Pacific Gas and Electric Company

Yvonne Meeks
Manager

Environmental Remediation
Gas T&D Department

Mailing Address
4325 South Higuera Street
San Luis Obispo, CA 93401
Location
6588 Ontario Road
San Luis Obispo, CA 93405
Tel: (805) 546-5243
Email: yjm1@pge.com

03 June, 2011

Mr. Aaron Yue
Chief Permitting Unit
California Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, California 90630

Ms. Pamela S. Innis
Office of Environmental Policy and Compliance
U.S. Department of Interior
P.O. Box 25007 (D-108)
Denver, CO 80225-0007

Subject: Topock Compressor Station – Summary of Media-to-Plant Uptake Models and their Application in the Topock Human and Ecological Risk Assessments

Dear Mr. Yue and Ms. Innis:

Enclosed is the memorandum: *Summary of Media-to-Plant Uptake Models and their Application in the Topock Human and Ecological Risk Assessments* prepared as part of the RCRA Facility Investigation/Remedial Investigation (RFI/RI) process to support the soil investigation and site characterization at the Pacific Gas and Electric (PG&E) Topock Compressor Station (the site).

This memorandum is prepared as an action item from the recent Plant Uptake Meeting held on April 28, 2011 in Needles, California where the agencies and tribes requested a compilation of media-to-plant uptake models that have been used in the site evaluation to date. Additionally, as requested, the previously submitted documents containing media-to-plant uptake models are also enclosed.

Also as requested by the tribes, the figure illustrating the future land use scenarios for the site, identifying which receptors will be evaluated in the upcoming human health risk assessment, is also enclosed. This figure (Figure 2-28) was part of the *Human Health and Ecological Risk Assessment Work Plan* submitted in August 2008.

Please let us know if you have any questions on the attached materials. We appreciate your input, and look forward to your participation in upcoming Plant Uptake meetings.

If you have any questions regarding this letter, please call me at (805) 234-2257.

Sincerely,

Yvonne Meeks
Topock Project Manager

Enclosures: Summary of Media-to-Plant Uptake Models and their Application in the Topock Human and Ecological Risk Assessments.

Attachment 1 – Previously submitted documents containing the media-to-plant uptake models:

- Technical Memorandum 3: Ecological Comparison Values for Metals and Polycyclic Aromatic Hydrocarbons in Soil.
- Technical Memorandum 4: Ecological Comparison Values for Additional Detected Chemicals in Soil.
- Appendix I of the Final GWRA (ARCADIS, 2009): Supplemental Ecological Risk Evaluation to Address HERD Comments Dated March 26, 2009; June 17, 2009; and September 10, 2009.
- Appendix K of the Final GWRA: Evaluation of Secondary Exposure Pathways.

Attachment 2 – Figure 2-28: Anticipated Future Land Use

cc: Michael Eichelberger, DTSC
Carrie Marr, USFWS
Shukla Roy-Semmen, DTSC
Karen Baker, DTSC
Dennis Smith, Herndon Solutions

ARCADIS

ARCADIS U.S., Inc.
100 Montgomery Street
Suite 300
San Francisco
California 94104
Tel 415 374 2744
Fax 415 374 2745

TECHNICAL MEMORANDUM

Date:
June 03, 2011

Subject:
Summary of Media-to-Plant Uptake Models and their Application in the Topock Human and Ecological Risk Assessments

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The purpose of this memorandum is to provide a summary of the media-to-plant uptake models (often referred to as bioaccumulation factors [BAFs]) proposed for evaluating data collected from the Pacific Gas and Electric (PG&E) Topock Compressor Station, located in San Bernardino County, California, 12 miles southeast of Needles (the site).

Media-to-plant BAFs are regressions or multipliers used to estimate concentrations of chemicals that can accumulate in plant tissue through uptake from site media (soil, groundwater). Once the constituent has been taken up into the plant tissue from site media, wildlife and human receptors can potentially be exposed to the constituents in plant tissue through ingestion of the plants. Media-to-plant BAFs are not used in evaluating risk to plants. Potential risk to plants is evaluated using soil screening values which are threshold values below which adverse effects to plants are unlikely. Soil screening values protective of plants are presented in the technical memoranda (TMs) provided as an attachment to this document.

Media-to-plant BAFs recommended by California Environmental Protection Agency (Cal/EPA), United States Environmental Protection Agency (USEPA), and/or other widely used sources in risk assessments have been proposed for use at the site and presented in the following risk assessment documents previously submitted to and approved by the agencies:

1) *Human Health and Ecological Risk Assessment Work Plan* (RAWP; ARCADIS 2008a) for use in the upcoming ecological risk assessment (ERA) for the site;

2) *Ecological Comparison Values Technical Memorandum 3* (ECV TM3; ARCADIS 2008b) and *Ecological Comparison Values Technical Memorandum 4* (ECV TM4; ARCADIS 2009a), where ECVs were developed for use in assessing the adequacy of site characterization; and

3) *Human and Ecological Risk Assessment of Groundwater Impacted by Activities at Solid Waste Management Unit (SWMU) 1/Area of Concern (AOC) 1 and SWMU 2* (GWRA: ARCADIS 2009b) where BAFs were used for characterizing risk to humans and herbivorous mammals ingesting plants that are potentially exposed to chemicals of interest (COI) in groundwater.

For convenience, the relevant portions of these documents where media-to-plant BAFs have been previously used and/or proposed for the site are presented as attachments to this memorandum.

Table 1 presents a brief summary of the data used in estimating soil-to-plant BAFs for total chromium and hexavalent chromium used in estimating the ECVs, as presented in ECV TM3[1] (ARCADIS 2008b). Table 2 presents a summary of the soil-to-plant BAFs for all detected constituents used in estimating the ECVs, as presented in ECV TM3[1] (ARCADIS 2008b) and ECV TM4 (ARCADIS 2009a). Soil ECVs are risk-based values protective of ecological receptors (i.e., wildlife) and were developed based on exposure to constituents in soil via incidental ingestion of soil and via ingestion of plants that could have accumulated constituents by passive and active uptake from soil. Table 3 presents a summary of the groundwater-to-plant BAFs used in the GWRA to evaluate pathway for COIs in groundwater to plant tissue via root uptake and translocation, then potential ingestion of these COIs in plant tissue by herbivorous mammals (ARCADIS 2009b). Table 4 presents a summary of the soil-to-plant BAFs used in the GWRA to characterize risk to humans who could ingest crops that were irrigated with impacted groundwater (ARCADIS 2009b). These tables present the media-to-plant BAFs, the source of the BAFs, and a brief summary of the data that form the basis of the BAFs. The following text provides a brief discussion of how the media-to-plant BAFs are used in the ecological and human health risk assessment to estimate the concentrations of constituents in plant tissue.

Use of Media-to-Plant BAFs in Estimating Concentrations of Constituents in Plant Tissue

Ecological Risk Assessment

In both ecological and human health risk assessments, the concentration of constituents in plant tissue is estimated using media-to-tissue BAFs. Specifically, if the impacted media is soil, then the concentration of the constituent that is predicted to be present in the plant tissue is estimated using the following equation:

$$C_{plant\_tissue} = C_{soil} \times BAF$$

Where:

C_{soil} = concentration of constituent in soil (mg/kg soil)

C_{plant_tissue} = concentration of constituent in plant tissue (mg/kg tissue)

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[1] The soil-to-plant BAFs presented in ECV TM3 (ARCADIS 2008b) are the same as those presented in the RAWP (ARCADIS 2008a).

BAF = bioaccumulation factor or regression for soil-to-plant uptake, reported as concentration in the plant tissue (mg/kg) divided by concentration in the soil (mg/kg), or kg soil/kg plant tissue (kg soil/kg plant tissue).

Once the constituent has been taken up into the plant tissue from soil, wildlife receptors may be exposed to the constituents in the plant tissue through ingestion of the plants. As indicated in the RAWP (ARCADIS 2008a), the site specific ecological risk assessment for Topock will include estimated ingestion of constituents in plant tissue in addition to exposure resulting from incidental ingestion of the soil.

Human Health Risk Assessment

Similarly for human health risk assessments, the concentration of chemicals in plants can be estimated using media-to-plant BAFs. The BAFs used in the GWRA were those recommended by Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA) for use in the Air Toxic Hot Spots Program (Cal/EPA 2003). Although the Air Toxic Hot Spots Program is focused on evaluating and regulating airborne releases from stationary sources, once a constituent is released and present in soil, the processes described in the Cal/EPA guidance document that govern how the constituent can be taken up into a plant, and how humans can subsequently be exposed to the plants, are directly applicable to the Topock site, and almost any other site where human exposure via plant uptake is a pathway of concern[2].

As presented by Cal/EPA (2003), the concentration of contaminants in plants is a function of root uptake as well as direct areal deposition onto the plant. The two processes are estimated via the equations shown below (Cal/EPA 2003).

The contribution of the contaminant that gets into the plant through areal deposition of soil particles suspended in air is estimated as follows (Cal/EPA 2003):

$$C_{plant\_tissue} = (C_{dep}) * (GRAF) + C_{trans}$$

Where:

C_{plant_tissue} = concentration of constituent in the plant tissue (mg/kg)(referred to as Cf, or concentration in food, in Cal/EPA 2003)

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[2] For the GWRA, we used the application of impacted groundwater to estimate the concentration of chromium in the soil and the concentration directly deposited onto the plant. Once the chromium is in the soil and deposited onto the plant, all methods used to estimate the final concentration of chromium in the plant are identical to the methods presented in Cal/EPA 2003.

C_{dep} =concentration of constituent in plant tissue due to direct areal deposition onto the plant (mg/kg)

GRAF = gastrointestinal relative adsorption fraction

C_{trans} = concentration of constituent in plant tissue due to translocation from the roots into the plant (mg/kg)

The contribution of the constituent in the plant tissue resulting from direct areal deposition is a function of the assumed concentration associated with suspended particulates in air, a vertical deposition rate, the fraction of the crop which is impacted by areal deposition, and other factors such as overall crop yield and the growth period of the crop (complete equations presented in Cal/EPA 2003[3]).

The contribution of the contaminant that gets into the plant through root translocation from the soil is estimated as follows (Cal/EPA 2003):

$$C_{trans} = C_{soil} \times BAF$$

Where:

C_{soil} =concentration of constituent in the soil (mg/kg)

BAF =bioaccumulation factor (referred to as a root uptake factor in Cal/EPA 2003), reported as concentration in the plant tissue (mg/kg) divided by concentration in the soil (mg/kg), or kg soil/kg plant tissue.

Based on available empirical studies, Cal/EPA recommends the use of different BAFs for three common types of garden vegetables: vine crops (such as tomatoes, beans, snap peas, summer sqaush, grapes, strawberries, zucchini, peppers and cucumbers); leafy crops (such as lettuce, greens, cabbage, asparagus, and broccoli); and root crops (such as carrots, potatoes, radishes and onions). Human receptors can potentially be exposed to the constituents in the plant tissue through ingestion of the plants (i.e., the crops). As indicated in the RAWP (ARCADIS 2008a), the site specific human health risk assessment for Topock will include estimated ingestion of constituents in plant tissue in addition to exposure resulting from ingestion, dermal contact with, and inhalation of the soil.

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[3] For the GWRA, we used irrigation water application to estimate the contribution from direct deposition. All assumptions are presented in Appendix K of the GWRA, and presented as an attachment to this memorandum.

Tables:

1. Summary of Data Used to Estimate Soil-to-Plant Uptake Factors for Total Chromium and Hexavalent Chromium.

2. Summary of Soil-to-Plant Uptake Models Used to Estimate Ecological Comparison Values for Detected Constituents in Soil

3. Summary of Groundwater-to-Plant Uptake BAFs Used in Ecological GWRA

4. Summary of Soil-to-Plant Uptake BAFs Used in Human Health GWRA

Attachment 1:

- Technical Memorandum 3: Ecological Comparison Values for Metals and Polycyclic Aromatic Hydrocarbons in Soil (ARCADIS, 2008b).

- Technical Memorandum 4: Ecological Comparison Values for Additional Detected Chemicals in Soil (ARCADIS, 2009a).

- Appendix I of the Final GWRA (ARCADIS, 2009b): Supplemental Ecological Risk Evaluation to Address HERD Comments Dated March 26, 2009; June 17, 2009; and September 10, 2009.

- Appendix K of the Final GWRA (ARCADIS, 2009b): Evaluation of Secondary Exposure Pathways.

References

ARCADIS. 2008a. *Human Health and Ecological Risk Assessment Work Plan*. PG&E Topock Compressor Station, Needles California. February.

ARCADIS. 2008b. *Technical Memorandum 3: Ecological Comparison Values for Metals and Polycyclic Aromatic Hydrocarbons in Soil*. May.

ARCADIS. 2009a. *Technical Memorandum 4: Ecological Comparison Values for Additional Detected Chemicals in Soil.* July.

ARCADIS. 2009b. *Human and Ecological Risk Assessment of Groundwater Impacted by Activities as Solid Waste Management Unit (SWMU) 1/Area of Concern (AOC) 1 and SWMU 2.* December.

CalEPA. 2003. *Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA). August.

TABLES

Table 1.
Summary of Data Used to Estimate Soil-to-Plant Uptake Factors for Total Chromium and Hexavalent Chromium

PG&E Topock Compressor Station
Needles, California

Analyte	Soil-to-Plant Uptake Models to Estmate Plant Tissue Concentrations[a]		
	Plant BAF/Regression	**Source**	**Summary of Data used in the Model**
Metals			
Chromium, total	$Cp = 0.041 * C_s$	USEPA, 2007	EcoSSL guidance (USEPA, 2007) recommends the median plant uptake value for total chromium derived by Bechtel Jacobs (1998; ORNL guidance). Bechtel Jacobs (1998) derived the plant uptake value for total chromium based on data from a field study conducted in Bartlesville, Oklahoma (PTI, 1995). An uptake factor for total chromium was calculated by dividing the concentration of total chromium in plants (stem/leaves) by the concentration of total chromium in collocated soil. A median value was then calculated based on 28 such individual uptake factors. Plant species used in this uptake calculation included annual ragweed (*Ambrosia artemisiifolia*), beggar's ticks (*Bidens polylepsis*), Bermuda grass (*Cynodon dactylon*), big bluestem (*Andropogon gerardi*), giant ragweed (*Ambrosia trifida*), 6 Indian grass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*).
Chromium, hexavalent	$Cp = 0.041 * C_s$	USEPA, 2007	Data for developing a plant uptake factor specifically for hexavalent chromium is not available. USEPA (2007) recommends the plant uptake factor based on data for total chromium. See BAF for total chromium for details.

Notes:
-- = not applicable
C_p = constituent concentration in plants (expressed in mg/kg, dry weight)
C_s = constituent concentration in soil (expressed in mg/kg, dry weight)
ORNL = Oakridge National Laboratory
USEPA = United States Environmental Protection Agency

a. Soil-to-plant uptake model for chromium presented in ECV TM3 (ARCADIS, 2008).

References:

ARCADIS. 2008. Topock Compressor Station – Technical Memorandum: Ecological Comparison Values for Metals and Polycyclic Aromatic Hydrocarbons. May 23.

Bechtel Jacobs Company LLC. 1998. Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants. Bechtel Jacobs Company LLC, Oak Ridge, TN. BJC/OR-133.

PTI Environmental Services. 1995. National Zinc Site Remedial Investigation Feasibility Study. Volume IV. Ecological Risk Assessment -- Operable Unit 2. Prepared for City of Bartlesville, Oklahoma, Cyprus Amax Minerals Company, Salomon Inc.

USEPA 2007. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER Directive 9285.7-55. United States Environmental Protection Agency Office of Solid Waste and Emergency Response. Washington, DC. November 2003, revised March, 2005. http://www.epa.gov/ecotox/ecossl/

Table 2.
Summary of Soil-to-Plant Uptake Models Used to Estimate Ecological Comparison Values for Detected Constituents in Soil

PG&E Topock Compressor Station
Needles, California

Analyte	Log K_{ow} [b]	Soil-to-Plant Uptake Models to Estmate Plant Tissue Concentrations [a]		
		Plant BAF/Regression	Source	Summary of Data used in the Model
Metals				
Aluminum	--	NA	--	Aluminum is considered a COPEC when soil pH < 5.5 (USEPA 2007), which is not the case at the Site.
Antimony	--	$\ln(C_p) = 0.938 * \ln(C_s) - 3.233$	USEPA, 2007	Regression developed based on data from two studies (17 observations) measuring tissue concentrations in stems and/or leaves from a variety of plants (ragweed, beggar's tick, grass etc.)
Arsenic	--	$Cp = 0.03752 * C_s$	USEPA, 2007	Median value based on field data (122 observations) measuring tissue concentrations in a varitey of plants (corn, grasses, millet, barley, peas, beans, etc. [Bechtel Jacobs, 1998]).
Barium	--	$Cp = 0.156 * C_s$	USEPA, 2007	Median value based on field data (24 observations) measuring tissue concentrations in a varitey of plants (ragweed, beggar's tick, grasses, etc. [Bechtel Jacobs, 1998]).
Beryllium	--	$\ln(C_p) = 0.7345 * \ln(C_s) - 0.5361$	USEPA, 2007	Regression developed based on data (18 observations) from studies measuring tissue concentrations in a variety of plants (soybean, oat, grass, collard).
Cadmium	--	$\ln(C_p) = 0.546 * \ln(C_s) - 0.475$	USEPA, 2007	Regression developed based on data (207 observations) from studies measuring tissue concentrations in a variety of plants (corn, cabbage, soybean, vegetables, etc.).
Calcium	--	no literature uptake model available	chemical generally not considered in risk assessments	--
Chromium, total	--	$Cp = 0.041 * C_s$	USEPA, 2007	Median value based on field data (28 observations) measuring tissue concentrations in a varitey of plants (ragweed, beggar's tick, grasses, etc. [Bechtel Jacobs, 1998]). See Table 1 for details.
Chromium, hexavalent	--	$Cp = 0.041 * C_s$	USEPA, 2007	Based on data for total chromium. See Table 1 for details.
Cobalt	--	$Cp = 0.0075 * C_s$	USEPA, 2007	Median value based on field data (28 observations) measuring tissue concentrations in a varitey of plants (ragweed, beggar's tick, grasses, etc. [Bechtel Jacobs, 1998]).
Copper	--	$\ln(C_p) = 0.394 * \ln(C_s) + 0.668$	USEPA, 2007	Regression developed based on data (180 observations) from studies measuring tissue concentrations in a variety of plants (soybean, spinach, ryegrass, onion, etc.).
Cyanide	--	Cp = 0	assumed[e]	Cyanide is highly reactive and readily metabolized in organisms demonstrating low bioaccumulation potential (Eisler, 1991).
Iron	--	no literature uptake model available	chemical generally not considered in risk assessments	--
Lead	--	$\ln(C_p) = 0.561 * \ln(C_s) - 1.328$	USEPA, 2007	Regression developed based on data (187 observations) from studies measuring tissue concentrations in a variety of plants (grasses, clover, corn, cabbage, lettuce, etc.).
Magnesium	--	no literature uptake model available	chemical generally not considered in risk assessments	--

Table 2.
Summary of Soil-to-Plant Uptake Models Used to Estimate Ecological Comparison Values for Detected Constituents in Soil

PG&E Topock Compressor Station
Needles, California

Analyte	Log K_{ow} [b]	Soil-to-Plant Uptake Models to Estmate Plant Tissue Concentrations [a]		
		Plant BAF/Regression	**Source**	**Summary of Data used in the Model**
Mercury	--	$\ln(C_p) = 0.544 * \ln(C_s) - 0.996$	USEPA, 2007	Regression developed based on data (145 observations) from studies measuring tissue concentrations in a variety of plants (grasses, wheat, carrots, oat, herbs, etc.).
Molybdenum	--	$Cp = 0.25 * C_s$	Baes et al., 1984	Baes et al. 1984 cites a soil-to-plant concentration factor "Bv" of 0.25. The Bv for molybdenum of 0.25 is based on plant data from various studies (pumpkins, vines, white sweet clover, cabbage, and cauliflower).
Nickel	--	$\ln(C_p) = 0.748 * \ln(C_s) - 2.223$	USEPA, 2007	Regression developed based on data (111 observations) from studies measuring tissue concentrations in a variety of plants (grasses, carrots, oat, herbs, etc.).
Potassium	--	no literature uptake model available	chemical generally not considered in risk assessments	--
Selenium	--	$\ln(C_p) = 1.104 * \ln(C_s) - 0.677$	USEPA, 2007	Regression developed based on data (158 observations) from studies measuring tissue concentrations in a variety of plants (mustard, orach, sorgrass, lettuce, spinach, etc.).
Silver	--	$Cp = 0.014 * C_s$	USEPA, 2007	Median value based on field data (10 observations) measuring tissue concentrations in a varitey of plants (ragweed, beggar's tick, grasses, etc. [Bechtel Jacobs, 1998]).
Sodium	--	no literature uptake model available	chemical generally not considered in risk assessments	--
Thallium	--	$Cp = 0.004 * C_s$	Baes et al., 1984	Baes et al. 1984 cites a soil-to-plant concentration factor "Bv" of 0.004. No data were available to estimate a thallium Bv and therefore, corollary information was used to estimate oil-to-plant concentration factor thallium. The Bv for for compounds such as aluminum, gallium, and indium were used as a surrogate for thallium. However, elemental concentrations of gallium, indium, and thallium in soils and a variety of produce are not well-documented. However, Baes et al (1984) assumed the vaues to be consistent with the fragmentary information of observed plant concentrations of these elements.
Vanadium	--	$Cp = 0.00485 * C_s$	USEPA, 2007	Median value based on field data (21 observations) measuring tissue concentrations in a varitey of plants (ragweed, beggar's tick, grasses, etc. [Bechtel Jacobs, 1998]).
Zinc	--	$\ln(C_p) = 0.554 * \ln(C_s) + 1.575$	USEPA, 2007	Median value based on field data (220 observations) measuring tissue concentrations in a varitey of plants (ragweed, beggar's tick, grasses, etc. [Bechtel Jacobs, 1998]).

Table 2.
Summary of Soil-to-Plant Uptake Models Used to Estimate Ecological Comparison Values for Detected Constituents in Soil

PG&E Topock Compressor Station
Needles, California

Analyte	Log K_{ow} [b]	Soil-to-Plant Uptake Models to Estmate Plant Tissue Concentrations [a]		
		Plant BAF/Regression	Source	Summary of Data used in the Model
Polycyclic Aromatic Hydrocarbons (PAHs)				
Total LMW PAH	--	ln(Cp) = 0.4544 * ln(Cs)-1.3205	USEPA, 2007	Regression developed based on data from studies measuring tissue concentrations in a variety of plants (ryegrass, clover, carrot, beet, tc.).
Total HMW PAH	--	ln(Cp) = 0.9469 * ln(Cs)-1.7026	USEPA, 2007	Regression developed based on data from studies measuring tissue concentrations in a variety of plants (ryegrass, clover, carrot, beet, tc.).
Polychlorinated Biphenyls (PCBs)				
Total PCBs	6.3	Cp = 0.01 * Cs	USEPA, 1999 (using Travis and Arms model, 1988; LogKow for Aroclor 1254)	Due to lack of sufficient empirical data uptake estimated based on LogKow for Aroclor 1254
Pesticides				
DDT and Metabolites	6.36	ln(Cp)= 0.7524 * ln(Cs) - 2.5119	USEPA, 2005-2007[c]	Regression developed based on data from studies measuring tissue concentrations in grass.
Alpha-Chlordane	6.16	Cp = 0.19 * Cs	USEPA, 2007 (based on model for non-ionic chemicals)[d]	Due to lack of sufficient empirical data uptake estimated based on LogKow for chlordane.
Gamma-Chlordane	6.16	Cp = 0.19 * Cs	USEPA, 2007 (based on model for non-ionic chemicals)[d]	Due to lack of sufficient empirical data uptake estimated based on LogKow for chlordane.
Dieldrin	4.55	Cp = 0.41 * Cs	USEPA, 2007	Median value based on field data (9 observations) measuring tissue concentrations in a varitey of plants (alfalfa, grass, lettuce).
Volatile Organic Compounds (VOCs)				
Methyl Acetate	0.18	no literature uptake concentration/model available	--	--
Semi-Volatile Organic Compounds (SVOCs)				
2,4-Dimethylphenol	2.3	no literature uptake concentration/model available	--	--
4-Methylphenol (p-Creso	1.94	no literature uptake concentration/model available	--	--
Bis(2-ethylhexyl)phthala	5.11	Cp = 0	assumed based on study by Staples et.al.,1997[e]	Studies demonstrated extremely limited uptake of bis(2-ethylhexyl)phthalate by plants.
Butyl benzyl phthalate	4.91	no literature uptake concentration/model available	--	--
Carbazole	3.23	log (Cp) = 1.588-0.573*(log Kow)	USEPA, 1999 (using Travis and Arms model, 1988)	Due to lack of sufficient empirical data uptake estimated based on LogKow.
Dibenzofuran	4.12	no literature uptake concentration/model available	--	--
Di-n-butylphthalate	4.72	Cp = 0	assumed based on study by Staples et.al.,1997[e]	Studies demonstrated extremely limited uptake of di-n-butyl phthalate by plants.
Pentachlorophenol	5.12	Cp = 5.93 * Cs	USEPA, 2007	Median value based on field data (10 observations) measuring tissue concentrations in a varitey of plants (corn, sybean, fescue, etc.).
Dioxin TEQ	6.64	Cp = 0.0056 * Cs	USEPA, 1999 (using Travis and Arms model, 1988)	Due to lack of sufficient empirical data uptake estimated based on LogKow of 6.64 for TCDD.

Table 2.
Summary of Soil-to-Plant Uptake Models Used to Estimate Ecological Comparison Values for Detected Constituents in Soil

PG&E Topock Compressor Station
Needles, California

Analyte	Log K_{ow}[b]	Soil-to-Plant Uptake Models to Estmate Plant Tissue Concentrations[a]		
		Plant BAF/Regression	Source	Summary of Data used in the Model

Notes:

-- = not applicable

C_p = constituent concentration in plants (expressed in mg/kg, dry weight)

C_s = constituent concentration in soil (expressed in mg/kg, dry weight)

ECV = ecological comparison value

HMW PAHs = high molecular weight polycyclic aromatic hydrocarbons

In = natural log

LMW PAHs = low molecular weight polycyclic aromatic hydrocarbons

mg/kg = milligrams per kilogram

Log Kow = octanol-water partition coefficient

NA = not available

TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin

TEQ = toxic equivalent

TM = technical memorandum

USEPA = United States Environmental Protection Agency

a. Soil-to-plant uptake models presented in ECV TM3 (ARCADIS, 2008) and ECV TM4 (ARCADIS, 2009).

b. Log Kow values were obtained from the Hazardous Substances Data Bank (HSDB, 2007) or the Syracuse Research Corporation (SRC) Chem Fate database or KowWin Demo (SRC, 2007). Chemicals with low Log Kows (<2.0) do not bioaccumulate (CalEPA, 1996 and USEPA, 2000); therefore, uptake models for these chemicals were assumed to be zero.

c. Based on DDT and metabolites.

d. Chlordane used as surrogate; similar model used in the EcoSSL guidance (USEPA, 2007).

e. See ECV TM4 (ARCADIS, 2009) for details.

References:

ARCADIS. 2008. Topock Compressor Station – Technical Memorandum: Ecological Comparison Values for Metals and Polycyclic Aromatic Hydrocarbons. May 23.

ARCADIS. 2009. Technical Memorandum 4: Ecological Comparison Values for Additional Detected Chemicals in Soil. July 1.

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PG&E Topock Compressor Station
Needles, California

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		Plant BAF/Regression	Source	Summary of Data used in the Model

Travis, C.C, and A.D. Arms. 1988. Bioconcentration of Organics in Beef, Milk, and Vegetation. Environmental Science and Technology. 22(3):271-274.

USEPA. 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* . Peer Review Draft. August.

USEPA 2005-2007. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER Directive 9285.7-55. United States Environmental Protection Agency Office of Solid Waste and Emergency Response. Washington, DC. November 2003, revised March, 2005. http://www.epa.gov/ecotox/ecossl/

USEPA. 2007. Updated Attachment 4-1 to USEPA's 2005 *Guidance for Developing Ecological soil screening Levels (EcoSSLs)* : *Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs* Office of Solid Waste and Emergency Response, Washington D.C. February. 113 pp.

Table 3.
Summary of Groundwater-to-Plant Uptake BAFs Used in Ecological GWRA

PG&E Topock Compressor Station
Needles, California

Analyte	Log K_{ow}	Concentrations[a]		
		Plant BAF/Regression	**Source**	**Summary of Data used in the Model**
Metals				
Chromium, hexavalent	--	$Cp = 0.95 * C_w$	Sorrenson et al., 2009	Uptake of hexavalent chromium from water to saltcedar (Tamarix ramsissima) was evaluated. In this study, 6-week-old saltcedar plants were placed in treatment solution containing tapwater (0.0007 mg/L) for control plants and tapwater with chromium (2 mg/L) trioxide, and results were reported as concentrations of elemental chromium. The concentration of chromium in plants grown in 2 mg/L of chromium in treatment solution contained an average of 1.89 mg/kg chromium. The accumulation factor based on this study is approximately 0.95 (i.e., concentration in plant tissue divided by the concentration in water).
Molybdenum	--	not a complete pathway	GWRA (ARCADIS, 2009)	not evaluated
Selenium	--	not a complete pathway	GWRA (ARCADIS, 2009)	not evaluated
Other				
Nitrate	--	not evaluated; no risk predicted	GWRA (ARCADIS, 2009)	not evaluated

Notes:
-- = not applicable
C_p = constituent concentration in plants (expressed in mg/kg, dry weight)
C_w = constituent concentration in water (expressed in mg/L)
GWRA = Groundwater Risk Assessment
mg/kg = milligrams per kilogram
mg/L = milligrams per liter

a. Groundwater-to-plant uptake models presented in the GWRA (ARCADIS, 2009).

References:

ARCADIS. 2009. Final Human Health and Ecological Risk Assessment of Groundwater Impacted by Activities at Solid Waste Management Unit (SWMU) 1/Area of Concern (AOC) 1 and SWMU 2, PG&E Topock Compressor

Sorenson, M.A. , D.R. Parker, and J. T. Trumble. 2009. Effects of pollutant accumulation by the invasive weed saltcedar (*Tamarix ramosissima*) on the biological control agent *Diorhabda elongata* (Coleoptera: Chrysomelidae) *Environmental Pollution* 157: 384–391.

Table 4.
Summary of Soil-to-Plant Uptake BAFs Used in Human Health GWRA

PG&E Topock Compressor Station
Needles, California

Analyte	Soil-to-Plant Uptake Models to Estmate Plant Tissue Concentrations[a]		
	Plant BAF/Regression	**Source of BAF**	**Summary of Data used to Derive BAFs**
Metals			
Chromium, hexavalent, leafy crops[b]	$Cp = 0.0008 * C_s$	Baes et al., 1984	Derived from two studies; one is unpublished (Baes and Katz, no date) , in which the concentration of chromium was measured in pumpkins and pumpkin vines and the corresponding soil, obtained from various different farms in East Tennessee. The second study (Furr et al, 1978) measured chromium levels in sweet clover and the corresponding soil. The number of samples collected and analyzed from both of these studies is not known. The soil-to-plant BAFs were then adjusted by Cal/EPA, to represent wet-weight BAFs, using the dry-weight to wet-weight conversions recommended by Clement Associates (Clement 1988).
Chromium, hexavalent, exposed and protected crops[b]	$Cp = 0.0007 * C_s$	Baes et al., 1984	Derived from three studies; one is unpublished (Baes and Katz, no date) , in which the concentration of chromium was measured in pumpkins and pumpkin vines and the corresponding soil, obtained from various different farms in East Tennessee. The second study (Cherry and Guthrie, 1979) measured chromium levels in leaves, seeds, root and stems of sedge grass and nut grasss. In the third study (Keefer et al, 1979), the concentration of chromium was measured in sweet corn and field corn leaves and grain grown on soils where sewage sludge had been applied. The number of samples collected and analyzed from all of these studies is not known. The soil-to-plant BAFs were then adjusted by Cal/EPA, to represent wet-weight BAFs, using the dry-weight to wet-weight conversions recommended by Clement Associates (Clement 1988).
Chromium, hexavalent, root crops[b]	$Cp = 0.001 * C_s$	Baes et al., 1984	Derived from three studies; one is unpublished (Baes and Katz, no date) , in which the concentration of chromium was measured in pumpkins and pumpkin vines and the corresponding soil, obtained from various different farms in East Tennessee. The second study (Cherry and Guthrie, 1979) measured chromium levels in leaves, seeds, root and stems of sedge grass and nut grasss. In the third study (Keefer et al, 1979), the concentration of chromium was measured in sweet corn and field corn leaves and grain grown on soils where sewage sludge had been applied. The number of samples collected and analyzed from all of these studies is not known. The soil-to-plant BAFs were then adjusted by Cal/EPA, to represent wet-weight BAFs, using the dry-weight to wet-weight conversions recommended by Clement Associates (Clement 1988).

Analyte	**Soil-to-Plant Uptake Models to Estmate Plant Tissue Concentrations[a]**		
	Plant BAF/Regression	**Source of BAF**	**Summary of Data used to Derive BAFs**

Notes:

-- = not applicable

C_p = constituent concentration in plants (expressed in mg/kg, wet weight) resulting from translocation from the roots into the plants.

C_s = constituent concentration in soil (expressed in mg/kg, wet weight)

mg/kg = milligrams per kilogram

a. Soil-to-plant uptake BAFs presented by Cal/EPA 2003 were used in GWRA to estimate root uptake into plants following use of impacted ground water for irrigation purpose. See Appendix K of GWRA (ARCADIS 2009).

b. Empiracle studies appear to be based on measurements of total chromium. However, Cal/EPA (2003) recommends the use of these BAFs for hexavalent chromium.

References:

ARCADIS. 2009. Final Human Health and Ecological Risk Assessment of Groundwater Impacted by Activities at Solid Waste Management Unit (SWMU) 1/Area of Concern (AOC) 1 and SWMU 2, PG&E Topock Compressor Station, Needles, California. December 4.

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CalEPA 2003. Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of ealth Risk Assessments. California Environmental Protection Agency, Office of Environmetnal Health Hazard Assessment (OEHHA). August.

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Clement Associates. 1988. Multipathway Health Risk Assessment Input Parameters Guidance Document. Prepared for the South Coast Air Quality management District under Contract #8798. June.

Furr, K.A., T.F. Parkinson, C.L. Heffron, J. T. Reid, W.M. Hascheck, W.H. Gutenmann, C.A. Bache, L.E. St. John, D.J. Lisk. 1978. Elemental Content of Tissues and Excreta of Lambs, Goats and Kids Fed White Sweet Clover Growing on Fly Ash. J. Agric. Food Chem., Vol 26, No. 4. 847-851.

ARCADIS

ATTACHMENT 1

Pacific Gas and Electric Company

Yvonne Meeks
Manager

Environmental Remediation
Gas T&D Department

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

May 28, 2008

Dr. J. Michael Eichelberger
Associate Toxicologist
California Department of Toxic Substances Control
Human and Ecological Risk Division
8800 Cal Center Drive
Sacramento, California 95826

Ms. Carrie Marr
Environmental Contaminants Specialist
United States Fish and Wildlife Service
2321 W. Royal Palm Road, Suite 103
Phoenix, Arizona 85021

Subject: Topock Compressor Station – Technical Memorandum 3: Ecological Comparison Values for Metals and Polycyclic Aromatic Hydrocarbons in Soil

Dear Dr. Eichelberger and Ms. Marr:

Enclosed is a technical memorandum prepared as part of the RCRA Facility Investigation/Remedial Investigation (RFI/RI) process to support the soil investigation and site characterization at the Pacific Gas and Electric (PG&E) Topock Compressor Station. This technical memorandum describes the methods used to develop soil ecological comparison values (ECVs) for the currently defined chemicals of potential ecological concern (COPECs) potentially associated with activities at the Topock site. The currently identified COPECs are metals and polycyclic aromatic hydrocarbons (PAHs). The ECVs, while based on information developed during the ecological risk assessment (ERA) scoping, are to be applied only to soil investigation planning in conjunction with background values. Specifically, the ECVs are not intended for use as either cleanup goals or as screening levels to eliminate COPECs. This technical memorandum provides the background and objectives for this effort, the approach used to develop the ECVs, and the recommended ECVs for the current COPECs. Note that the COPEC list may be expanded or contracted based on the results of planned site investigation activities, including the development of soil background levels.

