW-67-225	TCS Downgradient and TWB Extraction	2-10 years	Q	SA	---	Q
MW-67-260	TCS Downgradient and TWB Extraction	2-10 years	Q	SA	---	Q
MW-68-180	TWB Extraction	10-20 years	Q	SA	---	Q
MW-68-240	TWB Extraction	10-20 years	Q	SA	---	Q
MW-69-195	Water Level Monitoring	10-20 years	BE[7]	BE[7]	---	Q
MW-72-80	East Ravine Extraction	10-20 years	Q	SA	---	Q
MW-73-80	East Ravine Extraction	2-10 years	Q	SA	---	Q
PT-5D	NTH IRZ Downgradient	2-10 years	Q	SA	---	Q
PT-8D	Water Level Monitoring	20-30 years	BE[7]	BE[7]	---	Q
PT-9D	Water Level Monitoring	~ 30 years	BE[7]	BE[7]	---	Q
PT-9M	Water Level Monitoring	~ 30 years	BE[7]	BE[7]	---	Q
PT-9S	Water Level Monitoring	20-30 years	BE[7]	BE[7]	---	Q
Surface Water Monitoring Locations						
C-NR4 (River channel)	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
C-NR3 (River channel)	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
C-NR1 (River channel)	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
C-CON (River channel)	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
C-MAR (River channel)	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
C-R27 (River channel)	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
C-BNS (River channel)	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
C-R-22A (River channel)	Riverbank and ER Extraction	---	Q	SA	Q (Mn, As)	Q
C-I-3 (River channel)	Riverbank and ER Extraction	---	Q	SA	Q (Mn, As)	Q
C-TAZ (River channel)	Riverbank and ER Extraction	---	Q	SA	Q (Mn, As)	Q
RBB (Shoreline)	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
R-19 (Shoreline)	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
R-28 (Shoreline)	Riverbank Extraction	---	Q	SA	Q (Mn, As)	Q
R-63 (Shoreline)	Riverbank and ER Extraction	---	Q	SA	Q (Mn, As)	Q
SW-1 (East Ravine)	Riverbank and ER Extraction	---	Q	SA	Q (Mn, As)	Q
SW-2 (East Ravine)	Riverbank and ER Extraction	---	Q	SA	Q (Mn, As)	Q

Notes:
[1] Sampling program will be re-evaluated after two years of operation.
[2] Timeframes are based on nominal baseline values and current solute transport model predictions. These estimates may be updated as the system is installed and baseline sampling is conducted, and continually adjusted during the remedy as the solute transport model is refined. The basis for these ranges and maximum thresholds are described in the text.

[3] Unless otherwise indicated, sampling frequencies are based on the Process Control Monitoring Program sampling frequencies.
[4] Based on Process Control Monitoring Program sampling frequency for analytes other than Cr(VI) and Cr(T).
[5] Based on current sampling frequency
[6] Not regularly sampled currently and not in Process Control Monitoring Program for sample collection.
[7] Based on anticipated treatment timeframe

Frequencies:
T: Potentially monitored continuously via transducer
M: Monthly
Q: Quarterly
SA: Semi-Annually
A: Annually
BE: Biennially
(yr): Frequency for the first year

Analytes:
Cr(VI): Chromium (VI)
Cr(T): Total dissolved chromium
Mn: Manganese
As: Arsenic

Abbreviations

ER	East Ravine
IRL	Inner Recirculation Loop
IRZ	In-situ Reactive Zone
NTH	National Trails Highway
TCS	Topock Compressor Station

Table 2.2-1
Process Control Monitoring Program Anticipated Concentration Ranges and Timeframes
Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan
Revised Basis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy
PG&E Topock Compressor Station, Needles, California

	Currently-Anticipated Concentration Range/Trend (Maximum) [1,2]				Currently-Anticipated Cr(VI) Attenuation Timeframe [1]	Currently-Anticipated Byproduct Arrival Timeframe [1]
	Total Organic Carbon (ppm)	Dissolved Manganese (ppm)	Dissolved Iron (ppm)	Dissolved Arsenic (ppb)		
National Trails Highway In-Situ Reactive Zone						
Dose Response Monitoring Wells	15 - 50 [3]	1 - 2.5 (5)	1 - 2.5 (5)	2 - 10 (15)	< 6 months	< 6 months
Downgradient NTH IRZ Monitoring Wells	0.5 - 15	1 - 2.5 (5)	1 - 2.5 (5)	2 - 10 (15)	2-10 years	2-10 years[4]
Riverbank Extraction Monitoring Wells	0.5 - 10	0.1 - 2 (3)	0.1 - 2 (3)	2 - 5 (8)	---	10 - 30 years [5]
Northern Extraction Monitoring Wells	N/A	N/A	N/A	N/A	---	No anticipated change
Inner Recirculation Loop						
Dose Response Wells	0 - 50	1 - 2.5 (5)	1 - 2.5 (5)	1 - 16 (20)	---	< 6 months
Downgradient Wells	0.5 - 2.0	0.1 - 1 (3)	0.1 - 1 (3)	2 - 4 (5)	< 10 years	2-10 years
Byproduct Monitoring Wells	N/A	< 0.5 (1.3)	< 0.5 (1.3)	2 - 4 (5)	---	No anticipated change
Topock Compressor Station Recirculation Loop						
TCS Loop Injection Dose Response Wells	50 - 1000	1 - 2.5 (5)	1 - 2.5 (5)	1 - 10 (15)	< 6 months	< 6 months
TCS Loop Injection Downgradient Wells	1 - 25	0.1 - 2 (3)	0.1 - 2 (3)	2 - 4 (5)	2 - 10 years	2-10 years
Transwestern Bench Extraction Monitoring Wells	N/A	N/A	N/A	N/A	2 - 30 years	---
East Ravine Extraction Monitoring Wells	N/A	N/A	N/A	N/A	< 30 years	---

Notes:

[1] Concentration ranges and arrival/attenuation timeframes are based on nominal baseline values and current solute transport model predictions. These estimates may be updated as the system is installed and baseline sampling is conducted, and continually adjusted during the remedy as the solute transport model is refined. The basis for these ranges and maximum thresholds are described in the text.

[2] Concentration ranges and maximum thresholds do not apply to individual wells that already exhibit natural baseline levels above the given ranges/thresholds.

[3] Total organic carbon concentration range applies to dose response wells midway between injection points. Higher concentrations are anticipated in the immediate vicinity of injection wells depending on injection concentrations.

[4] Greater than 10 year byproduct arrival time expected for more distant wells, such as MW-43, MW-52, and MW-53.

[5] Range does not apply to Arizona wells MW-54, MW-55, and MW-56, which are not anticipated to receive byproducts.

Abbreviations

<	less than
Cr(VI)	hexavalent chromium
ppb	parts per billion
ppm	parts per million
N/A	not applicable

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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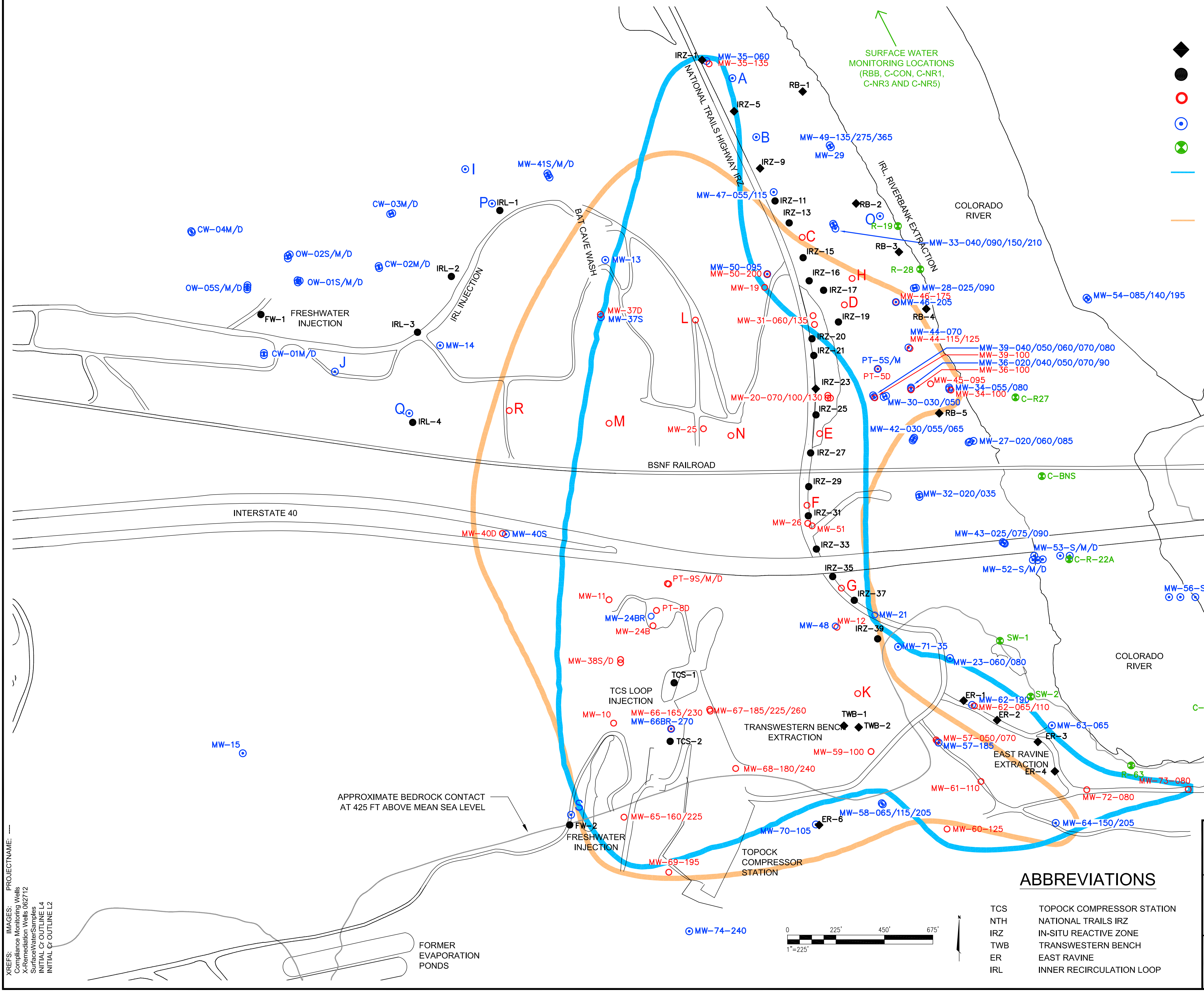
X-Remediation Wells 062712
SurfaceWaterSamples
INITIAL Cr OUTLINE L4
INITIAL Cr OUTLINE L2



LEGEND

◆ REMEDIATION WELL (EXTRACTION)

● REMEDIATION WELL (INJECTION)

○ COMPLIANCE MONITORING WELL: INSIDE PLUME

⊙ COMPLIANCE MONITORING WELL: OUTSIDE PLUME

⊗ SURFACE WATER SAMPLE LOCATIONS

— APPROXIMATE OUTLINE OF HEXAVALENT CHROMIUM CONCENTRATIONS GREATER THAN 32 MICROGRAMS PER LITER BASED ON FIRST QUARTER 2012 DATA, MODEL LAYER 2

— APPROXIMATE OUTLINE OF HEXAVALENT CHROMIUM CONCENTRATIONS GREATER THAN 32 MICROGRAMS PER LITER BASED ON FIRST QUARTER 2012 DATA, MODEL LAYER 4

ABBREVIATIONS

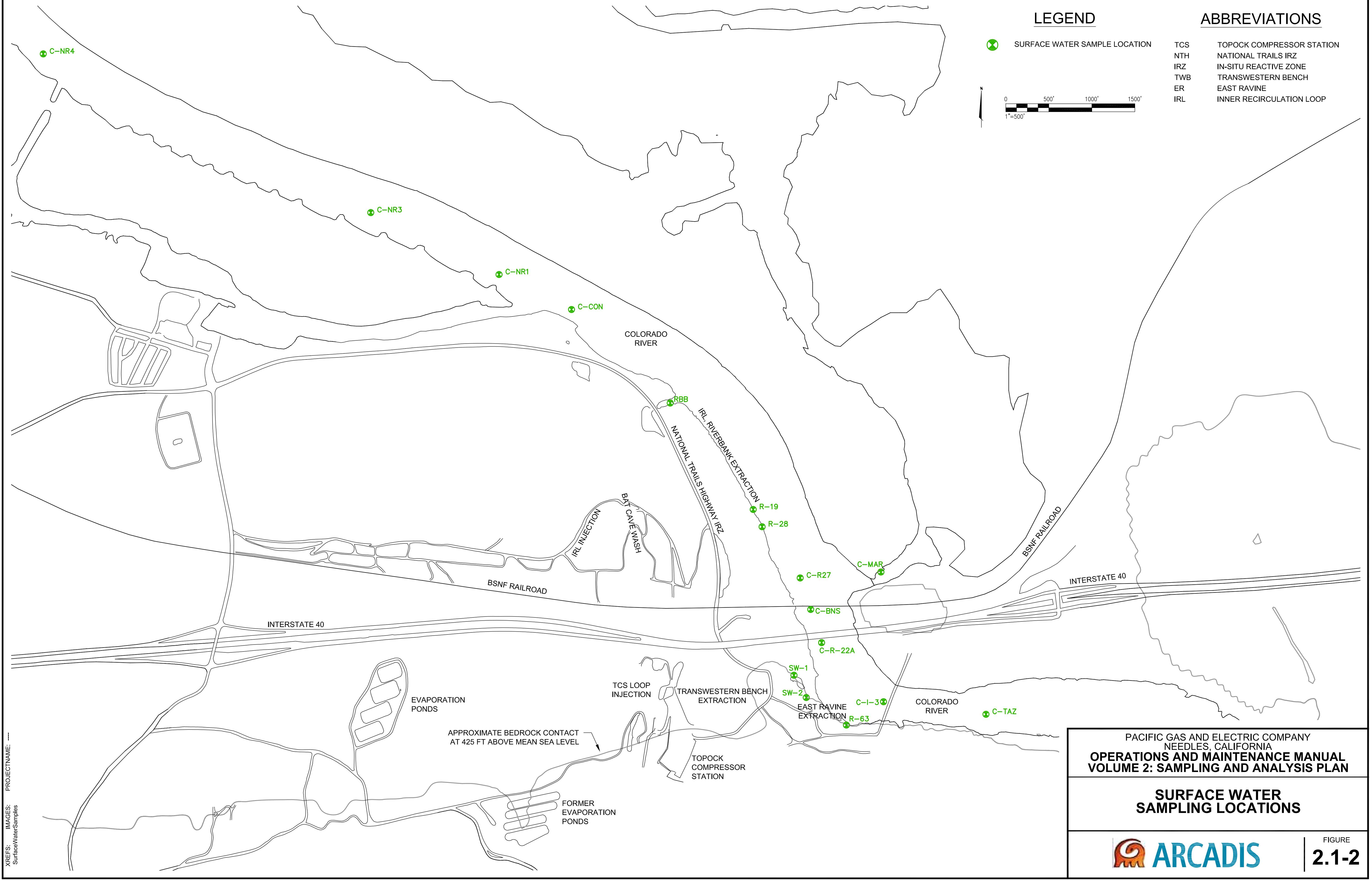
TCS	TOPOCK COMPRESSOR STATION
NTH	NATIONAL TRAILS IRZ
IRZ	IN-SITU REACTIVE ZONE
TWB	TRANSWESTERN BENCH
ER	EAST RAVINE
IRL	INNER RECIRCULATION LOOP

PACIFIC GAS AND ELECTRIC COMPANY
NEEDLES, CALIFORNIA
OPERATIONS AND MAINTENANCE MANUAL
VOLUME 2: SAMPLING AND ANALYSIS PLAN

COMPLIANCE MONITORING NETWORK

ARCADIS

FIGURE
2.1-1



LEGEND

● SURFACE WATER SAMPLE LOCATION

ABBREVIATIONS

TCS	TOPOCK COMPRESSOR STATION
NTH	NATIONAL TRAILS IRZ
IRZ	IN-SITU REACTIVE ZONE
TWB	TRANSWESTERN BENCH
ER	EAST RAVINE
IRL	INNER RECIRCULATION LOOP

PACIFIC GAS AND ELECTRIC COMPANY
NEEDLES, CALIFORNIA

OPERATIONS AND MAINTENANCE MANUAL
VOLUME 2: SAMPLING AND ANALYSIS PLAN

SURFACE WATER SAMPLING LOCATIONS

ARCADIS

FIGURE
2.1-2

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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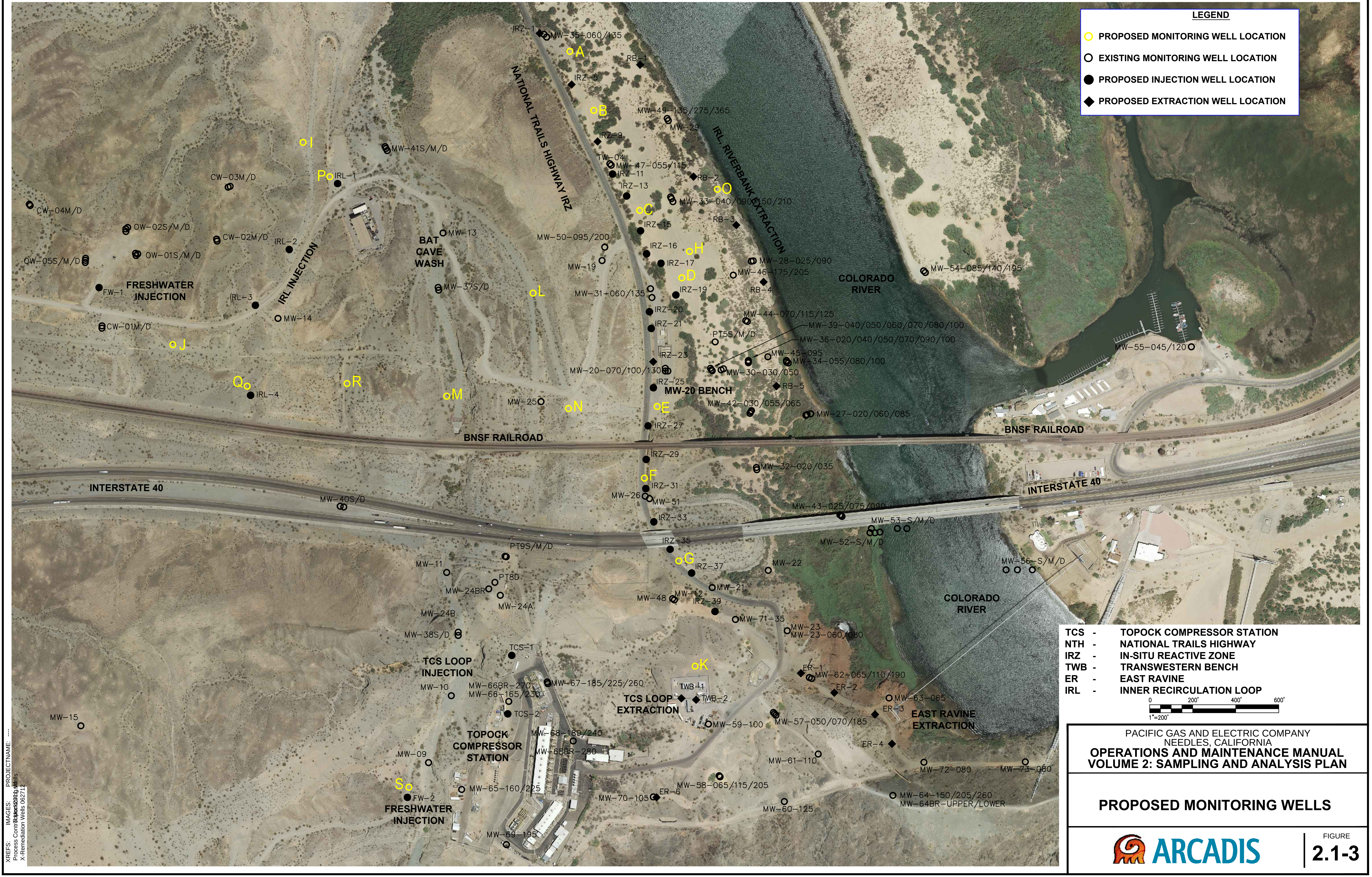
SurfaceWaterSamples



LEGEND

○ PROPOSED MONITORING WELL LOCATION

○ EXISTING MONITORING WELL LOCATION

● PROPOSED INJECTION WELL LOCATION

◆ PROPOSED EXTRACTION WELL LOCATION

TCS	-	TOPOCK COMPRESSOR STATION
NTH	-	NATIONAL TRAILS HIGHWAY
IRZ	-	IN-SITU REACTIVE ZONE
TWB	-	TRANSWESTERN BENCH
ER	-	EAST RAVINE
IRL	-	INNER RECIRCULATION LOOP

PACIFIC GAS AND ELECTRIC COMPANY
NEEDLES, CALIFORNIA

OPERATIONS AND MAINTENANCE MANUAL
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PROPOSED MONITORING WELLS

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FIGURE
2.1-3

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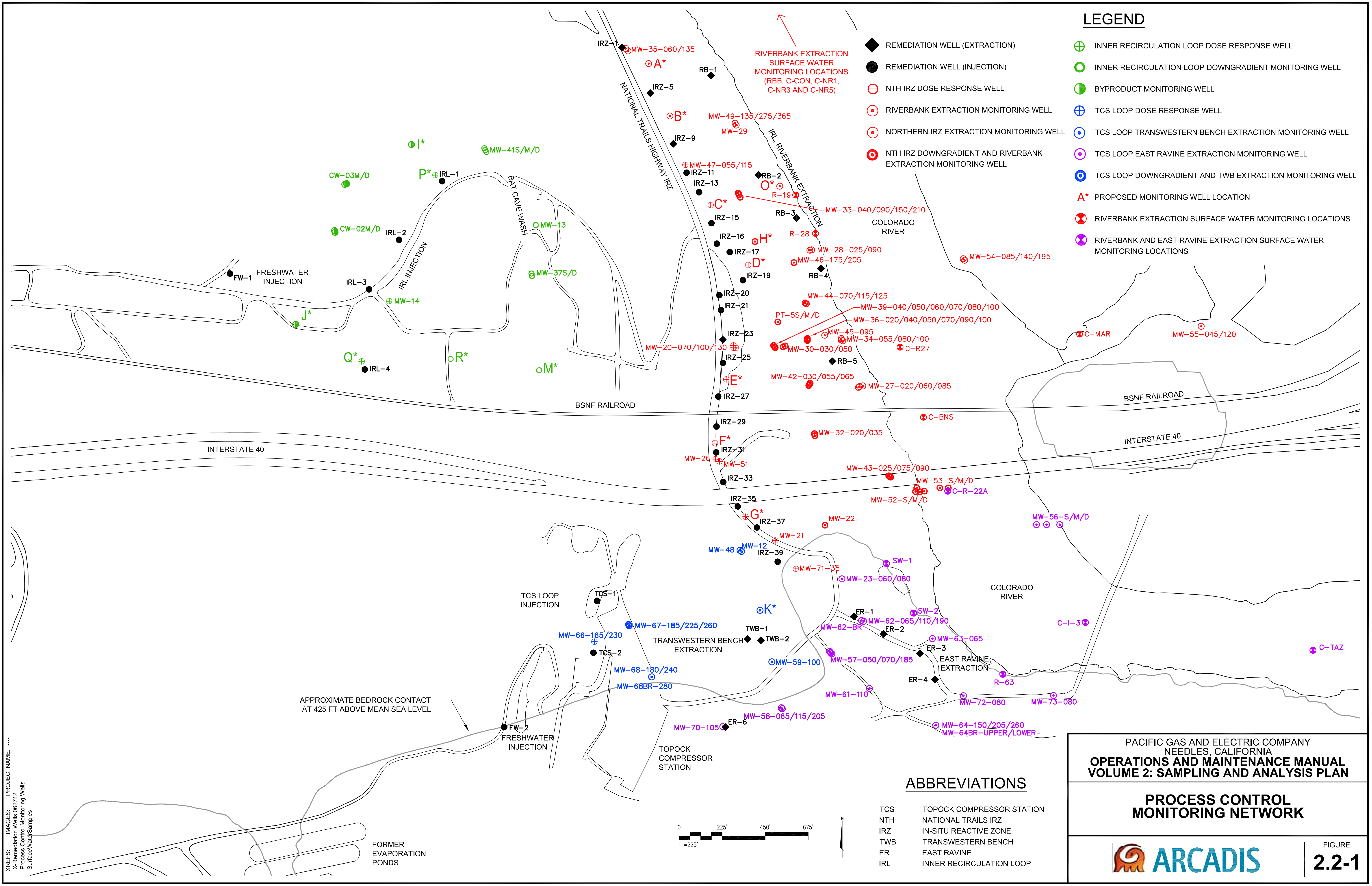
X-Remediation Wells 062712
Process Control Monitoring Wells
SurfaceWaterSamples



ABBREVIATIONS

TCS	TOPOCK COMPRESSOR STATION
NTH	NATIONAL TRAILS IRZ
IRZ	IN-SITU REACTIVE ZONE
TWB	TRANSWESTERN BENCH
ER	EAST RAVINE
IRL	INNER RECIRCULATION LOOP

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PROCESS CONTROL MONITORING NETWORK

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FIGURE
2.2-1

Figure 2.2-2. NTH IRZ Injection Decision Rules/Operational Framework

Notes:
1. See Figure 2.2-3 for Northern NTH IRZ Extraction Decision Rules/Operational Framework
2. The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.

Acronyms and Abbreviations:
Cr(VI)- hexavalent chromium
Fe(II)- ferrous iron (measured as dissolved iron)
IRZ - in-situ reductive zone
NTH - National Trails Highway
ppb - parts per billion
TOC - total organic carbon

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PG&E TOPOCK COMPRESSOR STATION
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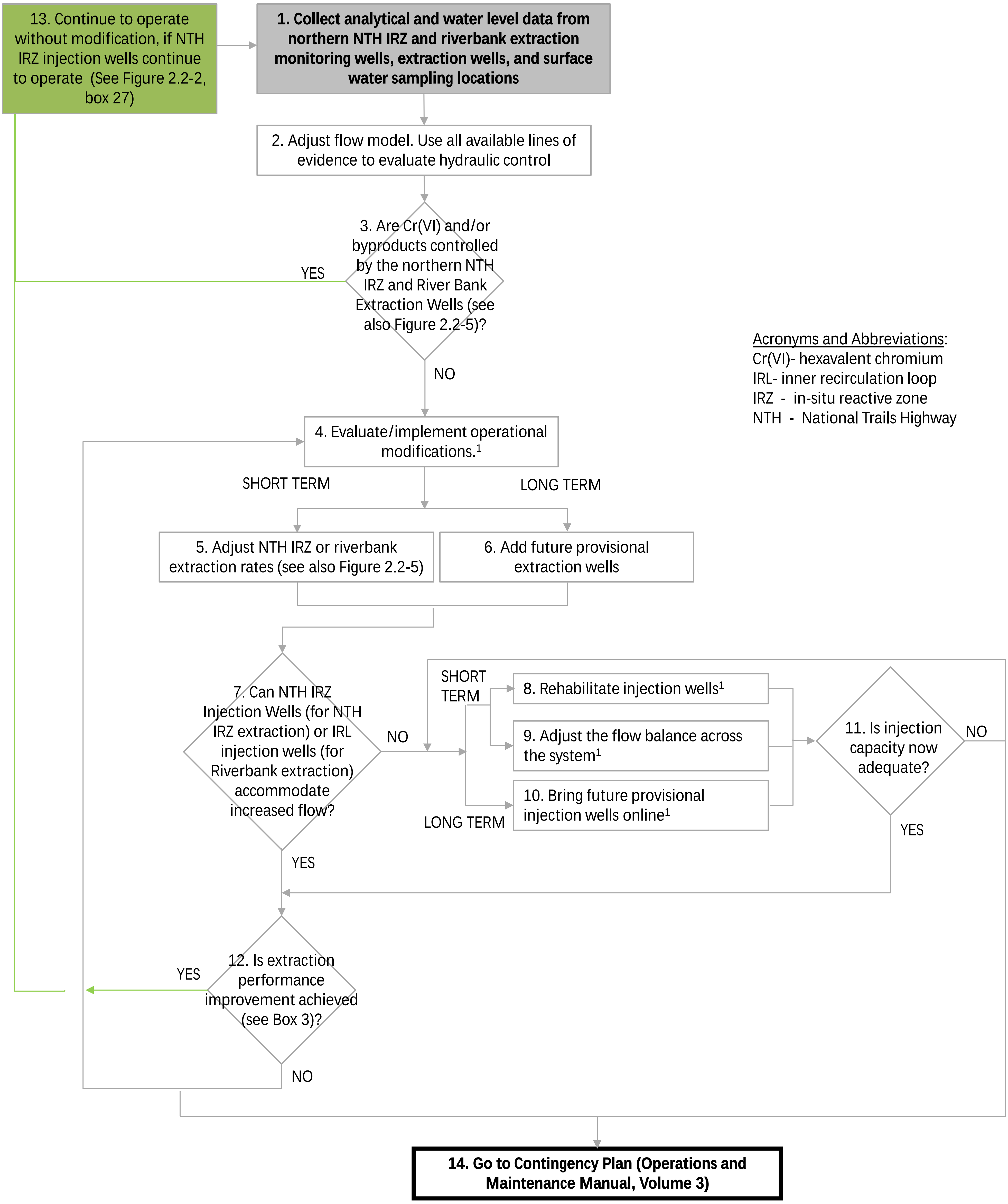

Acronyms and Abbreviations:
Cr(VI)- hexavalent chromium
IRL- inner recirculation loop
IRZ - in-situ reactive zone
NTH - National Trails Highway

Figure 2.2-3. Northern NTH IRZ Extraction Rules/Operational Framework

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Notes:
1.The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.

Notes:
1. The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.

Acronyms and Abbreviations:
Cr(VI)- hexavalent chromium
IRL - Inner Recirculation Loop
ppb - parts per billion
TOC - total organic carbon

Figure 2.2-4. Inner Recirculation Loop Injection Decision Rules/Operational Framework

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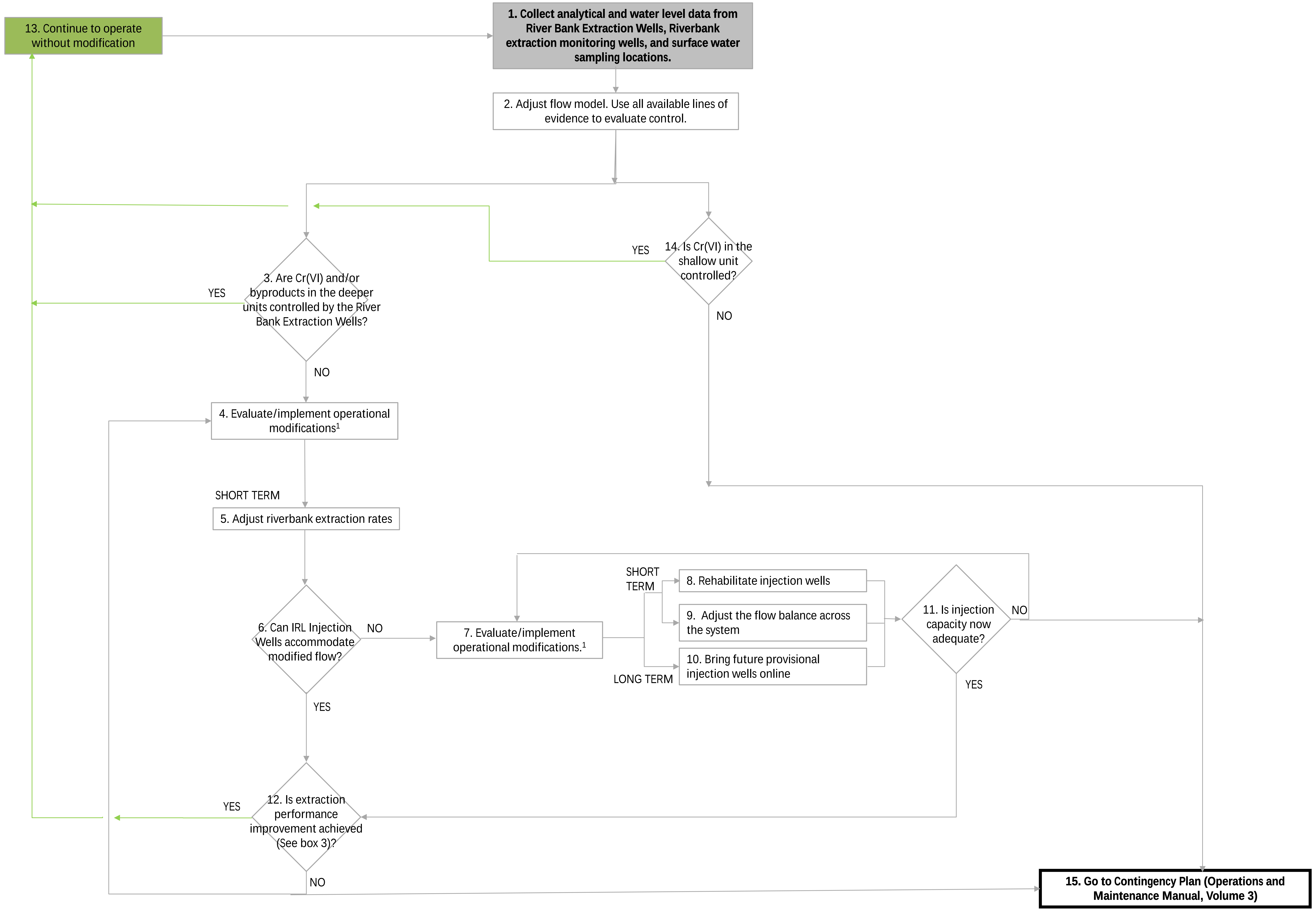
1. Collect analytical and water level data from River Bank Extraction Wells, Riverbank extraction monitoring wells, and surface water sampling locations.

2. Adjust flow model. Use all available lines of evidence to evaluate control.

3. Are Cr(VI) and/or byproducts in the deeper units controlled by the River Bank Extraction Wells?

YES

NO

4. Evaluate/implement operational modifications[1]

SHORT TERM

5. Adjust riverbank extraction rates

6. Can IRL Injection Wells accommodate modified flow?

NO

YES

7. Evaluate/implement operational modifications.[1]

SHORT TERM

8. Rehabilitate injection wells

9. Adjust the flow balance across the system

LONG TERM

10. Bring future provisional injection wells online

11. Is injection capacity now adequate?

NO

YES

12. Is extraction performance improvement achieved (See box 3)?

YES

NO

13. Continue to operate without modification

14. Is Cr(VI) in the shallow unit controlled?

YES

NO

15. Go to Contingency Plan (Operations and Maintenance Manual, Volume 3)

Notes:
1. The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.

Acronyms and Abbreviations:
Cr(VI)- hexavalent chromium
IRL - Inner Recirculation Loop

Figure 2.2-5. Inner Recirculation Loop Extraction Decision Rules/Operational Framework

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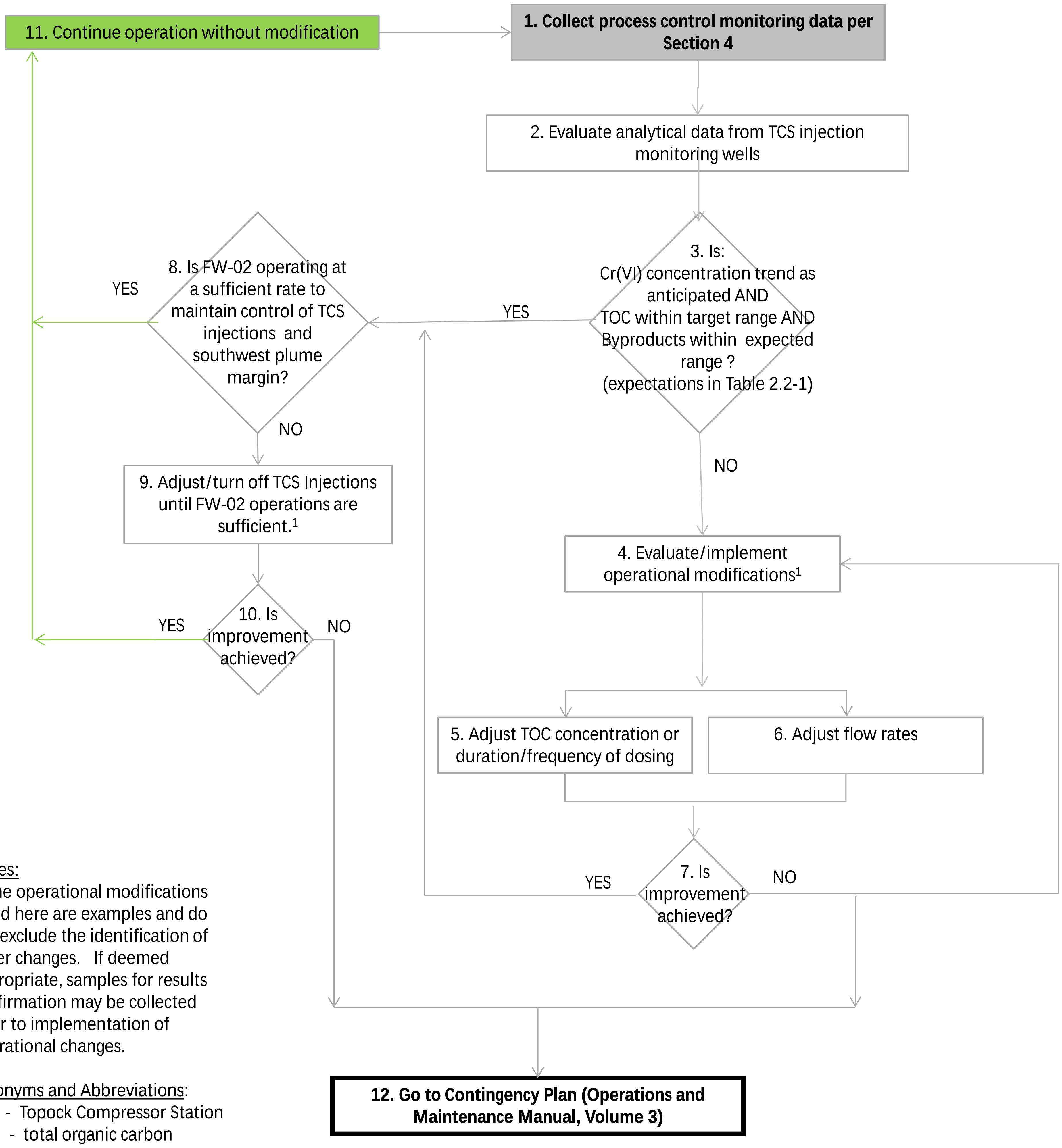

Notes:

1.The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.

Acronyms and Abbreviations:

TCS - Topock Compressor Station

TOC - total organic carbon

Figure 2.2-6. TCS Recirculation Loop Injection Decision Rules/Operational Framework

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PG&E TOPOCK COMPRESSOR STATION
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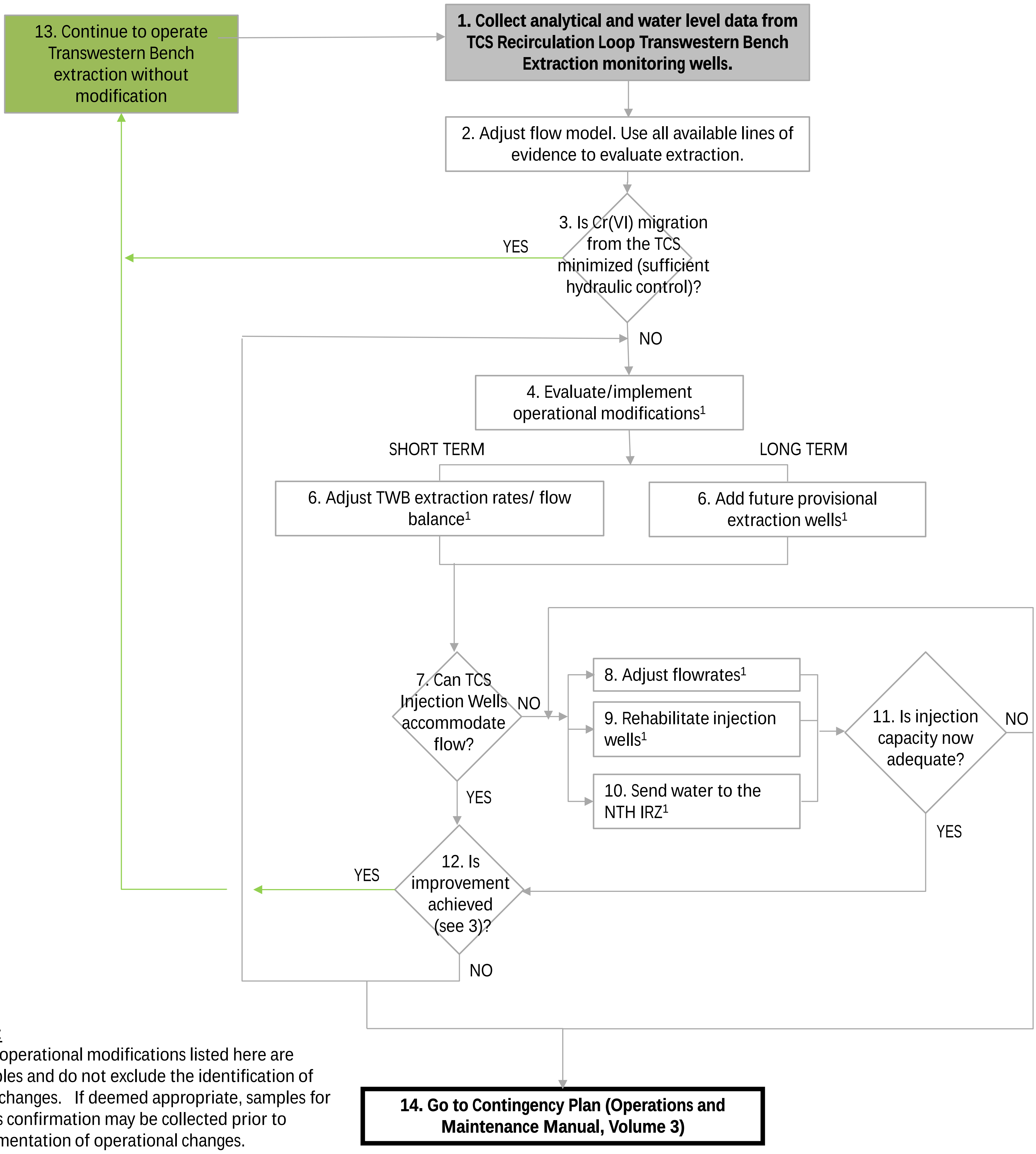

Notes:
1.The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.

Figure 2.2-7. TCS Recirculation Loop Transwestern Bench Extraction Decision Rules/Operational Framework

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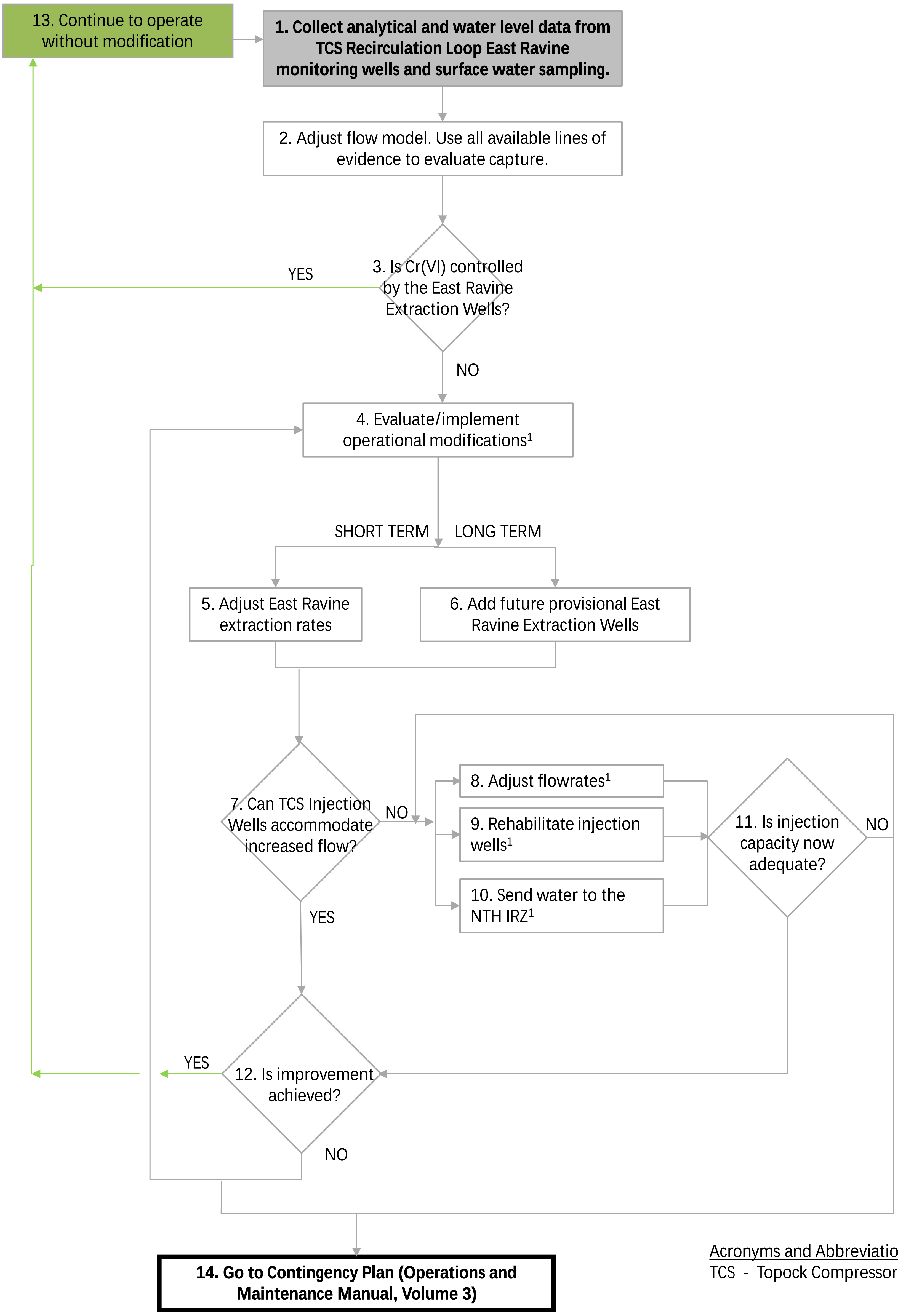
Acronyms and Abbreviations:
Cr(VI)- hexavalent chromium
NTH - National Trails Highway
IRZ - in-situ reactive zone
TCS - Topock Compressor Station
TWB - Transwestern Bench



Acronyms and Abbreviations:
TCS - Topock Compressor Station

Figure 2.2-8. TCS Recirculation Loop East Ravine Extraction Decision Rules/Operational Framework

Notes:
1.The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.

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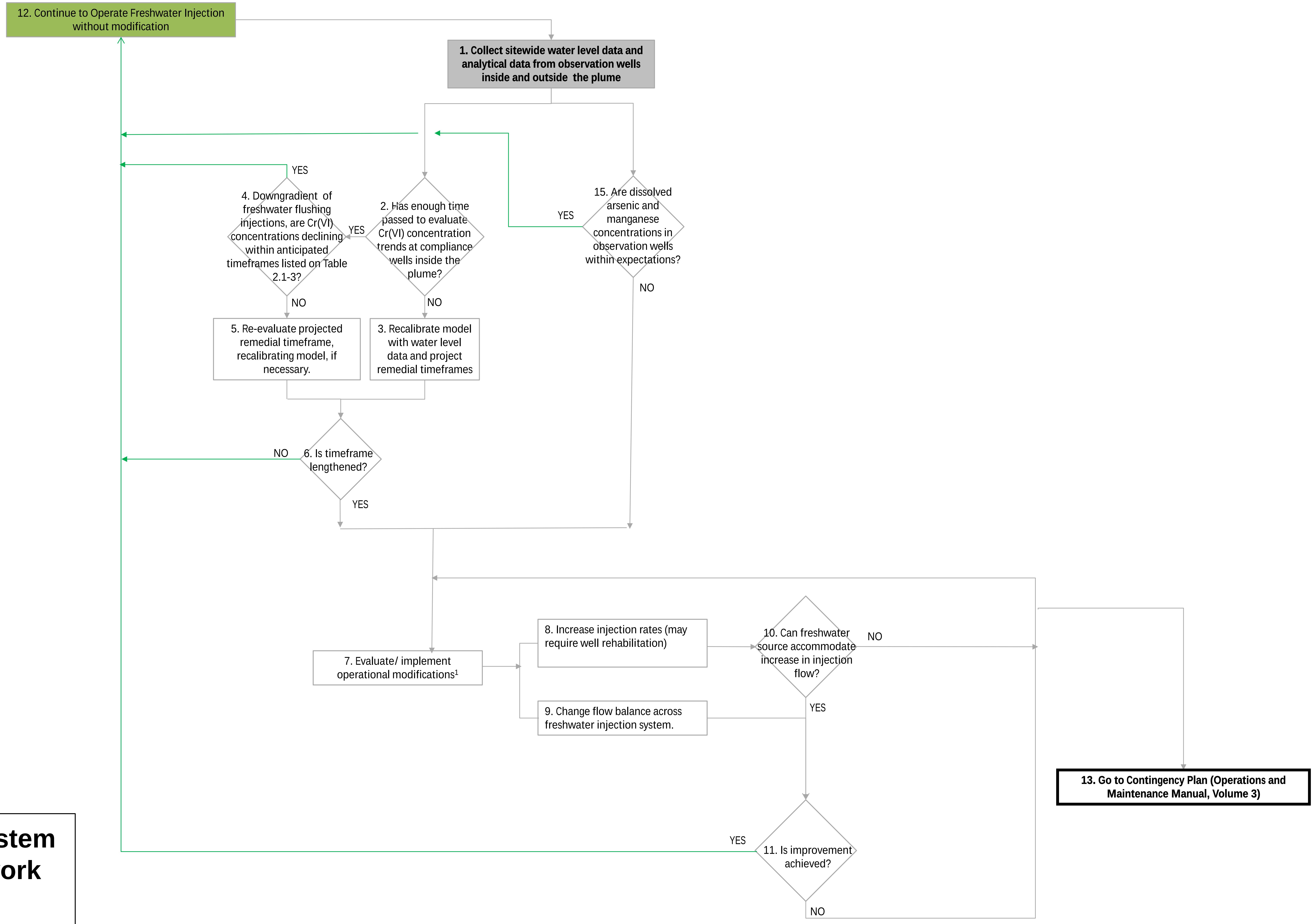

Notes:

1. The operational modifications listed here are examples and do not exclude the identification of other changes. If deemed appropriate, samples for results confirmation may be collected prior to implementation of operational changes.

Acronyms and Abbreviations:

Cr(VI)- hexavalent chromium

Figure 2.2-9. Freshwater Injection System Decision Rules/Operational Framework

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SAMPLING AND MONITORING PLAN

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3.0 Remedy Compliance Monitoring

As described in Section 2, groundwater and surface water will be periodically sampled to ensure that RAO-2, -3, and -4 are being met as part of the compliance monitoring program. This section will describe the sampling locations, anticipated changes in concentrations and timeframes, and sampling analytes and frequencies for the monitoring program.

3.1 Monitoring Locations, Anticipated Concentration Changes, and Timeframes

The compliance monitoring program will include 156 pre-existing monitoring intervals, 19 proposed locations, and 16 surface water sampling locations. These monitoring wells and surface water sampling locations are shown on Figures 2.1-1 and 2.1-2, respectively, and listed in Table 2.1-3. Monitoring well locations are also located on maps representing the current Cr(VI) plume, at different depth intervals, in Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4. Figures 3.1-5, 3.1-6, 3.1-7, and 3.1-8 show the well network overlaid with the predicted manganese distribution at 30 years. Predicted manganese distributions are based on the results of the base case solute transport model, described in Appendix B of the 60% BOD Report.

The surface water sampling network includes ten river channel sampling points, four shoreline sampling points located along the Colorado River, and two surface water sampling points in the East Ravine. All of these locations are currently being sampled quarterly as part of the ongoing Interim Measures Performance Monitoring Program; therefore no new locations are being proposed. Locations C-NR1, C-NR3, C-NR4, C-CON, and RBB are located upriver from the site, with C-CON and RBB capturing the potential effects of small surface water inlets to the main channel. Similarly, C-MAR is located at the outlet of the Topock Marsh to characterize surface water inputs that may affect water quality downstream of the site. Shoreline sampling points R-19, R-28, R-63, C-R27, C-BNS, and C-R-22A are located on the river bank downgradient of the River Bank Extraction Wells and the TCS Recirculation Loop East Ravine Extraction Wells. Finally, river channel points C-I-3 and C-TAZ will be sampled to monitor for changes in river chemistry in the body of the river channel directly downstream of the site.

The outer compliance monitoring well network consists of wells that currently lie outside of the Cr(VI) plume boundary, defined as the 32 μg/L Cr(VI) concentration contour (Figure 2.1-1, Table 2.1-3). The outer compliance well network has been designed to obtain adequate coverage surrounding the plume, while taking full advantage of the pre-existing monitoring well network and minimizing the need for additional wells. New monitoring wells proposed as part of the Process Control Monitoring Program (Section 4) will also be used for compliance monitoring. New monitoring wells I, J, P, and Q are proposed to the northwest. New monitoring well S to the southwest is proposed primarily to evaluate hydraulic gradient development near freshwater injection well FW-2, but will also be useful for outer compliance monitoring. The majority of the existing wells are located on the eastern portion of the site within the floodplain, downgradient of the Cr(VI) plume, since this area will need to be monitored most intensively to assess the potential Cr(VI) plume migration into the river. Outer compliance wells are also located to the northwest of the plume, in the vicinity of the IRL and freshwater injection areas (Figure 2.1-1). Other regions to the north, west, and south of the plume do not have high well densities due to a lack of suitable installation areas (e.g., culturally-sensitive land to the northwest and complex topography and access restrictions in the southwest).

The outer compliance wells will be sampled for Cr(VI) and Cr(T) to evaluate RAO 3. In addition, several of the outer compliance wells and surface water points will also be sampled for by-products. All of the river bank extraction monitoring wells listed within the Process Control Monitoring Program will be sampled for manganese and arsenic as part of the Compliance Monitoring Plan; anticipated by-product concentrations and arrival timeframes for this area are discussed in Section 4. By-products will also be monitored in wells in the vicinity of the IRL injection wells northwest of the plume. These include wells CW-02, CW-03, and proposed wells I and J. Solute transport model results indicate that arsenic and/or manganese generated by IRL injections will not reach these wells within the remedial timeframe; therefore the wells will be monitored to assess this prediction (manganese predictions shown with monitoring well network on Figures 3.1-5 through 3.1-8). Outer compliance wells closer to injection points that are predicted to be or potentially within the arsenic or manganese footprint include P, Q, MW-14, and MW-41 located in the vicinity of the IRL Injection Wells (Figure 2.1-1). These wells will be monitored to assess the likelihood of concentrations exceeding anticipated ranges as determined by solute transport model results. Anticipated by-product concentrations and arrival timeframes for these wells are discussed in Section 4.

The inner compliance network consists of wells that currently lie inside of the Cr(VI) plume boundary. These wells are also shown on Figure 2.1-1 as well as Figures 3.1-1, 3.1-2, 3.1-3, and 3.1-4. Wells from across the site within the plume will be used to monitor Cr(VI) concentrations as the remedy proceeds and demonstrate removal of Cr(VI) and Cr(T) from groundwater. To increase spatial coverage within the center of the plume where the existing monitoring well network did not provide coverage, three new monitoring well locations are being proposed as part of the Compliance Monitoring Program (wells L, M, and N; Figure 2.1-1, Table 2.1-2). As the Cr(VI) plume shrinks, wells will be re-categorized as outer compliance monitoring wells, and their functions will change accordingly. In this way, the compliance well network will evolve as the remedy proceeds.

The currently anticipated Cr(VI) remediation timeframe for each inner compliance well is listed in Table 2.1-3. The anticipated concentrations and timeframes are based on nominal baseline values and current solute transport model predictions, as presented in Appendix B of the 60% BOD Report. These estimates will be updated as the 90 percent design is completed, as the system is installed, and as baseline sampling is conducted. The estimates will also be adjusted during remedy implementation as data are collected during operations and the solute transport model is refined. Cr(VI) remediation timeframes vary from less than six months for wells in the vicinity of carbon injection points, to approximately 30 years for zones just upgradient of the IRZ that will be the last to be flushed as the plume is flushed towards the NTH IRZ line.

3.2 Sampling Analytes and Frequencies

Sampling analytes and frequencies for the Compliance Monitoring Program are summarized in Table 2.1-3. The sampling program presented is an initial program. As data are collected during remedy installation and initial operations, the conceptual site model (CSM) will be updated. The monitoring program may be refined based on baseline data prior to remedy operation, and the sampling program will be revisited and refined after the first two years of operation.

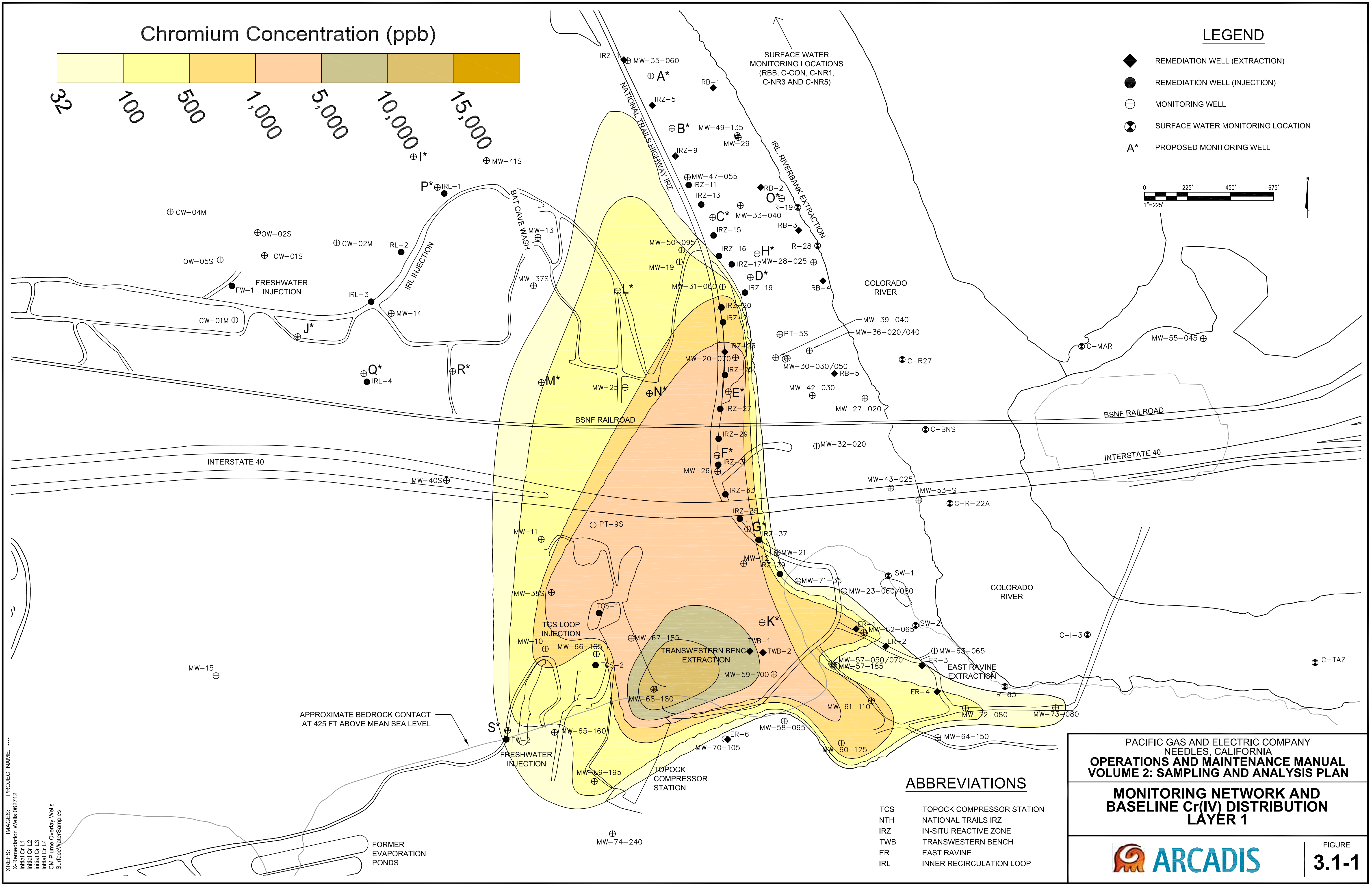
All compliance monitoring wells and surface water sampling locations will be sampled for Cr(VI) and Cr(T). Field sampling will follow the protocol outlined in Section 7 of this plan and will also include collection of field parameters (pH, DO, ORP, temperature, and specific conductance). Regardless of sampling frequency specified in the Compliance Monitoring Program, baseline data will be collected from all monitoring wells in the program for the full suite of analytes listed in Table 4.2-1 where these data do not already exist.

For wells that are also sampled for process control monitoring, the sampling frequencies follow the frequencies proposed within the Process Control Monitoring Program (Section 4; see Table 4.2-1). Outer compliance wells that are not part of the Process Control Monitoring Program will either be sampled annually or at their current sampling frequency, as outlined in Table 2.1-3. Inner compliance wells not within the Process Control Monitoring Program will be sampled with a frequency depending on the anticipated remediation timeframe, which is listed in Table 2.1-3.

Water level measurements will be collected at all locations on a quarterly basis for comparison against groundwater flow model predictions. The frequency of water level collection will be re-assessed after the first two years of operation. These results will be used to measure hydraulic gradients and directions as lines of evidence in the assessment of hydraulic plume control, as discussed in Section 4.4.

Outer compliance wells near and downgradient of carbon injection points will be monitored for the IRZ by-products manganese and arsenic to assess whether concentrations remain within expected ranges. Monitoring frequencies will follow the same frequencies outlined for Cr(VI).

Locations, analytes, and sampling frequencies within the Compliance Monitoring Program overlap substantially with the Process Control Monitoring Program, outlined in Section 4. In these cases, the same analytical results are intended to be used for both compliance and process-control monitoring.