If you have any questions regarding this technical memorandum, please call me at (805) 546-5243.

Sincerely,

Yvonne Meeks

Yvonne Meeks
Topock Project Manager

Enclosures: Technical Memorandum 3: Ecological Comparison Values for Metals and Polycyclic Aromatic Hydrocarbons in Soil.

cc: Aaron Yue, DTSC
Karen Baker, DTSC
Kris Doebbler, DOI

ARCADIS
155 Montgomery Street
Suite 1510
San Francisco
California 94104
Tel 415.374.2744
Fax 415.374.2745

MEMO

To:
Yvonne Meeks
4325 South Hiquera,
San Luis Obispo, CA 93401

Copies:
Dave Gilbert
Bob Doss
Curt Russell
Rob Knutson
Drew Page
Robb Kapla
Elidia Dostal
Lisa Kellogg
Janis Lutrick
Bridgette DeShields
Wini Curley

From:
Mala Pattanayek
Kim Walsh

Date:
May 23, 2008

ARCADIS Project No.:
RC000689.0002.00005

Subject:
Technical Memorandum 3: Ecological Comparison Values for Metals and Polycyclic Aromatic Hydrocarbons in Soil

The purpose of this technical memorandum is to describe the methods used to develop soil ecological comparison values (ECVs) for the currently defined chemicals of potential ecological concern (COPECs) potentially associated with activities at the Pacific Gas and Electric (PG&E) Topock Compressor Station, located in San Bernardino County, California, 15 miles southeast of Needles (site). The currently identified COPECs are metals and polycyclic aromatic hydrocarbons (PAHs). The ECVs, while based on information developed during the ecological risk assessment (ERA) scoping, are to be applied only to soil investigation planning in conjunction with background values. Specifically, the ECVs are not intended for use as either cleanup goals or as screening levels to eliminate COPECs. The following sections provide the background and objectives for this effort, the approach used to develop the ECVs, and the recommended ECVs for the current COPECs. Note that the COPEC list may be expanded or contracted based on the results of planned site investigation activities, including the development of soil background levels.

Background and Objectives

The Topock Compressor Station began operations in December 1951, compressing natural gas supplied from the southwest United States for transport through pipelines to PG&E's service territory in central and northern California. This site is currently active and will continue operating into the foreseeable future.

PG&E is currently conducting investigative and remedial activities at the site. Historically, chromium was added to cooling water, and from 1951 to 1964, untreated wastewater was discharged to Bat Cave Wash. In 1996, PG&E entered into a Corrective Action Consent Agreement with the California Department of Toxic Substances Control (DTSC) to govern the investigation and remediation of the site. In July 2005, a Consent Agreement was executed with U.S. Department of Interior agencies that outlined the process by which PG&E would comply with the Comprehensive Environmental Response, Compensation, and Liability Act requirements for remediation of the site.

As part of the remedial investigation, soil data are being collected and analyzed for site characterization. The primary objective of soil ECVs, along with background data and Preliminary Remediation Goals (PRGs), is to assist in evaluating the adequacy of the site characterization. The ECVs, PRGs, and background concentrations will be used to evaluate the data collected for the Part A Phase I soil investigation and assist in identifying data gaps that may require Phase II soil sampling. As explained by CH2M HILL (2006a), developing soil ECVs can provide a tool for (1) confirming data adequacy and quality; and (2) evaluating the need for, and designing the sampling and analysis program for, the Part A Phase 2 soil investigation. Procedures for field sampling, chain of custody, laboratory analysis, reporting, and data validation are designed to provide an accurate measure of site characterization. However, technical issues exist that may impair the sampling and analysis process (e.g., typical laboratory-proposed detection limits may be elevated relative to risk-based comparison values). The soil ECVs developed herein can be used for additional soil data quality assessment such as to evaluate the use of appropriate method detection limits. The soil ECVs can also be used to evaluate the data collected to define the extent of the site-related constituents in soil and assess the need for additional site characterization data. Furthermore, the soil ECVs can also be used to optimize the selection of sampling locations to limit disturbing the existing habitat and evaluate the program for additional sampling, if deemed necessary.

The soil ECVs, which are risk-based values, were developed based on conservative exposure and effects assumptions using the standard hazard quotient (HQ) model for assessing risk to ecological receptors (USEPA,1997). The soil ECVs are not strictly site-specific but are relevant to the site. The approach is generic ecological assessment to the extent that off-the-shelf exposure parameters and toxicity values were used. The exposure assumptions and effect levels or toxicity values used in the model were obtained from guidance documents and widely accepted literature sources. The exposure assumptions were based on representative species likely present at the site based on species observation records, habitat, and feeding guilds. The toxicity values were based on endpoints measuring survival, growth, and reproduction to meet the assessment endpoint such as protection of ecological receptor populations. Details of the model are described below.

Approach

In this technical memorandum, soil ECVs were developed for metals and PAHs identified as preliminary COPECs in the *Human Health and Ecological Risk Assessment Work Plan* (RAWP) (ARCADIS, 2008).

The preliminary COPECs include Title 22 metals, hexavalent chromium, manganese, total petroleum hydrocarbons (TPH), and PAHs. Toxicity values are not available for TPH, and therefore, soil ECVs were not developed for TPH. The Title 22 metals include antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc. The PAHs include total low molecular weight (LMW) PAHs and total high molecular weight (HMW) PAHs. The National Oceanic and Atmospheric Administration (NOAA) defines LMW PAHs as PAHs with less than or equal to 3 rings and with molecular weight less than or equal to 192 atomic mass units (amu) (NOAA, 2000). Parent LMW PAHs include naphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, and phenanthrene. HMW PAHs are defined as PAHs with greater than or equal to 4 rings and with molecular weight greater than or equal to 202 amu (NOAA, 2000). Parent HMW PAHs include pyrene, fluoranthene, benz(a)anthracene, chrysene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, and dibenz(a,h)anthracene.

For the objectives of this memorandum, soil ECVs were calculated for metals and PAHs using both lowest observed adverse effect levels or concentrations (LOAELs or LOAECs) and no-adverse effect levels or concentrations (NOAELs or NOAECs). The soil ECVs selected were based on the target toxicity values (i.e., values below which no unacceptable risk is expected; NOAELs or NOAECs) for the protection of the ecological receptors based on the representative receptors selected for the ecological risk assessment (ARCADIS, 2008) and include:

- Plants
- Invertebrates
- Birds
  - Gambel's Quail (granivore)
  - Cactus Wren (insectivore)
  - Red-Tailed Hawk (carnivore)
- Mammals
  - Desert Shrew (insectivore)
  - Merriam's Kangaroo Rat (granivore)
  - Desert Kit Fox (carnivore).

Soil Ecological Comparison Values Based on Plants and Invertebrates

For plants and invertebrates, although more than one exposure pathway is considered complete, generally route-specific doses are not quantified for plants and invertebrates. Exposures to soil are expressed in milligrams per kilogram (mg/kg), rather than doses, and generally encompass all potential exposure pathways for plants and invertebrates. Therefore, the screening values for the protection of plants and invertebrates discussed in the RAWP (ARCADIS, 2008) were used as soil ECVs, as presented in Table 1. The sources of screening values for plants and soil invertebrates used to develop soil ECVs are listed in order of preference:

- *Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs)* (USEPA, 2008b)

- Oak Ridge National Laboratory (ORNL) documents (Efroymson et al., 1997a,b).

Confidence in certain screening values presented in the ORNL documents is low, as indicated in Table 1. Confidence in plant screening values for antimony, barium, beryllium, hexavalent chromium, mercury, molybdenum, thallium, and vanadium is low due to the low number of studies on which the screening values are based or other factors (Efroymson et al., 1997a). The soil type and test species (typically agricultural) may also vary significantly from site-specific conditions, or the toxic effects may be unspecified in the source study. There may be significant variability in the toxic responses noted. Similarly, confidence in the invertebrate screening values is low for arsenic, hexavalent chromium, and mercury because of the low number of studies on which they are based or other factors (Efroymson et al., 1997b).

In the RAWP, screening values were developed only for metals as presented in Table 1. These values were obtained from the sources listed above and are not discussed in this memorandum. To calculate soil ECVs for PAHs, screening values for plants and invertebrates were developed as described below.

Polycyclic Aromatic Hydrocarbon Screening Values for Plants

Plant screening values are not readily available for PAHs from literature sources, except for acenaphthene (Efroymson et al., 1997a), an LMW PAH, and benzo(a)pyrene (USEPA, 1999), an HMW PAH. Empirical toxicity data for naphthalene, another LMW PAH, are available in the U.S. Environmental Protection Agency (USEPA) ECOTOX database (USEPA, 2008a). A study reporting ecologically relevant adverse effects at the lowest concentration was used to develop plant screening values for naphthalene. Hulzebos et al. (1993) reported a 7-day EC50 of 100 mg/kg for reduced biomass in lettuce. This study tested nearly 40 organic contaminants in both soil and a nutrient solution to determine the relationship between toxicity thresholds in both matrices. In this study, an EC50 (i.e., concentration of a chemical causing an effect to 50 percent of the population) of 100 mg/kg was conservatively assumed to be equivalent to a lowest-observed adverse effects concentration (LOAEC) for more serious adverse effects. Following California Environmental Protection Agency (CalEPA) DTSC guidance (CalEPA, 1996), an uncertainty factor (UF) of

10 was applied to extrapolate to a no-observed adverse effects concentration (NOAEC) resulting in a value of 10 mg/kg, which was used as the plant screening value for naphthalene.

As naphthalene is a more common LMW PAH than acenapthene, the comparison value for total LMW PAHs for protection of plants was based on the NOAEC-based screening value of 10 mg/kg for naphthalene, and the comparison value for total HMW PAHs was based on the screening value of 1.2 mg/kg for benzo(a)pyrene (USEPA, 1999).

Polycyclic Aromatic Hydrocarbon Screening Values for Soil Invertebrates

PAH screening values for soil invertebrates are available in the USEPA's *Guidance for Developing Ecological Soil Screening Levels (EcoSSL)* (USEPA, 2008b). The EcoSSL for LMW PAH is 29 mg/kg and the EcoSSL for HMW PAH is 18 mg/kg (Table 1); these values were selected as comparison values for protection of soil invertebrates.

Soil Ecological Comparison Values Based on Wildlife Protection

For wildlife, soil ECVs were developed using a risk-based approach incorporating exposure pathways for food and soil ingestion, which are considered the most significant pathways for most sites (USEPA, 2008b). The wildlife indicator receptors were selected to represent a cross-section of feeding guilds for each assessment endpoint so that sufficient rates of survival, growth, and reproduction for their representative populations could be evaluated.

For each wildlife receptor (i.e., bird and mammal) listed above, soil ECVs were developed following USEPA guidance (USEPA, 1997; USEPA, 2008b) and were based on a food-web model integrating ecological receptor exposures and effects. The exposure assumptions and effects levels for wildlife described in the RAWP (ARCADIS, 2008) were used to develop soil ECVs. The exposure assumptions that were used to estimate exposure dose for the indicator species such as body weights, food ingestion rates, composition of diet, and bioaccumulation factors (BAFs) were obtained from guidance documents or widely accepted literature sources as described in the RAWP (ARCADIS, 2008). The exposure assumptions used in the soil ECV model for each wildlife receptor are presented in Attachment 1. The effects levels or toxicity reference values (TRVs) that were used in the soil ECV model were also obtained from guidance documents or widely accepted literature sources. A TRV is defined as a daily dose of a chemical expressed in milligrams of chemical per kilogram of body weight per day (mg/kg bw-day) and represents a dose associated with no-effect or lowest-effect at the population level of ecological organization, even if exposure occurs over an extended duration. The TRVs used in the model are presented in Tables 2 and 3 and the details are explained below.

Soil ECVs were developed by re-arranging the standard USEPA (1997) HQ model (Equation 1) to solve for a target HQ of 1, which is considered to be protective of ecological receptors. The model used to solve for ECVs is as follows:

$$HQ = \frac{Dose}{TRV} = \frac{(C_{soil} \times SIR) + (C_{tissue} \times FIR) \times SUF}{TRV \times BW} = \frac{(C_{soil} \times SIR) + (C_{soil} \times BAF \times FIR) \times SUF}{TRV \times BW} = 1$$

Equation 1

Or:

$$ECV = C_{soil} = \frac{HQ \times TRV \times BW}{(SIR + [FIR \times BAF]) \times SUF}$$

Equation 2

Where:

Dose	*= exposure dose (mg/kgBW-day)*
HQ	*= hazard quotient (unitless); set at a target value of 1*
TRV	*= toxicity reference value (milligrams per kilogram body weight per day [mg/kgBW-day])*
C_{soil}	*= concentration of constituent in soil (mg/kg soil)*
SIR	*= soil ingestion rate (kilogram soil per day [kg soil/day])*
C_{tissue}	*= concentration of constituent in biota or tissue (mg/kg tissue)*
FIR	*= food or biota ingestion rate (kilograms tissue per day [kg tissue/day])*
BW	*= body weight of receptor (kilograms [kgBW])*
BAF	*= bioaccumulation factor or regression for media-to-biota uptake (kilogram tissue per kilogram soil [kg soil/kg tissue])*
SUF	*= site use factor (unitless); represents the fraction of the exposure area for the receptor represented by the area of contamination generally calculated by dividing the area of contamination by the home or foraging range of the receptor.*

ECV = *ecological comparison value (mg/kg soil)*

Depending on the chemical, tissue concentrations (C_{tissue}) were calculated using different combinations of uptake regressions or uptake factors (referred to as soil-to-biota BAFs in the RAWP [ARCADIS, 2008]). Uptake regressions are linear exponential equations, while UFs are simple multipliers, as shown in Equation 3.

$$C_{tissue} = e^{a} \times \left(C_{soil}\right)^{b} \quad or \quad \ln\left(C_{tissue}\right) = a + b \times \ln\left(C_{soil}\right) \qquad \text{Equation 3}$$

Alternatively:

$$C_{tissue} = UF_{tissue} \times C_{soil}$$

Where:

C_{tissue} = *tissue concentration (mg/kg of tissue)*

C_{soil} = *soil concentration (mg/kg of soil)*

a = *compound specific regression equation constant (unitless)*

b = *compound specific regression equation constant (unitless)*

UF_{tissue} = *uptake factor from soil to tissue (unitless)*

Incorporating uptake regressions in lieu of a simple UF in the dose equation (Equation 2) significantly complicates the overall dose calculation. As the bioaccumulation regression places C_{soil} subject to an exponential term, solving for C_{soil} becomes extremely cumbersome. Because of the challenges associated with back-calculating ECVs with dose equations that rely on exponential regressions for modeling tissue concentrations, a forward-calculation methodology was developed to simplify the calculation steps and reduce the potential for mathematical error. An automated, iterative calculation algorithm was used to combine the dose equation and tissue regression equation(s) into a single forward calculation by using the Microsoft® Solver™ software. Solver™ is an add-on to Microsoft® Excel that finds a solution by iterative trial-and-error that satisfies calculation constraints introduced by having interdependent mathematical equations. In this case, the interdependent equations are the tissue uptake equation(s), which rely on a media concentration and a dose equation that rely on the same media concentration (as the tissue uptake equation) and the solution of the uptake equation(s). The media uptake regression(s) and dose equation were combined using Solver™ and used to calculate ECVs. Figure 1 depicts (as an example) a flowchart of the iterative process that was followed, and the associated equations that were used to calculate ECV for the desert shrew.

An added benefit of using Solver^{TM} to determine ECV is that it allows instant confirmation of accuracy. The spreadsheet cell representing C_{soil} (the results output from Solver^{TM}) is instantaneously fed back through the tissue uptake, dose, and HQ equations to calculate an HQ. As long as the resulting HQ value equals 1 (dose/TRV), it can be confidently concluded that the Solver^{TM}-based model performed the calculations correctly and that the resulting C_{soil} is the accurate ECV.

In the RAWP (ARCADIS, 2008), wildlife TRVs and BAFs were developed only for metals. To calculate soil ECVs for PAHs, wildlife TRVs and BAFs for PAHs were also developed as described below.

Bioaccumulation Factors for Polycyclic Aromatic Hydrocarbons

Bioaccumulation in animal tissue or uptake in plants is the process where COPECs in the surrounding media are accumulated within the tissues of ecological receptors, especially to concentrations higher than in the surrounding media. Any COPEC that is excreted or metabolized at a slower rate than its uptake through absorption and ingestion will increase in tissues over time, resulting in bioaccumulation. Constituents with high octanol-water partitioning coefficient (log K_{ow}) are more likely to bioaccumulate in tissues of prey (plants, invertebrates, and mammals) due to their lipophilic nature (USEPA, 2000). Additionally, some metals that are not readily excreted are also known to bioaccumulate (e.g., lead). COPECs that bioaccumulate have the potential to be passed up the food chain.

BAFs are multipliers that are used to estimate concentrations of constituents that can accumulate in tissues through any route of exposure (USEPA, 2000). For plants, the BAF is sometimes referred to as a plant uptake factor. In this memorandum, BAFs were used to estimate concentrations of COPECs in biota and food item tissue (i.e., prey) from soil.

The approach used to develop BAFs for metals in the RAWP (ARCADIS, 2008) was also used to develop soil-to-biota BAFs for PAHs. BAFs for soil-to-plants and soil-to-invertebrates for LMW and HMW PAHs are available in USEPA's EcoSSL guidance (USEPA, 2008b) and are not discussed in this memorandum. According to USEPA EcoSSL guidance, semivolatile organic compounds, including PAHs tend to metabolize rapidly in birds and mammals, and therefore, uptake of these constituents from soil-to-mammal were assumed to be zero (USEPA, 2008b). The BAFs for metals and PAHs used to develop soil ECVs are presented in Table 4.

Toxicity Reference Values

In the RAWP (ARCADIS, 2008), two sets of wildlife TRVs for metals were presented as shown in Tables 2 and 3, and these were:

- Proposed TRVs: these were primarily based on the TRVs used to develop USEPA's EcoSSLs (USEPA, 2008b); other sources included ORNL: Toxicological Benchmarks for Wildlife (Sample et al., 1996) and other published sources (e.g., USEPA Region 6 ERA Guidance [USEPA, 1999]).

- DTSC-recommended TRVs: these were preferably based on the Region 9 Biological Technical Assistance Group (BTAG) TRVs (CalEPA, 2002).

For each set of wildlife TRVs, a range of TRVs were developed to estimate a range of potential risks to wildlife (ARCADIS, 2008). The low TRVs were preferably based on chronic no observable adverse effects levels (NOAELs) and the high TRVs were preferably based on the lowest observed adverse effects levels (LOAELs). In the case of DTSC-recommended TRVs, the low BTAG TRVs are NOAEL-based and the high BTAG TRVs are based on a midpoint of a variety of adverse effects and are not necessarily LOAEL-based (CalEPA, 2002). Some of the TRVs were allometrically adjusted for account for significant difference in body weights between the test species and the representative indicator species based on CalEPA guidance (CalEPA, 1999). For the calculation of soil ECVs, the allometrically adjusted TRVs listed in Table 2 and 3 were used for the representative receptors.

Similarly, following the approach described in the RAWP (ARCADIS, 2008), a range of wildlife TRVs for PAHs were developed as described below.

Bird Toxicity Reference Values for Polycyclic Aromatic Hydrocarbons

The bird TRVs for PAHs used to develop soil ECVs are presented in Table 2 and 3. For birds, there are no TRVs for PAHs reported in the EcoSSL guidance (USEPA, 2007). Published TRVs are available in USEPA Region 6 guidance (USEPA, 1999). However, the study (Brunstrom et al., 1991) was based on egg injection tests that are not considered appropriate for developing TRVs (USEPA, 2008b). Several studies were reviewed, and the most appropriate study was selected to develop bird TRVs for PAHs.

For LMW PAHs, Patton and Dieter's study (1980) evaluating the effect of PAH mixtures on hepatic function in mallard duck livers using a mixture of paraffins and aromatic hydrocarbons was selected. There were visible signs of toxicity, indicated by significant increase in liver weight for the group that were administered 4,000 mg/kg PAH mixture, but livers appeared normal in texture and color. No effects were observed for the 400 mg/kg treatment group. Therefore, 400 mg/kg was selected as the NOAEC and the 4,000 mg/kg was selected as the LOAEC. The NOAEC and the LOAEC were then converted to a NOAEL-based TRV and a LOAEL-based TRV, respectively, using the standard dose equations shown below:

$$TRV_{NOAEL} = \frac{NOAEC \times IR}{BW} = \frac{400\ mg/kg \times 0.059\,kg/day}{1.04\,kgBW} = 22.8\,mg/kgBW - day$$

Equation 4

$$TRV_{LOAEL} = \frac{LOAEC \times IR}{BW} = \frac{4000\,mg/kg \times 0.059\,kg/day}{1.04\,kgBW} = 228\,mg/kgBW - day$$

Equation 5

Where:

TRV_{NOAEL} = *no-observed adverse effects level based toxicity reference value (milligrams per kilogram body weight per day [mg/kgBW-day])*

TRV_{LOAEL} = *lowest-observed adverse effects level based toxicity reference value (milligrams per kilogram body weight per day [mg/kgBW-day])*

IR = *ingestion rate (kilogram soil per day [kg soil/day]); calculated from allometric equation for food ingestion rate in dry weight for all birds (USEPA,1993)*

BW = *body weight of receptor (kilograms [kgBW]); assuming approximately 1.04 kg for the mallard ducks (from USEPA, 1993)*

For HMW PAHs, a study by Trust et al. (1994) reporting a NOAEL of 10 mg/kg bw-day and a LOAEL of 100 mg/kg bw-day for overt signs of toxicity, such as decreased body mass in European starlings exposed to 7,12-dimethylbenz(a)anthracene, was selected to develop TRVs. Immunosuppression was observed at higher doses. The exposures were via oral gavage, and the study was conducted on nestlings, a sensitive life-stage. No UFs were applied, and therefore, an avian low TRV of 10 mg/kg bw-day and an avian high TRV of 100 mg/kg bw-day were used for HMW PAHs.

There are no BTAG PAH TRVs for birds. Therefore, there are no separate DTSC-recommended PAH TRVs for birds.

Mammal Toxicity Reference Values for Polycyclic Aromatic Hydrocarbons

Mammal TRVs for PAHs are available in the EcoSSL guidance (USEPA, 2007). The NOAEL of 65.6 mg/kg bw-day was selected as the low TRV for LMW PAHs and the LOAEL of 0.6 mg/kg bw-day was selected as the low TRV for HMW PAHs. The EcoSSL guidance (USEPA, 2007; USEPA, 2008b) does not report LOAELs; therefore, LOAELs for PAHs were developed following the approach described in the RAWP (ARCADIS, 2008). For LMW and HMW PAHs, bounded NOAELs were reported as TRVs; therefore, the LOAELs from the same study and endpoint was selected.

BTAG TRVs are available for mammals (CalEPA, 2002). The BTAG TRVs for naphthalene was used for LMW PAHs and the BTAG TRVs for benzo(a)pyrene was used for HMW PAHs.

The mammal TRVs for metals and PAHs used to develop soil ECVs are presented in Table 3 and 4.

Selection of Soil Ecological Comparison Values

The soil ECVs based on plants and invertebrates are presented in Table 1. For wildlife, a range of soil ECVs were developed following the approach described above and presented in tables in Attachment 1. A summary of the soil ECVs developed, based on the proposed wildlife TRVs and the DTSC-recommended TRVs, is presented in Table 5. As discussed earlier, the purpose of this technical memorandum is to develop soil ECVs for data quality assessment and use in evaluating the Part A Phase 1 data and making further site characterization decisions. The ECVs are conservative values but are not intended to be used to screen out COPECs. ECVs are also specifically not intended to be used as cleanup goals.

In order to select the most appropriate soil ECVs for each constituent, the most conservative of all the ecological receptor-based soil ECVs was selected as the final soil ECV unless the screening value or TRVs used to calculate that soil ECV was low in confidence. In such cases, the next less conservative soil ECV was selected as the final (e.g., soil ECV for mercury). The minimum of all the soil ECVs from Table 1 (plants and invertebrates) and Table 5 (wildlife) for each constituent and the selected soil ECVs are presented in Table 6. It should be noted that certain ECVs (e.g. antimony, cadmium, lead, mercury, and selenium) are below the standard reporting limits defined in the *Quality Assurance Project Plan, PG&E Topock Program* (QAPP; CH2M HILL, 2004, 2006b, 2008). Additionally, certain ECVs will likely be lower than final background soil concentrations. In that case, background concentrations would be used to set analytical detection limits and to consider the need for additional characterization.

Tables

Figure

Attachment

1 Derivation of Wildlife Based Soil ECVs

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Tables

Table 1
Soil Ecological Comparison Values
Based on Plant and Invertebrate Screening Values

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Constituents	Plant (mg/kg)	Invertebrate (mg/kg)
Antimony	5*	78
Arsenic	18	60**
Barium	500*	330
Beryllium	10*	40
Cadmium	32	140
Chromium, trivalent	NA	NA
Chromium, hexavalent	1*	0.4**
Chromium, total	NA	NA
Cobalt	13	NA
Copper	70	80
Lead	120	1700
Manganese	220	450
Mercury	0.3*	0.1**
Molybdenum	2*	NA
Nickel	38	280
Selenium	0.52	4.1
Silver	560	NA
Thallium	1*	NA
Vanadium	2*	NA
Zinc	160	120
LMW PAHs	10	29
HMW PAHs	1.2	18

Notes:
*Confidence in this benchmark is low due to the low number of studies on which it is based or other factors. The soil type and test species (typically agricultural) may also vary significantly from site-specific conditions, or the toxic effects may be uncertain.
**Confidence in this benchmark is low due to the low number of studies on which it is based or other factors. The tests were conducted with earthworms.

Indicates USEPA EcoSSL
Indicates ORNL Screening Benchmark
Primary sources (see text).

LMW PAHs - low molecular weight polycyclic aromatic hydrocarbons
HMW PAHs - high molecular weight polycyclic aromatic hydrocarbons
mg/kg = milligrams per kilograms
ORNL - Oak Ridge National Laboratory
USEPA - U.S. Environmental Protection Agency

Sources:

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten. 1997a. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision*. Prepared for the Oak Ridge Laboratory. November 1997.

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Table 2
Proposed Toxicity Reference Values

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Constituent	Wildlife TRVs (mg/kgBW-day)							
	Birds				Mammals			
	Low TRV (NOAEL)	Source	High TRV (LOAEL)	Source	Low TRV (NOAEL)	Source	High TRV (LOAEL)	Source
Antimony	NA	--	NA	--	0.059	USEPA, 2005	0.59	USEPA, 2005
Arsenic	2.24	USEPA, 2005	3.55	USEPA, 2005	1.04	USEPA, 2005	1.66	USEPA, 2005
Arsenic (allom adj)[a]	--	--	--	--	1.53	for desert shrew[a]	2.44	for desert shrew[a]
	--	--	--	--	1.46	for kangaroo rat[a]	2.33	for kangaroo rat[a]
Barium	NA	--	NA	--	51.8	USEPA, 2005	82.6	USEPA, 2005
Beryllium	NA	--	NA	--	0.532	USEPA, 2005	0.630	USEPA, 2005
Cadmium	1.47	USEPA, 2005	6.35	USEPA, 2005	0.770	USEPA, 2005	7.7	USEPA, 2005
Chromium	2.66	USEPA, 2005	15.6	USEPA, 2005	2.40	USEPA, 2005	9.62	USEPA, 2005
Hexavalent Chromium	NA	--	NA	--	9.24	USEPA, 2008	38.8	USEPA, 2008
Cobalt	7.61	USEPA, 2005	18.3	USEPA, 2005	7.33	USEPA, 2005	18.8	USEPA, 2005
Copper	4.05	USEPA, 2007	12.1	USEPA, 2007	5.60	USEPA, 2007	9.34	USEPA, 2007
Copper (allom adj)[a]	--	--	--	--	9.43	for desert shrew[a]	15.73	for desert shrew[a]
	--	--	--	--	9.04	for kangaroo rat[a]	15.07	for kangaroo rat[a]
Lead	1.63	USEPA, 2005	3.26	USEPA, 2005	4.70	USEPA, 2005	8.90	USEPA, 2005
Mercury	0.039	CalEPA BTAG, 2002	0.2	CalEPA BTAG, 2002	0.25	CalEPA BTAG,	4	CalEPA BTAG,
Molybdenum	3.5	Sample et al., 1996	35.3	Sample et al., 1996	0.26	Sample et al., 1996	2.6	Sample et al., 1996
Nickel	6.71	USEPA, 2007	18.6	USEPA, 2007	1.70	USEPA, 2007	3.40	USEPA, 2007
Selenium	0.290	USEPA, 2007	0.579	USEPA, 2007	0.143	USEPA, 2007	0.215	USEPA, 2007
Selenium (allom adj)[a]	--	--	--	--	0.23	for desert shrew[a]	0.35	for desert shrew[a]
	--	--	--	--	0.21	for kangaroo rat[a]	0.31	for kangaroo rat[a]
Silver	2.02	USEPA, 2006	20.2	USEPA, 2006	6.02	USEPA, 2006	60.2	USEPA, 2006
Silver (allom adj)[a]	--	--	--	--	8.77	for desert shrew[a]	87.68	for desert shrew[a]
	--	--	--	--	8.40	for kangaroo rat[a]	84.01	for kangaroo rat[a]
Thallium	0.35	USEPA, 1999	3.5	USEPA, 1999	0.48	CalEPA BTAG,	1.43	CalEPA BTAG,
Vanadium	0.344	USEPA, 2005	0.688	USEPA, 2005	4.16	USEPA, 2005	8.31	USEPA, 2005
Zinc	66.1	USEPA, 2007	171	USEPA, 2007	75.4	USEPA, 2007	298	USEPA, 2007
Total LMW PAHs	22.8	1980	228	1980	65.6	USEPA, 2007	328	USEPA, 2007
Total HMW PAHs	10	Trust et al., 1994	100	Trust et al., 1994	0.6	USEPA, 2007	3	USEPA, 2007

Table 2
Proposed Toxicity Reference Values

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Notes:
TRVs for metals presented in the *Human Health and Ecological Risk Assessment Work Plan* (RAWP; ARCADIS, 2008).
TRVs updated in guidance since the RAWP was submitted.
TRVs developed for this technical memorandum.

a. TRVs allometrically adjusted significant difference in body weights using the following equation (Sample and Arenal, 1999):
Aw - At * (BWt/BWw)^1-b
where:
Aw - toxicity value of wildlife species
At - toxicity value of test species (TRV)
BWt - body weight of test species
BWw - body weight of wildlife species
b - allometric scaling factor (1.2 for birds, 0.94 for mammals)

-- - not applicable
BTAG - Biological Technical Assistance Group
CalEPA - California Environmental Protection Agency
LOAEL - lowest observed adverse effects level
mg/kgBW-day - milligrams per kilogram of body weight per day
NA - not available
NOAEL - no observed adverse effects level
TRV - toxicity reference value
USEPA - U.S. Environmental Protection Agency

Sources:
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Table 3
DTSC-Recommended Toxicity Reference Values

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

	Wildlife TRVs (mg/kgBW-day)							
	Birds				Mammals			
Constituent	Low TRV (NOAEL)	Source	High TRV (LOAEL)	Source	Low TRV (NOAEL)	Source	High TRV (LOAEL)	Source
Antimony	NA	--	NA	--	0.059	USEPA, 2005	0.59	USEPA, 2005
Arsenic	5.5	CalEPA BTAG, 2002	22.0	CalEPA BTAG, 2002	0.32	CalEPA BTAG, 2002	4.7	CalEPA BTAG, 2002
Barium	NA	--	NA	--	51.8	USEPA, 2005	82.6	USEPA, 2005
Beryllium	NA	--	NA	--	0.532	USEPA, 2005	0.630	USEPA, 2005
Cadmium	0.08	CalEPA BTAG, 2002	10.4	CalEPA BTAG, 2002	0.060	CalEPA BTAG, 2002	2.64	CalEPA BTAG, 2002
Chromium	2.66	USEPA, 2005	15.6	USEPA, 2005	2.40	USEPA, 2005	9.62	USEPA, 2005
Hexavalent Chromium	NA	--	NA	--	9.24	USEPA, 2008	38.8	USEPA, 2008
Cobalt	7.61	USEPA, 2005	18.3	USEPA, 2005	1.2	CalEPA BTAG, 2002	20	CalEPA BTAG, 2002
Copper	2.30	CalEPA BTAG, 2002	52.3	CalEPA BTAG, 2002	2.67	CalEPA BTAG, 2002	632	CalEPA BTAG, 2002
Lead	0.014	CalEPA BTAG, 2002	8.75	CalEPA BTAG, 2002	1.0	CalEPA BTAG, 2002	241	CalEPA BTAG, 2002
Mercury	0.039	2002	0.18	CalEPA BTAG, 2002	0.25	CalEPA BTAG, 2002	4	2002
Molybdenum	3.5	Sample et al., 1996	35.3	Sample et al., 1996	0.26	Sample et al., 1996	2.6	Sample et al., 1996
Nickel	1.38	CalEPA BTAG, 2002	56.3	CalEPA BTAG, 2002	0.133	CalEPA BTAG, 2002	31.6	CalEPA BTAG, 2002
Selenium	0.23	2002	0.93	CalEPA BTAG, 2002	0.05	CalEPA BTAG, 2002	1.21	2002
Silver	2.02	USEPA, 2006	20.2	USEPA, 2006	6.02	USEPA, 2006	60.2	USEPA, 2006
Silver (allom adj)[a]	--	--	--	--	8.77	for desert shrew[a]	87.68	for desert shrew[a]
	--	--	--	--	8.40	for kangaroo rat[a]	84.01	for kangaroo rat[a]
Thallium	0.35	USEPA, 1999b	3.5	USEPA, 1999b	0.48	CalEPA BTAG, 2002	1.43	2002
Vanadium	0.344	USEPA, 2005	0.688	USEPA, 2005	4.16	USEPA, 2005	8.31	USEPA, 2005
Zinc	17.2	2002	172	CalEPA BTAG, 2002	9.60	CalEPA BTAG, 2002	411	2002
LMW PAHs	NA	--	NA	--	50	CalEPA BTAG, 2002	150	2002
HMW PAHs	NA	--	NA	--	1.31	CalEPA BTAG, 2002	32.8	CalEPA BTAG,

Table 3
DTSC-Recommended Toxicity Reference Values

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Notes:

TRVs for metals presented in the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).

TRVs updated in guidance since the RAWP was submitted.

TRVs developed for this technical memorandum.

a. TRVs allometrically adjusted significant difference in body weights using the following equation (Sample and Arenal, 1999):

Aw - At * (BWt/BWw)^1-b

where:

Aw - toxicity value of wildlife species

At - toxicity value of test species (TRV)

BWt - body weight of test species

BWw - body weight of wildlife species

b - allometric scaling factor (1.2 for birds, 0.94 for mammals)

-- - not applicable

BTAG - Biological Technical Assistance Group

CalEPA - California Environmental Protection Agency

DTSC - Department of Toxic Substances Control

kg - kilograms

LOAEL - lowest observable adverse effects level

mg/kgBW-day - milligram(s) per kilogram body weight per day

NA - not available

NOAEL - no observable adverse effects level

TRV - toxicity reference value

UF - uncertainty factor

USEPA - U.S. Environmental Protection Agency

Sources:

CalEPA 2002. *Currently Recommended U.S. Environmental Protection Agency Region 9 Biological Technical Assistance Group (BTAG) Mammalian and Avian Toxicity Reference Values (TRVs)* . Department of Toxic Substances Control: Human and Ecological Risk Division.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision* . Oak Ridge National Laboratory, Oak Ridge, TN. 227 pp. ES/ER/TM-86/R3.