LEGEND

◆ REMEDIATION WELL (EXTRACTION)

● REMEDIATION WELL (INJECTION)

⊕ MONITORING WELL

⊗ SURFACE WATER MONITORING LOCATION

A* PROPOSED MONITORING WELL

ABBREVIATIONS

TCS	TOPOCK COMPRESSOR STATION
NTH	NATIONAL TRAILS IRZ
IRZ	IN-SITU REACTIVE ZONE
TWB	TRANSWESTERN BENCH
ER	EAST RAVINE
IRL	INNER RECIRCULATION LOOP

PACIFIC GAS AND ELECTRIC COMPANY
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OPERATIONS AND MAINTENANCE MANUAL
VOLUME 2: SAMPLING AND ANALYSIS PLAN

MONITORING NETWORK AND BASELINE Cr(IV) DISTRIBUTION LAYER 1

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FIGURE
3.1-1

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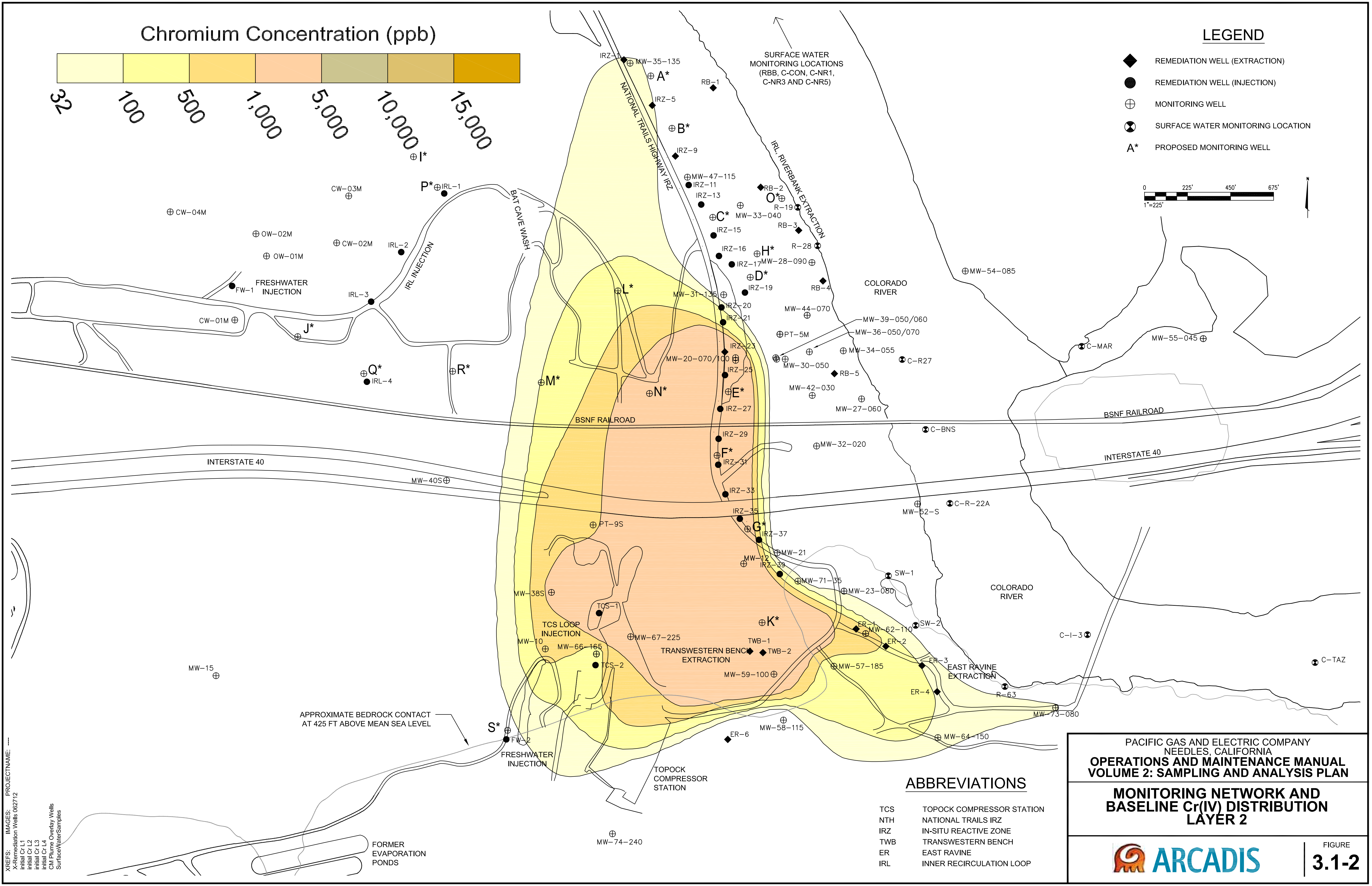
initial Cr L2
initial Cr L3
initial Cr L4
CM Plume Overlay Wells
SurfaceWaterSamples



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X-Remediation Wells 062712
initial Cr L1
initial Cr L2
initial Cr L3
initial Cr L4
CM Plume Overlay Wells
SurfaceWaterSamples

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MONITORING NETWORK AND
BASELINE Cr(IV) DISTRIBUTION
LAYER 2

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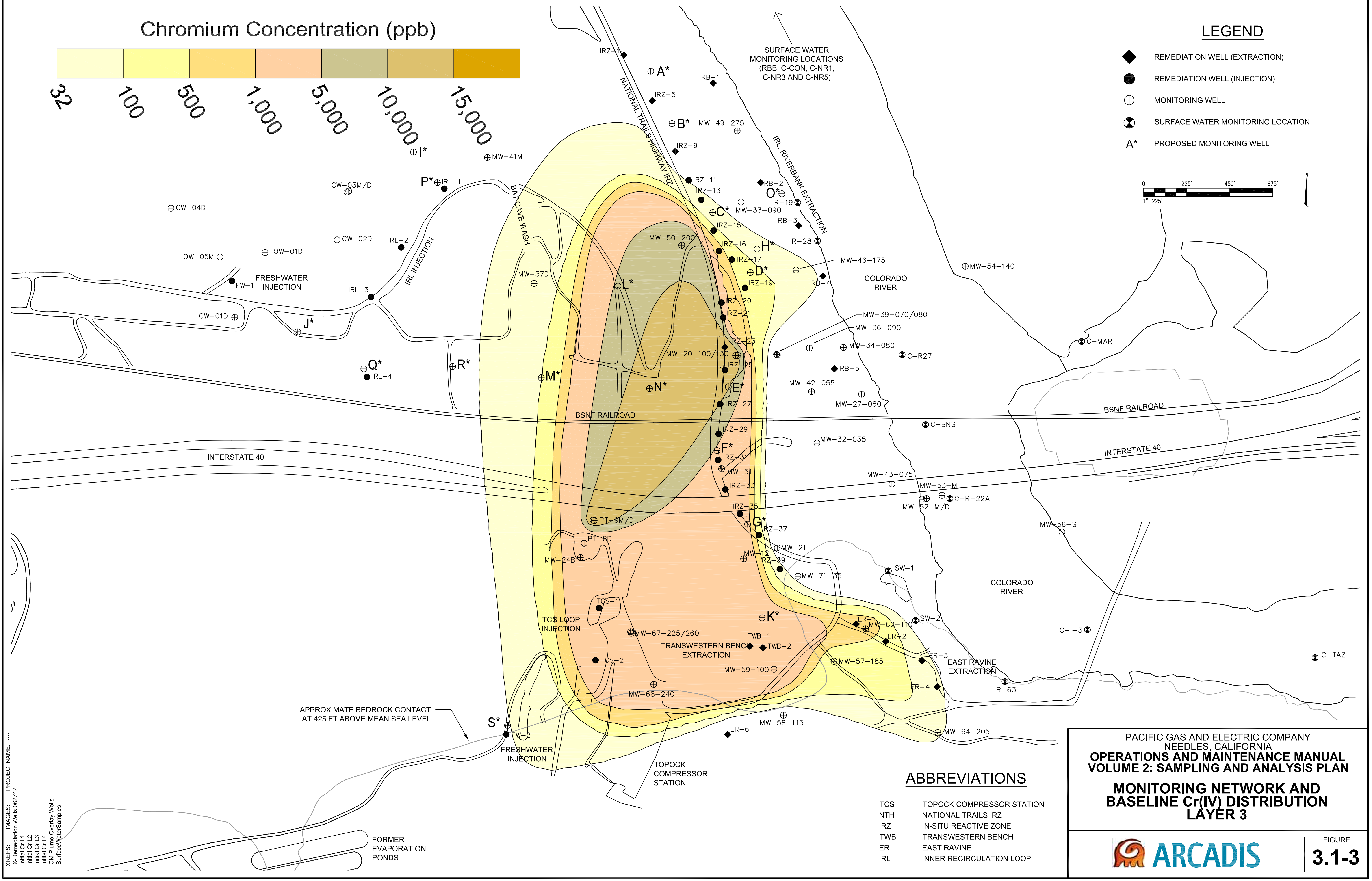
FIGURE
3.1-2



LEGEND

- ◆ REMEDIATION WELL (EXTRACTION)
- ● REMEDIATION WELL (INJECTION)
- ⊕ MONITORING WELL
- ⊗ SURFACE WATER MONITORING LOCATION
- A* PROPOSED MONITORING WELL

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MONITORING NETWORK AND BASELINE Cr(IV) DISTRIBUTION LAYER 3

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FIGURE
3.1-3

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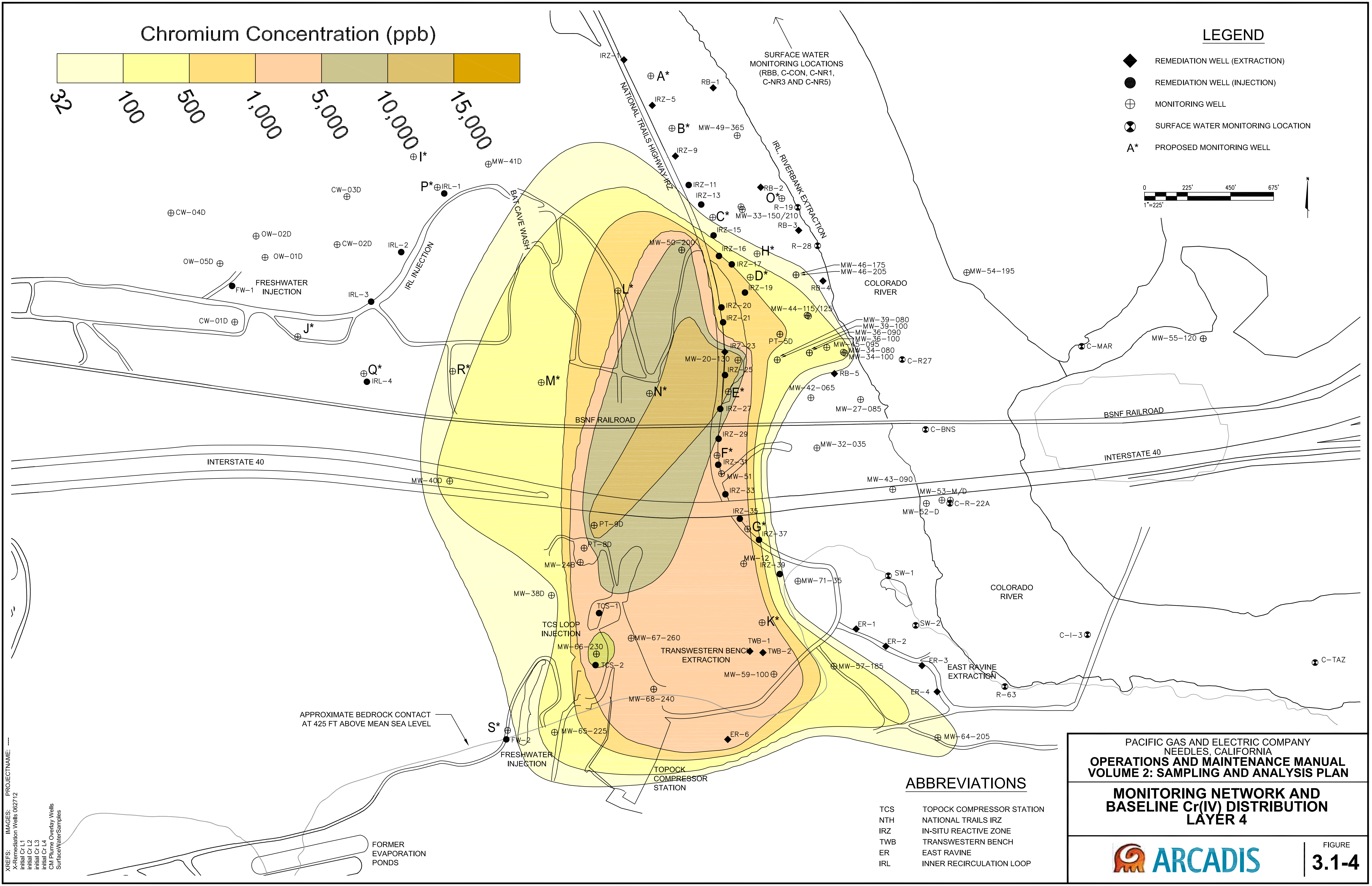
initial Cr L3
initial Cr L4
CM Plume Overlay Wells
SurfaceWaterSamples



LEGEND

◆	REMEDIATION WELL (EXTRACTION)
●	REMEDIATION WELL (INJECTION)
⊕	MONITORING WELL
⊗	SURFACE WATER MONITORING LOCATION
A*	PROPOSED MONITORING WELL

ABBREVIATIONS

TCS	TOPOCK COMPRESSOR STATION
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MONITORING NETWORK AND BASELINE Cr(IV) DISTRIBUTION LAYER 4

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FIGURE
3.1-4

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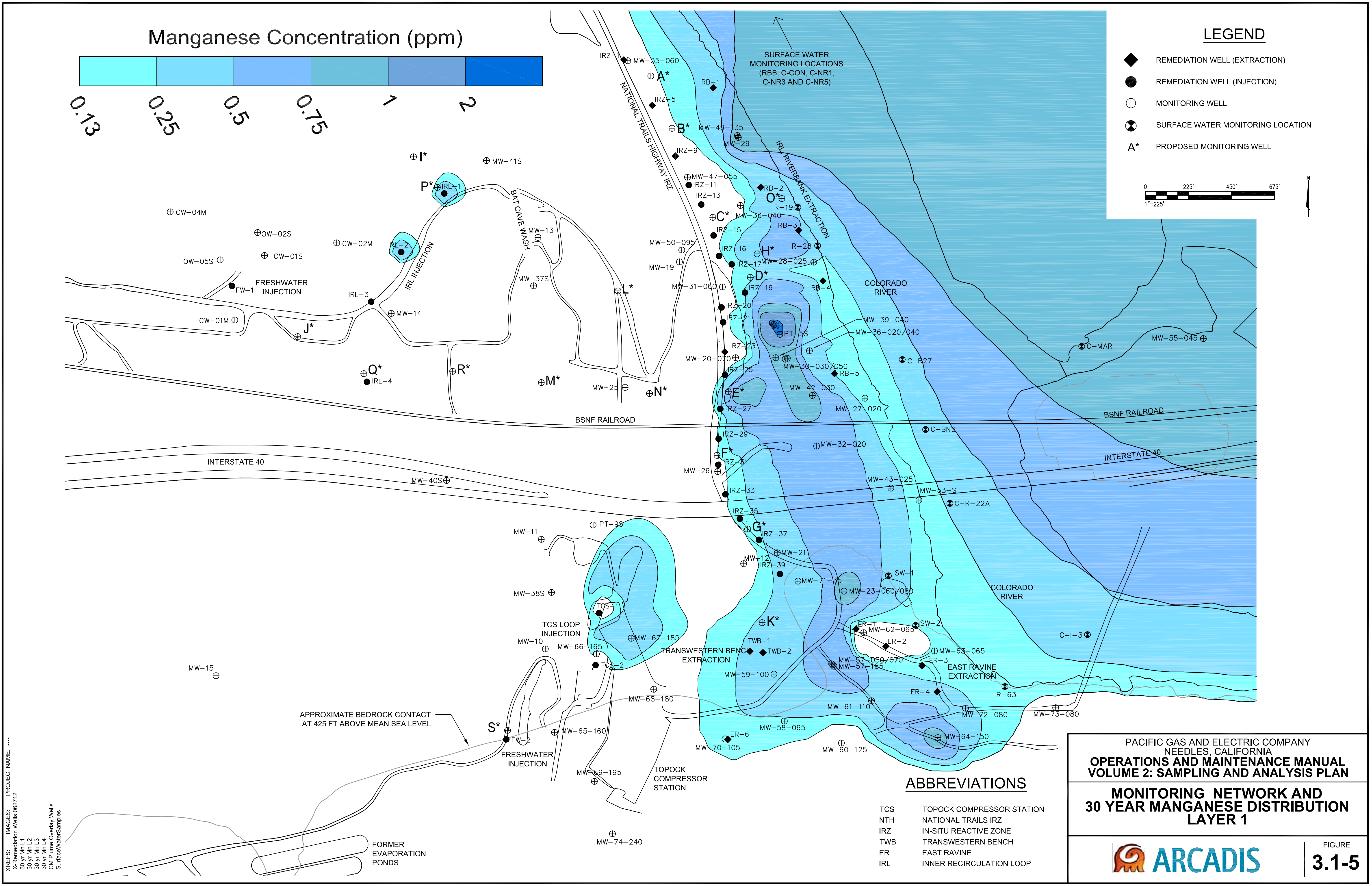
initial Cr L2
initial Cr L3
initial Cr L4
CM Plume Overlay Wells
SurfaceWaterSamples



LEGEND

◆ REMEDIATION WELL (EXTRACTION)
● REMEDIATION WELL (INJECTION)
⊕ MONITORING WELL
⊗ SURFACE WATER MONITORING LOCATION
A* PROPOSED MONITORING WELL

0 225' 450' 675'
1"=225'

ABBREVIATIONS

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MONITORING NETWORK AND 30 YEAR MANGANESE DISTRIBUTION LAYER 1

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FIGURE
3.1-5

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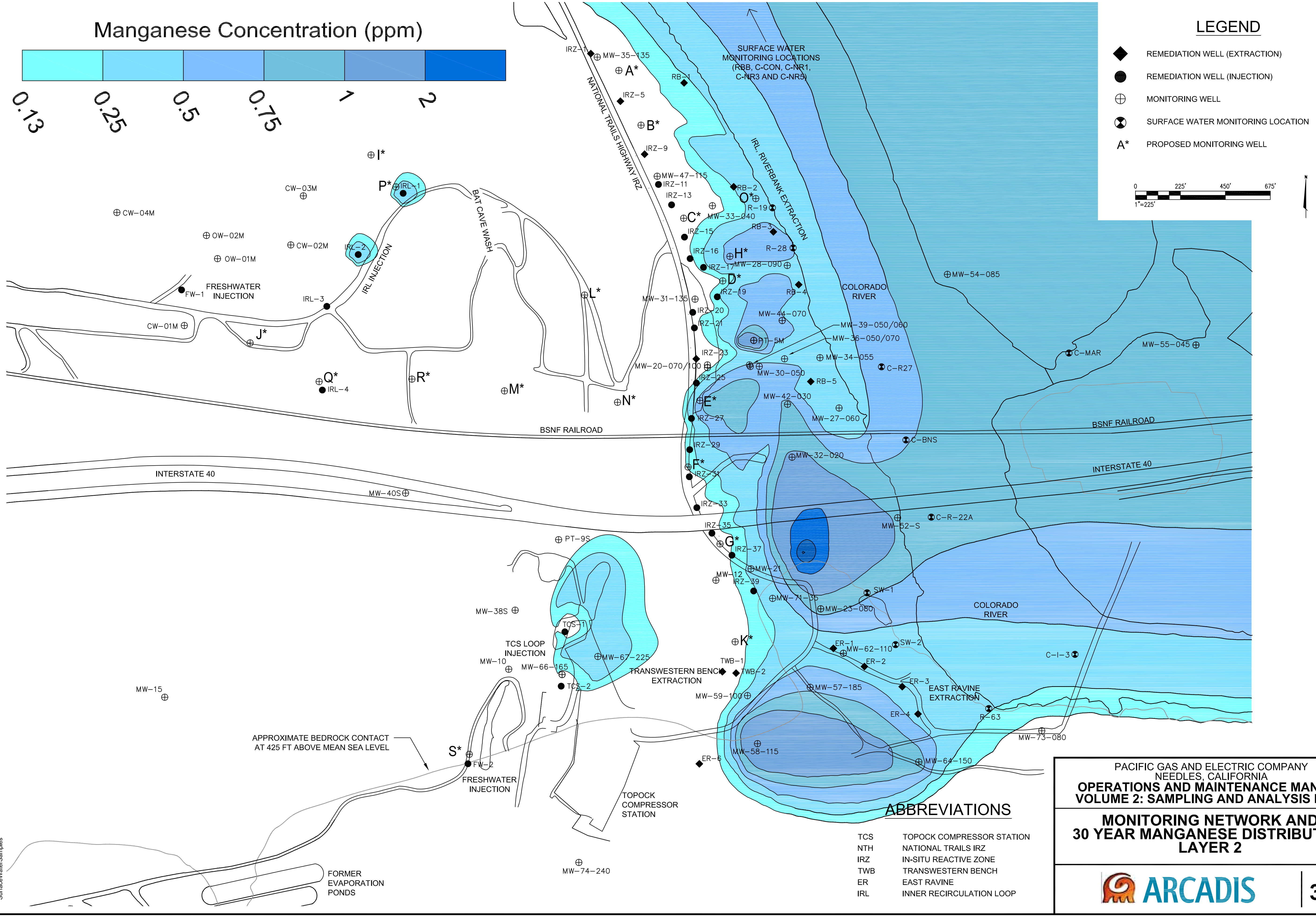
30 yr Mn L4
CM Plume Overlay Wells
SurfaceWaterSamples



LEGEND

◆	REMEDIATION WELL (EXTRACTION)
●	REMEDIATION WELL (INJECTION)
⊕	MONITORING WELL
⊗	SURFACE WATER MONITORING LOCATION
A*	PROPOSED MONITORING WELL

ABBREVIATIONS

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MONITORING NETWORK AND 30 YEAR MANGANESE DISTRIBUTION LAYER 2

ARCADIS

FIGURE
3.1-6

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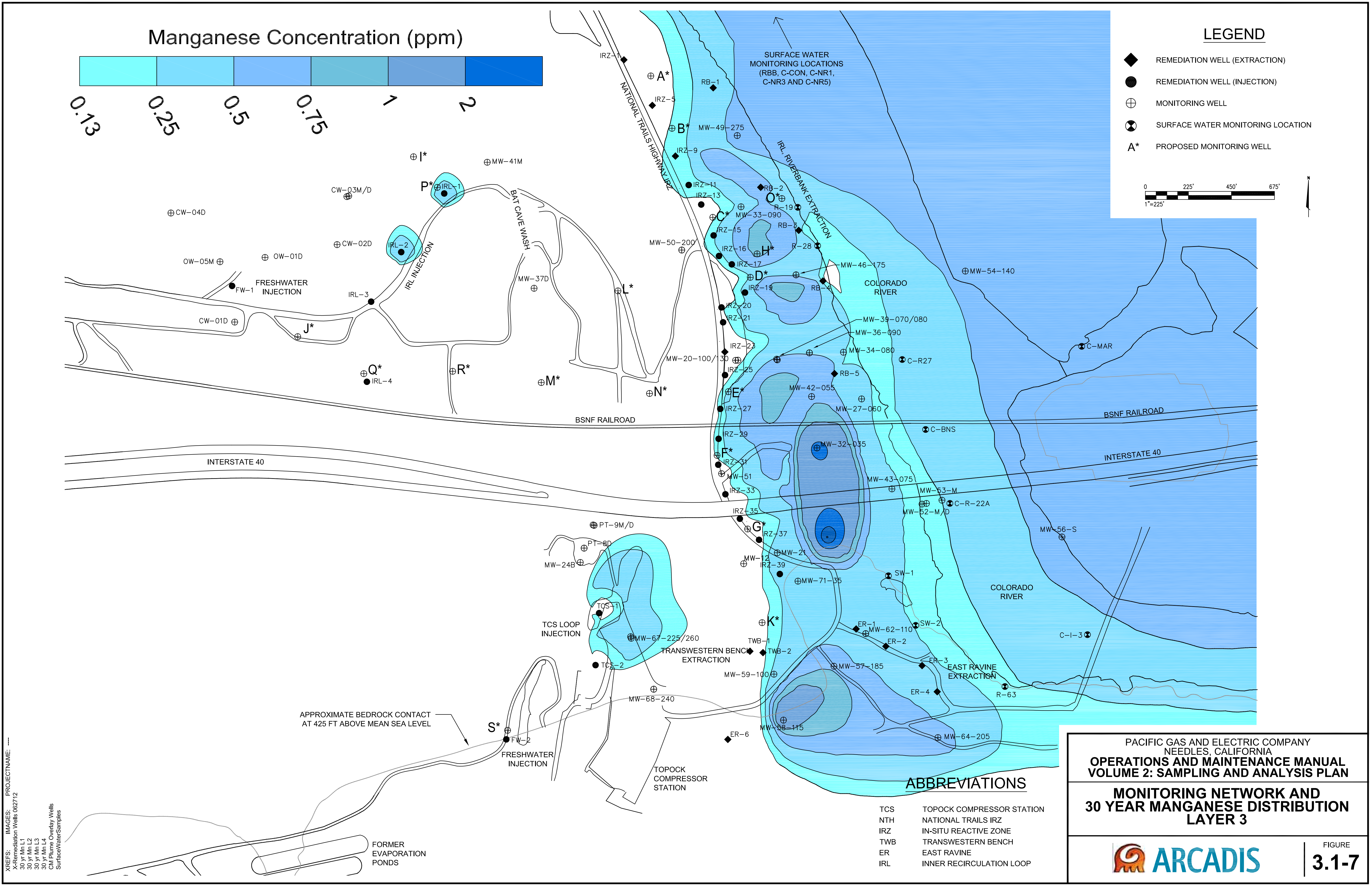
CM Plume Overlay Wells
SurfaceWaterSamples



ABBREVIATIONS

TCS	TOPOCK COMPRESSOR STATION
NTH	NATIONAL TRAILS IRZ
IRZ	IN-SITU REACTIVE ZONE
TWB	TRANSWESTERN BENCH
ER	EAST RAVINE
IRL	INNER RECIRCULATION LOOP

PACIFIC GAS AND ELECTRIC COMPANY
NEEDLES, CALIFORNIA
OPERATIONS AND MAINTENANCE MANUAL
VOLUME 2: SAMPLING AND ANALYSIS PLAN

MONITORING NETWORK AND 30 YEAR MANGANESE DISTRIBUTION LAYER 3

ARCADIS

FIGURE
3.1-7

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30 yr Mn L4
CM Plume Overlay Wells
SurfaceWaterSamples

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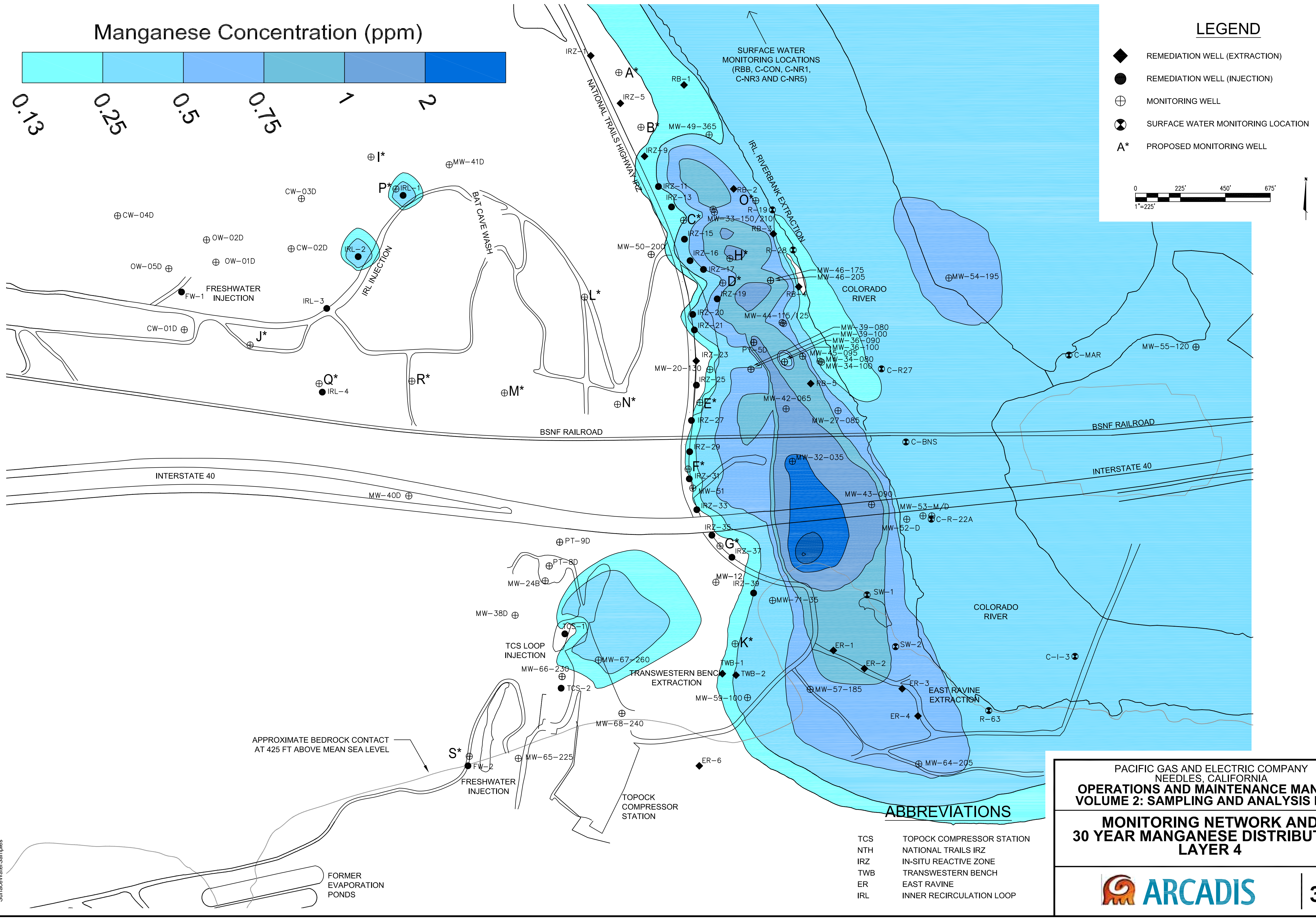
30 yr Mn L4
CM Plume Overlay Wells
SurfaceWaterSamples



ABBREVIATIONS

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MONITORING NETWORK AND 30 YEAR MANGANESE DISTRIBUTION LAYER 4

ARCADIS

FIGURE
3.1-8

4.0 In-Situ Remediation Performance Monitoring

Process control monitoring will involve sampling of groundwater and surface water to verify that the different components of the remedy are functioning as anticipated and to guide adaptive operations. The following sections describe the locations and functions of different monitoring wells, the construction of new monitoring wells, analytes to be monitored and their collection frequencies, and anticipated concentration changes and timeframes.

4.1 Anticipated Concentration Ranges and Timeframes

To guide the operations of the remedy, this section will establish the anticipated timeframes over which changes in concentrations of Cr(VI), by-products, and other water quality parameters is expected to occur. These expectations are based on solute transport modeling completed in support of the design, as summarized in Appendix B of the 60% BOD Report. The anticipated concentrations and timeframes are based on nominal baseline values and current solute transport model predictions. These estimates will be updated as the 90 percent design is completed, as the system is installed, and as baseline sampling is conducted. The estimates will also be adjusted during remedy implementation as data are collected during operations and the solute transport model is refined. The timeframes set forth will be also used to evaluate progress toward achieving RAO 3 regarding reduction of Cr(VI) and Cr(T) mass in groundwater, in accordance with compliance DQO-2. The anticipated concentrations and timeframes will also serve as triggers for implementing adaptive operations as laid out in the decision rules/operational flowcharts in Section 2.2.

Table 2.2-1 summarizes the anticipated timeframes for the arrival of the treated groundwater for various components of the Process Control Monitoring Program. These estimates were based on the solute transport modeling and provide part of the basis for the sampling frequencies of the Process Control Monitoring Program.

For the IRZ portions of the remedy, Table 2.2-1 also summarizes the predicted concentration ranges and timeframes for TOC that will be distributed by in-situ injections and for by-products (arsenic, iron, and manganese) that will be generated by in-situ treatment. Note, barium concentrations are not predicted and are not anticipated to be significant unless strong sulfate reducing conditions develop.

In addition to anticipated concentration ranges for by-products, Table 2.2-1 also lists maximum concentrations in parentheses for manganese, iron, and arsenic. The purpose of these thresholds is to provide flexibility for individual wells that may exhibit behavior deviating from the average. Although it is expected that the majority of the wells will exhibit by-product concentrations within the anticipated ranges, it is possible that any given well may exhibit deviations outside of those ranges based on spatial variability in the hydraulic and geochemical characteristics of the aquifer that may cause locally high by-product concentrations. If a relatively small number of monitoring wells fall above the anticipated range but below the maximum, operational adjustments may not be necessary as long as the majority of the wells still fall within the anticipated range.

TOC

TOC will be analyzed to evaluate the distribution of organic carbon substrate in the subsurface within the IRZs. For dose response wells located at the midpoint between injection locations along the NTH IRZ, TOC concentrations of 15 to 50 milligrams per liter (mg/L) are targeted. For monitoring wells located closer to injection points within the NTH IRZ, IRL injection area, and TCS injection area, higher concentrations are anticipated and may exceed the average target injection concentrations depending on how continuously the substrate is applied. TOC arrival, and Cr(VI) removal, are anticipated to be observed in all dose response wells within the first six months of operation.

Arsenic

Baseline concentrations and anticipated concentration ranges for arsenic are given in Table 2.2-1. The anticipated ranges are based on a combination of generalized baseline concentrations and solute transport model predictions. Solute transport model results used in determining anticipated concentration ranges included the base-case parameter model run (i.e., all parameters for sorption, precipitation, and generation are set at their nominal values) and one sensitivity model run testing an increased arsenic generation rate (Appendix B, 60% BOD Report). Some wells exhibit baseline concentrations above these ranges and are anticipated to remain above the anticipated ranges during remedy implementation.

NTH IRZ monitoring wells. Although arsenic concentrations are expected to increase due to IRZ operations, arsenic is expected to attenuate rapidly outside of the IRZ footprint. In NTH IRZ dose response wells, concentrations are expected to be between 2 and 10 μg/L, with a maximum of 15 μg/L. This concentration range accounts for background values in the 2 to 5 μg/L range, combined with maximum modeled arsenic concentrations between 5 and 10 μg/L in the immediate vicinity of injection wells (based on the base-case modeling runs, as well as the increased-generation sensitivity runs presented in Appendix B of the 60% BOD Report). Downgradient of the IRZ, by-product arsenic concentrations are not expected to exceed 5 μg/L; however, baseline concentrations are higher in some locations due to the naturally reducing conditions within the floodplain. A similar anticipated concentration range of 2 to 10 μg/L is expected for most wells, based on observed baseline concentrations and uncertainty in how those baseline concentrations may change as Interim Measure No. 3 pumping is switched off and the flow regime changes. Timing of by-product arrival in dose response wells is expected to roughly coincide with TOC arrival (within the first six months of operation).

The anticipated concentration range is lower in river bank extraction monitoring wells (2 to 5 μg/L for most wells, with a maximum of 8 μg/L), since no by-product arsenic is expected to reach these wells, and since baseline concentrations are generally lower than in the mid-floodplain.

TCS injection monitoring wells. Since similar TOC concentrations will be used in the NTH IRZ and TCS Recirculation Loop injections, a similar concentration range for arsenic of 1 to 10 μg/L is expected in the TCS Recirculation Loop dose response wells, while arsenic is not expected to increase significantly above baseline in downgradient monitoring wells (MW-67 cluster; Table 2.2-1).

Iron and Manganese

Anticipated concentration ranges for iron and manganese are based on a combination of generalized baseline values and by-product concentration predictions determined from solute transport modeling. Solute transport model results used in determining anticipated concentration ranges included the base-case parameter model run and parameter sensitivity analysis runs, including a run with an increased manganese generation rate and a run considering TOC injection in the IRL, as described in Appendix B of the 60% BOD Report. Solute transport modeling for iron was not conducted. It is therefore assumed that iron will follow concentration trends similar to manganese, which is a conservative assumption given that iron typically attenuates more quickly than manganese downgradient of an IRZ.

Dose response wells. Based on the solute transport modeling results, including the base-case parameter run (Figures 3.1-5 through 3.1-8) and the increased-generation parameter sensitivity run (Appendix B, 60% BOD Report), IRZ dose response wells are expected to see a range in dissolved manganese concentrations between 1 and 2.5 mg/L, with an maximum concentration of 5 mg/L. As described above, this maximum value reflects potential spatial variability in hydraulic properties and solid phase manganese distributions within the aquifer. Such variability may cause manganese concentrations in any given well to increase above the anticipated range, even though on average the majority of the wells are expected to lie within the anticipated range. Arrival of TOC and by-products and the treatment of Cr(VI) at these dose response wells is expected within the first six months of operation.

Downgradient and river bank extraction monitoring wells. Monitoring wells downgradient of the NTH IRZ are expected to see a similar range in manganese concentrations, based on baseline and modeled by-product concentrations (base-case and increased manganese generation runs). Manganese and iron concentrations in the vicinity of the IRL Injection Wells will depend strongly on the concentration and duration of TOC dosing. A solute transport model parameter sensitivity run was conducted that included phased TOC injection into the IRL

(Appendix B, 60% BOD Report). Based on this run, manganese concentrations in dose response wells (P, Q, MW-14) are expected within 1 to 2.5 mg/L (maximum of 5 mg/L).

4.2 Sampling Locations, Analytes and Frequencies

Analytes and monitoring frequencies are outlined below according to location and category within the Process Control Monitoring Program. The sampling program presented is an initial program. As data are collected during remedy installation and initial operations, the CSM will be updated. The monitoring program may be refined based on baseline data prior to remedy operation, and the sampling program will be revisited and refined after the first two years of operation.

All sampling events, regardless of the analytes being sampled, will also include collection of field parameters (pH, DO, ORP, temperature, and specific conductance). Field sampling will follow the protocols outlined in Section 7 of this manual. Regardless of sampling frequency specified in the Process Control Monitoring Program, baseline data will be collected from all monitoring wells in the program for the full suite of analytes listed in Table 4.2-1 where these data do not already exist.

4.2.1 IRZ Dose Response Monitoring Wells

Wells that will receive organic carbon injections as part of the IRZ remedy will include NTH IRZ Injection Wells (Figure 2.2-1), TCS Injection Wells (TCS-1 and -2), and potentially the IRL Injection Wells (IRL-1 through -4). Dose response monitoring wells will be located within the immediate vicinity of these IRZ injection wells, within the anticipated IRZ footprint. The dose response wells are used to verify that the NTH IRZ is completely established and that Cr(VI) treatment is initiated and maintained over time.

To establish the NTH IRZ, the organic carbon substrate will be distributed laterally from the injection points. Monitoring wells located in between the injection points will be used to assess the completeness of the organic carbon distribution and/or establishment of Cr(VI) reducing conditions. It will be the most difficult to establish the IRZ at locations roughly halfway between the injection points given that these locations are the farthest from the injection points. As such, proposed monitoring locations (C, D, E, F, and G) were located in the spaces between approximately every other pair of injection wells. The placement in every other space allows for data collection along the full extent of the IRZ, providing a balance in data density appropriate for evaluating the effect of potentially varying hydrogeological environments while minimizing the total number of locations required (i.e., the number of boreholes would be roughly doubled if a monitoring well was placed between every space). In addition, many pre-existing monitoring wells in the near vicinity of injection wells (within approximately 60 feet; e.g., MW-47-055/115, MW-26, MW-51) will be used to provide additional data on TOC distribution, Cr(VI) treatment, and by-product generation closer to the injection points where reducing conditions are expected to be stronger and develop faster.

For the IRL Injection Wells, organic carbon will be amended if Cr(VI) concentrations in the injection water are above 32 μg/L. New monitoring wells (P and Q) will be installed within 50 to 100 feet of the injection wells to monitor water levels, TOC distribution, and by-product generation within the injection zone, and to verify the treatment of Cr(VI). MW-14 located further downgradient of IRL-3 may also be used to monitor dose response, if IRL-3 injections are amended with carbon.

For the TCS IRZ, the pre-existing monitoring wells MW-66-165/230 are located less than 100 ft from injection wells TCS-1 and -2, respectively, and will function as dose response wells.

IRZ dose response wells will be monitored for the following constituents:

- **TOC, Cr(VI), and dissolved iron:** These three parameters are critical for monitoring the establishment of the IRZ at the dose response wells. TOC will be sampled to evaluate and verify distribution of organic carbon substrate in subsurface, Cr(VI) will be sampled to evaluate reduction of Cr(VI), and dissolved iron will be sampled to evaluate the generation of the Cr(VI) reductant ferrous iron through the stimulation of iron reduction. As discussed in Section 4.1, the changes at the dose response wells are anticipated to happen within the first six months of operation. As such, at the NTH IRZ, where IRZ establishment and maintenance is most critical (see NTH IRZ DQO-2), dose response well monitoring will be conducted monthly for the first year, which is planned to include a six-month period of operation followed by a six-month period of shutdown. If results are within expectations, the sampling frequency may be reduced to quarterly thereafter. For the TCS Recirculation Loop and the IRL, the dose response well monitoring frequency will be quarterly, less than for the NTH IRZ given the less critical nature of establishing a complete IRZ in these areas.

- **Cr(T):** This parameter will be sampled to verify that chromium is precipitating out of groundwater following reduction. Results to date have not indicated any issues with precipitation of Cr(III) formed by reduction, and as such the Cr(T) sampling frequency is less than the Cr(VI) sampling frequency (i.e., quarterly for the first year, followed by semi-annually for the IRZ dose response wells).
- **In-situ by-products (arsenic, manganese, iron, barium):** These parameters will also be monitored at the dose response wells to evaluate by-product generation. By-products are also an indication of the establishment of reducing conditions. Sampling for by-products will be conducted at the same frequency as sampling for TOC and Cr(VI).
- **Nitrate:** Nitrate is a primary indicator of the establishment of reducing conditions that are sufficient for the reduction of Cr(VI). Nitrate is a good indicator of the arrival of treated water and may provide information on whether the hydraulics of injection versus the amount of organic carbon delivered is controlling treatment effectiveness. Nitrate will be sampled at the same frequency as TOC and Cr(VI) in the IRZ dose response wells.
- **Sulfate:** Sulfate will be monitored at the same frequency as the other analytes in the NTH IRZ dose response wells to ensure that the reducing environment is such that excessive sulfate reduction and release of barium does not occur.
- **General water quality parameters:** Cations and anions may be useful to evaluate the potential for mineral deposit formation and may serve as tracers of injected solution. Alkalinity will be measured to monitor changes due to microbial activity and the potential for mineral deposits formation, i.e. as carbonate minerals. Total dissolved solids (TDS) will be measured as an additional water quality indicator for evaluation of changes in water chemistry. These parameters may be will be used to answer specific questions that arise, but will not be monitored on a routine basis at dose response wells to ensure the effectiveness of the IRZs.

4.2.2 IRZ Downgradient Monitoring Wells

For the NTH IRZ, downgradient monitoring wells will be on the edge or outside of the anticipated TOC footprint to observe downgradient Cr(VI) and by-product concentration trends. Downgradient of the NTH IRZ line, downgradient monitoring wells are located midway between the NTH and the river bank, running roughly along a north-south transect (Figure 2.2-1). Existing monitoring wells will provide adequate downgradient coverage, with the exception of the region between IRZ-17 and extraction well RB-3 where well H is being proposed.

For the IRL IRZ, downgradient monitoring wells will be located within 300 to 900 ft downgradient of the IRL Injection Wells. This will include the pre-existing well clusters MW-41, MW-13, and MW-37, located between IRL-1 through -4 and the NTH IRZ line. Wells R and M are proposed to obtain better downgradient coverage to the southeast, if needed to monitor carbon injections at IRL-4. Wells I and J are being proposed as by-product monitoring wells for the IRL injections. These locations were selected because they were the optimal locations that were located more than 200 feet from injection points upgradient of IRL-1 and IRL-4 on the ends of the IRL injection line. Other locations considered within varying distances and directions from IRL-1 and IRL-4 were not as optimal based on topographic, access, and cultural considerations. For example, the potential locations considered for well I are shown on Figure 4.2-1. Well clusters CW-02 and CW-03 will also serve as by-product monitoring wells upgradient of the IRL injection points to monitor for Cr(VI) and potential injection by-products.

For the TCS IRZ, the pre-existing well cluster MW-67 will be used to monitor downgradient of the TCS injection zone. Because of the location of the injection wells within the interior of the plume upgradient of the extraction zones, more extensive downgradient monitoring will not be necessary.

Downgradient monitoring wells will be monitored for the following constituents:

- **Cr(VI), nitrate, and Cr(T):** These constituents will be sampled to evaluate the arrival of treated water. The frequency of sampling varies depending on the anticipated arrival of treated water at downgradient wells in the different systems. These wells double as inner compliance monitoring wells, and the anticipated arrival times are summarized in Table 2.1-3. Cr(T) will be sampled on a less frequent basis at the downgradient monitoring wells, similar to at the dose response wells.
- **TOC:** This will be sampled to verify the downgradient edge of TOC distribution (NTH IRZ and TCS Recirculation Loop downgradient wells only). Sampling frequency will be the same as for Cr(VI) and nitrate.
- **In-situ by-products:** These constituents will be sampled to evaluate the downgradient migration of by-products generated by the IRZ. Sampling frequency will be the same as for Cr(VI) and nitrate.
- **Sulfate and general water quality parameters:** As for the dose response wells, sulfate and general water quality parameters will be sampled on an as-needed frequency to answer specific questions as they arise.

4.2.3 River Bank Extraction and Northern NTH Extraction Monitoring Wells

The NTH IRZ downgradient monitoring wells will also serve as river bank extraction monitoring wells, along with additional proposed and pre-existing wells closer to the river bank. The goal of these wells will be to monitor water levels and water quality specifically as it relates to water that will be extracted by the River Bank Extraction Wells or potentially discharged to the river. As such, the river bank extraction monitoring program includes newly installed wells and one proposed well located in between River Bank Extraction Wells (well O), as well as surface water sampling points to monitor the effects of groundwater discharge on river water quality. Monitoring wells on the Arizona side of the river (MW-54 and MW-55 clusters) will also be included in the river bank extraction monitoring well network. These will serve as sentinel wells to assess the potential for Cr(VI) and by-product concentrations to increase above baseline in this area.

River bank extraction monitoring wells will be monitored for the same constituents as the IRZ downgradient monitoring wells and at a similar frequency. In addition to evaluating the arrival of treated groundwater and by-products, the data from these locations will be used to evaluate hydraulic control and the condition of the reducing rind, as described in IRL DQO-5.

Monitoring wells, including the MW-35 cluster and proposed wells A and B, will be located on the northern end of the NTH IRZ network in the vicinity of extraction wells IRZ-1, -5, and -9. Monitoring in this area, which will focus on Cr(VI) and water levels, will be used to assess hydraulic control of the Cr(VI) plume on the northern end of the NTH IRZ and will be conducted on a monthly basis for the first quarter of operation, as the new hydraulic regime is established, and quarterly thereafter.

4.2.4 Transwestern Bench and East Ravine Extraction Monitoring Wells

As part of the TCS Recirculation Loop, water containing elevated Cr(VI) will be extracted from the Transwestern Bench and East Ravine areas. The monitoring network will primarily include pre-existing wells surrounding the extraction wells on all sides within approximately 500 feet (Figure 2.2-1). Well K is proposed to enhance monitoring coverage to the east of the Transwestern Bench extraction.

Wells will be sampled on a quarterly basis for Cr(VI) and on a semi-annual basis for Cr(T). More distant wells will also be monitored, including MW-73-080, which has shown elevated Cr(VI) concentrations, and the Arizona wells, but at a lower frequency.

4.2.5 Extraction Wells and Combined Extraction Streams

In addition to the monitoring wells, the remedy extraction wells in the NTH IRZ, IRL, and Transwestern Bench Recirculation Loop will also be sampled as a part of the process control monitoring. Individual extraction wells will be sampled, as well as the combined stream of extracted groundwater. In addition to monitoring for water quality parameters, water level measurements will be collected with a probe in two locations: within the well via a stilling tube and within the filter pack via a piezometer.

Samples collected from all of the extraction wells and combined extracted groundwater streams will be analyzed for Cr(VI). The data will be used to evaluate hydraulic control of the plume (Section 4.4) and to determine if treatment is required prior to re-injection in the IRL (Section 2.2.2).

Because several of the NTH IRZ Extraction Wells are located close to the injection wells, the extraction wells will be sampled for dissolved and total iron and manganese and TOC which may be extracted from nearby injection locations and which may cause fouling. Oxidation of dissolved iron and/or manganese may form mineral deposits and cause fouling of pipelines and injection wells. Excess TOC can cause biological growth in pipelines and extraction wells, causing fouling.

Additional water quality parameters can be used to evaluate the potential for precipitate formation that could lead to fouling and will be evaluated if needed for troubleshooting.

4.2.6 Carbon Amendment System Sampling Locations

Samples will be collected from sampling points located throughout the carbon amendment system to evaluate its effectiveness. At the MW-20 Bench, the carbon substrate will be fed into three conveyance forcemains (one to the IRL Injection Wells, one to the northern NTH IRZ injection leg, and one to the southern NTH IRZ injection leg), each equipped with an in-line static mixer. Samples for each line will be collected from sampling ports located just downstream of each mixer (M1005, M1006, and M1007). At the Transwestern Bench, carbon substrate is fed into one conveyance forcemain equipped with a static mixer (M907), and samples will be collected from a port located just downstream of this mixer. In addition, sampling ports are available within each injection vault to sample the distribution of organic carbon to individual injection wells.

4.2.7 Water Level Monitoring

Water levels will be measured in all monitoring wells, injection wells, and extraction wells in support of addressing the hydraulic and hydrogeologic components of remedy assessment. To assist in hydraulic gradient in the nearby vicinity of IRL/freshwater injection wells in particular, new monitoring wells Q, P, and S and existing monitoring wells MW-14 and OW-05S/M/D will be used. The measurements will be made either by manual methods or by use of dedicated, in-well pressure transducers. The water level measurements will be converted to elevations referenced to sea level so that the water levels can be integrated site-wide for interpretation of potentiometric levels and hydraulic gradients. Tables 2.1-3 and 4.2-1 indicate the frequency of water level measurements.

4.3 Hydraulic Control Evaluation

4.3.1 Objective and Approach

The objective of RAO 2 is to limit Cr(VI) dissolved in groundwater at the site from migrating into the Colorado River. The remedy addresses this requirement through in-situ and groundwater pumping. The groundwater extraction wells are to be installed as part of the NTH IRZ (River Bank Extraction Wells) and the TCS Loop (East Ravine Extraction Wells). The hydraulic control evaluation is to assess the performance of the groundwater extraction well element of the remedy. The approach and methodology for this assessment will be consistent with regulatory guidance prepared and distributed by the U.S. Environmental Protection Agency (USEPA), including the document *A Systematic Approach for Evaluation of Capture Zones at Pump and Treat Systems*, dated January 2008 (USEPA 2008).

The approach is considered iterative because assessments will be conducted periodically as additional data are collected as part of performance and compliance monitoring. These additional data will also be used to continually refine the CSM and to make operational improvements to the remedy. Thus, as additional data are collected at the site, additional monitoring locations and/or additional types of information will be identified to address any identified data gaps and ambiguities.

The approach includes these three basic steps:

1. Define the Target Capture Zone in conjunction with the CSM and the RAOs.
2. Interpret the Actual Capture Zone.
3. Demonstrate consistency between the Target Capture Zone and the Actual Capture Zone.

This approach reflects the process of assessing information to determine what requires hydraulic control, analyzing performance data to determine the dimensions of the actual zone of control created by groundwater extraction, and assessing whether the requirements are met by the created capture zone. The ability to perform these steps successfully depends in large part on whether the appropriate information has been collected at the site. These three steps are discussed in the following sections.

4.3.2 Definition of the Target Capture Zone in Conjunction CSM and RAOs

The current extent of Cr(VI) concentrations in groundwater that exceed 32 μg/L, the regional background concentration, is illustrated in Figure 2.1-1. The RAO that applies to hydraulic containment of Cr(VI) in groundwater is stated in Section 2.1:

> *RAO 2: Prevent or minimize migration of Cr(T) and Cr(VI) in groundwater to ensure concentrations in surface water do not exceed water quality standards that support the designated beneficial uses of the Colorado River (11 µg/L Cr[VI]).*

Based on this RAO, the objective of hydraulic capture of Cr(VI) in groundwater at the site is to protect the designated beneficial uses of the Colorado River. The degree to which Cr(VI) in groundwater requires containment with respect to the numeric level associated with the designated beneficial uses (11 μg/L Cr[VI]) has not been quantified. However, due to several factors, it can be assumed that the amount of mass of Cr(VI) that could migrate from groundwater into the Colorado River to result in a detectable concentration of Cr(VI) above 11 μg/L would translate to a concentration of Cr(VI) in groundwater significantly above the 11 μg/L surface water quality standard and the 32 μg/L regional background level.

With this considered, the extent of Cr(VI) in groundwater above the regional background level of 32 μg/L will be used as the Target Capture Zone for purpose of providing a metric for hydraulic control assessments. However, achieving this metric will not be necessary for groundwater extraction to achieve the RAO discussed herein.

4.3.3 Interpretation of the Actual Capture Zone: Lines-of-Evidence Approach

Numerous factors influence the resulting dimensions of the Actual Capture Zone created by groundwater extraction. These factors indicate the potential complexity of determining the capture zone created by groundwater extraction, because the subsurface—and the response to it being stressed by pumping—is complex, due in large part to natural heterogeneities. In other words, interpreting the Actual Capture Zone is difficult due to inherent uncertainties. Consequently, a single line of evidence is not considered sufficient to demonstrate plume capture because the uncertainties inherent to any single method are likely too great. Therefore, plume control is best demonstrated through multiple lines of evidence.

There are a number of methods or tools available to assess plume control. Each of these methods is considered a separate line of evidence. The lines of evidence considered for this assessment are grouped into four main categories and are discussed in the following sections.

1. Interpretation of water levels
    - Groundwater flow direction based on water level pairs / three-point gradient analysis
    - Groundwater flow direction based on water level contour maps
2. Calculations
    - Simple analytical modeling
    - Groundwater discharge comparison: aquifer seepage versus pumping
    - Numerical modeling
3. Concentration trends
    - Contaminant concentrations in wells downgradient of extraction wells
4. Field methods
    - Tracer testing

4.3.3.1 Interpretation of Water Level Data

Lines of evidence involving the interpretation of water levels are the most common for capture zone assessments. The particular lines of evidence in this group are: (1) gradient analyses using either well pairs or three-point gradient assessments that can provide information regarding lateral flow directions in the vicinity of extraction wells; and (2) construction of water level contour maps, either hand-drawn or automated, to interpret capture zones.

Water Level Pairs / Three-Point Gradient Analysis

Assessment of water levels via water level pairs is performed to determine ‘inward flow’ toward extraction wells based on sets of two water level elevation measurements. The principle here is that hydraulic gradient directions that are “away” from an operating extraction well indicate a potential lack of hydraulic control, whereas hydraulic gradient directions that are toward an operating extraction well indicate potential control. The USEPA (2008) guidance document outlines the potential pitfalls of using this method as gradient directions can be misleading. Thus, additional lines of evidence are recommended to enhance the level of confidence in assessments of plume capture.

A slightly more robust approach would include the use of water level ‘triangles’—using data from monitoring wells or piezometers that are spatially arranged as a network of triangles. This type of evaluation potentially allows for a more reliable assessment of hydraulic gradient magnitude and direction by using three water levels rather than two (well pairs) in order to interpret a gradient direction.

This line of evidence (water level pairs/three-point gradient analysis) will be used to the extent allowed by the locations of the monitoring wells. In the areas downgradient of the River Bank Extraction Wells and East Ravine Extraction Wells, this will not be possible due to the presence of the river. Therefore, river stage measurements will be used and compared to water levels in monitoring wells representing the water table to evaluate the effect of the River Bank and East Ravine Extraction Wells on minimizing the potential discharge of groundwater containing Cr(VI) into the river.

Water Level Contour Maps

With a sufficient number of monitoring locations, the water level elevation data can be spatially integrated by contouring, either manually or via an automated method. Water levels measured in the extraction wells will not be used in the contouring because of the head loss associated with extraction. Methods available to account for such head losses will be used in lieu of installing piezometers immediately adjacent to the extraction wells in an effort to minimize the number of monitoring locations installed. The contour maps will be constructed similarly to the maps presented in past quarterly and annual groundwater monitoring reports for the site.

4.3.3.2 Calculations

Lines of evidence involving calculations generally range from a simple groundwater flux/pumping rate calculation to simple analytical models, to complex numerical flow models, including: (1) simple analytical modeling using an equation representing a well pumping from an aquifer to estimate the dimensions of a capture zone; (2) groundwater discharge comparison; and (3) numerical modeling.

Simple Analytical Modeling

A simple equation representing a well pumping from an aquifer, such as that presented in the USEPA (2008) guidance document, can be used as a line of evidence for assessing plume control. The equation is an expression of Darcy’s Law with a ‘factor,’ as recommended by the USEPA guidance, to account for other potential contributions of water to the extraction location. The addition of the factor increases the requisite extraction rate to achieve a capture zone of a given width. The equation can be used to determine the maximum width of the capture zone created when pumping at a certain extraction rate from an aquifer with certain properties.

This method is based on assumptions similar to those used for Darcy’s Law itself, but nonetheless is considered a useful line of evidence. It should be noted that this assessment method is based on a single pumping well. The operation of multiple pumping wells will create four capture zones that, with sufficient individual extraction rates, will each be larger in dimension due to the superposition of drawdown effects. Thus, this line of evidence should be viewed as conservative (i.e., understates capture zone dimensions) with respect to the potential for intersecting pumping cones.

Groundwater Discharge Comparison

This line of evidence relies on: (1) an estimation of groundwater discharge through the cross-sectional area of a plume where the groundwater extraction system is located; and (2) the measured rates of groundwater extracted by the pumping wells. If the groundwater extraction rate of the plume containment system exceeds the estimated natural groundwater discharge through the portion of the aquifer requiring capture, then the containment system is shown to be successfully capturing the contaminant plume. The limitations of this method are similar to the limitations associated with the previous calculation method for estimating the dimensions of a capture zone (e.g., most notably, the variability of hydraulic conductivity), and thus groundwater discharge comparisons will only be used as one of multiple lines of evidence.

Numerical Modeling

The most robust line of evidence involving calculations is numerical modeling for capture zone assessments. MODFLOW, a three-dimensional groundwater flow simulation program developed by the United States Geological Survey (USGS)—and currently being used to simulate groundwater flow at the site and to assist in the design of the remedy—will continue to be used to evaluate hydraulic capture. MODFLOW will generate a simulated flow field, and groundwater flow paths can then be assessed using path line or particle-tracking procedures such as the MODPATH or MODALL simulations. Due to the limitations associated with locating monitoring wells downgradient of the River Bank and East Ravine Extraction Wells (i.e., the presence of the Colorado River), the use of numeric modeling will be an important line of evidence.

4.3.3.3 Concentration Trends

Although the concentration trends line-of-evidence approach is completely different from other approaches (i.e., water levels analysis or hydraulic calculations), it can be integrated with those other lines of evidence. In the concentration trends approach, assessment of plume control is performed by evaluating the contaminant concentration trends in wells downgradient of the extraction wells. If the analysis of water level data indicates that an extraction system is likely to be preventing any further migration of a plume, then this should also be evident in the concentration response. There are two principles that are applied for this line of evidence:

1. If hydraulic control is likely achieved, wells that are not currently impacted by contaminants (sentinel wells) will remain without impacts over time.
2. If hydraulic control is likely achieved, wells located downgradient of the capture system, but still within the plume, will show decreasing concentrations over time.

The reliability of this line of evidence depends in large part on the locations of the monitoring network with respect to the groundwater extraction wells. With the exception of the few monitoring wells located east of the river, there are very few monitoring wells located downgradient of the proposed River Bank and East Ravine Extraction Wells. Therefore, surface water sample analytical results will be heavily relied upon for this line of evidence, by necessity.

4.3.3.4 Field Methods

The one field method that establishes the actual path of groundwater migration is injecting a tracer into an aquifer and observing that tracer at some location downgradient of the injection point. The use of tracers has several advantages. However, as outlined in the USEPA (2008) guidance document, the use of tracer testing has significant limitations. For example, if the tracer is injected only at select locations as opposed to along an entire vertical and/or horizontal transect of the contaminant plume, a tracer test that appears to support capture may not demonstrate capture of the entire Target Capture Zone. Thus, such field methods are not proposed as a line of evidence to evaluate hydraulic capture at the site.

4.3.4 Demonstration of Consistency Between the Target Capture Zone and the Actual Capture Zone

The final step in the assessment process is evaluating consistency between the defined Target Capture Zone and the interpreted Actual Capture Zone. This step comprises four main components illuminated by key questions:

1. Assess the Target Capture Zone with regard to requirements and objectives. Does the current system achieve RAOs with respect to plume capture?
2. Assess uncertainties in the interpretation of the Actual Capture Zone. Are alternative interpretations possible that would change the conclusions as to whether or not sufficient capture is achieved? In other words, are there data gaps that could be practicably filled?
3. Assess the need for additional characterization and/or monitoring. Is there a need for additional plume delineation or additional monitoring locations to increase the confidence in whether or not actual capture is sufficient?
4. Evaluate the need to reduce or increase extraction rates. Should extraction rates, number of extraction wells, and/or locations be modified based on the results of the capture zone analysis?

Table 4.2-1

Process Control Monitoring Program Analytes and Sampling Frequencies

Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan

Revised Basis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy

PG&E Topock Compressor Station, Needles, California

Analytes:	TOC	Cr(VI)	Cr(T)	Dissolved Mn/Fe/As/Ba	Nitrate	Sulfate	Alkalinity, Cations/ Anions, TDS	Total Fe/Mn	Water Level
National Trails Highway In-Situ Reactive Zone[5]									
Dose Response Monitoring Wells	M(yr), Q	M(yr), Q	Q(yr), SA	M(yr), Q	M(yr), Q	M(yr), Q	as needed	---	Q
Downgradient NTH IRZ Monitoring Wells	Q	Q	SA	Q	Q[3]	as needed	as needed	---	Q
Riverbank Extraction Monitoring Wells [4]	Q	Q	SA	Q	Q[3]	as needed	as needed	---	Q / T
Northern NTH Extraction Monitoring Wells	---	Q	SA	---	---	---	---	---	Q / T
Surface Water	---	Q	SA	Q	---	---	---	---	Q
Northern NTH and Riverbank Extraction Wells	M(Q), Q	M(Q), Q	---	M(Q), Q	---	---	as needed	as needed	Q / T
Combined Extraction Stream	M(Q), Q	M(Q), Q	---	M(Q), Q	---	as needed	as needed	as needed	---
Inner Recirculation Loop[5]									
Dose Response Wells	Q [1]	Q	Q(yr), SA	Q	Q [1]	as needed	as needed	---	Q
Downgradient Wells	---	SA	SA	SA	SA [1]	as needed	as needed	---	Q
Byproduct Monitoring Wells	SA [1]	SA	SA	SA	SA [1]	as needed	as needed	---	Q
Sitewide Monitoring Well Network	---	---	---	---	---	---	---	---	Q
Topock Compressor Station Recirculation Loop[5]									
Dose Response Wells	Q	Q	Q(yr), SA	Q	Q	as needed	as needed	---	Q
Downgradient Wells	SA	SA	SA	SA	SA	as needed	as needed	---	Q
Transwestern Bench Extraction Monitoring Wells	---	Q	SA	---	---	---	---	---	Q / T
East Ravine Extraction Monitoring Wells [4]	---	Q	SA	---	---	---	---	---	Q / T
TW Bench Extraction Wells, East Ravine Extraction Wells	M(Q), Q	M(Q), Q	---	M(Q), Q	---	---	as needed	as needed	Q / T
Combined Extraction Stream	M(Q), Q	M(Q), Q	---	M(Q), Q	---	---	as needed	as needed	--
Freshwater Injection[5]									
Sitewide Monitoring Well Network	---	---	---	---	---	---	---	---	Q

Notes:

Sampling program will be re-evaluated after two years of operation.

[1] If associated injection wells receive carbon injections

[2] Arsenic only (other species if present in injected water above background)

[3] Frequency may be less for shallow wells in the natural reducing rind where nitrate concentrations are non-detect at baseline

[4] Frequency will be less for Arizona wells MW-54, MW-55, and MW-56, with annual monitoring for Cr(VI).

[5] Data collection for each part of the system will begin when operation of that part of the system starts.

Frequencies:

T: Potentially monitored continuously via transducer
M: Monthly
Q: Quarterly
SA: Semi-Annually
A: Annually
(yr): Frequency for the first year, frequency reduction to be considered after first year

Analytes:

TOC: Total organic carbon
Cr(VI): Chromium (VI)
Cr(T): Total dissolved chromium
Mn: Manganese
Fe: Iron
As: Arsenic
Ba: Barium
TDS: Total dissolved solids

Table 4.3-1

Preliminary Construction of Proposed Groundwater Monitoring Wells

Operations and Maintenance Manual Volume 2: Sampling and Analysis Plan

Revised Basis of Design Report/Intermediate (60%) Design Submittal for the Final Groundwater Remedy

PG&E Topock Compressor Station, Needles, California

Monitoring Category / Well ID	Projected Depth to Groundwater (ft bgs)	Projected Saturated Thickness Above Bedrock (ft)	Projected Depth to Bedrock (Projected Well Depth) (ft bgs)	Preliminary Number of Screened Intervals[1]	Preliminary Screened Interval Thickness (ft)[1]	Preliminary Estimate of Screened Intervals (ft bgs)[1]			
Northern NTH IRZ Extraction Monitoring Well									
A	13	359	372	4	40	40 to 80	140 to 180	230 to 270	310 to 350
B	17	327	344	4	40	40 to 80	130 to 170	220 to 260	290 to 330
NTH IRZ Dose Response Monitoring Well									
C	22	197	219	4	20	30 to 50	80 to 100	130 to 150	180 to 200
D	21	166	187	4	20	40 to 60	90 to 110	130 to 150	160 to 180
E	36	99	135	2	20	50 to 70	105 to 125		
F	54	81	135	2	20	70 to 90	105 to 125		
G	57	32	89	1	20	65 to 85			
NTH IRZ Downgradient Well and Riverbank Extraction Monitoring Well									
H	14	184	198	4	20	30 to 50	80 to 100	120 to 140	170 to 190
NTH IRZ Riverbank Extraction Monitoring Well									
O	1	254	255	4	40	20 to 60	80 to 120	140 to 180	200 to 240
IRL Downgradient Monitoring Well									
M	59	169	228	4	20	70 to 90	110 to 130	155 to 175	195 to 215
R	100	184	284	4	20	115 to 135	160 to 180	205 to 225	250 to 270
IRL Dose Response Monitoring Well									
P	57	274	331	4	30	75 to 105	140 to 170	210 to 240	285 to 315
Q	105	195	300	4	30	110 to 140	160 to 190	210 to 240	260 to 290
IRL Byproduct Monitoring Well									
I	67	281	348	4	30	85 to 115	55 to 185	220 to 250	300 to 330
J	118	217	335	4	30	130 to 160	180 to 210	230 to 260	290 to 320
TCS Loop Transwestern Bench Extraction Monitoring Well									
K	94	24	118	1	20	95 to 115			
Freshwater Injection Observation Well									
S	13	149	162	2	40	30 to 70	100 to 140		
Compliance Monitoring Well- Inside Plume									
L	76	177	253	4	20	90 to 110	140 to 160	180 to 200	220 to 240
N	112	124	236	3	20	130 to 150	170 to 190	210 to 230	

Notes:

[1] The identification of separate, laterally-continuous lithostratigraphic or hydrostratigraphic zones by means of correlation from borehole to borehole is not facilitated by the information given on the borehole logs. Therefore, the screened intervals as shown are preliminary, and only based in part on the total projected thickness of the saturated sediments as well as the function of the proposed monitoring. Final determination of the screened intervals will be made based on information collected in the field associated with drilling boreholes for the wells. The objective will be to screen across the most permeable portions of the vertical section and also potentially zones that have the highest concentrations of hexavalent chromium. See report text for more information.

Abbreviations

IRL	Inner Recirculation Loop
NTH IRZ	National Trails Highway In-Situ Reactive Zone
TCS	Topock Compressor Station

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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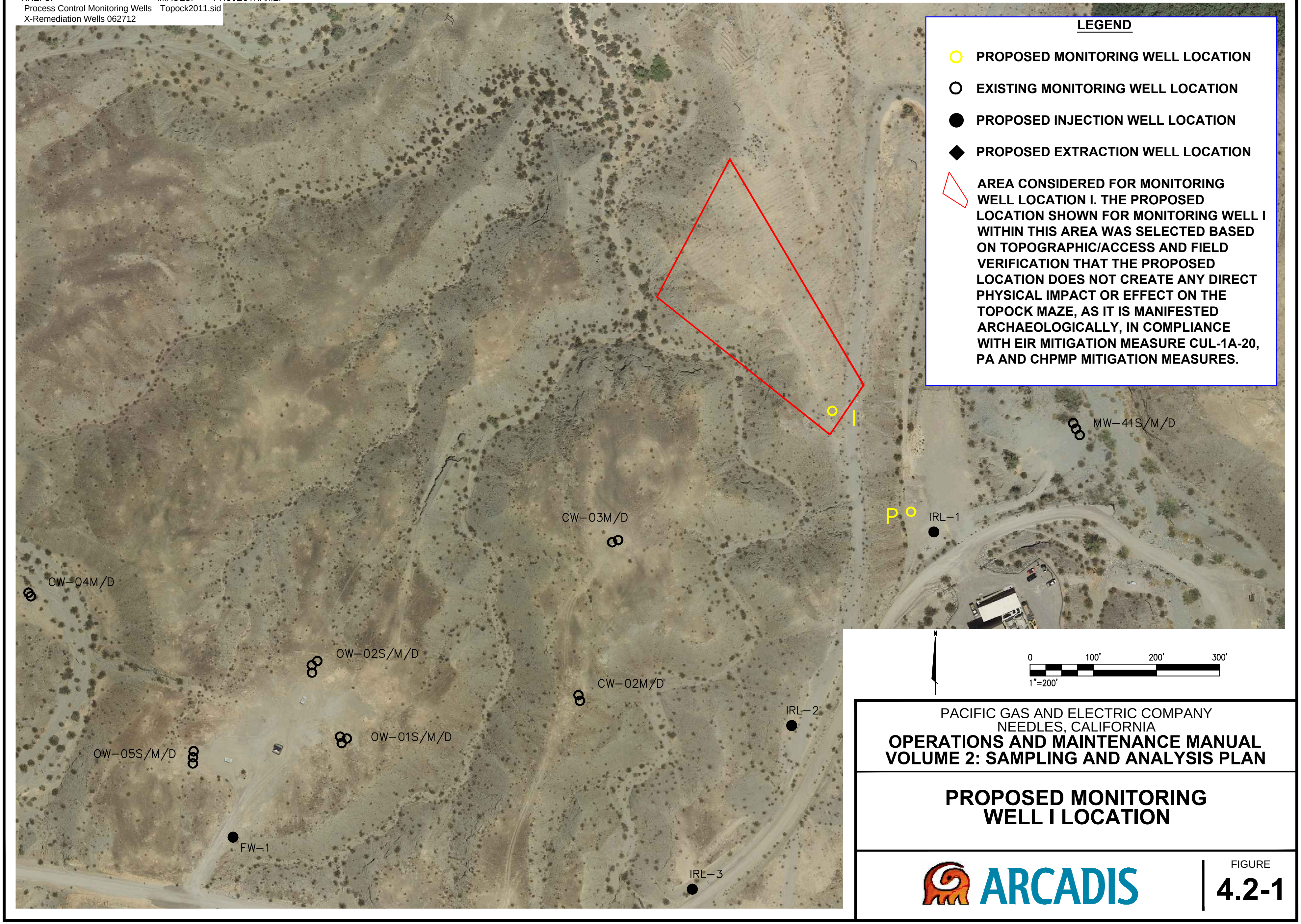


LEGEND

○ PROPOSED MONITORING WELL LOCATION

○ EXISTING MONITORING WELL LOCATION

● PROPOSED INJECTION WELL LOCATION

◆ PROPOSED EXTRACTION WELL LOCATION

▱ AREA CONSIDERED FOR MONITORING WELL LOCATION I. THE PROPOSED LOCATION SHOWN FOR MONITORING WELL I WITHIN THIS AREA WAS SELECTED BASED ON TOPOGRAPHIC/ACCESS AND FIELD VERIFICATION THAT THE PROPOSED LOCATION DOES NOT CREATE ANY DIRECT PHYSICAL IMPACT OR EFFECT ON THE TOPOCK MAZE, AS IT IS MANIFESTED ARCHAEOLOGICALLY, IN COMPLIANCE WITH EIR MITIGATION MEASURE CUL-1A-20, PA AND CHPMP MITIGATION MEASURES.