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Table 4
Bioaccumulation Factors

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

	Soil-to-Biota Bioaccumulation Factors[a]		
Constituent	**BAF_{plant} (dw) (kg soil/kg tissue)**	**BAF_{invert} (dw) (kg soil/kg tissue)**	**BAF_{mammal} (dw) (kg soil/kg tissue)**
Antimony	$\ln(C_p) = 0.938 * \ln(C_s) - 3.233$	1.00	$0.05 * C_d$
Arsenic	0.03752	$\ln(C_i) = 0.706 * \ln(C_s) - 1.421$	$\ln(C_m) = 0.8188 * \ln(C_s) -4.8471$
Barium	0.156	0.091	$0.0075 * C_d$
Beryllium	$\ln(C_p) = 0.7345 * \ln(C_s) - 0.5361$	0.045	$0.05 * C_d$
Cadmium	$\ln(C_p) = 0.546 * \ln(C_s) - 0.475$	$\ln(C_i) = 0.795 * \ln(C_s) + 2.114$	$\ln(C_m) = 0.4723 * \ln(C_s) - 1.2571$
Chromium, total	0.041	0.306	$\ln(C_m) = 0.7338 * \ln(C_s) - 1.4599$
Chromium, hexavalent	0.041	0.306	$\ln(C_m) = 0.7338 * \ln(C_s) - 1.4599$
Cobalt	0.0075	0.122	$\ln(C_m) = 1.307 * \ln(C_s) - 4.4669$
Copper	$\ln(C_p) = 0.394 * \ln(C_s) + 0.668$	0.515	$\ln(C_m) = 0.1444 * \ln(C_s) + 2.042$
Lead	$\ln(C_p) = 0.561 * \ln(C_s) - 1.328$	$\ln(C_i) = 0.807 * \ln(C_s) - 0.218$	$\ln(C_m) = 0.4422 * \ln(C_s) + 0.0761$
Mercury	$\ln(C_p) = 0.544 * \ln(C_s) - 0.996$	$\ln(C_i) = 0.3369 * \ln(C_s) - 0.078$	0.192
Molybdenum	0.25	5.50E-01	$\ln(C_m) = 0.006 * 50 * C_d$[b]
Nickel	$\ln(C_p) = 0.748 * \ln(C_s) - 2.223$	1.059	$\ln(C_m) = 0.4658 * \ln(C_s) - 0.2462$
Selenium	$\ln(C_p) = 1.104 * \ln(C_s) - 0.677$	$\ln(C_i) = 0.733 * \ln(C_s) - 0.075$	$\ln(C_m) = 0.3764 * \ln(C_s) - 0.4158$
Silver	0.014	2.045	0.004
Thallium	0.004	5.50E-01	0.112
Vanadium	0.00485	0.042	0.0123
Zinc	$\ln(C_p) = 0.554 * \ln(C_s) + 1.575$	$\ln(C_i) = 0.328 * \ln(C_s) + 4.449$	$\ln(C_m) = 0.0706 * \ln(C_s) + 4.3632$
Total LMW PAH	ln(Cp) = 0.4544 * ln(Cs)-1.3205	3.04	0.0
Total HMW PAH	ln(Cp) = 0.9469 * ln(Cs)-1.7026	2.6	0.0

Notes:

BAFs for metals presented in the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).

BAFs developed for this technical memorandum.

a. All BAFs from USEPA's Guidance for Developing Ecological Soil Screening Levels (EcoSSLs). U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington D.C. 2005 Revision, updated December 2006. 85 pp. http://www.epa.gov/ecotox/ecossl., except as otherwise noted.

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BAF - bioaccumulation factor
BAF_{invert} - soil-to-invertebrate uptake bioaccumulation factor (unitless)
BAF_{plant} - soil-to-plant uptake bioaccumulation factor (unitless)
C_p - constituent concentration in plants
C_i - constituent concentration in invertebrates
C_s - constituent concentration in soil
C_m - constituent concentration in mammals
C_d - concentration in diet
dw - dry weight
HMW PAHs - high molecular weight polycyclic aromatic hydrocarbons
ln - natural log
LMW PAHs - low molecular weight polycyclic aromatic hydrocarbons
USEPA - U.S. Environmental Protection Agency

Table 5
Summary of Soil Ecological Comparison Values
Based on Wildlife

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Ecological Receptor	Based on:	Antimony Soil ECVs (mg/kg dw)		Arsenic Soil ECVs (mg/kg dw)		Arsenic (Allometrically Adjusted)[e] Soil ECVs (mg/kg dw)		Barium Soil ECVs (mg/kg dw)		Beryllium Soil ECVs (mg/kg dw)		Cadmium Soil ECVs (mg/kg dw)	
		Low[c]	High[d]	Low[c]	High[d]	High[d]	Low[c]	Low[c]	High[d]	High[d]	Low[c]	Low[c]	High[d]
Gambel's Quail	Proposed TRVs[a]	NA	NA	4.13E+02	6.54E+02	NA	NA	NA	NA	NA	NA	2.48E+02	1.29E+03
Cactus Wren	Proposed TRVs[a]	NA	NA	7.61E+01	1.28E+02	NA	NA	NA	NA	NA	NA	9.47E-01	5.93E+00
Red-tailed Hawk	Proposed TRVs[a]	NA	NA	1.76E+03	2.82E+03	NA	NA	NA	NA	NA	NA	8.37E+02	4.63E+03
Desert Shrew	Proposed TRVs[a]	2.85E-01	2.85E+00	NA	NA	8.90E+01	1.62E+02	2.30E+03	3.67E+03	4.03E+01	4.77E+01	3.74E-01	6.75E+00
Merriam's Kangaroo Rat	Proposed TRVs[a]	1.24E+01	1.35E+02	NA	NA	2.89E+02	4.62E+02	3.50E+03	5.58E+03	2.33E+01	2.91E+01	8.93E+01	2.18E+03
Desert Kit Fox	Proposed TRVs[a]	2.14E+01	2.14E+02	9.72E+02	1.56E+03	NA	NA	5.11E+04	8.14E+04	4.97E+02	5.89E+02	5.74E+02	7.11E+03
Gambel's Quail	DTSC-Recommended TRVs[b]	NA	NA	1.01E+03	4.06E+03	NA	NA	NA	NA	NA	NA	5.26E+00	2.21E+03
Cactus Wren	DTSC-Recommended TRVs[b]	NA	NA	2.10E+02	9.60E+02	NA	NA	NA	NA	NA	NA	2.45E-02	1.10E+01
Red-tailed Hawk	DTSC-Recommended TRVs[b]	NA	NA	4.41E+03	1.81E+04	NA	NA	NA	NA	NA	NA	1.05E+01	7.96E+03
Desert Shrew	DTSC-Recommended TRVs[b]	2.85E-01	2.85E+00	1.14E+01	3.71E+02	NA	NA	2.30E+03	3.67E+03	4.03E+01	4.77E+01	1.51E-02	1.76E+00
Merriam's Kangaroo Rat	DTSC-Recommended TRVs[b]	1.24E+01	1.35E+02	6.33E+01	9.29E+02	NA	NA	3.50E+03	5.58E+03	2.33E+01	2.92E+01	1.24E+00	5.37E+02
Desert Kit Fox	DTSC-Recommended TRVs[b]	2.14E+01	2.14E+02	2.94E+02	4.47E+03	NA	NA	4.13E+04	6.58E+04	1.93E+02	2.28E+02	1.94E+01	2.27E+03

Table 5
Summary of Soil Ecological Comparison Values
Based on Wildlife

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
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		Total Chromium		Hexavalent Chromium		Cobalt		Copper		Copper (Allometrically Adjusted)[e]		Lead	
		Soil ECVs (mg/kg dw)		Soil ECVs (mg/kg dw)		Soil ECVs (mg/kg dw)		Soil ECVs (mg/kg dw)		Soil ECVs (mg/kg dw)		Soil ECVs (mg/kg dw)	
Ecological Receptor	**Based on:**	**High[d]**	**Low[c]**	**Low[c]**	**High[d]**	**High[d]**	**Low[c]**	**Low[c]**	**High[d]**	**High[d]**	**Low[c]**	**Low[c]**	**High[d]**
Gambel's Quail	Proposed TRVs[a]	4.79E+02	2.81E+03	NA	NA	1.78E+03	4.28E+03	7.60E+02	2.62E+03	NA	NA	3.42E+02	7.16E+02
Cactus Wren	Proposed TRVs[a]	3.64E+01	2.13E+02	NA	NA	1.93E+02	4.64E+02	3.63E+01	1.09E+02	NA	NA	1.57E+01	3.59E+01
Red-tailed Hawk	Proposed TRVs[a]	5.95E+02	5.21E+03	NA	NA	9.00E+02	1.80E+03	2.00E+03	8.86E+03	NA	NA	3.90E+02	1.18E+03
Desert Shrew	Proposed TRVs[a]	3.63E+01	1.45E+02	1.40E+02	5.86E+02	2.54E+02	6.52E+02	NA	NA	8.69E+01	1.45E+02	6.02E+01	1.31E+02
Merriam's Kangaroo Rat	Proposed TRVs[a]	4.49E+02	1.80E+03	1.73E+03	7.26E+03	2.83E+03	7.26E+03	NA	NA	2.74E+03	5.26E+03	1.67E+03	3.45E+03
Desert Kit Fox	Proposed TRVs[a]	1.05E+03	5.26E+03	5.02E+03	2.51E+04	1.52E+03	3.22E+03	4.72E+03	8.42E+03	NA	NA	3.35E+03	7.05E+03
Gambel's Quail	DTSC-Recommended TRVs[b]	4.79E+02	2.81E+03	NA	NA	1.78E+03	4.28E+03	3.82E+02	1.24E+04	NA	NA	9.85E-01	2.01E+03
Cactus Wren	DTSC-Recommended TRVs[b]	3.64E+01	2.13E+02	NA	NA	1.93E+02	4.64E+02	2.06E+01	4.69E+02	NA	NA	5.00E-02	1.15E+02
Red-tailed Hawk	DTSC-Recommended TRVs[b]	5.95E+02	5.21E+03	NA	NA	9.00E+02	1.80E+03	6.65E+02	4.45E+04	NA	NA	1.66E-02	4.66E+03
Desert Shrew	DTSC-Recommended TRVs[b]	3.63E+01	1.45E+02	1.40E+02	5.86E+02	4.16E+01	6.94E+02	2.46E+01	5.82E+03	NA	NA	9.02E+00	7.20E+03
Merriam's Kangaroo Rat	DTSC-Recommended TRVs[b]	4.49E+02	1.80E+03	1.73E+03	7.26E+03	4.63E+02	7.72E+03	4.51E+02	3.08E+05	NA	NA	2.58E+02	1.15E+05
Desert Kit Fox	DTSC-Recommended TRVs[b]	1.05E+03	5.26E+03	5.02E+03	2.51E+04	3.49E+02	3.38E+03	1.88E+03	6.36E+05	NA	NA	4.41E+02	2.34E+05

Table 5
Summary of Soil Ecological Comparison Values
Based on Wildlife

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Ecological Receptor	Based on:	Mercury Soil ECVs (mg/kg dw) High[d]	Mercury Low[c]	Molybdenum Soil ECVs (mg/kg dw) Low[c]	Molybdenum High[d]	Nickel Soil ECVs (mg/kg dw) High[d]	Nickel Low[c]	Selenium Soil ECVs (mg/kg dw) Low[c]	Selenium High[d]	Selenium (Allomterically Adjusted)[e] Soil ECVs (mg/kg dw) High[d]	Selenium (Allomterically Adjusted)[e] Low[c]	Silver Soil ECVs (mg/kg dw) Low[c]	Silver High[d]
Gambel's Quail	Proposed TRVs[a]	3.15E+00	2.48E+01	2.58E+02	2.60E+03	1.44E+03	4.14E+03	1.01E+01	1.90E+01	NA	NA	4.47E+02	4.47E+03
Cactus Wren		1.25E-02	9.13E-01	2.97E+01	3.00E+02	3.18E+01	8.81E+01	1.78E+00	4.40E+00	NA	NA	5.15E+00	5.15E+01
Red-tailed Hawk		2.39E+00	1.10E+01	2.47E+02	2.49E+03	3.54E+03	1.23E+04	5.23E+01	1.85E+02	NA	NA	1.42E+03	1.42E+04
Desert Shrew		2.11E+00	5.89E+02	2.25E+00	2.25E+01	7.76E+00	1.55E+01	NA	NA	1.29E+00	2.17E+00	NA	NA
Merriam's Kangaroo Rat		2.96E+01	1.27E+03	1.15E+01	1.15E+02	4.36E+02	9.57E+02	NA	NA	4.13E+00	5.98E+00	NA	NA
Desert Kit Fox		3.21E+01	5.14E+02	3.81E+01	3.81E+02	1.01E+03	2.39E+03	4.54E+01	8.93E+01	NA	NA	5.32E+03	5.32E+04
Gambel's Quail	DTSC-Recommended TRVs[b]	3.15E+00	2.48E+01	2.58E+02	2.60E+03	2.76E+02	1.29E+04	8.15E+00	2.94E+01	NA	NA	4.47E+02	4.47E+03
Cactus Wren		1.25E-02	9.13E-01	2.97E+01	3.00E+02	6.54E+00	2.67E+02	1.31E+00	8.15E+00	NA	NA	5.15E+00	5.15E+01
Red-tailed Hawk		2.39E+00	1.10E+01	1.41E+02	1.42E+03	3.68E+02	4.27E+04	3.25E+01	3.92E+02	NA	NA	1.42E+03	1.42E+04
Desert Shrew		2.11E+00	5.89E+02	2.25E+00	2.25E+01	6.07E-01	1.44E+02	1.77E-01	1.06E+01	NA	NA	1.44E+01	1.44E+02
Merriam's Kangaroo Rat		2.96E+01	1.27E+03	1.15E+01	1.15E+02	2.19E+01	1.12E+04	1.13E+00	2.05E+01	NA	NA	1.93E+03	1.93E+04
Desert Kit Fox		3.21E+01	5.14E+02	2.24E+01	2.24E+02	2.04E+01	2.86E+04	5.56E+00	9.15E+02	NA	NA	5.32E+03	5.32E+04

Table 5
Summary of Soil Ecological Comparison Values
Based on Wildlife

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Ecological Receptor	Based on:	Silver (Allomterically Adjusted)[e] Soil ECVs (mg/kg dw)		Thallium Soil ECVs (mg/kg dw)		Vanadium Soil ECVs (mg/kg dw)		Zinc Soil ECVs (mg/kg dw)		LMW PAHs Soil ECVs (mg/kg dw)		HMW PAHs Soil ECVs (mg/kg dw)	
		High[d]	Low[c]	Low[c]	High[d]	High[d]	Low[c]	Low[c]	High[d]	High[d]	Low[c]	Low[c]	High[d]
Gambel's Quail	Proposed TRVs[a]	NA	NA	8.45E+01	8.45E+02	8.24E+01	1.65E+02	9.26E+03	2.92E+04	5.59E+03	5.68E+04	1.14E+03	1.22E+04
Cactus Wren		NA	NA	2.97E+00	2.97E+01	1.39E+01	2.78E+01	7.57E+01	1.05E+03	3.97E+01	3.97E+02	2.03E+01	2.03E+02
Red-tailed Hawk		NA	NA	3.50E+01	3.50E+02	1.65E+02	3.30E+02	4.76E+04	1.42E+05	2.05E+04	2.05E+05	9.01E+03	9.01E+04
Desert Shrew		2.09E+01	2.09E+02	2.32E+00	6.91E+00	3.31E+02	6.60E+02	8.67E+01	4.72E+03	1.06E+02	5.28E+02	1.16E+00	5.77E+00
Merriam's Kangaroo Rat		2.69E+03	2.69E+04	2.09E+02	6.21E+02	1.75E+03	3.50E+03	8.32E+03	6.08E+04	3.20E+04	1.64E+05	4.32E+01	2.33E+02
Desert Kit Fox		NA	NA	9.69E+01	2.89E+02	2.92E+03	5.83E+03	7.00E+04	2.94E+05	6.62E+04	3.31E+05	6.21E+02	3.10E+03
Gambel's Quail	DTSC-Recommended TRVs[b]	NA	NA	8.45E+01	8.45E+02	8.24E+01	1.65E+02	1.57E+03	2.93E+04	5.59E+03	5.68E+04	1.14E+03	1.22E+04
Cactus Wren		NA	NA	2.97E+00	2.97E+01	1.39E+01	2.78E+01	1.32E+00	1.06E+03	3.97E+01	3.97E+02	2.03E+01	2.03E+02
Red-tailed Hawk		NA	NA	3.50E+01	3.50E+02	1.65E+02	3.30E+02	5.23E+03	1.42E+05	2.05E+04	2.05E+05	9.01E+03	9.01E+04
Desert Shrew		2.09E+01	2.09E+02	4.15E+00	1.24E+01	3.31E+02	6.60E+02	1.64E-01	1.09E+04	8.05E+01	2.41E+02	2.46E+00	6.17E+01
Merriam's Kangaroo Rat		2.69E+03	2.69E+04	2.09E+02	6.21E+02	1.75E+03	3.50E+03	2.82E+02	9.39E+04	2.42E+04	7.42E+04	9.54E+01	2.78E+03
Desert Kit Fox		NA	NA	9.69E+01	2.89E+02	2.92E+03	5.83E+03	4.61E+03	4.08E+05	5.05E+04	1.51E+05	1.32E+03	3.31E+04

Notes:

(yellow highlight) Selected Final Soil ECV (see Table 6).

[1] Proposed TRVs based primarily on USEPA's EcoSSLs (USEPA, 2008b); from the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).
[2] DTSC-recommended TRVs based primarily on Region 9 Biological Technical Assistance Group (BTAG) TRVs (CalEPA, 2002); from the Risk Assessment Work Plan (ARCADIS, 2008).
[3] Low ECVs based on low TRVs or no-observed adverse effects level (NOAEL) TRVs.
[4] High ECVs based on high TRVs or lowest-observed adverse effects level (LOAEL) TRVs.
[5] TRVs allometrically adjusted for representative receptors (ARCADIS, 2008).

CalEPA - California Environmental Protection Agency
DTSC - Department of Toxic Substance Control
ECV - ecological comparison value
HMW PAHs - high molecular weight polycyclic aromatic hydrocarbons
LMW PAHs - low molecular weight polycyclic aromatic hydrocarbons
mg/kg dw - milligrams per kilogram dry weight
NA - not available
TRV - toxocity reference values
USEPA - U.S. Environmental Protection Agency

Table 6
Summary of Selected Soil Ecological Comparison Values

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

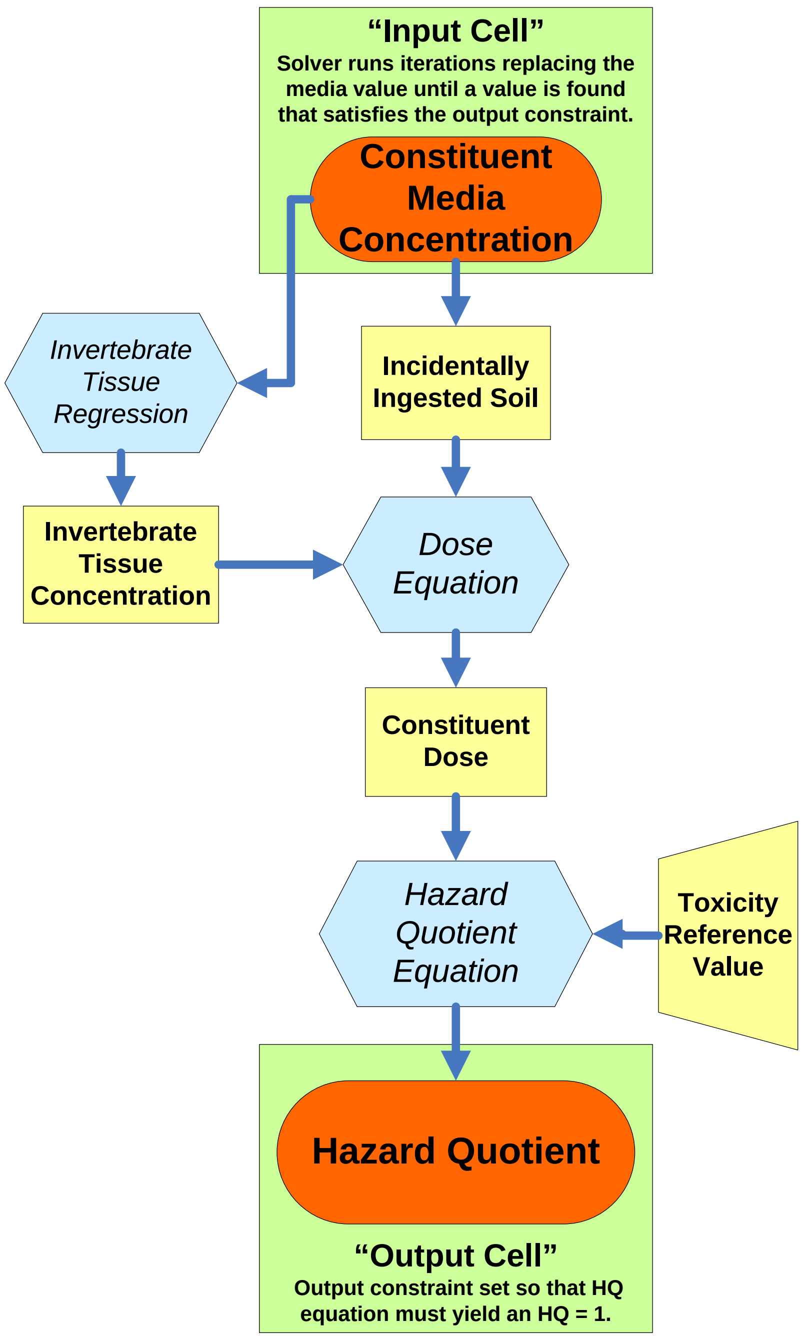
Constituent	Lowest Wildlife ECV (mg/kg)	Based On	Lowest Plant/Invertebrate ECV (mg/kg)	Based On	Selected Final Soil ECV[a] (mg/kg)	Based On
Antimony	0.285	Desert Shrew	5	Plant*	0.285	Desert Shrew
Arsenic	11.4	Desert Shrew	18	Plant	11.4	Desert Shrew
Barium	2,299	Desert Shrew	330	Invertebrate	330	Invertebrate
Beryllium	23.3	Merriam's Kangaroo Rat	10	Plant*	23.3	Merriam's Kangaroo Rat
Cadmium	0.0151	Desert Shrew	32	Plant	0.0151	Desert Shrew
Trivalent Chromium	NA	NA	NA	NA	NA	NA
Hexavalent Chromiu	139.6	Desert Shrew	0.4	Invertebrate**	139.6	Desert Shrew
Total Chromium	36.3	Desert Shrew	NA	NA	36.3	Desert Shrew
Cobalt	41.6	Desert Shrew	13	Plant	13	Plant
Copper	20.6	Cactus Wren	70	Plant	20.6	Cactus Wren
Lead	0.0166	Red-tailed Hawk	120	Plant	0.0166	Red-tailed Hawk
Manganese	NA	NA	220	Plant	220	Plant
Mercury	0.0125	Cactus Wren	0.1	Invertebrate**	0.0125	Cactus Wren
Molybdenum	2.25	Desert Shrew	2	Plant*	2.25	Desert Shrew
Nickel	0.607	Desert Shrew	38	Plant	0.607	Desert Shrew
Selenium	0.177	Desert Shrew	0.52	Plant	0.177	Desert Shrew
Silver	5.15	Cactus Wren	560	Plant	5.15	Cactus Wren
Thallium	2.32	Desert Shrew	1	Plant*	2.32	Desert Shrew
Vanadium	13.9	Cactus Wren	2	Plant	13.9	Cactus Wren
Zinc	0.164	Desert Shrew	120	Invertebrate	0.164	Desert Shrew
LMW PAHs	39.7	Cactus Wren	10	Plant	10	Plant
HMW PAHs	1.16	Desert Shrew	1.2	Plant	1.16	Desert Shrew

Notes:
*Confidence in this benchmark is low due to the low number of studies on which it is based or other factors. The soil type and test species (typically agricultural) may also vary significantly from site-specific conditions, or the toxic effects may be uncertain.
**Confidence in this benchmark is low due to the low number of studies on which it is based or other factors. The tests were conducted with earthworms.
a. The final soil ECV selected based on minimum of soil ECVs based on plants and invertebrates and wildlife. If the minimum soil ECV was based toxicity valu low confidence, then the next minimum soil ECV was selected.

ECV - ecological comparison value
HMW PAHs - high molecular weight polycyclic aromatic hydrocarbons
LMW PAHs - low molecular weight polycyclic aromatic hydrocarbons
mg/kg dw - miligrams per kilogram dry weight
NA - not available

Figures

Figure 1. Diagram Depicting ECV Derivation Methodology for the Desert Shrew



Formulae and Variables Description

Invertebrate Tissue Regression Equation

$$\ln(C_{tissue}) = a + b[\ln(C_{soil})] \quad \therefore \quad C_{tissue} = e^{a} \times (C_{soil})^{b}$$

Dose Equation

$$Dose = \frac{((C_{soil} \times SIR) + (C_{soil} \times BAF \times FIR)) \times SUF}{BW}$$

Hazard Quotient Equation

$$HQ = \frac{Dose}{TRV}$$

ECV Equation

$$ECV = C_{Soil} = \frac{HQ \times TRV \times BW}{(SIR + [FIR \times BAF]) \times SUF}$$

Where:

C_{tissue}	= concentration of constituent in biota or tissue (milligrams of constituent per kilogram tissue [mg/kg tissue])
a	= compound specific regression equation constant (unitless)
b	= compound specific regression equation constant (unitless)
C_{soil}	= concentration of constituent in exposure soil (mg/kg soil)
Dose	= daily exposure dose of constituent resulting from ingestion of media and invertebrates (milligrams per kilogram body weight per day [mg/kgBW-day])
SIR	= soil ingestion rate (kilograms soil per day [kg soil/day])
BAF	= bioaccumulation factor (kg soil/kg tissue)
FIR	= food or biota ingestion rate (kilograms tissue per day [kg tissue/ day])
SUF	= site use factor (unitless)
BW	= body weight of receptor (kilograms [kgBW])
HQ	= hazard quotient (unitless); set at target of 1
TRV	= toxicity reference value (milligrams per kilogram body weight per day)
ECV	= ecological comparison value (mg/kg soil)

ARCADIS

Attachment 1

Table A-1
Ecological Comparison Values Based on Gambel's Quail and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
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Protective Media Concentrations (mg/kg)	Antimony mg/kg (dw)		Arsenic mg/kg (dw)		Barium mg/kg (dw)		Beryllium mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	NA	NA	4.1E+02	6.5E+02	NA	NA	NA	NA	2.5E+02	1.3E+03	4.8E+02	2.8E+03	NA	NA
Plant tissue	NA	NA	1.5E+01	2.5E+01	NA	NA	NA	NA	1.3E+01	3.1E+01	2.0E+01	1.2E+02	NA	NA
Invertebrate tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Prey (mammal) tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	ln(Cp) = 0.938 * ln(Cs) - 3.233		3.8E-02		1.6E-01		ln(Cp) = 0.7345 * ln(Cs) - 0.5361		ln(Cp) = 0.546 * ln(Cs) - 0.475		4.1E-02		4.1E-02	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	NA	NA	2.2E+00	3.5E+00	NA	NA	NA	NA	1.5E+00	6.4E+00	2.7E+00	1.6E+01	NA	NA
HQ	NA	NA	1.0E+00	1.0E+00	NA	NA	NA	NA	1.0E+00	1.0E+00	1.0E+00	1.0E+00	NA	NA

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR	0.00649	kg tissue/day
Soil Ingestion Rate (SIR)	0.0006750	kg soil/day
Plant Ingestion Fraction (F_{food})	100%	Percent
Invertebrate Ingestion Fraction (F_{food})	0%	Percent
Mammal Ingestion Fraction (F_{food})	0%	Percent
Home Range	35.7	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	0.1693	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(yellow highlight) soil ECV.

1 bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.
2 exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).
3 dose caluated for a target HQ of 1 (NOAEL and LOAEL based).
4 Low and High ECVs based on low and high TRVs (from Table 3), respectively.

ECV	ecological comparison value for soil.
dw	dry weight.
High	lowest-observed adverse effects level (LOAEL).
HMW PAHs	high molecular weight polycyclic aromatic hydrocarbons.
kg	kilograms.
kg/day	kilograms per day.
LMW PAHs	low molecular weight polycyclic aromatic hydrocarbons.
Low	no-observed adverse effects level (NOAEL).
mg/kg	milligrams per kilogram.
mg/kgBW-day	milligrams per kilogram body weight per day.
NA	not available or not applicable.

Table A-1
Ecological Comparison Values Based on Gambel's Quail and Proposed TRVs

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PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum mg/kg (dw)		Nickel mg/kg (dw)		Selenium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	1.8E+03	4.3E+03	7.6E+02	2.6E+03	3.4E+02	7.2E+02	3.2E+00	2.5E+01	2.6E+02	2.6E+03	1.4E+03	4.1E+03	1.0E+01	1.9E+01
Plant tissue	1.3E+01	3.2E+01	2.7E+01	4.3E+01	7.0E+00	1.1E+01	6.9E-01	2.1E+00	6.4E+01	6.5E+02	2.5E+01	5.5E+01	6.5E+00	1.3E+01
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	7.5E-03		ln(Cp) = 0.394 * ln(Cs) + 0.668		ln(Cp) = 0.561 * ln(Cs) - 1.328		ln(Cp) = 0.544 * ln(Cs) - 0.996		2.5E-01		ln(Cp) = 0.748 * ln(Cs) - 2.223		ln(Cp) = 1.104 * ln(Cs) - 0.677	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	7.6E+00	1.8E+01	4.1E+00	1.2E+01	1.6E+00	3.3E+00	3.9E-02	1.8E-01	3.5E+00	3.5E+01	6.7E+00	1.9E+01	2.9E-01	5.8E-01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-1
Ecological Comparison Values Based on Gambel's Quail and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs												
Soil	4.5E+02	4.5E+03	8.5E+01	8.5E+02	8.2E+01	1.6E+02	9.3E+03	2.9E+04	5.6E+03	5.7E+04	1.1E+03	1.2E+04
Plant tissue	6.3E+00	6.3E+01	3.4E-01	3.4E+00	4.0E-01	8.0E-01	7.6E+02	1.4E+03	1.3E+01	3.9E+01	1.4E+02	1.3E+03
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	1.4E-02		4.0E-03		4.9E-03		ln(Cp) = 0.554 * ln(Cs) + 1.575		ln(Cp) = 0.4544 * ln(Cs)-1.3205		ln(Cp) = 0.9469 * ln(Cs)-1.7026	
Soil-to-Invertebrates	--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	2.0E+00	2.0E+01	3.5E-01	3.5E+00	3.4E-01	6.9E-01	6.6E+01	1.7E+02	2.3E+01	2.3E+02	1.0E+01	1.0E+02
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-2
Ecological Comparison Values Based on the Cactus Wren and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony mg/kg (dw)		Arsenic mg/kg (dw)		Barium mg/kg (dw)		Beryllium mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	NA	NA	7.6E+01	1.3E+02	NA	NA	NA	NA	9.5E-01	5.9E+00	3.6E+01	2.1E+02	NA	NA
Plant tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Invertebrate tissue	NA	NA	5.1E+00	7.4E+00	NA	NA	NA	NA	7.9E+00	3.4E+01	1.1E+01	6.5E+01	NA	NA
Prey (mammal) tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	1.0E+00		ln(Ci) = 0.706 * ln(Cs) - 1.421		9.1E-02		4.5E-02		ln(Ci) = 0.795 * ln(Cs) + 2.114		3.1E-01		3.1E-01	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	NA	NA	2.2E+00	3.6E+00	NA	NA	NA	NA	1.5E+00	6.4E+00	2.7E+00	1.6E+01	NA	NA
HQ	NA	NA	1.0E+00	1.0E+00	NA	NA	NA	NA	1.0E+00	1.0E+00	1.0E+00	1.0E+00	NA	NA

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR	0.00713	kg tissue/day
Soil Ingestion Rate (SIR)	0.0006631	kg soil/day
Plant Ingestion Fraction (F_{food})	0%	Percent
Invertebrate Ingestion Fraction (F_{food})	100%	Percent
Mammal Ingestion Fraction (F_{food})	0%	Percent
Home Range	4.8	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	0.0389	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(yellow highlight) soil ECV.

1 bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.
2 exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).
3 dose caluated for a target HQ of 1 (NOAEL and LOAEL based).
4 Low and High ECVs based on low and high TRVs (from Table 3), respectively.

ECV ecological comparison value for soil.
dw dry weight.
High lowest-observed adverse effects level (LOAEL).
HMW PAHs high molecular weight polycyclic aromatic hydrocarbons.
kg kilograms.
kg/day kilograms per day.
LMW PAHs low molecular weight polycyclic aromatic hydrocarbons.
Low no-observed adverse effects level (NOAEL).
mg/kg milligrams per kilogram.
mg/kgBW-day milligrams per kilogram body weight per day.
NA not available or not applicable.

Table A-2
Ecological Comparison Values Based on the Cactus Wren and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum mg/kg (dw)		Nickel mg/kg (dw)		Selenium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	1.9E+02	4.6E+02	3.6E+01	1.1E+02	1.6E+01	3.6E+01	1.3E-02	9.1E-01	3.0E+01	3.0E+02	3.2E+01	8.8E+01	1.8E+00	4.4E+00
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	2.4E+01	5.7E+01	1.9E+01	5.6E+01	7.4E+00	1.4E+01	2.1E-01	9.0E-01	1.6E+01	1.6E+02	3.4E+01	9.3E+01	1.4E+00	2.7E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	1.2E-01		5.2E-01		ln(Ci) = 0.807 * ln(Cs) - 0.218		ln(Ci) = 0.3369 * ln(Cs) - 0.078		5.5E-01		1.1E+00		ln(Ci) = 0.733 * ln(Cs) - 0.075	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	7.6E+00	1.8E+01	4.0E+00	1.2E+01	1.6E+00	3.3E+00	3.9E-02	1.8E-01	3.5E+00	3.5E+01	6.7E+00	1.9E+01	2.9E-01	5.8E-01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-2
Ecological Comparison Values Based on the Cactus Wren and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs												
Soil	5.2E+00	5.2E+01	3.0E+00	3.0E+01	1.4E+01	2.8E+01	7.6E+01	1.0E+03	4.0E+01	4.0E+02	2.0E+01	2.0E+02
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	1.1E+01	1.1E+02	1.6E+00	1.6E+01	5.8E-01	1.2E+00	3.5E+02	8.4E+02	1.2E+02	1.2E+03	5.3E+01	5.3E+02
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	--		--		--		--		--		--	
Soil-to-Invertebrates	2.0E+00		5.5E-01		4.2E-02		ln(Ci) = 0.328 * ln(Cs) + 4.449		3.0E+00		2.6E+00	
Soil-to-Mammals	--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	2.0E+00	2.0E+01	3.5E-01	3.5E+00	3.4E-01	6.9E-01	6.6E+01	1.7E+02	2.3E+01	2.3E+02	1.0E+01	1.0E+02
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-3
Ecological Comparison Values Based on Red Tailed Hawk and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony mg/kg (dw)		Arsenic mg/kg (dw)		Barium mg/kg (dw)		Beryllium mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs														
Soil	NA	NA	1.8E+03	2.8E+03	NA	NA	NA	NA	8.4E+02	4.6E+03	5.9E+02	5.2E+03	NA	NA
Plant tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Invertebrate tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Prey (mammal) tissue	NA	NA	3.6E+00	5.3E+00	NA	NA	NA	NA	6.8E+00	1.5E+01	2.5E+01	1.2E+02	NA	NA
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	0.05 * Cd		ln(Cm) = 0.8188 * ln(Cs) -4.8471		0.0075 * Cd		0.05 * Cd		ln(Cm) = 0.4723 * ln(Cs) - 1.2571		ln(Cm) = 0.7338 * ln(Cs) - 1.4599		ln(Cm) = 0.7338 * ln(Cs) - 1.4599	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	NA	NA	2.2E+00	3.6E+00	NA	NA	NA	NA	1.5E+00	6.4E+00	2.7E+00	1.6E+01	NA	NA
HQ	NA	NA	1.0E+00	1.0E+00	NA	NA	NA	NA	1.0E+00	1.0E+00	1.0E+00	1.0E+00	NA	NA

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR	0.08990	kg tissue/day
Soil Ingestion Rate (SIR)	0.0012586	kg soil/day
Plant Ingestion Fraction (F_{food})	0%	Percent
Invertebrate Ingestion Fraction (F_{food})	0%	Percent
Mammal Ingestion Fraction (F_{food})	100%	Percent
Home Range	2471	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	1.134	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(highlighted) soil ECV.

[1] bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.

[2] exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).

[3] dose caluated for a target HQ of 1 (NOAEL and LOAEL based).

[4] Low and High ECVs based on low and high TRVs (from Table 3), respectively.

ECV	ecological comparison value for soil.
dw	dry weight.
High	lowest-observed adverse effects level (LOAEL).
HMW PAHs	high molecular weight polycyclic aromatic hydrocarbons.
kg	kilograms.
kg/day	kilograms per day.
LMW PAHs	low molecular weight polycyclic aromatic hydrocarbons.
Low	no-observed adverse effects level (NOAEL).
mg/kg	milligrams per kilogram.
mg/kgBW-day	milligrams per kilogram body weight per day.
NA	not available or not applicable.

Table A-3
Ecological Comparison Values Based on Red Tailed Hawk and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum[4] mg/kg (dw)		Nickel mg/kg (dw)		Selenium mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs														
Soil	9.0E+02	1.8E+03	2.0E+03	8.9E+03	3.9E+02	1.2E+03	2.4E+00	1.1E+01	2.5E+02	2.5E+03	3.5E+03	1.2E+04	5.2E+01	1.9E+02
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	8.3E+01	2.1E+02	2.3E+01	2.9E+01	1.5E+01	2.5E+01	4.6E-01	2.1E+00	4.1E+01	4.1E+02	3.5E+01	6.3E+01	2.9E+00	4.7E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	ln(Cm) = 1.307 * ln(Cs) - 4.4669		ln(Cm) = 0.1444 * ln(Cs) + 2.042		ln(Cm) = 0.4422 * ln(Cs) + 0.0761		1.9E-01		0.006 * 50 * Cd		ln(Cm) = 0.4658 * ln(Cs) - 0.2462		ln(Cm) = 0.3764 * ln(Cs) - 0.415	
Dose Calulations for Target Hazard Quotients (HQs)[2]						**0.0E+00**								
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	7.6E+00	1.8E+01	4.1E+00	1.2E+01	1.6E+00	3.3E+00	3.9E-02	1.8E-01	3.5E+00	3.5E+01	6.7E+00	1.9E+01	2.9E-01	5.8E-01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-3
Ecological Comparison Values Based on Red Tailed Hawk and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs												
Soil	1.4E+03	1.4E+04	3.5E+01	3.5E+02	1.6E+02	3.3E+02	4.8E+04	1.4E+05	2.1E+04	2.1E+05	9.0E+03	9.0E+04
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	5.7E+00	5.7E+01	3.9E+00	3.9E+01	2.0E+00	4.1E+00	1.7E+02	1.8E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--	
Soil-to-Mammals	4.0E-03		1.1E-01		1.2E-02		ln(Cm) = 0.0706 * ln(Cs) + 4.3632		0.0E+00		0.0E+00	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	2.0E+00	2.0E+01	3.5E-01	3.5E+00	3.4E-01	6.9E-01	6.6E+01	1.7E+02	2.3E+01	2.3E+02	1.0E+01	1.0E+02
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-4
Ecological Comparison Values Based on Desert Shrew and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony mg/kg (dw)		Arsenic mg/kg (dw)		Barium mg/kg (dw)		Beryllium mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	2.8E-01	2.8E+00	8.9E+01	1.6E+02	2.3E+03	3.7E+03	4.0E+01	4.8E+01	3.7E-01	6.8E+00	3.6E+01	1.5E+02	1.4E+02	5.9E+02
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	2.8E-01	2.8E+00	5.7E+00	8.8E+00	2.1E+02	3.3E+02	1.8E+00	2.1E+00	3.8E+00	3.8E+01	1.1E+01	4.4E+01	42.724563	1.8E+02
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	1.0E+00		ln(Ci) = 0.706 * ln(Cs) - 1.421		9.1E-02		4.5E-02		ln(Ci) = 0.795 * ln(Cs) + 2.114		3.1E-01		3.1E-01	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	5.9E-02	5.9E-01	1.5E+00	2.4E+00	5.2E+01	8.3E+01	5.3E-01	6.3E-01	7.7E-01	7.7E+00	2.4E+00	9.6E+00	9.2E+00	3.9E+01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR)	0.00102	kg tissue/day
Soil Ingestion Rate (SIR)	0.0000203	kg soil/day
Plant Ingestion Fraction (F_{food})	0%	Percent
Invertebrate Ingestion Fraction (F_{food})	100%	Percent
Mammal Ingestion Fraction (F_{food})	0%	Percent
Home Range	0.1	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	0.005	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(highlighted) soil ECV.

[1] bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.
[2] exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).
[3] dose caluated for a target HQ of 1 (NOAEL and LOAEL based).
[4] Low and High ECVs based on low and high TRVs (from Table 3), respectively.

ECV	ecological comparison value for soil.
dw	dry weight.
High	lowest-observed adverse effects level (LOAEL).
HMW PAHs	high molecular weight polycyclic aromatic hydrocarbons.
kg	kilograms.
kg/day	kilograms per day.
LMW PAHs	low molecular weight polycyclic aromatic hydrocarbons.
Low	no-observed adverse effects level (NOAEL).
mg/kg	milligrams per kilogram.
mg/kgBW-day	milligrams per kilogram body weight per day.
NA	not available or not applicable.

Table A-4
Ecological Comparison Values Based on Desert Shrew and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum mg/kg (dw)		Nickel mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs												
Soil	2.5E+02	6.5E+02	8.7E+01	1.4E+02	6.0E+01	1.3E+02	2.1E+00	5.9E+02	2.2E+00	2.2E+01	7.8E+00	1.6E+01
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	3.1E+01	8.0E+01	4.5E+01	7.5E+01	2.2E+01	4.1E+01	1.2E+00	7.9E+00	1.2E+00	1.2E+01	8.2E+00	1.6E+01
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	--		--		--		--		--		--	
Soil-to-Invertebrates	1.2E-01		5.2E-01		ln(Ci) = 0.807 * ln(Cs) - 0.218		ln(Ci) = 0.3369 * ln(Cs) - 0.078		5.5E-01		1.1E+00	
Soil-to-Mammals	--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	7.3E+00	1.9E+01	9.4E+00	1.6E+01	4.7E+00	8.9E+00	2.5E-01	4.0E+00	2.6E-01	2.6E+00	1.7E+00	3.4E+00
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-4
Ecological Comparison Values Based on Desert Shrew and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Selenium mg/kg (dw)		Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	1.3E+00	2.2E+00	2.1E+01	2.1E+02	2.3E+00	6.9E+00	3.3E+02	6.6E+02	8.7E+01	4.7E+03	1.1E+02	5.3E+02	1.2E+00	5.8E+00
Plant tissue	6.7E-01	1.2E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.1E-01	9.6E-01
Invertebrate tissue	1.1E+00	1.7E+00	4.3E+01	4.3E+02	2.3E+00	6.9E+00	1.4E+01	2.8E+01	3.7E+02	1.4E+03	3.2E+02	1.6E+03	3.0E+00	1.5E+01
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	ln(Ci) = 0.733 * ln(Cs) - 0.075		2.0E+00		5.5E-01		4.2E-02		ln(Ci) = 0.328 * ln(Cs) + 4.449		3.0E+00		2.6E+00	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	2.3E-01	3.5E-01	8.8E+00	8.8E+01	4.8E-01	1.4E+00	4.2E+00	8.3E+00	7.5E+01	3.0E+02	6.6E+01	3.3E+02	6.1E-01	3.1E+00
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-5
Ecological Comparison Values Based on Kangaroo Rat and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony mg/kg (dw)		Arsenic mg/kg (dw)		Barium mg/kg (dw)		Beryllium mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	1.2E+01	1.4E+02	2.9E+02	4.6E+02	3.5E+03	5.6E+03	2.3E+01	2.9E+01	8.9E+01	2.2E+03	4.5E+02	1.8E+03	1.7E+03	7.3E+03
Plant tissue	4.2E-01	3.9E+00	1.1E+01	1.7E+01	5.5E+02	8.7E+02	5.9E+00	7.0E+00	7.2E+00	4.1E+01	1.8E+01	7.4E+01	7.1E+01	3.0E+02
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	ln(Cp) = 0.938 * ln(Cs) - 3.233		3.8E-02		1.6E-01		ln(Cp) = 0.7345 * ln(Cs) - 0.5361		ln(Cp) = 0.546 * ln(Cs) - 0.475		4.1E-02		4.1E-02	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	5.9E-02	5.9E-01	1.5E+00	2.3E+00	5.2E+01	8.3E+01	5.3E-01	6.3E-01	7.7E-01	7.7E+00	2.4E+00	9.6E+00	9.2E+00	3.9E+01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR	0.00282	kg tissue/day
Soil Ingestion Rate (SIR)	0.0000677	kg soil/day
Plant Ingestion Fraction (F_{food})	100%	Percent
Invertebrate Ingestion Fraction (F_{food})	0%	Percent
Mammal Ingestion Fraction (F_{food})	0%	Percent
Home Range	0.13	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	0.0343	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(yellow highlight)	soil ECV.
1	bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.
2	exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).
3	dose caluated for a target HQ of 1 (NOAEL and LOAEL based).
4	Low and High ECVs based on low and high TRVs (from Table 3), respectively.
ECV	ecological comparison value for soil.
dw	dry weight.
High	lowest-observed adverse effects level (LOAEL).
HMW PAHs	high molecular weight polycyclic aromatic hydrocarbons.
kg	kilograms.
kg/day	kilograms per day.
LMW PAHs	low molecular weight polycyclic aromatic hydrocarbons.
Low	no-observed adverse effects level (NOAEL).
mg/kg	milligrams per kilogram.
mg/kgBW-day	milligrams per kilogram body weight per day.
NA	not available or not applicable.

Table A-5
Ecological Comparison Values Based on Kangaroo Rat and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum mg/kg (dw)		Nickel mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs												
Soil	2.8E+03	7.3E+03	2.7E+03	5.3E+03	1.7E+03	3.4E+03	3.0E+01	1.3E+03	1.2E+01	1.2E+02	4.4E+02	9.6E+02
Plant tissue	2.1E+01	5.4E+01	4.4E+01	5.7E+01	1.7E+01	2.6E+01	2.3E+00	1.8E+01	2.9E+00	2.9E+01	1.0E+01	1.8E+01
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	7.5E-03		ln(Cp) = 0.394 * ln(Cs) + 0.668		ln(Cp) = 0.561 * ln(Cs) - 1.328		ln(Cp) = 0.544 * ln(Cs) - 0.996		2.5E-01		ln(Cp) = 0.748 * ln(Cs) - 2.223	
Soil-to-Invertebrates	--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	7.3E+00	1.9E+01	9.0E+00	1.5E+01	4.7E+00	8.9E+00	2.5E-01	4.0E+00	2.6E-01	2.6E+00	1.7E+00	3.4E+00
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-5
Ecological Comparison Values Based on Kangaroo Rat and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Selenium mg/kg (dw)		Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	4.1E+00	6.0E+00	2.7E+03	2.7E+04	2.1E+02	6.2E+02	1.8E+03	3.5E+03	8.3E+03	6.1E+04	3.2E+04	1.6E+05	4.3E+01	2.3E+02
Plant tissue	2.4E+00	3.7E+00	3.8E+01	3.8E+02	8.3E-01	2.5E+00	8.5E+00	1.7E+01	7.2E+02	2.2E+03	3.0E+01	6.2E+01	6.4E+00	3.2E+01
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	ln(Cp) = 1.104 * ln(Cs) - 0.677		1.4E-02		4.0E-03		4.9E-03		ln(Cp) = 0.554 * ln(Cs) + 1.575		ln(Cp) = 0.4544 * ln(Cs)-1.3205		ln(Cp) = 0.9469 * ln(Cs)-1.7026	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	2.1E-01	3.1E-01	8.4E+00	8.4E+01	4.8E-01	1.4E+00	4.2E+00	8.3E+00	7.5E+01	3.0E+02	6.6E+01	3.3E+02	6.2E-01	3.1E+00
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-6
Ecological Comparison Values Based on Desert Kit Fox and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony[4] mg/kg (dw)		Arsenic mg/kg (dw)		Barium[4] mg/kg (dw)		Beryllium[4] mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs														
Soil	2.1E+01	2.1E+02	9.7E+02	1.6E+03	5.1E+04	8.1E+04	5.0E+02	5.9E+02	5.7E+02	7.1E+03	1.1E+03	5.3E+03	5.0E+03	2.5E+04
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	1.1E+00	1.1E+01	2.2E+00	3.2E+00	3.5E+01	5.6E+01	1.1E+00	1.3E+00	5.7E+00	1.9E+01	3.8E+01	1.2E+02	1.2E+02	3.9E+02
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	0.05 * Cd		ln(Cm) = 0.8188 * ln(Cs) -4.8471		0.0075 * Cd		0.05 * Cd		ln(Cm) = 0.4723 * ln(Cs) - 1.2571		n(Cm) = 0.7338 * ln(Cs) - 1.4599		ln(Cm) = 0.7338 * ln(Cs) - 1.4599	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	5.9E-02	5.9E-01	1.0E+00	1.7E+00	5.2E+01	8.3E+01	5.3E-01	6.3E-01	7.7E-01	7.7E+00	2.4E+00	9.6E+00	9.2E+00	3.9E+01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR	0.07020	kg tissue/day
Soil Ingestion Rate (SIR)	0.0019656	kg soil/day
Plant Ingestion Fraction (F_{food})	0%	Percent
Invertebrate Ingestion Fraction (F_{food})	0%	Percent
Mammal Ingestion Fraction (F_{food})	100%	Percent
Home Range	3039	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	1.985	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(highlighted) soil ECV.

1 bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.
2 exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).
3 dose caluated for a target HQ of 1 (NOAEL and LOAEL based).
4 Low and High ECVs based on low and high TRVs (from Table 3), respectively.

ECV ecological comparison value for soil.
dw dry weight.
High lowest-observed adverse effects level (LOAEL).
HMW PAHs high molecular weight polycyclic aromatic hydrocarbons.
kg kilograms.
kg/day kilograms per day.
LMW PAHs low molecular weight polycyclic aromatic hydrocarbons.
Low no-observed adverse effects level (NOAEL).
mg/kg milligrams per kilogram.
mg/kgBW-day milligrams per kilogram body weight per day.
NA not available or not applicable.

Table A-6
Ecological Comparison Values Based on Desert Kit Fox and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum[4] mg/kg (dw)		Nickel mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs												
Soil	1.5E+03	3.2E+03	4.7E+03	8.4E+03	3.4E+03	7.0E+03	3.2E+01	5.1E+02	3.8E+01	3.8E+02	1.0E+03	2.4E+03
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	1.6E+02	4.4E+02	2.6E+01	2.8E+01	3.9E+01	5.4E+01	6.2E+00	9.9E+01	6.3E+00	6.3E+01	2.0E+01	2.9E+01
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--	
Soil-to-Mammals	ln(Cm) = 1.307 * ln(Cs) - 4.4669		ln(Cm) = 0.1444 * ln(Cs) + 2.042		ln(Cm) = 0.4422 * ln(Cs) + 0.0761		1.9E-01		0.006 * 50 * Cd		ln(Cm) = 0.4658 * ln(Cs) - 0.2462	
Dose Calulations for Target Hazard Quotients (HQs)[2]						**0.0E+00**						
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	7.3E+00	1.9E+01	5.6E+00	9.3E+00	4.7E+00	8.9E+00	2.5E-01	4.0E+00	2.6E-01	2.6E+00	1.7E+00	3.4E+00
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-6
Ecological Comparison Values Based on Desert Kit Fox and Proposed TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Selenium mg/kg (dw)		Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs														
Soil	4.5E+01	8.9E+01	5.3E+03	5.3E+04	9.7E+01	2.9E+02	2.9E+03	5.8E+03	7.0E+04	2.9E+05	6.6E+04	3.3E+05	6.2E+02	3.1E+03
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	2.8E+00	3.6E+00	2.1E+01	2.1E+02	1.1E+01	3.2E+01	3.6E+01	7.2E+01	1.7E+02	1.9E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	ln(Cm) = 0.3764 * ln(Cs) - 0.4158		4.0E-03		1.1E-01		1.2E-02		ln(Cm) = 0.0706 * ln(Cs) + 4.3632		0.0E+00		0.0E+00	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
Dose = TRV	1.4E-01	2.2E-01	6.0E+00	6.0E+01	4.8E-01	1.4E+00	4.2E+00	8.3E+00	7.5E+01	3.0E+02	6.6E+01	3.3E+02	6.2E-01	3.1E+00
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-7
Ecological Comparison Values Based on the Gambel's Quail and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony mg/kg (dw)		Arsenic mg/kg (dw)		Barium mg/kg (dw)		Beryllium mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	NA	NA	1.0E+03	4.1E+03	NA	NA	NA	NA	5.3E+00	2.2E+03	4.8E+02	2.8E+03	NA	NA
Plant tissue	NA	NA	3.8E+01	1.5E+02	NA	NA	NA	NA	1.5E+00	4.2E+01	2.0E+01	1.2E+02	NA	NA
Invertebrate tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Prey (mammal) tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	ln(Cp) = 0.938 * ln(Cs) - 3.233		3.8E-02		1.6E-01		ln(Cp) = 0.7345 * ln(Cs) - 0.5361		ln(Cp) = 0.546 * ln(Cs) - 0.475		4.1E-02		4.1E-02	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	NA	NA	5.5E+00	2.2E+01	NA	NA	NA	NA	8.0E-02	1.0E+01	2.7E+00	1.6E+01	NA	NA
HQ	NA	NA	1.0E+00	1.0E+00	NA	NA	NA	NA	1.0E+00	1.0E+00	1.0E+00	1.0E+00	NA	NA

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR	0.00649	kg tissue/day
Soil Ingestion Rate (SIR)	0.0006750	kg soil/day
Plant Ingestion Fraction (F_{food})	100%	Percent
Invertebrate Ingestion Fraction (F_{food})	0%	Percent
Mammal Ingestion Fraction (F_{food})	0%	Percent
Home Range	35.7	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	0.1693	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

soil ECV.

1 bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.
2 exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).
3 dose caluated for a target HQ of 1 (NOAEL and LOAEL based).
4 Low and High ECVs based on low and high TRVs (from Table 4), respectively.

ECV	ecological comparison value for soil.
DTSC	Department of Toxic Substances Control.
dw	dry weight.
High	lowest-observed adverse effects level (LOAEL).
HMW PAHs	high molecular weight polycyclic aromatic hydrocarbons.
kg	kilograms.
kg/day	kilograms per day.
LMW PAHs	low molecular weight polycyclic aromatic hydrocarbons.
Low	no-observed adverse effects level (NOAEL).
mg/kg	milligrams per kilogram.
mg/kg-bw/day	milligrams per kilogram body weight per day.
NA	not available or not applicable.

Table A-7
Ecological Comparison Values Based on the Gambel's Quail and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum mg/kg (dw)		Nickel mg/kg (dw)		Selenium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	1.8E+03	4.3E+03	3.8E+02	1.2E+04	9.8E-01	2.0E+03	3.2E+00	2.5E+01	2.6E+02	2.6E+03	2.8E+02	1.3E+04	8.2E+00	2.9E+01
Plant tissue	1.3E+01	3.2E+01	2.0E+01	8.0E+01	2.6E-01	1.9E+01	6.9E-01	2.1E+00	6.4E+01	6.5E+02	7.3E+00	1.3E+02	5.2E+00	2.1E+01
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	7.5E-03		ln(Cp) = 0.394 * ln(Cs) + 0.668		ln(Cp) = 0.561 * ln(Cs) - 1.328		ln(Cp) = 0.544 * ln(Cs) - 0.996		2.5E-01		ln(Cp) = 0.748 * ln(Cs) - 2.223		ln(Cp) = 1.104 * ln(Cs) - 0.677	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	7.6E+00	1.8E+01	2.3E+00	5.2E+01	1.4E-02	8.8E+00	3.9E-02	1.8E-01	3.5E+00	3.5E+01	1.4E+00	5.6E+01	2.3E-01	9.3E-01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-7
Ecological Comparison Values Based on the Gambel's Quail and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs												
Soil	4.5E+02	4.5E+03	8.5E+01	8.5E+02	8.2E+01	1.6E+02	1.6E+03	2.9E+04	5.6E+03	5.7E+04	1.1E+03	1.2E+04
Plant tissue	6.3E+00	6.3E+01	3.4E-01	3.4E+00	4.0E-01	8.0E-01	2.9E+02	1.4E+03	1.3E+01	3.9E+01	1.4E+02	1.3E+03
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	1.4E-02		4.0E-03		4.9E-03		ln(Cp) = 0.554 * ln(Cs) + 1.575		ln(Cp) = 0.4544 * ln(Cs)-1.3205		ln(Cp) = 0.9469 * ln(Cs)-1.7026	
Soil-to-Invertebrates	--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	2.0E+00	2.0E+01	3.5E-01	3.5E+00	3.4E-01	6.9E-01	1.7E+01	1.7E+02	2.3E+01	2.3E+02	1.0E+01	1.0E+02
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-8
Ecological Comparison Values Based on the Cactus Wren and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony mg/kg (dw)		Arsenic mg/kg (dw)		Barium mg/kg (dw)		Beryllium mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	NA	NA	2.1E+02	9.6E+02	NA	NA	NA	NA	2.5E-02	1.1E+01	3.6E+01	2.1E+02	NA	NA
Plant tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Invertebrate tissue	NA	NA	1.1E+01	3.1E+01	NA	NA	NA	NA	4.3E-01	5.6E+01	1.1E+01	6.5E+01	NA	NA
Prey (mammal) tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	1.0E+00		ln(Ci) = 0.706 * ln(Cs) - 1.421		9.1E-02		4.5E-02		ln(Ci) = 0.795 * ln(Cs) + 2.114		3.1E-01		3.1E-01	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	NA	NA	5.5E+00	2.2E+01	NA	NA	NA	NA	8.0E-02	1.0E+01	2.7E+00	1.6E+01	NA	NA
HQ	NA	NA	1.0E+00	1.0E+00	NA	NA	NA	NA	1.0E+00	1.0E+00	1.0E+00	1.0E+00	NA	NA

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR	0.00713	kg tissue/day
Soil Ingestion Rate (SIR)	0.0006631	kg soil/day
Plant Ingestion Fraction (F_{food})	0%	Percent
Invertebrate Ingestion Fraction (F_{food})	100%	Percent
Mammal Ingestion Fraction (F_{food})	0%	Percent
Home Range	4.8	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	0.0389	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(highlighted) soil ECV.

[1] bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.
[2] exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).
[3] dose caluated for a target HQ of 1 (NOAEL and LOAEL based).
[4] Low and High ECVs based on low and high TRVs (from Table 4), respectively.

ECV	ecological comparison value for soil.
DTSC	Department of Toxic Substances Control.
dw	dry weight.
High	lowest-observed adverse effects level (LOAEL).
HMW PAHs	high molecular weight polycyclic aromatic hydrocarbons.
kg	kilograms.
kg/day	kilograms per day.
LMW PAHs	low molecular weight polycyclic aromatic hydrocarbons.
Low	no-observed adverse effects level (NOAEL).
mg/kg	milligrams per kilogram.
mg/kg-bw/day	milligrams per kilogram body weight per day.
NA	not available or not applicable.

Table A-8
Ecological Comparison Values Based on the Cactus Wren and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum mg/kg (dw)		Nickel mg/kg (dw)		Selenium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	1.9E+02	4.6E+02	2.1E+01	4.7E+02	5.0E-02	1.2E+02	1.3E-02	9.1E-01	3.0E+01	3.0E+02	6.5E+00	2.7E+02	1.3E+00	8.1E+00
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	2.4E+01	5.7E+01	1.1E+01	2.4E+02	7.2E-02	3.7E+01	2.1E-01	9.0E-01	1.6E+01	1.6E+02	6.9E+00	2.8E+02	1.1E+00	4.3E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	1.2E-01		5.2E-01		ln(Ci) = 0.807 * ln(Cs) - 0.218		ln(Ci) = 0.3369 * ln(Cs) - 0.078		5.5E-01		1.1E+00		ln(Ci) = 0.733 * ln(Cs) - 0.075	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	7.6E+00	1.8E+01	2.3E+00	5.2E+01	1.4E-02	8.8E+00	3.9E-02	1.8E-01	3.5E+00	3.5E+01	1.4E+00	5.6E+01	2.3E-01	9.3E-01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-8
Ecological Comparison Values Based on the Cactus Wren and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs												
Soil	5.2E+00	5.2E+01	3.0E+00	3.0E+01	1.4E+01	2.8E+01	1.3E+00	1.1E+03	4.0E+01	4.0E+02	2.0E+01	2.0E+02
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	1.1E+01	1.1E+02	1.6E+00	1.6E+01	5.8E-01	1.2E+00	9.4E+01	8.4E+02	1.2E+02	1.2E+03	5.3E+01	5.3E+02
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	--		--		--		--		--		--	
Soil-to-Invertebrates	2.0E+00		5.5E-01		4.2E-02		ln(Ci) = 0.328 * ln(Cs) + 4.449		3.0E+00		2.6E+00	
Soil-to-Mammals	--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	2.0E+00	2.0E+01	3.5E-01	3.5E+00	3.4E-01	6.9E-01	1.7E+01	1.7E+02	2.3E+01	2.3E+02	1.0E+01	1.0E+02
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-9
Ecological Comparison Values Based on the Red-Tailed Hawk and on DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony mg/kg (dw)		Arsenic mg/kg (dw)		Barium mg/kg (dw)		Beryllium mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs														
Soil	NA	NA	4.4E+03	1.8E+04	NA	NA	NA	NA	1.0E+01	8.0E+03	5.9E+02	5.2E+03	NA	NA
Plant tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Invertebrate tissue	NA	NA	0.0E+00	0.0E+00	NA	NA	NA	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	NA	NA
Prey (mammal) tissue	NA	NA	7.6E+00	2.4E+01	NA	NA	NA	NA	8.6E-01	2.0E+01	2.5E+01	1.2E+02	NA	NA
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	0.05 * Cd		ln(Cm) = 0.8188 * ln(Cs) -4.8471		0.0075 * Cd		0.05 * Cd		ln(Cm) = 0.4723 * ln(Cs) - 1.2571		ln(Cm) = 0.7338 * ln(Cs) - 1.4599		ln(Cm) = 0.7338 * ln(Cs) - 1.4599	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	NA	NA	5.5E+00	2.2E+01	NA	NA	NA	NA	8.0E-02	1.0E+01	2.7E+00	1.6E+01	NA	NA
HQ	NA	NA	1.0E+00	1.0E+00	NA	NA	NA	NA	1.0E+00	1.0E+00	1.0E+00	1.0E+00	NA	NA

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR)	0.08990	kg tissue/day
Soil Ingestion Rate (SIR)	0.0012586	kg soil/day
Plant Ingestion Fraction (F_{food})	0%	Percent
Invertebrate Ingestion Fraction (F_{food})	0%	Percent
Mammal Ingestion Fraction (F_{food})	100%	Percent
Home Range	2471	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	1.134	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(yellow highlight) soil ECV.

1 bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.

2 exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).

3 dose caluated for a target HQ of 1 (NOAEL and LOAEL based).

4 Low and High ECVs based on low and high TRVs (from Table 4), respectively.

ECV	ecological comparison value for soil.
DTSC	Department of Toxic Substances Control.
dw	dry weight.
High	lowest-observed adverse effects level (LOAEL).
HMW PAHs	high molecular weight polycyclic aromatic hydrocarbons.
kg	kilograms.
kg/day	kilograms per day.
LMW PAHs	low molecular weight polycyclic aromatic hydrocarbons.
Low	no-observed adverse effects level (NOAEL).
mg/kg	milligrams per kilogram.
mg/kg-bw/day	milligrams per kilogram body weight per day.
NA	not available or not applicable.

Table A-9
Ecological Comparison Values Based on the Red-Tailed Hawk and on DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum[4] mg/kg (dw)		Nickel mg/kg (dw)		Selenium mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs														
Soil	9.0E+02	1.8E+03	6.7E+02	4.5E+04	1.7E-02	4.7E+03	2.4E+00	1.1E+01	1.4E+02	1.4E+03	3.7E+02	4.3E+04	3.3E+01	3.9E+02
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	8.3E+01	2.1E+02	2.0E+01	3.6E+01	1.8E-01	4.5E+01	4.6E-01	2.1E+00	2.3E+01	2.3E+02	1.2E+01	1.1E+02	2.4E+00	6.2E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	ln(Cm) = 1.307 * ln(Cs) - 4.4669		ln(Cm) = 0.1444 * ln(Cs) + 2.042		ln(Cm) = 0.4422 * ln(Cs) + 0.0761		1.9E-01		0.006 * 50 * Cd		ln(Cm) = 0.4658 * ln(Cs) - 0.2462		ln(Cm) = 0.3764 * ln(Cs) - 0.4158	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	7.6E+00	1.8E+01	2.3E+00	5.2E+01	1.4E-02	8.8E+00	3.9E-02	1.8E-01	2.0E+00	2.0E+01	1.4E+00	5.6E+01	2.3E-01	9.3E-01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	5.7E-01	5.7E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-9
Ecological Comparison Values Based on the Red-Tailed Hawk and on DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs												
Soil	1.4E+03	1.4E+04	3.5E+01	3.5E+02	1.6E+02	3.3E+02	5.2E+03	1.4E+05	2.1E+04	2.1E+05	9.0E+03	9.0E+04
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	5.7E+00	5.7E+01	3.9E+00	3.9E+01	2.0E+00	4.1E+00	1.4E+02	1.8E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--	
Soil-to-Mammals	4.0E-03		1.1E-01		1.2E-02		ln(Cm) = 0.0706 * ln(Cs) + 4.3632		0.0E+00		0.0E+00	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	2.0E+00	2.0E+01	3.5E-01	3.5E+00	3.4E-01	6.9E-01	1.7E+01	1.7E+02	2.3E+01	2.3E+02	1.0E+01	1.0E+02
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-10
Ecological Comparison Values Based on the Desert Shrew and on DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony mg/kg (dw)		Arsenic mg/kg (dw)		Barium mg/kg (dw)		Beryllium mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	2.8E-01	2.8E+00	1.1E+01	3.7E+02	2.3E+03	3.7E+03	4.0E+01	4.8E+01	1.5E-02	1.8E+00	3.6E+01	1.5E+02	1.4E+02	5.9E+02
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.5E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	2.8E-01	2.8E+00	1.3E+00	1.6E+01	2.1E+02	3.3E+02	1.8E+00	2.1E+00	3.0E-01	1.3E+01	1.1E+01	4.4E+01	4.27E+01	1.8E+02
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	1.0E+00		ln(Ci) = 0.706 * ln(Cs) - 1.421		9.1E-02		4.5E-02		ln(Ci) = 0.795 * ln(Cs) + 2.114		3.1E-01		3.1E-01	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	5.9E-02	5.9E-01	3.2E-01	4.7E+00	5.2E+01	8.3E+01	5.3E-01	6.3E-01	6.0E-02	2.6E+00	2.4E+00	9.6E+00	9.2E+00	3.9E+01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR	0.00102	kg tissue/day
Soil Ingestion Rate (SIR)	0.0000203	kg soil/day
Plant Ingestion Fraction (F_{food})	0%	Percent
Invertebrate Ingestion Fraction (F_{food})	100%	Percent
Mammal Ingestion Fraction (F_{food})	0%	Percent
Home Range	0.1	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	0.005	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(yellow highlight) soil ECV.

1 bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.
2 exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).
3 dose caluated for a target HQ of 1 (NOAEL and LOAEL based).
4 Low and High ECVs based on low and high TRVs (from Table 4), respectively.

ECV	ecological comparison value for soil.
DTSC	Department of Toxic Substances Control.
dw	dry weight.
High	lowest-observed adverse effects level (LOAEL).
HMW PAHs	high molecular weight polycyclic aromatic hydrocarbons.
kg	kilograms.
kg/day	kilograms per day.
LMW PAHs	low molecular weight polycyclic aromatic hydrocarbons.
Low	no-observed adverse effects level (NOAEL).
mg/kg	milligrams per kilogram.
mg/kg-bw/day	milligrams per kilogram body weight per day.
NA	not available or not applicable.

Table A-10
Ecological Comparison Values Based on the Desert Shrew and on DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum mg/kg (dw)		Nickel mg/kg (dw)		Selenium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	4.2E+01	6.9E+02	2.5E+01	5.8E+03	9.0E+00	7.2E+03	2.1E+00	5.9E+02	2.2E+00	2.2E+01	6.1E-01	1.4E+02	1.8E-01	1.1E+01
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	5.1E+00	8.5E+01	1.3E+01	3.0E+03	4.7E+00	1.0E+03	1.2E+00	7.9E+00	1.2E+00	1.2E+01	6.4E-01	1.5E+02	2.4E-01	5.7E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	1.2E-01		5.2E-01		ln(Ci) = 0.807 * ln(Cs) - 0.218		ln(Ci) = 0.3369 * ln(Cs) - 0.078		5.5E-01		1.1E+00		ln(Ci) = 0.733 * ln(Cs) - 0.075	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	1.2E+00	2.0E+01	2.7E+00	6.3E+02	1.0E+00	2.4E+02	2.5E-01	4.0E+00	2.6E-01	2.6E+00	1.3E-01	3.2E+01	5.0E-02	1.2E+00
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Pacific Gas and Electric Company

Yvonne Meeks
Manager

Environmental Remediation
Gas T&D Department

Mailing Address
4325 South Higuera Street
San Luis Obispo, CA 93401
Location
6588 Ontario Road
San Luis Obispo, CA 93405
Tel: (805) 546-5243
Email: yjm1@pge.com

18 August 2009

Mr. Aaron Yue
Chief Permitting Unit
California Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, California 90630

Ms. Pamela S. Innis
Office of Environmental Policy and Compliance
U.S. Department of Interior
P.O. Box 25007 (D-108)
Denver, CO 80225-0007

Subject: ***Topock Compressor Station – Final Technical Memorandum 4: Ecological Comparison Values for Additional Detected Chemicals in Soil***

Dear Mr. Yue and Ms. Innis:

This letter transmits the *Final Technical Memorandum 4: Ecological Comparison Values for Additional Detected Chemicals in Soil* (ECV TM4) prepared as part of the RCRA Facility Investigation/Remedial Investigation (RFI/RI) process to support the soil investigation and site characterization at the Pacific Gas and Electric Company (PG&E) Topock Compressor Station.