PACIFIC GAS AND ELECTRIC COMPANY
NEEDLES, CALIFORNIA
OPERATIONS AND MAINTENANCE MANUAL
VOLUME 2: SAMPLING AND ANALYSIS PLAN

PROPOSED MONITORING WELL I LOCATION

ARCADIS

FIGURE
4.2-1

SECTION 5

5.0 Other Sampling and Monitoring

5.1 Monitoring for COPCs

The RCRA Facility Investigation/Remedial Investigation Volume 2 Report and Volume 2 Addendum (CH2M HILL 2009a, 2009b) described that, in addition to Cr(VI), three constituents in groundwater—namely molybdenum, selenium, and nitrate—are potentially related to past releases from SWMU 1/AOC 1. Although the groundwater risk assessment concluded that these three constituents were not present in groundwater at levels of potential concern to future human health or the environment (ARCADIS 2009), DTSC and DOI directed that molybdenum, selenium, and nitrate be monitored in the site-wide groundwater monitoring program and that their associated impacts be considered in future soil and soil to groundwater risk evaluations (DTSC 2009, DOI 2009). The agencies concluded that although the non-cancer hazards associated with these constituents are much lower than those associated with Cr(VI), these constituents do have risks above a hazard index (HI) of 1 and they do contribute to a hazard quotient greater than 1 at localized areas within the plume.

This section provides a description of the monitoring program proposed for these three non-chromium COPCs.

5.1.1 Sampling Locations

The sampling locations for the non-chromium COPCs were selected based on the distribution of these compounds in groundwater. Figures 5.1-1 through 5.1-3 show the average concentrations of one or more COPCs in groundwater. Monitoring wells where COPCs exceed background were included in the monitoring program. In addition, monitoring wells that will be downgradient from areas where COPC concentrations are elevated above background when the remedy is active were also included. Because the remedy is designed to move groundwater across the IRZ, most of these downgradient wells are located on the floodplain or near National Trails Highway. This monitoring network is designed track COPC concentrations in areas where they are currently elevated as well as areas where they may be transported during the remedial action. The monitoring locations and frequencies for the non-chromium COPCs are shown in Table 2.1-2.

Based on monitoring data collected to date, molybdenum is the COPC for which elevated concentrations above background are most widespread (Figure 5.1-1). Many of the bedrock wells in the East Ravine have molybdenum concentrations above background. Molybdenum is also more widespread in the alluvial aquifer, particularly in the deep zone. There are 66 wells identified for molybdenum sampling.

Selenium is elevated above background in just a few wells scattered across the site and only in the alluvial aquifer. The highest concentrations are in the vicinity of the compressor station (Figure 5.1-2). It is not elevated in bedrock wells. There are 31 wells identified for selenium sampling.

Nitrate is distributed similarly to selenium, with highest concentrations near the compressor station and a few sporadic other locations (Figure 5.1-3). Because nitrate is a sensitive geochemical indicator parameter, extensive nitrate monitoring is proposed to be performed as part of the process control monitoring for the final remedy (see Section 4.0). The 25 sampling locations where nitrate is assigned an annual monitoring frequency in Table 2.1-2 are intended primarily for monitoring nitrate as a non-chromium COPC. The sampling locations where nitrate is assigned a more frequent monitoring interval are intended for process control monitoring.

If there is a need to perform another risk assessment in the future, it is recommended that a wider network of wells be included for non-chromium COPC monitoring. The network proposed herein is specifically designed to monitor the highest concentrations of these compounds and will therefore not accurately reflect their average concentrations across the site.

5.1.2 Sampling Frequencies

An annual sampling frequency is proposed for the non-chromium COPCs. This is considered to be adequate for tracking the changes in the distribution of these constituents during the remedial action. Trend analysis will be conducted using the data collected and monitoring frequency can be increased or decreased if needed in any wells or areas.

5.2 Monitoring of Freshwater Source (HNWR-1)

This section describes the program that will be implemented to monitor the quality of water produced by the Havasu National Wildlife Reserve well HNWR-1 during the implementation of the Topock remedial action. The purpose of this monitoring program is to ensure that the quality of the fresh water meets the desired water quality for the freshwater injection system at the Topock site (i.e., desired quality to prevent well and aquifer plugging and to protect the receiving aquifer water quality). A detailed discussion of the desired water quality for injection is included in the 60% BOD Report (Section 3.3, Freshwater Supply and Storage).

HNWR-1 has been sampled and analyzed by Pacific Gas and Electric Company (PG&E) between November 2010 and January 2013 (see Exhibit 5.2-1). The analytical suite has included a broad range of compounds, both organic and inorganic. Arsenic was the only compound that exceeded a Maximum Contaminant Level (10 μg/L). The naturally occurring arsenic concentration in Well HNWR-1 ranges from 15 to 16 μg/L, below the site background concentration of 24.3 μg/L.

The specific chemical of concern (COC) at the Topock site is hexavalent chromium, and the COPCs are selenium, molybdenum, and nitrate. Generally, the water from HNWR-1 contains concentrations of selenium, molybdenum, and nitrate that are significantly lower than those found at the Topock site. The highest Cr(VI) concentration found in HNWR-1 to date is 18 μg/L, which is well below the site background concentration of 32 μg/L.

5.2.1 Proposed Analytes and Frequencies

The monitoring program for HNWR-1 is designed to track concentrations of the COC and COPCs associated with Topock as well as to provide periodic monitoring for a wide range of potential contaminants, both organic and inorganic, that have never been detected at the Topock site but could be undesirable or harmful if present in the injected water. Because of the lack of nearby sources, the likelihood of organic contaminants being present in HNWR-1 is small; therefore, the frequency of analysis for organics and pesticides will be lower than for metals and common ions.

The monitoring program will include metals, common anions and cations, total dissolved and suspended solids, total organic carbon, and stable isotopes of oxygen and hydrogen. These analyses provide a means for tracking overall changes in water quality with time. In addition, one of the common cations, manganese (Mn), has been found to be an important factor in partial plugging of injection wells at the Topock site, so it will be important to track Mn concentrations in order to maintain the performance of the injection wells. The proposed analytes list for HNWR-1 is provided in Exhibit 5.2-2.

Monitoring frequency for the inorganic suite will be quarterly for the first year of operation, switching to semi-annual in subsequent years. Monitoring frequency for the organic analytical suite will be annual for the first two years, switching to every other year in subsequent years. The monitoring frequency can be adjusted as needed based on actual data and information collected at the supply well (HNWR-1) as well as at the monitoring locations for the freshwater injection points.

Exhibit 5.2-1
Summary of HNWR-1 Well Sample Results
Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

	Location:	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
	Sample Date:	11/10/2010	2/23/2012	3/14/2012	4/4/2012	6/27/2012	1/22/2013
Parameter	**Units**						
Field							
Dissolved oxygen	mg/L	**5.33**	**3.52**	**3.29**	**3.72**	---	---
Oxidation reduction potential	mV	**159**	**172**	**200**	**112**	**33.5**	---
pH	pH units	**7.84**	**7.68**	**7.61**	**8.07**	**7.51**	---
Salinity	%	**0.42**	**0.0662**	**0.0537**	**0.0509**	**0.439**	---
Specific conductance	µS/cm	**870**	**1,024**	**830**	**787**	**6,791**	---
Temperature	°C	**35.9**	**38.3**	**38.1**	**38.0**	**37.9**	---
Turbidity	NTU	**5.10**	**5.10**	**2.50**	---	**8.00**	---
Anions							
Chloride	mg/L	---	**130**	**130**	**130**	**130**	---
Fluoride	mg/L	**3.80**	---	---	---	**4.00**	**3.90**
Nitrate (as nitrogen)	mg/L	**2.50**	**2.60**	**2.50**	**2.50**	**2.60**	---
Sulfate	mg/L	**47.0**	**45.0**	**44.0**	**45.0**	**44.0**	---
General Chemistry							
Alkalinity, bicarb as CaCO3	mg/L	---	**110**	**110**	**110**	**100**	---
Alkalinity, carb as CaCO3	mg/L	---	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	---
Alkalinity, hydroxide	mg/L	---	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	---
Alkalinity, total as CaCO3	mg/L	**100**	**110**	**110**	**110**	**100**	---
Ammonia as nitrogen	mg/L	ND (0.1)	**0.13**	**0.12**	**0.15**	ND (0.1)	---
Cyanide	mg/L	---	---	ND (0.01)	ND (0.01)	ND (0.01)	---
Deuterium	0/00	**-75.3**	**-73.8**	---	---	**-77.1**	---
Oxygen 18	0/00	**-10.3**	**-10.2**	---	---	**-10.2**	---
Soluble silica	mg/L	**28.6**	---	---	---	**25.9**	---
Specific conductance	µS/cm	**740**	---	---	---	---	---
Total dissolved solids	mg/L	**490 J**	**480**	**510**	**430**	**440**	---
Total Kjeldahl Nitrogen	mg/L	ND (0.4)	---	---	---	---	---
Total organic carbon	mg/L	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	---
Total suspended solids	mg/L	---	---	ND (10)	---	ND (10)	---
Herbicides							
2,4,5-T	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
2,4,5-TP (Silvex)	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
2,4-D	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
2,4-DB	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
4-Nitrophenol	µg/L	---	---	ND (2.7)	---	---	---
Dalapon	µg/L	---	---	ND (4.4)	ND (0.42)	---	---
Dicamba	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
Dichlorprop	µg/L	---	---	ND (2.7)	ND (0.26)	---	---

Exhibit 5.2-1
Summary of HNWR-1 Well Sample Results
Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

	Location:	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
	Sample Date:	11/10/2010	2/23/2012	3/14/2012	4/4/2012	6/27/2012	1/22/2013
Parameter	**Units**						
Herbicides							
Dinoseb	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
MCPA	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
MCPP	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
Pentachlorophenol	µg/L	---	---	ND (2.7)	ND (0.26)	---	---
Metals							
Aluminum, dissolved	µg/L	ND (50)	---	ND (50)	ND (50)	ND (50)	---
Antimony, dissolved	µg/L	ND (10)	ND (10)	ND (10)	ND (0.5)	ND (0.5)	---
Arsenic	µg/L	---	---	---	---	---	**16.0**
Arsenic, dissolved	µg/L	**15.0**	**15.0**	**16.0**	**15.0**	**16.0**	**16.0**
Barium, dissolved	µg/L	**130**	**110**	**110**	**110**	**110**	---
Beryllium, dissolved	µg/L	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	---
Boron, dissolved	µg/L	**380**	---	---	---	---	---
Cadmium, dissolved	µg/L	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0)	---
Calcium, dissolved	µg/L	**23,000**	**19,000 J**	**19,000**	**20,000**	---	---
Chromium, Hexavalent	µg/L	**17.5**	**15.0**	**18.0**	**14.0**	**15.0**	---
Chromium, total dissolved	µg/L	**19.2**	**16.0**	**18.0**	**17.0**	**18.0**	---
Cobalt, dissolved	µg/L	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0)	---
Copper, dissolved	µg/L	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	---
Iron, dissolved	µg/L	ND (20)	**37.0**	ND (20)	**25.0**	**38.0**	---
Lead, dissolved	µg/L	ND (10)	ND (10)	ND (10)	ND (10)	ND (10)	---
Magnesium, dissolved	µg/L	**4,000**	**3,100**	**3,200 J**	**3,100 J**	---	---
Manganese, dissolved	µg/L	ND (10)	**1.90**	**0.64**	**1.70**	**1.70**	---
Mercury, dissolved	µg/L	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	ND (0.2)	---
Molybdenum, dissolved	µg/L	**11.0**	**9.40**	**10.0**	**9.00**	**9.10**	---
Nickel, dissolved	µg/L	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	ND (5.0)	---
Potassium, dissolved	µg/L	**5,100**	**4,400**	**4,000**	**3,700**	---	---
Selenium, dissolved	µg/L	**0.73**	**0.87**	**0.75**	**0.75**	**0.71**	---
Silver, dissolved	µg/L	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0)	ND (3.0) J	---
Sodium, dissolved	µg/L	**130,000**	**130,000**	**130,000**	**130,000**	---	---
Thallium, dissolved	µg/L	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	---
Vanadium, dissolved	µg/L	**20.0**	**21.0**	**22.0 J**	**20.0**	**20.0**	---
Zinc, dissolved	µg/L	ND (10)	ND (10)	**16.0**	ND (10)	ND (10)	---
Perchlorate							
Perchlorate	µg/L	---	---	ND (2.0)	ND (2.0)	---	---
Pesticides							
4,4-DDD	µg/L	---	---	ND (0.053)	ND (0.052)	---	---

Exhibit 5.2-1

Summary of HNWR-1 Well Sample Results

Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

	Location:	**HNWR-01**	**HNWR-01**	**HNWR-01**	**HNWR-01**	**HNWR-01**	**HNWR-01**
	Sample Date:	**11/10/2010**	**2/23/2012**	**3/14/2012**	**4/4/2012**	**6/27/2012**	**1/22/2013**
Parameter	**Units**						
Pesticides							
4,4-DDE	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
4,4-DDT	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
Aldrin	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
alpha-BHC	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
alpha-Chlordane	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
beta-BHC	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
delta-BHC	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
Dieldrin	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
Endo sulfan I	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
Endo sulfan II	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
Endosulfan sulfate	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
Endrin	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
Endrin aldehyde	µg/L	---	---	ND (0.053)	ND (0.052)	---	---
gamma-BHC	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
gamma-Chlordane	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
Heptachlor	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
Heptachlor Epoxide	µg/L	---	---	ND (0.027)	ND (0.026)	---	---
Methoxy chlor	µg/L	---	---	ND (0.27)	ND (0.26)	---	---
Toxaphene	µg/L	---	---	ND (2.7) J	ND (2.6) J	---	---
Polyaromatic Hydrocarbons							
1-Methyl naphthalene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
2-Methyl naphthalene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Acenaphthene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Acenaphthylene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Anthracene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
B(a)P Equivalent	µg/L	---	---	ND (0.19)	ND (0.18)	---	---
Benzo (a) anthracene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Benzo (a) pyrene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Benzo (b) fluoranthene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Benzo (ghi) perylene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Benzo (k) fluoranthene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Chrysene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Dibenzo (a,h) anthracene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Fluoranthene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Fluorene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Indeno (1,2,3-cd) pyrene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Naphthalene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---

Exhibit 5.2-1
Summary of HNWR-1 Well Sample Results
Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

Location:		HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
Sample Date:		11/10/2010	2/23/2012	3/14/2012	4/4/2012	6/27/2012	1/22/2013
Parameter	**Units**						
Polyaromatic Hydrocarbons							
PAH High molecular weight	µg/L	---	---	ND (0.0)	ND (0.0)	---	---
PAH Low molecular weight	µg/L	---	---	ND (0.0)	ND (0.0)	---	---
Phenanthrene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Pyrene	µg/L	---	---	ND (0.22)	ND (0.2)	---	---
Polychlorinated Biphenyls							
Aroclor 1016	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Aroclor 1221	µg/L	---	---	ND (1.1)	ND (1.0)	---	---
Aroclor 1232	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Aroclor 1242	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Aroclor 1248	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Aroclor 1254	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Aroclor 1260	µg/L	---	---	ND (0.53)	ND (0.52)	---	---
Total Petroleum Hydrocarbons							
TPH as diesel	µg/L	---	---	**190**	ND (51) J	---	---
TPH as gasoline	µg/L	---	---	ND (100)	ND (100)	---	---
TPH as motor oil	µg/L	---	---	ND (53)	ND (51)	---	---
Volatile Organic Compounds							
1,1,1,2-Tetrachloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1,1-Trichloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1,2,2-Tetrachloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1,2-Trichloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1,2-Trichlorotrifluoroethane (Freon 113)	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1-Dichloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1-Dichloroethene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,1-Dichloropropene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2,3-Trichlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2,3-Trichloropropane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2,4-Trichlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2,4-Trimethylbenzene	µg/L	---	---	ND (1.0)	ND (1.0) J	---	---
1,2-Dibromo-3-chloropropane	µg/L	---	---	ND (2.0)	ND (2.0)	---	---
1,2-Dibromoethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2-Dichlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2-Dichloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,2-Dichloropropane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,3,5-Trimethylbenzene	µg/L	---	---	ND (1.0)	ND (1.0) J	---	---
1,3-Dichlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---

Exhibit 5.2-1
Summary of HNWR-1 Well Sample Results

Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

	Location:	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01	HNWR-01
	Sample Date:	11/10/2010	2/23/2012	3/14/2012	4/4/2012	6/27/2012	1/22/2013
Parameter	**Units**						
Volatile Organic Compounds							
1,3-Dichloropropane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
1,4-Dichlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
2,2-Dichloropropane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
2-Chlorotoluene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
4-Isopropyltoluene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Acetone	µg/L	---	---	ND (10)	ND (10)	---	---
Acrolein	µg/L	---	---	ND (20)	ND (20)	---	---
Acrylonitrile	µg/L	---	---	ND (20)	ND (20)	---	---
Benzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Bromobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Bromochloromethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Bromodichloromethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Bromoform	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Bromomethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Carbon disulfide	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Carbon tetrachloride	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Chloro methane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Chlorobenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Chloroethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Chloroform	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
cis-1,2-Dichloroethene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
cis-1,3-Dichloropropene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Dibromochloromethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Dibromomethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Dichlorodifluoromethane	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Ethylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Hexachlorobutadiene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Isopropylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
m,p-Xylenes	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Methyl ethyl ketone	µg/L	---	---	ND (10)	ND (10)	---	---
Methyl isobutyl ketone	µg/L	---	---	ND (10)	ND (10)	---	---
Methyl tert-butyl ether (MTBE)	µg/L	---	---	ND (1.0)	ND (1.0) J	---	---
Methylene chloride	µg/L	---	---	ND (5.0)	ND (5.0)	---	---
N-Butylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
N-Propylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
o-Xylene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
p-Chlorotoluene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---

Exhibit 5.2-1

Summary of HNWR-1 Well Sample Results

Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

Location:		**HNWR-01**	**HNWR-01**	**HNWR-01**	**HNWR-01**	**HNWR-01**	**HNWR-01**
Sample Date:		**11/10/2010**	**2/23/2012**	**3/14/2012**	**4/4/2012**	**6/27/2012**	**1/22/2013**
Parameter	**Units**						
Volatile Organic Compounds							
sec-Butylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Styrene	µg/L	---	---	ND (1.0)	ND (1.0) J	---	---
tert-Butylbenzene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Tetrachloroethene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Toluene	µg/L	---	---	ND (2.5)	ND (2.5)	---	---
trans-1,2-Dichloroethene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
trans-1,3-Dichloropropene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Trichloroethene	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Trichlorofluoromethane (Freon 11)	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Vinyl chloride	µg/L	---	---	ND (1.0)	ND (1.0)	---	---
Xylenes, total	µg/L	---	---	ND (2.0)	ND (2.0)	---	---

Notes:

---	not collected or not available.
%	percent
0/00	differences from global standards in ppt.
°C	degrees Celcius.
J	analyte was present, but reported value was estimated.
mg/L	milligrams per liter.
mV	millivolts.
ND	parameter not detected at the listed reporting limit.
NTU	nephelometric turbidity units.
µg/L	micrograms per liter.
µS/cm	microSiemens per centimeter.

EXHIBIT 5.2-2

Analytical Suite for HNWR-1 Samples

Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

INORGANIC ANALYTICAL SUITE – Initial Frequency Quarterly			
Field Parameters			
Dissolved oxygen	pH	Specific conductance	Turbidity
Oxidation reduction potential	Salinity	Temperature	
Anions (Method E300.0)			
Chloride	Fluoride	Nitrate (as nitrogen)	Sulfate
General Chemistry (Methods SM2320-B, SM4500-NH3, SM4500-CN, SM4500-Si C/D, SM2540-C, SM2540, SM5310, CF-IRMS)			
Alkalinity, total as $CaCO_3$	Deuterium	Soluble silica	Total organic carbon (TOC)
Ammonia as nitrogen	Oxygen 18	Total dissolved solids (TDS)	Total suspended solids (TSS)
Cyanide			
Metals (Methods SW6010C, SW6020A, SW7470A, E218.6)			
Aluminum, dissolved	Calcium, dissolved	Magnesium, dissolved	Silver, dissolved
Antimony, dissolved	Chromium, Hexavalent	Manganese, dissolved	Sodium, dissolved
Arsenic, dissolved	Chromium, total dissolved	Mercury, dissolved	Thallium, dissolved
Barium, dissolved	Cobalt, dissolved	Molybdenum, dissolved	Vanadium, dissolved
Beryllium, dissolved	Copper, dissolved	Nickel, dissolved	Zinc, dissolved
Boron, dissolved	Iron, dissolved	Potassium, dissolved	
Cadmium, dissolved	Lead, dissolved	Selenium, dissolved	
ORGANIC ANALYTICAL SUITE – Initial Frequency Annually			
Herbicides (Method SW8151A)			
2,4,5-T	2,4-DB	Dicamba	MCPA
2,4,5-TP (Silvex)	4-Nitrophenol	Dichlorprop	MCPP
2,4-D	Dalapon	Dinoseb	Pentachlorophenol
Pesticides (Method SW8081A)			
4,4-DDD	alpha-Chlordane	Endo sulfan II	gamma-Chlordane
4,4-DDE	beta-BHC	Endosulfan sulfate	Heptachlor
4,4-DDT	delta-BHC	Endrin	Heptachlor epoxide
Aldrin	Dieldrin	Endrin aldehyde	Methoxychlor
alpha-BHC	Endo sulfan I	gamma-BHC	Toxaphene
Polyaromatic Hydrocarbons (Method SW8270SIM)			
1-Methyl naphthalene	Benzo (a) anthracene	Chrysene	Naphthalene
2-Methyl naphthalene	Benzo (a) pyrene	Dibenzo (a,h) anthracene	Phenanthrene
Aenaphthene	Benzo (b) fluoranthene	Fluoranthene	Pyrene
Acenaphthylene	Benzo (ghi) perylene	Fluorene	
Anthracene	Benzo (k) fluoranthene	Indeno (1,2,3-cd) pyrene	
Volatile Organic Compounds (Method SW8260B or C)			
1,1,1,2-Tetrachloroethane	1,3,5-Trimethylbenzene	Carbon tetrachloride	Methylene chloride
1,1,1-Trichloroethane	1,3-Dichlorobenzene	Chloro methane	N-Butylbenzene
1,1,2,2-Tetrachloroethane	1,3-Dichloropropane	Chlorobenzene	N-Propylbenzene
1,1,2-Trichloroethane	1,4-Dichlorobenzene	Chloroethane	o-Xylene
1,1,2-Trichlorotrifluoroethane	2,2-Dichloropropane	Chloroform	p-Chlorotoluene
1,1-Dichloroethane	2-Chlorotoluene	cis-1,2-Dichloroethene	sec-Butylbenzene
1,1-Dichloroethene	4-Isopropyltoluene	cis-1,3-Dichloropropene	Styrene
1,1-Dichloropropene	Acetone	Dibromochloromethane	tert-Butylbenzene
1,2,3-Trichlorobenzene	Acrolein	Dibromomethane	Tetrachloroethene
1,2,3-Trichloropropane	Acrylonitrile	Dichlorodifluoromethane	Toluene
1,2,4-Trichlorobenzene	Benzene	Ethylbenzene	trans-1,2-Dichloroethene
1,2,4-Trimethylbenzene	Bromobenzene	Hexachlorobutadiene	trans-1,3-Dichloropropene
1,2-Dibromo-3-chloropropane	Bromochloromethane	Isopropylbenzene	Trichloroethene
1,2-Dibromoethane	Bromodichloromethane	m,p-Xylenes	Trichlorofluoromethane (Freon 11)
1,2-Dichlorobenzene	Bromoform	Methyl ethyl ketone	Vinyl chloride
1,2-Dichloroethane	Bromomethane	Methyl isobutyl ketone	Xylenes, total
1,2-Dichloropropane	Carbon disulfide	Methyl tert-butyl ether (MTBE)	

5.2.2 Source Water Assessment

In response to comments received at the May 16, 2012 Technical Working Group (TWG) meeting on protection of the water quality at HNWR-1 and the potential need for additional monitoring wells for source protection, a source water assessment was conducted to identify potential sources of contaminants within the radius of influence of a supply well (HWNR-1). Arizona guidelines provide a method of calculating the appropriate radius for this assessment, based on a simple equation that represents the area from which water would be drawn over a specific period of time. Arizona uses a travel time of five years for public water supply assessments.

The calculated fixed-radius equation from Arizona guidance (ADEQ 1999) is as follows:

$$r = \sqrt{}(\frac{Qt}{\pi n H})$$

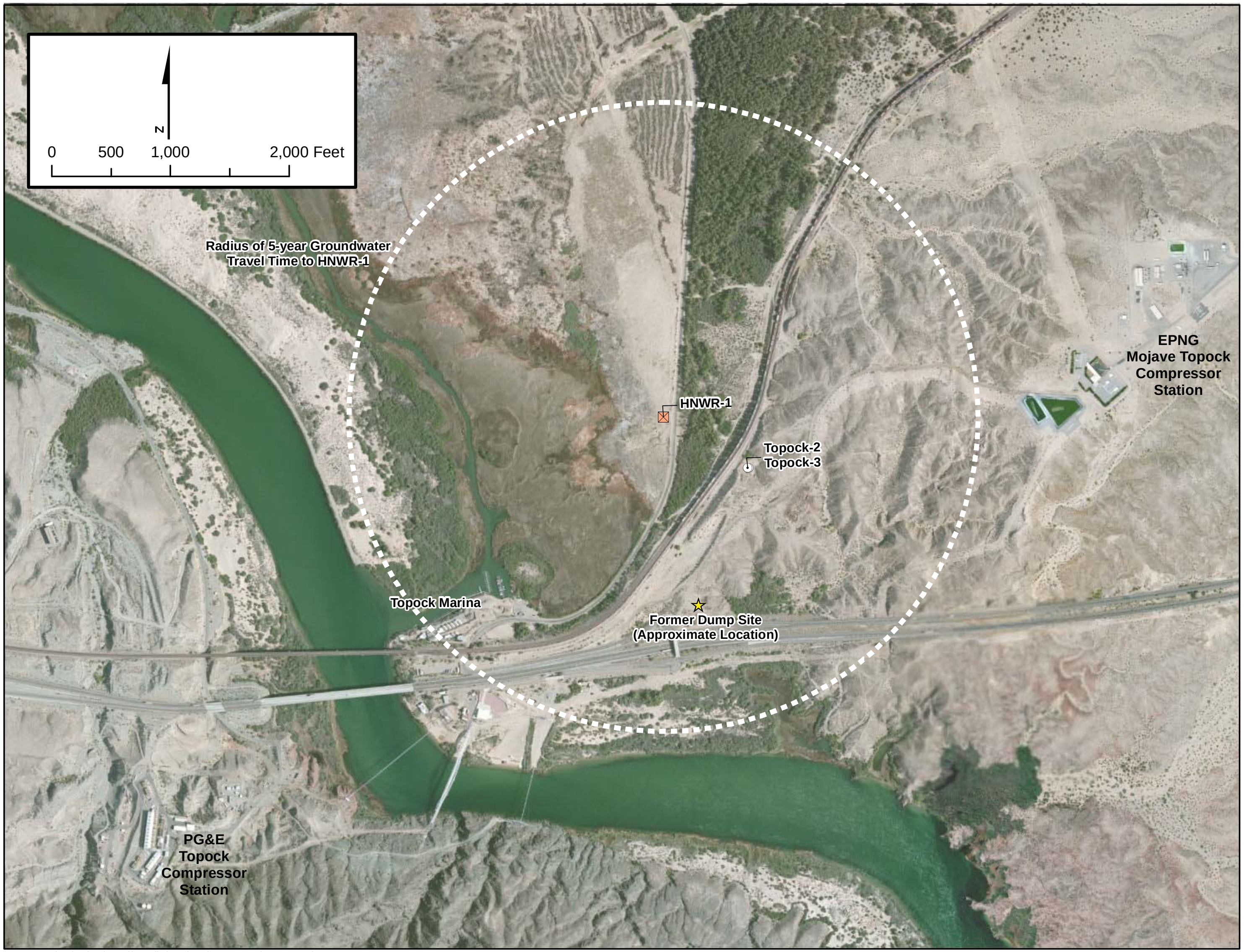
Where:

Q = well’s discharge in cubic feet per year (31,620,321 ft^2/yr)
t = time of travel in years (5 years for public supply wells in Arizona)
π = 3.1416
n = aquifer porosity (11 percent)
H = screen length in feet (65 feet)
r = radius (defines the boundary of the delineated source water protection area in feet around the well)

For the HNWR-1 well, with a screened interval spanning 65 feet and pumping at the current design (modeled) flow rate of 450 gallons per minute (gpm), this equation resolves to a radius of 2,653 feet, or approximately half a mile. This radius extends to within 500 feet of the Kinder Morgan Mojave Topock Compressor Station in Arizona and encompasses the Topock Marina area (see Exhibit 5.2-3). As shown in Exhibit 5.2-3, the majority of the property in this radius is undeveloped (most is HNWR land); known/planned developments in the area include the Topock Marina on Historic Route 66, Topock Mobile Home Park, nearby private properties, Southwest Water Company, BNSF Railroad, Interstate 40, and Kinder Morgan Mojave Topock Compressor Station. Also within this radius is a former dump area about which DTSC expressed concern. This dump consists of small area of rusty cans and other metal debris scattered on the land surface. The source and date of deposition of this debris is currently unknown. It is located adjacent to a flat area that may have housed a military or work crew encampment.

Most of the water produced by HNWR-1 is expected to come from the Colorado River (via its partial diversion into Topock Marsh), although some will be derived from groundwater flowing down from the Sacramento Valley to the east (CH2M HILL 2012c). There are currently no monitoring wells in Sacramento Wash. The property upstream in Sacramento Wash is undeveloped for miles. The ADEQ conducted a survey of water quality in the Sacramento Valley in 1999 (ADEQ 2001). This survey found fluoride, chloride, and TDS to be the only constituents present in slightly elevated concentrations in the Topock area. Considering the lack of existing contaminant sources in the Sacramento Valley (Exhibit 5.2-3), the installation of monitoring wells in Sacramento Wash upstream of HNWR-1 for source water protection is not considered warranted. The Topock-2 and -3 wells are located between HNWR-1 and the former dump area, so in the unlikely event that groundwater contaminants are migrating from the dump area, they would be expected to be detected first at Topock-2 and -3.

As mentioned previously, the majority of the water produced from HNWR-1 will likely originate from the Colorado River. The travel time of constituents in river water to a nearby well may take many years, depending on their mobility (CH2M HILL 2012c); therefore, river water quality is a good indicator and should be used for source water protection of HNWR-1. There is an abundance of water quality data available for the Colorado River. The river in the immediate vicinity of the site and downstream is monitored by the Metropolitan Water District of Southern California (MWD). MWD samples for a wide range of parameters, including emerging contaminants. In addition, the Lower Colorado River Regional Water Quality Database (http://www.snwa.com/apps/wq_database/index.cfml) contains more than 2 million records covering nearly 1,000 different parameters, including depth, temperature, pH, conductivity, dissolved oxygen, nutrients, metals, and organics. Information in the database is provided by Southern Nevada Water Authority, City of Las Vegas,



Document Path: D:\Projects\Topock\MapFiles\2013\CMS\5yr_GWTravel_HNWR1.mxd

EXHIBIT 5.2-3
RADIUS OF 5-YEAR GROUNDWATER TRAVEL TIME TO HNWR-1

GROUNDWATER REMEDY DRAFT OPERATION AND MAINTENANCE MANUAL
VOLUME 2: SAMPLING AND MONITORING PLAN
PG&E TOPOCK COMPRESSOR STATION, NEEDLES, CALIFORNIA

CH2MHILL®

Clark County Water Reclamation District, University of Nevada Las Vegas (UNLV), U.S. Bureau of Reclamation Denver, U.S. Bureau of Reclamation Lower Colorado River, City of Henderson, MWD, Clark County Regional Flood Control District, and the Colorado River Regional Sewer Coalition. Considering the large volume of good quality data available on water quality in the Lower Colorado River, additional river sampling for the purposes of source water protection of HNWR-1 is not considered warranted.

5.3 Process Control Monitoring for Remedy-produced Water Management System

This section describes the program that will be implemented to monitor the quality of water at the Remedy-produced Water Management System during the implementation of the Topock remedial action. The primary objective for process control monitoring is to evaluate effluent water quality and its possible effects with regard to the reuse options (Cooling Tower makeup and re-injection to the NTH IRZ wells), and allow for process optimization/adjustment. Periodic monitoring of influent water will also assist with process optimization.

5.3.1 Sampling Locations

Samples will be collected from the following areas of the Remedy-produced Water Management System:

- Interconnecting piping sampling port to the four influent tanks
- Remedy A Side and Freshwater B Side filter system effluent sampling ports
- Conditioned water tank farm (TNK-401 to TNK-404) discharge piping sampling port
- Conditioned water tank (TNK-510) discharge piping sampling port

Sample locations are identified on the piping and instrumentation diagram (P&ID) shown on Exhibit 5.3-1. Samples will be collected only during regular daytime working hours on the weekdays and while the Remedy-produced Water Management System is in service.

5.3.2 Sampling Analytes and Frequencies

The monitoring program will include metals, common anions and cations, total dissolved and suspended solids, and total organic carbon. The proposed analytical suite for process control monitoring is provided in Exhibit 5.3-2.

Samples will be collected for the inorganic analytical suite annually. Field parameters will be measured on a daily or weekly basis as shown on Exhibit 5.3-2. The monitoring frequency can be adjusted as needed based on actual data and information collected during operation of the Remedy-produced Water Management System.

5.4 Process Control Monitoring for Freshwater Pre-injection Treatment System

This section describes the program that will be implemented to monitor the quality of water at the Freshwater Pre-Injection Treatment System (FWPTS) during the implementation of the Topock remedial action. The primary objective for process control monitoring is to evaluate effluent water quality, treatment and regeneration performance, and allow for process optimization/adjustment. Periodic monitoring of influent water will also assist with process optimization.

5.4.1 Sampling Locations

Samples will be collected from the following areas of the FWPTS:

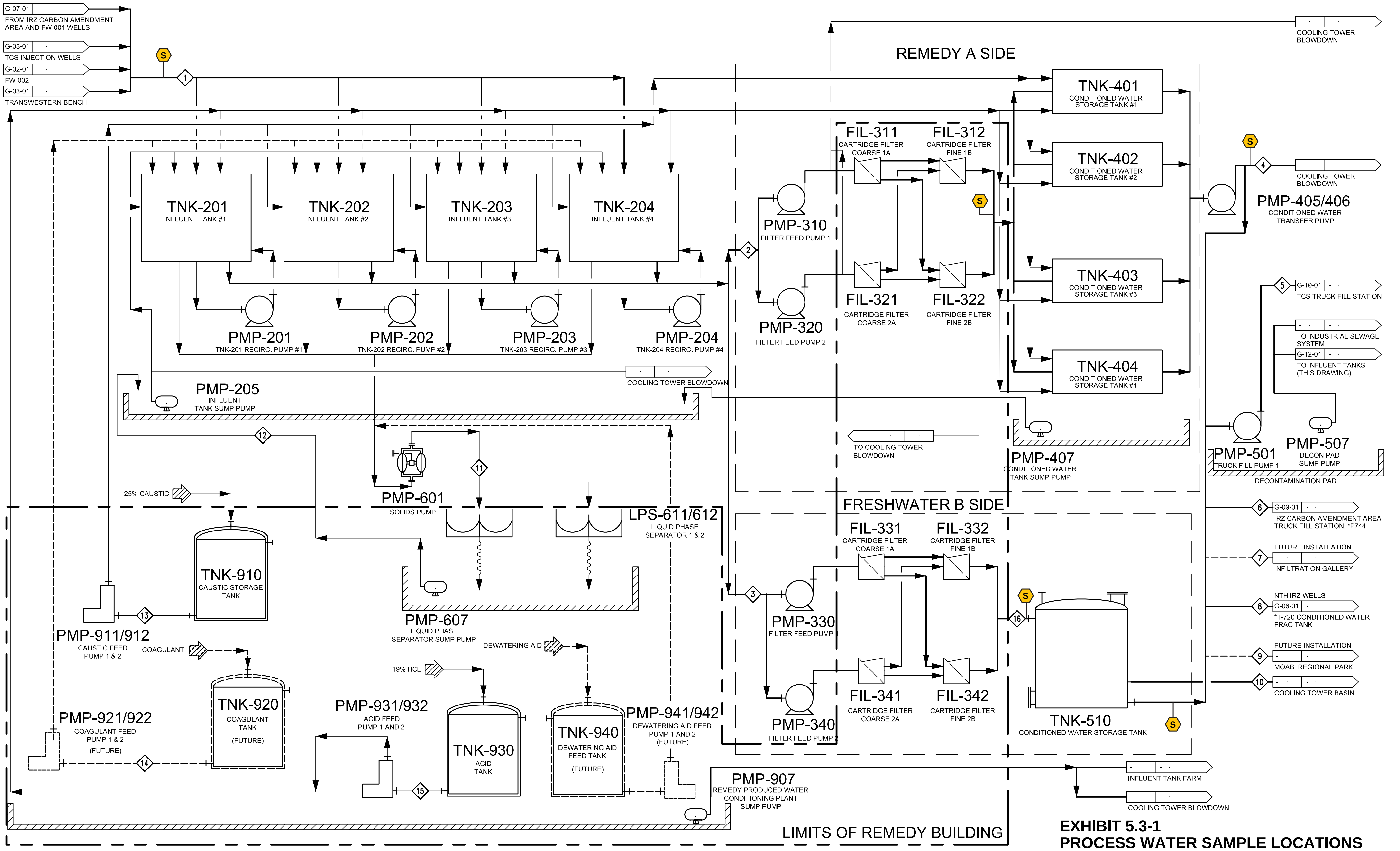
- Untreated water pre- and post-filter
- Treated water pre and post-filter
- Pre and post-backwash/regeneration and
- Final wastewater quality location

Preliminary sample locations are identified on the process flow diagram shown on Exhibit 5.4-1; more precise sample locations will be identified on the forthcoming P&ID. Samples will be collected only during regular daytime working hours on the weekdays and while the FWPTS is in service.

5.4.2 Sampling Analytes and Frequencies

The monitoring program will include metals, common anions and cations, residual chlorine, turbidity, total dissolved and suspended solids. The proposed analytical suite for process control monitoring is provided in Exhibit 5.4-2.

Samples will be collected for fluoride, arsenic, pH, residual chlorine, turbidity, total suspended solids, and conductivity. Field parameters will be measured on a daily or weekly basis as shown on Exhibit 5.4-2. The monitoring frequency can be adjusted as needed based on actual data and information collected during operation of the FWPTS.



LEGEND

S Sampling Port

EXHIBIT 5.3-1
PROCESS WATER SAMPLE LOCATIONS
REMEDY-PRODUCED WATER CONDITIONING
GROUNDWATER REMEDY BASIS OF DESIGN REPORT
INTERMEDIATE (60%) DESIGN,
PG&E TOPOCK COMPRESSOR STATION,
NEEDLES, CALIFORNIA

CH2MHILL®

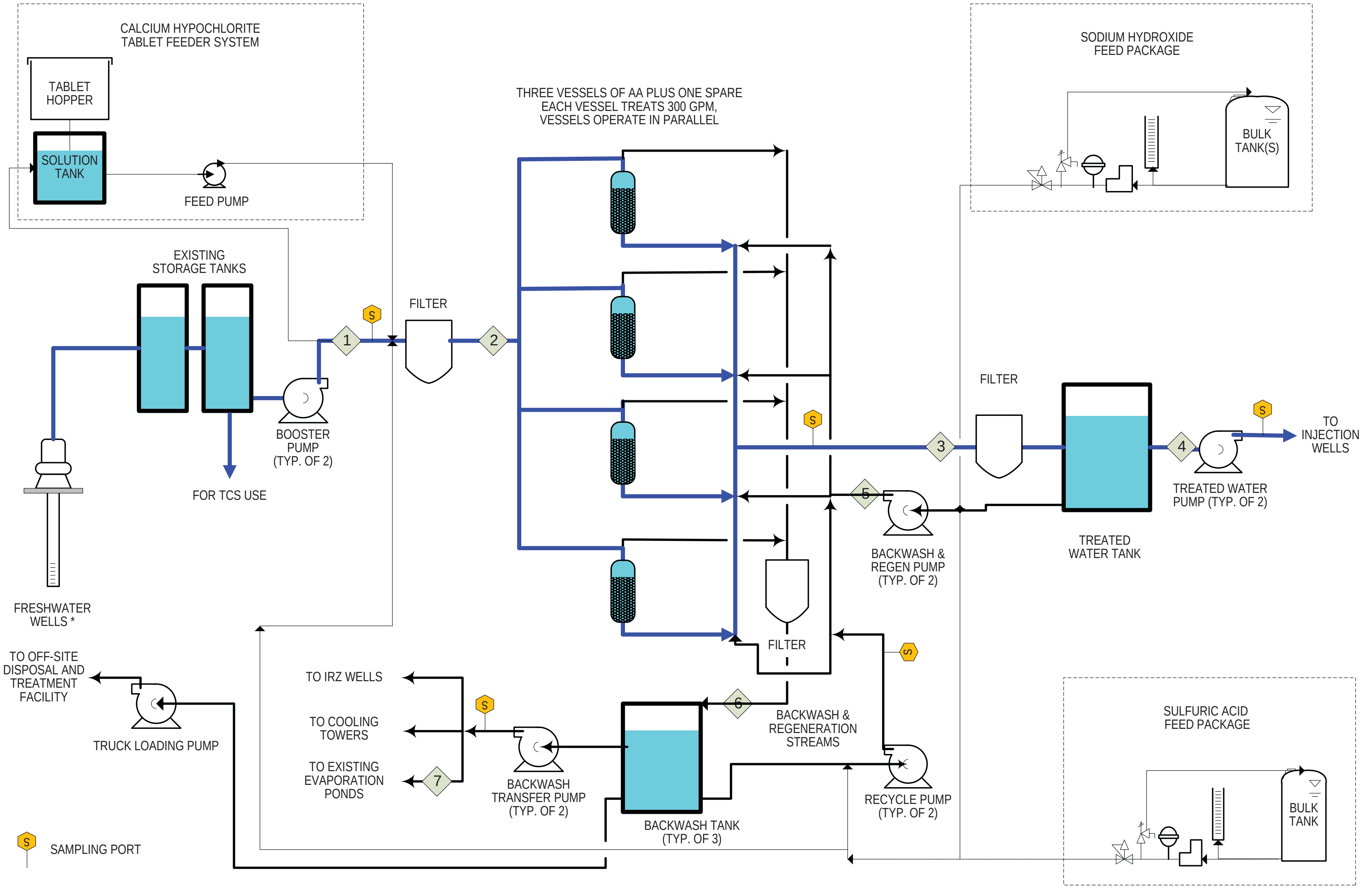
ES102411163118BAO_Exhibit_5-3-1_ProcessWaterSample_LocSchematic.ai_032613_lho

EXHIBIT 5.3-2

Analytical Suite for Process Control Monitoring – Remedy-produced Water Management

Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

FIELD PARAMETERS			
All Sample Locations – Daily			
Temperature	pH	Specific conductance	Turbidity
Influent Sample Location – Weekly			
Oxidation reduction potential	Salinity		
All Sample Locations – Weekly			
Total Chromium	Dissolved Iron	Dissolved Manganese	Hexavalent Chromium
INORGANIC ANALYTICAL SUITE – Initial Frequency Quarterly from Influent and Conditioned Water Tanks			
Anions (Method E300.0)			
Chloride	Fluoride	Nitrate (as nitrogen)	Sulfate
General Chemistry (Methods SM2320-B, SM4500-NH3, SM4500-CN, SM4500-Si C/D, SM2540-C, SM2540, SM5310, CF-IRMS)			
Alkalinity, total as $CaCO_3$	Deuterium	Soluble silica	Total organic carbon (TOC)
Ammonia as nitrogen	Oxygen 18	Total dissolved solids (TDS)	Total suspended solids (TSS)
Cyanide			
Metals (Methods SW6010C, SW6020A, SW7470A, E218.6)			
Aluminum, dissolved	Calcium, dissolved	Magnesium, dissolved	Silver, dissolved
Antimony, dissolved	Chromium, Hexavalent	Manganese, dissolved	Sodium, dissolved
Arsenic, dissolved	Chromium, total dissolved	Mercury, dissolved	Thallium, dissolved
Barium, dissolved	Cobalt, dissolved	Molybdenum, dissolved	Vanadium, dissolved
Beryllium, dissolved	Copper, dissolved	Nickel, dissolved	Zinc, dissolved
Boron, dissolved	Iron, dissolved	Potassium, dissolved	
Cadmium, dissolved	Lead, dissolved	Selenium, dissolved	



NOTE: * - FRESHWATER WELLS INCLUDE PRIMARY SOURCE HNWR-1 AND SECONDARY SOURCE TOPOCK-2/-3 WELLS THAT CURRENTLY SUPPLY THE TCS.

EXHIBIT 5.4-1
PROCESS WATER SAMPLE LOCATIONS – FRESHWATER PRE-INJECTION TREATMENT

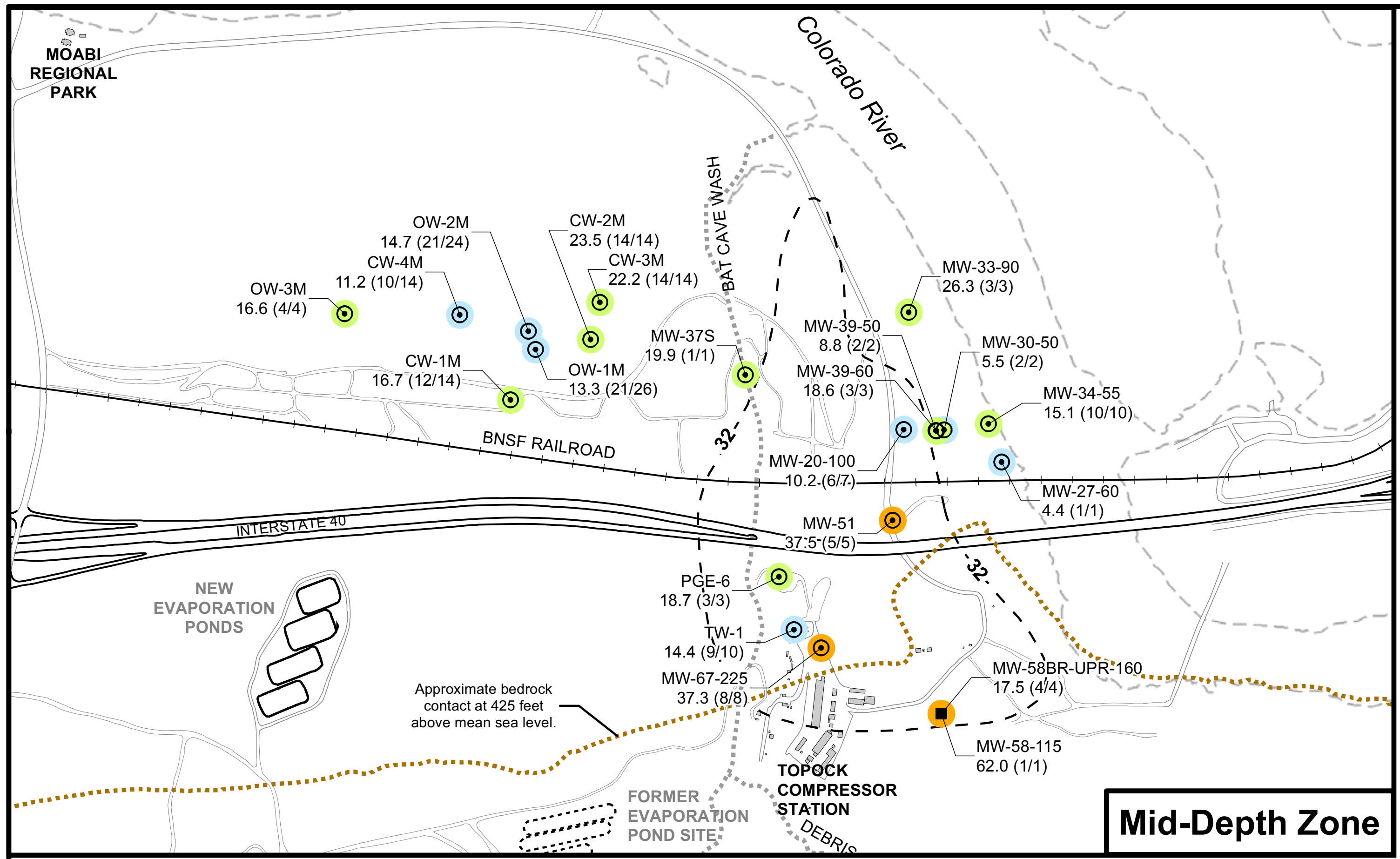
GROUNDWATER REMEDY DRAFT OPERATION AND MAINTENANCE MANUAL
VOLUME 2: SAMPLING AND MONITORING PLAN
PG&E TOPOCK COMPRESSOR STATION, NEEDLES, CALIFORNIA

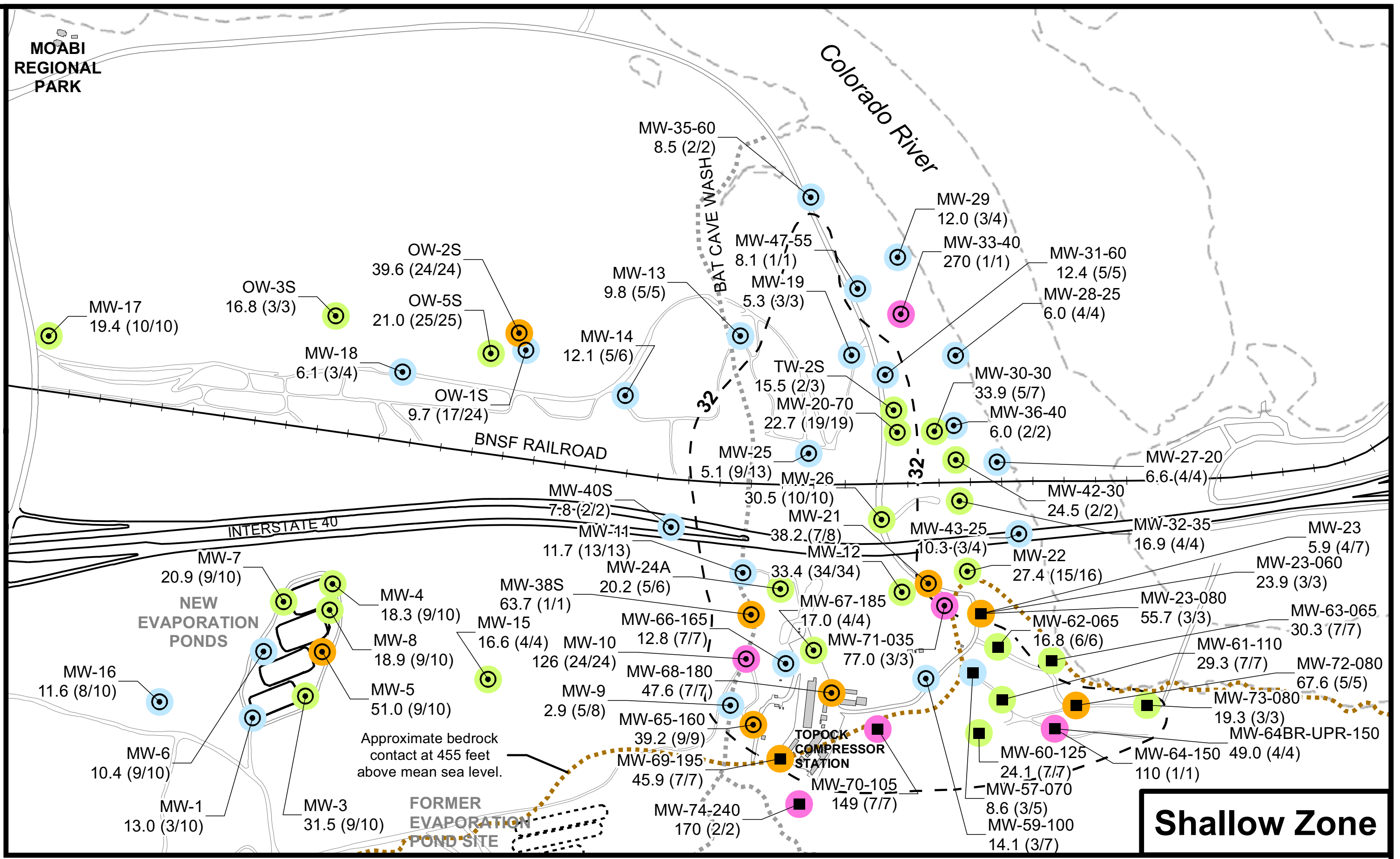
EXHIBIT 5.4-2

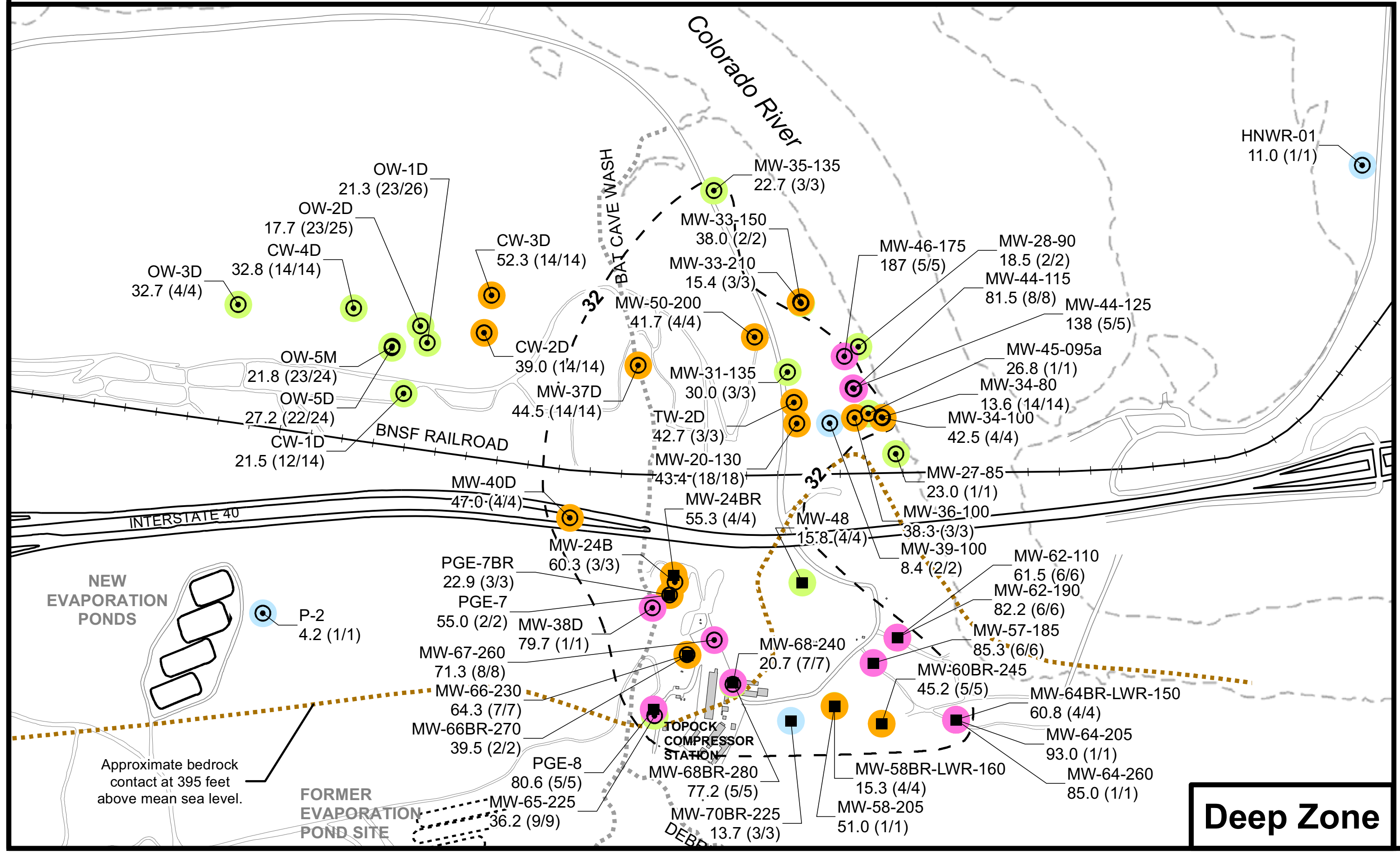
Analytical Suite for Process Control Monitoring – Freshwater Pre-injection Treatment System

Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

FIELD PARAMETERS			
All Sample Locations – Daily			
Temperature	pH, Fluoride, residual chlorine	Specific conductance	Turbidity
Influent Sample Location – Weekly			
Arsenic	Total Suspended Solids (TSS)		
INORGANIC ANALYTICAL SUITE – Initial Frequency Quarterly from Untreated Water and Treated Water			
Anions (Method E300.0)			
Chloride	Fluoride	Nitrate (as nitrogen)	Sulfate
General Chemistry (Methods SM2320-B, SM4500-NH3, SM4500-CN, SM4500-Si C/D, SM2540-C, SM2540, SM5310, CF-IRMS)			
Alkalinity, total as $CaCO_3$	Deuterium	Soluble silica	Total organic carbon (TOC)
Ammonia as nitrogen		Total dissolved solids (TDS)	Total suspended solids (TSS)
Cyanide			
Metals (Methods SW6010C, SW6020A, SW7470A, E218.6)			
Aluminum, dissolved	Calcium, dissolved	Magnesium, dissolved	Silver, dissolved
Antimony, dissolved	Chromium, Hexavalent	Manganese, dissolved	Sodium, dissolved
Arsenic, dissolved	Chromium, total dissolved	Mercury, dissolved	Thallium, dissolved
Barium, dissolved	Cobalt, dissolved	Molybdenum, dissolved	Vanadium, dissolved
Beryllium, dissolved	Copper, dissolved	Nickel, dissolved	Zinc, dissolved
Boron, dissolved	Iron, dissolved	Potassium, dissolved	
Cadmium, dissolved	Lead, dissolved	Selenium, dissolved	







LEGEND

⊙ Groundwater Well completed in Alluvial Aquifer (Shallow, Mid-depth or Deep Zones)
■ Groundwater Well completed in Bedrock

Dissolved Molybdenum Average Concentrations

MW-17 ← Well ID
5.8 (8/16) ← (No. of detections / No. of samples)
Average concentration, micrograms per liter (µg/L) 1997 - 2011 groundwater sampling

⊙ ≤ 15.0 µg/L
⊙ 15.0 - 36.3 µg/L
⊙ 36.4 - 70.0 µg/L
⊙ > 70.0 µg/L

- - - Approximate outline of Cr(VI) in Alluvial Aquifer depth zone ≥ 32 µg/L, Fourth Quarter 2011

Notes:
1. Includes data through February 2012 for the East Ravine-Topock Compressor Station wells.
2. Molybdenum Background Study Upper Tolerance Limit (UTL) = 36.3 µg/L
3. In computing averages, non-detects were assigned half of the reporting limit concentration. Some averages may be elevated due solely to high reporting limits for non-detect samples. Refer to the complete data set in Appendix A1 for verification.

FIGURE 5.1-1
MOLYBDENUM CONCENTRATIONS IN GROUNDWATER, JULY 1997 - DECEMBER 2011

GROUNDWATER REMEDY DRAFT OPERATION AND MAINTENANCE MANUAL
VOLUME 2: SAMPLING AND MONITORING PLAN
PG&E TOPOCK COMPRESSOR STATION,
NEEDLES, CALIFORNIA

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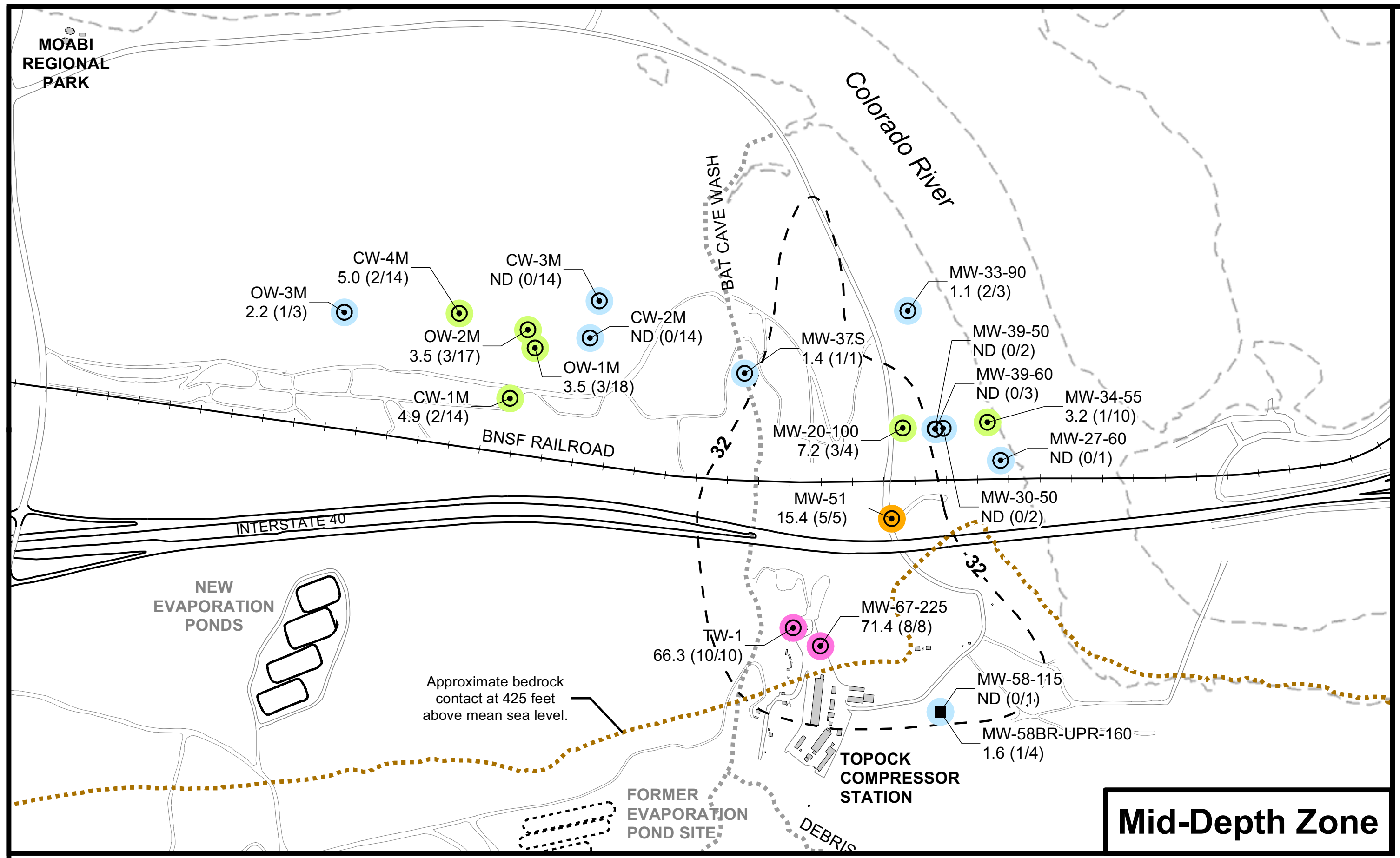

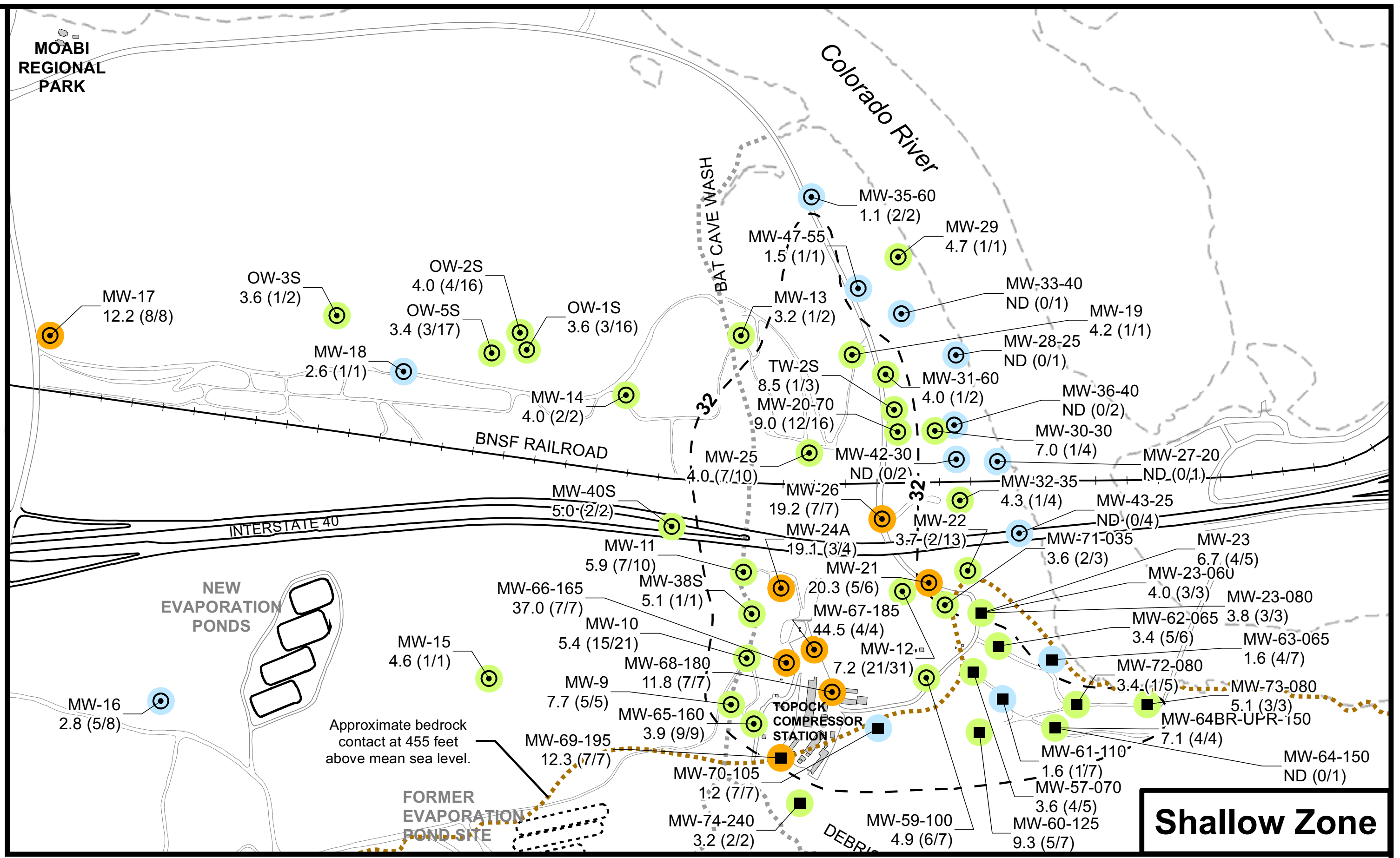

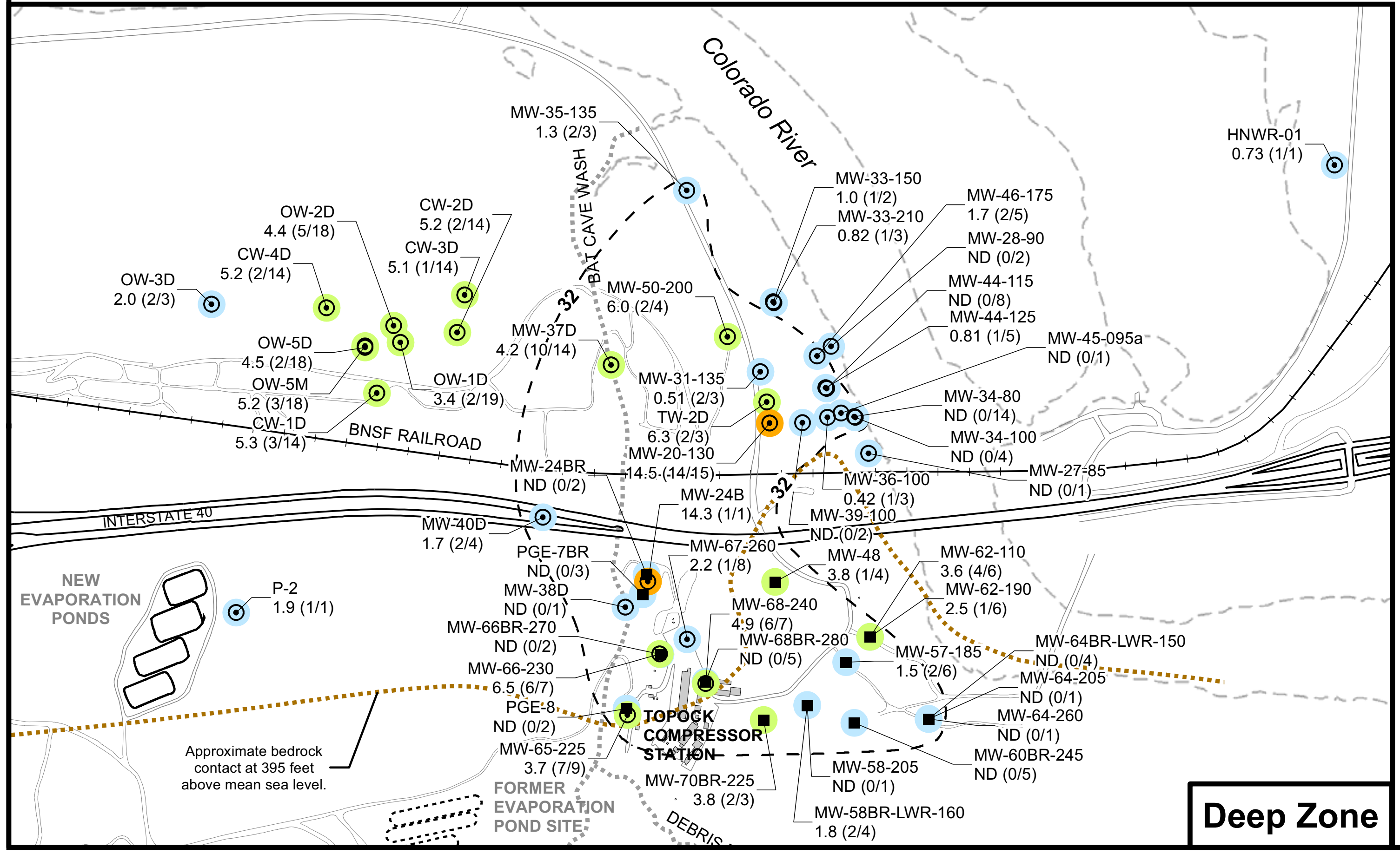

LEGEND

⊙ Groundwater Well completed in Alluvial Aquifer (Shallow, Mid-depth or Deep Zones)

■ Groundwater Well completed in Bedrock

Dissolved Selenium Average Concentrations

MW-17 ← Well ID

5.8 (8/16) ← (No. of detections / No. of samples)

Average concentration, micrograms per liter (µg/L) 1997 - 2011 groundwater sampling

⊙ ≤ 3.0 µg/L

⊙ 3.0 - 10.3 µg/L

⊙ 10.4 - 50.0 µg/L

⊙ > 50.0 µg/L

Approximate outline of Cr(VI) in Alluvial Aquifer depth zone ≥ 32 µg/L, Fourth Quarter 2011

Notes:

1. Includes data through February 2012 for the East Ravine-Topock Compressor Station wells.
2. Selenium Background Study Upper Tolerance Limit (UTL) = 10.3 µg/L
3. Selenium applicable or relevant and appropriate requirement (ARAR) = 50.0 µg/L
4. In computing averages, non-detects were assigned half of the reporting limit concentration. Some averages may be elevated due solely to high reporting limits for non-detect samples. Refer to the complete data set in Appendix A1 for verification.

FIGURE 5.1-2
SELENIUM CONCENTRATIONS IN GROUNDWATER, JULY 1997 - DECEMBER 2011

GROUNDWATER REMEDY DRAFT OPERATION AND MAINTENANCE MANUAL
VOLUME 2: SAMPLING AND MONITORING PLAN
PG&E TOPOCK COMPRESSOR STATION,
NEEDLES, CALIFORNIA

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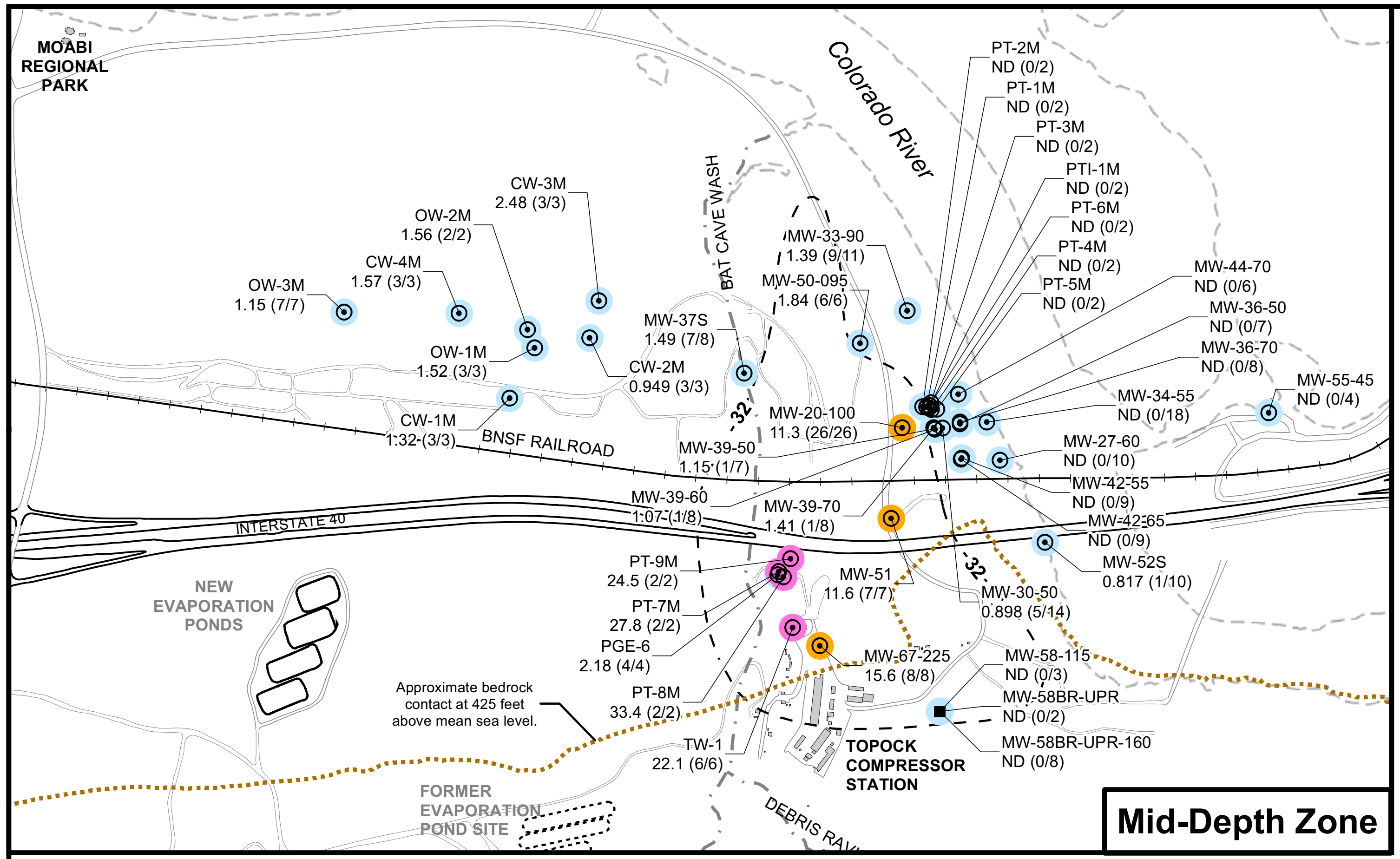

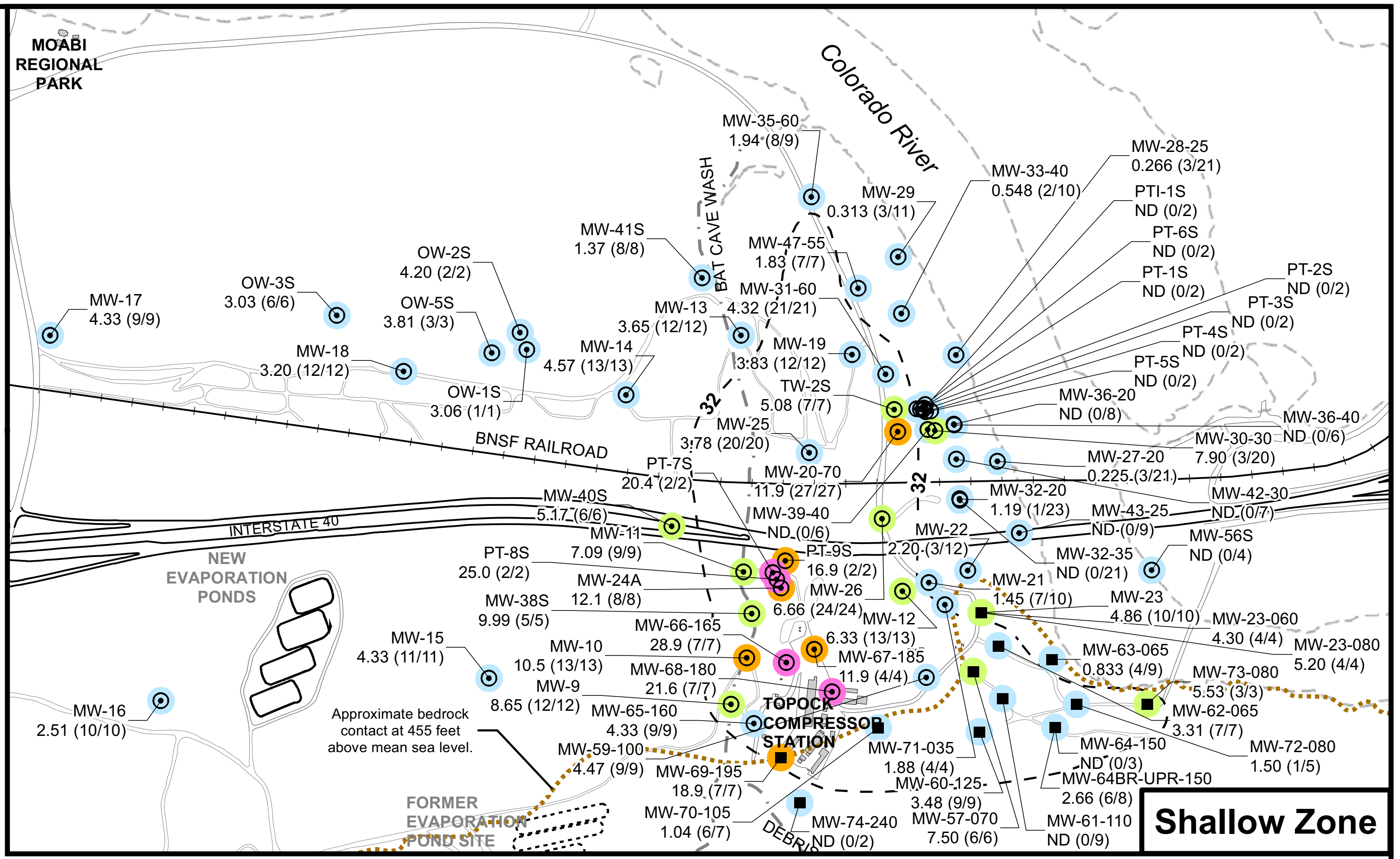

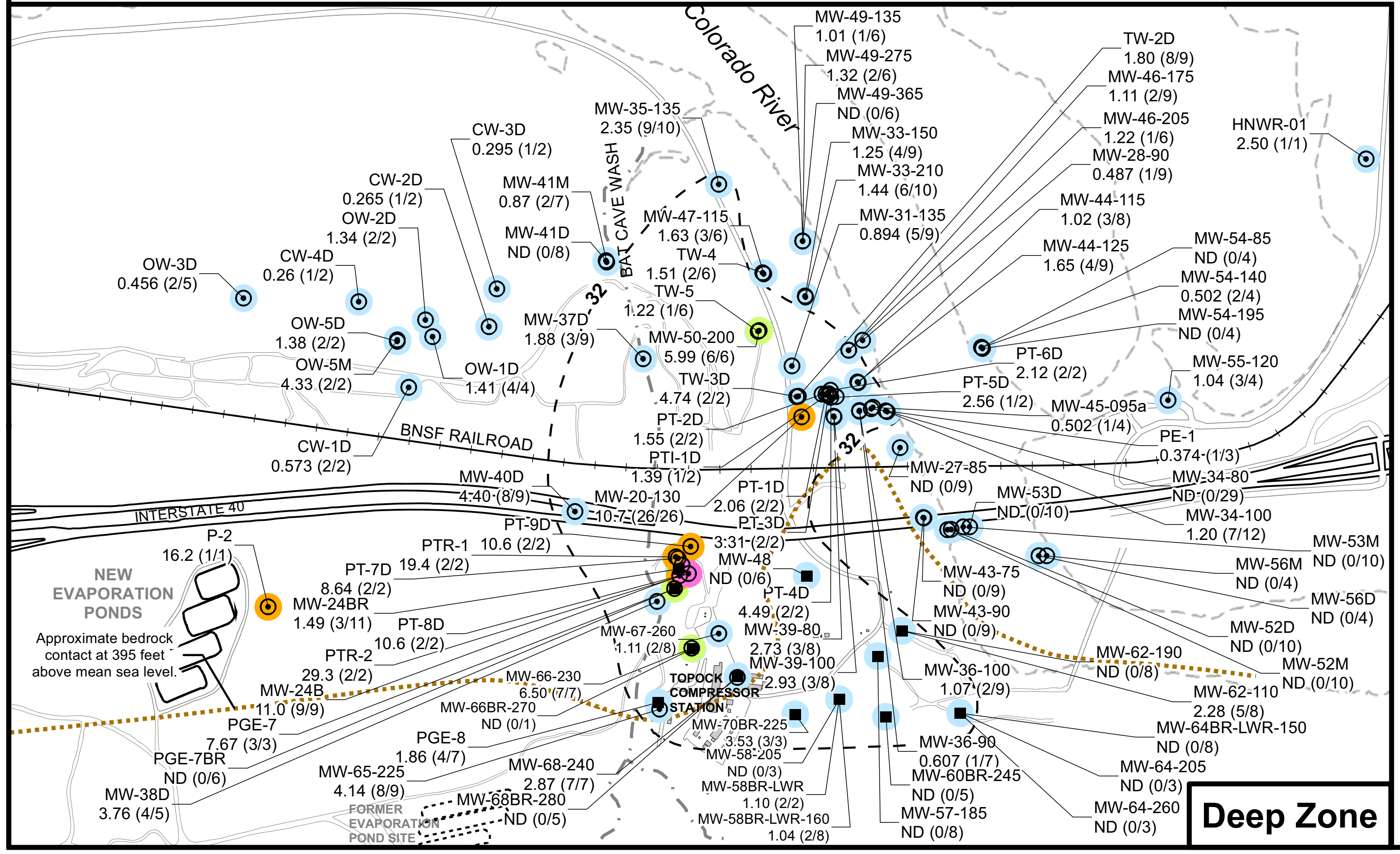

LEGEND

⊙ Groundwater Well completed in Alluvial Aquifer (Shallow, Mid-depth or Deep Zones)

■ Groundwater Well completed in Bedrock

Nitrate Average Concentrations

MW-17 ← Well ID

5.8 (8/16) ← (No. of detections / No. of samples)

Average concentration, milligrams per liter (mg/L) (expressed as Nitrogen) 1997 - 2011 groundwater sampling

Approximate outline of Cr(VI) in Alluvial Aquifer depth zone ≥ 32 µg/L, Fourth Quarter 2011

🔵 ≤ 5.03 mg/L

🟢 5.03 - 10.0 mg/L

🟠 10.1 - 19.9 mg/L

🟣 > 19.9 mg/L

Notes:
1. Includes data through February 2012 for the East Ravine-Topock Compressor Station wells.
2. Nitrate Background Study Upper Tolerance Limit (UTL) = 5.03 mg/L
3. Nitrate applicable or relevant and appropriate requirement (ARAR) = 10.0 mg/L
4. In computing averages, non-detects were assigned half of the reporting limit concentration. Some averages may be elevated due solely to high reporting limits for non-detect samples. Refer to the complete data set in Appendix A1 for verification.

FIGURE 5.1-3
NITRATE CONCENTRATIONS IN GROUNDWATER, JULY 1997 - DECEMBER 2011

GROUNDWATER REMEDY DRAFT OPERATION AND MAINTENANCE MANUAL
VOLUME 2: SAMPLING AND MONITORING PLAN
PG&E TOPOCK COMPRESSOR STATION,
NEEDLES, CALIFORNIA

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6.0 Data Management, Documentation, and Reporting

6.1 Data Validation

Data validation procedures are provided in Sections 6.3 and 6.4 of the PG&E Program Quality Assurance Program Plan (QAPP) (CH2M HILL 2012b). In summary, laboratory data will be imported into the project database and the data will be validated by the project chemist or designee. A combination of automated data validation (AutoDV) and manual validation will be performed on the project data. A data quality evaluation form will be generated for all sample results. Data quality evaluation results will be summarized and included in the progress reports to the agencies. The summary will list and discuss data that do not meet the data quality objectives specified in the QAPP, if any.

6.2 Data Evaluation

Analytical results will be evaluated for attainment of the RAOs presented in Section 1.1.1 and to determine remedy performance. Data evaluation summaries will be provided in quarterly progress reports following implementation of the remedy.

6.3 Data Management

Three types of data are expected to be collected during implementation of the remedy: field measurement/ process monitoring data, onsite laboratory data, and offsite laboratory data. The management of each type of data is described below. Exhibit 6.3-1 presents a simplified data management process for the project.

Field Measurement/Process Monitoring Data

Field measurements will be collected from the monitoring and remediation well network, the carbon amendment facilities, and the remedy-produced water conditioning plant. Measurements will be conducted in accordance with the Standard Operating Procedure (SOPs) (as described in Section 7.1), and are recorded manually in a field logbook, field sampling form, and/or process monitoring checklist, or recorded automatically by stationary or handheld data loggers and transmitted to a database using a telemetry system. Manually recorded data will be entered into a field database. In addition, process monitoring and control data generated in facilities/plants will be automatically recorded into a data historian that resides in the plant control system.

Onsite Laboratory Data

Certain testing for process control monitoring will be performed at an onsite laboratory in accordance with site-specific SOPs. The data collected will be recorded in a bench log book and entered into a spreadsheet and/or database periodically.

Offsite Laboratory Data

The data flow (electronic and hard copy) from offsite laboratory to the project chemist is tracked to ensure that the data are reviewed and validated in a timely manner. The project chemist will discuss and resolve technical issues, if any, with the laboratory. The laboratory will maintain electronic and hardcopy records sufficient to re-create each analytical event. At a minimum, the laboratory will maintain the following records:

- Raw data, including instrument printouts, bench work sheets, and chromatograms, with compound identification and quantitation reports.
- Laboratory-specific, written SOPs for each analytical method and quality assurance/quality control (QA/QC) function implemented during the analysis of project samples.

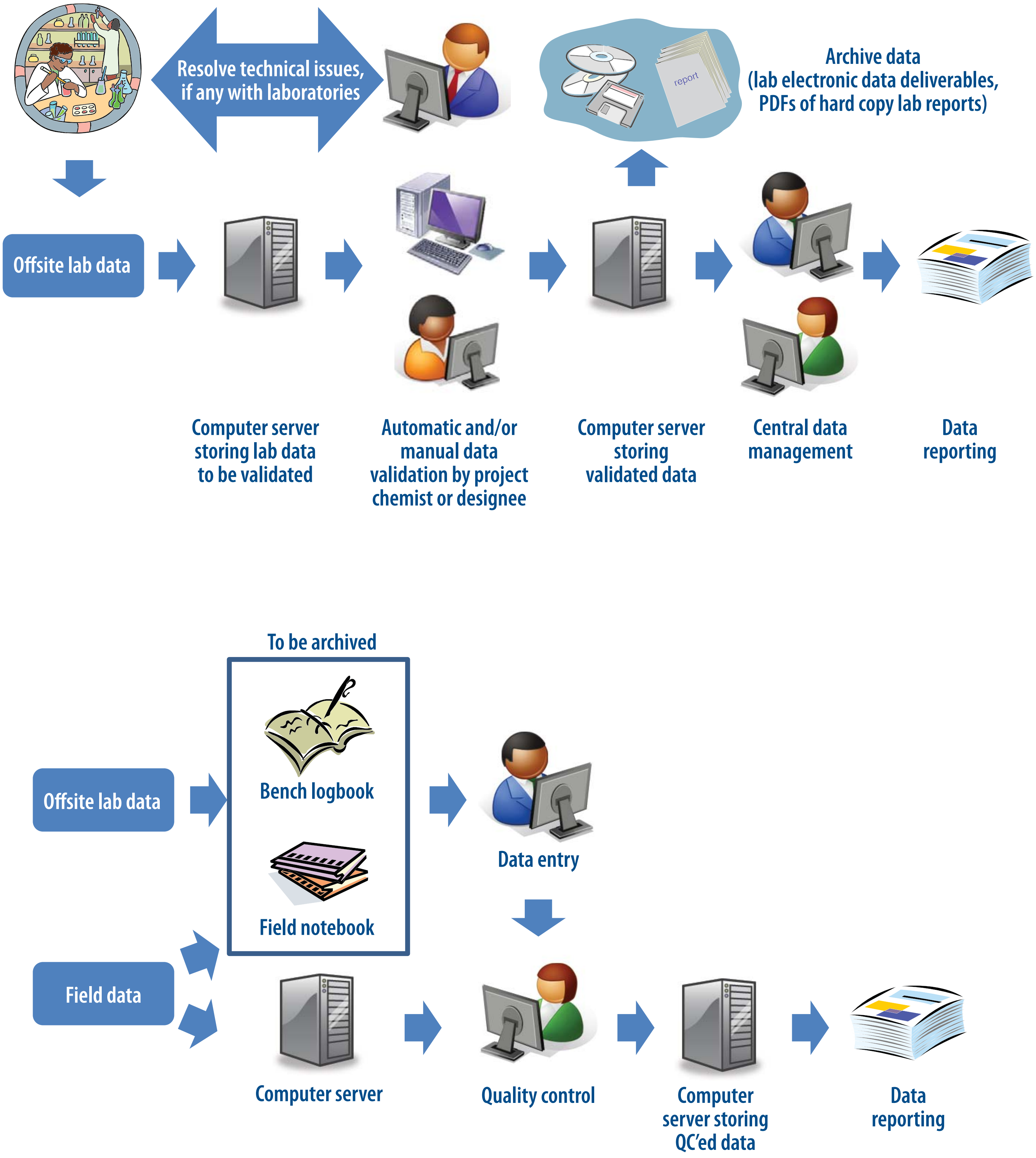

Exhibit 6.3-1
Simplified Data Management Process
Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

Maintenance/Calibration Records

It is the responsibility of the plant/system operators to incorporate regular preventative maintenance into the routine work schedule based on guidelines presented in this plan, and the maintenance recommendations provided in the manufacturer's manual for each piece of equipment in the plant. Computerized maintenance management programs will be implemented at the facility, as appropriate, to keep track of maintenance requirements. In those cases, operators will access the program to determine required maintenance tasks. Records documenting completion of preventative maintenance tasks will be kept onsite.

Hardcopy and electronic versions will be archived in project files, on electronic archive tapes, and/or on other electronic storage media for the duration of remedy operation as specified below in Section 6.4. All electronic data will be subject to routine back-up until it is archived for long-term retention.

6.4 Recordkeeping

In compliance with Section XII of the 1996 Corrective Action Consent Agreement (CACA) (DTSC 1996) and Section XXV of the Remedial Design/Remedial Action (RD/RA) Consent Decree (CD; DOI 2013), PG&E will maintain all records for 10 years following receipt of certification of completion. At the conclusion of the record retention period, PG&E will notify DOI and DTSC in writing at least 90 days prior to the destruction of any records and will provide DOI and DTSC with the opportunity to take possession of any records.

6.5 Reporting

In compliance with Attachment 7 of the 1996 CACA (DTSC 1996), Section XXIV and Appendix C of the CD Scope of Work and Section 5 of the RD/RA CD (DOI 2013), progress reports will be submitted monthly during RA construction and quarterly after the remedy has been implemented and demonstrated to be operating as intended. Exhibit 6.5-1 presents a quarterly report template that was developed with guidance from the *O&M Report Template for Ground Water Remedies (with Emphasis on Pump and Treat Systems)* (USEPA 2005). A monthly construction report template will be provided in the forthcoming Construction/Remedial Action Work Plan.

PG&E Topock Compressor Station Groundwater Remediation Project Quarterly Progress Report for Remedy Operations and Maintenance [Indicate Reporting Period]

Table of Contents

1. Introduction

PG&E is implementing the groundwater remedy to address chromium in groundwater at Solid Waste Management Unit (SWMU) 1/Area of Concern (AOC) 1 and AOC 10 near the Topock Compressor Station, in conformance with the requirements of the Resource Conservation and Recovery Act (RCRA) Corrective Action and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The groundwater remedy includes:

- Construction of an In-situ Reactive Zone (IRZ) along National Trails Highway (NTH) using a line of wells that may be used as both injection and extraction wells to circulate groundwater and distribute an organic carbon source to promote bacteriological reduction of the Cr(VI) to Cr(III).
- Flushing accomplished through a combination of fresh water injection and injection of carbon-amended water in wells upgradient of the plume.
- Extraction wells near the Colorado River to provide hydraulic capture of the plume, accelerate cleanup of the floodplain, and enhance the flow of contaminated groundwater through the IRZ line.
- Bedrock extraction wells in the eastern (downgradient) end of the East Ravine to provide hydraulic capture of contaminated groundwater in bedrock.
- Institutional controls to restrict surface land uses and prevent the use of groundwater.
- Monitored natural attenuation (MNA) as a long-term component to address residual Cr(VI) that may remain in recalcitrant portions of the aquifer after in-situ treatment.

The Remedial Action Objectives (RAOs) for the groundwater remedy are to:

1. Prevent ingestion of groundwater as a potable water source having Cr(VI) in excess of the regional background concentration of 32 micrograms per liter (µg/L).
2. Prevent or minimize migration of total chromium (Cr[T]) and Cr(VI) in groundwater to ensure concentrations in surface water do not exceed water quality standards that support the designated beneficial uses of the Colorado River (11 µg/L Cr[VI]).
3. Reduce the mass of Cr(T) and Cr(VI) in groundwater at the site to achieve compliance with ARARs in groundwater. This RAO will be achieved through the cleanup goal of the regional background concentration of 32 µg/L of Cr(VI).
4. Ensure that the geographic location of the target remediation area does not permanently expand following completion of the remedial action.

The completion criteria or performance standards for the groundwater remedy is mainly driven by RAO #3, reducing Cr(VI) concentrations throughout the plume to concentrations of 32 µg/L or less. Attainment of the completion criteria or achievement of performance standards, Cr(VI) concentrations of 32 µg/L or less, is intended to be applied throughout the area of contaminated groundwater. In establishing this criterion, the following are recognized:

- Attaining the cleanup criteria of 32 µg/L Cr(VI) in groundwater may be through active remediation or through natural attenuation.
- Different areas of the plume may reach the cleanup criteria of 32 µg/L Cr(VI) in groundwater at different times

EXHIBIT 6.5-1

Quarterly Progress Report Template

Groundwater Remedy Draft Operation and Maintenance Manual

Volume 2: Sampling and Monitoring Plan

PG&E Topock Compressor Station, Needles, California

In compliance with the 1996 CACA (Attachment 6, Part B, Section 12 and Attachment 7) and the 2009 CERCLA Model RD/RA CD, this quarterly report describes activities taken to implement the Corrective Measure/Remedial Action since last reporting period and activities planned for the next reporting period, presents available results from sampling and testing since last reporting period, summarizes progress towards attaining the RAOs, any issues encountered/deviations from design documents, O&M Manual, and Construction/Remedial Action Work Plan, and any optimizations and enhancements. In addition, this report discusses personnel changes and summarizes activities performed and activities planned in support of the Community Relation Plan and any contacts with local community, representatives of the press, and stakeholders/Tribes.

2. Operations Summary

Describe routine and non-routine system downtime, operational data and process monitoring data, utilities and consumables used and waste handling/disposal, any issues encountered with system operation, any personnel changes, any system optimizations and maintenance that were performed, and any material deviations from design documents, O&M Manual, and Construction/Remedial Action Work Plan.

- *In-situ remediation*
- *Freshwater supply*
- *Remedy-produced water management*

3. Performance Summary

Describe monitoring events and sampling performed during the current reporting period, the sampling results and interpretation of results, an interpretation of progress toward RAOs, and any material deviations from design documents, O&M Manual, and Construction/Remedial Action Work Plan (e.g., gaps or inconsistencies in the site conceptual model)

- *In-situ remediation*
- *Freshwater supply*
- *Remedy-produced water management.*

4. Green Remediation Evaluation Matrix (GREM) Summary

Summarize the O&M GREM and any changes since last reporting period.

5. Summary of Activities in Support of the Community Relations Plan and Contacts with the Press, Local Community, and Stakeholders/Tribes

Summarize activities performed in support of Community Relation Plan and contacts with local community, representatives of the press, and stakeholders/Tribes, if any.

6. Recommendations

Provide suggestions for system optimizations or procedural enhancements, as applicable, to improve performance, reduce costs, reduce wastes, etc. Optimizations and/or enhancements could be based on system inefficiencies, technological developments, modified regulations, etc.

7. Planned Activities for Next Reporting Period

Provide planned activities of the next reporting period (O&M activities, groundwater/surface monitoring events, activities in support of the Community Relations Plan, etc.)

8. References

7.0 Sampling Methods and Procedures

Sampling and field measurements will be performed in accordance with the Standard Operating Procedures presented in Appendix A. Required sample containers, preservation requirements, sample storage, and QC methods and requirements are described in further detail in the PG&E Program QAPP (CH2M HILL 2012b) and QAPP Addendum (see Appendix B).

In continued efforts to integrate sustainability practices into remedial implementation (see Section 4 of the Basis of Design Report), trials of alternative sampling and data collection methods are being conducted at Topock to further reduce the overall sampling and project footprint and minimize potential impacts to sensitive resources (e.g., reduce trips to well sites, reduce purge water generation and management, reduce time spent at well sites, etc.). Sections 7.1 and 7.2 discuss these ongoing trial efforts. Trial results will be evaluated and new information incorporated into the sampling and monitoring for the final remedy, as appropriate. Additional SOPs may be developed and added to the lists below, or existing SOPs may be modified and amended. The latest version of the SOPs will be available to the sampling crews at the Maintenance Facility (located at the Transwestern Bench), and in project files.

7.1 Field/On-site Lab Measurements

Field measurements will be collected in accordance with the following SOPs (included in Appendix A). Additional SOPs may be added as appropriate.

- SOP-A7 – Water Level Measurements
- SOP-A8 – Field Water Quality Measurements Using a Flow-through Cell
- SOP-A9 – Calibration of Field Instruments
- SOP-A11 – Total Depth Measurements
- SOP-B16 – Field-Portable X-Ray Fluorescence Soil Sampling

In addition, on-site laboratory measurements will be performed to assist with remedy process evaluation and monitoring of in-plant treatment performance (e.g., within the remedy-produced water conditioning plant); these measurements are not intended for formal reporting, but rather to provide operators with operational information to adjust or optimize system performance as needed. Only validated results from certified laboratories will be used for reporting purposes. Onsite lab measurements will be conducted in accordance with the following SOPs (included in Appendix A); additional SOPs may be added as appropriate:

- SOP-L1 – Hexavalent Chromium Analysis by Hach Method 1560
- SOP-L2 – Ferrous Iron Analysis by Hach Method 2150
- SOP-L3 – Total Chromium Analysis by Hach Method 8024
- SOP-L4 – Conductivity Analysis by Hach Method 8160
- SOP-L5 – Turbidity Analysis
- SOP-L8 – Matrix Spike Preparation
- SOP-L9 – pH Measurement
- SOP-L10 – HACH Model 2100P Turbidimeter Daily Checks and Calibration
- SOP-L11 – pH Analytical Equipment Calibration
- SOP-L12 – Ferrous Iron Analysis by Hach Method 2150 and Hexavalent Chromium

Field versus Standard Laboratory-certified Analyses

The following discussion is presented in response to a comment received on the 30% design document regarding comparison of field vs. laboratory measurement for Cr(VI).

The Hualapai comment stated that "Comparison of data from the Upland ISPT suggests field-analyzed Cr(VI) concentrations were greater than laboratory-analyzed Cr(VI) concentrations. This appears to be linked to high TOC concentrations in the water samples (Figure 2)." There could be many possible reasons that the subject Cr(VI) data may appear to suggest that additional reduction is occurring after field collection; however, if samples were filtered and preserved in the field, no additional reduction should occur. Regardless, based on examination of the cited data, possible reasons for the elevated field results and potential remedial solution(s) include, but are not limited to, the following:

- The samples analyzed in the field were probably not filtered and low levels of suspended matter (turbidity) caused elevated results. The remedial solution is to filter all Cr(VI) samples in the field (this will be accomplished by following SOP-L1, Hexavalent Chromium Analysis by Hach Method 1560).
- Although the field Cr(VI) colorimetric method is considered fairly robust, there is always the remote possibility of a false positive reaction occurring. The remedial solution requires identifying the issue first. Once identified, a series of steps can be performed to clarify/overcome the issue. Analyzing a matrix spike can often clarify the problem and analyzing a serial dilution can often overcome the issue. This is addressed in SOP-L1, Hexavalent Chromium Analysis by Hach Method 1560.
- If the samples collected for laboratory analysis were not field filtered and preserved, there is a possibility of further reduction prior to the analysis. The remedial solution is to follow SOP A6, Sample Field Filtration and Preservation for Metals Analyses and follow proper transport and storage procedures.

As for the Technical Review Committee (TRC) comment regarding "Other potentially unstable constituents," because sulfide (S[II-]) is so unstable in the environment and is difficult to use in a systematic way, it will not be used for monitoring the remedial system on a regular basis and will primarily be a field analysis if used for "additional knowledge." However, if preserved at the time of collection, it can be transported to a lab for analysis without additional reactions occurring. Unlike Cr(VI) and S(II-), Fe(II) cannot be preserved and has a very short holding time. However, by filtering and preserving the sample we remove all the ferric iron Fe(III) (primarily found in a solid form) and only have Fe(II) remaining, thus allowing Fe(II) to easily be transported and analyzed in the lab.

Data Telemetry System

To reduce the sampling footprint and minimize potential impacts to sensitive resources, trials of data telemetry systems have been conducted at Topock since 2011 with an eye towards integration into remedial implementation (see Exhibit 7.1-1). Telemetry systems can provide near-real-time access to data with data transmission intervals as short as one minute via cellular or satellite signals. Units can generate email alerts when user-defined minimum or maximum parameters, such as temperature or pressure, are exceeded or if a system fails to transmit data according to schedule. The trial consists of five telemetry units from two separate manufacturers deployed at five different well cluster locations on the site. Three of the units are from YSI's EcoNet remote telemetry line of devices while the remaining two are Solinst STS-9100 telemetry devices. While the current telemetry trial includes only these devices, additional systems or sensors may be added in the future due to the rapidly evolving nature of telemetry technology.

EXHIBIT 7.1-1
Pictures of Telemetry Units Used During Trial
Groundwater Remedy Operations and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Compressor Station, Needles, California

To date, the telemetry system trial has demonstrated success in:

- Automating the data retrieval process, allowing for efficient data collection, management, and access
- Reducing field labor, on-site footprint and fuel use, and activity in the vicinity of floodplain nesting habitat (because telemetry-equipped wells are accessed for quarterly salinity profiling or as-needed equipment maintenance, not for routine manual downloads)
- Increasing data quality/reliability (because transducer equipment failure is evident from telemetry data, rather than detected only after weekly or monthly manual downloads)
- Compatibility with existing and planned future infrastructure
- Use of various power source options, including solar-charged 12V marine batteries which minimize the amount of conduit runs
- Blending in with the natural surroundings so as to minimize visual impact to the site

7.2 Surface Water, Groundwater, and Process Water Sampling

Surface water, groundwater, and process water sampling will be performed in accordance with the following SOPs (included in Appendix A) (note that SOP-A7, SOP-A8, SOP-A9, and SOP-A11 are listed above in Section 7.1 and are also applicable to surface water/groundwater/process water sampling). Additional SOPs may be added as appropriate.

- SOP-A1 – Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method
- SOP-A2 – Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method
- SOP-A3 – Purging and Sampling of Active and Inactive Water Supply Wells
- SOP-A4 – Depth-Specific Surface Water Sampling (supersedes SOP-A12)
- SOP-A5 – Groundwater Sampling from Sonic Drilling Boreholes
- SOP-A6 – Sample Field Filtration and Preservation for Metals Analyses
- SOP-A10 – Decontamination of Water Sampling Equipment
- SOP-A13 – Spill Prevention, Containment, and Control Measures for Monitoring Well Sampling
- SOP-A14 – Pore Water Sampling
- SOP-A16 – Access Routes
- SOP-A17 – Groundwater and Surface Water Mobile Integrated Sample Tracking
- SOP-A18 – Purging and Sampling of Groundwater Wells Minimal Drawdown Method
- SOP-A19 – Sampling of Groundwater Monitoring Wells Hydrasleeve No Purge Method
- Remedy-SOP-01 – Process Water Sampling
- Remedy-SOP-02 – Safe Fueling and Fuel Handling Procedures

In continued efforts to integrate sustainability practices into remedial implementation (see Section 4 of the Basis of Design Report), PG&E is conducting a trial of alternative groundwater sampling approaches at Topock to further reduce the overall sampling footprint (e.g., reduce purge water generation and management, reduce time spent at each well, minimize potential impacts to sensitive resources) while maintaining or increasing data quality.

The trial began in third quarter 2012 (September) and will continue through first quarter 2013; it involves testing of two alternative sampling approaches at 18 site wells: the no-purge HydraSleeve^{TM} sampling system and the minimal drawdown (low flow purging) sampling technique. Additional information about these two approaches can be found in numerous publications and public websites including but not limited to the following:

- HydraSleeve^{TM} sampling system (www.hydrasleeve.com): A joint study completed by the U.S. Army Corps of Engineers, the Air Force Center for Environmental Excellence and the Air Force Real Property Agency in 2005 (Parsons 2005)
- Minimal drawdown (low flow purging) sampling technique: USEPA guidance on sampling procedures including the *Groundwater Issue Paper: Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures* (Puls and Barcelona 1996) and the *Groundwater Sampling Guidelines for Superfund and RCRA Project Managers* (USEPA 2002)

Trial results will be compared to the current standard three-volume purge technique, and evaluated for use in monitoring of the final groundwater remedy. SOPs associated with these alternative techniques have been included in Appendix A.

7.3 Sample Containers, Preservation, and Storage

The contracted analytical laboratory will provide the required sample containers for all samples including QC samples. All containers will have been cleaned and certified free of the analytes of concern for this project. No sample containers will be reused. The contracted laboratory will add preservatives, if required, prior to shipping the sample containers to the field or supply the preservative as appropriate. The laboratory, upon receipt of the samples, will verify and record the adequacy of preservation and will add additional preservative, if necessary.

The containers, minimum sample quantities, required preservatives, and maximum holding times for many parameters are shown in Table 7.3-1. Table 7.3-1 includes a list of sample containers, preservation, and holding times for analytes anticipated to be monitored during operation and maintenance of the remedy (see Sections 2 through 4).

7.4 Sampling Documentation and Shipment

Pre-preserved sample containers will be received from the laboratory. The laboratory markings will indicate the type of preservative in the container. The date and time of sampling and the initials of the sampler will be recorded on the pre-printed label immediately prior to collection. The waterproof labels will be placed carefully on the proper container, and if waterproof labels are unavailable, they will be secured using clear tape to protect the label. When shipping samples using a freight carrier such as Federal Express, the ice used in shipping containers will be double-bagged and laser printed labels and indelible ink pens will be used to complete sample labels to ensure that the samples arrive at the laboratory dry and appropriately marked. If a laboratory courier is used, no bagging of ice is necessary. Vital information regarding the collection of each sample will be recorded in a field logbook, field sampling form, and/or chain-of-custody (CoC) form, as appropriate.

Logbooks will be bound with consecutively numbered pages. All entries will be legibly written in black or blue ink and signed and dated by the individual making the entries. Factual and objective language will be used. All entries will be complete and accurate to allow reconstruction of each field activity. A line will be placed through any portion of a field notebook that is unused. One line strike-through will be used to show corrections to entries. The strike-through will be initialed and dated. No correction fluid will be used. The following information for each sample will be recorded in the field logbook, field sampling form, or CoC form, whichever is appropriate:

- Sampling location and description (sketch and measured distances from reference points will be recorded if there is no established identification for the sample location)
- Sample ID
- Sampler’s name
- Date and time of sampling
- Sample designation (e.g., composite, grab, etc.)

- Sample matrix
- Type and ID of sampling equipment
- Field measurement data (e.g., pH, temperature, conductivity)
- Field observations that may be relevant to the analysis or sample integrity (e.g., odor, color, and weather conditions)
- Associated QC blanks
- Shipping details (if the laboratory is providing courier service, the courier must sign and date the CoC forms; copies of the signed CoC forms should be transmitted to the office as soon as practical; if FedEx, UPS, or other courier is used, include shipping information for each shipment)
- Destination laboratory

Sample coolers will be transported to the laboratory immediately after sample collection. An overnight courier may be used to transport the samples. Intermediate stops will be avoided, except for emergencies, in which case the situation will be noted in the field notebooks. The laboratory will be notified that samples are being shipped.

7.5 Quality Control

Laboratory QC checks indicate the state of control that prevailed at the time of sample analysis. QC checks that involve field samples, such as matrix and surrogate spikes and field duplicates, also provide an indication of the presence of matrix effects. Field-originated blanks provide a way to monitor potential contamination that field samples are subjected to. The QAPP and QAPP Addendum specify requirements for method blanks, laboratory control samples (LCSs), surrogate spikes, and matrix spike/matrix spike duplicates (MS/MSDs) that must be followed by subcontracting laboratories.

A laboratory QC batch is defined as a method blank, LCS, MS/MSD, or a sample duplicate (depending upon the method) and 20 or fewer environmental samples of similar matrix that are extracted or analyzed together. For gas chromatography/mass spectrometry volatile analyses, a method blank, LCS, and MS/MSD must be analyzed in each 12-hour calibration period. The number of environmental samples allowed in the laboratory QC batch is defined by the remaining time in the method-prescribed 12-hour calibration period divided by the analytical run time. Each preparation or analytical batch will be identified in a way that will associate environmental samples with the appropriate laboratory QC samples.

The laboratory will maintain a quality assurance manual or equivalent document. The manual will include all of the requirements provided in the California Environmental Laboratory Accreditation Program (ELAP), and, if applicable, the National Environmental Laboratory Accreditation Program (NELAP).

The laboratory will also maintain SOPs for all analytical methods and laboratory operations. The format for SOPs will conform with the following:

- *Test Methods for Evaluating Solid Waste, Physical and Chemical Methods, SW-846, Third Edition, Update III, Section 1* (USEPA 1996)
- "Good Laboratory Practices" in *Principles and Guidance to Regulations for Ensuring Data Integrity in Automated Laboratory Operations* (USEPA 1995)

All SOPs will have a unique identification number that is traceable to previous revisions of the same document.

TABLE 7.3-1
Sample Containers, Preservation, and Holding Times
Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

		Container and Minimum Quantity			
Analyte	**Method**	**Water**	**Soil/Sediment**	**Preservation**	**Holding Time**
Metals (except hexavalent chromium)	SW6010B, SW6020A, EPA200.7, EPA200.8, SM3120B, EPA245.1, SW7000 series methods	1-liter P or G	8-oz P, G, or T	Water: Add HNO_3 to pH<2; soil/sediment: None	28 days for mercury; 180 days for all others
Hexavalent Chromium	SW7199	Not applicable	4-oz P, G, or T	Soil/sediment: Chill to 4°C (±2°C)	Soil: 30 days to extraction, 7 days to analysis
Hexavalent Chromium	EPA218.6	250-mL P	Not applicable	Chill to ≤6°C Laboratory or field filtration within 24 hours. After filtration adjust the pH to 9–9.5 by adding $(NH_4)_2SO_4/NH_4OH$ buffer solution	28 days
Hexavalent Chromium	SM3500-Cr B	250-mL P	Not applicable	Chill to ≤6°C Laboratory or field filtration within 24 hours. After filtration adjust the pH to 9–9.5 by adding $(NH_4)_2SO_4/NH_4OH$ buffer solution	28 days
Pesticides	SW8081A or B	Two 1-liter G	8-oz G or T	Chill to 4°C (±2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis 90 days to extraction if frozen to -10°C (±2°C)
VOCs	SW8260B or C Preparation methods: SW5035B (Soil) SW5030B (Water)	Three 40-mL G-TLC	Three 40-mL G-TLC	Water: Add HCl to pH<2; chill to 4°C (±2°C) Soil/sediment: Chill to 4°C (±2°C) or: • Frozen in 48 hours • Frozen onsite • Sodium bisulfate • Methanol	Water: 14 days (preserved); 7 days (unpreserved) Soil: 48 hours unless preserved with 48 hours 14 days if solid samples preserved by the following methods: • 4ºC/frozen in 48 hours • Frozen onsite • Sodium bisulfate • Methanol

TABLE 7.3-1

Sample Containers, Preservation, and Holding Times

Groundwater Remedy Draft Operation and Maintenance Manual
Volume 2: Sampling and Monitoring Plan
PG&E Topock Compressor Station, Needles, California

		Container and Minimum Quantity			
Analyte	**Method**	**Water**	**Soil/Sediment**	**Preservation**	**Holding Time**
Herbicides	SW8151A	Two 1-liter G	8-oz G or T	Chill to 4°C (± 2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis
PAH	SW8270SIM	Two 1-liter G	8-oz G or T	Chill to 4°C (±2°C)	Water: 7 days to extraction; 40 days to analysis Soil: 14 days to extraction; 40 days to analysis
Ammonia	EPA350.1 Revision 2 or SM4500-NH3	1-liter P or G	4-oz P, G, or T	Water: Add H_2SO_4 to pH<2; chill to ≤6°C Soil/sediment: 4°C (±2°C)	Water: 28 days Soil: Not available
Anions	EPA300.0 or SM4500	500-mL P or G	4-oz P, G, or T	Chill to ≤6°C (none required for chloride and fluoride) Ortho-Phosphate requires filtering within 15 minutes after sample collection	Bromide, chloride, fluoride, sulfate, and iodide in 28 days Nitrate and ortho-Phosphate in water 48 hours
Alkalinity (total, bicarbonate, carbonate, hydroxide)	EPA310.2 or SM2320 B	500-mL P or G	Not applicable	Chill to ≤6°C	14 days
TDS	SM2540 C	500-mL P or G	Not applicable	Chill to ≤6°C	7 days
TSS	SM2540 D	500-mL P or G	Not applicable	Chill to ≤6°C	7 days
Turbidity	EPA180.1 Revision 2 or SM2130	500-mL P or G	Not applicable	Chill to ≤6°C	48 hrs
Specific Conductance	EPA120.1 Revision 1, or SM2510 SW9050	500-mL P or G	4-oz P, G, or T	Chill to ≤6°C Soil/sediment: Chill to 4°C (±2°C)	28 days
pH	SM4500H+B or SW9040	500-mL P or G	4-oz P, G, or T	Chill to ≤6°C	15 minutes
TOC/DOC	SM 5310 C	500-mL G or 40-mL VOA	4-oz P, G, or T	Water: For 500-ml: Add H_2SO_4 to pH<2; chill to ≤6°C For 40-mL VOA: Add H_2PO_4 to pH<2; chill to ≤6°C	28 days
TOC	Walkley Black	Not applicable	4-oz P, G, or T	Chill to ≤6°C	28 days
Sulfide	SM4500-S^2	500-mL P or G	Not applicable	Add zinc acetate and NaOH to pH>9, chill to ≤6°C	7 days

TABLE 7.3-1
Sample Containers, Preservation, and Holding Times
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		Container and Minimum Quantity			
Analyte	**Method**	**Water**	**Soil/Sediment**	**Preservation**	**Holding Time**
Ferrous Iron (Fe +2)	SM3500D	500-mL P or G	Not applicable	Chill to ≤6°C	24 hours
Dissolved Silica	EPA200.7 or SM4500-Si or SM3120 B	500-mL P only	Not applicable	Chill to ≤6°C	28 days
18O and deuterium	Laboratory SOP (continuous flow mass spectrometer [CF-IRMS])	100-mL P or 40-mL VOA	Not applicable	Chill to ≤6°C	6 months
Cyanide	EPA335.4 (R1) or SM4500-CN C/D/E (water)	500-mL P or G	4-oz P, G, or T	Water: Add NaOH to pH>12; chill to ≤6°C	Water and soil: 14 days
	SW9010B, SW9012, or SW9014 (soil)			Soil/sediment: Chill to 4°C (±2°C)	

Notes:

$>$ = greater than
$<$ = less than
$\leq$ = less than or equal to
DOC = dissolved organic compounds
G = glass
G-TLC = glass with Teflon lined cap
H_2PO_4 = phosphoric acid
H_2SO_4 = sulfuric acid
HCl = hydrochloric acid
HNO_3 = nitric acid
mL = milliliters
NaOH = sodium hydroxide
NH_4 = ammonium

NH_4OH = ammonium hydroxide
$(NH_4)_2SO_4$ = ammonium sulfate
oz = ounce
P = polyethylene
PAH = polynuclear aromatic hydrocarbons
SIM = selected ion monitoring
SO_4 = sulfate
T = brass sleeves in the sample barrel (sometimes called California brass)
TDS = total dissolved solids
TOC = total organic compounds
TSS = total suspended solids
VOA = volatile organic analytic
VOC = volatile organic compound

SOURCE: CH2M HILL. 2012b. *PG&E Program Quality Assurance Project Plan*. Revision 2. August.

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Appendix A
Standard Operating Procedures for Groundwater, Surface Water, and Process Water Sampling

(***Provided on CD-ROM Only***)

SOP-A1

Purging and Sampling of Groundwater Monitoring Wells
Well-Volume Method
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and sampling all groundwater monitoring wells at the Topock site with casing diameters in excess of 1-inch. This SOP will be used for sampling groundwater monitoring wells using a dedicated electric submersible pump with a single discharge rate, a dedicated electric pump with a controllable discharge rate, or a portable electric pump with a controllable discharge rate. A peristaltic pump or inertial pump (Waterra or similar) can be used if an electrical submersible pump is not appropriate. A well-volume based purging and sampling method will be used for these wells. This SOP does not apply to FLUTe wells, or Blatypus pump equipped wells (MW-58BR). Those wells will be sampled according to the relevant Field Activities Work Plan (available from on-site field coordinator).

REQUIRED DOCUMENTS:

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP’s
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data tables
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC’s), and the designated groundwater sampling field notebook

REQUIRED EQUIPMENT:

- 2 or more (i.e. one is backup) YSI-556 WQ instruments with flow through cells, or equivalent.
- Hach 2100P turbidimeter or equivalent.
- 200 foot (or longer as needed) water level indicator (WLI).
- Trimble Rugged Reader hand held instrument for MIST data collection.
- Two, 200 gallon capacity purge tanks.
- Utility vehicles (UTV’s) as necessary.

- Back-up 2-inch pump and controller.
- Honda 2000 watt generator or alternate power source.

PREPARATION & SETUP:

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, HSP, and groundwater sampling supplies and equipment check list. (NOTE: the PST should also be reviewed for required "non-analytical event activities" such as water level measurements or other data collection that is planned in association with the groundwater sampling event).
- Acquire the existing field logbook for groundwater sampling and initiate entries.
- Inspect all equipment and verify that the field water quality (WQ) meters have been calibrated prior to use according to the manufacturer's instructions and SOP-A9, *Calibration of Field Instruments*.
- Inventory sample bottles, build sample sets for the required analytes at each sample location, ensure a sufficient supply of lab de-ionized water for equipment blanks, and confirm the lab courier schedule.
- Field-check sampling equipment and supplies: water level indicator (WLI), WQ meters, flow-through cell, pump controller, power supply, pump discharge/sampling tubing, N-dex gloves, D.I water sprayers, 5 gallon buckets, paper towels, 0.45 micron in-line filters, etc.

FIELD PROCEDURES:

- **Prior to opening any monitor well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the monitoring well, at least 2 members of the sampling team must confirm the well ID. Wells should be clearly marked on the well monument. If the well cannot be positively identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location. Report worn or unclear well markings to the on-site field coordinator.
- Place spill containment according to SOP A-13 *Spill Containment.*
- Collect an "EB", equipment blank, ***prior to pump installation*** if necessary according to the PST.
- Open the protective casing lid and, ***prior to moving it***, note the exact configuration of the transducer installation if present. Measure static WL according to SOP-A7, *Water level Measurements,* moving the transducer if necessary, and record WL value in MIST and on the sampling log.
- If the well is equipped with a transducer and does not have a dedicated pump installed, remove the transducer from the well according to SOP-C1, *Temporary Removal and Replacement of Transducers*.

- If the well does not have a dedicated pump installed, but does have dedicated sample tubing, attach the dedicated tubing to the appropriate pump and install decontaminated pump at the same intake/sampling depth as used in prior events. There is a marking on the purge tubing which corresponds with the monitor well top of casing (TOC) to facilitate this requirement. Purge and sample the well as described below.
- If the well does not have a dedicated pump ***or*** tubing, or has not been previously sampled, use new low-density polyethylene tubing and install the pump with the intake 15 feet below the surface of the static water column, or at the depth prescribed by the Project Manager (PM) or Field Team Manager (FTM), and record the intake depth in MIST and on the field data sheet. Purge and sample the well as described below.
- If the well ***does*** have a dedicated pumping system, connect the discharge tubing and purge and sample the well as described below.
- Collect daily equipment blanks and duplicate samples as required by the PST and instructed by the field team leader.

PURGING AND SAMPLING PROCEDURES:

- Prepare the groundwater sampling log. Use the static water level and the total depth provided on the field data sheet and in the PST to calculate the volume of one casing of standing water in the well.
- Calculate 3 casing volumes for the minimum required purge amount and record on sampling log.
- Evaluate previous purge rates, amount of drawdown, stability of field parameters, and total purge volume prior to sample collection from previous sampling records and historical data tables (Appendix B of *Monitoring Plan for Groundwater and Surface Water Monitoring Program*). If the well has not been previously sampled, estimate the expected purge rate using previous sampling information from nearby wells.
- If the pumping rate is in excess of one gpm, install the provided flow splitter so that the pumping rate does not need to be decreased to collect the sample. If the flow rate is at two gpm or above, install a second flow splitter to control the flow through the flow through cell.
- Install the pump as previously described. Immediately after installation, stuff a large trash bag, or place another barrier into the well bore around the pump discharge tubing. This will help to prevent foreign objects from falling into the well.
- Ensure that all tubing connections are properly tightened and then start the pump. Check for any leaks, monitor drawdown, and calculate/set the purge rate. The purge rate can be determined using the fill-time of a graduated container, or using a flow meter if available. The well specific purge rate and pump setting should be available on the previous purge form. Record pump setting (i.e. hertz) on sampling log if available.
- Purge water should be contained in a portable purge water storage tank. If approved by well owner and the governing regulatory agencies, water may be discharged directly to the ground (this presently applies to PM-03 and PM-04 water supply wells), as directed by the FTM.

- Continue purging, measuring WL and field indicator parameters periodically (time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, ORP, appearance, and any odors present). Time the readings such that there are a minimum of 4 sets of data collected over the course of the full purge.

- If significant drawdown is observed or turbidity increases dramatically, decrease the purge rate and measure/record new purge rate. Significant drawdown is considered to be 5 percent of the total height of the water column or to the top of screen. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems and change out the instrument.

- During the purge, compare the field parameters to historical purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) re-confirm the ID of the well. If the well ID is re-confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.

- Continue purging until ***3-casing volumes*** have been removed ***and*** field parameters stabilize. Indicator parameters are considered stabilized when 3 consecutive readings made several minutes apart fall within the following EPA stabilization criteria:

• pH	+/- 0.1 pH units
• Specific conductance	+/- 3%
• ORP	+/- 10 millivolts
• Turbidity	+/- 10% NTU units (when turbidity is >10 NTUs)
• Dissolved oxygen	+/- 0.3 mg/L
• Temperature	+/- 2° Celsius

- When the requirements above have been satisfied and the purge cycle is complete, disconnect the flow through cell and prepare to collect samples directly from the pump discharge tubing for analyses according to event-specific PST.
- If flow splitters have been used, do not change the flow rate, and collect the sample from the dedicated sampling port of the first splitter in line.
- Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry (cations, anions, stable isotopes).

- For filtered samples, attach a 0.45 micron in-line filter to the pump discharge and allow approximately 500 mL of sample to pass through the filter before beginning sample collection in accordance with SOP A-6 *Field filtration* and the QAPP.

- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.

- If transient pump previously installed, remove the pump from the well, detach the dedicated tubing and carefully drain any residual water to the purge water tank. Install appropriate tubing cap to prevent any residual water from leaking from the sample tubing. Store the dedicated tubing in a sealed, labeled trash bag. Decontaminate the pump according to SOP A-10, *Decontamination of Water Sampling Equipment*.
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and in accordance with SOP-C1, *Temporary Removal and Replacement of Transducers*.
- Close and secure well protection lid.
- Follow SOPs in *Program Procedures Manual* for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

LOW VOLUME AND POOR RECOVERY WELLS:

Some groundwater monitoring wells under the GMP may exhibit slow or poor recovery upon purging. These monitoring wells may not recharge sufficiently during purging, and may run completely dry without an opportunity to collect the required series of groundwater stabilization parameters, or requisite samples. The following procedures will be followed for collecting representative groundwater samples from wells that go dry during purging.

PREPARATION & SETUP:

Follow the steps above.

PURGING AND SAMPLING PROCEDURES FOR LOW RECOVERY WELLS:

- Prepare the groundwater sampling log. Use the static water level and the total depth provided on the field data sheet (comparing to the previous values used on the PST) to calculate the volume of one casing of standing water in the well.
- Calculate 3 casing volumes for the minimum required purge amount, and record on purge log.
- Evaluate previous purge rates, amount of drawdown, stability of field parameters, and total purge volume prior to sample collection from previous sampling records and historical data tables (Appendix B of *Monitoring Plan for Groundwater and Surface Water Monitoring Program*). If the well has not been previously sampled, estimate the expected purge rate using previous sampling information from nearby wells.
- Connect the dedicated purge tubing if available or use new tubing if necessary. Install the pump as previously described and start the purge. Monitor drawdown, and calculate/set the purge rate. Record the pump setting (i.e. hertz) on the sampling log if available.
- Continue purging, measuring WL and field indicator parameters periodically (time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, ORP, and any

odors present). Space the readings such that there are a minimum of 4 sets of data collected over the course of the available purge volume.

- During the purge, compare the field parameters to previous purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) confirm the ID of the well. If the well ID is confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.
- Continue purging until ***3-casing volumes*** have been removed ***and*** field parameters stabilize, or until the well purges dry. If 3 casing volumes are removed, sample as described above. If the well runs dry, continue as instructed below.
- If previously installed, remove the pump from the well and decontaminate according to SOP A-10, *Decontamination of Water Sampling Equipment*. The pump may also be left in place to facilitate subsequent purging and sampling.
- Record the final water level, time, the volume of water discharged and the elapsed time for the dewatering of the well.
- Allow the well to recharge to 80 percent of the original height of the water column. Ideally, this should be within 24 hours of the monitoring well being purged dry. The recovery period to achieve 80 percent of the height of the water column could take longer than 24 hours in some instances (MW-48).
- ***At MW-24BR only,*** return to the well the following day and continue purging until a total of 190 gallons have been removed, then sample normally.
- Once recovery has reached 80%, or 48 hours have elapsed (whichever comes first), a bailer can be used for sample collection. Collect samples for analyses according to PST. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]), then general chemistry (cations, anions, stable isotopes).
- If an insufficient volume of water is available to fill all of the sample containers, first contact laboratory personnel to determine the minimum allowable volumes needed for the required analyses. *(Talk to FTM as the FTM may have already contact lab personnel and may have the instructions for you.)* Then verify the critical analyte list with the PM or the FTM and prioritize the sample collection to obtain the critical analytes for the main contaminants of concern first. Continue collecting samples until all samples have been collected, or the groundwater supply is exhausted. Unfiltered samples are to be filled by transferring water directly from the bailer to the sample container.
- For filtered samples, attach a 0.45 micron in-line filter to the bailer and allow approximately 200 mls of sample to pass through the filter before beginning sample collection in accordance with SOP A-6 *Field filtration*. If gravity flow is insufficient to filter the sample, use a pressurized bailer and filter for sample filtration.

- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and according to SOP-C1, *Temporary Removal and Replacement of Transducers*.
- Close and secure well protection lid.
- Follow *Procedures Manual* for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

SOP-A2

Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells
Modified Well-Volume Method
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and sampling all groundwater monitoring wells at the Topock site with 1-inch casing diameters. This SOP will be used for sampling groundwater monitoring wells using dedicated tubing and a peristaltic pump. A well-volume based purging and sampling method will be used for such wells.

REQUIRED DOCUMENTS:

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

REQUIRED EQUIPMENT:

- 2 or more YSI-556 water quality (WQ) instruments with flow through cells, or equivalent.
- Hach 2100P turbidimeter or equivalent.
- 200 foot Water level indicator (WLI).
- Trimble Rugged Reader hand held instrument for MIST data collection.
- 30 gallon purge water tank.
- Decontamination spray bottles
- Utility vehicles (UTV's) as necessary.
- 12 volt peristaltic pump.

- 12 volt power source.

PREPARATION & SETUP:

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, HSP, and groundwater sampling supplies and equipment check list. (NOTE: the PST should also be reviewed for required "non-analytical event activities" such as water level measurements or other data collection to be performed in association with the groundwater sampling event).
- Acquire the existing field logbook for groundwater sampling and initiate entries.
- Inspect all equipment and verify that the field WQ meters have been calibrated prior to use according to the manufacturer's instructions and SOP-A9, *Calibration of Field Instruments*.
- Inventory sample bottles, build sample sets for the required analytes at each sample location, ensure a sufficient supply of lab de-ionized water for equipment blanks, and confirm the lab courier schedule.
- Field-check sampling equipment and supplies: WLI, WQ meters, flow-through cell, peristaltic pump, power supply, pump discharge/sampling tubing, N-dex gloves, deionized water sprayers, 5 gallon buckets, paper towels, 0.45 micron in-line filters, etc.
- Field-check and setup sampling equipment: WLI, WQ meters, flow-through cell, pump and power supply, pump discharge/sampling tubing, etc. Install dedicated tubing and connect to peristaltic pump. Connect peristaltic pump to 12 volt power supply.