The Final Technical Memorandum 4 was prepared incorporating all comments received to date from the California Department of Toxic Substances Control (DTSC) and the U.S. Department of Interior (DOI) and was submitted to DTSC and DOI on July 1, 2009. Two versions of the final technical memorandum were submitted:

1. The final technical memorandum showing changes to the text in red-line-strike-out mode.
2. Cover letter and the “clean” version of the final technical memorandum (with all changes incorporated).

No additional changes have been made to the Final Technical Memorandum 4 since it was submitted to DTSC and DOI on July 1, 2009.

PG&E received concurrence on the Final Technical Memorandum 4 from DTSC and DOI on August 3, 2009.

We appreciate your attention to this document and look forward to your participation in the data gaps assessment.

If you have any questions regarding this letter, please call me at (805) 234-2257.

Sincerely,

Yvonne Meeks

Yvonne Meeks
Topock Project Manager

Enclosures: Topock Compressor Station – Final Technical Memorandum: Ecological Comparison Values for Additional Detected Chemicals in Soil.

cc: Michael Eichelberger, DTSC
Carrie Marr, USFWS
Shukla Roy-Semmen, DTSC
Karen Baker, DTSC
Dennis Smith, SAIC
Jose Marcos, DTSC

Pacific Gas and Electric Company

Yvonne Meeks
Manager

Environmental Remediation
Gas T&D Department

Mailing Address
4325 South Higuera Street
San Luis Obispo, CA 93401
Location
6588 Ontario Road
San Luis Obispo, CA 93405
Tel: (805) 546-5243
Email: yjm1@pge.com

1 July 2009

Mr. Aaron Yue
Chief Permitting Unit
California Department of Toxic Substances Control
5796 Corporate Avenue
Cypress, California 90630

Ms. Pamela S. Innis
Office of Environmental Policy and Compliance
U.S. Department of Interior
P.O. Box 25007 (D-108)
Denver, CO 80225-0007

Subject: ***Topock Compressor Station – Final Technical Memorandum 4: Ecological Comparison Values for Additional Detected Chemicals in Soil***

Dear Mr. Yue and Ms. Innis:

Enclosed is the *Final Technical Memorandum 4: Ecological Comparison Values for Additional Detected Chemicals in Soil* (ECV TM4) prepared as part of the RCRA Facility Investigation/Remedial Investigation (RFI/RI) process to support the soil investigation and site characterization at the Pacific Gas and Electric (PG&E) Topock Compressor Station (the site). Thank you for your effort in resolving the remaining technical comments on the technical memorandum.

ECV TM4 is based on methods provided in a previously-approved technical memorandum (ECV TM3) that provided soil ecological comparison values (ECVs) for certain metals and polycyclic aromatic hydrocarbons (PAHs). ECV TM4 provides ECVs for other chemicals (for example, dioxins/furans, polychlorinated biphenyls) that were detected during the Part A Phase 1 soil investigation at the site.

ECV TM4 was first submitted to the Department of Toxic Substances (DTSC) and the U.S. Department of Interior (DOI) on January 15, 2009. PG&E received written comments (January 30, 2009) and oral comments (February 26, 2009) on the technical memorandum. PG&E submitted responses to those comments to DTSC and DOI on March 17, 2009. PG&E received further written comments on PG&E's responses from DTSC/Human and Ecological Risk Division (HERD) on March 30, 2009. DOI had no further comments on the March 17, 2009 response to comments (communicated at the RCRA/CERCLA meeting on April 1, 2009). Based on the written comments from DTSC/HERD (March 30, 2009), PG&E submitted closing responses and the revised technical memorandum incorporating all comments (in red-line-strike-out) on April 27, 2009. DTSC and DOI accepted most of the changes to the revised ECV TM4 but requested additional clarification and information on a technical call on June 1, 2009. A summary of the discussion from June 1, 2009 along with the requested information was provided by ARCADIS to the agencies by email on June 3, 2009. Additional information was requested by DOI on June 9, 2009, which was provided to the agencies via email on June 10, 2009 and discussed on another technical call on June 11, 2009. We received concurrence on all outstanding comments on the ECV TM4 from DTSC and DOI via emails dated June 24 and 25, 2009. PG&E has prepared the final technical memorandum incorporating all comments and direction received since the last submittal of the revised ECV TM4 (April 27, 2009). As requested by DOI, changes to the final memorandum text are in red-line-strike-out. The complete final ECV TM4 (text, tables, and Attachment 1) is also provided.

The primary objective of developing ECVs is to assist in evaluating the adequacy of the site characterization. The ECVs are to be applied only to soil investigation planning in conjunction with background values and comparison values for the protection of human health. The ECVs are not intended for use as either cleanup goals or as screening levels to eliminate constituents of potential ecological concern (COPECs).

Please review this final technical memorandum and provide concurrence or direction by July 10, 2009. The ECVs are needed for the forthcoming soil data gaps assessment for each AOC. Therefore, your timely concurrence with the ECVs is an integral part of the soil investigation planning process. We appreciate your attention to this document and look forward to your participation in the data gaps assessment.

If you have any questions regarding this letter, please call me at (805) 234-2257.

Sincerely,

Yvonne Meeks
Topock Project Manager

Enclosures: Topock Compressor Station – Final Technical Memorandum: Ecological Comparison Values for Additional Detected Chemicals in Soil.

cc: Michael Eichelberger, DTSC
Carrie Marr, USFWS
Shukla Roy-Semmen, DTSC
Karen Baker, DTSC
Dennis Smith, SAIC

ARCADIS
100 Montgomery Street
Suite 300
San Francisco
California 94104
Tel 415.374.2744
Fax 415.374.2745

MEMO

To:
Yvonne Meeks
4325 South Hiquera,
San Luis Obispo, CA 93401

Copies:
Dave Gilbert
Bob Doss
Curt Russell
Drew Page
Robb Kapla
Keith Sheets
Serena Lee

From:
ARCADIS Risk Team

Date:
July 1, 2009

ARCADIS Project No.:
RC000689.0006.00005

Subject:
Technical Memorandum 4: Ecological Comparison Values for Additional Detected Chemicals in Soil

---

The purpose of this revised technical memorandum is to provide the methods used to develop soil ecological comparison values (ECVs) for the additional chemicals detected during the Part A Phase 1 soil investigation at the Pacific Gas and Electric (PG&E) Topock Compressor Station, located in San Bernardino County, California, 12 miles southeast of Needles (the site). ECVs were previously provided for metals and polycyclic aromatic hydrocarbons (PAHs); ECVs for these chemicals were developed and presented in the Technical Memorandum 3 (ECV TM3; ARCADIS, 2008). The additional chemicals detected during the Part A Phase 1 soil investigation and the corresponding ECVs are listed in Table 1. U.S. Environmental Protection Agency's (USEPA's) Ecological Soil Screening Levels (EcoSSLs; USEPA 2007), if available for these additional chemicals, are also presented in Table 1 for reference.

The ECVs protective of ecological receptors are to be applied only to soil investigation planning in conjunction with background values and human health based comparison values. The human health based comparison values used are the California Human Health Screening Levels (CHHSLs) or the Regional Screening Levels (RSLs). Therefore, for site-characterization and to guide step-out sampling for each chemical, three comparison values may be used (as available). These comparison values are (1) ECVs, (2) CHHSLs or RSLs, as appropriate, and (3) background values. The ECVs are not intended for use as either cleanup goals or as screening levels to eliminate constituents of potential ecological concern (COPECs). The primary objective of ECVs is to assist in evaluating the adequacy of the site characterization (i.e., help determine the need for step-out sampling). The ECVs, background concentrations, and comparison values for the protection of human health will be used to evaluate the data collected for the Part A Phase 1 soil investigation and assist in identifying data gaps that may require Part A Phase 2 soil sampling. The ECVs developed in ECV TM3 and in this technical memorandum can be used to help define the extent of the site-related constituents in soil and assess the need for additional site characterization. Furthermore, the ECVs can also be used to optimize the selection of sampling locations to limit disturbing the existing habitat.

ECVs are risk-based values protective of ecological receptors and were developed based on direct exposures and food-chain exposures. PG&E attempted to develop ECVs for all chemicals detected at least once onsite; factors such as octanol-water partitioning coefficients (log Kow) were not used as selection criteria to include or exclude chemicals from ECV development.

The ECVs for the additional detected chemicals are listed in Table 1 and also provided below. Additional chemicals detected during the Part A Phase 1 soil investigation and historical investigations were inorganic compounds (aluminum, calcium, cyanide, iron, magnesium, potassium, and sodium), polychlorinated biphenyls (PCBs; Aroclor 1254 and Aroclor 1260), dioxins/furans, pesticides (4,4-dichlorodiphenyldichloroethylene [4,4'-DDE], 4,4- dichlorodiphenyltrichloroethane [4,4'-DDT], alpha-chlordane, gamma-chlordane, and dieldrin), volatile organic compounds (VOCs; methyl acetate), and semivolatile organic compounds (SVOCs; 4-methylphenol, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, carbazole, pentachlorophenol, dibenzofuran, butyl benzyl phthalate, and 2,4-dimethylphenol).

The approach and methodology, including input parameters and equations used to develop ECVs for the additional chemicals, are the same as those described in ECV TM3 (ARCADIS, 2008), approved by the Department of Toxic Substances Control (DTSC) on November 6, 2008 (technical meeting) and by e-mail on December 17, 2008 and approved by U.S. Department of Interior (USDOI) by e-mail on December 5, 2008, and are not repeated herein. The toxicity values (i.e., screening values for plants and soil invertebrates and toxicity reference values [TRVs] for wildlife) and the bioaccumulation factors (BAFs) and uptake models used in the derivation of ECVs for the additional chemicals are summarized in Attachment 1. Examples of the derivation of the wildlife-based ECVs for gamma-chlordane and cyanide are also provided in Attachment 1.

Selection of Soil Ecological Comparison Values

The selected ECVs for the additional chemicals are presented in Table 1. ECVs for the additional chemicals were based on the protection of plants, soil invertebrates, and wildlife receptors. The soil ECVs for plants and invertebrates were based on the screening values for these receptors (Table 1). ECVs were developed for each wildlife receptor following the approach and methodologies described in ECV TM3. Consistent with ECV TM3, ECVs for the additional chemicals were selected based on the most conservative no-observed adverse effects level (NOAEL)-based TRVs (Attachment 1). For the sake of brevity, ECVs based on the lowest-observed adverse effects (LOAEL)-based TRVs were not calculated in this technical memorandum.

Consistent with the approved ECV TM3, the most conservative of all the ecological receptor-based soil ECVs was selected as the final ECV unless confidence in the screening value or TRV used to calculate ECV was low. In such cases, the next most conservative ECV was selected as the final ECV. This is the case for alpha- and gamma-chlordanes and dieldrin (Table 1). Confidence in the soil invertebrate ECVs for these pesticides is low due to the low number of studies on which the screening values are based or other factors (use of uncertainty and adjustment factors, see Attachment 1). The soil type and test species used also vary from site-specific conditions, and the toxic effects were unspecified in the source study. Confidence in the wildlife ECVs for these pesticides, which were based on TRVs from USEPA's EcoSSL guidance (USEPA, 2007), was greater and wildlife ECVs were selected as the final ECVs.

PG&E attempted to develop ECVs to account for direct and food-chain exposures from all the detected chemicals onsite. However, for some detected chemicals, ECVs could not be developed due to limited toxicity data. In other cases, ECVs were not developed because the chemical was detected at a very low frequency of detection and at very low concentrations relative to the reporting limit resulting in insignificant potential exposures (see Table 2 for a summary of soil results for these compounds). In agreement with the agencies on a call on February 26, 2009 and in the letter dated March 30, 2009 from DTSC responding to PG&E's response to comments on ECV TM4, development ECVs for these chemicals was not warranted at this time. This is further explained below.

ECV development is not warranted for dibenzofuran, butyl benzyl phthalate, and 2,4-dimethylphenol at this time because these chemicals were detected once each and in separate historical samples from 1997 at Area of Concern 4 (AOC4). A total of 643 solid matrix (soil, sediment, debris, wood, and white powder) samples were analyzed for each of these chemicals. These three chemicals were detected at trace concentrations (below standard reporting limits). See Table 2 for a summary of the sampling results. Based on the low concentrations and low frequency of detects, exposures to dibenzofuran, butyl benzyl phthalate, and 2,4-dimethylphenol at the site are not expected to be significant. Therefore, with agency agreement, ECVs were not developed for these three chemicals at this time. In the event that new soil data are collected and these compounds are detected, the need for these ECVs will be reevaluated.

Similarly, methyl acetate was detected in only three solid matrix samples out of 67 collected to date. See Table 2 for a summary of the sampling results. These concentrations of methyl acetate are considered low (slightly above the reporting limits) and are not expected to result in significant accumulation in burrow air, the primary ecological pathway of concern. In addition, these three results are isolated detections from samples located in three different AOCs. They do not provide a consolidated or consistent opportunity for potential exposure in burrow air. Therefore, based on low frequency of detects, low detected concentrations, and divergent locations, potential ecological exposure is expected to be insignificant in burrow air, and, with agency concurrence, ECVs were not developed for methyl acetate.

Although toxicity data are available for essential nutrients (e.g., for iron), the likelihood of iron and other inorganic constituents (calcium, magnesium, potassium, and sodium) being risk drivers at the site is remote. Therefore, based on agency agreement, ECVs were not developed for iron, calcium, magnesium, potassium, and sodium.

PG&E attempted to develop ECVs for 4-methylphenol (p-cresol) based on direct exposure and food-chain exposures. Screening values were available for plants and invertebrates and ECVs for plants and soil invertebrates were based on these screening values. However, there is limited wildlife TRVs available for this chemical and a wildlife ECV could not be developed. Additionally, 4-methylphenol was detected at low concentrations (slightly above the reporting limits) in only 2 separate samples out of a total of 641 solid matrix samples collected to date. In addition, these two results are from isolated detections from samples located in two different AOCs. Based on the low concentrations, low frequency of detects, and lack of appropriate toxicity values, wildlife ECVs could not developed for 4-methylphenol. See Table 2 for a summary of the sampling results. The selected ECV for 4-methylphenol was based on the lowest of the plant and soil invertebrate ECVs.

As requested by the agencies (email from Aaron Yue/DTSC on May 13, 2009), data for the chemicals with low frequency of detects (dibenzofuran, butyl benzyl phthalate, 2,4-dimethylphenol, methyl acetate, and 4-methylphenol) in solid matrices are provided in Attachment 1.

Tables

1 Ecological Comparison Values Summary for Additional Chemicals Detected in Soil

2 Solid Matrix Detections for 2,4-Dimethylphenol, 4-Methylphenol, Butyl Benzyl Phthalate, Dibenzofuran, Methyl Acetate

Attachment

1 Input Parameters Used in Developing Ecological Comparison Values for Additional Chemicals Detected in Soil

References

ARCADIS. 2008. *Technical Memorandum 3: Ecological Comparison Values for Metals and Polycyclic Aromatic Hydrocarbons in Soil*. May

USEPA. 2007. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER Directive 9285.7-55. United States Environmental Protection Agency Office of Solid Waste and Emergency Response. Washington, DC. November 2993, revised March 2005. http://www.epa.gov/ecotoc/ecossl/

Tables

Table 1
Ecological Comparison Values Summary for Additional Chemicals Detected in Soil

Technical Memorandum 4
PG&E Topock
Needles, California

Chemical	Proposed Ecological Comparison Values (mg/kg)					Other Available Wildlife Soil Screening Values (mg/kg)[c]		
	Plant ECV	Soil Invertebrate ECV	Wildlife ECV[a]	Selected ECV[b]	ECV Basis[b]	EcoSSLs/ESLs	Source	Based On
Metals/Inorganic Constituents								
Aluminum[d]	pH<5.5	pH<5.5	pH<5.5	pH<5.5	All	NA	--	--
Calcium	no literature screening values available	no literature screening values available	NA	NA	NA	NA	--	--
Cyanide	NA	0.90	2.35	0.90	Soil Invertebrates	NA	--	--
Iron	no literature screening values available	no literature screening values available	NA	NA	NA	NA	--	--
Magnesium	no literature screening values available	no literature screening values available	NA	NA	NA	NA	--	--
Potassium	no literature screening values available	no literature screening values available	NA	NA	NA	NA	--	--
Sodium	no literature screening values available	no literature screening values available	NA	NA	NA	NA	--	--
Polychlorinated Biphenyls (PCBs)								
Total PCBs	40.0	1.00	0.204	0.204	Cactus Wren	--	--	--
Pesticides								
DDT and Metabolites	0.900	0.010	0.0021	0.0021	Red-Tailed Hawk	0.0210	USEPA, 2007	mammals
Alpha-Chlordane	0.224	0.00430	0.470	0.470	Cactus Wren	--	--	--
Dieldrin	1.00	0.050	0.0050	0.0050	Desert Shrew	0.0049	USEPA, 2007	mammals
Gamma-Chlordane	0.22	0.00430	0.470	0.470	Cactus Wren	--	--	--
Volatile Organic Compounds (VOCs)								
Methyl Acetate	no literature screening values available	no literature screening values available	[e]	[e]	[e]	--	--	--
Semi-Volatile Organic Compounds (SVOCs)								
2,4-Dimethylphenol	[e]	[e]	[e]	[e]	[e]	--	--	--
4-Methylphenol (p-Cresol)	10.0	0.500	[f]	0.500	Soil Invertebrates	--	--	--
Bis(2-ethylhexyl)phthalate	200	200	2.87	2.87	Cactus Wren	--	--	--
Butyl benzyl phthalate	[e]	[e]	[e]	[e]	[e]	--	--	--
Carbazole	no literature screening values available	2800	--	2800	Soil Invertebrates	--	--	--
Dibenzofuran	[e]	[e]	[e]	[e]	[e]	--	--	--
Di-n-butylphthalate	200	200	0.0469	0.0469	Cactus Wren	--	--	--
Pentachlorophenol	5.00	31.0	2.49	2.49	Cactus Wren	2.1	USEPA, 2007	birds
Dioxin/Furan								
Dioxin TEQ	--	--	1.6E-06	1.6E-06	Desert Shrew	--	--	--

Notes:
Please see Attachment 1 for complete sources of inputs to ECV calculations.
Example calculations for ecological comparison values for gamma-chlordane and cyanide are provided in Figures A-1 and A-2, respectively, in Attachment 1.

-- not available.
EcoSSL = Ecological Soil Screening Levels
ECV = Ecological Comparison Values
ESL = Environmental Screening Values
mg/kg = milligrams per kilogram
NA = not applicable
TEQ = toxic equivalent

a. Based on the lowest calculated ECV for wildlife.
b. Final ECV selected based on lowest ECV unless ECV was based on toxicity value of low confidence (e.g., alpha and gamma chlordanes).
c. Limited sources are available for widlife screening values; the lowest available value selected.
d. Potential ecological risks associated with aluminum are identified based on the measured soil pH. Aluminum is identified as a COPC only at sites where the soil pH is less than 5.5.
e. Due low concentrations and low frequency of detects, exposures to this chemical at the site are not expected to be significant. Therefore, with agency agreement, ECVs were not developed for this chemical at this time.
f. Due low concentrations and low frequency of detects, exposures to this chemical at the site are not expected to be significant. Therefore, wildlife ECVs were not developed for this chemical at this time.

USEPA, 2007. *Guidance for Developing Ecological Soil Screening Levels* (Eco-SSLs). OSWER Directive 9285.7-55. United States Environmental Protection Agency Office of Solid Waste and Emergency Response. Washington, DC. November 2003, revised March, 2005. http://www.epa.gov/ecotox/ecossl/

Table 2
Solid Matrix Detections for 2,4-Dimethylphenol, 4-Methylphenol, Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate

Technical Memorandum 4
PG&E Topock
Needles, California

Detected Chemical	Units	SampleDate	Matrix	Sample ID	RFI Area	Top Depth (ft bgs)	Bottom Depth (ft bgs)	Result	Site-wide FOD[a]
2,4-Dimethylphenol	µg/kg	04/24/97	Soil	DR-6-D	AOC4	0.5	1	44	1/643
4-Methylphenol	µg/kg	10/23/08	Soil	300B-1-10003	300B	2.5	3	460	2/641
4-Methylphenol	µg/kg	09/30/08	Soil	AOC14-2-8006	AOC14	0	0.5	430	
Butyl benzyl phthalate	µg/kg	04/24/97	Soil	DR-4-S	AOC4	0	0.5	60	1/643
Dibenzofuran	µg/kg	04/24/97	Soil	DR-6-S	AOC4	0	0.5	53	1/643
Methyl acetate	µg/kg	10/17/08	Soil	AOC1-T3a-048	AOC1	2	3	6.6	3/67
Methyl acetate	µg/kg	09/24/08	Soil	6051	AOC11	2	3	17	
Methyl acetate	µg/kg	10/14/08	Soil	AOC4-1-3003	AOC4	2	3	12	

Notes:
ft bgs = feet below ground surface
FOD = frequency of detects
RCRA = Resource Conservation and Recovery Act
RFI = RCRA Facility Investigation
µg/kg = micrograms per kilogram

a. Other solid matrices included in the FOD are: debris (AOC14-13-8089), sediment (AOC1-BCW6-122 and AOC1-BCW6-123), white powder (AOC4-D30-11051, AOC9-14-4032, AOC14-2-8088, SWMU1-WP10-2069, SWMU1-WP-6h-2040, SWMU1-WP7-2047, and SWMU1-WP-5h-2028), and wood (AOC4-Wood1-3070R and AOC4-Wood2-3071R). See Table A-2 for matrix-specific results.

ARCADIS

Attachment 1

Input Parameters Used in Developing Soil Ecological Comparison Values for Additional Chemicals Detected in Soil
Pacific Gas and Electric (PG&E)
Topock Compressor Station, Needles, California

Introduction

Soil ecological comparison values (ECVs) were calculated for the additional chemicals detected during Part A Phase 1 soil investigation. ECVs were based on conservative toxicity values (i.e., values below which no unacceptable risk is expected) protective of representative ecological receptors potentially present at the Pacific Gas and Electric (PG&E) Topock Compressor Station, Needles, California (the site). The ecological receptors include plants, soil invertebrates, and wildlife (birds and mammals). Representative ecological receptors include the following:

- Plants
- Invertebrates
- Birds
  - Gambel's Quail (granivore)
  - Cactus Wren (insectivore)
  - Red-Tailed Hawk (carnivore)
- Mammals
  - Desert Shrew (insectivore)
  - Merriam's Kangaroo Rat (granivore)
  - Desert Kit Fox (carnivore).

For plants and soil invertebrates, the target toxicity values were based on the lowest screening values. For wildlife, the target toxicity values were based on the lowest available no-observed adverse effects levels (NOAELs). For wildlife, ECVs were developed following the same ECV equation used in Technical Memorandum 3 (ECV TM3; ARCADIS, 2008a) (i.e., re-arrangement of the hazard quotient [HQ] equation to solve for a target HQ of 1). The input parameters for the ECV equation include body weight, soil and food ingestion rates, site use factors (SUFs), bioaccumulation factors (BAFs), and toxicity reference values (TRVs). Parameters such as body weight, soil and food ingestion rates, and SUFs are the same as those specified in the *Human Health and Ecological Risk Assessment Work Plan* (RAWP; ARCADIS, 2008b) and in ECV TM3 (ARCADIS, 2008a) and are not repeated herein. The sources for chemical-specific parameters such as screening values, TRVs, and BAFs are summarized in this attachment. The derivation of ECVs for gamma-chlordane and cyanide are provided as examples in Figures A-1 and A-2, respectively.

Screening values protective of plants and soil invertebrates and TRVs protective of wildlife were selected or developed from the literature sources listed below. Where available, screening values, TRVs, and BAFs were selected based on sources recommended in ecological risk assessment guidance documents (CalEPA, 1996, USEPA, 1999); sources were referenced for these parameters and study details are not provided in this attachment. Parameters for chemicals that were not readily available were developed based on literature reviewed are described in this attachment.

Plant and Soil Invertebrate Screening Levels

Plant and soil invertebrate screening levels were selected from the following sources in order of preference and presented in Table A-1:

- U.S. Environmental Protection Agency (USEPA)'s *Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs)* (USEPA, 2007a)
- Oak Ridge National Laboratory (ORNL): *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision* (Efroymson et al., 1997a) and *Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision* (Efroymson et al., 1997b)
- Lowest of chemical-specific, non-background values from:
  - USEPA's Region 5 Ecological Screening Levels (USEPA, 2003)
  - USEPA's *Supplemental Guidance to Risk Assessment Guidance for Superfund (RAGS): Region 4 Bulletins* (USEPA, 2001)
  - U.S. Fish and Wildlife Service *Evaluating Soil Contamination* (Beyer, 1990)
- Canadian Council of Ministers of the Environment *Soil Quality Guidelines* (CCME, 2006)
- Dutch "Maximum Permissible Concentrations" (MPCs) or derived values from toxicity data supporting the MPCs (i.e., Van de Plassche, 1994)
- Empirical data from USEPA's ECOTOX Database (USEPA, 2007b)
- Toxicity values based on surrogate chemicals.

Screening levels for plants and soil invertebrates were not available for calcium, iron, magnesium, sodium, and potassium, because these metals are considered essential nutrients (USEPA, 1989) and are generally not considered in risk evaluations. Plant screening levels were not available for cyanide and carbazole. Screening levels for the following chemicals were not readily available and, therefore, were developed as discussed below.

Plants

- For 4,4-dichlorodiphenyltrichloroethane (4,4'-DDT), toxicity data were available in the ECOTOX database (USEPA, 2007b). A study by Urzua et al. (1986) was selected for developing a plant screening level. In this study, Dutch clover was grown for 10 to 14 weeks in soil amended with 4,4'-DDT. Statistically significant reductions in plant biomass and mycorrhizal colonization were first observed at 9 milligrams per kilogram (mg/kg). Although effects on root mycorrhizal colonization were observed at soil concentrations of 1 mg/kg, these effects were beneficial to the clover. Therefore, the concentration of 9 mg/kg was assumed as a lowest-observed adverse effects concentration (LOAEC) and an uncertainty factor (UF) of 10 was applied to extrapolate to a chronic no-observed adverse effects concentration (NOAEC), resulting in a value of 0.9 mg/kg, which was used as the plant screening level for total DDT and all its metabolites (including 4,4- dichlorodiphenyldichloroethylene [4,4'-DDE]), as reported in Table A-1.

- For chlordane, a screening level of 0.224 (mg/kg) is recommended by USEPA's Region 5 guidance (USEPA, 2003) based on unreported toxicological effects. Additional empirical data for chlordane suggesting much higher screening levels were also available. However, the most conservative level of 0.224 mg/kg was selected as the plant screening level for alpha-chlordane and gamma-chlordane, as reported in Table A-1.

- For dieldrin, toxicity data were available in the ECOTOX database (USEPA, 2007b). A study by Rajanna and De la Cruz (1977) reported ecologically adverse effects at the lowest concentration and was used to develop screening levels for plants. In this study, cotton, soybean, bread wheat, and corn seeds were grown in soil amended with dieldrin for 21 days. The seeds were heat-treated at 40° C for 5 days, 2 days, or not treated. Heat-treated seeds showed reductions in biomass and plant height when grown in the amended soil, while non-treated seeds showed no effect. The LOAEC reported was 10 mg/kg for bread wheat. A UF of 10 was applied to extrapolate to a chronic NOAEC of 1 mg/kg, which was used as the plant screening level for dieldrin, as reported in Table A-1.

- For 4-methylphenol (or p-cresol), toxicity data were available for 2-methylphenol in the ECOTOX database (USEPA, 2007b), which was used as a surrogate for 4-methylphenol. A study by Adema and Henzen (2001) reported NOAECs based on effects on growth and mortality endpoints on *Lactuca sativa* ranging from 10 mg/kg to greater than 100 mg/kg. The screening level for 4-methylphenol was based on the lowest reported NOAEC of 10 mg/kg, as reported in Table A-1.

Soil Invertebrates

- For 4,4'-DDT, USEPA Region 4 (2001) recommends a soil screening level of 0.0025 mg/kg. This level is based on the Netherlands Ministry of Housing, Planning, and Environment (MHSPE) Target level, or typical ambient concentration (MHSPE, 1994). Background values are not based on toxicological effects to site receptors and, therefore, not preferred as screening levels despite being recommended by USEPA Region 4 (2001). The Canadian soil quality guideline (CCME, 2006) for total DDT (i.e., DDT and metabolites) based on residential soil is 0.7 mg/kg. In a study by Van de Plassche (1994), a DDT median lethal or effects concentration (i.e., LC50 or EC50) for *Collembola* of 10 mg/kg based on a total organic content (TOC) of 10 percent (%) was reported. The lethal or effects concentration was assumed to be an LC50 value, because invertebrate toxicity tests typically measure mortality. Empirical data from ECOTOX database (USEPA, 2007b) were also available for DDT. In a study by Harris (1966), 1st instar cricket larvae were exposed to soils amended with DDT for 18 hours and the mean LC50 of all soils reported was 39.4 mg/kg. However, the study reported by Van de Plassche (1994) was selected as the most appropriate and conservative basis for the DDT screening level. A UF of 100 was applied to extrapolate from an acute lethal concentration of 10 mg/kg to a chronic NOAEC, resulting in a value of 0.1 mg/kg as illustrated in Figure A-3. However, the TOC was assumed to be 1% (consistent with USEPA 2007a) and the soil invertebrate screening level was adjusted accordingly as illustrated in Figure A-4. The resulting soil invertebrate screening level is 0.01 mg/kg for 4,4'-DDT and its metabolites (including 4,4'-DDE) (Table 1, Table A-1).

- For chlordane, USEPA Region 4 (2001) recommends a soil screening level of 0.1 mg/kg; however, this value is based on the "A" value or background concentration for organochlorine pesticides from Beyer (1990). Screening levels based on ambient concentrations were not selected for developing ECVs. In a study by Van de Plassche (1994), a chlordane LC50 or EC50 for insects of 4.3 mg/kg based on a TOC of 10 % was reported. This value was assumed to be an LC50 value, because invertebrate toxicity tests typically measure mortality. Empirical data were also available from the ECOTOX database (USEPA, 2007a). Goats and Edwards (1988) reported a 14-day earthworm LC50 of 23.9 mg/kg. The study reported by Van de Plassche (1994) was selected as the most appropriate basis for the chlordane screening level. A UF of 100 was applied to extrapolate from an acute lethal concentration to a chronic NOAEC, resulting in a value of 0.043 mg/kg as illustrated in Figure A-3. The TOC of 10% was adjusted here using 1% TOC (USEPA, 2007a) resulting in a soil invertebrate screening level of 0.0043 mg/kg for chlordane as illustrated in Figure A-4 and reported in Table A-1. The screening level of 0.0043 mg/kg was reported as the soil invertebrate ECV for alpha- and gamma- chlordanes in Table 1.

- For dieldrin, Van de Plassche (1994) reports a lowest dieldrin NOAEC for *Onychiurus armatus* (of Order Collembola) of 0.5 mg/kg based on a TOC of 10 %. Due to lack of other published screening levels, the study reported by Van de Plassche (1994) was selected as the NOAEC for dieldrin as illustrated in Figure A-3. The TOC of 10% was adjusted here using 1% TOC (USEPA, 2007a) resulting in a soil invertebrate screening level of 0.05 mg/kg for dieldrin as illustrated in Figure A-4 and reported in Table A-1. The screening level of 0.05 mg/kg was reported as the soil invertebrate ECV for dieldrin in Table 1.

- For carbazole, toxicity data were available for in the ECOTOX database (USEPA, 2007b). A study by Svedrup et al. (2006) reported a NOAEC of 2800 mg/kg based on mortality endpoint. Due to limited toxicity data for carbazole, the result from this study was selected as the carbazole screening level for soil invertebrates.

Wildlife Toxicity Reference Values

The most conservative NOAEL-based TRVs for wildlife were selected from the following sources and presented in Table A-1:

- USEPA's EcoSSL Guidance (USEPA, 2007a).

- California Environmental Protection Agency (CalEPA)'s *Currently Recommended U.S. Environmental Protection Agency Region 9 Biological Technical Assistance Group (BTAG) Mammalian and Avian Toxicity Reference Values* (CalEPA, 2002).

- ORNL: *Toxicological Benchmarks for Wildlife:1996 Revision* (Sample et al., 1996).

Wildlife TRVs were not available for calcium, iron, sodium, magnesium, potassium, methyl acetate, 4-methylphenol, and carbazole. Therefore, soil ECVs based on wildlife could not be developed for these chemicals. Inorganic compounds such as calcium, iron, magnesium, potassium, and sodium are considered essential nutrients (USEPA, 1989) and are generally not considered in risk evaluations. Wildlife TRVs for the following chemicals were not readily available and, therefore, were developed as discussed below.

- For cyanide, a mammalian TRV was available from Sample et al. (1996). The Agency for Toxic substances and Disease Registry (ATSDR) Toxicological Profile for cyanide (ATSDR, 2006) contained several studies with more sensitive endpoints than reported in Sample et al. (1996). A 13-week National Toxicology Program study (NTP, 1993) conducted with rats was the most sensitive ecologically relevant study and was selected to develop mammalian TRVs. In this study, rats were exposed to sodium cyanide via drinking water. Decreased spermatogenesis in males was first observed at a dose of 12.5 milligrams per kilogram body weight per day (mg/kg-day), with a NOAEL of 4.5 mg/kg-day. The study is considered by ATSDR to be highly reliable, with adequate replication, number of dose groups, and an exposure of chronic duration. No UFs were applied to these values. Avian TRV of 0.04 mg/kg-day for cyanide was available in USEPA guidance (USEPA, 1999).

Bioaccumulation Factors

BAFs were selected for dietary uptake into plant, invertebrate, and mammal tissue. These values were selected from the following sources in order of preference and presented in Table A-1:

- USEPA's EcoSSL Guidance (USEPA, 2007a).

- USEPA's Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA, 1999).

- Other sources as listed in Table A-1.

BAFs for the following chemicals were not readily available and, therefore, were developed as discussed below.

- For bis(2-ethylhexyl)phthalate and di-n-butyl phthalate, numerous studies show limited potential for bioaccumulation in plants and wildlife. In a review of data for phthalate esters, Staples et al. (1997) demonstrated extremely limited uptake of bis(2-ethylhexyl)phthalate and di-n-butyl phthalate by plants as well as extensive metabolism in higher trophic levels (birds and mammals) (Aranda et al.,1989; Schmitzer et al., 1988; Kato et al., 1981; Lokke and Bro-Ramussen, 1981; Lokke, 1988; Belise et al., 1975; O'Shea and Stafford, 1980; Ishuida et al. 1982 – all as cited in Staples et al., 1997). Therefore, for plants and wildlife, the BAF for bis(2-ethylhexyl)phthalate and di-n-butyl phthalate was assumed to be zero. For invertebrates, the data was not so conclusive based on a review for phthalate esters by Staples et al. (1997): Lokke (1988) reported no accumulation of bis(2-ethylhexyl)phthalate in woodlice or their offspring fed a diet of bis(2-ethylhexyl)phthalate -containing oak leaves in a 6-month microcosm experiment. However, Albro et al. (1993) reported very slow bis(2-ethylhexyl)phthalate breakdown when injected in earthworms. No known bis(2-ethylhexyl)phthalate metabolites were found and hydrolysis was slow. Although no empirical data were available from these studies, and the route of exposure was injection not ingestion, the authors did conclude that bioaccumulation is likely to occur in earthworms. Therefore, for phthalates, an uptake model for non-ionic organic chemicals in soil based on partitioning theory and the K_{ow} of the contaminant (i.e., the Jager model [Jager, 1998]) as recommended by USEPA (2007a) was used to estimate bioaccumulation into invertebrates.

- Cyanide is highly reactive and readily metabolized in organisms demonstrating low bioaccumulation potential (Eisler, 1991). Eisler (1991) also reported that cyanide seldom remains biologically available in soils because it is either complexed by trace metals, metabolized by various microorganisms, or lost through volatilization. Also, wildlife can detoxify sublethal doses of cyanide and excrete it as thiocyanate in urine (Eisler, 1991). Therefore, the BAF for cyanide was assumed to be zero.