FIELD PROCEDURES:

- **Prior to opening any monitor well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the monitoring well, at least 2 members of the sampling team must confirm the well ID. Wells should be clearly marked on the well monument. If the well cannot be positively identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location.
- Place spill containment according to SOP A-13 *Spill Containment.*
- Open the protective casing lid and, ***prior to moving it***, note the exact configuration of the transducer installation if present. Measure static water level (WL) according to SOP-A7, *Water level Measurements,* moving the transducer if necessary, and record WL value in MIST on the sampling log.
- If the well is equipped with a transducer, remove the transducer from the well according to SOP-C1, *Temporary Removal and Replacement of Transducers*.
- Collect daily equipment blanks and duplicate samples as required by the PST and instructed by the field team leader.

PURGING AND SAMPLING PROCEDURES:

- Prepare the groundwater sampling log. Use the static water level determined above and the total depth provided on the field data sheet and in the PST to calculate the volume of one casing of standing water in the well. Calculate 3 casing volumes for the minimum required purge amount, and record on purge log.

- Prior to purging, evaluate previous purge rates, amount of drawdown, and purge volume from previous sampling records and historical data tables (Appendix B of *Monitoring Plan for Groundwater and Surface Water Monitoring Program* [currently in preparation]). If the well has not been previously sampled, estimate the expected purge parameters using previous sampling information from nearby wells.
- Install the dedicated tubing if available, or use new tubing as necessary. Connect the tubing to the peristaltic pump, check that all fittings are tight, and start purging the well. Check for leaks. Measure WL and calculate the purge rate immediately and adjust if necessary. Purge rate will be measured by using the fill-time of a graduated container. The well specific purge rate and pump setting should be available on the previous purge form.
- Allow the flow through cell to fill and field parameters to stabilize, then start recording field indicator parameters on the sampling sheet and in MIST.
- Continue purging, measuring WL and field indicator parameters periodically (time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, ORP, appearance, and any odors present). Time the readings such that there are a minimum of 5 sets of data collected over the course of the full purge.
- If significant drawdown is observed, or turbidity increases dramatically, decrease the purge rate and measure/record new purge rate. Significant drawdown is considered to be 5 percent of the total height of the water column or to the top of screen. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems.
- During the purge, compare the field parameters to historical purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) confirm the ID of the well. If the well ID is confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.
- Continue purging until ***3-casing volumes*** have been removed ***and*** field parameters stabilize. Indicator parameters are considered stabilized when 3 consecutive readings made several minutes apart fall within the following EPA stabilization criteria:

pH	+/- 0.1 pH units
Specific conductance	+/- 3%
ORP	+/- 10 millivolts

Turbidity	+/-	10% NTU units (when turbidity is >10 NTUs)
Dissolved oxygen	+/-	0.3 mg/L
Temperature	+/-	2^{o} Celsius

- When the requirements above have been satisfied and the purge cycle is complete, disconnect the flow through cell and prepare to collect samples directly from the pump discharge tubing for analyses according to event-specific PST. For all samples, decrease the discharge rate as necessary to reduce water turbulence at the pump discharge point. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry (cations, anions, stable isotopes).
- For filtered samples, attach a 0.45 micron in-line filter to the pump discharge and allow approx. 500 mls of sample to pass through the filter before beginning sample collection in accordance with SOP A-6 *Field filtration*.
- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
- If previously installed, remove the pump from the well, detach the dedicated tubing and carefully drain any residual water to the purge water tank. Fold both ends of the purge tubing and secure with wire ties as a further deterrent to leakage. Store the dedicated tubing in a sealed, labeled trash bag. Decontaminate the pump according to SOP A-10, *Decontamination of Water Sampling Equipment*.
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and according to SOP-C1, *Temporary Removal and Replacement of Transducers*.
- Close and secure well protection lid.
- Follow SOPs in *Program Procedures Manual* for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

LOW VOLUME AND POOR RECOVERY WELLS:

Some groundwater monitoring wells under the GMP may exhibit slow or poor recovery upon purging. These groundwater monitoring wells may not recover sufficiently during purging and run completely dry without an opportunity to collect the required series of groundwater stabilization parameters, or run dry prior to sampling. The following procedures should be followed for collection representative groundwater samples from wells that go dry during purging activities in preparation for groundwater sampling.

PREPARATION & SETUP:

Follow steps above.

PURGING AND SAMPLING PROCEDURES FOR LOW RECOVERY WELLS:

- Prepare the groundwater sampling log. Use the static water level determined above and the total depth provided on the field data sheet and in the PST to calculate the volume of one casing of standing water in the well.
- Calculate 3 casing volumes for the minimum required purge amount, and record on purge log.
- Evaluate previous purge rates, amount of drawdown, stability of field parameters, and total purge volume prior to sample collection from previous sampling records and historical data tables (Appendix B of *Monitoring Plan for Groundwater and Surface Water Monitoring Program*). If the well has not been previously sampled, estimate the expected purge rate using previous sampling information from nearby wells.
- Connect the dedicated purge tubing if available, or use new tubing if necessary. Install the pump as previously described and start the purge. Monitor drawdown, and calculate/set the purge rate.
- Continue purging, measuring WL and field indicator parameters periodically (time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, ORP, and any odors present). Space the readings such that there are a minimum of 5 sets of data collected over the course of the available purge volume.
- During the purge, compare the field parameters to previous purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) confirm the ID of the well. If the well ID is confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.
- Continue purging until ***3-casing volumes*** have been removed ***and*** field parameters stabilize, or until the well purges dry. If 3 casing volumes are removed, sample as described above. If the well runs dry, continue as instructed below.
- If previously installed, remove the pump from the well and decontaminate according to SOP A-10, *Decontamination of Water Sampling Equipment.* The pump may also be left in place to facilitate subsequent purging and sampling.
- Record the final water level, time, the volume of water discharged and the elapsed time for the dewatering of the well.
- Allow the well to recharge to 80 percent of the original height of the water column. Ideally, this should be within 24 hours of the monitoring well being purged dry. The recovery period to achieve 80 percent of the height of the water column could take longer than 24 hours in some instances (MW-48).

- Once recovery has reached 80%, or 48 hours have elapsed (whichever comes first), a bailer can be used for sample collection. Collect samples for analyses according to PST. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]), then general chemistry (cations, anions, stable isotopes).
- If an insufficient volume of water is available to fill all of the sample containers, first contact laboratory personnel to determine the minimum allowable volumes needed for the required analyses, then verify the critical analyte list with the PM or the FTM and prioritize the sample collection to obtain the critical analytes for the main contaminants of concern first. Continue collecting samples until all samples have been collected, or the groundwater supply is exhausted. Unfiltered samples are to be filled by transferring water directly from the bailer to the sample container.
- For filtered samples, attach a 0.45 micron in-line filter to the bailer and allow approx. 200 mls of sample to pass through the filter before beginning sample collection in accordance with SOP A-6 *Field filtration*. If gravity flow is insufficient to filter the sample, use a pressurized bailer and filter for sample filtration.
- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and according to SOP-C1, *Temporary Removal and Replacement of Transducers*.
- Close and secure well protection lid.
- Follow *Procedures Manual* for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

SOP-A3

Purging and Sampling of Active and Inactive Water Supply Wells Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and sampling active and inactive water supply wells in the vicinity of the Topock site. This procedure also applies to the collection of water quality samples from long-screen extraction, injection, and test wells. Active and inactive water supply wells with functional dedicated pumps and a sampling port will be sampled directly from the sampling port. Inactive supply wells without functional pumps will be sampled using a temporary submersible pump following the well-volume sampling procedure.

REQUIRED DOCUMENTS:

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

REQUIRED EQUIPMENT:

- 2 or more YSI-556 water quality (WQ) instruments with flow through cells, or equivalent.
- Hach 2100P turbidimeter or equivalent.
- 200 foot Water level indicator (WLI).
- Trimble Rugged Reader hand held instrument for MIST data collection.
- 200 gallon capacity purge tanks (2).
- Utility vehicles (UTV's) as necessary.
- Back-up 2 inch pump and controller.
- Honda 2000 watt generator or alternate power source.

PREPARATION AND SETUP:

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, HSP, and groundwater sampling supplies and equipment check list.
- Acquire the existing field logbook for surface water sampling and initiate entries.
- Inspect all equipment and verify that the field WQ meters have been calibrated prior to use according to the manufacturer's instructions and SOP-A9, *Calibration of Field Instruments*.
- Inventory sample bottles, build sample sets for the required analytes at each sample location, ensure a sufficient supply of lab de-ionized water for equipment blanks, and confirm the lab courier schedule.
- Field-check sampling equipment and supplies: WLI, WQ meters, flow-through cell, pump controller, power supply, pump discharge/sampling tubing, N-dex gloves, D.I water sprayers, paper towels, etc.

PURGING AND SAMPLING PROCEDURES FOR *ACTIVE* WATER SUPPLY WELLS:

- **Prior to opening any well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the well, at least 2 members of the sampling team must confirm the well ID. If the well cannot be clearly identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location.
- Access the well and, ***prior to moving it***, note the exact configuration of the transducer installation if present. If the well has been inactive for more than 24 hours, a water level measurement can be taken. Measure static water level (WL) according to SOP-A7, *Water level Measurements,* moving the transducer if necessary, and record WL value in MIST on the sampling log.
- If the well is equipped with a transducer and transducer removal is required for sampling, follow SOP-C1, *Temporary Removal and Replacement of Transducers*.
- If it is known that 3-casing volumes have been purged from the well in the last 24-hour period, purging will not be necessary prior to sampling. Connect one end of a new or dedicated piece of LDPE tubing to the pump discharge port and connect the other to the inlet of the flow through cell. If it is not possible to connect the flow-through cell, a clean 5-gallon bucket may be used by filling the bucket with purge water and inserting the instrument probes directly into the bucket. If a bucket is used, turbulence in the bucket should be minimized to the extent possible.
- Carefully open the valve at the sampling port until the desired flow rate is achieved, then allow the flow through cell to fill and the parameters to stabilize before collecting a single set of water quality parameters. Record in MIST and on the field data sheet. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems. Purge water should be contained in a portable purge water storage tank. If approved by well owner and the governing regulatory agencies, water may be discharged directly to the ground, as directed by the Field Team Manager (FTM).

- Observations on sample appearance and clarity during purging and at sampling are required! For standardization, use a clear glass jar to collect and record observations of discharge water appearance during purging. Also note characteristics such as any odors associated with the discharge water.
- Compare the field parameters to historical purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) confirm the ID of the well. If the well ID is confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.
- Disconnect the flow through cell and collect samples for analyses according to the PST. Sample containers are to be filled by transferring water directly from the pump discharge or sampling spigot to the appropriate sample container.
- For filtered samples, attach a 0.45 micron in-line filter to the pump discharge and allow approx. 500 mls of sample to pass through the filter before beginning sample collection in accordance with SOP A-6 *Field filtration*.
- When sample collection is complete, record sample information, final WL, and purge volume data on field log. If the pump is equipped with a flow meter, record the flow rate as well.
- If well was equipped with a transducer, replace transducer according to SOP-C1, *Temporary Removal and Replacement of Transducers*.
- Close and secure well including access gates or fences.
- Follow SOPs in *Program Procedures Manual* for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

PURGING AND SAMPLING PROCEDURES FOR *INACTIVE* WATER SUPPLY WELLS:

Inactive water wells may include: (1) wells with functioning dedicated pumps, (2) wells without dedicated pumps, and (3) wells with non-functioning dedicated pumps. A well-pump subcontractor may be required to install temporary pumps for purging wells without pumps and non-functioning dedicated pumps.

- **Prior to opening any monitor well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the well, at least 2 members of the sampling team must confirm the well ID. Wells will be clearly marked on the well monument. If the well cannot be clearly identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location.

- Access the well and, ***prior to moving it***, note the exact configuration of the transducer installation if present. If the well has been inactive for more than 24 hours, a water level measurement can be taken. Measure static WL according to SOP-A7, *Water level Measurements,* moving the transducer if necessary, and record WL value in MIST on the sampling log.
- If the well is equipped with a transducer and transducer removal is required for sampling, follow SOP-C1, *Temporary Removal and Replacement of Transducers*.
- If the well has had well volumes purged in the last 24 hours, then it is an active well and purging before *sampling may be limited to volume sufficient fo*r field parameter measurement.
- If it is determined that 3-casing volumes ***have not*** been purged in the last 24-hours, calculate 3-casing volumes using measured WL depth, casing diameter, and total well depth information. If it is not possible to measure the depth to water or total depth of the well, use well records or prior knowledge to calculate 3-casing volumes.
- Start purging using the functional dedicated equipment, if available. Check for any leaks, monitor drawdown, and calculate/set the purge rate.
- If dedicated equipment is not present or nonfunctional, a portable pump installed by subcontractor may be used for purging and sampling. Install a decontaminated pump at the same intake/sampling depth used in prior events and record intake depth. If the well has not been previously sampled, install the pump with the intake in the middle of the screened interval ,or the midpoint of the saturated interval if the water level is lower than the top of the screen, or at the depth proscribed by the Project Manager or FTM.
- Purge water should be contained in a portable purge water storage tank. If approved by well owner and the governing regulatory agencies, water may be discharged directly to the ground, (at present this is only the case at PM-03 and PM-04 supply wells), as directed by the Field Team Manager.
- Continue purging, measuring WL and field indicator parameters periodically (time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, ORP, and any odors present). Time the readings such that there are a minimum of 5 sets of data collected over the course of the full purge.
- Decrease the purge rate and measure/record new purge rate if significant drawdown is observed or turbidity increases dramatically. Significant drawdown is considered to be 5 percent of the total height of the water column or to the top of screen. Record time for all measurements collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems.
- During the purge, compare the field parameters to previous purge data. If the parameters are significantly different (greater than 50% difference for SC, pH, and/or ORP) confirm the ID of the well. If the well ID is confirmed by 2 crew members, and the readings continue to be significantly different than prior readings, set up a second WQ instrument in series to confirm readings. If the anomalous readings are confirmed by the second instrument, contact the field coordinator to resolve the issue. If the second WQ instrument produces readings that are comparable to historic values, note an instrument change and use the second instrument's readings.

- Continue purging until ***3-casing volumes*** have been removed ***and*** field parameters stabilize. Indicator parameters are considered stabilized when 3 consecutive readings made several minutes apart fall within the following EPA stabilization criteria:
    - pH +/- 0.1 pH units
    - Specific conductance +/- 3%
    - ORP +/- 10 millivolts
    - Turbidity +/- 10% NTU units (when turbidity is >10 NTUs)
    - Dissolved oxygen +/- 0.3 mg/L
    - Temperature +/- 2° Celsius
- When the requirements above have been satisfied and the purge cycle is complete, disconnect the flow through cell and prepare to collect samples directly from the pump discharge tubing for analyses according to event-specific PST. For all samples, decrease the discharge rate as necessary to reduce water turbulence at the pump discharge point. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry (cations, anions, stable isotopes).
- For filtered samples, attach a 0.45 micron in-line filter to the pump discharge and allow approx. 500 mls of sample to pass through the filter before beginning sample collection in accordance with SOP A-6 *Field filtration*.
- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
- If previously installed, remove the pump from the well and decontaminate according to SOP A-10, *Decontamination of Water Sampling Equipment*.
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and according to SOP-C1, *Temporary Removal and Replacement of Transducers*.
- Close and secure well, including fences and gates.
- Follow SOPs in *Program Procedures Manual* for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

SOP-A4

Depth-Specific River Water Sampling
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for river channel and shoreline surface water sampling at the Topock site. This SOP should be used for depth-specific river channel surface water sampling and single depth shoreline sampling stations on the Colorado River.

REQUIRED DOCUMENTS

1) Event-specific planned sample table (PST) or Mobile Integrated Sample Tracking (MIST) handheld database, Plan Versus Actual Report, Delegation of Authority, and Contingency Plan.
2) Applicable project work plan or monitoring plan. Refer to the PG&E Program Quality Assurance Project Plan, (QAPP) (CH2M HILL, 2012) or the Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy (CH2M HILL, 2012), as required.
3) Topock Program Health and Safety Plan (HSP).
4) Blank sampling logs, MIST database and field notebook. Purge and sampling information will be recorded on hard copy purge form and MIST handheld database.

PREPARATION & SETUP

1) Review event-specific SAP or event-specific field instructions, previous sampling logs, Field Procedures Manual, previous lessons learned, and HSP. (NOTE: the PST should also be reviewed for required "non-analytical event activities" in association with the river sampling event).
2) Initiate field logbook for sampling activity.
3) Inspect all equipment and calibrate field water quality (WQ) meters according to SOP-A9, *Calibration of Field Instruments*.
4) Inventory sample bottles and labels, required analyses, and confirm the lab courier schedule.
5) Field-check and set up sampling equipment: WQ meters, health and safety apparatuses (life vest, rescue rope, life preserver), water depth meter or depth-finder, peristaltic pump, filters, sufficient tygon and silicone tubing, polypropylene rope, sampling equipment, etc.
6) Prepare an ambient blank sample at the beginning of each day. Fill a 250 mL sample container with deionized water. This bottle is to remain open near the sampler for the duration of the day's sampling activities. At the end of the day close the sample container. Send the blank samples to the analytical lab for Cr(VI) analysis (by method

218.6), be sure to write "**hold**" on the COC. The blanks will only to be analyzed if there are anomalous results from the river samples.

IN-CHANNEL SAMPLING PROCEDURES

6) Prepare river water sampling log (use attached form).
7) The sampling team will travel to each river sampling station in a motorized boat. A safety inspection of the boat will be performed by the field crew prior to boarding (check for fire extinguisher, etc.). Samples will be collected from selected stations on the river approximately one-third the river width from the California shoreline.
8) Collect an equipment blank sample prior to sampling by running deionized water through a new/dedicated segment of tubing.
9) An industry standard (Trimble or similar) resource grade handheld DGPS unit (GeoXT or similar) will be used with real-time correction (wide area augmentation system) to locate the river channel sampling stations within a 1 meter radius (68% of the time, commonly referred to 1 sigma accuracy). At each location, two anchors should be positioned upstream at least 10 feet from each other (Attachment A). Record the GPS coordinates on the sampling log. In the event a sampling station is too shallow to safely approach by boat, the next closest location with adequate depth will be sampled and a remark noted on the sampling log with the new GPS coordinates.
10) Record the depth of the river at each sampling station using the depth-finder or a weighted tape. If a weighted tape is used, read the tape at the river water surface when the weight touches the river floor. Record river depth on the sample log.
11) Samples will be collected from two depths at each river channel sampling station: 1 foot from the bottom of the river, and 1 foot from the water surface.
12) Samples are to be collected using a variable-speed peristaltic pump with ¼-inch tygon tubing attached to a weighted polypropylene rope (Attachment A) and a segment of silicone tubing for use in the peristaltic pump. Alternatively, a weighted pole can be used in place of the polypropylene rope. Dedicated tubing will be used for each sample depth at each sample station. Once the sampling depths have been calculated for each station, pre-cut two pieces of tygon tubing and attach them to the rope so that their intakes are at the proper sampling depths. Lower the weighted rope and tubing until the weight touches the river bottom and the tubing intakes are at the correct depths. Confirm river depth using the depth-finder or weighted tape. Attach the discharge end of the sample tubing to the flow cell of the water quality meter. Start the peristaltic pump and allow the flow cell to fill and the water to equilibrate for approximately 3 minutes, or until the temperature readings remain stable for 30 seconds (+/- 1 °C). Record the time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, and ORP on the field log. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to an instrument problem. Turn off the peristaltic pump, remove tubing from the flow cell, and restart the pump. Attach a 0.45 micron filter when sampling for Cr(T) by USEPA SW-846 Method 6020A or for Cr(VI) by USEPA Method 218.6. Refer to SOP-A6 in the Field Procedures Manual for filtration procedures. Pump approximately 500 ml through the system and begin filling the

applicable sample bottles. Remove the filter prior to filling sample bottles for the other analyses, which do not require filtration. Ensure that the samples do not contact any source of metal. Place the samples on ice immediately after collection. Record all sample information on the field log.

13) Collect remaining samples for analyses according to the PST. Use a new piece of tygon tubing and change out the flexible silicone tubing in the peristaltic pump for each depth, at each location.

14) Follow the Field Procedures Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.

SHORELINE SAMPLING PROCEDURES

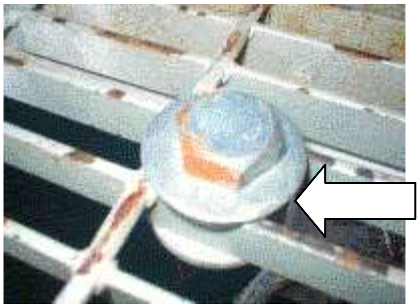
15) Prepare surface water sampling log (use attached form dated March 2005).

16) An industry standard (Trimble or similar) resource grade handheld DGPS unit (GeoXT or similar) will be used with real-time correction (wide area augmentation system) when available to locate the surface water sampling locations within a 1 meter radius (68% of the time, commonly referred to 1 sigma accuracy).

17) If sampling at locations RRB or I-3 (or any other river station where water levels are required), measure river WL according to SOP-A7, *Water level Measurements*. Record WL value on sampling log.

RRB: Water level measurement will be taken at the "X" on the bridge.

I-3: There is a bolt and nut in the metal bridge, water level is recorded to the base of the nut (see photo)



18) Where possible, place water quality meter probes in the Colorado River in a secure place near-shore for approximately 3 minutes, until the temperature reading stabilizes prior to reading field parameters from sample. Proceed with sampling activities while the temperature of the probes is equilibriating.

19) Collect samples for analyses according to event-specific PST.

RRB: Samples are collected using a disposable bailer and directly filling the sample bottles. An attempt will be made to ensure the water is collected from several inches beneath the surface of the water. If the water is too shallow to use a bailer, than the surface water sampling pole can be used. Make a notation on the sample log that the sample was not collected from the recommended depth.

I-3: Samples are collected using a disposable bailer and directly filling the sample bottles. An attempt will be made to ensure the water is collected from several inches beneath the surface of the water.

All other locations:

If collecting sample from the shore, samples are collected using a surface water sampling pole that is extended as far as possible in a safe manner (ideally 4 feet from the shoreline) and the sample collected approximately 6 inches below the surface, or by wading out and dipping the sampling bottle approximately 6 inches beneath the surface. The Sampling containers are connected to the sampling pole and filled directly from the river. If it is not possible to connect the sampling bottle directly to the sampling pole, a portable sampling bottle will be used. The portable sampling bottle will be decontaminated between locations in accordance with SOP-A10 and protected from ambient conditions as prescribed therein. Prior to filling the portable sampling bottle it will be rinsed with surface water at the sampling location.

If the shoreline samples are collected from a boat, the boat must be able to pull within 4 feet of the shore at the sample location. Samples are collected using a peristaltic pump by lowering the intake tubing 4-inches below the water surface. New or dedicated tubing must be used at each sampling location.

Samples that are to be filtered as part of the analytical suite will be field filtered at the support vehicle using a portable peristaltic pump to transfer water from the collection vessel through a 0.45 micron filter in accordance with SOP-A6 and discharged into the laboratory supplied sample container. At minimum, the required sample volume and an additional 500 milliliters will be collected to ensure there is sufficient volume for filtration.

20) Record sample information on field log.

21) Fill a clean bucket with Colorado River water collected approximately 6 inches below surface using a bailer or by directly filling the bucket (invert until desired depth) for measurement of water quality field parameters. Where possible (all locations except RRB), flowing water is collected for a one-time temperature stable reading of the following field parameters:

- pH
- Specific conductance
- ORP
- Turbidity
- Dissolved oxygen
- Temperature

22) Measure field parameters by removing the water quality probes from the river and inserting the Horiba probes directly into the bucket. The Hach vial shall be filled from the bucket. Record all parameters on the field sheet. <u>Record time for all measurements</u>

collected. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problem.

13) Follow the Field Procedures Manual for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

SOP-A5

Groundwater Sampling from Sonic Drilling Boreholes
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and collection of grab groundwater samples from boreholes during sonic drilling. When a pump sampling system (Prosonic "Isoflow") is available and feasible, Isoflow sampling is the preferred method. When Isoflow sampling is not available or not feasible then a bailer method will be used for grab groundwater sampling while drilling.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP), Work Plan or event-specific field instructions. Planned borehole depth, proposed well construction/specifications, and field sampling summary table, if available.
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
3) Topock Program Health and Safety Plan (HSP)
4) Previous sampling, drilling, or well construction logs from other boreholes or wells in the vicinity, if available
5) Blank sampling log and field notebook

PREPARATION & SETUP

1) Review event-specific Work Plan or event-specific field instructions, Procedures Manual, and HSP.
2) Initiate field logbook for sampling activity.
3) Review sampling procedures and equipment, and planned sample depths with drilling contractor and field crew.
4) Inspect all required field equipment and calibrate field water quality (WQ) meters according to SOP-A9, *Calibration of Field Instruments*.
5) Inventory sample bottles, review required analyses, and understand lab courier schedule.
6) Field-check and setup sampling equipment: Decontaminated Isoflow pump or stainless steel bailer, rig hoist, generator, containers for purge water management, water level (WL) meter, WQ meters, flow-through cell, pump control and power supply, pump discharge/sampling tubing, health and safety equipment, etc.

PURGING AND SAMPLING PROCEDURES FOR ISOFLOW SAMPLING FROM BOREHOLE

7) Prepare groundwater sampling log (use field notebook and summarize relevant information on sampling form).

8) Insert the Isoflow into the sonic casing. After the Isoflow is set, retract the sonic casing approximately 10 feet. Record the top and bottom of this open borehole interval and identify the grab groundwater sample as the mid-point of this interval. If possible, a water level measurement can be taken before Isoflow pumping begins. Measure initial static WL according to SOP-A7, *Water level Measurements*. Record WL value on sampling log. Monitor and record Isoflow pumping rate and WL measurements made while pumping. The length of the open borehole interval will be a field decision based on the frequency of Isoflow sampling and the formation conditions. Shorter open borehole intervals (as short as 5 feet) are appropriate for Isoflow sampling frequency of every 20 feet of drilled depth, or in heterogeneous conditions where it is desired to sample from a specific conductive zone. Longer open borehole intervals of up to 20 feet are appropriate if the Isoflow sampling frequency is every 50 to 60 feet of drill depth.

9) Measure water quality parameters using a flow-through cell connected directly to the sampling port. If it is not possible to connect the flow-through cell, a clean 5-gallon bucket may be used by filling the bucket with purge water and inserting the instrument probes directly into the bucket. If the bucket is used, turbulence in the bucket should be minimized to the extent possible. <u>Record time for all measurements collected</u>. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems. Record the purge rate. Purge water should be contained in a portable water storage tank, as directed by the Field Team Manager.

10) Observations on sample appearance and clarity during purging and at sampling are required. For standardization, use a clear glass jar to collect and record observations of discharge water appearance during purging. Also note characteristics such as any odors associated with the discharge water. Record the following water quality data on the field data sheet: pH, specific conductance, ORP, turbidity, TDS, and dissolved oxygen, and temperature. Indicator parameters are considered stabilized, and thus sampling may commence, when 3 consecutive readings made several minutes apart fall within the following EPA-recommended stabilization criteria:

• pH	+/- 0.1 pH units
• Specific conductance	+/- 3%
• ORP	+/- 10 millivolts
• Turbidity	+/- 10% NTU units (when turbidity is >10 NTUs)
• Dissolved oxygen	+/- 0.3 mg/L

However, parameter stabilization is not a requirement for sampling from open boreholes. Typically, TDS is used as a reliable indicator for borehole sampling at the site, given the known increasing concentration with depth across the site.

11) Collect samples for analyses according to event-specific SAP. For all samples, decrease the discharge rate to reduce water turbulence at the pump discharge point. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order

will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]), then general chemistry (cations, anions, stable isotopes). Sample containers are to be filled by transferring water directly from the pump discharge to the appropriate sample container.

12) Record sample information, final WL, and purge volume data on field log.
13) Oversee the driller's removal and decontamination of the Isoflow sampling pump.
14) Oversee the driller in resuming drilling and soil sampling.
15) Follow SOPs in Program Procedures Manual for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

PURGING AND SAMPLING PROCEDURES FOR BAILER SAMPLING FROM BOREHOLE

7) Prepare groundwater sampling log (use field notebook and summarize relevant information on sampling form).
8) Collect the grab groundwater sample by bailing the open hole interval below the sonic casing after removing a 10 to 20-foot sonic core run.
9) Sound the bottom of the borehole after removing the core barrel. Measure initial static WL according to SOP-A7, *Water level Measurements*. Record WL value on sampling log.
10) Calculate 1-casing volume using measured WL depth, casing diameter, and total well depth information. Insert the decontaminated stainless steel bailer into the borehole and begin bailing a minimum of one casing volume. Purge water should be contained in a portable water storage tank, as directed by the Field Team Manager.
11) Measure water quality parameters using a clean 5-gallon bucket and inserting the instrument probes directly into the bucket. If the bucket is used, turbulence in the bucket should be minimized to the extent possible. Record time for all measurements collected. Record the following water quality data on the field data sheet: pH, specific conductance, ORP, turbidity, TDS, dissolved oxygen, sample appearance, and odor. Parameter stabilization is not a requirement for sampling from open boreholes. Typically, TDS is used as a reliable indicator for borehole sampling at the site, given the known increasing concentration with depth across the site.
12) Collect samples for analyses according to event-specific SAP. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]), then general chemistry (cations, anions, stable isotopes). Sample containers are to be filled by transferring water directly from the bailer to the appropriate sample container. For all samples, handle the bailer with care and decant from the bailer slowly to minimize the potential for aeration and turbulence as containers are filled.
13) Record sample information, final WL, and purge volume data on field log.

14) Follow SOPs in Program Procedures Manual for sample handing and management, equipment decontamination, and IDW management.

PRIVILEGED AND CONFIDENTAL

SOP-A6

Sample Field Filtration and Preservation for Metals Analyses
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for collecting groundwater / surface water samples for field filtered metals analyses at the Topock site. Refer to SOP- A1, A2, A3, or A4 for specific groundwater and surface water sampling methods.

REQUIRED DOCUMENTS

1) Event-specific planned sample table (PST).
2) Applicable project work plan or monitoring plan. Refer to the PG&E Program Quality Assurance Project Plan, (QAPP) (CH2M HILL, 2012) or the Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy (CH2M HILL, 2012), as required.
3) Topock Program Health and Safety Plan (HSP).
4) Previous sampling logs or tabular table of historic field data.
5) Blank sampling logs and field notebook.

PREPARATION & SETUP

1) Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
2) Initiate field logbook for sampling activity.
3) Inventory sample containers and labels, required analyses, and lab courier schedule.
4) Field-check and setup sampling equipment: field filters, buffering solution, acid, and sample containers.

FIELD-FILTRATION AND SAMPLE COLLECTION PROCEDURES FOR GROUNDWATER FROM MONITORING AND EXTRACTION WELLS

1) Follow SOPs A1 and A2.

Sample Collection

1) Once parameters are stabilized and a minimum 3-casing volumes have been removed from the well, disconnect the tubing from the flow-through cell and connect the inline 0.45 micron filter.

2) Allow 500 milliliters (mL) to flow through the inline filter, prior to sample collection. Fill the sample container by transferring water directly from the filter discharge to the appropriate sample container.

Total Chromium and Metals analyzed by the 6000 / 7000 Series of SW 846 Methods and metals analyzed by EPA Methods of the 200 Series

i. Fill a laboratory provided pre-preserved sample container (250 or 500 mL poly containing (HNO_3). CARE MUST BE TAKEN NOT TO OVERFILL THE CONTAINER.

In the event that no pre-preserved sample containers are available, the sampling team will need to follow the following protocol.

ii. If you are preserving the container in the field, check the pH of the sample with laboratory provided pH paper. If the pH of the sample is greater than 2, add 5 drops of HNO_3. Close the container, shake and check the pH. Continue adding HNO_3 in 5-drop increments until the pH is less than 2.

iii. Record the total amount of HNO_3 added to the sample and the pH on the chain of custody and field form. Seal, label, and place the sample on ice.

Hexavalent Chromium Method SM3500and 218.6

i. Fill a laboratory provided pre-preserved sample container (250 mL poly containing (NH4)2S O4/NH4OH buffer solution) to the top of the container neck.

ii. Seal, label, and place the sample on ice.

In the event that no pre-preserved sample containers are available, the sampling team will need to follow the following protocol.

i. If you are preserving the container in the field, fill a laboratory provided sample container (250 mL poly) to approximately 235 mL, leaving headspace for the addition of buffer solution.

ii. Add 3 mL of laboratory provided buffer solution using a pipette. Place the lid on the sample container and shake gently. Check the pH using laboratory provided pH strips.

iii. If the pH is less than 9, add 1 mL of buffer solution, close container and shake gently. Check the pH using laboratory provided pH strips. If the pH is less than 9; continue adding the buffer solution in 1 mL increments until the pH is between 9 and 9.5 or until 12 mL of buffer solution is added.

iv. If the pH is less than 9 and 12 mL of buffer solution has been added, add one drop of 20% NH_4OH, close container, gently shake, and check the pH. Continue until the pH is between 9 and 9.5.

v. When the pH of the sample is between 9 and 9.5, record the total amount of pH buffer and 20% NH_4OH added to the sample and the pH of the sample on the chain of custody and field form. Seal, label, and place the sample on ice.

3) Discard used pH paper(s) and filter in IDW bin.

4) Record sample information, final WL, and purge volume data on field log.

SOP-A7

Water Level Measurements
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for manually measuring the depth to water at surface water locations, groundwater monitoring wells and production wells.

REQUIRED DOCUMENTS:

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
- Topock Program Health and Safety Plan (HSP)
- Well construction logs/specifications
- Current site access map
- Previous water level data
- Water level data collection sheet and field notebook
- Blank sampling logs if applicable

PREPARATION & SETUP:

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
- Ensure that the WL meter has been decontaminated (check for label/tag) or decontaminate as needed following SOP-A10 *Decontamination of Water Sampling Equipment.*
- Initiate field logbook for sampling activity.
- Inspect all equipment and calibrate water level meters if multiple meters are being used according to SOP-A9, *Calibration of Field Instruments*.
- If a transducer is present in the well and it is necessary to remove the transducer to allow well access, first note the exact position of the transducer and refer to SOP-C1, *Temporary Removal and Replacement of Transducers* before proceeding.

REQUIRED EQUIPMENT:

- 200 foot or 400 foot water level indicator (WLI)
- Well access keys, including gate keys if necessary
- De-ionized water spray bottle

- N-dex gloves, paper towels, clipboard

MEASUREMENT PROCEDURES:

- Prepare groundwater sampling log or water level data collection form.
- Decontaminate the lower 5 feet of the water level probe before using by rinsing thoroughly with de-ionized water according to SOP-A10, *Decontamination of Water Sampling Equipment*.
- Place water level probe into well, or measure from surface water monitoring point and lower the probe until the tone sounds. Raise the probe out of the water and gently shake the line to remove any retained water. Adjust the WLI sensitivity if necessary. The groundwater on site is highly conductive and may cause a constant tone from the WLI. This means that the sensitivity is set too high, turn the knob to the left to decrease sensitivity. Conversely, if measuring surface water which typically has very low conductance, and you are having difficulty getting a tone, the sensitivity may be set too low, increase the sensitivity by turning the knob to the right. Slowly lower the probe once again just until the tone sounds. Note depth to water (DTW) value at the measuring point on the PVC well casing. If there is no mark on the PVC casing, measure DTW at the northern edge of the PVC casing. Repeat the measurement 3 times to confirm DTW, and record to the nearest hundredth of a foot on the sampling log. Record well identification, time, date, DTW, and water level meter number.
- Replace pressure transducer if removed. Ensure that transducer is placed exactly as it was before removal.
- Compare DTW measurement with previous data and note discrepancies on the sampling form. Repeat step the previous step if an unexpected discrepancy is noted.
- Decontaminate any portion of the instrument that came in contact with water by rinsing thoroughly with de-ionized water, or wiping with a DI water moistened paper towel according to SOP-A10, *Decontamination of Water Sampling Equipment*.
- Close and secure well.

SOP-A8

Field Water Quality Measurements Using a Flow-through Cell Standard Operating Procedures for PG&E Topock Program

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This Standard Operating Procedure (SOP) provides general guidelines for using the YSI-556® water quality (WQ) meter and flow-through cell, or similar device for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of groundwater samples. Also addressed are procedures for measuring water sample turbidity using the Hach turbidity meter. All instruments will be calibrated daily in accordance with the manufacturer's instructions and SOP-A9, *Calibration of Field Instruments*.

REQUIRED DOCUMENTS:

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

REQUIRED EQUIPMENT:

- YSI-556 WQ meter or equivalent
- YSI-556 flow through cell or equivalent
- Hach 2100P turbidimeter or equivalent
- Trimble Rugged Reader hand held device with the CH2M HILL event specific MIST electronic data collection database loaded

PREPARATION & SETUP:

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
- Acquire the existing field logbook for the specific field activity and initiate entries.

- Inspect all equipment : YSI-556 WQ meter or similar device, flow-through cell, o-rings, and fittings , Hach turbidity meter, distilled water in spray bottle.
- Prior to each day's use, clean the probes and flow-through cell and calibrate the field water quality (WQ) meters according to SOP-A9, *Calibration of Field Instruments* and the manufacturer's instructions.

<u>YSI-556 WQ Meter (or equivalent):</u>

- Attach the probe body securely to the flow through cell. Attach the pump discharge line to the bottom fitting of the flow through cell, and a second discharge line to the top fitting of the flow through cell. Route the flow through cell discharge line to the purge water storage tank and secure.
- Prior to starting the pump, place the flow through cell into a 5 gallon bucket, ensure that all fittings are properly tightened and that spill containment is in place in accordance with SOP A-13 *Spill Containment.*
- Start the pump and allow the flow through cell to fill. Check for excessive leakage from the cell. A small amount of leakage is typical and allowable, and will be caught by the 5 gallon bucket. If leakage is excessive, stop the pump, remove the probe body from the flow through cell and inspect the O-ring and threads for damage. Replace if necessary, re-attach to flow through cell, and restart the pump.
- Ensure that there are no air bubbles entering the flow through cell since this will skew the dissolved oxygen and ORP readings.
- Allow instrument readings to stabilize and collect water quality data in MIST and on the field data sheet. Time the readings such that there at least 5 sets of readings collected over the length of the full purge.
- When sampling is complete, carefully remove the fittings and drain the flow through cell into the bucket. Rinse the instrument probes and flow through cell thoroughly with de-ionized water in accordance with SOP A-10, *Decontamination of Water Sampling Equipment,* catching the rinsate in the bucket.
- Mount the specially cut "dumping lid" on the bucket, and carefully pour the contents into the purge water storage tank.
- Carefully clean and store the WC instrument in accordance with the manufacturer's recommendations in preparation for the next use.

<u>HACH 2100P TURBIDIMETER:</u>

- Turn the turbidity meter on and select the auto-range mode.
- Inspect the measurement vial for scratches, dirt or staining. Replace or clean as necessary.
- Fill the measurement vial with water and carefully wipe dry.
- If bubbles cling to the side of the vial, gently swirl the sample to sweep them loose.

- Place the measurement vial in the instrument, close the lid and press the measure button.
- Record the value on the sample sheet and in MIST.
- Clean and store the instrument and vial. Fill the vial with DI water for storage, this prevents water spotting.

SOP-A9

Calibration of Field Instruments
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for calibration of field instruments at the Topock site. This SOP will be used for calibration of water level meters, YSI-556 water quality (WQ) meter, In-Situ Troll 9500 WQ meter, and Hach turbidity meter.

Required Documents:

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
- Equipment Manufacturers' Manuals
- Previous Calibration Records
- Field Equipment Binder (documents equipment servicing, calibration, etc…)
- Blank Calibration Sheets (see attached)
- Zobells ORP vs. temperature chart

YSI-556 WQ Meter Calibration Equipment List:

- pH 4, 7, and 10 buffer solutions
- 1000 micro-mhos/cm conductivity solution
- Zobell's ORP check solution
- Spare batteries
- DI water sprayer
- Rinsate bucket
- Calibration vessels

In-situ Troll 9500 WQ Meter Calibration Equipment List:

- Quick-cal. solution
- DI water sprayer
- Spare batteries
- Rinsate bucket
- Calibration vessels
- Dissolved oxygen bubbler

Hach Turbidity Meter Calibration Equipment List:

- LabDI water, NTU = <1

- Standard Hach solutions, NTU= 10 and NTU=100
- Spare Batteries
- Paper towels or cloth rag

Preparation and Setup:

- Acquire the existing field logbook for the specific sampling activity and initiate entries.
- Always use fresh, unexpired solutions for calibration.
- Calibration should be performed prior to use each day, but, with the exception of dissolved oxygen (DO) on the YSI-556, may also be completed in the afternoon of the day before use.
- DO calibration on the YSI-556 is dependent on the current barometric pressure and should be calibrated immediately before use.
- The Rugged Dissolved Oxygen (RDO) sensor on the Troll 9500 is very resistant to drift and only requires a 100% saturated water calibration once every 3 months. The 0% oxygen calibration is only required once every 3 months as well.
- Review Field Equipment Binder and equipment servicing records to anticipate next service.
- All equipment and solutions are stored in an air-conditioned office onsite to maintain their integrity.
- The YSI-556, and In-Situ Troll 9500 WQ meters and Hach turbidity meter will be used as the principal field instruments for measuring water quality parameters during groundwater and surface water sampling.

Calibration Procedures:

YSI-556 WQ Meter:

- Check expiration date of calibration solutions and discard if expired.
- Dissolved oxygen (DO) calibration: Remove the protective probe cover and thoroughly rinse probes and probe cover with DI water. Gently shake the probe body to remove excess water. Pour about ¼ to ½ inch of water into the protective probe cover and screw slightly onto the probe body. The idea is that the ambient atmospheric pressure be maintained within the vessel, while retaining the water saturated air necessary for calibration. Turn the YSI-556 instrument on, it will be in “run” mode. Using the navigation buttons on the face of the instrument, hit “escape”, then scroll down to “calibrate” and hit the “enter” key to begin calibration. Select DO, 2 mil PE (the probe style), then DO %. Enter the current barometric pressure in millimeters of Hg. Of the two YSI-556’s on site, one has an on board barometer and the other doesn’t. When calibrating the instrument with no barometer, simply enter the barometric pressure displayed by the other instrument. The barometric pressure is also available at various web sites and also at airports. Press the “enter” key again to begin the calibration. Wait for 10 to 15 minutes for the DO probe to stabilize. When satisfied that that the reading is stable, press the “enter” key a final time to lock in the calibration. Record the temp., barometric pressure, and DO value on the calibration sheet.

- pH calibration: Thoroughly rinse the probes and calibration cups with DI water and gently shake off the excess liquid. Pour a sufficient volume of pH buffer 4 into a calibration cup and insert the probe body, ensuring that the pH probe is fully immersed, and stir gently. Using the navigation keys as above, “escape” from ”run” mode and enter “calibration” mode. You may still be in calibration mode if you’ve just completed the DO calibration. Scroll down to the “pH” entry and push the “enter” key to begin the pH probe calibration process. Select a “3 point calibration”, and enter the first pH buffer value (usually 4.00). Allow several minutes for the probe to stabilize, then press the “enter” key to lock in the calibration. Enter the calibration value on the calibration form. Repeat the above steps for the remaining 2 pH buffers, 7.00 and 10.00, rinsing the probe and calibration cup with DI water between buffers. Dispose of used solutions in the rinsate bucket and thoroughly rinse the calibration vessels with DI water.

- Specific conductance (SC) calibration: Thoroughly rinse the probes and calibration cups with DI water and gently shake off the excess liquid. Pour a sufficient volume of 1000 micro-mhos/cm specific conductivity (SC) solution into a calibration cup and insert the probe body, ensuring that the conductivity probe is fully immersed, and stir gently. The SC probe has sensors located very high in the probe, so near full submergence is required. Using the navigation keys as above, “escape” from ”run” mode and enter “calibration” mode. You may still be in calibration mode if you’ve just completed the DO or pH calibrations. Scroll down to the “conductivity” entry and push the “enter” key to begin the SC probe calibration process. Select “specific conductance” and enter the SC solution value (usually 1.000 milli-mhos/cm) making sure of the correct units. The instrument may measure in **milli**-mhos/cm or micro-mhos/cm, and the calibration standard is commonly referenced in **micro**-mhos/cm (1.000 milli-mhos = 1000 micro-mhos). Allow several minutes for the probe to stabilize, then press the “enter” key to lock in the calibration. Enter the calibration value on the calibration form. Dispose of used solutions in the rinsate bucket and thoroughly rinse the calibration cups with DI water.

- ORP calibration: Thoroughly rinse the probes and calibration cups with DI water and gently shake off the excess liquid. Pour a sufficient volume of Zobells ORP solution into a calibration cup and insert the probe body, ensuring that the pH/ORP probe is fully immersed, and stir gently. Using the navigation keys as above, “escape” from ”run” mode and enter “calibration” mode. You may still be in calibration mode if you’ve just completed the DO, pH or SC calibrations. Scroll down to the “ORP” entry and push the “enter” key to begin the ORP probe calibration process. Consult the Zobells ORP vs. temp. table provided with the ORP solution, and enter the temperature corrected ORP value into the instrument. Allow several minutes for the probe to stabilize, then press the “enter” key to lock in the calibration. Enter the calibration value on the calibration form. Dispose of used solutions in the rinsate bucket and thoroughly rinse the calibration vessels with DI water.

- Proceed with field measurements as needed while noting:
  - probes must be rinsed thoroughly with DI water after each well.
  - probes must always be submersed in liquid (DI water or pH 7 buffer when not in use).

- absolutely no air bubbles or leaks should be present in the flow-through cell, repair and/or replace as needed.
- ensure all readings have stabilized prior to recording a measurement.
- all field parameters must be compared with historic data and documented on the field data sheet.

In-Situ Troll 9500 WQ multisensor probe:

- Check expiration date of calibration solutions and discard if expired.
- Connect the Troll 9500 to a data collection device (Trimble Recon or equivalent) and start the Win-situ 4 or Pocket-situ 4 program. Tap to highlight the "COM-1-19200" on the start-up screen, then tap "Find" at the bottom left of the screen to connect to the Troll 9500.
- While waiting for the device to connect, spray the Troll 9500 multi-sensors thoroughly with DI water and shake gently over the rinsate bucket to remove excess water. Fill the In-Situ calibration vessel to the "fill" line with "Quick Cal" solution and gently screw the calibration vessel onto the probe body.
- After the data collection device "finds" the Troll 9500, tap "parameters" near the top of the screen and wait for the device to change screens, then tap "Quick Cal" at the bottom right of the screen. After the screen changes, ensure that the correct parameters are checked (pH, SC, and ORP, but ***not*** DO), then tap "Next" to access the calibration screen.
- Tap "Run" in the middle left of the screen to start the calibration stabilization process. A tone will sound when the pH, ORP, SC, and temperature stabilize to nominal values. The calibration values can be accepted at this point, but it is better to continue to wait until a second tone sounds to indicate that the calibration values are completely stable.
- Tap the "Accept" button at the bottom of the screen to lock the calibration values. After accepting the calibration you will be asked if you want to view the calibration reports. Tap "yes", review, and document on the field calibration data sheet.

Dissolved oxygen (DO) calibration: (Note: DO calibration is only required once every 3 months) Remove the protective probe cover and thoroughly rinse probes and probe cover with DI water.

- Fill the In-Situ DO calibration bubbler with room temperature potable water and activate the pump to begin oxygenation of the water. Place the multi-sensor into the bubbler and ensure that the Rugged Dissolved Oxygen (RDO) sensor is not in the direct stream of the rising bubbles.
- Connect the Troll 9500 to a data collection device (Trimble Recon or equivalent) and start the Win-situ 4 or Pocket-situ 4 program. Tap to highlight the "COM-1-19200" on the start-up screen, then tap "Find" at the bottom left of the screen to connect to the Troll 9500.
- After the data collection device "finds" the Troll 9500, tap "parameters" near the top of the screen and wait for the device to change screens, then double tap on "DO" in the parameter list. This will open the DO calibration menu. Tap "Calibrate" to continue.

- You will be asked if you want to edit the barometric pressure, tap "Yes", review and record the barometric pressure on the field calibration sheet. Tap "Next" to continue.
- The next screen will show three choices for calibration: "Calibrate", "Restore defaults then calibrate", and "Restore defaults and don't calibrate". Select option one or option two.
- Tap "Run" to begin the 100% DO saturation calibration routine. A tone will sound when the DO and temperature stabilize to nominal values. The calibration values can be accepted at this point, but it is better to continue to wait until a second tone sounds to indicate that the calibration values are completely stable.
- Tap "Accept" to lock in the 100% DO saturation calibration.
- Tap "Next" to continue. You will then be asked if you want to conduct a 0% DO calibration (Note: This calibration is only required once every 3 months). If you are completing a 100% saturated water calibration only, hit "Next", then "Next" again to complete the single point calibration.
- If you want to complete the 0% calibration as well, immerse the probe in the 0% DO solution (Sodium sulfite (Na2SO3), Catalog No. 0017670) and tap "Next", then "Run". The calibration routine will run as before. When the readings are stable hit "Accept", then review the calibration report and record on the field calibration data sheet. This will complete the DO calibration routine.
- Close the calibration report, tap "Parameters", then "Profiler" to enter run mode.
- If you intend to collect electronic data, name the file and hit "Next" to proceed to the live parameters screen. In this screen you may choose to collect continuous or snapshot data.
- If you do not intend to collect electronic data simply hit "Next" to go to the live parameters screen and record the data by hand as necessary.

- Proceed with field measurements as needed while noting:
  - probes must be rinsed thoroughly with DI water after each well.
  - probes must always be submersed in liquid (DI water when not in use).
  - absolutely no air bubbles or leaks should be present in the flow-through cell, repair and/or replace as needed.
  - ensure all readings have stabilized prior to recording a measurement.
  - all field parameters must be compared with historic data and documented on the field data sheet.

Hach Turbidity Meter:

- Perform a check as per manufacturer's instructions with Hach DI water and standard solutions. Wipe each calibration vial carefully to remove any dust and place into instrument.
- Press the measure button and record the result on the calibration sheet. Record reading, time, and date on calibration sheet for both DI water and standard solution.
- If the readings are within 10%, proceed with turbidity measurements; If not within this range, troubleshoot and repeat as needed.

Water-level Meters:

When using multiple water-level meters at the site it is necessary to calibrate each against the other at least once during the sampling event using the following procedure:

- At a well with shallow depth to water (less than 20 feet), without dedicated tubing, piping, pump, or transducer, lower each water level meter into the well and record the reading to the nearest hundredth of a foot on the calibration sheet along with water-level meter number, time, and date.
- Repeat step #1 at a well with deep depth to water (greater than 70 feet).

SOP-A10

Decontamination of Water Sampling Equipment
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for decontamination of sampling equipment at the Topock site.

REQUIRED DOCUMENTS:

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's

REQUIRED EQUIPMENT AND SUPPLIES:

- 2 each decontamination vessels
- Potable water source
- Purified water source
- 120 volt power source
- 12 volt power source
- Alconox or Liquinox detergent
- Scrub brushes, nitrile gloves, and spray bottle
- Spill containment
- Pump specific submersible pump controllers

PREPARATION AND SET-UP:

- Acquire the existing field logbook for specific activity and initiate entries.
- Inspect all equipment necessary to carry out decontamination activities.
- Place spill containment in accordance with *SOP A-13 Spill Containment.*
- Fill a clean tub, bucket , PVC pipe, or similar vessel about 2/3 full of potable water and add the appropriate amount of Alconox or Liquinox detergent. If a new or clean vessel is not available a trash bag can be used to line the vessel prior to use.
- Fill a second tub, bucket , PVC pipe, or similar vessel about 2/3 full with clean potable water.

- Have purified water ready for final decon rinse use.

FIELD EQUIPMENT DECONTAMINATION PROCEDURES:

- Water-level Indicators: Any portion of a water-level indicator that contacts the groundwater must be decontaminated after use by rinsing with purified water, or wiping thoroughly with a paper towel moistened with purified water.
- Instrument probes: Water quality instrument probes (e.g., pH or specific ion electrodes, etc.) that come into contact with groundwater will be decontaminated by rinsing thoroughly with purified water.
- Submersible pumps - Grundfos Rediflo2: TransientRediflo2 submersible pumps will be decontaminated after each use with the following procedure:
  - If attached, detach the discharge tubing from the pump. Carefully drain any excess water to a bucket or the purge water tank. If dedicated, install the dedicated tubing cap to prevent leakage. Coil and store the dedicated tubing in a sealed and marked trash bag. If the tubing is not dedicated, discard.
  - Immerse the pump completely in an Alconox or Liquinox and potable water solution and run the pump at low to medium speed for one minute. A scrub brush will then be used to clean the outside of the pump body using the detergent solution.
  - Allow the pump to drain back into soapy water vessel, then immerse completely in clear potable water and run the pump at low to medium speed for one minute to rinse it. Ensure that the body of the pump is properly rinsed as well.
  - Allow the pump to drain back into clear water vessel, then rinse the pump body thoroughly by pouring purified or bottled water over the entire pump, ensuring that the purified water runs through the internal pump stages as well. Place the pump in a clean plastic bag and store in a plastic tub with the pump reel.
  - If the pump is not to be used immediately, or is to be stored, tag the pump or plastic tub as “decontaminated” with the date and team members initials.
  - If the decontamination vessels contain less than 2 gal. of volume each be sure to change all decontamination fluids for new solutions ***after each use***.
- Submersible pumps – 12V GeoSub, Typhoon, Mega-Monsoon: Transient DC-powered submersible pumps will be ***decontaminated*** after each use as above ***or*** using the following procedures. Pressurized gas powered bladder pumps will be decontaminated after each use using the following procedures:
  - If attached, detach the discharge tubing from the pump. Carefully drain any excess water to a bucket or the purge water tank. If dedicated, install the dedicated tubing cap to prevent leakage. Coil and store the dedicated tubing in a sealed and marked trash bag. If the tubing is not dedicated, discard.

  - ▪ Using the tools provided, disassemble the pump body to expose the pumping mechanism. Immerse all parts in an Alconox or Liquinox and potable water solution and scrub thoroughly with a clean scrub brush. Gently shake the pump parts to remove excess soapy water, taking care not to spill or splash any fluids outside of the decon. vessel. Immerse all pump parts in clean potable water and rinse thoroughly. Gently shake the pump parts to remove excess rinse water, taking care not to spill or splash any fluids outside of the decon. vessel. Carefully pour purified (or bottled) water over and through all pump parts. Gently shake the pump parts to remove excess purified rinse water, taking care not to spill or splash any fluids outside of the decon. vessel.Reassemble the pump and place in a clean plastic bag, then store in a plastic tub with the pump reel.
  - ▪ Bladder pumps do not typically include a reel and will be stored in a clean plastic bag only.
  - ▪ If the pump is not to be used immediately, or is to be stored, tag the pump or plastic tub as decontaminated with the date and team members initials.
  - ▪ If the decontamination vessels contain less than 2 gallons of volume each, be sure to change all decontamination fluids for new solutions ***after each use***.

- Water-level Indicators: Any portion of a water-level indicator that contacts the groundwater must be decontaminated after use by rinsing with purified water, or wiping thoroughly with a paper towel moistened with purified water.
- Instrument probes: Water quality instrument probes (e.g., pH or specific ion electrodes, etc.) that come into contact with groundwater will be decontaminated by rinsing thoroughly with purified water.
- Follow SOPs in *Program Procedures Manual* for handling of investigation-derived waste (IDW). Such IDW is typically disposed to the process stream at *IM-3. See an IM-3 operato*r for assistance in off-loading the decon fluids.

SOP-A11

Total Depth Measurements
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for manually measuring the total depth at groundwater monitoring wells and production wells.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP).
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
3) Topock Program Health and Safety Plan (HSP)
4) Well construction logs/specifications
5) Previous total depth data
6) Blank sampling logs and field notebook

PREPARATION & SETUP

1) Review event-specific SAP or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
2) Ensure that the measurement probe (weighted tape measure) has been decontaminated (check for label/tag) or decontaminate as needed following SOP-A10 *Decontamination of Water Sampling Equipment.*
3) Initiate field logbook for sampling activity.
4) If a transducer is present in the well and it is necessary to remove transducer to allow well access, refer to SOP-C1, *Temporary Removal and Replacement of Transducers.*
5) Calibrate wrist-watch to the atomic clock at the Topock Compressor Station.

MEASUREMENT PROCEDURES

6) Prepare Total Depth measurement log (use attached form dated March 2005).
7) Decontaminate the entire length of the measuring tape before using, according to SOP-A10*, Decontamination of Water Sampling Equipment*.
8) Place measurement tape into well and lower until the bottom of the probe touches the bottom of the well. Note total depth (TD) measurement to mark on well casing, if there is no mark on casing measure to the north. Repeat 3 times and record final TD to the nearest hundredth of a foot on the log. Also note the condition of the well bottom (i.e. hard bottom, soft bottom). Record well identification, time, date, TD, and measurement tape identification.

9) Compare TD measurement with previous data and note discrepancies on the sampling form. Repeat step #8 if an unexpected discrepancy is noted.

10) Decontaminate the entirety of the measuring tape, or any portion of the instrument that came in contact with water, following SOP-A10, *Decontamination of Water Sampling Equipment*.

SOP-A13

Spill Prevention, Containment, and Control Measures for Monitoring Well Development, Purging, and Sampling Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for spill prevention, containment, and control associated with monitor well activities at the Topock site. This SOP applies to containment and control of potential spills from purge and equipment decontamination water generated during the development, purging, and sampling of monitoring wells.

REQUIRED DOCUMENTS:

- Topock Program Health and Safety Plan (HSP).
- Emergency Notification Binder.
- SOP-A16 Access Routes and Sensitivity to Biological and Cultural Resources.
- SOP-B6 Disposal of Waste Fluid and Solids (IDW).

REQUIRED EQUIPMENT:

- Large (10′ by 11′ by 4″ deep) bermed spill containment pad. This pad is to be placed on the ground beneath the truck or UTV mounted purge water tank. It will be placed so that the work area at the rear of the vehicle is covered and so that small spills or drips from the purge tank or work area are captured.
- Medium (4′ by 8′ by 4″ deep) bermed spill containment pad. This pad is used at the FLUTe wells, Blatypus wells, and peristaltic wells, or for additional work space at any well.
- Small (4′ by 4′ by 4″ deep) bermed spill containment. This pad fits inside the UTV beds beneath the purge tank when sampling using UTVs (flood plain and special access wells, see SOP-A16).
- Small (2′ by 4′ by 4″ deep) bermed "pizza cut" spill containment pad for placement around well heads.
- Additional spill containment pads as necessary or as directed by the field team leader.
- Purge water tanks as appropriate for the task.
- Extra spring clamps, fittings, paper towels, and tools, etc…
- Small trash bags for temporary storage of dedicated transducers removed from wells.
- Trash pump, for transferring purge and decon. water at IM-3.
- 4 or more 5-gallon buckets and specially cut "pouring lid"
- Hydrophilic sorbent material (absorbent pads, booms, or mats)
- Plastic sheeting
- Shovel and/or other hand tools
- Plastic bags or buckets for storage and disposal of used sorbent material

PREPARATION & SETUP:

- Review this and other applicable SOP's, as well as the Emergency Notification Binder.
- Inspect all required spill containment pads for holes or tears that would compromise their effectiveness. Report such damage to the CH2M HILL Topock site coordinator or field team leader. Repair or replace damaged spill containment pads before use.
- Load spill containment equipment onto appropriate vehicle(s) and secure.

GENERAL SPILL PREVENTION PRACTICES:

- Topock is a "No Spill" site. We have all the necessary spill containment equipment, ***use it!***
- Place all items exposed to purge or decon water on the spill containment pads, not directly on the ground.
- No drops of well or purge water should ever hit the ground. Use 5-gallon buckets and spill containment pads to prevent any water from sampling equipment reaching the ground.
- Double check all fittings and connections for tightness before activating any pump.
- Check all fittings and connections for leaks immediately after starting the pump.
- Place the flow through cell and associated fittings in a 5 gal. bucket. There is often a small amount of leakage from the cell.
- If a spill does occur, immediately stop the pump, or take such action as is necessary to safely mitigate the volume or severity of the spill.
- Report all spills to the CH2M HILL site coordinator or field team leader immediately, no matter how small.
- Only use restroom facilities at the CH2M HILL job trailer or the IM3 facility.

SPILL RESPONSE ACTIONS:

In the event purge water is spilled outside of containment basins, the field team will take the following actions:

PROCEDURES:

- Stop the pump or take what action is necessary to safely stop or mitigate the volume or severity of the spill.
- Notify the CH2M HILL Site Coordinator or field team leader immediately, no matter how small the spill, and follow their instructions. PG&E and CH2M HILL staff may want to photo document the incident, so do not proceed with any clean-up until cleared to do so.
- The CH2M HILL Site Coordinator will perform the notifications as required in the Emergency Notification Binder and complete the Notification Documentation Form provided in the Binder.

- When cleared to do so, use sorbent material and bermed spill containment to absorb and contain the spilled purge water if possible.
- Transfer any contained purge water into the purge water tank.
- When cleared to do so, manually dig up any saturated soil and place in 5-gallon bucket(s) or other appropriate containers for disposal.
- Dispose of containerized soil, used sorbent material, and gloves in accordance with SOP-B6, *Disposal of Waste Fluids and Solids (IDW)*.

CONTAINMENT SCENARIO 1: SAMPLING OF UTV ACCESS WELLS USING DEDICATED OR TRANSIENT PUMPS:

For monitor well sampling at UTV access wells with dedicated or transient pumps, purge water is pumped to a tank placed on 4′ X 4′spill containment pad in the back of the UTV. The UTV is parked on a 10′ X 11′ spill containment pad adjacent to the monitoring well to be sampled. Purge water is pumped directly to a YSI flow through cell contained in a 5 gal. bucket in the work area, and then into the purge tank through a discharge tube at the appropriate purge rate for that well. The small amount of leakage from the YSI flow cell is contained in a 5-gallon bucket and is manually transferred into the purge water tank using the special "pouring lid" to prevent spills.

Potential Spill Scenarios:

- Overfill of UTV-mounted purge water tank
- Failing to place lid on purge tank before mobilizing to next well
- Spills at time of tubing disconnection from tank or during manual transfer into tank from bucket
- Spills from tubing disconnection or leakage from flow cell
- Spills from tubing disconnection at well head between dedicated and non-dedicated tubing
- Spilled bucket of purge water from flow cell
- During removal of dedicated transducers from wells

PROCEDURES:

- Before mobilization to any well, place appropriately sized tanks on small 4′ X 4′ bermed spill containment pads in UTV beds.
- Evaluate the remaining capacity of the tank prior to initiating well purging to ensure that there is sufficient capacity to hold the amount of purge water anticipated to be generated during purging of the well. Offload if needed following procedures under Containment Scenario 4.
- At the well, deploy the large 10′ X 11′ bermed spill containment pad adjacent to the well. Park the UTVs with purge water tanks on the spill pad and as close to the well head as possible, while still leaving room to work. Deploy a second or third spill containment pad as necessary to ensure adequate coverage. There should be no exposed soil between the work area and the well.

- Place the small 2′ X 4′ "pizza cut" bermed spill containment around well head.
- For a dedicated pump well: Attach the transfer tubing to the existing dedicated pump tubing at the top of the well so that the tubing connection is located ***inside*** the well protective casing and any leakage will be contained within the well head.
- Secure the transfer tubing to the bottom connection of the flow cell using hose clamps. Attach the flow through cell discharge tubing to the top fitting of the flow through cell and place the cell into a 5 gal. bucket to contain any leakage from the cell.
- Route the discharge tubing to the purge tank opening and secure using spring clamps.
- Stuff a large, unused trash bag into the top of the protective casing above the tubing connection so that any leakage or spray will be contained inside the protective casing.
- For a transient pump well: Attach the new or well specific dedicated discharge tubing to a decontaminated transient submersible pump and install into well following *SOP-A1 Purging and Sampling of Groundwater Monitoring Wells.* Transport the pump to the well head in a 5 gal. bucket to contain leakage of any residual water. With no tubing connections at the top of the well, no additional spill containment is necessary at the well head.
- All equipment is to be placed on the 10′ X 11′ bermed spill containment pad prior to the start of purging.
- Double check all tubing connections for tightness before activating the pump.
- Double check that discharge tubing is properly secured with spring clamp at purge water tank.
- Immediately after starting the pump, check all tubing connections for leakage.
- During purging, field staff will monitor the transfer of water into the purge water tank. When the tank reaches 80% full, discontinue purging to that tank. Depending on the situation, either stop the pump and properly dispose the purge water according to the SOP's in *Program Procedures Manual* for handling of investigation-derived waste (IDW), or briefly stop the pump and switch to a different purge tank. Such IDW is typically disposed to the process stream at IM-3, see Containment Scenario 4 below for instructions.
- At the completion of purging, stop the pump and carefully disconnect the discharge tubing from both ports of the flow through cell, working inside the bucket and over containment, and allow the tubing and flow cell to drain inside of the bucket.
- Working over containment, clamp the pump discharge tubing inside a 5 gal. bucket and start the pump at low speed. Collect the sample directly from the pump discharge line, allowing excess flow to pump into the 5 gallon bucket.
- When sampling is complete, stop the pump and carefully disconnect and drain all other tubing while working over spill containment to ensure that any drips of purge water are contained on the pad.

- If a transient pump was installed, double fold the end of the dedicated down-hole tubing and secure with wire-ties to prevent leakage during pump removal. Carefully remove the pump from the well while wiping the water and power lines as they emerge with a paper towel, and coiling the tubing neatly. As the pump clears the well, place it immediately in a 5 gal. bucket, over containment, to drain.
- Disconnect the dedicated tubing from the pump and double fold the end of the tubing, securing with wire ties to prevent leakage of the residual water still contained in the tubing. Place the tubing in its designated storage bag. At the end of the day, use compressed air from the sampling truck to carefully push the residual water out of the dedicated tubing and into the purge tank.
- Place the specially cut “pouring lid” on any 5 gallon buckets containing purge water and carefully pour contents into the purge water tank.
- If any purge water is present on the containment pad, either wipe up the water using paper towels, or collect it a bucket and dump it to the purge tank. Dispose the wet paper towels with the rest of the contaminated trash.
- Close purge water tank openings and ensure that the tank is well secured to the UTV.
- Before mobilization, check back of UTVs for any drips that may have occurred and wipe up with a paper towel if needed.
- Pull the UTV off of the spill containment pad, fold the pad, load, and secure.
- Mobilize to the next well to be sampled and repeat the preceding steps.
- When the UTV-mounted purge water tank is 80% full, continue with procedures under Containment Scenario 4 to dump the water at IM-3.