- For carbazole, the soil-to-invertebrates BAF of 0.01 recommended by the agencies based on the study by Sverdrup et al., (2006) was used to calculate ECVs for insectivorous wildlife (i.e., the wren and the shrew). The soil-to-mammal BAF for carbazole of was modeled based on prey uptake rather than soil uptake, similar to the method described by Baes et al. (1984) used in the EcoSSL guidance (USEPA, 2007a). As described in USEPA guidance (USEPA, 1999), the Travis and Arms (1988) model was used to calculate the prey-to-animal uptake.

- For chlordane, there are no readily available literature soil-to-mammal BAFs. Because dieldrin is structurally similar to chlordane,the soil-to-mammal BAF for dieldrin (USEPA, 2007a)was used in estimating chlordane uptake from soil to mammal tissue.

Tables

Figures

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Tables

Table A-1
Screening Levels, TRVs, and Tissue Uptake Concentrations

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

	Screening Levels (mg/kg)				Proposed Toxicity Reference Values[a] (mg/kg-day)					Tissue Uptake Concentration (mg/kg)					
Analyte	**Plants**	**Source**	**Invertebrates**	**Source**	**Avian**	**Source**	**Mammalian**	**Source**	**Log K_{ow}[i]**	**Plant**	**Source**	**Invertebrate**	**Source**	**Mammal**	**Source**
Metals															
Aluminum	pH<5.5	EcoSSL Guidance (USEPA, 2005-2007)	pH<5.5	(USEPA, 2005-2007)	pH<5.5	EcoSSL Guidance (USEPA, 2005-2007)	pH<5.5	EcoSSL Guidance (USEPA, 2005-2007)	--	NA	--	NA	--	NA	--
Calcium	no literature screening values available	chemical generally not considered in risk assessments	no literature screening values available	chemical generally not considered in risk assessments	no literature TRVs available	chemical generally not considered in risk assessments	no literature TRVs available	chemical generally not considered in risk assessments	--	no literature uptake model available	chemical generally not considered in risk assessments	no literature uptake model available	chemical generally not considered in risk assessments	no literature uptake model available	chemical generally not considered in risk assessments
Cyanide	NA	--	0.9	Region 4 ESL (USEPA, 2001)	0.04	USEPA, 1999	4.5	ATSDR, 2006 (NTP, 1993)	--	Cp = 0	assumed[j]	Ci = 0	assumed[j]	Cm = 0	assumed[j]
Iron	no literature screening values available	chemical generally not considered in risk assessments	no literature screening values available	chemical generally not considered in risk assessments	no literature TRVs available	chemical generally not considered in risk assessments	no literature TRVs available	chemical generally not considered in risk assessments	--	no literature uptake model available	chemical generally not considered in risk assessments	no literature uptake model available	chemical generally not considered in risk assessments	no literature uptake model available	chemical generally not considered in risk assessments
Magnesium	no literature screening values available	chemical generally not considered in risk assessments	no literature screening values available	chemical generally not considered in risk assessments	no literature TRVs available	chemical generally not considered in risk assessments	no literature TRVs available	chemical generally not considered in risk assessments	--	no literature uptake model available	chemical generally not considered in risk assessments	no literature uptake model available	chemical generally not considered in risk assessments	no literature uptake model available	chemical generally not considered in risk assessments
Potassium	no literature screening values available	chemical generally not considered in risk assessments	no literature screening values available	chemical generally not considered in risk assessments	no literature TRVs available	chemical generally not considered in risk assessments	no literature TRVs available	chemical generally not considered in risk assessments	--	no literature uptake model available	chemical generally not considered in risk assessments	no literature uptake model available	chemical generally not considered in risk assessments	no literature uptake model available	chemical generally not considered in risk assessments
Sodium	no literature screening values available	chemical generally not considered in risk assessments	no literature screening values available	chemical generally not considered in risk assessments	no literature TRVs available	chemical generally not considered in risk assessments	no literature TRVs available	chemical generally not considered in risk assessments	--	no literature uptake model available	chemical generally not considered in risk assessments	no literature uptake model available	chemical generally not considered in risk assessments	no literature uptake model available	chemical generally not considered in risk assessments
Polychlorinated Biphenyls (PCBs)															
Total PCBs	40	ORNL (Efroymson et al., 1997a)	1.0	Beyer, 1990[d]	0.09	BTAG (Platonow & Reinhart, 1973/CalEPA 2002)	0.36	BTAG (Simmons & McKee, 1992/CalEPA, 2002)	6.3	Cp = 0.01 * Cs	USEPA, 1999 (using Travis and Arms model, 1988; Kow for Aroclor 1254)	ln(Ci) = 1.361 * ln(Cs) + 1.41	Sample, 1998a	Cm = 0.025* Cd	USEPA, 1999 (Travis and Arms food-to mammal uptake model, 1988)[n]
Pesticides															
DDT and Metabolites	0.9	USEPA Ecotox, 2007b (Urzua et al.,1986)[b, l]	0.010	Van de Plassche (1994)[b,m,j]	0.009	BTAG (USEPA [Great Lakes], 1995/ CalEPA 2002)	0.147	EcoSSL Guidance (Wrenn et al., 1970/ USEPA, 2005-2007a)[b]	6.36	ln(Cp)= 0.7524 * ln(Cs) - 2.5119	USEPA, 2005-2007a[c]	Ci = 11.2 * Cs	USEPA, 2005-2007a	Cm = 4.83* Cd	USEPA, 2005-2007a
Alpha-Chlordane	0.224	Region 5 ESLs (USEPA, 2003[e])	0.0043	Van de Plassche (1994)[e,m,j]	2.1	ORNL (Sample et al., 1996)[e]	4.6	ORNL (Sample et al., 1996[e])	6.16	Cp = 0.19 * Cs	USEPA, 2007a (based on model for non-ionic chemicals)[e]	Ci = 24.3 * Cs	Jager model, 1998[e]	Cm = 1.2 * Cd	USEPA, 2007a[f]
Gamma-Chlordane	0.224	Region 5 ESLs (USEPA, 2003[e])	0.0043	Van de Plassche (1994)[e,m,j]	2.1	ORNL (Sample et al., 1996)[e]	4.6	ORNL (Sample et al., 1996[e])	6.16	Cp = 0.19 * Cs	USEPA, 2007a (based on model for non-ionic chemicals)[e]	Ci = 24.3 * Cs	Jager model, 1998[e]	Cm = 1.2 * Cd	USEPA, 2007a[f]
Dieldrin	1.0	USEPA Ecotox 2007b (Rajanna and De la Cruz,1977)[j,l]	0.05	Van de Plassche (1994)[m,j]	0.0709	EcoSSL Guidance (Nebeker, et al., 1992/ USEPA, 2005-2007)	0.015	EcoSSL Guidance ((Harr et al., 1970/USEPA, 2005-2007a)	4.55	Cp = 0.41 * Cs	USEPA, 2007a	Ci = 14.7 * Cs	USEPA, 2007a	Cm = 1.2 * Cd	USEPA, 2007a
Volatile Organic Compounds (VOCs)															
Methyl Acetate	no literature screening values available	--	no literature screening values available	--	no literature TRVs available	--	no literature TRVs available	--	0.18	no literature uptake concentration/model available	--	no literature uptake concentration/model available	--	no literature uptake concentration/model available	--
Semi-Volatile Organic Compounds (SVOCs)															
2,4-Dimethylphenol	no literature screening values available	--	no literature screening values available	--	no literature TRVs available	--	no literature TRVs available	--	2.3	no literature uptake concentration/model available	--	no literature uptake concentration/model available	--	no literature uptake concentration/model available	--
4-Methylphenol (p-Cresol)	10	USEPA Ecotox 2007b (Adema et al., 2001)[j]	0.5	Region 4 ESL (USEPA, 2001)	NA	--	NA	--	1.94	no literature uptake concentration/model available	--	no literature uptake concentration/model available	--	no literature uptake concentration/model available	--
Bis(2-ethylhexyl)phthalate	200	ORNL (Efroymson et al., 1997a)[g]	200	ORNL (Efroymson et al., 1997b)[h]	1.1	ORNL (Sample et al., 1996)	18.3	ORNL (Sample et al., 1996)	5.11	Cp = 0	assumed based on study by Staples et.al.,1997[j]	Ci = 1.995 * Cs	USEPA, 2007a (based on Jager model, 1998)	Cm = 0	assumed based on study by Staples et.al.,1997[j]
Butyl benzyl phthalate	no literature screening values available	--	no literature screening values available	--	no literature TRVs available	--	no literature TRVs available	--	4.91	no literature uptake concentration/model available	--	no literature uptake concentration/model available	--	no literature uptake concentration/model available	--
Carbazole	no literature screening values available	--	2800	USEPA Ecotox 2008 (Svedrup et al., 2006)[j]	NA	--	no literature TRVs available	--	3.23	log (Cp) = 1.588-0.573*(log Kow)	USEPA, 1999 (using Travis and Arms model, 1988)	Ci = 0.01 * Cs	Sverdrup, 2006.	Cm = 0.000012 * Cs	USEPA, 1999 (Travis and Arms food-to-mammal uptake model, 1988)[n]
Dibenzofuran	no literature screening values available	--	no literature screening values available	--	no literature TRVs available	--	no literature TRVs available	--	4.12	no literature uptake concentration/model available	--	no literature uptake concentration/model available	--	no literature uptake concentration/model available	--

Table A-1
Screening Levels, TRVs, and Tissue Uptake Concentrations

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

Analyte	Screening Levels (mg/kg)				Proposed Toxicity Reference Values[a] (mg/kg-day)					Tissue Uptake Concentration (mg/kg)					
	Plants	Source	Invertebrates	Source	Avian	Source	Mammalian	Source	Log K_{ow}[i]	Plant	Source	Invertebrate	Source	Mammal	Source
Di-n-butylphthalate	200	ORNL (Efroymson et al., 1997a)	200	ORNL (Efroymson et al., 1997b)[h]	0.11	ORNL (Sample et al., 1996)	550	ORNL (Sample et al., 1996)	4.72	Cp = 0	assumed based on study by Staples et.al.,1997[j]	Ci = 12.7 * Cs	USEPA, 2007a (based on Jager model, 1998)	Cm = 0	assumed based on study by Staples et.al.,1997[j]
Pentachlorophenol	5.0	EcoSSL Guidance (USEPA, 2005-2007); geomean	31	EcoSSL Guidance (USEPA, 2005-2007); geomean	6.73	EcoSSL Guidance (Stedman et al, 1980/USEPA, 2005-2007)	8.42	EcoSSL Guidance (USEPA, 2005-2007a); geomean	5.12	Cp = 5.93 * Cs	USEPA, 2007a	Ci = 14.63 * Cs	USEPA, 2007a	Cm = 0.00452 * Cd + 0.198	USEPA, 2007a
Dioxin TEQ	--	--	--	--	1.4E-05	ORNL (Sample et.al., 1996)[k]	1.0E-06	ORNL (Sample et.al., 1996)[k]	6.8	Cp = 0.0056 * Cs	USEPA, 1999; for TCDD	ln(Ci) = 1.182 * ln(Cs) + 3.533	ORNL (Sample et.al., 1998a)	ln(Cm)= 1.0993 * ln(Cs) + 0.8113	ORNL (Sample et.al., 1998b)

Notes:
Example calulations for ecological comparion values for gamma-chlordane and cyanide are provided in Figures A-1 and A-2, respectively.
-- = not applicable
BTAG = Biological Technical Assistance Group
CalEPA = California Environmental Protection Agency
Cs = Concentration of chemical in soil
Cp = Concentration of chemical in plant tissue
Ci = Concentration of chemical in invertebrate tissue
Cm = Concentration of chemical in mammal tissue
Cd = Concentration of chemical in diet
DTSC = Department of Toxic Substances Control
EcoSSL = Ecological Soil Screening Levels
ECV = Ecological Comparison Values
HERD = Human and Ecological Risk Division
mg/kg = milligrams per kilogram
mg/kg-day = milligrams per kilogram body weight per day
NA = not available
ORNL = Oak Ridge National Laboratory
TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
TEQ = toxic equivalent
USEPA = United States Environmental Protection Agency

a. Proposed TRV is based on the most conservative and appropriate TRV found in the literature.
b. DDT used as surrogate.
c. Based on DDT and metabolites.
d. "B" Values, toxicity data indicate need for further assessment.
e. Chlordane used as surrogate; similar model used in the EcoSSL guidance (USEPA, 2007a).
f. Based on uptake model for dieldrin. There are no readily available literature soil-to-mammal uptake models for chlordane. It was assumed that the uptake of chlordane into mammal tissue would be similar to other organochlorine pesticides such as dieldrin.
Therefore, the mammal tissue uptake concentration for chlorade was based on the same uptake model used to estimate mammal tissue concentration of dieldrin.
g. Di-n-butylphthalate used as a surrogate.
h. Dimethylphthalate surrogate used.
i. Octanol-water partition coefficient (Log Kow) values were obtained from the Hazardous Substances Data Bank (HSDB, 2007) or the Syracuse Research Corporation (SRC) Chem Fate database or KowWin Demo (SRC, 2007). Chemicals with low Log Kows (<2.0) do not bioaccumulate (CalEPA, 1996 and USEPA, 2000); therefore, uptake models for these cl
j. See text for details.
k. For dioxins/furans, the lowest value based on the ORNL TRV was used (EcoSSL and BTAG do not present TRVs for dioxins/furans).
l. An uncertainty factor of 10 was applied to extrapolate from a low-effect to a no-effect toxicity value.
m. The screening values from this source were based on a total orgnaic content (TOC) of 10 percent (%); adjusted here using 1% TOC (USEPA, 2007a).
n. The food-to-mammal uptake model was selected based on the salt marsh harvest mouse, which was the most conservative value available in USEPA 1999 (Appendix D)

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Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
300B	UA2-300B-1	Soil	300B-1-10001	9/23/2008	0	0.5	<330	<330	<330	<330	--
300B	UA2-300B-1	Soil	300B-1-10002	9/23/2008	0.5	1	<330	<330	<330	<330	--
300B	UA2-300B-1	Soil	300B-1-10003	10/23/2008	2.5	3	<330	460	<330	<330	<6.3
300B	UA2-300B-1	Soil	300B-1-10004	10/23/2008	5.5	6	<330	<330	<330	<330	--
300B	UA2-300B-2	Soil	300B-2-10005	10/3/2008	0	0.5	<330	<330	<330	<330	--
300B	UA2-300B-2	Soil	300B-2-10006	10/3/2008	0.5	1	<330	<330	<330	<330	--
300B	UA2-300B-2	Soil	300B-2-10007	10/3/2008	2	3	<330	<330	<330	<330	--
300B	UA2-300B-3	Soil	300B-3-10009	10/3/2008	0	0.5	<330	<330	<330	<330	--
300B	UA2-300B-3	Soil	300B-3-10010	10/3/2008	0.5	1	<330	<330	<330	<330	--
300B	UA2-300B-3	Soil	300B-3-10011	10/3/2008	0.5	1	<330	<330	<330	<330	--
300B	UA2-300B-3	Soil	300B-3-10012	10/3/2008	2	3	<330	<330	<330	<330	--
300B	UA2-300B-3	Soil	300B-3-10013	10/3/2008	5	6	<330	<330	<330	<330	--
300B	UA2-300B-4	Soil	300B-4-10014	10/3/2008	0	0.5	<330	<330	<330	<330	--
300B	UA2-300B-4	Soil	300B-4-10015	10/3/2008	0.5	1	<330	<330	<330	<330	--
300B	UA2-300B-4	Soil	300B-4-10016	10/3/2008	2	3	<330	<330	<330	<330	--
300B	UA2-300B-5	Soil	300B-5-10018	10/3/2008	0	0.5	<330	<330	<330	<330	--
300B	UA2-300B-5	Soil	300B-5-10019	10/3/2008	0.5	1	<330	<330	<330	<330	--
300B	UA2-300B-5	Soil	300B-5-10020	10/3/2008	2	3	<340	<340	<340	<340	<7.7
AOC10	AOC10-1	Soil	AOC10-1-5001	10/2/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10-1	Soil	AOC10-1-5002	10/2/2008	2	3	<330	<330	<330	<330	--
AOC10	AOC10-1	Soil	AOC10-1-5003	10/2/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10-1	Soil	AOC10-1-5004	10/2/2008	9	10	<330	<330	<330	<330	--
AOC10	AOC10-2	Soil	AOC10-2-5005	10/2/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10-2	Soil	AOC10-2-5006	10/2/2008	2	3	<340	<340	<340	<340	--
AOC10	AOC10-2	Soil	AOC10-2-5007	10/2/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10-2	Soil	AOC10-2-5008	10/2/2008	7	8	<340	<340	<340	<340	--
AOC10	AOC10-3	Soil	AOC10-3-5009	9/19/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10-3	Soil	AOC10-3-5010	9/19/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10-3	Soil	AOC10-3-5011	9/19/2008	2	3	<340	<340	<340	<340	<7.2
AOC10	AOC10-3	Soil	AOC10-3-5012	9/19/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10-4	Soil	AOC10-4-5014	9/19/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10-4	Soil	AOC10-4-5015	9/19/2008	2	3	<340	<340	<340	<340	--
AOC10	AOC10-4	Soil	AOC10-4-5016	9/19/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10-5	Soil	AOC10-5-5018	9/19/2008	0	0.5	<1700	<1700	<1700	<1700	--
AOC10	AOC10-5	Soil	AOC10-5-5019	9/19/2008	2	3	<340	<340	<340	<340	<7.7
AOC10	AOC10-5	Soil	AOC10-5-5020	9/19/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10-5	Soil	AOC10-5-5021	9/19/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10-6	Soil	AOC10-6-5023	9/20/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10-6	Soil	AOC10-6-5024	9/20/2008	2	3	<840	<840	<840	<840	--
AOC10	AOC10-7	Soil	AOC10-7-5027	9/20/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10-7	Soil	AOC10-7-5028	9/20/2008	2	3	<330	<330	<330	<330	--
AOC10	AOC10-7	Soil	AOC10-7-5029	9/20/2008	5	6	<340	<340	<340	<340	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
AOC10	AOC10-8	Soil	AOC10-8-5031	8/22/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10-8	Soil	AOC10-8-5033	8/22/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10a-1	Soil	AOC10a-1-5036	10/17/2008	0	0.5	<21000	<21000	<21000	<21000	--
AOC10	AOC10b-1	Soil	AOC10b-1-5040	9/30/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10b-1	Soil	AOC10b-1-5041	9/30/2008	2	3	<330	<330	<330	<330	<6.9
AOC10	AOC10b-1	Soil	AOC10b-1-5042	9/30/2008	2	3	<330	<330	<330	<330	<6.8
AOC10	AOC10b-1	Soil	AOC10b-1-5043	9/30/2008	5	6	<330	<330	<330	<330	--
AOC10	AOC10b-1	Soil	AOC10b-1-5044	9/30/2008	9	10	<330	<330	<330	<330	--
AOC10	AOC10b-2	Soil	AOC10b-2-5045	9/30/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10b-2	Soil	AOC10b-2-5046	9/30/2008	2	3	<330	<330	<330	<330	--
AOC10	AOC10b-2	Soil	AOC10b-2-5047	9/30/2008	5	6	<330	<330	<330	<330	--
AOC10	AOC10b-2	Soil	AOC10b-2-5048	9/30/2008	9	10	<330	<330	<330	<330	--
AOC10	AOC10b-3	Soil	AOC10b-3-5049	9/30/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10b-3	Soil	AOC10b-3-5050	10/1/2008	2	3	<340	<340	<340	<340	--
AOC10	AOC10b-3	Soil	AOC10b-3-5051	10/1/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10b-3	Soil	AOC10b-3-5052	10/1/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10b-3	Soil	AOC10b-3-5053	10/1/2008	9	10	<340	<340	<340	<340	--
AOC10	AOC10b-4	Soil	AOC10b-4-5054	9/30/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10b-4	Soil	AOC10b-4-5055	9/30/2008	2	3	<330	<330	<330	<330	--
AOC10	AOC10b-4	Soil	AOC10b-4-5056	9/30/2008	5	6	<330	<330	<330	<330	--
AOC10	AOC10b-4	Soil	AOC10b-4-5057	9/30/2008	9	10	<340	<340	<340	<340	--
AOC10	AOC10c-1	Soil	AOC10c-1-5058	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10c-1	Soil	AOC10c-1-5059	10/1/2008	2	3	<330	<330	<330	<330	<8.9
AOC10	AOC10c-1	Soil	AOC10c-1-5060	10/1/2008	5	6	<330	<330	<330	<330	--
AOC10	AOC10c-1	Soil	AOC10c-1-5061	10/1/2008	9	10	<340	<340	<340	<340	--
AOC10	AOC10c-2	Soil	AOC10c-2-5062	10/1/2008	0	0.5	<330	<330 J	<330	<330	--
AOC10	AOC10c-2	Soil	AOC10c-2-5063	10/1/2008	2	3	<330	<330 J	<330	<330	<5.8
AOC10	AOC10c-2	Soil	AOC10c-2-5064	10/1/2008	2	3	<330	<330 J	<330	<330	<6.3
AOC10	AOC10c-2	Soil	AOC10c-2-5065	10/1/2008	5	6	<330	<330	<330	<330	--
AOC10	AOC10c-2	Soil	AOC10c-2-5066	10/1/2008	9	10	<340	<340	<340	<340	--
AOC10	AOC10c-3	Soil	AOC10c-3-5067	10/2/2008	0	0.5	<340	<340	<340	<340	--
AOC10	AOC10c-3	Soil	AOC10c-3-5068	10/2/2008	2	3	<340	<340	<340	<340	--
AOC10	AOC10c-3	Soil	AOC10c-3-5069	10/2/2008	2	3	<340	<340	<340	<340	--
AOC10	AOC10c-3	Soil	AOC10c-3-5070	10/2/2008	5	6	<330	<330	<330	<330	--
AOC10	AOC10c-3	Soil	AOC10c-3-5071	10/2/2008	9	10	<340	<340	<340	<340	--
AOC10	AOC10c-4	Soil	AOC10c-4-5072	10/1/2008	0	0.5	<340	<340 J	<340	<340	--
AOC10	AOC10c-4	Soil	AOC10c-4-5073	10/1/2008	2	3	<340	<340	<340	<340	--
AOC10	AOC10c-4	Soil	AOC10c-4-5074	10/1/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10c-4	Soil	AOC10c-4-5075	10/1/2008	9	10	<340	<340	<340	<340	--
AOC10	AOC10c-5	Soil	AOC10c-5-5076	10/1/2008	0	0.5	<330	<330 J	<330	<330	--
AOC10	AOC10c-5	Soil	AOC10c-5-5077	10/1/2008	2	3	<340	<340 J	<340	<340	--
AOC10	AOC10c-5	Soil	AOC10c-5-5078	10/1/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10c-5	Soil	AOC10c-5-5079	10/1/2008	9	10	<340	<340	<340	<340	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
AOC10	AOC10d-1	Soil	AOC10d-1-5080	9/18/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10d-1	Soil	AOC10d-1-5081	9/18/2008	2	3	<340	<340	<340	<340	--
AOC10	AOC10d-1	Soil	AOC10d-1-5082	9/18/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10d-1	Soil	AOC10d-1-5083	9/18/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10d-2	Soil	AOC10d-2-5085	9/17/2008	0	0.5	<830	<830	<830	<830	--
AOC10	AOC10d-2	Soil	AOC10d-2-5086	9/17/2008	2	3	<340	<340	<340	<340	<7.2
AOC10	AOC10d-2	Soil	AOC10d-2-5087	9/17/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10d-3	Soil	AOC10d-3-5089	9/17/2008	0	0.5	<330	<330	<330	<330	--
AOC10	AOC10d-3	Soil	AOC10d-3-5090	9/18/2008	2	3	<340	<340	<340	<340	<6.8
AOC10	AOC10d-3	Soil	AOC10d-3-5091	9/18/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10d-3	Soil	AOC10d-3-5092	9/18/2008	5	6	<340	<340	<340	<340	--
AOC10	AOC10d-4	Soil	AOC10d-4-5094	9/18/2008	0	0.5	<340	<340	<340	<340	--
AOC10	AOC10d-4	Soil	AOC10d-4-5095	9/18/2008	2	3	<350	<350	<350	<350	--
AOC10	AOC10d-4	Soil	AOC10d-4-5096	9/18/2008	5	6	<340	<340	<340	<340	--
AOC11	AOC11a-1	Soil	AOC11a-1-6001	9/21/2008	0	0.5	<330	<330	<330	<330	--
AOC11	AOC11a-1	Soil	AOC11a-1-6002	9/21/2008	2	3	<340	<340	<340	<340	<8.6
AOC11	AOC11a-1	Soil	AOC11a-1-6003	9/21/2008	5	6	<340	<340	<340	<340	--
AOC11	AOC11a-2	Soil	AOC11a-2-6005	9/21/2008	0	0.5	<340	<340	<340	<340	--
AOC11	AOC11a-2	Soil	AOC11a-2-6006	9/21/2008	2	3	<350	<350	<350	<350	<8.2
AOC11	AOC11a-2	Soil	AOC11a-2-6007	9/21/2008	5	6	<340	<340	<340	<340	--
AOC11	AOC11a-3	Soil	AOC11a-3-6009	9/20/2008	0	0.5	<340	<340	<340	<340	--
AOC11	AOC11a-3	Soil	AOC11a-3-6010	9/20/2008	2	3	<340	<340	<340	<340	<9.3
AOC11	AOC11a-3	Soil	AOC11a-3-6011	9/20/2008	2	3	<340	<340	<340	<340	<7.4
AOC11	AOC11a-3	Soil	AOC11a-3-6012	9/20/2008	5	6	<340	<340	<340	<340	--
AOC11	AOC11a-4	Soil	AOC11a-4-6014	9/20/2008	0	0.5	<340	<340	<340	<340	--
AOC11	AOC11a-4	Soil	AOC11a-4-6015	9/20/2008	2	3	<840	<840	<840	<840	--
AOC11	AOC11a-4	Soil	AOC11a-4-6016	9/20/2008	5	6	<340	<340	<340	<340	--
AOC11	AOC11a-5	Soil	AOC11a-5-6018	9/21/2008	0	0.5	<340	<340	<340	<340	--
AOC11	AOC11a-5	Soil	AOC11a-5-6019	9/21/2008	2	3	<340	<340	<340	<340	--
AOC11	AOC11a-5	Soil	AOC11a-5-6020	9/21/2008	5	6	<340	<340	<340	<340	--
AOC11	AOC11a-5	Soil	AOC11a-5-6021	9/21/2008	5	6	<340	<340	<340	<340	--
AOC11	AOC11b-1	Soil	AOC11b-1-6023	9/17/2008	0	0.5	<830	<830	<830	<830	--
AOC11	AOC11b-1	Soil	AOC11b-1-6024	9/17/2008	0	0.5	<830	<830	<830	<830	--
AOC11	AOC11b-1	Soil	AOC11b-1-6025	9/17/2008	2	3	<830	<830	<830	<830	<5.6
AOC11	AOC11b-1	Soil	AOC11b-1-6026	9/17/2008	5	6	<850	<850	<850	<850	--
AOC11	AOC11b-2	Soil	AOC11b-2-6028	9/17/2008	0	0.5	<830	<830	<830	<830	--
AOC11	AOC11b-2	Soil	AOC11b-2-6029	9/17/2008	2	3	<340	<340	<340	<340	--
AOC11	AOC11b-2	Soil	AOC11b-2-6030	9/17/2008	5	6	<340	<340	<340	<340	--
AOC11	AOC11c-1	Soil	AOC11c-1-6032	9/21/2008	0	0.5	<330	<330	<330	<330	--
AOC11	AOC11c-1	Soil	AOC11c-1-6033	9/22/2008	2	3	<340	<340	<340	<340	--
AOC11	AOC11c-1	Soil	AOC11c-1-6034	9/22/2008	2	3	<340	<340	<340	<340	--
AOC11	AOC11c-1	Soil	AOC11c-1-6035	9/22/2008	5	6	<340	<340	<340	<340	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

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PG&E Topock
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RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
AOC11	AOC11c-2	Soil	AOC11c-2-6037	9/21/2008	0	0.5	<330	<330	<330	<330	--
AOC11	AOC11c-2	Soil	AOC11c-2-6038	9/22/2008	2	3	<350	<350	<350	<350	<16 J
AOC11	AOC11c-2	Soil	AOC11c-2-6039	9/22/2008	5	6	<340	<340	<340	<340	--
AOC11	AOC11d-1	Soil	AOC11d-1-6041	9/23/2008	0	0.5	<340	<340	<340	<340	--
AOC11	AOC11d-1	Soil	AOC11d-1-6042	9/23/2008	0	0.5	<330	<330	<330	<330	--
AOC11	AOC11d-1	Soil	AOC11d-1-6043	9/23/2008	2.5	3	<340	<340	<340	<340	<4.4
AOC11	AOC11d-1	Soil	AOC11d-1-6044	9/23/2008	5	6	<340	<340	<340	<340	--
AOC11	AOC11d-1	Soil	AOC11d-1-6045	9/23/2008	9	10	<340	<340	<340	<340	--
AOC11	AOC11e-1	Soil	AOC11e-1-6046	9/23/2008	0	0.5	<330	<330	<330	<330	--
AOC11	AOC11e-1	Soil	AOC11e-1-6047	9/23/2008	2.5	3	<330	<330	<330	<330	--
AOC11	AOC11e-1	Soil	AOC11e-1-6048	9/23/2008	5.5	6	<340	<340	<340	<340	--
AOC11	AOC11e-1	Soil	AOC11e-1-6049	9/23/2008	9.5	10	<340	<340	<340	<340	--
AOC11	AOC11e-2	Soil	AOC11e-2-6050	9/24/2008	0	0.5	<330	<330	<330	<330	--
AOC11	AOC11e-2	Soil	AOC11e-2-6051	9/24/2008	2	3	<330	<330	<330	<330	17
AOC11	AOC11e-2	Soil	AOC11e-2-6052	9/24/2008	2	3	<360	<360	<360	<360	--
AOC11	AOC11e-2	Soil	AOC11e-2-6053	9/24/2008	5	6	<330	<330	<330	<330	--
AOC11	AOC11e-2	Soil	AOC11e-2-6054	9/24/2008	9	10	<350	<350	<350	<350	--
AOC11	AOC11e-SS1	Soil	AOC11e-SS-1-6075	9/23/2008	0	0.5	<330	<330	<330	<330	--
AOC11	AOC11e-SS1	Soil	AOC11e-SS-1-6076	9/23/2008	2.5	3	<330	<330	<330	<330	--
AOC11	AOC11e-SS1	Soil	AOC11e-SS-1-6077	9/23/2008	5.5	6	<330	<330	<330	<330	--
AOC11	AOC11e-SS1	Soil	AOC11e-SS-1-6078	9/23/2008	9.5	10	<340	<340	<340	<340	--
AOC11	AOC11e-SS2	Soil	AOC11e-SS-2-6079	9/23/2008	0	0.5	<330	<330	<330	<330	--
AOC11	AOC11e-SS2	Soil	AOC11e-SS-2-6080	9/23/2008	2.5	3	<340	<340	<340	<340	--
AOC11	AOC11e-SS2	Soil	AOC11e-SS-2-6081	9/23/2008	5.5	6	<340	<340	<340	<340	--
AOC11	AOC11e-SS2	Soil	AOC11e-SS-2-6082	9/23/2008	5.5	6	<340	<340	<340	<340	--
AOC11	AOC11e-SS2	SOIL	AOC11e-SS-2-6083	9/23/2008	9.5	10	<350	<350	<350	<350	--
AOC12	AOC12a-T1a	Soil	AOC12a-T1a-7001	9/22/2008	0	0.5	<330	<330	<330	<330	--
AOC12	AOC12a-T1a	Soil	AOC12a-T1a-7002	9/22/2008	2	3	<330	<330	<330	<330	<4.1
AOC12	AOC12a-T1a	Soil	AOC12a-T1b-7003	9/22/2008	7	8	<340	<340	<340	<340	--
AOC12	AOC12a-T1c	Soil	AOC12a-T1c-7004	9/22/2008	7	8	<340	<340	<340	<340	--
AOC12	AOC12a-T2a	Soil	AOC12a-T2a-7005	9/22/2008	6	7	<340	<340	<340	<340	--
AOC12	AOC12a-T2b	Soil	AOC12a-T2b-7006	9/22/2008	7	8	<340	<340	<340	<340	--
AOC12	AOC12b-T1a	Soil	AOC12b-T1a-7009	9/20/2008	2	3	<340	<340	<340	<340	--
AOC12	AOC12b-T1b	Soil	AOC12b-T1b-7010	9/20/2008	2	3	<350	<350	<350	<350	--
AOC12	AOC12c-T1a	Soil	AOC12c-T1a-7014	9/20/2008	10	11	<350	<350	<350	<350	--
AOC12	AOC12c-T1a	Soil	AOC12c-T1b-7015	9/20/2008	0	0.5	<330	<330	<330	<330	--
AOC12	AOC12c-T1a	Soil	AOC12c-T1b-7016	9/20/2008	2	3	<340	<340	<340	<340	<6.5
AOC12	AOC12c-T1b	Soil	AOC12c-T1c-7017	9/20/2008	10	11	<340	<340	<340	<340	--
AOC12	AOC12c-T1b	Soil	AOC12c-T1c-7023	9/22/2008	3	4	<340	<340	<340	<340	--
AOC12	AOC12c-T2a	Soil	AOC12c-T2a-7018	9/20/2008	7	8	<350	<350	<350	<350	--
AOC12	AOC12c-T2b	Soil	AOC12c-T2b-7019	9/20/2008	7	8	<340	<340	<340	<340	--
AOC12	AOC12c-T1b	Soil	AOC12c-T2c-7020	9/20/2008	2	3	<340	<340	<340	<340	--
AOC12	AOC12c-T1c	Soil	AOC12c-T2d-7021	9/20/2008	10	11	<350	<350	<350	<350	--
AOC12	AOC12c-T1c	Soil	AOC12c-T2d-7022	9/20/2008	10	11	<350	<350	<350	<350	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
AOC14	AOC14-10	Soil	AOC14-10-8050	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-10	Soil	AOC14-10-8051	10/1/2008	2	3	<330	<330	<330	<330	<4.7
AOC14	AOC14-10	Soil	AOC14-10-8052	10/1/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-10	Soil	AOC14-10-8053	10/1/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-10	Soil	AOC14-10-8054	10/1/2008	9	10	<340	<340	<340	<340	--
AOC14	AOC14-10	Soil	AOC14-10-8055	10/1/2008	14	15	<330	<330	<330	<330	--
AOC14	AOC14-11	Soil	AOC14-11-8056	10/1/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-11	Soil	AOC14-11-8057	10/1/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-11	Soil	AOC14-11-8058	10/1/2008	14	15	<340	<340	<340	<340	--
AOC14	AOC14-12	Soil	AOC14-12-8059	9/30/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-12	Soil	AOC14-12-8060	9/30/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-12	Soil	AOC14-12-8061	9/30/2008	14	15	<330	<330	<330	<330	--
AOC14	AOC14-13	Soil	AOC14-13-8062	9/30/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-13	Soil	AOC14-13-8063	9/30/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-13	Soil	AOC14-13-8064	9/30/2008	14	15	<340	<340	<340	<340	--
AOC14	AOC14-13	Soil	AOC14-13-8065	9/30/2008	14	15	<340	<340	<340	<340	--
AOC14	AOC14-13	Debris	AOC14-13-8089	10/1/2008	0.5	1.5	<330 J	<330 J	<330 J	<330 J	--
AOC14	AOC14-1	Soil	AOC14-1-8001	9/30/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-1	Soil	AOC14-1-8002	9/30/2008	2	3	<340	<340	<340	<340	<6.7
AOC14	AOC14-1	Soil	AOC14-1-8003	9/30/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-1	Soil	AOC14-1-8004	9/30/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-1	Soil	AOC14-1-8005	9/30/2008	14	15	<340	<340	<340	<340	--
AOC14	AOC14-2	Soil	AOC14-2-8006	9/30/2008	0	0.5	<340	430	<340	<340	--
AOC14	AOC14-2	Soil	AOC14-2-8007	9/30/2008	2	3	<350	<350	<350	<350	<8.9
AOC14	AOC14-2	Soil	AOC14-2-8008	9/30/2008	5	6	<340	<340	<340	<340	--
AOC14	AOC14-2	Soil	AOC14-2-8009	9/30/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-2	Soil	AOC14-2-8010	9/30/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-2	Soil	AOC14-2-8011	9/30/2008	14	15	<340	<340	<340	<340	--
AOC14	AOC14-2	WhitePowder	AOC14-2-8088	10/1/2008	3	3.25	<370 J	<370 J	<370 J	<370 J	--
AOC14	AOC14-3	Soil	AOC14-3-8012	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-3	Soil	AOC14-3-8013	10/1/2008	2	3	<330	<330	<330	<330	<5.1
AOC14	AOC14-3	Soil	AOC14-3-8014	10/1/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-3	Soil	AOC14-3-8015	10/1/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-3	Soil	AOC14-3-8016	10/1/2008	14	15	<330	<330	<330	<330	--
AOC14	AOC14-4	Soil	AOC14-4-8017	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-4	Soil	AOC14-4-8018	10/1/2008	2	3	<330	<330	<330	<330	<4.6
AOC14	AOC14-4	Soil	AOC14-4-8019	10/1/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-4	Soil	AOC14-4-8020	10/1/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-4	Soil	AOC14-4-8021	10/1/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-4	Soil	AOC14-4-8022	10/1/2008	14	15	<330	<330	<330	<330	--
AOC14	AOC14-5	Soil	AOC14-5-8023	10/2/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-5	Soil	AOC14-5-8024	10/2/2008	2	3	<830	<830	<830	<830	<4.6
AOC14	AOC14-5	Soil	AOC14-5-8025	10/2/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-5	Soil	AOC14-5-8026	10/2/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-5	Soil	AOC14-5-8027	10/2/2008	14	15	<330	<330	<330	<330	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
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Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
AOC14	AOC14-6	Soil	AOC14-6-8028	10/2/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-6	Soil	AOC14-6-8029	10/2/2008	2	3	<330	<330	<330	<330	--
AOC14	AOC14-6	Soil	AOC14-6-8030	10/2/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-6	Soil	AOC14-6-8031	10/2/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-6	Soil	AOC14-6-8032	10/2/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-6	Soil	AOC14-6-8033	10/2/2008	14	15	<330	<330	<330	<330	--
AOC14	AOC14-7	Soil	AOC14-7-8034	10/2/2008	0	0.5	<830	<830	<830	<830	--
AOC14	AOC14-7	Soil	AOC14-7-8035	10/2/2008	2	3	<830	<830	<830	<830	<4.1
AOC14	AOC14-7	Soil	AOC14-7-8036	10/2/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-7	Soil	AOC14-7-8037	10/2/2008	9	10	<340	<340	<340	<340	--
AOC14	AOC14-7	Soil	AOC14-7-8038	10/2/2008	14	15	<330	<330	<330	<330	--
AOC14	AOC14-8	Soil	AOC14-8-8039	10/2/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-8	Soil	AOC14-8-8040	10/2/2008	2	3	<330	<330	<330	<330	<4.7
AOC14	AOC14-8	Soil	AOC14-8-8041	10/2/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-8	Soil	AOC14-8-8042	10/2/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-8	Soil	AOC14-8-8043	10/2/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-8	Soil	AOC14-8-8044	10/2/2008	14	15	<340	<340	<340	<340	--
AOC14	AOC14-9	Soil	AOC14-9-8045	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-9	Soil	AOC14-9-8046	10/1/2008	2	3	<330	<330	<330	<330	--
AOC14	AOC14-9	Soil	AOC14-9-8047	10/1/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-9	Soil	AOC14-9-8048	10/1/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-9	Soil	AOC14-9-8049	10/1/2008	14	15	<340	<340	<340	<340	--
AOC14	AOC14-SS1	Soil	AOC14-SS-1-8066	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-SS1	Soil	AOC14-SS-1-8067	10/1/2008	2	3	<340	<340	<340	<340	--
AOC14	AOC14-SS1	Soil	AOC14-SS-1-8068	10/1/2008	5	6	<340	<340	<340	<340	--
AOC14	AOC14-SS1	Soil	AOC14-SS-1-8069	10/1/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-SS1	Soil	AOC14-SS-1-8070	10/1/2008	14	15	<340	<340	<340	<340	--
AOC14	AOC14-SS2	Soil	AOC14-SS-2-8071	10/1/2008	0	0.5	<3300	<3300	<3300	<3300	--
AOC14	AOC14-SS2	Soil	AOC14-SS-2-8072	10/1/2008	2	3	<330	<330	<330	<330	--
AOC14	AOC14-SS2	Soil	AOC14-SS-2-8073	10/1/2008	5	6	<340	<340	<340	<340	--
AOC14	AOC14-SS2	Soil	AOC14-SS-2-8074	10/1/2008	9	10	<340	<340	<340	<340	--
AOC14	AOC14-SS2	Soil	AOC14-SS-2-8075	10/1/2008	14	15	<330	<330	<330	<330	--
AOC14	AOC14-SS2	Soil	AOC14-SS-2-8076	10/1/2008	14	15	<330	<330	<330	<330	--
AOC14	AOC14-SS3	Soil	AOC14-SS-3-8077	10/2/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-SS3	Soil	AOC14-SS-3-8078	10/2/2008	2	3	<330	<330	<330	<330	--
AOC14	AOC14-SS3	Soil	AOC14-SS-3-8079	10/2/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-SS3	Soil	AOC14-SS-3-8080	10/2/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-SS3	Soil	AOC14-SS-3-8081	10/2/2008	14	15	<330	<330	<330	<330	--
AOC14	AOC14-SS4	Soil	AOC14-SS-4-8082	10/2/2008	0	0.5	<330	<330	<330	<330	--
AOC14	AOC14-SS4	Soil	AOC14-SS-4-8083	10/2/2008	2	3	<330	<330	<330	<330	--
AOC14	AOC14-SS4	Soil	AOC14-SS-4-8084	10/2/2008	5	6	<330	<330	<330	<330	--
AOC14	AOC14-SS4	Soil	AOC14-SS-4-8085	10/2/2008	9	10	<330	<330	<330	<330	--
AOC14	AOC14-SS4	Soil	AOC14-SS-4-8086	10/2/2008	14	15	<330	<330	<330	<330	--
AOC14	AOC14-SS4	Soil	AOC14-SS-4-8087	10/2/2008	14	15	<330	<330	<330	<330	--
AOC1	AOC1-BCW1	Soil	AOC1-BCW1-100	9/20/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-BCW1	Soil	AOC1-BCW1-101	9/20/2008	2	3	<330	<330	<330	<330	<5.2