CONTAINMENT SCENARIO 2: SAMPLING UTV ACCESS WELLS USING A PERISTALTIC PUMP:

For monitor well sampling using a peristaltic pump, purge water is placed in a small UTV or truck mounted purge tank, or 5 gallon bucket with lid. The purge tank or bucket is situated adjacent to the monitoring well to be sampled. Purge water is pumped directly to a YSI flow cell in a 5 gal. bucket, then to a 5-gallon bucket with lid, or purge tank for storage. The purge water in the bucket is manually dumped to the purge tank using the specially cut “pouring lid” to prevent spills.

Potential Spill Scenarios:

- Spills at time of hose disconnection from pump mechanism
- Spills during manual transfer into purge tank from bucket
- Spills from leakage from flow cell
- During removal or placement of tubing
- Disrupted bucket of purge water

PROCEDURES:

- Before mobilization to any well, place appropriately sized tank on small 4′ X 4′ bermed spill containment pad in UTV bed.
- Evaluate the remaining capacity of the tank prior to initiating well purging to ensure that there is sufficient capacity to hold the amount of purge water anticipated to be generated during purging of the well. Offload if needed following procedures under Containment Scenario 4.
- At the well, deploy the large 10′ X 11′ bermed spill containment pad adjacent to the well. Park the UTV with the purge water tank on the spill pad and as close to the well as possible, while still leaving room to work. Deploy a second or third spill containment pad as necessary to ensure adequate coverage. There should be no exposed soil between the work area and the well head.
- Place the small 2′ X 4′ "pizza cut" bermed spill containment around well head. With no tubing connections at the well, there is no need for additional spill containment at the well-head.
- Install the dedicated down-hole tubing. Take care to ensure that any residual water in the tubing is contained on spill pads. In the slant wells (MW-52′s, 53′s and 56′s) the dedicated tubing is stored in the well itself.
- Attach the peristaltic pump-head tubing to both the dedicated down-hole tubing and the pump discharge tubing, and use a wire-tie to secure each. Clamp the pump-head tubing into the peristaltic pump, ensuring that it is not pinched in the clamp (this could wear a hole), and place the pump on the 10′ X 11′ bermed spill containment pad.
- Attach the pump discharge tubing to the bottom connection of the flow cell and secure with a wire-tie. Attach the flow cell discharge tubing to the top fitting of the cell, secure with a wire-tie and place the cell into a 5 gal. bucket to contain any leakage.
- Route the discharge tube to a 5-gallon bucket or purge tank and secure with a spring clamp. Make sure additional empty purge buckets are available.
- All equipment is to be placed on the 10′ X 11′ bermed spill containment pad prior to the start of purging.
- Double check all tubing connections for tightness before activating the pump.
- Double check that discharge tubing is properly secured with spring clamp at purge water tank or bucket.
- Immediately after starting the pump, check all tubing connections for leakage.
- During purging, field staff will monitor the transfer of water into the bucket or purge water tank. If purging to a 5 gallon bucket, briefly shut down the pump and move the discharge line to another 5 gal. bucket when the bucket reaches 50% full, then use the specially cut "pouring lid" to transfer the water from the purge bucket to the purge tank. If purging to the UTV mounted purge tank, discontinue purging to that tank when the tank reaches 80% full. Depending on the situation, either stop the pump and properly

dispose the purge water according to the SOP's in *Program Procedures Manual* for handling of investigation-derived waste (IDW), or briefly stop the pump and switch to a different purge bucket or tank. Such IDW is typically disposed to the process stream at IM-3. Refer to Containment Scenario 4 below for instructions.

- At the completion of purging, stop the pump and carefully disconnect the discharge tubing from the flow through cell, working inside the bucket and over containment, and allow the tubing and flow cell to drain inside of the bucket.
- Working over containment, clamp the pump discharge tubing inside a 5 gal. bucket and start the pump. Collect the sample directly from the pump discharge line, allowing excess flow to pump into the 5 gallon bucket.
- When sampling is complete, stop the pump and carefully disconnect and drain all other tubing while working over spill containment to ensure that any drips of purge water are contained on the pad.
- Remove the dedicated tubing from the well and carefully drain any remaining water into purge tank. Working over containment, coil the tubing and place it into the marked ziplock bag from which it was removed.
- Place the specially cut "pouring lid" on any 5 gallon buckets containing purge water and carefully pour contents into the purge water tank.
- If any purge water is present on the containment pad, either wipe up the water using paper towels, or collect it a bucket and dump it to the purge tank. Dispose the wet paper towels with the rest of the contaminated trash.
- Close purge water tank openings and ensure that the tank is well secured to the UTV.
- Before mobilization, check back of UTVs for any drips that may have occurred and wipe up with a paper towel if needed.
- Pull the UTV off of the spill containment pad, fold the pad, load, and secure.
- Mobilize to the next well to be sampled and repeat the preceding steps.
- When the UTV-mounted purge water tank is 80% full, continue with procedures under Containment Scenario 4.

CONTAINMENT SCENARIO 3: SAMPLING TRUCK ACCESS MONITOR WELLS:

For monitor well sampling in upland, truck accessed areas of the site, purge water is placed in a 400-gallon truck-mounted tank. Purge water is pumped directly into this tank via a transfer tube at rates up to 10 gpm. Purge water leakage from the YSI flow cell is contained in a 5-gallon bucket and is manually transferred into the purge water tank using the specially cut "pouring lid". For upland wells that are UTV access only, follow procedures under Containment Scenarios 1 or 2, as applicable.

Potential Spill Scenarios:

- Overfill of truck-mounted purge water tank

- Spills at time of hose disconnection from tank or during manual transfer into tank from bucket
- Spills from hose disconnection at well head between dedicated and non-dedicated tubing
- Spills from hose disconnection or leakage from flow cell
- During removal of dedicated transducers in wells
- Disrupted bucket of purge water
- During removal or placement of pump and/or tubing
- Spills or leaks from "splitter" if used at wells with higher velocity purge rates

PROCEDURES:

- Evaluate the remaining capacity of the tank prior to initiating well purging to ensure that there is sufficient capacity to hold the amount of purge water anticipated to be generated during purging of the well. Offload if needed following procedures under Containment Scenario 4.

- At the well, deploy the large 10′ X 11′ bermed spill containment pad adjacent to the well. Park the sampling truck on the spill pad and as close to the well as possible, while still leaving room to work. Deploy a second or third spill containment pad as necessary to ensure adequate coverage. There should be no exposed soil between the work area and the well head.

- Place the small 2′ X 4′ "pizza cut" bermed spill containment around well head.

- For a dedicated pump well: Attach the transfer tubing to the existing dedicated pump tubing at the top of the well using the riser and valve provided.

- If a splitter is used to split the flow between the flow cell and the purge tank at high flow wells, wrap the splitter with a fresh trash bag such that any leakage or spray will be contained inside the well head or on containment. Route the high flow purge line to the purge tank and secure.

- For a transient pump well: Working over containment, attach the well specific dedicated discharge tubing to a decontaminated transient submersible pump and install into well following *SOP-A1 Purging and Sampling of Groundwater Monitoring Wells.* Transport the pump to the well head in a 5 gal. bucket to contain leakage of any residual water. With no tubing connections at the top of the well, no additional spill containment is necessary at the well head.

- Secure the transfer tubing to the bottom connection of the flow cell using hose clamps. Attach the flow through cell discharge tubing to the top fitting of the flow through cell and place the cell into a 5 gal. bucket to contain any leakage from the cell.

- Route the flow cell discharge tubing to the purge tank opening and secure using spring clamps.

- All equipment is to be placed on the 10′ X 11′ bermed spill containment pad prior to the start of purging.

- Double check all tubing connections for tightness before activating the pump.

- Double check that discharge tubing is properly secured with spring clamp at purge water tank.
- Immediately after starting the pump, check all tubing connections for leakage.
- During purging, field staff will monitor the transfer of water into the purge water tank. When the tank reaches 90% full, discontinue purging to that tank. Stop the pump and properly dispose the purge water according to the SOP's in *Program Procedures Manual* for handling of investigation-derived waste (IDW). Such IDW is typically disposed to the process stream at IM-3. Refer to Containment Scenario 4 below for instructions. Resume pumping to the empty tank.
- At the completion of purging, stop the pump and carefully disconnect the discharge tubing from the flow through cell, working inside the bucket and over containment, and allow the tubing and flow cell to drain inside of the bucket.
- Clamp the pump discharge line to the sink at the rear of the sampling truck and start the pump at low speed. Collect the sample over containment directly from the pump discharge line, allowing excess flow to pump into the sink.
- When sampling is complete, stop the pump and carefully disconnect and drain all other tubing while working over spill containment to ensure that any drips of purge water are contained on the pad.
- If a transient pump was installed, double fold the end of the dedicated down-hole tubing and secure with wire-ties to prevent leakage during pump removal. Carefully remove the pump from the well while wiping the water and power lines as they emerge with a paper towel, and coiling the tubing neatly. As the pump clears the well, place it immediately in a 5 gal. bucket, over containment, to drain.
- Disconnect the dedicated tubing from the pump and double fold the end of the tubing, securing with wire ties to prevent leakage of the residual water still contained in the tubing. Place the tubing in its designated storage bag. At the end of the day, use compressed air from the sampling truck to carefully push the residual water out of the dedicated tubing and into the purge tank.
- Place the specially cut "pouring lid" on any 5 gallon buckets containing purge water and carefully pour contents into the purge water tank.
- If any purge water is present on the spill containment pad, either wipe up the water using paper towels, or collect it a bucket and dump it to the purge tank. Dispose the wet paper towels with the rest of the contaminated trash.
- Ensure that all water is pumped from sink into the truck-mounted tanks. Inspect back of truck and sink and wipe off any purge water drops with paper towel.
- Before mobilization, ensure that all tank openings are secure, and wipe up any drips that may have occurred in the work area.
- Mobilize to the next well to be sampled and repeat the preceding steps.

- When the truck mounted purge water tank is 90% full, continue with procedures under Containment Scenario 4 below.

CONTAINMENT SCENARIO 4: TRANSFER OF PURGE WATER FROM TRUCK MOUNTED TANK OR UTV MOUNTED TANK TO IM-3:

When the truck or UTV mounted purge water tank requires emptying, the following procedures will be used. Purge water is transferred into a 5,500-gallon storage tank at the IM3 Treatment Plant, at rates up to 20 gpm. The 5,500-gallon tank is located within a permanent containment structure.

Potential Spill Scenarios:

- Overfill of tank at final storage location
- Pump or transfer hose leakage during pumping into tank or at time of hose disconnection.

PROCEDURES:

- See an IM-3 plant operator for assistance in transferring purge water.
- Park the truck or UTV on the bermed spill containment pad at the IM-3 transfer location.
- Follow the instructions of the IM-3 plant operator and use the trash pump to transfer purge water from the purge tank to the receiving tank. The IM-3 plant operator and field staff will be present during the entire transfer to monitor the water level in the receiving tank and to ensure no leakage or spills occur. If the receiving tank approaches being full, discontinue transfer operations.
- At the completion of transfer operations, take care when removing the transfer hose from the truck or UTV mounted purge water tank opening, since some residual water will be present in the hose.
- Secure tank openings on the truck-mounted or UTV-mounted purge water tank.
- Proceed to the next well for sampling.

SOP-A14

Pore Water Sampling
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures and equipment to be used for pore water sampling at the Topock site. This SOP should be used for pore water sampling stations on the Colorado River.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP).
2) Pore Water and Seepage Study Work Plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Field Procedures Manual), as required.
3) Topock Program Health and Safety Plan (HSP).
4) Blank sampling logs and field notebook.

PREPARATION & SETUP

1) Review event-specific SAP or event-specific field instructions, Work Plan, and HSP.
2) Initiate field logbook for sampling activity.
3) Inspect all equipment and calibrate field water quality (WQ) meters according to SOP-A9, *Calibration of Field Instruments*.
4) Inventory sample bottles, required analyses, and confirm the lab courier schedule.
5) Field-check and set up sampling equipment: drive point sampler, WQ meters, health and safety apparatuses (life vest, rescue rope, life preserver), water depth meter or depth-finder, weighted tape, peristaltic pump, filters, sufficient tygon and silicone tubing, sampling equipment, etc.
6) Conduct tailgate meeting to discuss health and safety issues and event objectives.

SAMPLING PROCEDURES

1) Prepare pore water sampling log (use attached form).
2) The sampling team will travel to each pore water sampling station in a motorized boat. A safety inspection of the boat will be performed by the field crew prior to boarding (check for fire extinguisher, etc.). Samples will be collected from selected stations along transects across the river.
3) An industry standard (Trimble or similar) resource grade handheld DGPS unit (GeoXT or similar) will be used with real-time correction (wide area augmentation system) to locate the sampling stations within a 1 meter radius (68% of the time, commonly referred to 1 sigma accuracy). At each location, two anchors should be positioned upstream at

least 10 feet from each other (refer to SOP A-12 Attachment A). Record the GPS coordinates on the sampling log. In the event a sampling station is too shallow to safely approach by boat, the next closest location with adequate depth will be sampled and a remark noted on the sampling log with the new GPS coordinates.

4) Record the depth of the river at each sampling station using the depth-finder or a weighted tape. If a weighted tape is used, read the tape at the river water surface when the weight touches the river floor. Record river depth on the sample log.

5) Samples will be collected at a depth below the river bottom determined from the pilot study.

6) Samples are to be collected using a drive point sampler and variable-speed peristaltic pump with ¾-inch tygon tubing. Dedicated tubing will be used for each sample. Once the sampling depths have been calculated for each station, pre-cut two pieces of tygon tubing and attach them to the drive point sampler. Lower the sampler and tubing until the tip of the sampler touches the river bottom. Then hand-drive the sampler into the river sediment until desired depth is achieved. Attach the discharge end of the sample tubing to the flow cell of the water quality meter. Start the peristaltic pump and purge 3 sampler volumes. Record the time, pH, conductivity, turbidity, dissolved oxygen, temperature, salinity, TDS, and ORP on the field log. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to an instrument problem. Turn off the peristaltic pump, remove tubing from the flow cell, and restart the pump. Attach a 0.45 micron filter when sampling for Cr(T) by USEPA Method 6010B or for Cr(VI) by USEPA Method 7199. Refer to SOP-A6 in the Field Procedures Manual for filtration procedures. Pump approximately 500 ml through the system and begin filling the applicable sample bottles. Remove the filter prior to filling sample bottles for the other analyses, which do not require filtration. Record all sample information on the field log.

7) Collect remaining samples for analyses according to the event-specific SAP. Use a new piece of tygon tubing and change out the flexible silicone tubing in the peristaltic pump at each location.

8) Follow the Field Procedures Manual for sample handling and management, equipment decontamination, and investigation-derived waste (IDW) management.

9) Decontaminate the sampling apparatus after each sample is collected. The decontamination will be a triple rinse with 5-gallon buckets containing soapy water, potable water, and deionized (DI) water, respectively. First, the apparatus will be placed in the soapy water and the outside scrubbed. Then pump approximately 3 sampler volumes through the apparatus using the peristaltic pump and dedicated tubing used. Re-circulate the water back into the 5-gallon bucket. Repeat the rinse with the potable and deionized water.

10) Collect an equipment rinse blank after the first decontamination of the day. Collect the sample by attaching the decontaminated sampling apparatus to a length of clean peristaltic tubing. Run deionized water through the sampler and collect a sample to be shipped to the analytic laboratory for hexavalent chromium analysis.

SOP-A16

Access Routes
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures to be used when accessing wells or other sampling stations at the Topock site. This SOP should be used for all travel to collect data on site. All field personnel and subcontractors are required to read this SOP and sign on the Employee Signoff Form. Although no groundwater sampling is currently planned to be conducted at any SWFL habitat wells during SWFL nesting season, the procedures below will be used if such sampling does become necessary.

OVERVIEW:

Figure 1 at the end of this SOP shows the Topock project groundwater and surface water data collection locations. The map also shows the access routes used for sampling and transducer downloads. These lines indicate vehicle access on existing roads, and indicate where utility vehicle (UTV) or foot access is used at locations where pickup truck access is not allowed. Purple lines on the map indicate where either pickup trucks or UTVs are used. Blue lines indicate routes with allowed access by UTV but not by pickup truck. Black dotted lines indicate foot access routes. Where the black dots overlay the blue routes on the floodplain area, the access is on foot or by electric UTV during the southwestern willow flycatcher (SWFL) nesting season (May 1st through September 30th), and by any UTV outside of nesting season. The access routes with specific mitigation measures or access procedures discussed herein are highlighted in green.

There are 3 access procedures that are to be followed depending on when/where fieldwork is to occur:

A = Universal for the site

B = SWFL habitat during SWFL summer nesting season (May 1st through September 30th)

C = Upland close to cultural resources (Year-round)

A site sensitivity orientation is to be provided to all field personnel regarding cultural and biological resources and the spiritual importance of the geographic area and the river to local tribes. The orientation will emphasize the need to stay within the established, marked access routes and work areas, and to prevent enlargement of previously used areas.

A SITES ACCESS PROCEDURES – APPLIES TO ALL SITES:

Personnel must obey the following procedures when accessing all data collection sites (refer to Figure 1):

- Access by vehicles is restricted to established roads or tracks. For off-road access the number of vehicles used should be minimized.
- All vehicles are to observe a 10-mph speed limit on Historic Route 66 (H-66), drive in the center of H-66 to avoid wear on the H-66 shoulders, and not cut corners when exiting H-66 to access well locations.
- All vehicles are to travel slowly off-road (5 mph speed where possible) to give time to observe and avoid wildlife and minimize noise, dust, and vehicle rutting.
- Most off-road access is to be by low-impact utility vehicles (UTV's) which carry sampling or data collection equipment as well as purge water tanks.
- Access beyond the purple lines on the map is by UTV (blue lines). Dotted black lines indicate access by foot or electric UTV. Access follows consistent routes or paths.
- Minimize time near possible wildlife habitat.
- Coordinate with on-site field client representative (FCR) to prevent unauthorized access to site areas.

These minimum procedures are followed for all data collection locations. More rigorous procedures are to be used at locations where potential concerns have been identified.

B SITES ACCESS PROCEDURES:

Field crews are to follow the following mitigation measures for the floodplain wells listed below during the SWFL nesting season, May 1st through September 30th. The universal A sites measures that were outlined above will also apply at these locations. Site B locations include:

- Well clusters MW-27, MW-34, and shoreline location R-27 on the Bureau of Land Management (BLM) managed area
- Well clusters MW-22, MW-43, MW-52, MW-53, and shoreline location R-22 on the Havasu National Wildlife Refuge (HNWR) area

Well sampling, transducer data collection, and any other work activities will not occur during the biennial protocol survey for SWFL's. Upon completion of the surveys, the onsite biologist will approve/disapprove of work activities depending on the survey results. If a SWFL is not detected, then the biologist will permit the activities. If a SWFL is detected, then the biologist will not permit the work activities, and the regulatory agencies will be consulted.

Specialized Field Equipment:

An electric UTV will be utilized while accessing B sites on BLM and HNWR property during the nesting season. The electric UTV will minimize noise and enable the sampling crew to minimize the number of trips needed to transport equipment to a well cluster in SWFL habitat.

Power supply outlets have been installed at PE-1 and a leak detection vault north of MW-39. By using this power supply to power the groundwater pumps instead of a generator, the sampling operation is virtually noiseless when sampling the MW-34 monitor well cluster.

New ½" I.D. LDPE tubing will be used to connect the pumps at the well head to the purge tanks at the staging areas. Spill containment will be placed under any hose connections where multiple hose segments are required to reach more distant wells. The hose will be cleared of all water after sampling is completed. Clearing water from the hose will be accomplished by lifting the hose to shoulder height to drain the water into the purge water storage tank.

New dedicated pumps were installed in late 2005 in MW-27, MW-34, and MW-43 well clusters. Therefore, pumps and decontamination equipment will no longer need to be transported to these wells, decreasing the overall impact associated with sampling at these locations.

Access Procedures for Wells on BLM Property:

Well clusters MW-27, MW-30, MW-34, MW-36, MW-39, MW-42 and MW-45 will be accessed directly by UTV's from the south access, under the railroad tracks. For sampling the MW-34 cluster, an electric UTV will be used to carry equipment and access the wells, and a second UTV with the purge tank will park in the staging area at the PE-1 location. New or dedicated ½" ID LDPE tubing and a power cord will be stretched from the well heads to the purge tank and power source at PE-1. For sampling the MW-27 cluster and R-27 when necessary, the electric UTV will be used to carry equipment and access the wells, and a second UTV with the purge tank will park in the staging area just north of the railroad bridge between MW-42 and MW-27. New or dedicated ½" ID LDPE tubing and a power cord will be stretched from the well heads to the purge tank and generator at the staging area.

Access Procedures for Wells on HNWR Property:

Monitor well clusters MW-22, MW-43, MW-52, and MW-53 and shoreline station R-22 are located on HNWR property, south of the railroad bridge. UTV mounted equipment is to be staged at the cleared and graded area to the west of well cluster MW-32 (Figure 1). All power generation equipment and purge water storage tanks are staged at this location. The electric UTV will be used to carry equipment and access the wells, and a second UTV with the large purge tank will park in the staging area described above. New or dedicated ½" ID LDPE tubing and a power cord will be stretched from the well heads to the purge tank and power source at the staging area. For MW-22 and the MW-52 and MW-53 clusters, a peristaltic pump and battery are used for purging directly to a small tank on the electric UTV.

Sampling Procedures for B Site Wells:

The following list summarizes the modified "nesting season" sampling procedures for the B site monitoring wells with dedicated pumps. These modified procedures will be followed each year during May 1st through September 30th:

- A biologist or authorized individual will pre-survey the planned work area for the presence of nesting listed-bird species, and sampling will proceed if the survey results are negative. BLM and DTSC will be contacted and sampling will not proceed if the pre-survey finds nesting listed-bird species.
- New sampling procedures and biological resource sensitivity will be reviewed at each field event kickoff briefing.
- The UTVs will maintain low speeds and low revolutions per minute to minimize noise. The target speed will be 5 mph on the floodplain, per BLM direction. The UTVs will maintain a reduced speed to the extent possible while avoiding getting lodged or stuck.
- A biologist will accompany the sampling team upon startup of activities and will provide a reconnaissance "sweep" during the sampling event.
- A generator will be operated at the staging areas only when there is no nearby power supply (HNWR).
- Water level measurements are to be taken at the beginning and end of the purge only. No measurements will be taken during the purge.
- Spill prevention, containment, and control measures outlined in SOP-A13 will be implemented.
- At all times, conversation noise and abrupt or unnecessary movements will be avoided, and equipment noise will be minimized. Equipment will be muffled or padded during transport and setup to avoid clanging or other impact noises from bottles and metal components.
- A biologist's report of the sampling activities will be completed within a week of the sampling and submitted to DTSC and BLM.

C SITES ACCESS PROCEDURES:

Field crews are to implement the following mitigation measures for the upland wells listed below to prevent impact from data collection on cultural or biological resources.

- East Mesa wells (IW-2, IW-3, OW-1, OW-2, and OW-5 well clusters)
- West Mesa wells (OW-3 well cluster)
- Compliance wells (CW-1, CW-2, CW-3, and CW-4 well clusters).
- Monitoring wells MW-14, MW-15, MW-16, MW-18, and MW-25.

The goal of these additional precautions is to prevent any excursion onto areas that were not previously disturbed and minimize the impact of field work. Unlike the B sites access procedures that were developed for use on the floodplain only during the summer SWFL nesting season, the precautions for these upland area C sites will be applied on a year-round basis. The universal A sites measures that were outlined above will also apply at these locations year round.

- Personnel and vehicles are required to stay within the areas that were previously disturbed. The work areas are delineated where possible using straw “wattles”, these barriers are not to be crossed with any vehicle.
- For the less frequent quarterly or semiannual access to wells MW-15, MW-16, MW-18, and MW-25, crews must stay on the clearly defined gravel access roads to each well.
- Use lathe stakes to mark boundaries during construction and well installation, rather than orange plastic fencing. These boundary stakes will be maintained, and if needed a similar marker for both access routes and work area boundaries may be substituted in the future. Any replacement should have limited visual impacts, such as straw wattles to prevent travel off existing designated work areas. Specific areas where these boundary markings are maintained include:
  - Access route on and off H-66 and edges of the East Mesa.
  - Access route from H-66 and a turnaround/work area near OW-3 on the West Mesa.
  - Access route from H-66 and a turnaround/work area near CW-4 in the unnamed wash.
  - Access routes past CW-2 and turnaround area at CW-3.
  - Defined access turn-off from H-66 to CW-1 and MW-14.
- Drive one-way on the CW-2 and CW-3 access track and turn vehicles only at the established turnaround at CW-3.
- Drive in only the active channel area of the wash when accessing CW-4. Follow the previous access path, marked where possible with straw wattles.
- Stay on established roads to access MW-15 and MW-16.

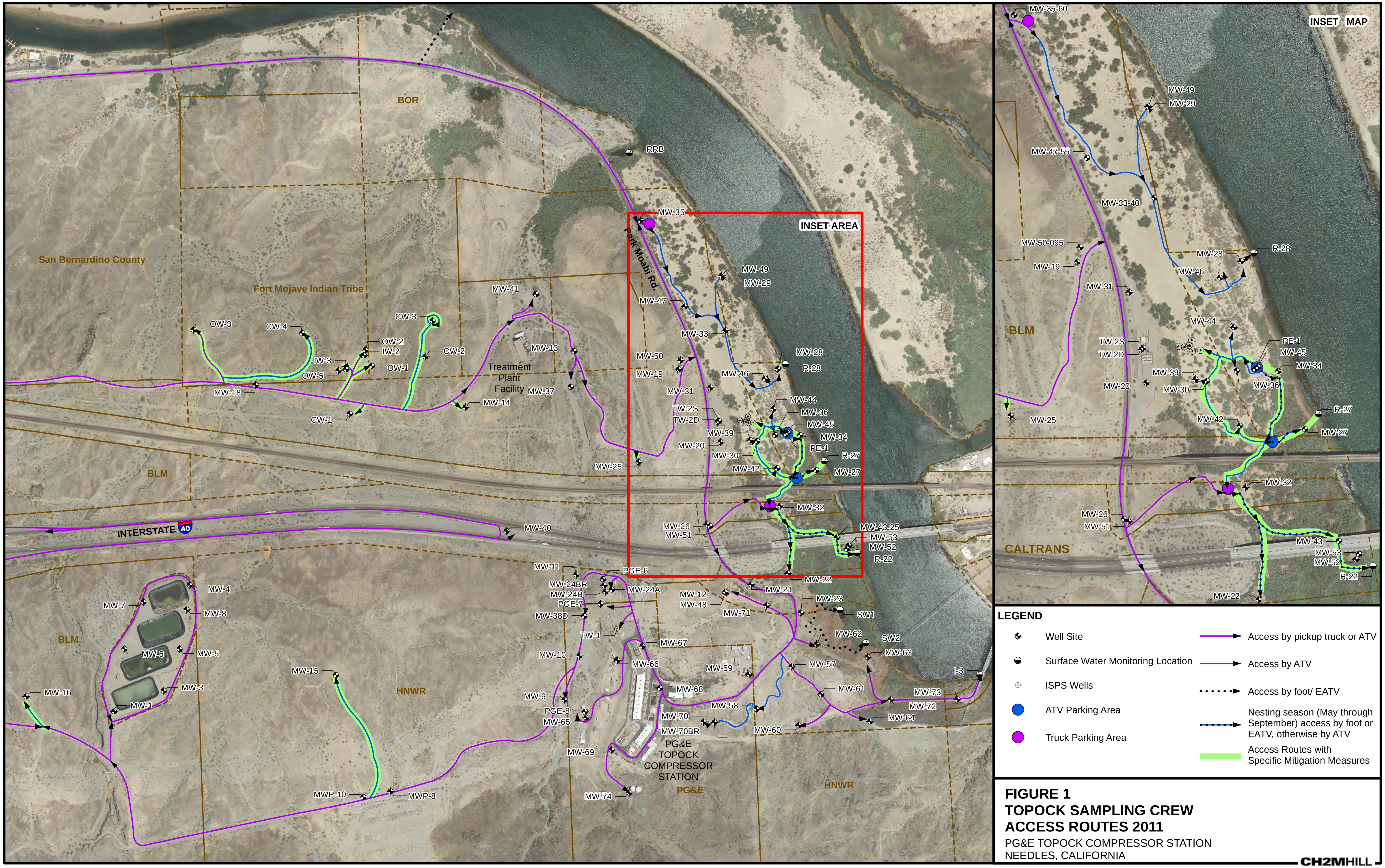

FIGURE 1
TOPOCK SAMPLING CREW ACCESS ROUTES 2011

PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

Path: D:\Projects\Topock\MapFiles\2012\AccessRoutes.mxd Date Saved: 4/25/2012 10:47:40 AM

SOP-A17

Groundwater and Surface Water Mobile Integrated Sample Tracking Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and tools to be used for collecting and managing field data as well as managing analytical samples collected in the field associated with the Topock Monitoring Programs. This SOP is a guideline to be used during the collection of surface water and groundwater data. This includes the Groundwater Monitoring Program (GMP), Compliance Monitoring Program (CMP), and River Monitoring Program (RMP) samples.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP).
2) Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual as required.
3) Mobile Integrated Sample Tracking (MIST) Operators Manual
4) PG&E Programs Data Management Plan
5) Topock Quality Assurance Program Plan (QAPP)

FIELD DATABASE PREPARATION & SETUP

This section describes the upfront planning a preparation steps necessary to properly set-up a groundwater or surface water sampling event using the Topock Field Database. This SOP provides the how-to information for properly entering information into the field database.

1) Ensure that you have the latest version of the Topock field database. This actually consists of two database files. The “Front end” that is the interface for information entry and management and the “backend” that stores the field data and sampling information.

2) Set up the “Project Name” in the field database using the established Topock Event nomenclature, year-program-event number. For example, if you are preparing the field database for the 144th GMP sampling event, which will occur in 2008, the event title will be 2008-GMP-144.

3) Sample IDs will be entered into the database using the following convention: well ID--event number. For example, well MW-34-100 sampled during event 2008-GMP-144 would be named MW-34-100-144.

4) Analyses will be entered into the field database in accordance with the most recent SAP and any modifying documents or correspondences. Modifying documents may include the most recent Contract Work Assignment, correspondences from the regulatory agencies and client, and additional direction from project managers.

QUALITY CONTROL PROCEDURES PRIOR TO SAMPLING EVENT

The following steps describe the QC procedures prior to the initiation of sampling activities necessary to ensure all the required samples are collected.

1) Prepare a planned sample table (PST) from the database including all locations and analyses for the sampling event to be performed. An example of the PST is included as an attachment to this SOP.
2) The PST is to be reviewed by the project manager (PM) responsible for the upcoming event and the designated QC manager. If the PM and the QC manager concur with the PST, both will sign the form indicating that the samples listed are complete in accordance with all guidance documents.
3) When the PST is reviewed and accepted, prepare the event paperwork from the field database. This includes sample labels, purge forms and blank chains of custody. In addition, a list of bottles can be generated to be used to order sample bottles from the analytical laboratories. Compare the forms against the approved PST for completeness and accuracy.

USING THE MIST HANDHELD UNIT AND FIELD DATABASE

The Topock monitoring program uses the CH2M HILL proprietary Mobile Integrated Sample Tracking (MIST) system for field data acquisition and analytical sample tracking. This SOP provides an outline of steps for using the system. Details for using the MIST system are provided in the MIST operator’s manual.

1. Load the appropriate field database onto the computer that is to be used for sample tracking during the field sampling event. Follow the steps in the users manual to properly prepare the database for upload into the handheld unit (Recon).
2. Load the data for the upcoming sampling event(s) onto the MIST handheld computer. Boot the system and check to ensure that the complete sampling set is included.
3. Upon arrival at a monitoring well or other sample location select the correct sample location ID manually or scan the radio frequency identification (RFID) tag if the location is so equipped. The RFID tag is a black disc approximately the size of a quarter that is attached to the well casing. Upon scanning the RFID tag, the well ID and construction information will appear on the Recon screen. **Confirm that you are at the location you intend to sample. If the well cannot be properly identified via RFID tag and or clear marking, the location is to be identified by measuring the total depth of the well.** Wells sampled on a monthly sampling frequency are indicated by a colored band around the top of the well casing.
4. Purge and sample the location in accordance with the appropriate sampling SOP (see SOPs A-1 through A-4 for sampling procedures). Record the well and purge information in the MIST unit as directed by the MIST Operator’s Manual. In addition, record all field data on a hardcopy purge form. The hardcopy forms will serve as backup in case the data on the handheld unit is lost.

5. When the necessary purge volume has been purged, use the MIST unit to confirm that the field parameters are stable in accordance with site SOPs. If the parameters are not stable, continue purge. If stabilization is achieved, collect the analytical samples.

6. The MIST handheld unit will provide a table of samples to be collected at the location. The table will also indicated required preservation and filtration. Confirm that the appropriate bottle, preservative and filtration is used for each analyte. Confirm the collection of the bottle for each analyte by entering the sample time and date. Doing so indicates that the sample has been collected and it will be recorded as such in the database.

7. After the completion of each sample location, run the "Sprite Backup" tool on the Recon unit to ensure that no data is lost in the event of power loss or other unforeseen mishap. Backup the Recon before changing battery units as well.

8. At the end of sampling each day, the data in the handheld unit is to be uploaded to the field database as directed by the MIST Operator's Manual. Once the upload is completed, run the automated COC forms from the field database.

POST SAMPLING QUALITY CONTROL

This section describes the quality control steps required at the end of each sampling day. In addition, proper sample packing and shipment are discussed.

1. After the field data has been collected and uploaded into the field database as described above, COCs forms are to be generated from the field database. Compare the COC forms to the sample bottles collected to confirm all samples are properly recorded in the COC forms.

2. Compare the COC forms to the PST to confirm that all samples were collected. Certain quality control samples may be required to be held by the lab and not analyzed unless there is a data discrepancy. Confirm that these samples are labeled "Hold" in the comments column of the COC form. If there are any deviations from the PST that are intentional record the reasons for the change on the appropriate purge form and daily log. **If there are any sampling inconsistencies that cannot be explained, the location that needs additional or other samples will need to be re-sampled. The Sampling coordinator, Project Chemist and Project Manager should be notified as soon as possible, at a minimum on each day of the sampling event, of any inconsistencies that are identified.**

3. The field database has an additional tool to compare planned samples versus samples that were actually collected. Run the Planned vs. Actual (PvA) at the end of each day to confirm that all samples were collected as planned. If there are any deviations from the PST that are intentional record the reasons for the change on the appropriate purge form and daily log. **If there are any sampling inconsistencies that cannot be explained, the location that needs additional or other samples will need to be re-sampled. The Sampling coordinator, Project Chemist and Project Manager should be notified as soon as possible, at a minimum on each day of the sampling event, of any inconsistencies that are identified.**

4. At the end of each day, forward the purge forms and COCs to the sampling task lead via email or fax. The sampling task lead is responsible for additional review of the purge and sampling information for the following:
    - Appropriate purge and sampling techniques were used.
    - The purge was complete.
    - The purge parameters are in-line with historic purge data.
    - The correct samples were collected from each location.

If there are discrepancies in the purge or sample the location may need to be re-sampled.

SOP-A18

Purging and Sampling of Groundwater Monitoring Wells Minimal Drawdown Method Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for purging and sampling all groundwater monitoring wells approved for the minimal drawdown sampling approach. This SOP will be used for sampling groundwater monitoring wells using an adjustable rate, positive displacement pump.

REQUIRED DOCUMENTS:

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data tables
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

REQUIRED EQUIPMENT:

- 2 or more (i.e. one is backup) WQ instruments with flow through cells, or equivalent.
- Hach 2100P turbidimeter or equivalent.
- 200 foot (or longer as needed) water level indicator (WLI).
- Trimble Rugged Reader hand held instrument for MIST data collection.
- Two, 200 gallon capacity purge tanks.
- Utility vehicles (UTV's) as necessary.
- Honda 2000 watt generator or alternate power source.
- Adjustable-rate, positive-displacement pump
- Sample containers, cooler and ice

PREPARATION & SETUP:

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, HSP, and groundwater sampling supplies and equipment check list. (NOTE: the PST should also be reviewed for required "non-analytical event activities" such as water level measurements or other data collection that is planned in association with the groundwater sampling event).
- Acquire the existing field logbook for groundwater sampling and initiate entries.
- Inspect all equipment and verify that the field water quality (WQ) meters have been calibrated prior to use according to the manufacturer's instructions and SOP-A9, *Calibration of Field Instruments*.
- Inventory sample bottles, build sample sets for the required analytes at each sample location, ensure a sufficient supply of lab de-ionized water for equipment blanks, and confirm the lab courier schedule.
- Field-check sampling equipment and supplies: water level indicator (WLI), WQ meters, flow-through cell, pump controller, power supply, pump discharge/sampling tubing, N-dex gloves, D.I water sprayers, 5 gallon buckets, paper towels, 0.45 micron in-line filters, etc.

FIELD PROCEDURES:

- **Prior to opening any monitor well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the monitoring well, at least 2 members of the sampling team must confirm the well ID. Wells should be clearly marked on the well monument. If the well cannot be positively identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location. Report worn or unclear well markings to the on-site field coordinator.
- Place spill containment according to SOP A-13 *Spill Containment.*
- If using a transient pump,collect an "EB", equipment blank, ***prior to pump installation*** if necessary according to the PST.
- Open the protective casing lid and, ***prior to moving it***, note the exact configuration of the transducer installation if present. Measure static WL according to SOP-A7, *Water level Measurements,* moving the transducer if necessary, and record WL value in MIST and on the sampling log.
- If the well is equipped with a transducer and does not have a dedicated pump installed, remove the transducer from the well according to SOP-C1, *Temporary Removal and Replacement of Transducers*.
- If the well does not have a dedicated pump installed, but does have dedicated sample tubing, attach the dedicated tubing to the appropriate pump and install decontaminated pump at the same intake/sampling depth as used in prior events. There is a marking on

the purge tubing which corresponds with the monitor well top of casing (TOC) to facilitate this requirement. Purge and sample the well as described below.

- If the well does not have a dedicated pump ***or*** tubing, or has not been previously sampled, use new low-density polyethylene tubing and install the pump with the intake at approximately the midpoint of the well screen. Purge and sample the well as described below.
- If the well ***does*** have a dedicated pumping system, connect the discharge tubing and purge and sample the well as described below.
- Collect daily equipment blanks and duplicate samples as required by the PST and instructed by the field team leader.

PURGING AND SAMPLING PROCEDURES:

- Install the pump in the well. Slowly lower the pump (with the attached tubing and safety line) into the well to the desired depth. The pump will be set near the middle of the well screen, if possible. At a minimum, the pump intake will not be positioned lower than 2 feet from the bottom of the well. The depth to the pump intake will be recorded on the Groundwater Sampling Form. If there is less than 3 feet of available water, the groundwater well will be purged and sampled using a bottom-loading bailer.
- Measure the water level in the well after pump insertion. Leave the water level probe in the well to facilitate continued water level monitoring during purging activities.
- Start purging the well at a low flow rate between 0.2 and 0.5 liters per minute. Measure the purge rate using a container of known volume, and record this information on the Groundwater Sampling Form
- The water level should be monitored during purging, and ideally, the purge rate should equal the well recharge rate so there is limited drawdown in the well. (The water level should stabilize for the specific purge rate). The purge rate may be increased above 0.2 and 0.5 liters per minute as long as a constant water level in the well can be maintained. There should be at least 1 foot of water over the pump intake. This assures that there is no risk of the pump suction being broken, or of entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water on the field data sheet. Purge rates should, if needed, be decreased to the minimum capabilities of the pump (0.1 to 0.2 liters per minute) to avoid affecting well drawdown. If using a pulse style pump, measure the water level at the end of the pressure cycle when the water level has recovered as much as it will, before again filling the pump during the fill cycle. This method will generate consistent drawdown data.
- During purging, the water quality parameters will be measured periodically (every 3 to 5 minutes) until the parameters have stabilized as shown below. If parameter stabilization has not occurred after 4 hours, purging activities will be considered complete.

•	pH	+/- 0.1 pH units
•	Specific conductance	+/- 3%
•	ORP	+/- 10 millivolts
•	Turbidity	+/- 10% NTU units (when turbidity is >10 NTUs)

- Dissolved oxygen +/- 0.3 mg/L
- Temperature +/- 2° Celsius

- When the requirements above have been satisfied and the purge cycle is complete, disconnect the flow through cell and prepare to collect samples directly from the pump discharge tubing for analyses according to event-specific PST. Prepare sample containers and collect gas-sensitive analytes first. The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry (cations, anions, stable isotopes).
- For filtered samples, attach a 0.45 micron in-line filter to the pump discharge and allow approximately 500 mL of sample to pass through the filter before beginning sample collection in accordance with SOP A-6 *Field filtration* and the QAPP.
- When sample collection is complete, record sample information, final WL, and purge volume data in MIST and on the field sampling log.
- If transient pump previously installed, remove the pump from the well, detach the dedicated tubing and carefully drain any residual water to the purge water tank. Fold both ends of the purge tubing and secure with wire ties as a further deterrent to leakage. Store the dedicated tubing in a sealed, labeled trash bag. Decontaminate the pump according to SOP A-10, *Decontamination of Water Sampling Equipment.*
- If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and in accordance with SOP-C1, *Temporary Removal and Replacement of Transducers*.
- Close and secure well protection lid.
- Follow SOPs in *Program Procedures Manual* for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

SOP-A19

Sampling of Groundwater Monitoring Wells HydraSleeve No Purge Method Standard Operating Procedures for PG&E Topock Program

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This standard operating procedure (SOP) addresses the procedures and equipment to be used for sampling all groundwater monitoring wells approved for the HydraSleeve sampling approach.

REQUIRED DOCUMENTS:

- Event-specific planned sample table (PST).
- Applicable project work plan or monitoring plan. Refer to Topock Program Sampling, Analysis, and Field Procedures Manual and QAPP (Procedures Manual), as required.
- Topock Program Health and Safety Plan (HSP)
- Applicable SOP's
- Well construction logs/specifications
- Mobile Integrated Sample Tracking (MIST) handheld database
- Previous sampling logs or tabular historic field data tables
- Current site access map
- Blank sampling logs, maps, sample labels, chains of custody (COC's), and the designated groundwater sampling field notebook

REQUIRED EQUIPMENT:

- 2 or more (i.e. one is backup) YSI-556 WQ instruments, or equivalent.
- Hach 2100P turbidimeter or equivalent.
- 200 foot (or longer as needed) water level indicator (WLI).
- Trimble Rugged Reader hand held instrument for MIST data collection.
- HydraSleeve samplers (from supplier)
- Pointed plastic discharge tube (included with sampler)
- Polypropylene strapping (from supplier)
- Stainless steel weights
- Small cable ties
- String reel
- Utility knife

- Scissors (stainless steel)
- Well caps with small eyelet on bottom allowing a string to be tied off
- Sample containers, cooler and ice

PREPARATION & SETUP:

- Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, HSP, and groundwater sampling supplies and equipment check list. (NOTE: the PST should also be reviewed for required "non-analytical event activities" such as water level measurements or other data collection that is planned in association with the groundwater sampling event).
- Acquire the existing field logbook for groundwater sampling and initiate entries.
- Inspect all equipment and verify that the field water quality (WQ) meters have been calibrated prior to use according to the manufacturer's instructions and SOP-A9, *Calibration of Field Instruments*.
- Inventory sample bottles, build sample sets for the required analytes at each sample location, ensure a sufficient supply of lab de-ionized water for equipment blanks, and confirm the lab courier schedule.
- Field-check sampling equipment and supplies: water level indicator (WLI), WQ meters, HydraSleeve supplies, N-dex gloves, D.I water sprayers, 5 gallon buckets, paper towels, 0.45 micron in-line filters, etc.

FIELD PROCEDURES:

- **Prior to opening any monitor well, remove all pens, lighters, calculators, or any other loose items from vest pockets, or from any other location where they could fall into the well.**
- Upon arrival at the monitoring well, at least 2 members of the sampling team must confirm the well ID. Wells should be clearly marked on the well monument. If the well cannot be positively identified by the marking, measure total depth of the well and compare to the well installation details to confirm the correct location. Report worn or unclear well markings to the on-site field coordinator.
- Place spill containment according to SOP A-13 *Spill Containment.*
- Open the protective casing lid and, ***prior to moving it***, note the exact configuration of the transducer installation if present. Measure static WL according to SOP-A7, *Water level Measurements,* moving the transducer if necessary, and record WL value in MIST and on the sampling log.
- If the well is equipped with a transducer and does not have a dedicated pump installed, remove the transducer from the well according to SOP-C1, *Temporary Removal and Replacement of Transducers*.

PURGING AND SAMPLING PROCEDURES:

HydraSleeve Deployment

1. Remove HydraSleeve sampler from package and pinch the top to create an opening. See Attachment 1 for a representation of an unfilled HydraSleeve sampler.
2. Use a HydraSleeve Spring Clip to fasten the pre-looped string to the top of the HydraSleeve sampler. Fold the two holes at the bottom of the HydraSleeve together and attach a weight using a HydraSleeve Stainless Steel weight clip. Attach the weight clip to the pre-measured string.
3. If using two HydraSleeve samplers, follow steps 1 and 2 above for placing the second sampler below the first on the pre-measured string.
4. Lower the sampler into the well until the pre-marked hanging location is level with the ground surface.
5. Following placement in the well, fasten the end of the string to the locking tab on the well casing, secure with a cable tie and the well lock.
6. Place cap back onto well.
7. Secure monitoring well and area prior to demobilization.

HydraSleeve Sample Recovery

Once a sufficient period of time has elapsed so that re-equilibration of the water within the well with surrounding groundwater conditions has occurred (typically a minimum of 48 hours), the HydraSleeve samplers can be recovered and samples collected for analysis.

For standard HydraSleeve sampler recovery, the following procedures will be performed at each well:

1. Measure the depth to water to the nearest 0.01 foot.
2. Remove all securing cable ties and remove the sampler from the well. The best method is to pull the HydraSleeve sampler upward continuously from its starting point, at a rate of one to two feet per second or faster, until the sampler is full, which is a vertical distance of 36 to 72 inches for a 36-inch long sampler.
3. The condition of the sampler should be recorded in the field sampling sheets, including the presence of any headspace within the sampler.

HydraSleeve Sample Collection

Samples for chemical analysis will be collected from the HydraSleeve samplers immediately following removal from the well. The following sampling procedures will be used at each well:

1. Identification labels for sample bottles will be filled out for each sample.
2. Hang the filled HydraSleeve from the hanger device after removal from the well..
3. Squeeze the full sampler just below its top to expel water resting above the flexible check valve.
4. Push the pointed discharge tube perpendicularly through the outer polyethylene sleeve approximately three to four inches above the bottom of the HydraSleeve.
5. Transfer the sample from both HydraSleeve samplers into a 2.5 liter compositing container. Pinching the sample sleeve just above the discharge tube will control the flow of the sample. The sample sleeve can also be squeezed, forcing fluid up through the discharge tube, similar to squeezing a tube of toothpaste.
    - The preferred collection order will be volatile organic compounds (VOCs), semi-volatile organic compound (SVOCs), metals (including hexavalent chromium [Cr(VI)] and total chromium [Cr(T)]; see SOP-A6), then general chemistry (cations, anions, stable isotopes).
    - For filtered samples, transfer the sample out of the compositing container using a peristaltic pump through a 0.45 micron in-line and allow approximately 250 mL of sample to pass through the filter beginning sample collection. The limited volume in the HydraSleeve sampler requires that less sample be run through the filter than is dictated in SOP A-6 *Field filtration* and the QAPP.
6. If sample volume allows, transfer water into a container to obtain field parameter readings with a YSI-556 WQ or equivalent instrument (note in the field forms the results are approximate because a flow-through cell could not be used). Field parameter readings are to be recorded on the groundwater sample form.
7. Excess sampler water will be emptied into the purged waste water tank.
8. Samples will be preserved and managed as detailed in the QAPP. Time of sampling will be recorded in the field logbook, field sample sheets, sample labels, MIST and chains of custody.
9. After the samples have been collected, immediately place the sample bottles in an ice-filled cooler. Before decontamination of field equipment, the well cap will be replaced and locked.
10. If redeployment of a new HydraSleeve sampler is not intended, sampling equipment, except for string, stainless steel weight and rubber stopper, will be discarded as with other PPE trash, and the blank string with weight will be Stored for later use. However, if deployment of a new sampler is required, the new

sampler will be reattached to the existing string and stainless steel weight. The sampler can then be deployed in the well for the next sampling event.

11. If well was equipped with a transducer, replace the transducer in exactly the same configuration in which it was found and in accordance with SOP-C1, *Temporary Removal and Replacement of Transducers*.
12. Prior to leaving the site, field documentation, including the chain-of-custody form, will be completed.
13. Secure monitoring well and area prior to demobilization.
14. Follow SOPs in *Program Procedures Manual* for sample handing and management, equipment decontamination, and investigation-derived waste (IDW) management.

Attachment 1
Representation of HydraSleeve Sampler

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Hexavalent Chromium Analysis by Hach Method 1560
Number: IM3-SOP-L01_Rev2
Revision Date: 9/25/2006

Scope

Standard procedure for analysis of hexavalent chromium using Hach program 1560.

Procedure:

First thing each shift, calibrate the pH/COND meter (**Record the results on the calibration log sheet**)

With the first analysis of Hexavalent Chromium each shift:

- **Analyze a CCV** (Continuing Calibration Verification) standard:
- Carefully measure 24 mLs of DI water
- Add 1 mL of 2.5 mg/L Hexavalent Chromium (Cr^{+6}) standard.
- Add the Hexavalent Chromium reagent pillow… At the same time as your samples. (ChromVer 3 Reagent)
- Invert the CCV sample 4 – 5 times,
- Use the same 8 minute timer for CCV and Samples
- (**Record the results in the Cr^{+6} bench log book**) if the Hach reading is not between 0.075 mg/L and 0.125 mg/L re-prepare the standard and re-analyze, if still not between 0.075 mg/L and 0.125 mg/L call Shawn Duffy at 530-229-3303)

<u>SC-100B, SC-001, and SC-002</u>

- Collect the sample: (from the SC-100B/SC-001/SC-002 sampling point)
- Verify the Hach DR/4000V is set for **Hexavalent Chromium (Cr^{+6})**, program **1560**
- Take the pH (**Record the results in the Cr^{+6} bench log book**)
- Transfer 5 mLs of sample SC-100B into a 100 mL volumetric flask
- Add DI water to bring the volume to 100 mLs
- Mix sample (invert sample 4 – 5 times)
- Transfer 25 mLs of diluted sample into sample cell
- Add ChromVer 3 Reagent to the sample

- Invert sample 4 – 5 times,
- start timer (8 min)
- Run a Blank (Zero the DR/4000V using at least 25 mLs of diluted sample)
- After 8 minute timer, pour the sample into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook
- Multiply the instrument reading (result) by 20 for the adjusted value

Example: instrument reading is 0.304
X 20
= 6.08 mg/L (final result)

SC-605/SC-700C or SC700B/SC-701

- Collect the sample:
- Verify the Hach DR/4000V is set for **Hexavalent Chromium (Cr^{+6})**, program **1560**
- Take the pH (**Record the results in the Cr^{+6} bench log book**)
- Transfer 25 mLs of sample into sample cell
- Add ChromVer 3 Reagent to sample
- Invert sample 4 – 5 times,
- start timer (8 min)
- Run a Blank (Zero the DR/4000V using at least 25 mLs of DI)
- After 8 minute timer, pour the sample into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook

SC-301C or SC-500

- Collect the sample:
- Verify the Hach DR/4000V is set for **Hexavalent Chromium (Cr^{+6})**, program **1560**
- Take the pH (**Record the results in the Cr^{+6} bench log book**)
- Set up the vacuum filter apparatus
- Filter ~100 mLs of sample
- Transfer 25 mLs of filtered sample into a sample cell
- Carefully measure 24 mLs of filtered sample into a sample cell - **Matrix Spike (MS)**

- Add 1 mL of 2.5 mg/L Hexavalent Chromium (Cr^{+6}) standard to the 24 mLs of filtered sample
- Add ChromVer 3 Reagent to all the sample(s) / MS
- Invert sample 4 – 5 times,
- Start timer (8 min)
- Run a Blank (Zero the DR/4000V using at least 25 mLs of DI)
- After 8 minute timer, pour the sample(s) into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook

Example: Matrix Spike (0.117 mg/L) - Sample (0.006 mg/L) = 0.111 mg/L

Concentration of Spike Standard is = 0.100 mg/L

% recovery is = 0.111/0.100

= 111% **MS % recovery must be between 75 – 125%**

or you will need to re-analyze

SC-201B or SC-300A

- Make a 5% NaOH solution. Start with 80 mLs of DI water and add 20 mLs of 25% NaOH. Because the 5% solution will be used only to adjust pH, the concentration does not need to be exact.
- Collect the sample:
- Verify the Hach DR/4000V is set for **Hexavalent Chromium (Cr^{+6})**, program **1560**
- Take the pH (**Record the results in the Cr^{+6} bench log book**)
- Adjust the pH of 100 – 150 mLs of the non-filtered sample to around 10 (9.5 – 11) by adding 5% NaOH solution - one drop at a time. Note the pH of the adjusted sample in the log book note section.
- Set up the vacuum filter apparatus.
- Allow the precipitate to settle and filter ~100 mLs of the pH adjusted sample (try not to disturb the precipitate at the bottom).
- Transfer 25 mLs of filtered sample into a sample cell
- Carefully measure 24 mLs of filtered sample into a sample cell - **Matrix Spike (MS)**
- Add 1 mL of 2.5 mg/L Hexavalent Chromium (Cr^{+6}) standard to the 24 mLs of filtered sample
- Add ChromVer 3 Reagent to all the sample(s) / MS
- Invert sample 4 – 5 times,

- Start timer (8 min)
- Run a Blank (Zero the DR/4000V using at least 25 mLs of DI)
- After 8 minute timer, pour the sample(s) into the sample port of the Hach DR/4000V

Record the instrument reading in the Lab Bench Logbook

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Ferrous Iron Analysis by Hach Method 2150
Number: IM3-SOP-L02_Rev01
Revision Date: 12/31/2009

Scope

Standard operating procedure for analysis of ferrous iron.

Procedure:

- Take the pH (Record the results in the Fe^{+2} bench log books)
- Verify the Hach DR/4000V is set for Ferrous Iron, program 2150
- Transfer 5 mLs of the sample into a 100 mL volumetric flask,
- Add DI water to bring the volume to 100 mLs,
- Mix sample (invert sample 4 – 5 times),
- Transfer 25 mLs into a sample cell,
- Add Ferrous Iron Reagent,
- Invert sample 4 – 5 times,
- Start timer (3 min)
- Filter 25 mLs of the remaining diluted sample (should have 75 mLs) and analyze as a Blank (Zero the DR/4000V)
- After 3 minute timer, filter the sample with the Reagent added and pour the sample(s) into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook
- Multiply the instrument reading (result) by 20 for the adjusted value– the adjusted value should be between 2 and 16 mg/L.

Example: instrument reading is 0.704

X 20

= 14.08 mg/L (final result, recorded in Fe^{+2} book)

Note: If the Fe^{+2} adjusted value is not in the 2 – 16 mg/L range notify the lead operator.

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Total Chromium Analysis by Hach Method 8024
Number: IM3-SOP-L03_Rev00
Revision Date: 7/24/2005

Scope

Standard operating procedure for analysis of total chromium.

Procedure (for SC-501/SC-700C or SC700B/SC-701)

- Turn on the hot plate and set to 390 degrees
- Make sure the water bath is ~ ½ inch below the top
- Verify the Hach DR/4000V is set for Chromium, Total (Cr+3), program 1580
- Transfer 25 mLs of sample into a sample cell
- Carefully transfer 24 mLs of the sample into a sample cell
- Add 1 mL of 2.5 mg/L Chrom Cr+3 Standard… Matrix Spike (MS)

Analyze a CCV (Continuing Calibration Verification) standard:

- Carefully measure 24 mLs of DI water
- Add 1 mL of 2.5 mg/L Chrom Cr+3 Standard.
- Add Chrom 1 Reagent to each of the sample cells,
- Invert sample 4 – 5 times,
- Place in the hot water bath and start the 5 min timer "Heat".
- After 5 minutes, remove the sample cells and cool to room temperature in an ice bath.
- Add Chrom 2 Reagent to each of the sample cells, invert sample 4 – 5 times.
- Add Acid Reagent to each of the sample cells, invert sample 4 – 5 times.
- Add ChromVer 3 Reagent (for 25 mLs samples) to each of the sample cells, invert sample 4 – 5 times
- Start the 5 min timer "wait".
- Analyze a Blank (Zero the DR/4000V using at least 25 mLs of DI)
- After 5 minute timer,
- Pour the sample(s) into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook.

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Conductivity Analysis by Hach Method 8160
Number: IM3-SOP-L04_Rev00
Revision Date: 10/15/2005

Samples need to be between 20°C and 25°C before conductivity is measured. Conductivity is the measure of the ability of a solution to conduct an electric current and is dependent on temperature. The conductivity can then multiplied by an empirically derived factor to calculate the amount of total dissolved solids (TDS) in the sample.

PROCEDURE

1. Verify the calibration by checking the conductivity of the 1000 μS/cm standard at the beginning of each shift.
   - Rinse the conductivity probe with distilled water and shake it to remove excess water, the meter should read below 10 μS/cm.
   - Place probe in standard/sample and swirl to remove air and provide positive contact between the probe and the standard/sample.
   - Verify the meter is in COND mode.
   - Record value after the reading stabilizes on the calibration sheet.
2. If the results are within 10% of the true value (900 to 1100 μS/cm) continue with analysis of the samples making sure to rinse the probe with distilled water after each sample. If not within 10%, recalibrate the meter following the Steps on page 5 of the HACH **Quick Reference Guide** sens**ion156** and sens**ion378** Multiparameter Meters (54650-23).
3. For each of the samples, using the steps listed above. Record the conductivity result on the bench sheet and include the units. The result is automatically corrected to the reference temperature of 20°C.

Note: The meter automatically changes the units from μS/cm to mS/cm above 1999 μS/cm

CALCULATIONS

To convert from mS/cm to μS/cm multiply the result by 1000.

TDS, mg/L (ppm) = Conductivity (μS/cm) * 0.63

PRECAUTIONS, TROUBLESHOOTING, & REMEDIAL ACTIONS

- Make sure the cell is properly rinsed between measurements
- Check to make sure there are no bubbles in cell – be sure to swirl probe in the solution.
- Ensure that the conductivity standard solution is not expired.
- If DI water does not clean the cell, try cleaning the cell as follows: Wash with warm water and laboratory soap and rinse with copious amounts of DI water before use. Alternatively 3% 3 HCl acid solution may be used. Solvents such as acetone or ethanol should only be used as a last resort and then the cell should not be immersed for longer than 5 minutes. Always completely rinse with DI water. Re-calibrated after these cleanings.

REAGENTS

Conductivity Standards – 1000 µS/cm, (HACH 14400-42)
Distilled water

REFERENCES

Standard Methods for the Examination of Water and Wastewater, APHA et al, 20th Edition, 1998, Method 2510.
Water Analysis Handbook, HACH Company, 4th Edition, 2003, Method 8160

Standard Operating Procedure – Laboratory PG&E Topock Groundwater Extraction and Treatment System

Title: Turbidity Analysis

Number: IM3-SOP-L05_Rev00
Revision Date: 9/8/2005

PROCEDURE

1. Once, at the beginning of each shift, each operator should follow the steps in **Figure 1** to check the calibration using the Gelex Standard (0-100 NTU) instead of a sample. The result must be within +/- 10% of the true value, based off the last Calibration (as shown below). If not, the meter must be re-calibrated. (Consult instrument manual for recalibration procedure using Formazin).

Example:

	True Value	**Lower Limit (-10%)**	**Upper Limit (+10%)**
Gelex 0 – 100 NTU	45 NTU	40.5 NTU	49.5 NTU

Note: the true value for the Gelex standards must be determined each time the meter is calibrated using the Formazin standards.

2. Follow the steps in **Figure 1** below for each of the samples. Record the turbidity result on the bench sheet.

CALCULATIONS

The result is reported directly in NTU.

PRECAUTIONS, TROUBLESHOOTING, & REMEDIAL ACTIONS

- Always orient the cell the same way – diamond lining up with mark on instrument.
- Cap the sample cell to prevent spillage of sample into the instrument.
- When taking a reading, place the instrument on a level, stationary surface. It should not be held in the hand during measurement.
- Always close the sample compartment lid during measurement and storage.
- Always use clean sample cells in good condition. Properly clean cells between measurements
- Dirty, scratched, or damaged cells can cause inaccurate readings. Handle cells only by the top to minimize dirt, scratches and fingerprints in the light path.
- Avoid excess coating of oil. Oil is not needed if the sample cells are properly maintained. (Do not use a brush on the sample cell, always use chemwipes or equivalent optical wipes to dry the cells)
- Do not leave a sample cell in the cell compartment for extended periods of time. This may compress the spring in the cell holder.

- Remove sample cell and batteries from instrument if the instrument is stored for extended time period (more than a month).
- Make certain hot samples do not evaporate and condense in the sample cell.
- Avoid settling of sample prior to measurement. Allow samples to degas but do not allow settling of solids.
- Keep sample compartment lid closed to prevent dust and dirt from entering.
- If 9.99 or 99.9 are flashing on display press ‘Range’ button to change range of meter.

QUALITY CONTROL

Activities that will help ensure the accuracy and precision of this method include:

- **Using Optically matched (or single) cells for Low Level Turbidity** - Precise measurements of low turbidity (< 2 NTU) samples require using a single cell for all measurements or using optically matched cells – *see HACH instruction manual Section 2.3.3 Pages 22-25*.
- **Use Dedicated Cells** – the use of cells dedicated to Turbidity measurement is recommended
- **Removing Trapped Gases** - *see HACH instruction manual Section 2.3.3 Pages 22-25.* This would only be a problem for samples that exhibit foaming or where gas bubbles are observed.
- **Avoid Sample Dilution where possible**– Sample dilution may alter characteristics of the suspended particles and should be avoided if possible. If dilution is performed use only reagent water.
- **Calibration Checks using the Gelex standards** – Once per rotation, measure the 0 to 100 NTU Gelex standard.
- **Recalibration Using Formazin standards** – Once every two months, or sooner if the Gelex Calibration check standards indicate a problem, recalibrate using the Formazin standards - *see HACH instruction manual Section 3.6,* pages *35-54*.

APPARATUS

- Model 2100P Portable Turbidimeter
- Sample cells with caps.
- Carrying Case
- Four AA alkaline batteries

REAGENTS

- Formazin Primary Standards - HACH Part # 26594-05, StableCal Standards, <0.1, 20, 100, 800 NTU, ampoules
- Gelex™ Secondary Standards - HACH Part # 24641-05
- Reagent water – ASTM Type I water produced by de-ionization.
- Silicone Oil - HACH Part # 1269-36

QUALITY CONTROL CRITERIA

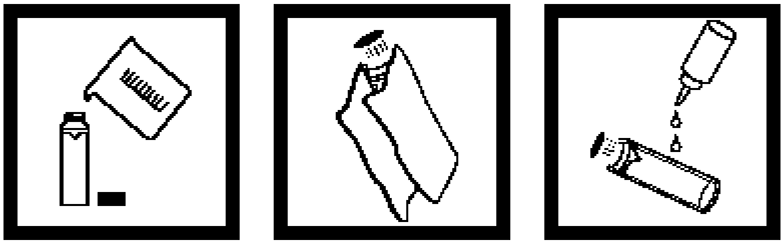
QAQC Sample	Frequency	Criteria
Gelex 0 – 100 NTU Standard Checks	Each operator checks each shift before samples are analyzed.	90%-110% of expected concentration
Primary Standard re-calibration	As needed or at least every two months	90% - 110% recovery for check of new standard

REFERENCES

Standard Methods for the Examination of Water and Wastewater, APHA et al, 20th Edition, 1998, Method 2130 B.

HACH Model 2100P, Instrument and Procedure Manual, CAT. NO. 46500-88, 2004

Figure 1
Making a Turbidity Measurement



1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL), taking care to handle the sample cell by the top. Cap the cell. (See *Section 2.3* on page *22* for more information about collecting a representative sample).

Note: The instrument automatically shuts off after 5.5 minutes if no keystrokes occur. To resume operation, press I/O.

2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.

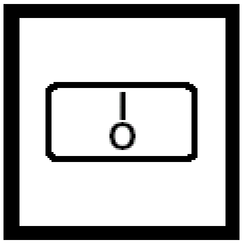
3. Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface.

Analyze one sample in duplicate each shift. Results for duplicate analyses should be within 20% of each other.

Using silicone oil is optional – Call project chemist before using oil.

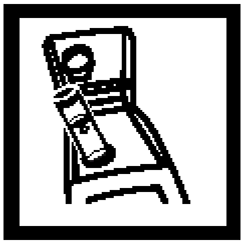
Figure 1 continued

Making a Turbidity Measurement

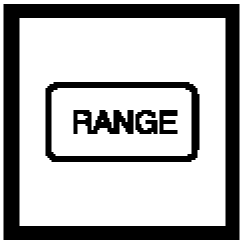


4. Press: I/O.

The instrument will turn on. Place the instrument on a flat, sturdy surface. Do not hold the instrument while making measurements.

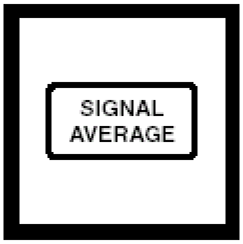


5. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment. **Close the lid.**

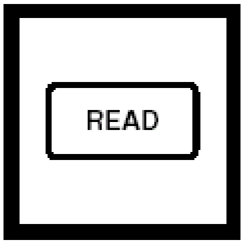


6. Select manual or automatic range selection by pressing the RANGE key. The display will show **AUTO RNG** when the instrument is in automatic range selection.

Use the automatic range mode (**AUTO RNG)** for routine measurements.



7. Select signal averaging mode by pressing the SIGNAL AVERAGE key. The display will show **SIG AVG** when the instrument is using signal averaging. Use signal average mode if the sample causes a noisy signal (display changes constantly).



8. Press: READ

The display will show **- - - - NTU**, then the turbidity in NTU. Record the turbidity after the lamp symbol turns off.

Note: The instrument defaults to the last operating mode selected. If automatic range mode and signal averaging were used on the previous measurements, these options will automatically be selected for subsequent samples.

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: Matrix Spike Preparation
Number: IM3-SOP-L08_Rev00
Revision Date: 9/8/2005

Prepare a Spiking Solution for Reagent Spikes (CCV) and Sample Matrix Spikes (MS)

Hexavalent Chromium

- Add ~50 mls of -- DI water to a 100ml volumetric flask.
- Add 5 mls of a 50 mg/L hexavalent chromium standard using a 1 ml pipette.
- Bring the volume of the flask to 100 mls using DI water.
- Cap, and mix thoroughly.