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
AOC1	AOC1-BCW2	Soil	AOC1-BCW2-104	10/4/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-BCW2	Soil	AOC1-BCW2-105	10/4/2008	2	3	<340	<340	<340	<340	--
AOC1	AOC1-BCW2	Soil	AOC1-BCW2-106	10/4/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-BCW2	Soil	AOC1-BCW2-107	10/4/2008	9	10	<350	<350	<350	<350	--
AOC1	AOC1-BCW3	Soil	AOC1-BCW3-108	10/4/2008	0	0.5	<340	<340	<340	<340	--
AOC1	AOC1-BCW3	Soil	AOC1-BCW3-109	10/4/2008	2	3	<330	<330	<330	<330	--
AOC1	AOC1-BCW3	Soil	AOC1-BCW3-110	10/4/2008	5	6	<340	<340	<340	<340	--
AOC1	AOC1-BCW3	Soil	AOC1-BCW3-111	10/4/2008	9	10	<350	<350	<350	<350	--
AOC1	AOC1-BCW3	Soil	AOC1-BCW3-112	10/4/2008	9	10	<350	<350	<350	<350	--
AOC1	AOC1-BCW4	SOIL	AOC1-BCW4-113	10/4/2008	0	0.5	<340	<340	<340	<340	--
AOC1	AOC1-BCW4	Soil	AOC1-BCW4-114	10/4/2008	2	3	<330	<330	<330	<330	--
AOC1	AOC1-BCW4	Soil	AOC1-BCW4-115	10/4/2008	5	6	<340	<340	<340	<340	--
AOC1	AOC1-BCW4	Soil	AOC1-BCW4-116	10/4/2008	9	10	<350	<350	<350	<350	--
AOC1	AOC1-BCW5	Soil	AOC1-BCW5-117	10/4/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-BCW5	Soil	AOC1-BCW5-118	10/4/2008	2	3	<330	<330	<330	<330	<5.2
AOC1	AOC1-BCW5	Soil	AOC1-BCW5-119	10/4/2008	5	6	<340	<340	<340	<340	--
AOC1	AOC1-BCW5	Soil	AOC1-BCW5-120	10/4/2008	9	10	<350	<350	<350	<350	--
AOC1	AOC1-BCW5	Soil	AOC1-BCW5-121	10/4/2008	9	10	<350	<350	<350	<350	--
AOC1	AOC1-BCW6	Sediment	AOC1-BCW6-122	8/22/2008	0	0.5	<470	<470	<470	<470	--
AOC1	AOC1-BCW6	Sediment	AOC1-BCW6-123	8/22/2008	2	3	<480	<480	<480	<480	<6.4
AOC1	AOC1-T1a	Soil	AOC1-T1a-001	10/16/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T1a	Soil	AOC1-T1a-002	10/16/2008	2	3	<330	<330	<330	<330	<7
AOC1	AOC1-T1a	Soil	AOC1-T1a-003	10/16/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T1a	Soil	AOC1-T1a-004	10/16/2008	9	10	<330	<330	<330	<330	--
AOC1	AOC1-T1b	Soil	AOC1-T1b-005	10/16/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T1b	Soil	AOC1-T1b-006	10/16/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T1b	Soil	AOC1-T1b-007	10/16/2008	2	3	<340	<340	<340	<340	<4.9
AOC1	AOC1-T1b	Soil	AOC1-T1b-008	10/16/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T1b	Soil	AOC1-T1b-009	10/16/2008	9	10	<330	<330	<330	<330	--
AOC1	AOC1-T1c	Soil	AOC1-T1c-010	10/16/2008	0	0.5	<340	<340	<340	<340	--
AOC1	AOC1-T1c	Soil	AOC1-T1c-011	10/16/2008	2	3	<340	<340	<340	<340	<5.2
AOC1	AOC1-T1c	Soil	AOC1-T1c-012	10/16/2008	2	3	<350	<350	<350	<350	<5
AOC1	AOC1-T1c	Soil	AOC1-T1c-013	10/16/2008	5	6	<340	<340	<340	<340	--
AOC1	AOC1-T1c	Soil	AOC1-T1c-014	10/16/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T2a	Soil	AOC1-T2a-015	10/5/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T2a	Soil	AOC1-T2a-016	10/16/2008	2	3	<330	<330	<330	<330	--
AOC1	AOC1-T2a	Soil	AOC1-T2a-017	10/16/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T2a	Soil	AOC1-T2a-018	10/16/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T2b	Soil	AOC1-T2b-019	10/16/2008	0	0.5	<340	<340	<340	<340	--
AOC1	AOC1-T2b	Soil	AOC1-T2b-020	10/16/2008	2	3	<340	<340	<340	<340	<5.2
AOC1	AOC1-T2b	Soil	AOC1-T2b-021	10/16/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T2b	Soil	AOC1-T2b-022	10/16/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T2b	Soil	AOC1-T2b-023	10/16/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T2c	Soil	AOC1-T2c-024	10/8/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T2c	Soil	AOC1-T2c-025	10/8/2008	2	3	<330	<330	<330	<330	--
AOC1	AOC1-T2c	Soil	AOC1-T2c-026	10/8/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T2c	Soil	AOC1-T2c-027	10/8/2008	9	10	<340	<340	<340	<340	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
AOC1	AOC1-T2d	Soil	AOC1-T2d-028	10/7/2008	0	0.5	<340	<340	<340	<340	--
AOC1	AOC1-T2d	Soil	AOC1-T2d-029	10/7/2008	2	3	<340	<340	<340	<340	--
AOC1	AOC1-T2d	Soil	AOC1-T2d-030	10/7/2008	5	6	<340	<340	<340	<340	--
AOC1	AOC1-T2d	Soil	AOC1-T2d-031	10/7/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T2d	Soil	AOC1-T2d-032	10/7/2008	19	20	<350	<350	<350	<350	--
AOC1	AOC1-T2d	Soil	AOC1-T2d-033	10/7/2008	29	30	<340	<340	<340	<340	--
AOC1	AOC1-T2d	Soil	AOC1-T2d-034	10/7/2008	29	30	<350	<350	<350	<350	--
AOC1	AOC1-T2d	Soil	AOC1-T2d-035	10/7/2008	39	40	<350	<350	<350	<350	--
AOC1	AOC1-T2d	Soil	AOC1-T2d-036	10/7/2008	49	50	<350	<350	<350	<350	--
AOC1	AOC1-T2d	Soil	AOC1-T2d-037	10/8/2008	59	60	<330	<330	<330	<330	--
AOC1	AOC1-T2d	Soil	AOC1-T2d-038	10/8/2008	69	70	<360	<360	<360	<360	--
AOC1	AOC1-T2e	Soil	AOC1-T2e-042	10/16/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T2e	Soil	AOC1-T2e-043	10/16/2008	2	3	<330	<330	<330	<330	--
AOC1	AOC1-T2e	Soil	AOC1-T2e-044	10/16/2008	2	3	<340	<340	<340	<340	--
AOC1	AOC1-T2e	Soil	AOC1-T2e-045	10/16/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T2e	Soil	AOC1-T2e-046	10/16/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T3a	Soil	AOC1-T3a-047	10/5/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T3a	Soil	AOC1-T3a-048	10/17/2008	2	3	<330	<330	<330	<330	6.6
AOC1	AOC1-T3a	Soil	AOC1-T3a-049	10/17/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T3a	Soil	AOC1-T3a-050	10/17/2008	9	10	<330	<330	<330	<330	--
AOC1	AOC1-T3b	Soil	AOC1-T3b-051	10/5/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T3b	Soil	AOC1-T3b-052	10/17/2008	2	3	<350	<350	<350	<350	--
AOC1	AOC1-T3b	Soil	AOC1-T3b-053	10/17/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T3b	Soil	AOC1-T3b-054	10/17/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T3b	Soil	AOC1-T3b-055	10/17/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T3c	Soil	AOC1-T3c-056	10/5/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T3c	Soil	AOC1-T3c-057	10/5/2008	2	3	<330	<330	<330	<330	--
AOC1	AOC1-T3c	Soil	AOC1-T3c-058	10/5/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T3c	Soil	AOC1-T3c-059	10/5/2008	9	10	<330	<330	<330	<330	--
AOC1	AOC1-T4a	Soil	AOC1-T4a-060	10/3/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T4a	Soil	AOC1-T4a-061	10/3/2008	2	3	<330	<330	<330	<330	--
AOC1	AOC1-T4a	Soil	AOC1-T4a-062	10/3/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T4a	Soil	AOC1-T4a-063	10/3/2008	9	10	<330	<330	<330	<330	--
AOC1	AOC1-T4b	Soil	AOC1-T4b-064	10/2/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T4b	Soil	AOC1-T4b-065	10/2/2008	2	3	<340	<340	<340	<340	--
AOC1	AOC1-T4b	Soil	AOC1-T4b-066	10/2/2008	2	3	<340	<340	<340	<340	--
AOC1	AOC1-T4b	Soil	AOC1-T4b-067	10/2/2008	5	6	<340	<340	<340	<340	--
AOC1	AOC1-T4b	Soil	AOC1-T4b-068	10/2/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T4c	Soil	AOC1-T4c-069	10/4/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T4c	Soil	AOC1-T4c-070	10/4/2008	2	3	<340	<340	<340	<340	<6.9
AOC1	AOC1-T4c	Soil	AOC1-T4c-071	10/4/2008	5	6	<340	<340	<340	<340	--
AOC1	AOC1-T4c	Soil	AOC1-T4c-072	10/4/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T5a	Soil	AOC1-T5a-073	10/4/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T5a	Soil	AOC1-T5a-074	10/4/2008	2	3	<330	<330	<330	<330	--
AOC1	AOC1-T5a	Soil	AOC1-T5a-075	10/4/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T5a	Soil	AOC1-T5a-076	10/4/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T5a	Soil	AOC1-T5a-077	10/4/2008	9	10	<340	<340	<340	<340	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
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Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
AOC1	AOC1-T5b	Soil	AOC1-T5b-078	10/4/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T5b	Soil	AOC1-T5b-079	10/4/2008	2	3	<340	<340	<340	<340	<7.4
AOC1	AOC1-T5b	Soil	AOC1-T5b-080	10/4/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T5b	Soil	AOC1-T5b-081	10/4/2008	9	10	<340	<340	<340	<340	--
AOC1	AOC1-T5c	Soil	AOC1-T5c-082	10/4/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T5c	Soil	AOC1-T5c-083	10/4/2008	2	3	<330	<330	<330	<330	--
AOC1	AOC1-T5c	Soil	AOC1-T5c-084	10/4/2008	5	6	<330	<330	<330	<330	--
AOC1	AOC1-T5c	Soil	AOC1-T5c-085	10/4/2008	9	10	<330	<330	<330	<330	--
AOC1	AOC1-T6a	Soil	AOC1-T6a-086	9/30/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T6a	Soil	AOC1-T6a-087	9/30/2008	2.5	3	<340	<340	<340	<340	--
AOC1	AOC1-T6a	Soil	AOC1-T6a-088	9/30/2008	2.5	3	<340	<340	<340	<340	--
AOC1	AOC1-T6a	Soil	AOC1-T6a-089	9/30/2008	5.5	6	<340	<340	<340	<340	--
AOC1	AOC1-T6a	Soil	AOC1-T6a-090	9/30/2008	9.5	10	<340	<340	<340	<340	--
AOC1	AOC1-T6b	Soil	AOC1-T6b-091	9/30/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T6b	Soil	AOC1-T6b-092	9/30/2008	2.5	3	<330	<330	<330	<330	--
AOC1	AOC1-T6b	Soil	AOC1-T6b-093	9/30/2008	5.5	6	<330	<330	<330	<330	--
AOC1	AOC1-T6b	Soil	AOC1-T6b-094	9/30/2008	9.5	10	<330	<330	<330	<330	--
AOC1	AOC1-T6b	Soil	AOC1-T6b-099	9/30/2008	9.5	10	<330	<330	<330	<330	--
AOC1	AOC1-T6c	Soil	AOC1-T6c-095	9/30/2008	0	0.5	<330	<330	<330	<330	--
AOC1	AOC1-T6c	Soil	AOC1-T6c-096	9/30/2008	2.5	3	<330	<330	<330	<330	<5
AOC1	AOC1-T6c	Soil	AOC1-T6c-097	9/30/2008	5.5	6	<330	<330	<330	<330	--
AOC4	AOC4-10	Soil	AOC4-10-3030R	10/3/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-T3a	Soil	AOC4-11041	10/23/2008	2.5	3	<1700	<1700	<1700	<1700	--
AOC4	AOC4-11	Soil	AOC4-11-3034R	10/3/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-12A	Soil	AOC4-12-3037	8/24/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-12	Soil	AOC4-12-3037R	10/3/2008	0	0.5	<330 J	<330 J	<330 J	<330 J	--
AOC4	AOC4-12	Soil	AOC4-12-3038R	10/3/2008	0.5	1	<330 J	<330 J	<330 J	<330 J	--
AOC4	AOC4-1	Soil	AOC4-1-3001	10/14/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-1	Soil	AOC4-1-3002	10/14/2008	0.5	1	<330	<330	<330	<330	--
AOC4	AOC4-1	Soil	AOC4-1-3003	10/14/2008	2	3	<330	<330	<330	<330	12
AOC4	AOC4-13	Soil	AOC4-13-3040	8/24/2008	0	0.5	<1700	<1700	<1700	<1700	--
AOC4	AOC4-14	Soil	AOC4-14-3043	8/24/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-14	Soil	AOC4-14-3044	8/24/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-15	Soil	AOC4-15-3047	9/19/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-15	Soil	AOC4-15-3048	9/19/2008	0.5	1	<330	<330	<330	<330	--
AOC4	AOC4-15	Soil	AOC4-15-3049	9/19/2008	2	3	<340	<340	<340	<340	--
AOC4	AOC4-2	Soil	AOC4-2-3004	10/3/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-2	Soil	AOC4-2-3005	10/3/2008	0.5	1	<330	<330	<330	<330	--
AOC4	AOC4-3	Soil	AOC4-3-3007	8/24/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-3	Soil	AOC4-3-3008	8/24/2008	0.5	1	<330	<330	<330	<330	--
AOC4	AOC4-4	Soil	AOC4-4-3010	8/24/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-4	Soil	AOC4-4-3011	8/24/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-5	Soil	AOC4-5-3014R	10/3/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-6	Soil	AOC4-6-3017	8/24/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-6	Soil	AOC4-6-3018	8/24/2008	0.5	1	<330	<330	<330	<330	--
AOC4	AOC4-6	Soil	AOC4-6-3019	10/3/2008	2	3	<340	<340	<340	<340	--
AOC4	AOC4-7	Soil	AOC4-7-3020	10/3/2008	0	0.5	<330	<330	<330	<330	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
AOC4	AOC4-8	Soil	AOC4-8-3024R	10/3/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-9	Soil	AOC4-9-3027	8/24/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-B10	Soil	AOC4-B10-11005	10/5/2008	0	0.5	<330 J	<330 J	<330 J	<330 J	--
AOC4	AOC4-B20	Soil	AOC4-B20-11006	10/5/2008	0	0.5	<340 J	<340 J	<340 J	<340 J	--
AOC4	AOC4-B30	Soil	AOC4-B30-11007	10/5/2008	0	0.5	<450 J	<450 J	<450 J	<450 J	--
AOC4	AOC4-D10	Soil	AOC4-D10-11013	10/5/2008	0	0.5	<1800 J	<1800 J	<1800 J	<1800 J	--
AOC4	AOC4-D20	Soil	AOC4-D20-11014	10/5/2008	0	0.5	<360 J	<360 J	<360 J	<360 J	--
AOC4	AOC4-D30	WhitePowder	AOC4-D30-11015	10/5/2008	0	0.5	<850 J	<850 J	<850 J	<850 J	--
AOC4	AOC4-DE5	Soil	AOC4-DE5-11002	10/5/2008	0	0.5	<370 J	<370 J	<370 J	<370 J	--
AOC4	AOC4-GH10	Soil	AOC4-GH10-11029	10/5/2008	0	0.5	<360 J	<360 J	<360 J	<360 J	--
AOC4	AOC4-GH30	Soil	AOC4-GH30-11031	10/5/2008	0	0.5	<360 J	<360 J	<360 J	<360 J	--
AOC4	AOC4-I20	Soil	AOC4-I20-11038	10/5/2008	0	0.5	<350 J	<350 J	<350 J	<350 J	--
AOC4	AOC4-I30	Soil	AOC4-I30-11039	10/5/2008	0	0.5	<360 J	<360 J	<360 J	<360 J	--
AOC4	AOC4-SS1	Soil	AOC4-SS-1-3088R	9/19/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-SS2	Soil	AOC4-SS-2-3089R	10/3/2008	0	0.5	<830	<830	<830	<830	--
AOC4	AOC4-SS3	Soil	AOC4-SS-3-3090R	10/3/2008	0	0.5	<830	<830	<830	<830	--
AOC4	AOC4-T1a	Soil	AOC4-T-12000	10/22/2008	0	0.5	<340	<340	<340	<340	--
AOC4	AOC4-T1a	Soil	AOC4-T-12001	10/22/2008	3.5	4	<360	<360	<360	<360	--
AOC4	AOC4-T2a	Soil	AOC4-T-12002	10/22/2008	3.5	4	<380	<380	<380	<380	--
AOC4	AOC4-T2b	Soil	AOC4-T-12003	10/22/2008	7.5	8	<360	<360	<360	<360	--
AOC4	AOC4-T2b	Soil	AOC4-T-12004	10/22/2008	2.5	3	<340	<340	<340	<340	--
AOC4	AOC4-T2c	Soil	AOC4-T-12005	10/22/2008	2.5	3	<350	<350	<350	<350	--
AOC4	AOC4-T2c	Soil	AOC4-T-12006	10/22/2008	0	0.5	<360	<360	<360	<360	--
AOC4	AOC4-T3a	Soil	AOC4-T-12007	10/23/2008	2.5	3	<1700	<1700	<1700	<1700	--
AOC4	AOC4-T3b	Soil	AOC4-T-12008	10/23/2008	2.5	3	<340	<340	<340	<340	--
AOC4	AOC4-T3c	Soil	AOC4-T-12009	10/23/2008	2.5	3	<340	<340	<340	<340	--
AOC4	AOC4-T4a	Soil	AOC4-T-12010	10/23/2008	2.5	3	<330	<330	<330	<330	<6.2
AOC4	AOC4-T4b	Soil	AOC4-T-12011	10/23/2008	2.5	3	<340	<340	<340	<340	--
AOC4	AOC4-T4c	Soil	AOC4-T-12012	10/23/2008	2.5	3	<340	<340	<340	<340	--
AOC4	AOC4-Stained	Soil	AOC4-T5a-3068	10/4/2008	0	0.5	<330	<330	<330	<330	--
AOC4	AOC4-Wood1	Wood	AOC4-Wood1-3070R	10/3/2008	0	0	<340	<340	<340	<340	--
AOC4	AOC4-Wood2	Wood	AOC4-Wood2-3071R	10/3/2008	0	0	<350	<350	<350	<350	--
AOC4	AOC4-Z25	Soil	AOC4-Z25-11001	10/5/2008	0	0.5	<340 J	<340 J	<340 J	<340 J	--
AOC9	AOC9-10	Soil	AOC9-10-4023	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC9	AOC9-10	Soil	AOC9-10-4024	10/1/2008	2	3	<330	<330	<330	<330	--
AOC9	AOC9-11	Soil	AOC9-11-4025	9/18/2008	0	0.5	<350	<350	<350	<350	--
AOC9	AOC9-11	Soil	AOC9-11-4026	9/18/2008	2	3	<330	<330	<330	<330	<6.3
AOC9	AOC9-12	Soil	AOC9-12-4027	10/1/2008	0	0.5	<340	<340	<340	<340	--
AOC9	AOC9-12	Soil	AOC9-12-4028	10/1/2008	2	3	<340	<340	<340	<340	<5.9
AOC9	AOC9-13	Soil	AOC9-13-4029	9/19/2008	0	0.5	<330	<330	<330	<330	--
AOC9	AOC9-13	Soil	AOC9-13-4030	9/19/2008	2	3	<340	<340	<340	<340	--
AOC9	AOC9-13	Soil	AOC9-13-4031	9/19/2008	2	3	<340	<340	<340	<340	--
AOC9	AOC9-1	Soil	AOC9-1-4001	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC9	AOC9-1	Soil	AOC9-1-4002	10/1/2008	2	3	<340	<340	<340	<340	--
AOC9	AOC9-14	whitepowder	AOC9-14-4032	10/2/2008	0	0.5	<360	<360	<360	<360	--
AOC9	AOC9-14	Soil	AOC9-14-4033	10/2/2008	2	3	<340	<340	<340	<340	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
AOC9	AOC9-2	Soil	AOC9-2-4003	9/18/2008	0	0.5	<330	<330	<330	<330	--
AOC9	AOC9-2	Soil	AOC9-2-4004	9/18/2008	2	3	<330	<330	<330	<330	--
AOC9	AOC9-3	Soil	AOC9-3-4005	9/18/2008	0	0.5	<330	<330	<330	<330	--
AOC9	AOC9-3	Soil	AOC9-3-4006	9/18/2008	2	3	<340	<340	<340	<340	--
AOC9	AOC9-4	Soil	AOC9-4-4007	9/18/2008	0	0.5	<330	<330	<330	<330	--
AOC9	AOC9-4	Soil	AOC9-4-4008	9/18/2008	2	3	<330	<330	<330	<330	--
AOC9	AOC9-5	Soil	AOC9-5-4009	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC9	AOC9-5	Soil	AOC9-5-4010	10/1/2008	2	3	<330	<330	<330	<330	<5.3
AOC9	AOC9-5	Soil	AOC9-5-4011	10/1/2008	2	3	<330	<330	<330	<330	<4.3
AOC9	AOC9-6	Soil	AOC9-6-4012	9/18/2008	0	0.5	<830	<830	<830	<830	--
AOC9	AOC9-6	Soil	AOC9-6-4013	9/18/2008	2	3	<340	<340	<340	<340	--
AOC9	AOC9-7	Soil	AOC9-7-4014	9/18/2008	0	0.5	<330	<330	<330	<330	--
AOC9	AOC9-7	Soil	AOC9-7-4015	9/18/2008	2	3	<330	<330	<330	<330	--
AOC9	AOC9-8	Soil	AOC9-8-4016	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC9	AOC9-8	Soil	AOC9-8-4017	10/1/2008	2.5	3	<340	<340	<340	<340	--
AOC9	AOC9-8	Soil	AOC9-8-4018	10/1/2008	5.5	6	<340	<340	<340	<340	--
AOC9	AOC9-9	Soil	AOC9-9-4019	10/1/2008	0	0.5	<330	<330	<330	<330	--
AOC9	AOC9-9	Soil	AOC9-9-4020	10/1/2008	2.5	3	<340	<340	<340	<340	--
AOC9	AOC9-9	Soil	AOC9-9-4021	10/1/2008	5.5	6	<340	<340	<340	<340	--
AOC9	AOC9-9	Soil	AOC9-9-4022	10/1/2008	5.5	6	<340	<340	<340	<340	--
AOC4	DR-1	Soil	DR-1-D	4/24/1997	0.5	1	<330	<330	<330	<330	--
AOC4	DR-1	Soil	DR-1-S	4/24/1997	0	0.5	<330	<330	<330	<330	--
AOC4	DR-2	Soil	DR-2-S	4/24/1997	0	0.5	<330	<330	<330	<330	--
AOC4	DR-3	Soil	DR-3-D	4/24/1997	0.5	1	<330	<330	<330	<330	--
AOC4	DR-3	Soil	DR-3-S	4/24/1997	0	0.5	<330	<330	<330	<330	--
AOC4	DR-4	Soil	DR-4-S	4/24/1997	0	0.5	<340	<340	60 J	<340	--
AOC4	DR-5	Soil	DR-5-D	4/24/1997	0.5	1	<350	<350	<350	<350	--
AOC4	DR-5	Soil	DR-5-S	4/24/1997	0	0.5	<340	<340	<340	<340	--
AOC4	DR-6	Soil	DR-6-D	4/24/1997	0.5	1	44 J	<350	<350	<350	--
AOC4	DR-6	Soil	DR-6-S	4/24/1997	0	0.5	<330	<330	<330	53 J	--
AOC4	DR-7	Soil	DR-7-D	4/24/1997	0.5	1	<380	<380	<380	<380	--
AOC4	DR-7	Soil	DR-7-S	4/24/1997	0	0.5	<330	<330	<330	<330	--
AOC14	S2-62	Soil	S2-62-3	11/1/1998	3	3	<550	--	<550	<550	--
AOC14	S8-23	Soil	S8-23-3	11/1/1998	3	3	<21000	--	<21000	<21000	--
SWMU1	SWMU1-10	Soil	SWMU1-10-1053	10/14/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-10	Soil	SWMU1-10-1054	10/14/2008	2	3	<330	<330	<330	<330	--
SWMU1	SWMU1-10	Soil	SWMU1-10-1055	10/14/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-10	Soil	SWMU1-10-1056	10/14/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-10	Soil	SWMU1-10-1057	10/14/2008	9	10	<350	<350	<350	<350	--
SWMU1	SWMU1-1	Soil	SWMU1-1-1001	10/16/2008	0	0.5	<400	<400	<400	<400	--
SWMU1	SWMU1-1	Soil	SWMU1-1-1002	10/16/2008	2	3	<340	<340	<340	<340	<5.3
SWMU1	SWMU1-1	Soil	SWMU1-1-1003	10/16/2008	5	6	<350	<350	<350	<350	--
SWMU1	SWMU1-1	Soil	SWMU1-1-1004	10/16/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-11	Soil	SWMU1-11-1058	10/15/2008	0	0.5	<350	<350	<350	<350	--
SWMU1	SWMU1-11	Soil	SWMU1-11-1059	10/15/2008	2	3	<350	<350	<350	<350	<19
SWMU1	SWMU1-11	Soil	SWMU1-11-1060	10/15/2008	5	6	<350	<350	<350	<350	--
SWMU1	SWMU1-11	Soil	SWMU1-11-1061	10/15/2008	9	10	<350	<350	<350	<350	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
SWMU1	SWMU1-12	Soil	SWMU1-12-1062	10/14/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-12	Soil	SWMU1-12-1063	10/14/2008	2	3	<330	<330	<330	<330	--
SWMU1	SWMU1-12	Soil	SWMU1-12-1064	10/14/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-12	Soil	SWMU1-12-1065	10/14/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-13	Soil	SWMU1-13-1066	10/14/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-13	Soil	SWMU1-13-1067	10/14/2008	2	3	<340	<340	<340	<340	<6
SWMU1	SWMU1-13	Soil	SWMU1-13-1068	10/14/2008	2	3	<340	<340	<340	<340	<5.8
SWMU1	SWMU1-13	Soil	SWMU1-13-1069	10/14/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-13	Soil	SWMU1-13-1070	10/14/2008	9	10	<350	<350	<350	<350	--
SWMU1	SWMU1-14	Soil	SWMU1-14-1071	10/14/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-14	Soil	SWMU1-14-1072	10/14/2008	2	3	<340	<340	<340	<340	--
SWMU1	SWMU1-14	Soil	SWMU1-14-1073	10/14/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-14	Soil	SWMU1-14-1074	10/14/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1075	9/22/2008	0	0.5	<340	<340	<340	<340	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1076	9/22/2008	2	3	<350	<350	<350	<350	<6.4
SWMU1	SWMU1-15	Soil	SWMU1-15-1077	9/22/2008	5	6	<350	<350	<350	<350	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1078	9/22/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1079	9/22/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1080	9/22/2008	19	20	<350	<350	<350	<350	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1081	9/22/2008	29	30	<350	<350	<350	<350	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1082	9/22/2008	39	40	<340	<340	<340	<340	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1083	9/22/2008	49	50	<360	<360	<360	<360	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1084	9/22/2008	59	60	<350	<350	<350	<350	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1085	9/22/2008	69	70	<350	<350	<350	<350	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1086	9/22/2008	79	80	<350	<350	<350	<350	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1087	9/23/2008	89	90	<330	<330	<330	<330	--
SWMU1	SWMU1-15	Soil	SWMU1-15-1089	9/22/2008	59	60	<350	<350	<350	<350	--
SWMU1	SWMU1-16	Soil	SWMU1-16-1090	9/21/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-16	Soil	SWMU1-16-1091	9/21/2008	2	3	<340	<340	<340	<340	--
SWMU1	SWMU1-16	Soil	SWMU1-16-1092	9/21/2008	5	6	<330	<330	<330	<330	--
SWMU1	SWMU1-17	Soil	SWMU1-17-1094	9/21/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-17	Soil	SWMU1-17-1095	9/21/2008	2	3	<330	<330	<330	<330	<7
SWMU1	SWMU1-17	Soil	SWMU1-17-1096	9/21/2008	5	6	<330	<330	<330	<330	--
SWMU1	SWMU1-17	Soil	SWMU1-17-1097	9/21/2008	9	10	<330	<330	<330	<330	--
SWMU1	SWMU1-17	Soil	SWMU1-17-1098	9/21/2008	9	10	<330	<330	<330	<330	--
SWMU1	SWMU1-2	Soil	SWMU1-2-1005	10/15/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-2	Soil	SWMU1-2-1006	10/15/2008	2	3	<330	<330	<330	<330	--
SWMU1	SWMU1-2	Soil	SWMU1-2-1007	10/15/2008	5	6	<330	<330	<330	<330	--
SWMU1	SWMU1-2	Soil	SWMU1-2-1008	10/15/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-3	Soil	SWMU1-3-1009	10/6/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-3	Soil	SWMU1-3-1010	10/6/2008	2	3	<340	<340	<340	<340	<7.7
SWMU1	SWMU1-3	Soil	SWMU1-3-1011	10/6/2008	2	3	<340	<340	<340	<340	<4.5
SWMU1	SWMU1-3	Soil	SWMU1-3-1012	10/6/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-3	Soil	SWMU1-3-1013	10/6/2008	9	10	<350	<350	<350	<350	--
SWMU1	SWMU1-3	Soil	SWMU1-3-1014	10/6/2008	19	20	<340	<340	<340	<340	--
SWMU1	SWMU1-3	Soil	SWMU1-3-1015	10/6/2008	29	30	<350	<350	<350	<350	--
SWMU1	SWMU1-3	Soil	SWMU1-3-1016	10/6/2008	39	40	<350	<350	<350	<350	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
SWMU1	SWMU1-3	Soil	SWMU1-3-1017	10/6/2008	49	50	<350	<350	<350	<350	--
SWMU1	SWMU1-3	Soil	SWMU1-3-1018	10/6/2008	59	60	<340	<340	<340	<340	--
SWMU1	SWMU1-3	Soil	SWMU1-3-1019	10/7/2008	69	70	<350	<350	<350	<350	--
SWMU1	SWMU1-3	Soil	SWMU1-3-1020	10/7/2008	79	80	<370	<370	<370	<370	--
SWMU1	SWMU1-3	Soil	SWMU1-3-1022	10/7/2008	79	80	<380	<380	<380	<380	--
SWMU1	SWMU1-4	Soil	SWMU1-4-1025	10/15/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-4	Soil	SWMU1-4-1026	10/15/2008	2	3	<340	<340	<340	<340	<5.3
SWMU1	SWMU1-4	Soil	SWMU1-4-1027	10/15/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-4	Soil	SWMU1-4-1028	10/15/2008	7	8	<340	<340	<340	<340	--
SWMU1	SWMU1-4	Soil	SWMU1-4-1029	10/15/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-4	Soil	SWMU1-4-1030	10/15/2008	13	14	<340	<340	<340	<340	--
SWMU1	SWMU1-5	Soil	SWMU1-5-1031	10/15/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-5	Soil	SWMU1-5-1032	10/15/2008	13	14	<350	<350	<350	<350	--
SWMU1	SWMU1-5	Soil	SWMU1-5-1033	10/15/2008	13	14	<350	<350	<350	<350	--
SWMU1	SWMU1-5	Soil	SWMU1-5-1034	10/15/2008	15	16	<340	<340	<340	<340	--
SWMU1	SWMU1-5	Soil	SWMU1-5-1035	10/15/2008	19	20	<350	<350	<350	<350	--
SWMU1	SWMU1-6	Soil	SWMU1-6-1036	10/15/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-6	Soil	SWMU1-6-1037	10/15/2008	2	3	<330	<330	<330	<330	--
SWMU1	SWMU1-6	Soil	SWMU1-6-1038	10/15/2008	5	6	<330	<330	<330	<330	--
SWMU1	SWMU1-6	Soil	SWMU1-6-1039	10/15/2008	9	10	<330	<330	<330	<330	--
SWMU1	SWMU1-7	Soil	SWMU1-7-1040	10/15/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-7	Soil	SWMU1-7-1041	10/15/2008	2	3	<340	<340	<340	<340	--
SWMU1	SWMU1-7	Soil	SWMU1-7-1042	10/15/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-7	Soil	SWMU1-7-1043	10/15/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-7	Soil	SWMU1-7-1044	10/15/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-8	Soil	SWMU1-8-1045	10/15/2008	0	0.5	<340	<340	<340	<340	--
SWMU1	SWMU1-8	Soil	SWMU1-8-1046	10/15/2008	2	3	<350	<350	<350	<350	--
SWMU1	SWMU1-8	Soil	SWMU1-8-1047	10/15/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-8	Soil	SWMU1-8-1048	10/15/2008	9	10	<360	<360	<360	<360	--
SWMU1	SWMU1-9	Soil	SWMU1-9-1049	10/14/2008	0	0.5	<340	<340	<340	<340	--
SWMU1	SWMU1-9	Soil	SWMU1-9-1050	10/14/2008	2	3	<1700	<1700	<1700	<1700	<6.2
SWMU1	SWMU1-9	Soil	SWMU1-9-1051	10/14/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-9	Soil	SWMU1-9-1052	10/14/2008	9	10	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-10	Soil	SWMU1-WP10-2068	10/5/2008	0	0.5	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-10	WhitePowder	SWMU1-WP10-2069	10/5/2008	2	3	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-10	Soil	SWMU1-WP10-2070	10/5/2008	5	6	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-10	Soil	SWMU1-WP10-2073	10/5/2008	9	10	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-1h	Soil	SWMU1-WP-1h-2001	10/7/2008	0	0.5	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-1h	Soil	SWMU1-WP-1h-2002	10/7/2008	2	3	<340	<340	<340	<340	<7.7
SWMU1	SWMU1-WP-1h	Soil	SWMU1-WP-1h-2003	10/7/2008	5	6	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-1h	Soil	SWMU1-WP-1h-2005	10/7/2008	9	10	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-3a	Soil	SWMU1-WP-3a-2006	10/14/2008	0	0.5	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-3a	Soil	SWMU1-WP-3a-2007	10/14/2008	2	3	<350	<350	<350	<350	<4.6
SWMU1	SWMU1-WP-3a	Soil	SWMU1-WP-3a-2008	10/14/2008	5	6	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-3a	Soil	SWMU1-WP-3a-2009	10/14/2008	7	8	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-3a	Soil	SWMU1-WP-3a-2010	10/14/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-3a	Soil	SWMU1-WP-3a-2011	10/14/2008	9	10	<340	<340	<340	<340	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
SWMU1	SWMU1-WP-3a	Soil	SWMU1-WP-3a-2012	10/14/2008	11	12	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-3a	Soil	SWMU1-WP-3a-2013	10/14/2008	13	14	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-3h	Soil	SWMU1-WP-3h-2014	10/7/2008	0	0.5	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-3h	Soil	SWMU1-WP-3h-2015	10/7/2008	2	3	<330	<330	<330	<330	--
SWMU1	SWMU1-WP-3h	Soil	SWMU1-WP-3h-2016	10/7/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-5a	Soil	SWMU1-WP-5a-2019	10/5/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-WP-5a	Soil	SWMU1-WP-5a-2020	10/5/2008	2	3	<340	<340	<340	<340	<5.2
SWMU1	SWMU1-WP-5a	Soil	SWMU1-WP-5a-2021	10/5/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-5a	Soil	SWMU1-WP-5a-2022	10/5/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-5a	Soil	SWMU1-WP-5a-2023	10/5/2008	7	8	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-5a	Soil	SWMU1-WP-5a-2024	10/5/2008	9	10	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-5a	Soil	SWMU1-WP-5a-2025	10/5/2008	11	12	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-5a	Soil	SWMU1-WP-5a-2026	10/5/2008	13	14	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-5h	Soil	SWMU1-WP-5h-2027	10/7/2008	0	0.5	<360	<360	<360	<360	--
SWMU1	SWMU1-WP-5h	WhitePowder	SWMU1-WP-5h-2028	10/7/2008	2	3	<350	<350	<350	<350	<5.8
SWMU1	SWMU1-WP-5h	Soil	SWMU1-WP-5h-2029	10/7/2008	5	5	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-6a	Soil	SWMU1-WP-6a-2032	10/5/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-WP-6a	Soil	SWMU1-WP-6a-2033	10/5/2008	2	3	<330	<330	<330	<330	<5.9
SWMU1	SWMU1-WP-6a	Soil	SWMU1-WP-6a-2034	10/5/2008	2	3	<330	<330	<330	<330	<4.8
SWMU1	SWMU1-WP-6a	Soil	SWMU1-WP-6a-2035	10/5/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-6a	Soil	SWMU1-WP-6a-2036	10/5/2008	7	8	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-6a	Soil	SWMU1-WP-6a-2037	10/5/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-6a	Soil	SWMU1-WP-6a-2038	10/5/2008	11	12	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-6a	Soil	SWMU1-WP-6a-2039	10/5/2008	13	14	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-6h	WhitePowder	SWMU1-WP-6h-2040	10/6/2008	0	0.5	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-6h	Soil	SWMU1-WP-6h-2041	10/6/2008	2	3	<340	<340	<340	<340	<4.7
SWMU1	SWMU1-WP-6h	Soil	SWMU1-WP-6h-2042	10/6/2008	5	6	<330	<330	<330	<330	--
SWMU1	SWMU1-WP-6h	Soil	SWMU1-WP-6h-2043	10/6/2008	5	6	<330	<330	<330	<330	--
SWMU1	SWMU1-WP-6h	Soil	SWMU1-WP-6h-2045	10/6/2008	9	10	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-7	Soil	SWMU1-WP7-2046	10/6/2008	0	0.5	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-7	WhitePowder	SWMU1-WP7-2047	10/6/2008	2	3	<370	<370	<370	<370	<7.9
SWMU1	SWMU1-WP-7	Soil	SWMU1-WP7-2048	10/6/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-7	Soil	SWMU1-WP7-2050	10/6/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-8	Soil	SWMU1-WP8-2053	10/6/2008	0	0.5	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-8	Soil	SWMU1-WP8-2054	10/6/2008	2	3	<350	<350	<350	<350	<3.8
SWMU1	SWMU1-WP-8	Soil	SWMU1-WP8-2055	10/6/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-8	Soil	SWMU1-WP8-2057	10/6/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-9	Soil	SWMU1-WP9-2060	9/21/2008	0	0.5	<330	<330	<330	<330	--
SWMU1	SWMU1-WP-9	Soil	SWMU1-WP9-2061	9/21/2008	2	3	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-9	Soil	SWMU1-WP9-2062	9/21/2008	2	3	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-9	Soil	SWMU1-WP9-2063	9/21/2008	5	6	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-9	Soil	SWMU1-WP9-2064	9/21/2008	7	8	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-9	Soil	SWMU1-WP9-2065	9/21/2008	9	10	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-9	Soil	SWMU1-WP9-2066	9/21/2008	11	12	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-9	Soil	SWMU1-WP9-2067	9/21/2008	13	14	<340	<340	<340	<340	--