The resultant concentration of the standard is 2.5 mg/L. This standard solution can be used to prepare a matrix spike and/or a calibration verification standard as outlined in the IM3 Treatment Chemistry Working SOP.

- Take 24 mls of -- DI water (reagent spike-CCV) or sample (sample matrix spike-MS) and place in a sample cell.
- Add 1 ml of the 2.5 mg/L hexavalent chromium standard.
- Mix by inverting the sample cell 4-5 times or by swirling vigorously until completely mixed. The concentration of hexavalent chromium in the cell is 0.1 mg/L.

Total Chromium

- Add ~50 mls of -- DI water to a 100ml volumetric flask.
- Add 5 mls of a 50 mg/L total chromium standard using a 1 ml pipette.
- Bring the volume of the flask to 100 mls using DI water.
- Cap, and mix thoroughly.

The resultant concentration of the standard is 2.5 mg/L. This standard solution can be used to prepare a matrix spike and/or a calibration verification standard as outlined in the IM3 Treatment Chemistry Working SOP.

- Take 24 mls of -- DI water (reagent spike-CCV) or sample (sample matrix spike-MS) and place in a sample cell.
- Add 1 ml of the 2.5 mg/L total chromium standard.
- Mix by inverting the sample cell 4-5 times or by swirling vigorously until completely mixed. The concentration of total chromium in the cell is 0.1 mg/L.

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: pH Measurement
Number: IM3-SOP-L09_Rev00
Revision Date: 10/11/2005

PROCEDURE

Calibration

The pH meter must be calibrated at the beginning of each shift by the operator and anytime the pH does not make sense.

1. Pour fresh portions (~ 50-mL) of the pH 4, 7 and 10 buffers into the calibration beakers (buffers should be replaced at least 2/week). Rinse each calibration beaker 3 times with small portions of buffer before filling the beaker with the portion to be analyzed.
2. Turn the pH meter on.
3. Make sure the meter is in pH mode.
4. Rinse the electrode with de-ionized (DI) water.
5. Depress the pumping mechanism at the upper end of the probe- once, dispensing 6 uL of Potassium Chloride Electrolyte Reference Gel.
6. Follow the calibration procedures on page 3 in the HACH **Quick Reference Guide** sens**ion156** and sens**ion378** Multi-parameter Meters (54650-23).
7. If the pH probe does not recognize the pH 4 buffer within 2 – 3 minutes, re-rinse the electrode and dry with a chemwipe.
8. With the tip of probe raised to allow viewing, depress the pumping mechanism several times until the Potassium Chloride Electrolyte Reference Gel can be seen emerging from the light colored tube next to the glass bulb.
9. Rinse the electrode with de-ionized (DI) water and re-start the calibration.
10. After calibrating with the pH 4, 7 and 10 buffers, record the Slope value on the calibration sheet and press enter to accept and return to the reading mode.

PRECAUTIONS AND TROUBLESHOOTING

Make sure the electrode is rinsed well between samples.

Store the pH electrode in the pH=4 or 7 buffer solution when it's not in use. Replace the storage solution every week.

Make sure the buffer solutions are not expired. Replace the working buffer solution at least twice a week or if re-calibrating the meter is required.

Be careful not to hit the electrode end against the sides of the beaker.

If the meter does not stabilize during a pH measurement a new calibration may be needed.

QUALITY CONTROL

Make sure the buffers and samples are a constant temperature before beginning analysis.

Standard Operating Procedure
PG&E Topock Groundwater Extraction and Treatment System

Title: HACH Model 2100P Turbidimeter Daily Checks and Calibration Procedure

Number: IM3-SOP-L10
Date: 07/28/2008

Revision: 0

Scope

The object of this SOP is to describe the procedure for daily GELEX checks and calibration of the Model 2100P Portable Turbidimeter. Daily GELEX checks are performed to ensure that the Turbidimeter is performing within manufacturer standards.

Precautions/Hazards

Operators will not attempt this task until they have been properly trained. Hazards include exposure to Formazin, GELEX, and silicone oil (Please refer to MSDS for all chemicals).

Equipment List

Safety glasses, Nitrile gloves, Kim wipes, Model 2100P Portable Turbidimeter, check and calibration log, Turbidimeter kit (Small blue tool box located in cabinet under counter below mixer).

Procedure

To perform daily GELEX checks:

1. Turn on Turbidimeter and select automatic range mode. You should see "AUTO RNG" on display.
2. Thoroughly clean the outside of all three GELEX vials with Kim wipe and apply one drop of silicone oil to each vial and wipe with Oiling Cloth.
3. Beginning with GELEX standard 0-10 place GELEX cell into compartment so that the diamond aligns with orientation mark on the Turbidimeter. Close the lid.
4. Press the read button.
5. Record the displayed value in the check and calibration log.
6. Repeat steps 2 through 5 for remaining GELEX standards.

If any of the GELEX standards are -/+ 5 % from assigned value the Turbidimeter must be calibrated. The Turbidimeter must be calibrated every three months as per manufacturer standards.

Procedure

To perform Turbidimeter Calibration:

For expediency you will be referred to the instrument manual to perform these procedures.

1. Prepare Formazin standards, located in the Turbidimeter kit, (Small blue tool box located in cabinet under counter below mixer) according to procedure on page 37, **3.6.1.3** of **Model 2100P Turbidimeter Instrument and Procedure Manual**.
2. Begin calibration procedure on page 42, **3.6.3** of **Model 2100P Turbidimeter Instrument and Procedure Manual**.
3. After the Turbidimeter has accepted the calibration, assign new values to all GELEX standards using the procedure “To Perform Daily GELEX Checks” note previously in this SOP.

Standard Operating Procedure – Laboratory
PG&E Topock Groundwater Extraction and Treatment System

Title: pH Analytical Equipment Calibration, Working SOP
Number: IM3-SOP-L11_Rev01
Revision Date: 3/11/2008

PROCEDURE

Calibration

The pH meter must be calibrated at the beginning of each day before the 8:00 am sampling event by the operator and anytime the pH does not make sense.

1. Pour fresh portions (~ 50-mL) of the pH 4, 7 and 10 buffers into the calibration beakers (buffers should be replaced at least 2/week). Rinse each calibration beaker 3 times with small portions of buffer before filling the beaker with the portion to be analyzed.
2. Turn the pH meter on.
3. Make sure the meter is in pH mode.
4. Rinse the electrode with de-ionized (DI) water.
5. Follow the calibration procedures on page 3 in the HACH **Quick Reference Guide** sens**ion156** and sens**ion378** Multi-parameter Meters (54650-23).
6. If the pH probe does not recognize the pH 4 buffer within 2 – 3 minutes, re-rinse the electrode and dry with a Kimwipe.
7. Rinse the electrode with de-ionized (DI) water and re-start the calibration.
8. After calibrating with the pH 4, 7 and 10 buffers, record the Slope value on the calibration sheet and press enter to accept and return to the reading mode. Also record the calibration date, calibration time, and calibration equipment number on the calibration sheet.

PRECAUTIONS AND TROUBLESHOOTING

Make sure the electrode is rinsed well between samples.
Store the pH electrode in pH=4 or 7 buffer solution when it's not in use. Or use the manufactures storage solution. Replace the storage solution every week.
Make sure the buffer solutions are not expired. Replace the working buffer solution at least twice a week or if re-calibrating the meter is required.
Be careful not to hit the electrode end against the sides of the beaker.
If the meter does not stabilize during a pH measurement a new calibration may be needed.

QUALITY CONTROL

Make sure the buffers and samples are a constant temperature before beginning analysis.

Standard Operating Procedure – IM3 Field Laboratory
PG&E Topock - Groundwater Analysis

Title: Ferrous Iron Analysis by Hach Method 2150 and Hexavalent Chromium Analysis by Hach Method 1560
Number: IM3-SOP-L12_Rev00
Revision Date: 3/20/2007

Scope

Standard operating procedure for analysis of ferrous iron and hexavalent chromium from undeveloped boreholes.

Procedure: Ferrous Iron Analysis

- Using the unfiltered sample
- Take the pH (**Record the results in the Misc. bench log book**)
- Take the specific conductivity (**Record the results in the Misc. bench log book**)
- Verify the Hach DR/4000V is set for Ferrous Iron, program **2150**
- Transfer 25 mLs of the sample into a sample cell,
- Add Ferrous Iron Reagent,
- Invert sample 4 – 5 times,
- Start timer (3 min)
- Analyze a Blank (Zero the DR/4000V using at least 25 mLs of the sample)
- After 3 minute timer, pour the sample(s) into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook
- **If the instrument reading is 'over range' or the reading is constantly drifting up or down a dilution will be required.**
- If a dilution is required, add 20 mLs of DI water to two sample cells using a volumetric pipette
- Transfer 5 mLs of the sample into to each sample cell bring the volume to 25 mLs,
- Mix sample (invert sample 4 – 5 times),
- Add Ferrous Iron Reagent to **one** of the sample cells
- Invert sample 4 – 5 times,
- Start timer (3 min)

- Use the diluted sample without reagent as the Blank. Analyze a Blank (Zero the DR/4000V using the diluted sample)
- After 3 minute timer, pour the sample(s) into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook
- Multiply the instrument reading (result) by 5 for the adjusted value

Example: instrument reading is 0.704

X 5

= 3.52 mg/L (final result, recorded in Fe^{+2} book)

Procedure: Hexavalent Chromium Analysis

- Use the Field Filtered sample
- Verify the Hach DR/4000V is set for **Hexavalent Chromium (Cr^{+6})**, program **1560**
- Transfer 25 mLs of filtered sample into a sample cell
- Carefully measure 24 mLs of filtered sample into a second sample cell – This is the **Matrix Spike (MS)**
- Add 1 mL of 2.5 mg/L Hexavalent Chromium (Cr^{+6}) standard to the 24 mLs of filtered sample
- Add ChromVer 3 Reagent to both sample cells
- Invert sample 4 – 5 times,
- Start timer (8 min)
- Run a Blank (Zero the DR/4000V using at least 25 mLs of Field Filtered sample)
- After 8 minute timer, pour the sample(s) into the sample port of the Hach DR/4000V
- Record the instrument reading in the Lab Bench Logbook

Example: Matrix Spike (0.117 mg/L) - Sample (0.006 mg/L)

- (**Record the results in the Cr^{+6} bench log book**) if the Hach reading for the MS is not between 0.075 mg/L and 0.125 mg/L call Shawn Duffy : Office 530-229-3303 or Cell 530-941-9227
- After analysis is complete, fax or PDF sample results along with the field purge form to Shawn Duffy at 530-339-3303

SOP-B16

Field-portable X-Ray Fluorescence Soil Sampling Standard Operating Procedures for PG&E Topock Program

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This SOP describes the analysis of *in-situ* and *ex-situ* soil samples using a field portable X-Ray Fluorescence instrument (XRF). SOP-B2 and SOP-B3 in the *Sampling, Analysis, and Field Procedures Manual, PG&E Topock Program* (CH2M HILL, 2005) provide additional guidance for soil characterization and logging.

Required Documents

1) Event-specific planned sample table (PST).
2) Applicable project work plan or monitoring plan. Refer to the Procedures Manual and QAPP as required.
3) Topock Program Health and Safety Plan (HSP).
4) Field notebook.
5) Database generated chain-of-custody.
6) XRF Functional Check Log

Preparation and Setup

1) Review event-specific PST or event-specific field instructions, previous sampling logs, Procedures Manual, and HSP.
2) Coordinate with the Project Chemist for coolers, sample containers, and courier pickup of the samples.
3) Initiate field logbook for sampling activity.
4) Initiate electronic file for X-Ray Fluorescence (XRF) instrument download.
5) Review sampling procedures and planned sample depths with field crew.
6) Field-check and set up equipment for functional checks, sampling, decontamination, spill prevention, and health and safety.

Equipment List

- Niton XRF Meter and stand
- Spare battery chargers
- Field notebook
- Trowel for smoothing soil surfaces
- Reusable plastic bags or stainless steel tray
- Disposable Sample cups with X-ray film and lids

- X-Ray window film (Mylar, Kapton, Spectrolene, polypropylene, or equivalent; 2.5 – 6.0 micrometers (um) thick)
- Disposable scoops, stainless steel spoons or other appropriate mixing tools
- Appropriate quality control (QC)/quality assurance (QA) standards, and blank sand
- Chemwipes
- Decontamination equipment (Alconox® solution (or equivalent) in spray bottle, brushes, buckets, rinse water spray bottle) for mixing tools and trowels
- Protective waterproof gloves (nitrile or latex)

XRF SOIL ANALYSIS DOCUMENTATION

The XRF sample results will be recorded by the associated software in an excel format. The files will be downloaded at the end of each day and emailed to the project chemist for review. Any additional sample logging and sample collection should follow the protocol and procedures found in the *Sampling, Analysis, and Field Procedures Manual, PG&E Topock Program* (CH2M HILL,2005). Detailed notes should be recorded in the sampler's field notebook or in a log generated from the field database. Items to be documented on the sampling log include (note: include as much of the following information in the XRF software as possible):

1) Record type of boring or excavation equipment and the total boring or excavation depth.
2) If multiple samples are being collected at one location at a variety of depths, record all sample depths.
3) Record date and time of sample collection in addition to the full sample ID that is listed in the PST.
4) Sampling difficulties shall be noted (i.e. difficult slope or abnormal debris in sample location).
5) Analysis start time and the source count time (i.e. 60 sec, 90 sec, or 120 sec etc.) will be documented on sample collection sheet. Note: analysis and count time are automatically recorded in the XRF software.

Field-portable X-Ray Fluorescence Soil Sampling- COLLECTION OF SAMPLES FOR ANALYSIS

In-Situ Sample Preparation

When the soil moisture is less than 20 percent, the error associated with moisture may be minimal. If areas are encountered where the moisture content is greater than 20 percent (moisture is visible), consult with the project chemist for options available for proceeding with field analysis.

For *in-situ* analysis,

1) Large or non-representative debris must be removed from the selected location. This debris includes rocks, gravel, vegetation and concrete.

2) The location chosen for analysis should be homogenized by mixing in place an area approximately 4″ by 4″ by 3″ deep, using a clean (or decontaminated) stainless steel or disposable spoon. The location should then be smoothed and firmly tamped to provide as flat and smooth an area as possible.
3) A section of x-ray window film should be stretched over the area to be tested to maintain a dust free environment for the nose of the instrument. (Note: use in-situ analysis for metals only samples).
4) To initiate a reading, the nose of the XRF will be positioned against the x-ray film, squeezing the shutter release, and firmly pressing the instrument flat against the surface. Source count times for *in-situ* analysis usually range from one to two minutes, varying among instruments and depending on requirement detection limits.
5) After the *in-situ* field screening is performed, inspect the nose of the instrument for contamination, which may affect future analysis. If necessary, clean it with a soft cloth or tissue.

For confirmation samples, or where samples for organic analysis are to be collected the soil samples should be treated as *ex-situ* samples, below.

***Ex-Situ* Sample Preparation**
For *ex-situ* analysis,

There are several possible correct methods for the ex-situ analysis of samples. The area that previously would have been homogenized for the in-situ analysis should be scooped out and placed into a clean (or decontaminated) stainless steel or disposable pan (do not use plastic if organic analysis will be performed on any of this homogenized sample), using a stainless steel or disposable spoon or spatula (do not use plastic if organic analysis are associated with the homogenized sample). The sample should then be thoroughly mixed (homogenized) using the same spoon or spatula.

1) The preferred method is to setup the portable field stand in an area where the XRF can be stationed and left in place for the day. Use the Niton software and a laptop computer to setup the method criteria and control the XRF instrument during the soil analysis.
    a) Starting with the previously homogenized sample, use the supplied soil sieves, bowl, and mortar to generate a finely ground well homogenized sample. (Note: This step is not required if the soil sample was passed through a sieve during the homogenization step.)
    b) Transfer the prepared sample into a new sample cup (order replacement supplies from Niton), place the X-ray film over the cup and snap the lid in place. Place the sample cup in the portable field test stand (The XRF points upward, the sample rests on top of the XRF with the X-ray film directly in contact with the nose of the XRF - cup lid facing down).
    c) Using the computer, start the analysis. The source count time should be at least two minutes for chromium. Consult previous analysis to determine if multiple scan frequencies are required (or contact the project chemist).
    d) Prepare the next sample while the XRF is analyzing the current sample.

2) An alternative method to using the portable field stand is to identify the sample for XRF analysis and homogenize the sample (as described above).
    a) Transfer the sample to a re-sealable plastic bag and firmly molded into a flat smooth surface.
    b) Use the Niton software and a laptop computer or the included PDA to setup the method criteria.
    c) To start the analysis, position the nose of the XRF against the flat smooth surface of the sample and squeeze the shutter release (or press the start button on the laptop or PDA). Be sure to maintain constant pressure against the sample. If contact is broken, the analysis will need to be restarted. The source count time for *ex-situ* analysis usually range from one to two minutes, depending on the required detection limits (see *c* above for count times).
    d) After the ex-situ field screening is performed, inspect the nose of the instrument for contamination, which may affect future analysis. If necessary, clean it with a soft cloth or tissue.

3) Transfer the sample to a labeled glass jar for shipment to the confirmation laboratory (if applicable).

Sample Analysis
In today's modern XRF models:

1) An X-ray source is used for detection. Expose the sample to the X-ray source for a minimum of one minute. Longer exposure times may be needed depending on the media that is being analyzed and the required detection levels. The time needed for analysis will be determined in the field by analyzing standards that have concentrations of the metals of concern near the required detection levels. Better detection limits can usually be obtained by homogenizing the sample, increasing the exposure time, and using two or more scan frequencies (Use a minimum of a two minute exposure for Chromium analysis).

2) When the XRF instrument displays the results they include the analyte, the result, and a percent confidence (displayed as a ± value). The result is displayed as non-detect for analytes that do not meet the percent confidence established in the instrument. The lower the required detection levels, the longer the analysis time required to meet the percent confidence.

3) Download saved data from XRF instrument daily (if data is collected in PDA). Foreword the data files to the project chemist daily.

4) All samples collected for off-site confirmation will also be analyzed using the XRF and treated as *ex-situ* samples.

Using older models:

1) Expose the sample to the energy source for a minimum of one minute. Longer exposure times may be needed depending on the media that is being analyzed as well as the age of the detector (non X-ray detectors). The time needed for analysis will be determined in the field by analyzing standards that have concentrations of the metals of concern near the required detection levels. Better detection limits can usually be obtained by homogenizing the sample, increasing the exposure time. (Use a minimum of a two minute exposure for Chromium)

2) When the XRF instrument indicates the results for the suite of analyzed elements and their concentrations, it includes a standard deviation for the reported concentrations. An analyte concentration is considered **not detected** if the result value is **less than two times the standard deviation**. The lower the required detection levels, the longer the analysis time required to reduce the result's standard deviation.

3) Record the readings (electronically or documented on the sampling log). Review the standard deviations for the elements of interest and determine if a longer analysis time is needed to reduce the standard deviations, thereby allowing the desired accuracy and precision for the concentrations. The standards will be analyzed using increasingly longer times until the required detection level is achieved.

4) Record values in field notebooks.

5) Download saved data from XRF instrument daily.

6) Samples collected for off-site confirmation will also be analyzed using the XRF and will be treated as *ex-situ* samples.

Calibration

Two forms of calibration are important with XRF testing: an energy calibration and a sample matrix calibration.

Energy Calibration

The Niton XLi 702 automatically re-calibrates the energy scale when powered on. The energy scale can also be re-calibrated by pressing "Reset" on the instrument. The energy calibration should be performed every two hours.

Sample Matrix Calibration

Modern XRF instruments, such as the Niton Xli 702, do not require site specific calibrations to account for sample matrix effects. EPA Method 6200 allows both fundamental parameters and Compton normalization as two techniques to eliminate site specific calibrations. Niton uses the Compton normalization method to automatically correct for sample specific matrix effects. The XRF is calibrated internally at the factory on NIST standard reference soil samples. Ensure the annual factory calibration certification is on file. This internal calibration is used for subsequent field work, without need for adjustment or recalibration at other sites.

Quality Assurance and Quality Control (Functional Checks)

Even though no onsite calibration will be performed, the method does require QA/QC Functional check testing protocols. The QA/QC that will be used to document that the XRF is operating properly will have the following steps:

- A startup operations check
- Analysis of a blank sample (clean sand)
- Analysis of standard sample(s)
- Analysis of duplicate samples
- QA/QC procedures will be compliant with manufacture's instructions.

1) At the beginning of each day perform QA/QC functional check procedure or when the instrument is turned on after more than 2 hours of down time or if the operating environment changes, such as a temperature change of more than 20 degrees Fahrenheit.
2) Two types of blanks should be analyzed, an instrument blank and a method blank. An instrument blank sample (silicon dioxide, provided by Niton) will be analyzed at the start and end of each day and once every 20 samples, to confirm proper zero calibration of the XRF. The blank will be analyzed following the procedure for the *ex-situ* sample analysis. A method blank is used to monitor for any field induced contamination. The method blank should follow any preparation procedures performed on the samples, such as mixing or *exsitu* analysis. **A method blank will be analyzed each day**.
3) A set of three to ten QC samples will be collected from the site during the initial field activities. These samples will be well homogenized, and a portion sent to the off-site laboratory for characterization. The remaining sample will be collected in re-sealable bags, labeled and stored with the XRF for use as standards. Three to five of the on-site standards will be analyzed at the start of each day. The results of the standards will be plotted against the original XRF results and a correlation value calculated. A correlation coefficient of 0.90 or greater must be achieved to meet the project objectives. A running log of all on-site standards analyzed will be maintained. One of the standards will be analyzed after every 20 samples. The readout from the XRF **must be within 20 percent RPD of the known QC sample concentration**.
4) The last QA/QC step will be to analyze duplicate samples (two separate aliquots) at a rate of 1 in 10. These duplicate measurements must be within 35 percent of each other for the analysis to continue. If the sample results are not in agreement, then the reason for this discrepancy must be determined.
5) The Niton XL3t 600 displays both concentration and precision for each sample analyte measurement. The precision displayed by the Niton's 95% (2-sigma) confidence intervals; where as the precision calculated in EPA method 6200 is at a 68% (1-sigma) level. The Niton also calculates and displays detection limits for analytes if the concentration is below three standard deviations. This bypasses the need for replicate measurements on low level standards.

Note: VOC, SVOC, and other organic samples can not be collected from the homogenized soil if plastic is used for homogenizing or after XRF analysis, if contacted by plastic.

Remedy-SOP-01

Process Water Sampling
Standard Operating Procedures for PG&E Topock Program

This standard operating procedure (SOP) addresses the procedures to be used for collection of process water samples from the groundwater remediation system.

REQUIRED DOCUMENTS

1) Event-specific sampling and analysis plan (SAP), work plan, or field instructions.
2) Applicable project work plan, monitoring plan, quality assurance project plan (QAPP), and/or Operations and Maintenance (O&M) Manual.
3) Topock Program Health and Safety Plan (HSP).
4) Blank sampling log and field notebook.

PREPARATION, SETUP, AND SAMPLING PROCEDURES

1) Review event-specific SAP or event-specific field instructions, Operations and Maintenance Manual, and HSP.
2) Review sampling procedures and equipment and planned sample ports with field crew.
3) Inventory sample bottles, review required analyses, and understand lab courier schedule.
4) Prepare sampling log (use field notebook and summarize relevant information on sampling form).
5) Gather sample containers and equipment and mobilize to the first sample location.
6) Open the sampling port and allow enough water to flow to flush the ‘off main pipe’.
7) Remove the cap of the sample container and collect the sample. Continue one container at a time, beginning with the containers for metals [including Cr(VI) and Cr(T)] and then the containers for general chemistry parameters.
8) After all containers for that sampling location have been filled, complete the sampling log sheet.
9) Repeat steps 5 through 8 for each sampling location.
10) Follow the Operation and Maintenance Manual for sample handling and management, equipment decontamination, waste management.

Standard Operating Procedure

PG&E Topock Groundwater Remedy Operations and Maintenance Plan

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Title: Safe Fueling and Fuel Handling Procedures
Number: Remedy-SOP-02_Rev0
Created Date: June 24, 2012

1 Background

PG&E is implementing a groundwater remedy near the intersection of Park Moabi Road and Interstate 40, approximately 10 miles west of Needles, California at the Pacific Gas and Electric Company (PG&E) Topock Compressor Station (TCS). The objective of this SOP is to describe the procedures required to fuel vehicles, fuel tanks, and refuel equipment/portable containers safely during work on and off the project site.

2 Work Description

Several steps must be accomplished before refueling can be initiated in order to avoid spills and incident. The following considerations and procedure will be followed during refueling:

Preparation, Pre-Fueling and Fueling Considerations

- Turn off all equipment or engines before refueling.
- Put vehicle in park and set the emergency brake.
- Material Safety Data Sheets (MSDSs) for diesel and gasoline product must be readily available and current.
- After exiting the vehicle, always touch a metal part away from the fuel door and pump to discharge any static buildup before fueling.
- Stage spill containment such as a spill pad (bermed) and absorbent pads under the equipment that is being refueled.
- Never smoke, light matches use lighters or conduct hot work such as welding and cutting during refueling operations.
- Keep fire extinguisher nearby.
- Do not breathe vapors.
- Do not use cell phones or other personal electronics while fueling. Keep them in the vehicle.
- Allow small engines (such as generators) to cool down before refueling as gasoline spilled on hot engine parts may ignite.

- While fueling, remain attentive and be prepared to shut-off the flow of fuel. Do not leave the equipment fueling point while refueling to avoid spills and spark ignition (Do not enter your vehicle during refueling).
- Never jam or force the hold-open latch open by using some other object.
- Use only UL approved container for portable gasoline storage cans. They must be:
    a. Red in color
    b. Have a vapor-tight cap
    c. Be no more than 5 gallons in size and in good repair.
- When filling a portable container, always place the container on level ground and keep the pump nozzle in contact with the container when refueling to avoid a static electricity ignition of fuel vapors. Fill slowly to avoid spillage and skin/clothing contact and use a funnel if needed.
- When fueling from a portable container, stage spill containment such as a spill pad (bermed) and absorbent pads under the equipment that is being refueled.
- Never store fuel near a generator or near any ignition sources.
- If a flash fire occurs during refueling, you should attempt to stop the flow of fuel before backing away from the equipment or vehicle.

General Remote Fueling Procedure

1. Position the fuel supply source as close to the equipment to be fueled, as practicable and safe. Chock wheels of involved vehicles to avoid adjustments in vehicle position during fueling.
2. Prepare the work area by positioning bermed spill pad(s) at both the fuel source, equipment fill point, and ALL areas between. A spill containment kit containing sorbent pads should be positioned nearby and its contents should be verified prior to fueling.
3. Don appropriate PPE as defined in the Health and Safety Plan.
4. Inspect fuel conveyance hose/equipment and all connections and fittings for signs of wear or defects prior to the initiation of fuel pumping or pouring. If pouring fuel from a portable container, a funnel constructed of suitable material must be used to avoid splashing.
5. Ensure the area is free from ignition sources (i.e., hot equipment/work, sources of spark or static electricity).
6. Position one crew member at the fuel pump and one crew member at the equipment fill point, and begin fueling. Only one crew member is required for filling equipment from a portable container. Do not over fill or top off the fuel tank.
7. Once fueling is complete, deactivate the fuel supply pump prior to removing the fill nozzle from the equipment, and ensure that residual fuel has been emptied from the conveyance hose (as appropriate based on design of the equipment used).

8. Replace all fueling equipment and re-inspect for signs of wear or defect (i.e. identify areas that may be seeping fuel at a slow rate).
9. Inspect work area for any signs of spills, and remove spill pad(s), as appropriate.

3 Communication and Contingency Action

If a spill occurs the appropriate clean-up actions should commence as efficiently and safely as possible. Further, the reason for the spill will be investigated, and the team will modify the fueling procedure or conduct equipment repairs, as determined appropriate to minimize the potential for future spills. Further, PG&E Site Operations Manager or designee must be notified immediately.

4 Waste Management

All waste generated during refueling, such as oily absorbent pads, must be transported and disposed as directed by PG&E immediately following generation. Do not dispose of any oil/fuel contaminated pads or rags in the soil roll-off bins or waste dumpsters.

Appendix B
Addendum to PG&E Program Quality Assurance Project Plan

Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy

PG&E Topock Compressor Station
Needles, California

Prepared for
Pacific Gas and Electric Company

Revision 0 (August 2012)

CH2MHILL®
155 Grand Avenue
Suite 800
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Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy

1.0 Introduction

This addendum to the *PG&E Program Quality Assurance Project Plan* (QAPP) Revision 2 (CH2M HILL 2012) has been prepared to address any variations from the QAPP or specifications associated with the Topock Groundwater Remedy (the project) that are not included or defined in the QAPP document. The laboratories will be required to adhere to the QAPP and then use the specific information outlined within this addendum to supersede the QAPP information.

In compliance with the 1996 Corrective Action Consent Agreement (CACA) (California Department of Toxic Substances Control [DTSC] 1996) and the Remedial Design/Remedial Action (RD/RA) Consent Decree (DOI 2013), the sampling and analytical procedures set forth in the QAPP (CH2M HILL 2012), this Addendum, as well as the Sampling and Monitoring Plan (Volume 2 of the Draft Operations and Maintenance Manual) will be followed during remedy operation.

Over the decades-long operation and optimization of the remedy, updates to the aforementioned documents may be necessary for a variety of reasons (e.g., changes driven by field conditions, changes driven by regulations, etc.). As with current practice and required by the QAPP, Standard Operating Procedures (SOPs) will be reviewed on annual basis, at a minimum, and PG&E will inform the agencies of material and substantive changes to the SOPs, as well as the rationale for the changes, prior to implementation.

2.0 Project Organization and Responsibility

2.1 Project Organization

For information on project organization refer to the Draft O&M Manual, Main Text Section L2.

2.2 Certification Requirements

All laboratories participating in analytical services will have a documented Quality System and be certified under the National Environmental Laboratory Accreditation Program (NELAP) or the State of California Environmental Laboratory Accreditation Program (ELAP). Laboratories in California will be required to be certified under the ELAP. Additional accreditation may also be required. The laboratory managers will be responsible for ensuring that all laboratory personnel have been properly trained and are qualified to perform their assigned tasks.

3.0 Sampling Procedures

3.1 Sampling Design

Sampling and monitoring activities are needed for compliance purposes and for effective operation and maintenance of the groundwater remedy. The rationale for the sampling design (sampling locations, frequency, and analytes) is included in the Sampling and Monitoring Plan.

3.2 Field Sampling Procedures

The groundwater remedy will use the project-specific field database, planned sample tables, chain-of-custody (CoC) forms, and other database-generated paperwork (e.g., purge forms, calibration log books). All sample collection and related activities will follow the SOPs provided in Appendix A of the Sampling and Monitoring Plan. Exhibit 3-1 lists the relevant SOPs for the remedy. Over the decades-long operation of the remedy, SOPs may be updated. The Field Lead and Project Chemist will ensure that the sampling is performed in accordance with the updated SOPs.

EXHIBIT 3-1
List of PG&E Program SOPs Applicable to the Topock Groundwater Remedy
Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy

SOP	Title	Version	Date
SOP-A1	Purging and Sampling of Groundwater Monitoring Wells, Well-Volume Method	Rev 05	7/19/2012
SOP-A2	Purging and Sampling of 1-inch-diameter Groundwater Monitoring Wells, Modified Well-Volume Method	Rev 05	10/31/2012
SOP-A3	Purging and Sampling of Active and Inactive Water Supply Wells	Rev 05	10/31/2012
SOP-A4	Depth-Specific Surface Water Sampling	Rev 04	7/31/2012
SOP-A5	Groundwater Sampling from Sonic Drilling Boreholes	Rev 01	7/31/2012
SOP-A6	Sample Field Filtration and Preservation for Metals Analyses	Rev 04	7/31/2012
SOP-A7	Water Level Measurements	Rev 03	9/23/2010
SOP-A8	Field Water Quality Measurements Using a Flow-through Cell	Rev 01	9/23/2010
SOP-A9	Calibration of Field Instruments	Rev 05	3/22/2013
SOP-A10	Decontamination of Water Sampling Equipment	Rev 05	3/22/2013
SOP-A11	Total Depth Measurements	Rev 00	3/31/2005
SOP-A13	Spill Prevention, Containment, and Control Measures for Monitoring Well Development, Purging, and Sampling	Rev 03	9/23/2010
SOP-A14	Pore Water Sampling	Rev 00	9/30/2005
SOP-A16	Access Routes	Rev 02	4/25/2012
SOP-A17	Groundwater and Surface Water Mobile Integrated Sample Tracking	Rev 02	12/5/2008
SOP-A18	Purging and Sampling of Groundwater Wells Minimal Drawdown Method	Rev 01	7/15/2012
SOP-A19	Sampling of Groundwater Monitoring Wells Hydrasleeve No Purge Method	Rev 00	7/15/2012
SOP-L1	Hexavalent Chromium Analysis by Hach Method 1560	Rev 02	9/25/2006
SOP-L2	Ferrous Iron Analysis by Hach Method 2150	Rev 01	12/31/2009
SOP-L3	Total Chromium Analysis by Hach Method 8024	Rev 00	7/24/2005
SOP-L4	Conductivity Analysis by Hach Method 8160	Rev 00	10/15/2005
SOP-L5	Turbidity Analysis	Rev 00	9/8/2005
SOP-L8	Matrix Spike Preparation	Rev 00	9/8/2005
SOP-L9	pH Measurement	Rev 00	10/11/2005
SOP-L10	Hach Model 2100P Turbidimeter Daily Checks and Calibration	Rev 00	7/28/2008
SOP-L11	pH Analytical Equipment Calibration	Rev 01	3/11/2008
SOP-L12	Ferrous Iron Analysis by Hach Method 2150 and Hexavalent Chromium Analysis by Hach Method 1560	Rev 00	3/20/2007
SOP-B16	Field-Portable X-Ray Fluorescence Soil Sampling	Rev 00	9/5/2008
Remedy-SOP-01	Process Water Sampling	Rev 00	6/19/2012
Remedy-SOP-02	Safe Fueling and Fuel Handling Procedures	Rev 00	6/24/2012

Note:
The SOPs listed in this exhibit are provided in Appendix A of the Sampling and Monitoring Plan (Volume 2 of the O&M Manual).

3.3 Additional or Revised QC Steps for Hexavalent Chromium

The following quality control (QC) steps will be implemented for all samples related to the groundwater remedy:

1. Additional QC Step - All equipment blanks will be blind (versus being identified to the laboratory as “blank”, or “EB” for equipment blanks), with the exception of additional well-specific equipment blanks for the floodplain wells (see Step 2 in Section 3.4).

2. Additional QC Step - Certified filters will be purchased for groundwater and surface water samples. These filters are packaged with manufactures’ testing data and certification. If uncertified filters must be used, each lot (if lot information is available) will be analyzed for hexavalent chromium (Cr[VI]). If no lot number information is available, one filter per day will be analyzed for Cr(VI).

3. Revised QC Step - The protocol for Cr(VI) has been established using the ammonium sulfate buffer solution for Cr(VI) sample preservation in the field:

    - Within 2 weeks prior to any field event requiring preservation for Cr(VI), fresh buffer solution will be made and the purity checked by the laboratory; the resulting chromatogram will be emailed to the CH2M HILL project chemist for verification.

    - All Cr(VI) samples will be field-filtered and preserved to a pH range of 9.3 to 9.7 with ammonium sulfate buffer solution.

    - The laboratory will confirm preservation at the time of sample receipt.

    - The Topock groundwater remedy will use EPA Methods E218.6 or SM3500-Cr (use of Methods SW7199 and SW7196 are restricted and must be approved by the project chemist) for Cr(VI) analyses. The use of these methods was approved by DTSC in 2008.

3.4 Additional QC Steps for Hexavalent Chromium in Select Floodplain Well Samples

In addition to the QC steps discussed in Section 3.3, the additional QC steps outlined in this section will be followed during sampling of a) monitoring wells located in the floodplain that are currently non-detect (or detected at less than 5 parts per billion) for Cr(VI), and b) future floodplain wells as determined by the CH2M HILL project chemist. The applicable floodplain wells are listed in Exhibit 3-2. As water quality changes, the list of wells in Exhibit 3-2 will be reviewed periodically (initially on an annual basis) and updated as applicable.

EXHIBIT 3-2
Floodplain Wells Recommended for Additional Quality Control Steps
Addendum to the PG&E Program Quality Assurance Project Plan for the Topock Groundwater Remedy

MW-21
MW-27-020
MW-27-060
MW-27-085
MW-28-025
MW-28-090
MW-29
MW-32-020
MW-32-035
MW-33-040
MW-34-055
MW-34-080
MW-36-070
MW-39-040
MW-42-055
MW-42-065
MW-43-025
MW-43-075
MW-43-090
MW-44-070
MW-49-135
MW-49-275
MW-49-365
MW-52D
MW-52M
MW-52S
MW-53D
MW-53M
MW-54-85
MW-54-140
MW-54-195
MW-55-45
MW-55-120

The additional QC steps for the wells listed in Exhibit 3-2 are as follows:

1. Two Cr(VI) sample containers will be filled for each floodplain well listed in Exhibit 3-2, field filtered, and preserved. The duplicate sample will be placed on hold and will not be analyzed unless needed to investigate an anomalous result.
    - Cr(VI) will be analyzed by method E218.6R.
    - The sample labels will have a designation of “1 of 2” and “2 of 2”.
    - The sample identifier (ID) will be recorded and the existence of two sample containers will be indicated on the CoC form.
2. For each of the wells listed in Exhibit 3-2 that have non-dedicated pumps, an extra equipment blank will be collected after decontaminating the pump and prior to lowering the pump down the well. For example, if sampling has just been completed at MW-42-055 and the next well is MW-42-065, the sampling team will need to decontaminate the portable pump and then collect MW-42-065-XXX-EB before placing the pump in MW-42-065.
    - The well-specific equipment blanks (e.g., MW-42-065-XXX-EB) will be placed on hold and will not be analyzed unless needed to investigate an anomalous result.

3.5 Additional QC Steps for Cr(T) and Cr(VI) — River Samples

In addition to the QC steps discussed in Section 3.3, all river samples (shoreline and in-channel) will require the following additional QC steps:

1. For surface water sampling events; three analyte-specific sample containers will be collected from each sample location for both total chromium (Cr[T]) and Cr(VI). The laboratory will analyze the initial sample aliquot; if that result is considered “suspect” (any detected concentration in the river will be considered suspect), an additional aliquot of the original sample will be reanalyzed along with an aliquot from each of the additional sample volumes for comparison purposes.
    - Cr(VI) will be analyzed by method E218.6R. Cr(T) will be analyzed by SW-6020A.
    - The sample labels will have a designation of “1 of 3”, “2 of 3”, and “3 of 3”.
    - The sample ID will be recorded and the existence of three sample containers will be indicated on the CoC form.
2. Blank samples will be collected daily from two sets of randomly selected dedicated equipment (tubing).
3. In addition, one atmospheric (ambient) blank will be collected at the PG&E Topock site per day of river sampling. The atmospheric blank and the dedicated equipment blanks will be placed on hold, and analyzed only in event of river sample detections.
4. The laboratory is required to ensure that the buffer solution and initial calibration method blank concentrations are less than the method detection limit (MDL) prior to proceeding with sample analysis. Previously the blank concentrations were required to be less than the reporting limit (RL); now sample analysis will only proceed after the buffer solution and method blank concentrations are less than the MDL. In all cases in which corrective actions are applied, the CH2M HILL project chemist will be notified to aid in the corrective action process.

4.0 Method Quality Objectives and Quality Assurance Program

The data quality goal for the groundwater remedy is to achieve defensible data with the highest quality possible, given the variability of parameters for the groundwater remedy. The final output is a data set designed and validated to meet the qualitative and quantitative needs of the project. See Tables 4-1 through 4-3 for project-specific reporting level requirements and EPA/California screening-level information that may differ from the QAPP.

4.1 Analytical Requirements

This Addendum specifies project-specific analytes and analytical methods that differ from the QAPP. All methods, analytes, or QC parameters specified in this Addendum that may differ from the QAPP supersede the criteria in the QAPP.

4.1.1 Reporting Limits

RLs should be a minimum of two times greater than the calculated MDLs. RLs used by the laboratory should not be greater than the RL objectives listed in Tables 4-1 through 4-3.

Only analytes detected at concentrations greater than the project-specific RL will be reported. Analytes detected at less than the RL will be flagged “U” and reported as not detected at the RL.

RLs and sample results shall be reported to two significant figures if less than 10 micrograms per liter (µg/L) (parts per billion) and to three significant figures otherwise.

4.1.2 Calibration

In the initial calibration (for all instruments), a standard at a concentration equal to or less than the RL must be included.

Initial calibration must be re-established if any of the following conditions exist:

- The last calibration was established more than 1 year prior to the start of a sample’s analysis (gas chromatography, gas chromatography-mass spectrometry, inductively coupled plasma, and inductively coupled plasma-mass spectrometry)
- The last calibration was established more than 2 weeks prior to the start of a sample’s analysis (ion chromatography, and other “wet” chemistry analytical instruments)
- Two consecutive continuing calibration standards fail
- The operating conditions change; for example, any of the following:
  - Major maintenance is performed
  - The fluid or gas “carrier” type changes
  - The instrument requires relocation

4.1.3 Matrix Spike for Hexavalent Chromium Analyses

Interference from Topock groundwater is known to reduce the sensitivity of Method EPA 218.6. This can result in an incorrect assessment of the analyte identification or the specific RL if the Matrix Spike and Dilution Protocol is not followed (see Section 5.4.4.1 of the QAPP). All Topock groundwater and surface water samples analyzed by Method EPA 218.6 will follow the Matrix Spike and Dilution Protocol.

4.1.4 Matrix Spike and Dilution Protocol

Matrix interference has been encountered that affects the sensitivity for hexavalent chromium by ion chromatography methods. CH2M HILL shall direct the laboratories to perform an additional quality assurance/quality control (QA/QC) analyses to aid in assessing any effect on method sensitivity for each project due to the sample matrix. All Topock groundwater and surface water samples analyzed by Method EPA218.6 will follow the Matrix Spike and Dilution Protocol.

The analytes and analytical requirements are presented in Tables 4-1 through 4-3.

4.1.5 Hexavalent Chromium Analysis

Analytical laboratories will follow these additional QC steps for all Cr(VI) samples:

- The laboratory will supply sample containers for all PG&E programs that are pre-cleaned and certified to EPA standards.
- The laboratory will analyze a QC sample (standard) after the initial calibration, at the RL concentration.
- The laboratory is required to ensure that the buffer solution and initial calibration method blank concentrations are less than the MDL prior to proceeding with sample analysis. Sample analysis will only proceed after the buffer solution and method blank concentrations are less than the MDL.
- In all cases in which corrective actions are applied, the CH2M HILL project chemist will be notified to aid in the corrective action process.
- For all river Cr(VI) samples and Cr(VI) samples from the floodplain wells listed in Exhibit 3-2 where Method E218.6R is used ("R" designates the additional laboratory QC criteria described in this section), if blank concentrations are determined to be greater than the MDL but below the RL, and if there are detections in any sample, the laboratory records will document the concentrations and corrective action will be performed. However, the manner of reporting results will remain unchanged (i.e., results less than the RL will be reported as a non-detected result at 0.2 µg/L). Corrective action may include sample reanalysis, change of reagents eluate and/or standards, and/or optimizing instrumentation. In all cases in which corrective actions are applied, the CH2M HILL project chemist will be notified to aid in the corrective action process.

4.2 Data Validation

The validation for this QAPP addendum will follow the Level 3B designation from the QAPP and will be performed by the project chemist and designees.

5.0 Retention of Records

Hardcopy and electronic versions will be archived in project files, on electronic archive tapes, and/or other electronic storage media for the duration of remedy operation plus 10 years, as specified in contractual agreements. All electronic data will be subject to routine back-up until it is archived for long-term retention.

6.0 References

California Department of Toxic Substances Control (DTSC). 1996. *Corrective Action Consent Agreement (Revised), Pacific Gas and Electric Company's Topock Compressor Station, Needles, California.* EPA ID No. CAT080011729. February 2.

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Tables

TABLE 4-1
Reporting Limits, Accuracy, and Precision Limits for Soil
PG&E Program Quality Assurance Project Plan

					EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL				LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
Method	**Constituent**	**CAS**	**Units**	**QAPP RL**	**Residential**	**Commercial**	**Residential**	**Commercial**	**Residential**	**Commercial**	**Most Stringent Screening Level**	**Does RL Exceed Screening Level?**	**Lower Limit**	**Upper Limit**	**Lower Limit**	**Upper Limit**	**% RPD**
SW9012 or SW9014	Cyanide	57-12-5	mg/kg	0.25	47	610	1,600	20,000	--	--	0,047	NO	*	*	*	*	30
WBLACK	Total organic carbon	TOC	mg/kg	50	--	--	--	--	--	--	--	NO	75	125	75	125	35
SW9050	Specific conductance	Conductance	µmhos/cm	5	--	--	--	--	--	--	--	NO	75	125	75	125	20
SW9045	pH	pH	pH units	0.1	--	--	--	--	--	--	--	NO	--	--	--	--	20
SM2540B/E160.3	percent moisture	Moist	Percent	--	--	--	--	--	--	--	--	NO	--	--	--	--	20
E300.0	Fluoride	Fluoride	mg/kg	2	--	--	4,700	61,000	--	--	4,700	NO	70	130	70	130	35
E300.0	Chloride	Chloride	mg/kg	2	--	--	--	--	--	--	--	NO	70	130	70	130	35
E300.0	Sulfate	Sulfate	mg/kg	2	--	--	--	--	--	--	--	NO	70	130	70	130	35
E821/R-91-100	Sulfide, acid volatile	18496-25-8	mg/kg	80	--	--	--	--	--	--	--	NO	70	130	70	130	30
SW7199	Chromium, hexavalent	18540-29-9	mg/kg	0.4	0.29	5.6	230	1,400	17	17	0.29	YES	85	115	85	115	20
SW6010B or C/SW6020A/E200.7/E200.8	Aluminum	7429-90-5	mg/kg	10	77,000	990,000	77,000	990,000	--	--	77,000	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Antimony	7440-36-0	mg/kg	2	31	410	31	410	30	380	30	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Arsenic	7440-38-2	mg/kg	0.5	0.39	1.6	0.39	1.6	0.07	0.42	0.07	YES	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Barium	7440-39-3	mg/kg	1	15,000	190,000	15,000	190,000	5,200	63,000	5,200	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Beryllium	7440-41-7	mg/kg	0.5	160	2,000	160	2,000	150	1,700	150	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Cadmium	7440-43-9	mg/kg	0.5	70	800	70	810	1.7	7.5	1.7	NO	85	115	75	125	20
SW6010B or C/E200.7	Calcium	7440-70-2	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Chromium	7440-47-3	mg/kg	1	--	--	280	1,400	*	*	280	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Cobalt	7440-48-4	mg/kg	1	23	300	23	300	660	3,200	23	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Copper	7440-50-8	mg/kg	1	3,100	41,000	3,100	41,000	3,000	38,000	3,000	NO	85	115	75	125	20
SW6010B or C/E200.7	Iron	7439-89-6	mg/kg	10	55,000	720,000	55,000	720,000	--	--	55,000	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Lead	7439-92-1	mg/kg	1	400	800	400	800	150	3,500	150	NO	85	115	75	125	20
SW6010B or C/E200.7	Magnesium	7439-95-4	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Manganese	7439-96-5	mg/kg	1	--	--	1,800	23,000	--	--	1,800	NO	85	115	75	125	20
SW7471A/E245.5	Mercury	7439-97-6	mg/kg	0.1	10	43	6.7	28	18	180	6.7	NO	75	125	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Molybdenum	7439-98-7	mg/kg	1	390	5,100	390	5,100	380	4,800	380	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Nickel	7440-02-0	mg/kg	1	1,500	20,000	1,600	20,000	1,600	16,000	1,500	NO	85	115	75	125	20
SW6010B or C/E200.7	Potassium	7440-09-1	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Selenium	7782-49-2	mg/kg	1	390	5,100	390	5,100	380	4,800	380	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Silver	7440-22-4	mg/kg	1	390	5,100	390	5,100	380	4,800	380	NO	85	115	75	125	20
SW6010B or C/E200.7	Sodium	7440-23-5	mg/kg	100	--	--	--	--	--	--	--	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Thallium	7440-28-0	mg/kg	2	0.78	10	5.1	66	5	63	0.78	YES	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Vanadium	7440-62-2	mg/kg	1	--	--	550	7,200	530	6,700	530	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Zinc	7440-66-6	mg/kg	2	23,000	310,000	23,000	310,000	23,000	100,000	23,000	NO	85	115	75	125	20
SW8015B or C or D	Motor Oil	TPH-motor oil	mg/kg	10	--	--	--	--	--	--	--	NO	60	120	60	120	50
SW8015B or C or D	TPH-Diesel	TPH-diesel	mg/kg	10	--	--	--	--	--	--	--	NO	51	153	51	153	50
SW8015B or C or D	TPH-Gasoline	TPH-gasoline	mg/kg	1	--	--	--	--	--	--	--	NO	57	146	57	146	50
SW8081A or B	4,4'-DDD	72-54-8	ug/kg	4	2,000	7,200	2,000	7,200	2,300	9,000	2,000	NO	50	139	50	139	50
SW8081A or B	4,4'-DDE	72-55-9	ug/kg	4	1,400	5,100	1,400	5,100	1,600	6,300	1,400	NO	68	126	68	126	50
SW8081A or B	4,4'-DDT	50-29-3	ug/kg	4	1,700	7,000	1,700	7,000	1,600	6,300	1,600	NO	46	135	46	135	50
SW8081A or B	Aldrin	309-00-2	ug/kg	4	29	100	29	100	33	130	29	NO	47	120	47	120	50
SW8081A or B	alpha-HCH	319-84-6	ug/kg	4	77	270	77	270	--	--	77	NO	62	125	62	125	50
SW8081A or B	alpha-Chlordane	5103-71-9	ug/kg	4	--	--	--	--	430	1,700	430	NO	63	121	63	121	50
SW8081A or B	beta-HCH	319-85-7	ug/kg	4	270	960	320	1,300	--	--	270	NO	62	127	62	127	50
SW8081A or B	delta-HCH	319-86-8	ug/kg	4	--	--	--	--	--	--	--	NO	57	130	57	130	50
SW8081A or B	Dieldrin	60-57-1	ug/kg	4	30	110	30	110	35	130	30	NO	67	125	67	125	50
SW8081A or B	Endosulfan I	959-98-8	ug/kg	4	--	--	--	--	--	--	--	NO	41	147	41	147	50
SW8081A or B	Endosulfan II	33213-65-9	ug/kg	4	--	--	--	--	--	--	--	NO	37	141	37	141	50
SW8081A or B	Endosulfan sulfate	1031-07-8	ug/kg	4	--	--	--	--	--	--	--	NO	62	135	62	135	50
SW8081A or B	Endrin	72-20-8	ug/kg	4	18,000	180,000	18,000	180,000	21,000	230,000	18,000	NO	61	133	61	133	50
SW8081A or B	Endrin aldehyde	7421-93-4	ug/kg	4	--	--	--	--	--	--	--	NO	37	147	37	147	50
SW8081A or B	gamma-HCH (Lindane)	58-89-9	ug/kg	4	520	2,100	520	21,000	500	2,000	500	NO	59	123	59	123	50
SW8081A or B	gamma-Chlordane	5103-74-2	ug/kg	4	--	--	--	--	430	1,700	430	NO	48	124	48	124	50
SW8081A or B	Heptachlor	76-44-8	ug/kg	4	110	380	110	380	130	520	110	NO	51	140	51	140	50
SW8081A or B	Heptachlor epoxide	1024-57-3	ug/kg	4	53	190	53	190	--	--	53	NO	66	130	66	130	50
SW8081A or B	Methoxychlor	72-43-5	ug/kg	20	310,000	3,100,000	310,000	3,100,000	340,000	3,800,000	310,000	NO	57	143	57	143	50
SW8081A or B	Toxaphene	8001-35-2	ug/kg	100	440	1,600	440	1,600	460	1,800	440	NO	31	136	31	136	50
SW8082 or A	Aroclor-1016	12674-11-2	ug/kg	50	3,900	21,000	3,900	21,200	--	--	3,900	NO	41	138	41	138	50
SW8082 or A	Aroclor-1221	11104-28-2	ug/kg	50	140	540	170	620	--	--	140	NO	45	136	45	136	50
SW8082 or A	Aroclor-1232	11141-16-5	ug/kg	50	140	540	170	620	--	--	140	NO	45	136	45	136	50
SW8082 or A	Aroclor-1242	53469-21-9	ug/kg	50	220	740	220	740	--	--	220	NO	43	150	43	150	50
SW8082 or A	Aroclor-1248	12672-29-6	ug/kg	50	220	740	220	740	--	--	220	NO	44	136	44	136	50
SW8082 or A	Aroclor-1254	11097-69-1	ug/kg	50	220	740	220	740	--	--	220	NO	41	141	41	141	50
SW8082 or A	Aroclor-1260	11096-82-5	ug/kg	50	220	740	220	740	--	--	220	NO	61	131	61	131	50

TABLE 4-1

Reporting Limits, Accuracy, and Precision Limits for Soil

PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL		Most Stringent Screening Level	Does RL Exceed Screening Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
					Residential	Commercial	Residential	Commercial	Residential	Commercial			Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW8082 or A	Total PCB	Total PCB	ug/kg	50	220	740	220	740	89	300	89	NO	--	--	--	--	--
SW8051	2,4-D	94-75-7	ug/kg	200	690,000	7,700,000	690	7,700	690	550	550	NO	32	121	32	121	50
SW8051	2,4-DB	94-82-6	ug/kg	500	490,000	4,900,000	490	4,900	--	--	490	YES	42	145	42	145	50
SW8051	2,4,5-T	93-76-5	ug/kg	500	610,000	6,200,000	610	6,200	7,700	6,100	610	NO	43	139	43	139	50
SW8051	2,4,5-TP	93-72-1	ug/kg	200	490,000	4,900,000	490	4,900	--	--	490	NO	46	128	46	128	50
SW8051	Dalapon	75-99-0	ug/kg	100	1,800,000	18,000,000	1,800	18,000	--	--	1,800	NO	22	125	22	125	50
SW8051	Dicamba	1918-00-9	ug/kg	500	1,800,000	18,000,000	1,800	18,000	--	--	1,800	NO	56	120	56	120	50
SW8051	Dichloroprop	120-36-5	ug/kg	500	--	--	--	--	--	--	--	NO	72	142	72	142	50
SW8051	Dinoseb	88-85-7	ug/kg	100	61,000	620,000	61	620	--	--	61	YES	20	131	20	131	50
SW8051	MCPA	94-74-6	ug/kg	1,000	31,000	310,000	31	310	--	--	31	YES	65	120	65	120	50
SW8051	MCPP	7085-19-0	ug/kg	1,500	--	--	61	620	--	--	61	YES	60	118	60	118	50
SW8260B or C	1,1,1,2-Tetrachloroethane	630-20-6	ug/kg	5	1,900	9,300	2,000	9,800	--	--	1,900	NO	74	125	74	125	30
SW8260B or C	1,1,1-Trichloroethane (TCA)	71-55-6	ug/kg	5	8,700,000	38,000,000	9,000,000	39,000,000	--	--	8,700,000	NO	68	130	68	130	30
SW8260B or C	1,1,2,2-Tetrachloroethane	79-34-5	ug/kg	5	560	2,800	590	2,900	--	--	560	NO	59	140	59	140	30
SW8260B or C	1,1,2-Trichloroethane	79-00-5	ug/kg	5	1,100	5,300	1,100	5,500	--	--	1,100	NO	62	127	62	127	30
SW8260B or C	1,1,2-Trichlorotrifluoroethane (Freon 113)	76-13-1	ug/kg	5	43,000,000	180,000,000	43,000,000	180,000,000	--	--	43,000,000	NO	65	135	65	135	30
SW8260B or C	1,1-Dichloroethane	75-34-3	ug/kg	5	3,300	17,000	3,400	17,000	--	--	3,300	NO	73	125	73	125	30
SW8260B or C	1,1-Dichloroethylene	75-35-4	ug/kg	5	240,000	1,100,000	250,000	1,100,000	--	--	240,000	NO	65	136	65	136	30
SW8260B or C	1,1-Dichloropropene	563-58-6	ug/kg	5	--	--	--	--	--	--	--	NO	70	135	70	135	30
SW8260B or C	1,2,3-Trichlorobenzene	87-61-6	ug/kg	5	49,000	490,000	--	--	--	--	49,000	NO	62	133	62	133	30
SW8260B or C	1,2,3-Trichloropropane	96-18-4	ug/kg	5	5	95	91	410	--	--	5	NO	63	130	63	130	30
SW8260B or C	1,2,4-Trichlorobenzene	120-82-1	ug/kg	5	22,000	99,000	87,000	400,000	--	--	22,000	NO	65	131	65	131	30
SW8260B or C	1,2,4-Trimethylbenzene	95-63-6	ug/kg	5	62,000	260,000	67,000	280,000	--	--	62,000	NO	65	135	65	135	30
SW8260B or C	1,2-Dibromo-3-chloropropane	96-12-8	ug/kg	5	5.4	69	5.6	73	--	--	5.4	NO	49	135	49	135	30
SW8260B or C	1,2-Dibromoethane (EDB)	106-93-4	ug/kg	5	34	170	34	170	--	--	34	NO	70	124	70	124	30
SW8260B or C	1,2-Dichlorobenzene	95-50-1	ug/kg	5	1,900,000	9,800,000	2,000,000	10,000,000	--	--	1,900,000	NO	74	120	74	120	30
SW8260B or C	1,2-Dichloroethane (EDC)	107-06-2	ug/kg	5	430	2,200	450	2,200	--	--	430	NO	72	137	72	137	30
SW8260B or C	1,2-Dichloropropane	78-87-5	ug/kg	5	940	4,700	930	4,700	--	--	930	NO	71	120	71	120	30
SW8260B or C	1,3,5-Trimethylbenzene	108-67-8	ug/kg	5	780,000	10,000,000	47,000	200,000	--	--	47,000	NO	65	133	65	133	30
SW8260B or C	1,3-Dichlorobenzene	541-73-1	ug/kg	5	--	--	--	--	--	--	--	NO	72	124	72	124	30
SW8260B or C	1,3-Dichloropropane	142-28-9	ug/kg	5	1,600,000	20,000,000	1,600,000	20,000,000	--	--	1,600,000	NO	76	123	76	123	30
SW8260B or C	1,4-Dichlorobenzene	106-46-7	ug/kg	5	2,400	12,000	2,600	13,000	--	--	2,400	NO	72	125	72	125	30
SW8260B or C	2,2-Dichloropropane	594-20-7	ug/kg	5	--	--	--	--	--	--	--	NO	67	134	67	134	30
SW8260B or C	2-Butanone (MEK)	78-93-3	ug/kg	50	28,000,000	200,000,000	28,000,000	190,000,000	--	--	28,000,000	NO	40	135	40	135	30
SW8260B or C	2-Chlorotoluene	95-49-8	ug/kg	5	1,600,000	20,000,000	1,600,000	20,000,000	--	--	1,600,000	NO	69	128	69	128	30
SW8260B or C	4-Chlorotoluene	106-43-4	ug/kg	5	1,600,000	20,000,000	5,500,000	72,000,000	--	--	1,600,000	NO	73	126	73	126	30
SW8260B or C	4-Isopropyltoluene	99-87-6	ug/kg	6	--	--	--	--	--	--	--	NO	75	133	75	133	30
SW8260B or C	4-Methyl-2-pentanone	108-10-1	ug/kg	50	5,300,000	53,000,000	5,300,000	52,000,000	--	--	5,300,000	NO	65	135	65	135	30
SW8260B or C	Acetone	67-64-1	ug/kg	50	61,000,000	630,000,000	61,000,000	610,000,000	--	--	61,000,000	NO	40	141	40	141	30
SW8260B or C	Acrolein	107-02-8	ug/kg	100	150	650	160	680	--	--	150	NO	65	135	65	135	30
SW8260B or C	Acrylonitrile	107-13-1	ug/kg	50	240	1,200	240	1,200	--	--	240	NO	65	135	65	135	30
SW8260B or C	Benzene	71-43-2	ug/kg	5	1,100	5,400	1,100	5,600	--	--	1,100	NO	73	126	73	126	30
SW8260B or C	Bromobenzene	108-86-1	ug/kg	5	300,000	1,800,000	94,000	410,000	--	--	94,000	NO	66	121	66	121	30
SW8260B or C	Bromochloromethane	74-97-5	ug/kg	5	160,000	680,000	--	--	--	--	160,000	NO	71	127	71	127	30
SW8260B or C	Bromodichloromethane	75-27-4	ug/kg	5	270	1,400	10,000	46,000	--	--	0,270	NO	72	128	72	128	30
SW8260B or C	Bromoform	75-25-2	ug/kg	6	62,000	220,000	61,000	220,000	--	--	61,000	NO	66	137	66	137	30
SW8260B or C	Bromomethane	74-83-9	ug/kg	5	7,300	32,000	7,900	35,000	--	--	7,300	NO	45	141	45	141	30
SW8260B or C	Carbon disulfide	75-15-0	ug/kg	5	820,000	3,700,000	670,000	3,000,000	--	--	670,000	NO	65	135	65	135	30
SW8260B or C	Carbon tetrachloride	56-23-5	ug/kg	5	610	3,000	250	1,300	--	--	250	NO	67	133	67	133	30
SW8260B or C	Chlorobenzene	108-90-7	ug/kg	5	290,000	1,400,000	310,000	1,500,000	--	--	290,000	NO	75	123	75	123	30
SW8260B or C	Chloroethane	75-00-3	ug/kg	5	15,000,000	61,000,000	15,000,000	62,000,000	--	--	15,000,000	NO	41	141	41	141	30
SW8260B or C	Chloroform	67-66-3	ug/kg	2	290	1,500	300	1,500	--	--	290	NO	72	124	72	124	30
SW8260B or C	Chloromethane	74-87-3	ug/kg	5	120,000	500,000	1,700	8,400	--	--	1,700	NO	51	129	51	129	30
SW8260B or C	cis-1,2-Dichloroethene	156-59-2	ug/kg	5	160,000	2,000,000	780,000	10,000,000	--	--	160,000	NO	67	125	67	125	30
SW8260B or C	cis-1,3-Dichloropropene	10061-01-5	ug/kg	5	--	--	--	--	--	--	--	NO	72	126	72	126	30
SW8260B or C	Dibromochloromethane	124-48-1	ug/kg	5	680	3,300	5,800	21,000	--	--	0,680	NO	66	130	66	130	30
SW8260B or C	Dibromomethane	74-95-3	ug/kg	5	25,000	110,000	780,000	10,000,000	--	--	25,000	NO	73	128	73	128	30
SW8260B or C	Dichlorodifluoromethane	75-71-8	ug/kg	5	94,000	400,000	190,000	780,000	--	--	94,000	NO	34	136	34	136	30
SW8260B or C	Ethylbenzene	100-41-4	ug/kg	5	5,400	27,000	5,700	29,000	--	--	5,400	NO	74	127	74	127	30
SW8260B or C	Hexachlorobutadiene	87-68-3	ug/kg	5	6,200	22,000	6,200	22,000	--	--	6,200	NO	53	142	53	142	30
SW8260B or C	Isopropylbenzene (Cumene)	98-82-8	ug/kg	5	2,100,000	11,000,000	2,200,000	11,000,000	--	--	2,100,000	NO	77	129	77	129	30
SW8260B or C	Methylene Chloride	75-09-2	ug/kg	5	56,000	960,000	1,100	5,400	--	--	1,100	NO	63	137	63	137	30
SW8260B or C	Naphthalene	91-20-3	ug/kg	5	3,600	18,000	3,900	20,000	--	--	3,600	NO	51	135	51	135	30
SW8260B or C	n-Butylbenzene	104-51-8	ug/kg	5	3,900,000	51,000,000	--	--	--	--	3,900,000	NO	65	138	65	138	30

TABLE 4-1

Reporting Limits, Accuracy, and Precision Limits for Soil

PG&E Program Quality Assurance Project Plan

					EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL				LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
Method	**Constituent**	**CAS**	**Units**	**QAPP RL**	**Residential**	**Commercial**	**Residential**	**Commercial**	**Residential**	**Commercial**	**Most Stringent Screening Level**	**Does RL Exceed Screening Level?**	**Lower Limit**	**Upper Limit**	**Lower Limit**	**Upper Limit**	**% RPD**
SW8260B or C	n-Propylbenzene	103-65-1	ug/kg	5	3,400,000	21,000,000	--	--	--	--	3,400,000	NO	63	135	63	135	30
SW8260B or C	sec-Butylbenzene	135-98-8	ug/kg	5	--	--	--	--	--	--	--	NO	63	132	63	132	30
SW8260B or C	Styrene	100-42-5	ug/kg	5	6,300,000	36,000,000	6,500,000	38,000,000	--	--	6,300,000	NO	74	128	74	128	30
SW8260B or C	tert-Butyl Methyl Ether (MTBE)	1634-04-4	ug/kg	20	43,000	220,000	39,000	190,000	--	--	39,000	NO	50	135	50	135	30
SW8260B or C	tert-Butylbenzene	98-06-6	ug/kg	5	--	--	--	--	--	--	--	NO	65	132	65	132	30
SW8260B or C	Tetrachloroethene	127-18-4	ug/kg	5	22,000	110,000	570	2,700	--	--	570	NO	67	139	67	139	30
SW8260B or C	Toluene	108-88-3	ug/kg	5	5,000,000	45,000,000	5,000,000	46,000,000	--	--	5,000,000	NO	71	127	71	127	30
SW8260B or C	trans-1,2-Dichloroethene	156-60-5	ug/kg	5	150,000	690,000	110,000	500,000	--	--	110,000	NO	66	134	66	134	30
SW8260B or C	trans-1,3-Dichloropropene	10061-02-6	ug/kg	5	--	--	--	--	--	--	--	NO	65	127	65	127	30
SW8260B or C	Trichloroethene	79-01-6	ug/kg	5	910	6,400	2,800	14,000	--	--	0,910	NO	77	124	77	124	30
SW8260B or C	Trichlorofluoromethane (Freon 11)	75-69-4	ug/kg	5	790,000	3,400,000	800,000	3,400,000	--	--	790,000	NO	49	139	49	139	30
SW8260B or C	Vinyl Chloride	75-01-4	ug/kg	5	60	1,700	60	1,700	--	--	60	NO	58	126	58	126	30
SW8260B or C	Xylenes, Total	1330-20-7	ug/kg	15	630,000	2,700,000	600,000	2,600,000	--	--	600,000	NO	65	125	65	125	50
SW8260B or C	m-Xylene	108-38-3	ug/kg	10	590,000	2,500,000	4,500,000	19,000,000	--	--	590,000	NO	79	126	79	126	30
SW8260B or C	p-Xylene	106-42-3	ug/kg	10	600,000	2,600,000	4,700,000	20,000,000	--	--	600,000	NO	79	126	79	126	30
SW8260B or C	o-Xylene	95-47-6	ug/kg	5	690,000	3,000,000	5,300,000	23,000,000	--	--	690,000	NO	77	125	77	125	30
SW8670C or D	1,2,4-Trichlorobenzene	120-82-1	ug/kg	330	22,000	99,000	87,000	400,000	--	--	22,000	NO	44	125	44	125	30
SW8670C or D	1,2-Dichlorobenzene	95-50-1	ug/kg	330	1,900,000	9,800,000	2,000,000	10,000,000	--	--	1,900,000	NO	45	125	45	125	30
SW8670C or D	1,3-Dichlorobenzene	541-73-1	ug/kg	330	--	--	--	--	--	--	--	NO	39	125	39	125	30
SW8670C or D	1,4-Dichlorobenzene	106-46-7	ug/kg	330	2,400	12,000	2,600	13,000	--	--	2,400	NO	35	125	35	125	30
SW8670C or D	2,4,5-Trichlorophenol	95-95-4	ug/kg	700	6,100,000	62,000,000	6,100,000	62,000,000	--	--	6,100,000	NO	49	125	49	125	30
SW8670C or D	2,4,6-Trichlorophenol	88-06-2	ug/kg	330	44,000	160,000	44,000	160,000	--	--	44,000	NO	43	125	43	125	30
SW8670C or D	2,4-Dichlorophenol	120-83-2	ug/kg	330	180,000	1,800,000	180,000	1,800,000	--	--	180,000	NO	45	125	45	125	30
SW8670C or D	2,4-Dimethylphenol	105-67-9	ug/kg	330	1,200,000	12,000,000	1,200,000	12,000,000	--	--	1,200,000	NO	32	125	32	125	30
SW8670C or D	2,4-Dinitrophenol	51-28-5	ug/kg	700	120,000	1,200,000	120,000	1,200,000	--	--	120,000	NO	25	132	25	132	30
SW8670C or D	2,4-Dinitrotoluene	121-14-2	ug/kg	330	1,600	5,500	120,000	1,200,000	--	--	1,600	NO	48	125	48	125	30
SW8670C or D	2,6-Dinitrotoluene	606-20-2	ug/kg	330	61,000	620,000	61,000	620,000	--	--	61,000	NO	48	125	48	125	30
SW8670C or D	2-Chloronaphthalene	91-58-7	ug/kg	330	6,300,000	82,000,000	6,300,000	82,000,000	--	--	6,300,000	NO	45	125	45	125	30
SW8670C or D	2-Chlorophenol	95-57-8	ug/kg	330	390,000	5,100,000	390,000	5,100,000	--	--	390,000	NO	44	125	44	125	30
SW8670C or D	2-Methylnaphthalene	91-57-6	ug/kg	330	230,000	2,200,000	310,000	4,100,000	--	--	230,000	NO	47	125	47	125	30
SW8670C or D	2-Methylphenol (o-Cresol)	95-48-7	ug/kg	330	3,100,000	31,000,000	3,100,000	31,000,000	--	--	3,100,000	NO	40	125	40	125	30
SW8670C or D	2-Nitroaniline	88-74-4	ug/kg	700	610,000	6,000,000	--	--	--	--	610,000	NO	44	125	44	125	30
SW8670C or D	2-Nitrophenol	88-75-5	ug/kg	700	--	--	--	--	--	--	--	NO	42	125	42	125	30
SW8670C or D	3,3'-Dichlorobenzidine	91-94-1	ug/kg	1,300	1,100	3,800	1,100	3,800	--	--	1,100	YES	25	128	25	128	30
SW8670C or D	3-Nitroaniline	99-09-2	ug/kg	700	--	--	18,000	82,000	--	--	18,000	NO	27	125	27	125	30
SW8670C or D	4,6-Dinitro-2-methylphenol	534-52-1	ug/kg	1600	4,900	49,000	6,100	62,000	--	--	4,900	NO	29	137	29	137	30
SW8670C or D	4-Bromophenyl phenyl ether	101-55-3	ug/kg	330	--	--	--	--	--	--	--	NO	46	125	46	125	30
SW8670C or D	4-Chloro-3-methylphenol	59-50-7	ug/kg	600	6,100,000	62,000,000	--	--	--	--	6,100,000	NO	46	125	46	125	30
SW8670C or D	4-Chloroaniline	106-47-8	ug/kg	700	2,400	8,600	9,000	32,000	--	--	2,400	NO	10	125	10	125	30
SW8670C or D	4-Chlorophenyl phenyl ether	7005-72-3	ug/kg	330	--	--	--	--	--	--	--	NO	47	125	47	125	30
SW8670C or D	4-Methylphenol (p-Cresol)	106-44-5	ug/kg	330	6,100,000	62,000,000	310,000	3,100,000	--	--	310,000	NO	41	125	41	125	30
SW8670C or D	4-Nitroaniline	100-01-6	ug/kg	700	24,000	86,000	23,000	82,000	--	--	23,000	NO	34	125	34	125	30
SW8670C or D	4-Nitrophenol	100-02-7	ug/kg	700	--	--	--	--	--	--	--	NO	25	138	25	138	30
SW8670C or D	Acenaphthene	83-32-9	ug/kg	330	3,400,000	33,000,000	3,400,000	33,000,000	--	--	3,400,000	NO	46	125	46	125	30
SW8670C or D	Acenaphthylene	208-96-8	ug/kg	330	--	--	--	--	--	--	--	NO	44	125	44	125	30
SW8670C or D	Anthracene	120-12-7	ug/kg	330	17,000,000	170,000,000	17,000,000	170,000,000	--	--	17,000,000	NO	53	125	53	125	30
SW8670C or D	Benzo (a) anthracene	56-55-3	ug/kg	330	150	2,100	150	2,100	--	--	150	YES	52	125	52	125	30
SW8670C or D	Benzo (a) pyrene	50-32-8	ug/kg	330	15	210	15	210	38	130	15	YES	50	125	50	125	30
SW8670C or D	Benzo (b) fluoranthene	205-99-2	ug/kg	330	150	2,100	150	2,100	--	--	150	YES	45	125	45	125	30
SW8670C or D	Benzo (g,h,i) perylene	191-24-2	ug/kg	330	--	--	--	--	--	--	--	NO	38	126	38	126	30
SW8670C or D	Benzo (k) fluoranthene	207-08-9	ug/kg	330	1,500	21,000	1,500	21,000	--	--	1,500	NO	45	125	45	125	30
SW8670C or D	Benzoic acid	65-85-0	ug/kg	5,000	240,000,000	2,500,000,000	240,000,000	2,500,000,000	--	--	240,000,000	NO	25	125	25	125	30
SW8670C or D	Benzyl alcohol	100-51-6	ug/kg	330	6,100,000	62,000,000	31,000,000	310,000,000	--	--	6,100,000	NO	25	125	25	125	30
SW8670C or D	bis (2-chloroethoxy) methane	111-91-1	ug/kg	330	180,000	1,800,000	180,000	1,800,000	--	--	180,000	NO	43	125	43	125	30
SW8670C or D	bis (2-chloroethyl) ether	111-44-4	ug/kg	330	210	1,000	190	900	--	--	190	YES	38	125	38	125	30
SW8670C or D	bis (2-chloroisopropyl) ether	108-60-1	ug/kg	330	4,600	22,000	3,500	17,000	--	--	3,500	NO	25	125	25	125	30
SW8670C or D	bis (2-ethylhexyl) phthalate	117-81-7	ug/kg	330	35,000	120,000	35,000	120,000	--	--	35,000	NO	47	127	47	127	30
SW8670C or D	Butyl benzylphthalate	85-68-7	ug/kg	1000	260,000	910,000	260,000	910,000	--	--	260,000	NO	49	125	49	125	30
SW8670C or D	Chrysene	218-01-9	ug/kg	330	15,000	210,000	15,000	210,000	--	--	15,000	NO	53	125	53	125	30
SW8670C or D	Dibenzo (a,h) anthracene	53-70-3	ug/kg	330	15	210	15	210	--	--	15	YES	41	125	41	125	30
SW8670C or D	Dibenzofuran	132-64-9	ug/kg	330	78,000	1,000,000	--	--	--	--	78,000	NO	51	125	51	125	30
SW8670C or D	Diethyl phthalate	84-66-2	ug/kg	330	49,000,000	490,000,000	49,000,000	490,000,000	--	--	49,000,000	NO	50	125	50	125	30
SW8670C or D	Dimethyl phthalate	131-11-3	ug/kg	330	--	--	--	--	--	--	--	NO	49	125	49	125	30
SW8670C or D	Di-n-butylphthalate	84-74-2	ug/kg	330	6,100,000	62,000,000	6,100,000	62,000,000	--	--	6,100,000	NO	56	125	56	125	30

TABLE 4-1

Reporting Limits, Accuracy, and Precision Limits for Soil

PG&E Program Quality Assurance Project Plan

					EPA Regional Screening Levels - May 2012		EPA Regional Screening Levels - 2008		DTSC CHHSL				LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
Method	**Constituent**	**CAS**	**Units**	**QAPP RL**	**Residential**	**Commercial**	**Residential**	**Commercial**	**Residential**	**Commercial**	**Most Stringent Screening Level**	**Does RL Exceed Screening Level?**	**Lower Limit**	**Upper Limit**	**Lower Limit**	**Upper Limit**	**% RPD**
SW8670C or D	Di-n-octylphthalate	117-84-0	ug/kg	1000	--	--	--	--	--	--	--	NO	41	132	41	132	30
SW8670C or D	Fluoranthene	206-44-0	ug/kg	330	2,300,000	22,000,000	2,300,000	22,000,000	--	--	2,300,000	NO	54	125	54	125	30
SW8670C or D	Fluorene	86-73-7	ug/kg	330	2,300,000	22,000,000	2,300,000	22,000,000	--	--	2,300,000	NO	49	125	49	125	30
SW8670C or D	Hexachlorobenzene	118-74-1	ug/kg	330	300	1,100	300	1,100	--	--	300	YES	47	125	47	125	30
SW8670C or D	Hexachlorobutadiene	87-68-3	ug/kg	330	6,200	22,000	6,200	22,000	--	--	6,200	NO	40	125	40	125	30
SW8670C or D	Hexachloroethane	67-72-1	ug/kg	330	12,000	43,000	35,000	120,000	--	--	12,000	NO	34	125	34	125	30
SW8670C or D	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/kg	330	150	2,100	150	2,100	--	--	150	YES	38	125	38	125	30
SW8670C or D	Isophorone	78-59-1	ug/kg	330	510,000	1,800,000	510,000	1,800,000	--	--	510,000	NO	43	125	43	125	30
SW8670C or D	Naphthalene	91-20-3	ug/kg	330	3,600	18,000	3,900	20,000	--	--	3,600	NO	40	125	40	125	30
SW8670C or D	Nitrobenzene	98-95-3	ug/kg	330	4,800	24,000	31,000	280,000	--	--	4,800	NO	41	125	41	125	30
SW8670C or D	n-Nitrosodi-n-propylamine	621-64-7	ug/kg	330	69	250	69	250	--	--	69	YES	40	125	40	125	30
SW8670C or D	n-Nitrosodiphenylamine	86-30-6	ug/kg	330	99,000	350,000	99,000	350,000	--	--	99,000	NO	49	125	49	125	30
SW8670C or D	Pentachlorophenol	87-86-5	ug/kg	700	890	2,700	3,000	9,000	4,400	13,000	0,890	NO	25	125	25	125	30
SW8670C or D	Phenanthrene	85-01-8	ug/kg	330	--	--	--	--	--	--	--	NO	50	125	50	125	30
SW8670C or D	Phenol	108-95-2	ug/kg	330	18,000,000	180,000,000	18,000,000	180,000,000	--	--	18,000,000	NO	39	125	39	125	30
SW8670C or D	Pyrene	129-00-0	ug/kg	330	1,700,000	17,000,000	1,700,000	17,000,000	--	--	1,700,000	NO	46	125	46	125	30
SW8270SIM	1-methylnaphthalene	90-12-0	ug/kg	5	16,000	53,000	22,000	99,000	--	--	16,000	NO	30	111	30	111	30
SW8270SIM	2-methylnaphthalene	91-57-6	ug/kg	5	230,000	2,200,000	310,000	4,100,000	--	--	230,000	NO	30	111	30	111	30
SW8270SIM	Acenaphthene	83-32-9	ug/kg	5	3,400,000	33,000,000	3,400,000	33,000,000	--	--	3,400,000	NO	28	110	28	110	30
SW8270SIM	Acenaphthylene	208-96-8	ug/kg	5	--	--	--	--	--	--	--	NO	23	126	23	126	30
SW8270SIM	Anthracene	120-12-7	ug/kg	5	17,000,000	170,000,000	17,000,000	170,000,000	--	--	17,000,000	NO	28	136	28	136	30
SW8270SIM	Benzo (a) anthracene	56-55-3	ug/kg	5	150	2,100	150	2,100	--	--	150	NO	31	146	31	146	30
SW8270SIM	Benzo (a) pyrene	50-32-8	ug/kg	5	15	210	15	210	38	130	15	NO	28	128	28	128	30
SW8270SIM	Benzo (b) fluoranthene	205-99-2	ug/kg	5	150	2,100	150	2,100	--	--	150	NO	30	139	30	139	30
SW8270SIM	Benzo (g,h,i) perylene	191-24-2	ug/kg	5	--	--	--	--	--	--	--	NO	21	149	21	149	30
SW8270SIM	Benzo (k) fluoranthene	207-08-9	ug/kg	5	1,500	21,000	1,500	21,000	--	--	1,500	NO	42	129	42	129	30
SW8270SIM	Chrysene	218-01-9	ug/kg	5	15,000	210,000	15,000	210,000	--	--	15,000	NO	39	134	39	134	30
SW8270SIM	Dibenzo (a,h) anthracene	53-70-3	ug/kg	5	15	210	15	210	--	--	15	NO	30	138	30	138	30
SW8270SIM	Fluoranthene	206-44-0	ug/kg	5	2,300,000	22,000,000	2,300,000	22,000,000	--	--	2,300,000	NO	30	142	30	142	30
SW8270SIM	Fluorene	86-73-7	ug/kg	5	2,300,000	22,000,000	2,300,000	22,000,000	--	--	2,300,000	NO	27	116	27	116	30
SW8270SIM	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/kg	5	150	2,100	150	2,100	--	--	150	NO	17	164	17	164	30
SW8270SIM	Naphthalene	91-20-3	ug/kg	5	3,600	18,000	3,900	20,000	--	--	3,600	NO	29	106	29	106	30
SW8270SIM	Phenanthrene	85-01-8	ug/kg	5	--	--	--	--	--	--	--	NO	32	127	32	127	30
SW8270SIM	Pyrene	129-00-0	ug/kg	5	1,700,000	17,000,000	1,700,000	17,000,000	--	--	1,700,000	NO	28	130	28	130	30

Notes:

Please keep in mind, Screening Levels are constantly revised by the EPA. The appropriate Screening levels are specific to the project, the location, the agency providing oversight, and the overall Goals of the project.

mg/kg = milligrams per kilogram
ug/kg = micrograms per kilogram
µmhos/cm = micromhos per centimeter

All soil results (with the exception of Waste characterization) must be reported as dry weight
SW7199 was be accompanied by a SW3060A extraction

[1] For soil, most stringent of:
EPA Regional Screening Levels - 2008 and May 2012
CHHSL = California Human Health Screening Levels, January 2005
DTSC = California Department of Toxic Substance Control, January 2005

TABLE 4-2

Reporting Limits, Accuracy, and Precision Limits for Groundwater

PG&E Program Quality Assurance Project Plan

					EPA Regional Screening Levels	EPA Regional Screening Levels	Federal Drinking Water Standards	California Drinking Water Standards			LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Water
Method	**Constituent**	**CAS**	**Units**	**QAPP RL**	**May 2012**	**2008**	**MCLs**	**MCLs**	**Most Stringent Screening Level**	**Does RL Exceed Screening Level?**	**Lower Limit**	**Upper Limit**	**Lower Limit**	**Upper Limit**	**% RPD**
E300.0M	Acetate	64-19-7	mg/L	0.1	--	--	--	--	--	NO	75	125	75	125	20
SM2320 B	Alkalinity	Alkalinity	mg/L	5	--	--	--	--	--	NO	85	115	75	125	20
SM4500-NH3 B, C, D, E, or G	Ammonia (as N)	7664-41-7	mg/L	0.5	--	--	--	--	--	NO	85	115	75	125	20
SM2320 B	Bicarbonate	Bicarbonate	mg/L	5	--	--	--	--	--	NO	85	115	75	125	20
SM5210 B	BOD	BOD	mg/L	--	--	--	--	--	--	NO	--	--	--	--	10
E300.0	Bromide	Bromide	mg/L	0.5	--	--	--	--	--	NO	90	110	80	120	20
E300.0M	Butyrate	107-92-6	mg/L	0.1	--	--	--	--	--	NO	75	125	75	125	20
SM4500 CO_2	Carbon dioxide	124-38-9	mg/L	5	--	--	--	--	--	NO	--	--	--	--	20
SM2320 B	Carbonate	Carbonate	mg/L	5	--	--	--	--	--	NO	85	115	75	125	20
E300.0/SM4500-Cl B, C, E, or D	Chloride	Chloride	mg/L	0.5	--	--	--	--	--	NO	90	110	80	120	20
SM2120 E	Color	Color	Color unit	1	--	--	--	--	--	NO	90	110	90	110	20
E300.0/SM4500-F B, C, D, or E	Fluoride	Fluoride	mg/L	0.5	--	2.2	4	--	2.2	NO	90	110	80	120	20
SM2340 B or C	Hardness	Hardness	mg/L	10	--	--	--	--	--	NO	75	125	75	125	20
SM2320 B	Hydroxide alkalinity	Hydroxide	mg/L	5	--	--	--	--	--	NO	85	115	75	125	20
E300.0M	Lactate	50-21-5	mg/L	0.1	--	--	--	--	--	NO	75	125	75	125	20
E300.0	Nitrate (as N)	14797-55-8	mg/L	0.5	25	58	10	--	10	NO	90	110	80	120	20
E353.2/SM4500-NO3 E, F or H	Nitrate/nitrite (as N)	NO3NO2N	mg/L	0.5	--	--	--	--	--	NO	85	115	75	125	20
E300.0/SM4500-NO2 B, F or E	Nitrite (as N)	14797-65-8	mg/L	0.5	--	3.7	1	--	1	NO	90	110	80	120	20
SM5310 B, C, or D	Organic carbon	DOC/TOC	mg/L	0.3	--	--	--	--	--	NO	85	115	75	125	10
E300.0/SM4500-P E or F	Ortho phosphate	Ortho Phosphate	mg/L	0.02	--	--	--	--	--	NO	90	110	80	120	20
E314.0	Perchlorate	Perchlorate	µg/L	4	--	26	--	--	26	NO	85	115	85	115	20
SM4500-H+ B SW9040	pH	pH	pH units	0.1	--	--	--	--	--	NO	--	--	--	--	20
E300.0M	Propionate	79-09-4	mg/L	0.1	--	--	--	--	--	NO	75	125	75	125	20
E300.0M	Pyruvate	127-17-3	mg/L	0.1	--	--	--	--	--	NO	75	125	75	125	20
SM4500-SiO_2 E	Reactive silica	7631-86-9	mg/L	1	--	--	--	--	--	NO	75	125	75	125	20
SM4500-SiO_2 C	Silica	7631-86-9	mg/L	0.04	--	--	--	--	--	NO	75	125	75	125	20
SILICA_CALC	Soluble silica	7631-86-9	mg/L	0.04	--	--	--	--	--	NO	75	125	75	125	20
E120.1/SW9050	Specific conductance	Conductance	µmhos/cm	2	--	--	--	--	--	NO	85	115	75	125	20
E300.0/SM4110 B	Sulfate	Sulfate	mg/L	0.5	--	--	--	--	--	NO	90	110	80	120	20
SM4500-S^{-2} F, E, D, or G	Sulfide	Sulfide	mg/L	0.05	--	--	--	--	--	NO	75	125	75	125	20
SM2540 C	Total dissolved solids	TDS	mg/L	10	--	--	--	--	--	NO	75	125	--	--	10
SM4500-N_{org} B or C	Total kjeldahl nitrogen	7727-37-9	mg/L	--	--	--	--	--	--	NO	75	125	75	125	20
E365.1/E365.3 SM4500-P E or F	Total phosphorous	Total Phosphorous	mg/L	0.02	--	--	--	--	--	NO	75	125	75	125	20
SM2540 D	Total suspended solids	TSS	mg/L	10	--	--	--	--	--	NO	75	125	75	125	10
E180.1/SM2130 B	Turbidity	TURB	NTU	0.1	--	--	--	--	--	NO	--	--	--	--	20
SW6010B or C/SW6020A/E200.7/E200.8	Aluminum	7429-90-5	ug/L	10	16,000	37,000	50*	1,000	50	NO	85	115	75	125	20
SW6020A/E200.8	Antimony	7440-36-0	ug/L	2	6	15	6	--	6	NO	85	115	75	125	20
SW6020A/E200.8	Arsenic	7440-38-2	ug/L	0.5	0.045	0.045	10	--	0.045	YES	85	115	75	125	20
SW6020A/E200.8	Barium	7440-39-3	ug/L	5	2,900	7,300	2,000	1,000	1,000	NO	85	115	75	125	20
SW6020A/E200.8	Beryllium	7440-41-7	ug/L	0.5	16	73	4	--	4	NO	85	115	75	125	20
SW6020A/E200.8	Cadmium	7440-43-9	ug/L	1	--	18	5	--	5	NO	85	115	75	125	20
SW6010B/200.7	Calcium	7440-70-2	ug/L	100	--	--	--	--	--	NO	85	115	75	125	20
SW6020A/E200.8	Chromium	7440-47-3	ug/L	1	--	--	100	50	50	NO	85	115	75	125	20
E218.6	Chromium, Hexavalent	18540-29-9	ug/L	0.2	0.031	110	100	--	0.031	YES	90	110	90	110	20
SM3500	Chromium, Hexavalent	18540-29-9	ug/L	10	0.031	110	100	--	0.031	YES	85	115	80	120	20
SW6010B or C/SW6020A/E200.7/E200.8	Cobalt	7440-48-4	ug/L	5	4.7	11	--	--	4.7	YES	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Copper	7440-50-8	ug/L	5	620	1,500	1,000*	--	620	NO	85	115	75	125	20
SW6010B or C/200.7	Iron	7439-89-6	ug/L	20	11,000	26,000	300*	--	300	NO	85	115	75	125	20
SW6010B or C/SW6020A/E200.7/E200.8	Lead	7439-92-1	ug/L	1	--	--	15	--	15	NO	85	115	75	125	20
SW6010B or C/200.7	Magnesium	7439-95-4	ug/L	100	--	--	--	--	--	NO	85	115	75	125	20
SW6020A/E200.8	Manganese	7439-96-5	ug/L	0.5	--	880	50*	--	50	NO	85	115	75	125	20
SW7070A/E245.1	Mercury	7439-97-6	ug/L	0.2	0.63	0.63	2	--	0.63	NO	75	125	75	125	20
SW6020A/E200.8	Molybdenum	7439-98-7	ug/L	2	78	180	--	--	78	NO	85	115	75	125	20
SW6020A/E200.8	Nickel	7440-02-0	ug/L	2	300	730	100*	100	100	NO	85	115	75	125	20
SW6010B or C/200.7	Potassium	7440-09-7	ug/L	100	--	--	--	--	--	NO	85	115	75	125	20
SW6020A/E200.8	Selenium	7782-49-2	ug/L	10	78	180	50	--	50	NO	85	115	75	125	20
SW6020A/E200.8	Silver	7440-22-4	ug/L	5	71	180	--	--	71	NO	85	115	75	125	20
SW6010B or C/200.7	Sodium	7440-23-5	ug/L	100	--	--	--	--	--	NO	85	115	75	125	20
E200.7	Strontium	7440-24-6	ug/L	1	9,300	22,000	--	--	9,300	NO	85	115	75	125	20
SW6020A/E200.8	Thallium	7440-28-0	ug/L	1	0.16	2.4	2	--	0.16	YES	85	115	75	125	20
6020A/200.8	Uranium	7440-61-1	ug/L	5	230	--	30	--	30	NO	85	115	75	125	20
SW6020A/E200.8	Vanadium	7440-62-2	ug/L	5	--	2.6	--	--	2.6	YES	85	115	75	125	20

TABLE 4-2

Reporting Limits, Accuracy, and Precision Limits for Groundwater

PG&E Program Quality Assurance Project Plan

Method	Constituent	CAS	Units	QAPP RL	EPA Regional Screening Levels	EPA Regional Screening Levels	Federal Drinking Water Standards	California Drinking Water Standards	Most Stringent Screening Level	Does RL Exceed Screening Level?	LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Water
					May 2012	2008	MCLs	MCLs			Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW6010B or C/SW6020A/E200.7/E200.8	Zinc	7440-66-6	ug/L	10	4,700	11,000	5,000*	--	4,700	NO	85	115	75	125	20
SW8015B or C or D	Motor Oil	TPH-motor oil	mg/L	1	--	--	--	--	--	NO	50	150	50	150	30
SW8015B or C or D	TPH-Diesel	TPH-diesel	mg/L	0.5	--	--	--	--	--	NO	61	143	61	143	30
SW8015B or C or D	TPH-Gasoline	TPH-gasoline	mg/L	0.1	--	--	--	--	--	NO	67	136	67	136	30
SW8081A or B	4,4'-DDD	72-54-8	ug/L	0.1	0.28	0.28	--	--	0.28	NO	50	139	50	139	30
SW8081A or B	4,4'-DDE	72-55-9	ug/L	0.1	0.2	0.2	--	--	0.2	NO	48	137	48	137	30
SW8081A or B	4,4'-DDT	50-29-3	ug/L	0.1	0.2	0.2	--	--	0.2	NO	47	138	47	138	30
SW8081A or B	Aldrin	309-00-2	ug/L	0.1	0.00021	0.004	--	--	0.00021	YES	42	138	42	138	30
SW8081A or B	alpha-HCH	319-84-6	ug/L	0.1	0.0062	0.011	--	--	0.0062	YES	60	128	60	128	30
SW8081A or B	alpha-Chlordane	5103-71-9	ug/L	0.1	--	--	2	--	2	NO	63	123	63	123	30
SW8081A or B	beta-HCH	319-85-7	ug/L	0.1	0.022	0.037	--	--	0.022	YES	66	126	66	126	30
SW8081A or B	delta-HCH	319-86-8	ug/L	0.1	--	--	--	--	--	NO	46	136	46	136	30
SW8081A or B	Dieldrin	60-57-1	ug/L	0.1	0.0015	0.0042	--	--	0.0015	YES	62	129	62	129	30
SW8081A or B	Endosulfan I	959-98-8	ug/L	0.1	--	--	--	--	--	NO	49	120	49	120	30
SW8081A or B	Endosulfan II	33213-65-9	ug/L	0.1	--	--	--	--	--	NO	42	130	42	130	30
SW8081A or B	Endosulfan sulfate	1031-07-8	ug/L	0.1	--	--	--	--	--	NO	54	137	54	137	30
SW8081A or B	Endrin	72-20-8	ug/L	0.1	1.7	11	2	--	1.7	NO	56	134	56	134	30
SW8081A or B	Endrin aldehyde	7421-93-4	ug/L	0.1	--	--	--	--	--	NO	56	137	56	137	30
SW8081A or B	gamma-HCH (lindane)	58-89-9	ug/L	0.1	0.036	0.061	0.2	--	0.036	YES	30	146	30	146	30
SW8081A or B	gamma-Chlordane	5103-74-2	ug/L	0.1	--	--	2	--	2	NO	67	120	67	120	30
SW8081A or B	Heptachlor	76-44-8	ug/L	0.1	0.0018	0.015	0.4	--	0.0018	YES	51	128	51	128	30
SW8081A or B	Heptachlor Epoxide	1024-57-3	ug/L	0.1	0.0033	0.0074	0.2	--	0.0033	YES	62	131	62	131	30
SW8081A or B	Methoxychlor	72-43-5	ug/L	0.5	27	180	40	--	27	NO	56	150	56	150	30
SW8081A or B	Toxaphene	8001-35-2	ug/L	1	0.013	0.061	3	--	0.013	YES	41	126	41	126	30
SW8082 or A	Aroclor-1016	12674-11-2	ug/L	0.5	0.96	0.96	0.5	--	0.5	NO	40	144	40	144	30
SW8082 or A	Aroclor-1221	11104-28-2	ug/L	0.5	0.0043	0.0068	0.5	--	0.0043	YES	41	136	41	136	30
SW8082 or A	Aroclor-1232	11141-16-5	ug/L	0.5	0.0043	0.0068	0.5	--	0.0043	YES	41	136	41	136	30
SW8082 or A	Aroclor-1242	53469-21-9	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	39	150	39	150	30
SW8082 or A	Aroclor-1248	12672-29-6	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	41	136	41	136	30
SW8082 or A	Aroclor-1254	11097-69-1	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	29	141	29	141	30
SW8082 or A	Aroclor-1260	11096-82-5	ug/L	0.5	0.034	0.034	0.5	--	0.034	YES	45	145	45	145	30
SW8151	2,4-D	94-75-7	ug/L	10	130	370	70	--	70	NO	39	120	39	120	30
SW8151	2,4-DB	94-82-6	ug/L	20	91	290	--	--	91	NO	44	120	44	120	30
SW8151	2,4,5-T	93-76-5	ug/L	20	120	370	--	--	120	NO	44	122	44	122	30
SW8151	2,4,5-TP	93-72-1	ug/L	10	84	290	--	--	84	NO	49	126	49	126	30
SW8151	Dalapon	75-99-0	ug/L	30	470	1,100	200	--	200	NO	40	120	40	120	30
SW8151	Dicamba	1918-00-9	ug/L	30	440	1,100	--	--	440	NO	60	120	60	120	30
SW8151	Dichloroprop	120-36-5	ug/L	20	--	--	--	--	--	NO	68	122	68	122	30
SW8151	Dinoseb	88-85-7	ug/L	3	11	37	7	--	7	NO	28	115	28	115	30
SW8151	MCPA	94-74-6	ug/L	100	5.7	18	--	--	5.7	YES	62	144	62	144	30
SW8151	MCPP	7085-19-0	ug/L	100	--	37	--	--	37	YES	60	133	60	133	30
SW8260B or C	1,1,1,2-Tetrachloroethane	630-20-6	ug/L	0.5	0.5	0.52	--	--	0.5	NO	81	129	81	129	20
SW8260B or C	1,1,1-Trichloroethane (TCA)	71-55-6	ug/L	1	7,500	9,100	200	200	200	NO	67	132	67	132	20
SW8260B or C	1,1,2,2-Tetrachloroethane	79-34-5	ug/L	0.5	0.066	0.067	--	1	0.066	YES	63	128	63	128	20
SW8260B or C	1,1,2-Trichloroethane	79-00-5	ug/L	1	0.24	0.24	5	5	0.24	YES	75	125	75	125	20
SW8260B or C	1,1,2-Trichlorotrifluoroethane (Freon 113)	76-13-1	ug/L	1	53,000	59,000	--	1,200	1,200	NO	75	125	75	125	20
SW8260B or C	1,1-Dichloroethane	75-34-3	ug/L	1	2.4	2.4	--	5	2.4	NO	69	133	69	133	20
SW8260B or C	1,1-Dichloroethene	75-35-4	ug/L	1	260	340	7	6	6	NO	68	130	68	130	20
SW8260B or C	1,1-Dichloropropene	563-58-6	ug/L	1	--	--	--	--	--	NO	73	132	73	132	20
SW8260B or C	1,2,3-Trichlorobenzene	87-61-6	ug/L	1	5.2	--	--	--	5.2	NO	67	137	67	137	20
SW8260B or C	1,2,3-Trichloropropane	96-18-4	ug/L	1	0.00065	0.0096	--	--	0.00065	YES	73	124	73	124	20
SW8260B or C	1,2,4-Trichlorobenzene	120-82-1	ug/L	1	0.99	8.2	70	5	0.99	YES	66	134	66	134	20
SW8260B or C	1,2,4-Trimethylbenzene	95-63-6	ug/L	1	15	15	--	--	15	NO	74	132	74	132	20
SW8260B or C	1,2-Dibromo-3-Chloropropane	96-12-8	ug/L	2	0.00032	0.00032	0.2	--	0.00032	YES	50	132	50	132	20
SW8260B or C	1,2-Dibromoethane (EDB)	106-93-4	ug/L	1	0.0065	0.0065	0.05	--	0.0065	YES	80	121	80	121	20
SW8260B or C	1,2-Dichlorobenzene	95-50-1	ug/L	1	280	370	600	600	280	NO	71	122	71	122	20
SW8260B or C	1,2-Dichloroethane (EDC)	107-06-2	ug/L	0.5	0.15	0.15	5	0.5	0.15	YES	69	132	69	132	20
SW8260B or C	1,2-Dichloropropane	78-87-5	ug/L	1	0.38	0.39	5	5	0.38	YES	75	125	75	125	20
SW8260B or C	1,3,5-Trimethylbenzene	108-67-8	ug/L	1	87	12	--	--	12	NO	74	131	74	131	20
SW8260B or C	1,3-Dichlorobenzene	541-73-1	ug/L	1	--	--	--	--	--	NO	75	124	75	124	20
SW8260B or C	1,3-Dichloropropane	142-28-9	ug/L	1	290	730	--	--	290	NO	73	126	73	126	20
SW8260B or C	1,4-Dichlorobenzene	106-46-7	ug/L	0.5	0.42	0.43	75	5	0.42	YES	74	123	74	123	20
SW8260B or C	2,2-Dichloropropane	594-20-7	ug/L	1	--	--	--	--	--	NO	69	137	69	137	20

TABLE 4-2

Reporting Limits, Accuracy, and Precision Limits for Groundwater

PG&E Program Quality Assurance Project Plan

					EPA Regional Screening Levels	EPA Regional Screening Levels	Federal Drinking Water Standards	California Drinking Water Standards			LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Water
Method	Constituent	CAS	Units	QAPP RL	May 2012	2008	MCLs	MCLs	Most Stringent Screening Level	Does RL Exceed Screening Level?	Lower Limit	Upper Limit	Lower Limit	Upper Limit	% RPD
SW8260B or C	2-Butanone (MEK)	78-93-3	ug/L	10	4,900	7,100	--	--	4,900	NO	49	136	49	136	20
SW8260B or C	2-Chlorotoluene	95-49-8	ug/L	1	180	730	--	--	180	NO	73	126	73	126	20
SW8260B or C	4-Chlorotoluene	106-43-4	ug/L	1	190	2,600	--	--	190	NO	74	128	74	128	20
SW8260B or C	4-Isopropyltoluene	99-87-6	ug/L	1	--	--	--	--	--	NO	73	130	73	130	20
SW8260B or C	4-Methyl-2-Pentanone	108-10-1	ug/L	10	1,000	2,000	--	--	1,000	NO	58	134	58	134	20
SW8260B or C	Acetone	67-64-1	ug/L	10	12,000	22,000	--	--	12,000	NO	40	135	40	135	20
SW8260B or C	Acrolein	107-02-8	ug/L	20	0.041	0.042	--	--	0.041	YES	75	125	75	125	20
SW8260B or C	Acrylonitrile	107-13-1	ug/L	20	0.045	0.045	--	--	0.045	YES	75	125	75	125	20
SW8260B or C	Benzene	71-43-2	ug/L	0.4	0.39	0.41	5	1	0.39	YES	81	122	81	122	20
SW8260B or C	Bromobenzene	108-86-1	ug/L	1	54	20	--	--	20	NO	76	124	76	124	20
SW8260B or C	Bromochloromethane	74-97-5	ug/L	1	83	--	--	--	83	NO	65	129	65	129	20
SW8260B or C	Bromodichloromethane	75-27-4	ug/L	0.5	0.12	1.1	100	--	0.12	YES	76	121	76	121	20
SW8260B or C	Bromoform	75-25-2	ug/L	1	7.9	8.5	100	--	7.9	NO	69	128	69	128	20
SW8260B or C	Bromomethane	74-83-9	ug/L	3	7	8.7	--	--	7	NO	53	141	53	141	20
SW8260B or C	Carbon Disulfide	75-15-0	ug/L	1	720	1,000	--	--	720	NO	75	125	75	125	20
SW8260B or C	Carbon Tetrachloride	56-23-5	ug/L	1	0.39	0.2	5	0.5	0.2	YES	66	138	66	138	20
SW8260B or C	Chlorobenzene	108-90-7	ug/L	0.5	72	91	100	--	72	NO	81	122	81	122	20
SW8260B or C	Chloroethane	75-00-3	ug/L	1	21,000	21,000	--	--	21,000	NO	58	133	58	133	20
SW8260B or C	Chloroform	67-66-3	ug/L	1	0.19	0.19	100	--	0.19	YES	69	128	69	128	20
SW8260B or C	Chloromethane	74-87-3	ug/L	1	190	1.8	--	--	1.8	NO	56	131	56	131	20
SW8260B or C	cis-1,2-Dichloroethene	156-59-2	ug/L	1	28	370	70	6	6	NO	72	126	72	126	20
SW8260B or C	cis-1,3-Dichloropropene	10061-01-5	ug/L	0.5	--	--	--	--	--	NO	69	131	69	131	20
SW8260B or C	Dibromochloromethane	124-48-1	ug/L	0.5	0.15	0.8	100	--	0.15	YES	66	133	66	133	20
SW8260B or C	Dibromomethane	74-95-3	ug/L	1	7.9	370	--	--	7.9	NO	76	125	76	125	20
SW8260B or C	Dichlorodifluoromethane (Freon 12)	75-71-8	ug/L	1	190	390	--	--	190	NO	53	153	53	153	20
SW8260B or C	Ethylbenzene	100-41-4	ug/L	1	1.3	1.5	700	--	1.3	NO	73	127	73	127	20
SW8260B or C	Hexachlorobutadiene	87-68-3	ug/L	0.6	0.26	0.86	--	--	0.26	YES	67	131	67	131	20
SW8260B or C	Isopropylbenzene (Cumene)	98-82-8	ug/L	1	390	680	--	--	390	NO	75	127	75	127	20
SW8260B or C	Methylene chloride	75-09-2	ug/L	1	9.9	4.8	5	5	4.8	NO	63	137	63	137	20
SW8260B or C	Naphthalene	91-20-3	ug/L	1	0.14	0.14	--	--	0.14	YES	54	138	54	138	20
SW8260B or C	n-Butylbenzene	104-51-8	ug/L	1	780	--	--	--	780	NO	69	137	69	137	20
SW8260B or C	n-Propylbenzene	103-65-1	ug/L	1	530	--	--	--	530	NO	72	129	72	129	20
SW8260B or C	sec-Butylbenzene	135-98-8	ug/L	1	--	--	--	--	--	NO	72	127	72	127	20
SW8260B or C	Styrene	100-42-5	ug/L	1	1,100	1,600	100	100	100	NO	65	134	65	134	20
SW8260B or C	tert-Butyl Methyl Ether (MTBE)	1634-04-4	ug/L	5	12	12	--	13	12	NO	65	123	65	123	20
SW8260B or C	tert-Butylbenzene	98-06-6	ug/L	1	--	--	--	--	--	NO	70	129	70	129	20
SW8260B or C	Tetrachloroethene	127-18-4	ug/L	1	9.7	0.11	5	5	0.11	YES	66	128	66	128	20
SW8260B or C	Toluene	108-88-3	ug/L	1	860	2,300	1,000	150	150	NO	77	122	77	122	20
SW8260B or C	trans-1,2-Dichloroethene	156-60-5	ug/L	1	86	110	100	10	10	NO	63	137	63	137	20
SW8260B or C	trans-1,3-Dichloropropene	10061-02-6	ug/L	1	--	--	--	--	--	NO	59	135	59	135	20
SW8260B or C	Trichloroethene	79-01-6	ug/L	1	0.44	1.7	5	5	0.44	YES	70	127	70	127	20
SW8260B or C	Trichlorofluoromethane (Freon 11)	75-69-4	ug/L	1	1,100	1,300	--	150	150	NO	57	129	57	129	20
SW8260B or C	Vinyl Chloride	75-01-4	ug/L	1	0.015	0.016	2	0.5	0.015	YES	50	134	50	134	20
SW8260B or C	Xylenes, Total	1330-20-7	ug/L	2	190	200	10,000	1,750	190	NO	75	125	75	125	20
SW8260B or C	m -Xylene	108-38-3	ug/L	2	190	1,400	--	--	190	NO	76	128	76	128	20
SW8260B or C	o-Xylene	95-47-6	ug/L	1	190	1,400	--	--	190	NO	80	121	80	121	20
SW8260B or C	p-Xylene	106-42-3	ug/L	1	190	1,500	--	--	190	NO	76	128	76	128	20
SW8670C or D	1,2,4-Trichlorobenzene	120-82-1	ug/L	10	0.99	8.2	70	--	0.99	YES	37	120	37	120	20
SW8670C or D	1,2-Dichlorobenzene	95-50-1	ug/L	10	280	370	600	--	280	NO	33	120	33	120	20
SW8670C or D	1,3-Dichlorobenzene	541-73-1	ug/L	10	--	--	--	--	--	NO	32	120	32	120	20
SW8670C or D	1,4-Dichlorobenzene	106-46-7	ug/L	10	0.42	0.43	75	--	0.42	YES	32	120	32	120	20
SW8670C or D	2,4,5-Trichlorophenol	95-95-4	ug/L	50	890	3,700	--	--	890	NO	49	120	49	120	20
SW8670C or D	2,4,6-Trichlorophenol	88-06-2	ug/L	10	3.5	6.1	--	--	3.5	YES	49	126	49	126	20
SW8670C or D	2,4-Dichlorophenol	120-83-2	ug/L	10	35	110	--	--	35	NO	48	120	48	120	20
SW8670C or D	2,4-Dimethylphenol	105-67-9	ug/L	10	270	730	--	--	270	NO	28	120	28	120	20
SW8670C or D	2,4-Dinitrophenol	51-28-5	ug/L	10	30	73	--	--	30	NO	25	130	25	130	20
SW8670C or D	2,4-Dinitrotoluene	121-14-2	ug/L	10	0.2	73	--	--	0.2	YES	51	120	51	120	20
SW8670C or D	2,6-Dinitrotoluene	606-20-2	ug/L	10	15	37	--	--	15	NO	49	120	49	120	20
SW8670C or D	2-Chloronaphthalene	91-58-7	ug/L	10	550	2,900	--	--	550	NO	49	120	49	120	20
SW8670C or D	2-Chlorophenol	95-57-8	ug/L	10	71	180	--	--	71	NO	37	120	37	120	20
SW8670C or D	2-Methylnaphthalene	91-57-6	ug/L	10	27	150	--	--	27	NO	46	120	46	120	20
SW8670C or D	2-Methylphenol (o-Cresol)	95-48-7	ug/L	10	720	1,800	--	--	720	NO	38	120	38	120	20
SW8670C or D	2-Nitroaniline	88-74-4	ug/L	50	150	--	--	--	150	NO	48	120	48	120	20

TABLE 4-2

Reporting Limits, Accuracy, and Precision Limits for Groundwater

PG&E Program Quality Assurance Project Plan

					EPA Regional Screening Levels	EPA Regional Screening Levels	Federal Drinking Water Standards	California Drinking Water Standards			LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Water
Method	**Constituent**	**CAS**	**Units**	**QAPP RL**	**May 2012**	**2008**	**MCLs**	**MCLs**	**Most Stringent Screening Level**	**Does RL Exceed Screening Level?**	**Lower Limit**	**Upper Limit**	**Lower Limit**	**Upper Limit**	**% RPD**
SW8670C or D	2-Nitrophenol	88-75-5	ug/L	10	--	--	--	--	--	NO	39	123	39	123	20
SW8670C or D	3,3'-Dichlorobenzidine	91-94-1	ug/L	20	0.11	0.15	--	--	0.11	YES	20	120	20	120	20
SW8670C or D	3-Nitroaniline	99-09-2	ug/L	50	--	3.2	--	--	3.2	YES	20	126	20	126	20
SW8670C or D	4,6-Dinitro-2-methylphenol	534-52-1	ug/L	50	1.2	3.7	--	--	1.2	YES	40	130	40	130	20
SW8670C or D	4-Bromophenyl Phenyl Ether	101-55-3	ug/L	10	--	--	--	--	--	NO	52	120	52	120	20
SW8670C or D	4-Chloro-3-methylphenol	59-50-7	ug/L	20	1,100	--	--	--	1,100	NO	47	120	47	120	20
SW8670C or D	4-Chloroaniline	106-47-8	ug/L	20	0.32	1.2	--	--	0.32	YES	20	120	20	120	20
SW8670C or D	4-Chlorophenyl phenyl ether	7005-72-3	ug/L	10	--	--	--	--	--	NO	50	120	50	120	20
SW8670C or D	4-Methylphenol (p-Cresol)	106-44-5	ug/L	50	1,400	180	--	--	180	NO	32	120	32	120	20
SW8670C or D	4-Nitroaniline	100-01-6	ug/L	50	3.3	3.2	--	--	3.2	YES	36	120	36	120	20
SW8670C or D	4-Nitrophenol	100-02-7	ug/L	50	--	--	--	--	--	NO	20	120	20	120	20
SW8670C or D	Acenaphthene	83-32-9	ug/L	10	400	2,200	--	--	400	NO	47	120	47	120	20
SW8670C or D	Acenaphthylene	208-96-8	ug/L	10	--	--	--	--	--	NO	50	120	50	120	20
SW8670C or D	Anthracene	120-12-7	ug/L	10	1,300	11,000	--	--	1,300	NO	54	120	54	120	20
SW8670C or D	Benzo (a) anthracene	56-55-3	ug/L	10	0.029	0.029	--	--	0.029	YES	56	100	56	100	20
SW8670C or D	Benzo (a) pyrene	50-32-8	ug/L	10	0.0029	0.0029	0.2	--	0.0029	YES	53	120	53	120	20
SW8670C or D	Benzo (b) fluoranthene	205-99-2	ug/L	10	0.029	0.029	--	--	0.029	YES	45	124	45	124	20
SW8670C or D	Benzo (g,h,i) perylene	191-24-2	ug/L	10	--	--	--	--	--	NO	38	123	38	123	20
SW8670C or D	Benzo (k) fluoranthene	207-08-9	ug/L	10	0.29	0.29	--	--	0.29	YES	45	124	45	124	20
SW8670C or D	Benzoic acid	65-85-0	ug/L	100	58,000	150,000	--	--	58,000	NO	20	120	20	120	20
SW8670C or D	Benzyl alcohol	100-51-6	ug/L	20	1,500	18,000	--	--	1,500	NO	30	120	30	120	20
SW8670C or D	bis (2-chloroethoxy) methane	111-91-1	ug/L	10	47	110	--	--	47	NO	46	120	46	120	20
SW8670C or D	bis (2-chloroethyl) ether	111-44-4	ug/L	10	0.012	0.012	--	--	0.012	YES	37	120	37	120	20
SW8670C or D	bis (2-chloroisopropyl) ether	108-60-1	ug/L	10	0.31	0.32	--	--	0.31	YES	26	131	26	131	20
SW8670C or D	bis (2-ethylhexyl) phthalate	117-81-7	ug/L	10	0.071	4.8	6	--	0.071	YES	42	126	42	126	20
SW8670C or D	Butyl benzylphthalate	85-68-7	ug/L	10	14	35	--	--	14	NO	46	120	46	120	20
SW8670C or D	Chrysene	218-01-9	ug/L	10	2.9	2.9	--	--	2.9	YES	55	120	55	120	20
SW8670C or D	Dibenzo (a,h) anthracene	53-70-3	ug/L	10	0.0029	0.0029	--	--	0.0029	YES	42	127	42	127	20
SW8670C or D	Dibenzofuran	132-64-9	ug/L	10	5.8	--	--	--	5.8	YES	54	120	54	120	20
SW8670C or D	Diethyl phthalate	84-66-2	ug/L	10	11,000	29,000	--	--	11,000	NO	41	120	41	120	20
SW8670C or D	Dimethyl phthalate	131-11-3	ug/L	10	--	--	--	--	--	NO	25	127	25	127	20
SW8670C or D	Di-n-butylphthalate	84-74-2	ug/L	10	670	3,700	--	--	670	NO	54	120	54	120	20
SW8670C or D	Di-n-octylphthalate	117-84-0	ug/L	10	--	--	--	--	--	NO	37	137	37	137	20
SW8670C or D	Fluoranthene	206-44-0	ug/L	10	630	1,500	--	--	630	NO	54	120	54	120	20
SW8670C or D	Fluorene	86-73-7	ug/L	10	220	1,500	--	--	220	NO	50	120	50	120	20
SW8670C or D	Hexachlorobenzene	118-74-1	ug/L	10	0.042	0.042	1	--	0.042	YES	52	120	52	120	20
SW8670C or D	Hexachlorobutadiene	87-68-3	ug/L	10	0.26	0.86	--	--	0.26	YES	27	120	27	120	20
SW8670C or D	Hexachloroethane	67-72-1	ug/L	10	0.79	4.8	--	--	0.79	YES	28	120	28	120	20
SW8670C or D	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/L	10	0.029	0.029	--	--	0.029	YES	43	125	43	125	20
SW8670C or D	Isophorone	78-59-1	ug/L	10	67	71	--	--	67	NO	50	120	50	120	20
SW8670C or D	Naphthalene	91-20-3	ug/L	10	0.14	0.14	--	--	0.14	YES	39	120	39	120	20
SW8670C or D	Nitrobenzene	98-95-3	ug/L	10	0.12	3.4	--	--	0.12	YES	44	120	44	120	20
SW8670C or D	n-Nitrosodi-n-propylamine	621-64-7	ug/L	10	0.0093	0.0096	--	--	0.0093	YES	34	128	34	128	20
SW8670C or D	n-Nitrosodiphenylamine	86-30-6	ug/L	10	10	14	--	--	10	NO	48	120	48	120	20
SW8670C or D	Pentachlorophenol	87-86-5	ug/L	50	0.17	0.56	1	--	0.17	YES	38	120	38	120	20
SW8670C or D	Phenanthrene	85-01-8	ug/L	10	--	--	--	--	--	NO	51	120	51	120	20
SW8670C or D	Phenol	108-95-2	ug/L	10	4,500	11,000	--	--	4,500	NO	20	120	20	120	20
SW8670C or D	Pyrene	129-00-0	ug/L	10	87	1,100	--	--	87	NO	49	128	49	128	20
SW8270SIM	1-methylnaphthalene	90-12-0	ug/L	0.2	0.97	2.3	--	--	0.97	NO	35	131	35	131	30
SW8270SIM	2-methylnaphthalene	91-57-6	ug/L	0.2	27	150	--	--	27	NO	36	121	36	121	30
SW8270SIM	Acenaphthene	83-32-9	ug/L	0.2	400	2,200	--	--	400	NO	39	125	39	125	30
SW8270SIM	Acenaphthylene	208-96-8	ug/L	0.2	--	--	--	--	--	NO	43	140	43	140	30
SW8270SIM	Anthracene	120-12-7	ug/L	0.2	1,300	11,000	--	--	1,300	NO	41	132	41	132	30
SW8270SIM	Benzo (a) anthracene	56-55-3	ug/L	0.2	0.029	0.029	--	--	0.029	YES	58	141	58	141	30
SW8270SIM	Benzo (a) pyrene	50-32-8	ug/L	0.2	0.0029	0.0029	0.2	--	0.0029	YES	31	142	31	142	30
SW8270SIM	Benzo (b) fluoranthene	205-99-2	ug/L	0.2	0.029	0.029	--	--	0.029	YES	42	156	42	156	30
SW8270SIM	Benzo (g,h,i) perylene	191-24-2	ug/L	0.2	--	--	--	--	--	NO	12	171	12	171	30
SW8270SIM	Benzo (k) fluoranthene	207-08-9	ug/L	0.2	0.29	0.29	--	--	0.29	NO	49	165	49	165	30
SW8270SIM	Chrysene	218-01-9	ug/L	0.2	2.9	2.9	--	--	2.9	NO	51	155	51	155	30
SW8270SIM	Dibenzo (a,h) anthracene	53-70-3	ug/L	0.2	0.0029	0.0029	--	--	0.0029	YES	28	153	28	153	30
SW8270SIM	Fluoranthene	206-44-0	ug/L	0.2	630	1,500	--	--	630	NO	47	158	47	158	30
SW8270SIM	Fluorene	86-73-7	ug/L	0.2	220	1,500	--	--	220	NO	40	140	40	140	30
SW8270SIM	Indeno (1,2,3-c,d) pyrene	193-39-5	ug/L	0.2	0.029	0.029	--	--	0.029	YES	20	167	20	167	30

TABLE 4-2

Reporting Limits, Accuracy, and Precision Limits for Groundwater

PG&E Program Quality Assurance Project Plan

					EPA Regional Screening Levels	EPA Regional Screening Levels	Federal Drinking Water Standards	California Drinking Water Standards			LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Water
Method	**Constituent**	**CAS**	**Units**	**QAPP RL**	**May 2012**	**2008**	**MCLs**	**MCLs**	**Most Stringent Screening Level**	**Does RL Exceed Screening Level?**	**Lower Limit**	**Upper Limit**	**Lower Limit**	**Upper Limit**	**% RPD**
SW8270SIM	Naphthalene	91-20-3	ug/L	0.2	0.14	0.14	--	--	0.14	YES	39	125	39	125	30
SW8270SIM	Phenanthrene	85-01-8	ug/L	0.2	--	--	--	--	--	NO	46	144	46	144	30
SW8270SIM	Pyrene	129-00-0	ug/L	0.2	87	1,100	--	--	87	NO	39	158	39	158	30
CF-IRMS	D18O	D18O	0/00	--	--	--	--	--	--	NO	--	--	--	--	20
CF-IRMS	DD	DD	0/00	--	--	--	--	--	--	NO	--	--	--	--	20
SM7110C	Gross alpha	Gross alpha	pCi/L	3	--	--	15	15	15	NO	--	--	--	--	20
E900.0	Gross beta	Gross beta	pCi/L	4	--	--	--	4	4	NO	--	--	--	--	20
E903.1	Radium-226	013982-63-3	pCi/L	1	--	--	5	--	5	NO	--	--	--	--	20
E904.0	Radium-228	015262-20-1	pCi/L	1	--	--	5	--	5	NO	--	--	--	--	20
E905.0	Strontium	7440-26-4	pCi/L	2	--	--	--	8	8	NO	--	--	--	--	20
E906.0	Tritium	10028-17-8	pCi/L	1,000	--	--	--	20,000	20,000	NO	--	--	--	--	20
E908.0	Uranium	7440-61-1	pCi/L	1	--	--	--	20	20	NO	--	--	--	--	20
RSK-175	Carbon Dioxide	124-38-9	ug/L	5	--	--	--	--	--	NO	80	120	80	120	20
RSK-175	Ethane	74-84-0	ug/L	5	--	--	--	--	--	NO	80	120	80	120	20
RSK-175	Ethene	74-85-1	ug/L	5	--	--	--	--	--	NO	80	120	80	120	20
RSK-175	Methane	74-82-8	ug/L	5	--	--	--	--	--	NO	80	120	80	120	20

Notes:

Please keep in mind, Screening Levels are constantly revised by the EPA. The appropriate Screening Levels are specific to the project, the location, the agency providing oversight, and the overall goals of the project.

mg/L = milligrams per liter
ug/L = micrograms per liter
µmhos/cm = micromhos per centimeter
pCi/L = picocuries per liter

[1] For groundwater, most stringent of:
EPA Regional Screening Levels - 2008 and May 2012
Federal Drinking Water Standards, MCLs
*Secondary Federal Drinking Water Standards, MCLs
California Drinking Water Standards, MCLs

TABLE 4-3

Maximum Concentrations for Title 22

PG&E Program Quality Assurance Project Plan

					CA TTCL/STLC						LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
Method	**Constituent**	**CAS**	**Units**	**TCLP Regulatory Standards**	**Title 22 TTLC MCL (mg/kg)**	**If TTLC Concentration is ≥ this value STLC Analysis Must be performed**	**Title 22 STLC MCL**	**Most Stringent Screening Level**	**RL**	**Does RL Exceed Screening Level?**	**Lower Limit**	**Upper Limit**	**Lower Limit**	**Upper Limit**	**% RPD**
SW6010B	Antimony	7440-36-0	mg/kg	--	500	150	15	15	5	NO	80	120	75	125	20
SW6010B	Arsenic	7440-38-2	mg/kg	5	500	50	5	5	5	NO	80	120	75	125	20
SW6010B	Barium	7440-39-3	mg/kg	100	10,000	1,000	100	100	10	NO	80	120	75	125	20
SW6010B	Beryllium	7440-41-7	mg/kg	--	75	7.5	0.75	0.75	1	YES	80	120	75	125	20
SW6010B	Cadmium	7440-43-9	mg/kg	1	100	10	1	1	1	NO	80	120	75	125	20
SW6010B	Chromium	7440-47-3	mg/kg	5	2,500	50	5	5	5	NO	80	120	75	125	20
SW3060A	Chromium, Hexavalent	18540-29-9	mg/kg	--	500	50	5	5	0.4	NO	80	120	75	125	20
SW6010B	Cobalt	7440-48-4	mg/kg	--	8,000	800	80	80	10	NO	80	120	75	125	20
SW6010B	Copper	7440-50-8	mg/kg	--	2,500	250	25	25	5	NO	80	120	75	125	20
SW6010B	Lead	7439-92-1	mg/kg	5	1,000	50	5	5	5	NO	80	120	75	125	20
SW7470A	Mercury	7439-97-6	mg/kg	0.2	20	2	0.2	0.2	0.1	NO	75	125	75	125	20
SW6010B	Molybdenum	7439-98-7	mg/kg	--	3,500	3,500	350	350	10	NO	80	120	75	125	20
SW6010B	Nickel	7440-02-0	mg/kg	--	2,000	200	20	20	5	NO	80	120	75	125	20
SW6010B	Selenium	7782-49-2	mg/kg	1	100	10	1	1	5	YES	80	120	75	125	20
SW6010B	Silver	7440-22-4	mg/kg	5	500	50	5	5	5	NO	80	120	75	125	20
SW6010B	Thallium	7440-28-0	mg/kg	--	700	70	7	7	5	NO	80	120	75	125	20
SW6010B	Vanadium	7440-62-2	mg/kg	--	2,400	240	24	24	5	NO	80	120	75	125	20
SW6010B	Zinc	7440-66-6	mg/kg	--	5,000	2,500	250	250	10	NO	80	120	75	125	20
SW8260B	Benzene	71-43-2	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8260B	Carbon tetrachloride	56-23-5	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8260B	Chlorobenzene	108-90-7	mg/L	100	--	--	--	100	--	YES	--	--	--	--	--
SW8260B	Chloroform	67-66-3	mg/L	6	--	--	--	6	--	YES	--	--	--	--	--
SW8260B	o-Cresol (2-Methylphenol)	95-48-7	mg/L	200	--	--	--	200	--	YES	--	--	--	--	--
SW8260B	m-Cresol	108-39-4	mg/L	200	--	--	--	200	--	YES	--	--	--	--	--
SW8260B	p-Cresol (4-Methylphenol)	106-44-5	mg/L	200	--	--	--	200	--	YES	--	--	--	--	--
SW8260B	Total Cresols		mg/L	200	--	--	--	200	--	YES	--	--	--	--	--
SW8260B	1,4-Dichlorobenzene	106-46-7	mg/L	7.5	--	--	--	7.5	--	YES	--	--	--	--	--
SW8260B	1,2-Dichloroethane (EDC)	107-06-2	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8260B	1,1-Dichloroethylene	75-35-4	mg/L	0.7	--	--	--	0.7	--	YES	--	--	--	--	--
SW8260B	Hexachlorobutadiene	87-68-3	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8260B	Tetrachloroethylene (PCE)	127-18-4	mg/L	0.7	2,040	--	204	0.7	--	YES	--	--	--	--	--
SW8260B	Vinyl chloride	75-01-4	mg/L	0.2	--	--	--	0.2	--	YES	--	--	--	--	--
SW8260B	Trichloroethylene (TCE)	79-01-6	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8260B	2-Butanone (MEK)	78-93-3	mg/L	200	--	--	--	200	--	YES	--	--	--	--	--
SW8270C	2,4-Dinitrotoluene	121-14-2	mg/L	0.13	--	--	--	0.13	--	YES	--	--	--	--	--
SW8270C	Hexachlorobenzene	118-74-1	mg/L	0.13	--	--	--	0.13	--	YES	--	--	--	--	--
SW8270C	Hexachloroethane	67-72-1	mg/L	3	--	--	--	3	--	YES	--	--	--	--	--
SW8270C	Hexachlorobutadiene	87-68-3	mg/L	0.5	--	--	--	0.5	--	YES	--	--	--	--	--
SW8270C	Nitrobenzene	98-95-3	mg/L	2	--	--	--	2	--	YES	--	--	--	--	--
SW8270C	Pentachlorophenol	87-86-5	mg/L	100	17	--	1.7	1.7	--	YES	--	--	--	--	--
SW8270C	2,4,5-Trichlorophenol	95-95-4	mg/L	400	--	--	--	400	--	YES	--	--	--	--	--
SW8270C	2,4,6-Trichlorophenol	88-06-2	mg/L	2	--	--	--	2	--	YES	--	--	--	--	--
SW8270C	Pyridine	110-86-1	mg/L	5	--	--	--	5	--	YES	--	--	--	--	--
SW8270C	3,3-Dichlorobenzidine		mg/L	0.01	--	--	--	0.01	--	YES	--	--	--	--	--
SW8081A	Endrin	72-20-8	mg/L	0.02	0.2	--	0.02	0.02	--	YES	--	--	--	--	--
SW8081A	Heptachlor (and its epoxide)	76-44-8	mg/L	0.008	4.7	--	0.47	0.008	--	YES	--	--	--	--	--
SW8081A	Methoxychlor	72-43-5	mg/L	10	100	--	10	10	--	YES	--	--	--	--	--
SW8081A	Toxaphene	8001-35-2	mg/L	0.5	5	--	0.5	0.5	--	YES	--	--	--	--	--
SW8081A	Chlordane	57-74-9	mg/L	0.03	2.5	--	0.25	0.03	--	YES	--	--	--	--	--
SW8081A	Lindane	58-89-9	mg/L	0.4	4	--	0.4	0.4	--	YES	--	--	--	--	--
SW8081A	Aldrin	309-00-2	mg/L	--	1.4	--	0.14	0.14	--	YES	--	--	--	--	--
SW8081A	Kepone	143-50-0	mg/L	--	21	--	2.1	2.1	--	YES	--	--	--	--	--
SW8081A	4,4'-DDD	72-54-8	mg/L	--	1	--	0.1	0.1	--	YES	--	--	--	--	--

TABLE 4-3

Maximum Concentrations for Title 22

PG&E Program Quality Assurance Project Plan

					CA TTCL/STLC						LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
Method	**Constituent**	**CAS**	**Units**	**TCLP Regulatory Standards**	**Title 22 TTLC MCL (mg/kg)**	**If TTLC Concentration is ≥ this value STLC Analysis Must be performed**	**Title 22 STLC MCL**	**Most Stringent Screening Level**	**RL**	**Does RL Exceed Screening Level?**	**Lower Limit**	**Upper Limit**	**Lower Limit**	**Upper Limit**	**% RPD**
SW8081A	4,4'-DDE	72-55-9	mg/L	--	1	--	0.1	0.1	--	YES	--	--	--	--	--
SW8081A	4,4'-DDT	50-29-3	mg/L	--	1	--	0.1	0.1	--	YES	--	--	--	--	--
SW8081A	Dieldrin	60-57-1	mg/L	--	8	--	0.8	0.8	--	YES	--	--	--	--	--
SW8081A	Heptachlor	76-44-8	mg/L	--	4.7	--	0.47	0.47	--	YES	--	--	--	--	--
SW8151A	2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	mg/L	10	100	--	10	10	--	YES	--	--	--	--	--
SW8151A	2,4,5-Trichlorophenoxypropionic acid (2,4,5-TP) (Silvex)	93-72-1	mg/L	1	10	--	1	1	--	YES	--	--	--	--	--
SW8082	Polychlorinated biphenyls (PCB)		mg/L	--	50	--	5	5	--	YES	--	--	--	--	--
Dioxins	Dioxin (2,3,7,8-TCDD)	1746-01-6	mg/L	--	0.01	--	0.001	0.001	--	YES	--	--	--	--	--

Notes:

mg/L = milligrams per liter
mg/kg = milligrams per kilogram

TCLP = toxicity characteristic leaching procedure
STLC = soluble threshold limit concentration
TTLC = total threshold limit concentration

TABLE 4-3

Maximum Concentrations for Title 22

PG&E Program Quality Assurance Project Plan

					CA TTCL/STLC						LCS Accuracy Control Limits (%R)		MS/MSD Accuracy Control Limits (%R)		Precision Soil
Method	**Constituent**	**CAS**	**Units**	**TCLP Regulatory Standards**	**Title 22 TTLC MCL (mg/kg)**	**If TTLC Concentration is ≥ this value STLC Analysis Must be performed**	**Title 22 STLC MCL**	**Most Stringent Screening Level**	**RL**	**Does RL Exceed Screening Level?**	**Lower Limit**	**Upper Limit**	**Lower Limit**	**Upper Limit**	**% RPD**
SW8081A	4,4'-DDE	72-55-9	mg/L	--	1	--	0.1	0.1	--	YES	--	--	--	--	--
SW8081A	4,4'-DDT	50-29-3	mg/L	--	1	--	0.1	0.1	--	YES	--	--	--	--	--
SW8081A	Dieldrin	60-57-1	mg/L	--	8	--	0.8	0.8	--	YES	--	--	--	--	--
SW8081A	Heptachlor	76-44-8	mg/L	--	4.7	--	0.47	0.47	--	YES	--	--	--	--	--
SW8151A	2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	mg/L	10	100	--	10	10	--	YES	--	--	--	--	--
SW8151A	2,4,5-Trichlorophenoxypropionic acid (2,4,5-TP) (Silvex)	93-72-1	mg/L	1	10	--	1	1	--	YES	--	--	--	--	--
SW8082	Polychlorinated biphenyls (PCB)		mg/L	--	50	--	5	5	--	YES	--	--	--	--	--
Dioxins	Dioxin (2,3,7,8-TCDD)	1746-01-6	mg/L	--	0.01	--	0.001	0.001	--	YES	--	--	--	--	--

Notes:

mg/L = milligrams per liter
mg/kg = milligrams per kilogram

TCLP = toxicity characteristic leaching procedure
STLC = soluble threshold limit concentration
TTLC = total threshold limit concentration