Table A-2
Data for 2,4-Dimethylphenol, 4-Methylphenol,
Butyl Benzyl Phthalate, Dibenzofuran, and Methyl Acetate in Solid Matrices

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

RFI Area	Location	Matrix	Sample ID	Sample Date	Top Depth (ft bgs)	Bottom Depth (ft bgs)	2,4-dimethylphenol (µg/kg)	4-methylphenol (µg/kg)	Butyl benzyl phthalate (µg/kg)	Dibenzofuran (µg/kg)	Methyl acetate (µg/kg)
SWMU1	SWMU1-WP-T3a	Soil	SWMU1-WP-T3a-2076	10/5/2008	0	0.5	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-T3a	Soil	SWMU1-WP-T3a-2077	10/5/2008	2	3	<340	<340	<340	<340	<5.3
SWMU1	SWMU1-WP-T3a	Soil	SWMU1-WP-T3a-2078	10/5/2008	5	6	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-T3a	Soil	SWMU1-WP-T3a-2079	10/5/2008	5	6	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-T3a	Soil	SWMU1-WP-T3a-2080	10/5/2008	7	8	<350	<350	<350	<350	--
SWMU1	SWMU1-WP-T3a	Soil	SWMU1-WP-T3a-2081	10/5/2008	9	10	<330	<330	<330	<330	--
SWMU1	SWMU1-WP-T3a	Soil	SWMU1-WP-T3a-2082	10/5/2008	11	12	<340	<340	<340	<340	--
SWMU1	SWMU1-WP-T3a	Soil	SWMU1-WP-T3a-2083	10/5/2008	13	14	<350	<350	<350	<350	--

Notes:

Data from Soil Part A Datadump (04.29.09): ftp://ftp.ch2m.com/Topock_DTSC_Site/
AOC = Area of Concern
ft bgs = feet below ground surface
RCRA = Resource Conservation and Recovery Act
RFI = RCRA Field Investigation
SE = sediment
SWMU = Solid Waste Management Unit
< = not detected at reporting limit noted.
-- = not analyzed.

Figures

Figure A-1
Sample ECV HQ Calculation for Gamma-Chlordane

Attachment 1 to Technical Memorandum 4
Topock Compressor Station
Needles, California

ECV for gamma-Chlordane Based on Cactus Wren Exposure

Species-Specific Exposure Parameters [a]		
Body Weight (kg; BW)	0.0389	
Food Intake Rate (kg_{tissue}/day, dw; FIR)	0.00713	
Soil Ingestion Rate (kg_{soil}/day, dw; FIR)	0.00066309	
Site Use Factor (unitless; SUF)	1.00	
Bioaccumulation Factor (Ct/Cs; BAF)	24.30	
Diet Composition		Representative EPC
Invertebrate	100%	Soil to invertebrate uptake equation (see below)

gamma-Chlordane Concentrations In Specific Media		
		Calculation Method
ECV = C_{soil} ($mg_{gamma\text{-}Chlordane}/kg_{soil}$)	0.470	Selected ECV[b]
C_{invert} ($mg_{gamma\text{-}Chlordane}/kg_{invert}$) = C_{soil} * BAF	11.414	Tissue Concentration[c]

Toxicity Reference Value (TRV)	
Avian NOAEL for gamma-Chlordane[d] ($mg_{gamma\text{-}Chlordane}/kg_{BW}$-day)	2.1

Equations [e]
HQ = Dose($mg_{gamma\text{-}Chlordane}/kg_{BW}$-day) / TRV($mg_{gamma\text{-}Chlordane}/kg_{BW}$-day)
Dose = ([(C_{soil} * SIR) + (C_{invert} * FIR)] / BW) * SUF

Incidental Soil Ingestion ($mg_{gamma\text{-}Chlordane}/kg_{BW}$-day)
ADD_{soil} =([C_{soil} * SIR] / BW) * SUF
ADD_{soil} = ([0.470 *0.00066309] / 0.0389) * 1.00
0.0080064

Ingestion from invertebrates ($mg_{gamma\text{-}Chlordane}/kg_{BW}$-day)
ADD_{invert} =([C_{invert} * FIR] /BW) * SUF
where C_{invert} = C_{soil} * BAF = (0.47 * 24.3) = 11.414
ADD_{invert} = ([11.414 * 0.00713] / 0.0389) * 1.00
2.092

Total Dose ($mg_{gamma\text{-}Chlordane}/kg_{BW}$-day)
Total Dose = ADD_{soil} + ADD_{invert}
Total Dose = 0.0080064 + 2.092
2.100

Hazard Quotient (unitless)
HQ = Dose / TRV
HQ = 2.1 / 2.1
1.00

Notes:
a. Species specific exposure parameters obtained from Table 6-3 of the Draft Human Health and Ecological Risk Assessment Work Plan.
b. ECV value obtained from Table 1.
c. Tissue concentration obtained from Attachment 1 Table.
d. TRV obtained from Attachment 1 Table.
e. Equations obtained from Technical Memorandum 3: Ecological comparison values for Metals and PAHs in Soil.

% = percent
ADDx = Average Daily Dose from "x" medium (soil, invertebrates)
BAF = bioaccumulation factor
BW = body weight
C_{invert} = concentration of chemical in invertebrate tissue
C_{soil} = concentration of chemical in soil
Ct/Cs = concentration of chemical in tissue per concentration of chemical in soil
dw = dry weight
TRV = toxicity reference value
ECV = Ecological Comparison Value
EPC = exposure point concentration
FIR = food ingestion rate
HQ = hazard quotient
kg/day = kilograms per day
mg/kg = milligrams per kilogram
mg/kg_{BW}-day = milligrams per kilogram body weight per day
NOAEL = no-observed adverse effect level
SUF = site use factor

Figure A-2
Sample ECV HQ Calculation for Cyanide

Attachment 1 to Technical Memorandum 4
Topock Compressor Station
Needles, California

ECV for Cyanide Based on Cactus Wren Exposure

Species-Specific Exposure Parameters [a]		
Body Weight (kg; BW)	0.0389	
Food Intake Rate (kg_{tissue}/day, dw; FIR)	0.00713	
Soil Ingestion Rate (kg_{soil}/day, dw; FIR)	0.00066309	
Site Use Factor (unitless; SUF)	1.00	
Bioaccumulation Factor (Ct/Cs; BAF)	0.00	
Diet Composition		Representative EPC
Invertebrate	100%	Soil to invertebrate uptake equation (see below)

Cyanide Concentrations In Specific Media		
		Calculation Method
ECV = C_{soil} ($mg_{cyanide}/kg_{soil}$)	2.35	Selected ECV[b]
C_{invert} ($mg_{cyanide}/kg_{invert}$) = C_{soil} * BAF	0.0	Tissue Concentration[c]

Toxicity Reference Value (TRV)	
Avian NOAEL for cyanide[d] ($mg_{cyanide}/kg_{BW}$-day)	0.04

Equations [e]
HQ = Dose($mg_{cyanide}/kg_{BW}$-day) / TRV($mg_{cyanide}/kg_{BW}$-day)
Total Dose = ([(C_{soil} * SIR) + (C_{invert} * FIR)] / BW) * SUF

Incidental Soil Ingestion ($mg_{cyanide}/kg_{BW}$-day)

ADD_{soil} =([C_{soil} * SIR] / BW) * SUF

ADD_{soil} = ([2.35 *0.00066309] / 0.0389) * 1.00

0.040

Ingestion from invertebrates ($mg_{cyanide}/kg_{BW}$-day)

ADD_{invert} =([C_{invert} * FIR] /BW) * SUF

where C_{invert} = C_{soil} * BAF = (2.35 * 0) = 0

ADD_{invert} = ([0 * 0.00713] / 0.0389) * 1.00

0.0

Total Dose ($mg_{cyanide}/kg_{BW}$-day)

Total Dose = ADD_{soil} + ADD_{invert}

Total Dose = 0.040 + 0.0

0.040

Hazard Quotient (unitless)

HQ = Dose / TRV

HQ = 0.04 / 0.04

1.00

Notes:

a. Species specific exposure parameters obtained from Table 6-3 of the Draft Human Health and Ecological Risk Assessment Work Plan.
b. ECV value obtained from Table 1.
c. Tissue concentration equation obtained from Attachment 1 Table.
d. TRV obtained from Attachment 1 Table.
e. Equations obtained from Technical Memorandum 3: Ecological comparison values for Metals and PAHs in Soil.

% = percent
ADDx = Average Daily Dose from "x" medium (soil, invertebrates)
BAF = bioaccumulation factor
BW = body weight
C_{invert} = concentration of chemical in invertebrate tissue
C_{soil} = concentration of chemical in soil
Ct/Cs = concentration of chemical in tissue per concentration of chemical in soil
dw = dry weight
ECV = Ecological Comparison Value
EPC = exposure point concentration
FIR = food ingestion rate
HQ = hazard quotient
kg/day = kilograms per day
mg/kg = milligrams per kilogram
mg/kg_{BW}-day = milligrams per kilogram body weight per day
NOAEL = no-observed adverse effect level
SUF = site use factor
TRV = toxicity reference value

Figure A-3
Pesticide Screening Levels for Soil Invertebrates

Attachment 1 to Technical Memorandum 4
PG&E Topock
Needles, California

Pesticide	Toxicity Data (Van de Plasche, 1994)	Based on	Uncertainty Factor (UF)	NOAEC	
DDT	10000 ug/kg	LC50	100 DTSC/USEPA	100 ug/kg	NOAEC based on 10%TOC
Chlordane	4300 ug/kg	LC50	100 DTSC/USEPA	43 ug/kg	NOAEC based on 10%TOC
Dieldrin	500 ug/kg	NOAEC	1 DTSC/USEPA	500 ug/kg	NOAEC based on 10%TOC

% = percent
DTSC = California Department of Toxic Substances Control
NOAEC = no-observed adverse effects concentration
TOC = total organic carbon
ug/kg = micrograms per kilogram
USEPA = United States Environmental Protection Agency

Van de Plassche, E.J. 1994. Towards Integrated Environmental Quality Objectives for Several Compounds with a Potential for Secondary Poisoning. National Institute of Public Health and Environmental Protection. The Netherlands. RIVM Report 679-101-012. 132 pp.

Figure A-4
Adjusting Total Organic Carbon for Screening Levels from 10% to 1%

Attachment 1 to Technical Memorandum 4
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Steps:

1 Use screening value of chemical "X" in micrograms per kilogram (ug/kg) based on 10% total organic carbon (TOC) (see Figure A-3 [NOAEC worksheet]).
2 Normalize the screening value by dividing the screening value by 10%TOC (0.1 kilogram [kg] TOC/kg soil).
3 Multiply by conversion units (1000 micrograms [ug] X/ milligrams [mg] X) to present results in mgX/kgTOC.
4 Use results of mgX/kgTOC based on Steps 1 through 3.
5 Convert to dry weight assuming 1%TOC (0.01 kg TOC/kg soil).
6 Results are soil invertebrate ecological comparison values ECVs (reported in Table 1 and Table A-1).

Soil Screening Value for DDT = 100 ug/kg

Step 1		Step 2		Step 3		Step 4
100 ug DDT / 1 kg soil	x	1 kg soil / 0.1 kg TOC	x	1 mg DDT / 1000 ug DDT	=	1 mg DDT / 1 kg TOC

Results from Step 4		Step 5		Step 6
1 mg DDT / 1 kg TOC	x	0.01 kg TOC / 1 kg soil	=	0.01 mg DDT / kg soil

Soil Invertebrate ECV for DDT

0.01 mg DDT / kg soil

Soil Screening Value for Chlordane = 43 ug/kg

Step 1		Step 2		Step 3		Step 4
43 ug chlordane / 1 kg soil	x	1 kg soil / 0.1 kg TOC	x	1 mg chlordane / 1000 ug chlordane	=	0.43 mg chlordane / 1 kg TOC

Results from Step 4		Step 5		Step 6
0.43 mg DDT / 1 kg TOC	x	0.01 kg TOC / 1 kg soil	=	0.0043 mg chlordane / kg soil

Soil Invertebrate ECV for chlordane

0.0043 mg chlordane / kg soil

Soil Screening Value for Dieldrin = 500 ug/kg

Step 1		Step 2		Step 3		Step 4
500 ug dieldrin / 1 kg soil	x	1 kg soil / 0.1 kg TOC	x	1 mg dieldrin / 1000 ug dieldrin	=	5 mg dieldrin / 1 kg TOC

Results from Step 4		Step 5		Step 6
5 mg DDT / 1 kg TOC	x	0.01 kg TOC / 1 kg soil	=	0.05 mg dieldrin / kg soil

Soil Invertebrate ECV for dieldrin

0.05 mg dieldrin / kg soil

Table A-10
Ecological Comparison Values Based on the Desert Shrew and on DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs												
Soil	2.1E+01	2.1E+02	4.1E+00	1.2E+01	3.3E+02	6.6E+02	1.6E-01	1.1E+04	8.0E+01	2.4E+02	2.5E+00	6.2E+01
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.3E-01	9.0E+00
Invertebrate tissue	4.3E+01	4.3E+02	2.3E+00	6.8E+00	1.4E+01	2.8E+01	4.7E+01	1.8E+03	2.4E+02	7.3E+02	6.4E+00	1.6E+02
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	--		--		--		--		--		--	
Soil-to-Invertebrates	2.0E+00		5.5E-01		4.2E-02		ln(Ci) = 0.328 * ln(Cs) + 4.449		3.0E+00		2.6E+00	
Soil-to-Mammals	--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	8.8E+00	8.8E+01	4.8E-01	1.4E+00	4.2E+00	8.3E+00	9.6E+00	4.1E+02	5.0E+01	1.5E+02	1.3E+00	3.3E+01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-11
Ecological Comparison Values for Merriam's Kangaroo Rat and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony mg/kg (dw)		Arsenic mg/kg (dw)		Barium mg/kg (dw)		Beryllium mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	1.2E+01	1.4E+02	6.3E+01	9.3E+02	3.5E+03	5.6E+03	2.3E+01	2.9E+01	1.2E+00	5.4E+02	4.5E+02	1.8E+03	1.7E+03	7.3E+03
Plant tissue	4.2E-01	3.9E+00	2.4E+00	3.5E+01	5.5E+02	8.7E+02	5.9E+00	7.0E+00	7.0E-01	1.9E+01	1.8E+01	7.4E+01	7.1E+01	3.0E+02
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.6E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	ln(Cp) = 0.938 * ln(Cs) - 3.233		3.8E-02		1.6E-01		ln(Cp) = 0.7345 * ln(Cs) - 0.5361		ln(Cp) = 0.546 * ln(Cs) - 0.475		4.1E-02		4.1E-02	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	5.9E-02	5.9E-01	3.2E-01	4.7E+00	5.2E+01	8.3E+01	5.3E-01	6.3E-01	6.0E-02	2.6E+00	2.4E+00	9.6E+00	9.2E+00	3.9E+01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR	0.00282	kg tissue/day
Soil Ingestion Rate (SIR)	0.0000677	kg soil/day
Plant Ingestion Fraction (F_{food})	100%	Percent
Invertebrate Ingestion Fraction (F_{food})	0%	Percent
Mammal Ingestion Fraction (F_{food})	0%	Percent
Home Range	0.13	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	0.0343	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(yellow highlight) soil ECV.

[1] bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.
[2] exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).
[3] dose caluated for a target HQ of 1 (NOAEL and LOAEL based).
[4] Low and High ECVs based on low and high TRVs (from Table 4), respectively.

ECV	ecological comparison value for soil.
DTSC	Department of Toxic Substances Control.
dw	dry weight.
High	lowest-observed adverse effects level (LOAEL).
HMW PAHs	high molecular weight polycyclic aromatic hydrocarbons.
kg	kilograms.
kg/day	kilograms per day.
LMW PAHs	low molecular weight polycyclic aromatic hydrocarbons.
Low	no-observed adverse effects level (NOAEL).
mg/kg	milligrams per kilogram.
mg/kg-bw/day	milligrams per kilogram body weight per day.
NA	not available or not applicable.

Table A-11
Ecological Comparison Values for Merriam's Kangaroo Rat and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum mg/kg (dw)		Nickel mg/kg (dw)		Selenium mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs														
Soil	4.6E+02	7.7E+03	4.5E+02	3.1E+05	2.6E+02	1.1E+05	3.0E+01	1.3E+03	1.2E+01	1.2E+02	2.2E+01	1.1E+04	1.1E+00	2.0E+01
Plant tissue	3.5E+00	5.8E+01	2.2E+01	2.8E+02	6.0E+00	1.8E+02	2.3E+00	1.8E+01	2.9E+00	2.9E+01	1.1E+00	1.2E+02	5.8E-01	1.4E+01
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	7.5E-03		ln(Cp) = 0.394 * ln(Cs) + 0.668		ln(Cp) = 0.561 * ln(Cs) - 1.328		ln(Cp) = 0.544 * ln(Cs) - 0.996		2.5E-01		ln(Cp) = 0.748 * ln(Cs) - 2.223		ln(Cp) = 1.104 * ln(Cs) - 0.677	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	1.2E+00	2.0E+01	2.7E+00	6.3E+02	1.0E+00	2.4E+02	2.5E-01	4.0E+00	2.6E-01	2.6E+00	1.3E-01	3.2E+01	5.0E-02	1.2E+00
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-11
Ecological Comparison Values for Merriam's Kangaroo Rat and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]	Low[4]	High[4]
Sitewide ECVs												
Soil	2.7E+03	2.7E+04	2.1E+02	6.2E+02	1.8E+03	3.5E+03	2.8E+02	9.4E+04	2.4E+04	7.4E+04	9.5E+01	2.8E+03
Plant tissue	3.8E+01	3.8E+02	8.3E-01	2.5E+00	8.5E+00	1.7E+01	1.1E+02	2.7E+03	2.6E+01	4.4E+01	1.4E+01	3.3E+02
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	1.4E-02		4.0E-03		4.9E-03		ln(Cp) = 0.554 * ln(Cs) + 1.575		ln(Cp) = 0.4544 * ln(Cs)-1.3205		ln(Cp) = 0.9469 * ln(Cs)-1.7026	
Soil-to-Invertebrates	--		--		--		--		--		--	
Soil-to-Mammals	--		--		--		--		--		--	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	8.4E+00	8.4E+01	4.8E-01	1.4E+00	4.2E+00	8.3E+00	9.6E+00	4.1E+02	5.0E+01	1.5E+02	1.3E+00	3.3E+01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-12
Ecological Comparison Values Based on the Desert Kit Fox and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Antimony[4] mg/kg (dw)		Arsenic mg/kg (dw)		Barium[4] mg/kg (dw)		Beryllium[4] mg/kg (dw)		Cadmium mg/kg (dw)		Chromium mg/kg (dw)		Hexavalent Chromium mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs														
Soil	2.1E+01	2.1E+02	2.9E+02	4.5E+03	4.1E+04	6.6E+04	1.9E+02	2.3E+02	1.9E+01	2.3E+03	1.1E+03	5.3E+03	5.0E+03	2.5E+04
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	1.1E+00	1.1E+01	8.2E-01	7.7E+00	2.8E+01	4.5E+01	4.3E-01	5.1E-01	1.2E+00	1.1E+01	3.8E+01	1.2E+02	1.2E+02	3.9E+02
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	0.05 * Cd		ln(Cm) = 0.8188 * ln(Cs) -4.8471		0.0075 * Cd		0.05 * Cd		ln(Cm) = 0.4723 * ln(Cs) - 1.2571		ln(Cm) = 0.7338 * ln(Cs) - 1.4599		ln(Cm) = 0.7338 * ln(Cs) - 1.4599	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	5.9E-02	5.9E-01	3.2E-01	4.7E+00	4.2E+01	6.7E+01	2.1E-01	2.4E-01	6.0E-02	2.6E+00	2.4E+00	9.6E+00	9.2E+00	3.9E+01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	8.1E-01	8.1E-01	3.9E-01	3.9E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Exposure Paramater[3]	value	units
Food Ingestion Rate (FIR	0.07020	kg tissue/day
Soil Ingestion Rate (SIR)	0.0019656	kg soil/day
Plant Ingestion Fraction (F_{food})	0%	Percent
Invertebrate Ingestion Fraction (F_{food})	0%	Percent
Mammal Ingestion Fraction (F_{food})	100%	Percent
Home Range	3039	Acres
Site Use Factor (SUF)	1.00	Unitless
Body Weight (BW)	1.985	kgBW

Microsoft Solver used to calculate ECVs based one re-arranging the standard HQ equation (USEPA, 1997) below:

$$ECV = \frac{HQ \times TRV}{Dose} = \left(\frac{1 \times TRV \times BW}{SIR + (FIR \times BAF) \times SUF} \right)$$

Notes:

(highlighted) soil ECV.

1 bioaccumulation factors (BAFs; kilograms soil per kilogram tissue [kg soil/kg tissue]); from Table 2.

2 exposure parameters from Table 6-3 of the *Human Health and Ecological Risk Assessment Work Plan* (ARCADIS, 2008).

3 dose caluated for a target HQ of 1 (NOAEL and LOAEL based).

4 Low and High ECVs based on low and high TRVs (from Table 4), respectively.

ECV	ecological comparison value for soil.
DTSC	Department of Toxic Substances Control.
dw	dry weight.
High	lowest-observed adverse effects level (LOAEL).
HMW PAHs	high molecular weight polycyclic aromatic hydrocarbons.
kg	kilograms.
kg/day	kilograms per day.
LMW PAHs	low molecular weight polycyclic aromatic hydrocarbons.
Low	no-observed adverse effects level (NOAEL).
mg/kg	milligrams per kilogram.
mg/kg-bw/day	milligrams per kilogram body weight per day.
NA	not available or not applicable.

Table A-12
Ecological Comparison Values Based on the Desert Kit Fox and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Cobalt mg/kg (dw)		Copper mg/kg (dw)		Lead mg/kg (dw)		Mercury mg/kg (dw)		Molybdenum[4] mg/kg (dw)		Nickel mg/kg (dw)		Selenium mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]
Sitewide ECVs														
Soil	3.5E+02	3.4E+03	1.9E+03	6.4E+05	4.4E+02	2.3E+05	3.2E+01	5.1E+02	2.2E+01	2.2E+02	2.0E+01	2.9E+04	5.6E+00	9.2E+02
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	2.4E+01	4.7E+02	2.3E+01	5.3E+01	1.6E+01	2.6E+02	6.2E+00	9.9E+01	3.7E+00	3.7E+01	3.2E+00	9.3E+01	1.3E+00	8.6E+00
Bioaccumulation Factors (BAFs)[1]														
Soil-to-Plants	--		--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--		--	
Soil-to-Mammals	ln(Cm) = 1.307 * ln(Cs) - 4.4669		ln(Cm) = 0.1444 * ln(Cs) + 2.042		ln(Cm) = 0.4422 * ln(Cs) + 0.0761		1.9E-01		0.006 * 50 * Cd		ln(Cm) = 0.4658 * ln(Cs) - 0.2462		ln(Cm) = 0.3764 * ln(Cs) - 0.4158	
Dose Calulations for Target Hazard Quotients (HQs)[2]														
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	1.2E+00	2.0E+01	2.7E+00	6.3E+02	1.0E+00	2.4E+02	2.5E-01	4.0E+00	1.5E-01	1.5E+00	1.3E-01	3.2E+01	5.0E-02	1.2E+00
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	5.9E-01	5.9E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00

Table A-12
Ecological Comparison Values Based on the Desert Kit Fox and DTSC-Recommended TRVs

Technical Memorandum 3: Ecological Comparison Values for Metals and PAHs in Soil
PG&E Topock
Needles, California

Protective Media Concentrations (mg/kg)	Silver mg/kg (dw)		Thallium mg/kg (dw)		Vanadium mg/kg (dw)		Zinc mg/kg (dw)		LMW PAHs mg/kg (dw)		HMW PAHs mg/kg (dw)	
	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low[5]	High[5]	Low	High
Sitewide ECVs												
Soil	5.3E+03	5.3E+04	9.7E+01	2.9E+02	2.9E+03	5.8E+03	4.6E+03	4.1E+05	5.0E+04	1.5E+05	1.3E+03	3.3E+04
Plant tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Invertebrate tissue	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Prey (mammal) tissue	2.1E+01	2.1E+02	1.1E+01	3.2E+01	3.6E+01	7.2E+01	1.4E+02	2.0E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Bioaccumulation Factors (BAFs)[1]												
Soil-to-Plants	--		--		--		--		--		--	
Soil-to-Invertebrates	--		--		--		--		--		--	
Soil-to-Mammals	4.0E-03		1.1E-01		1.2E-02		ln(Cm) = 0.0706 * ln(Cs) + 4.3632		0.0E+00		0.0E+00	
Dose Calulations for Target Hazard Quotients (HQs)[2]												
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Dose = TRV	6.0E+00	6.0E+01	4.8E-01	1.4E+00	4.2E+00	8.3E+00	9.6E+00	4.1E+02	5.0E+01	1.5E+02	1.3E+00	3.3E+01
HQ	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00	1.0E+00

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Appendix I

Supplemental Ecological Risk Evaluation to Address HERD Comments Dated March 26, 2009; June 17, 2009; and September 10, 2009

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Appendix I – Supplemental Ecological Risk Evaluation to Address HERD Comments dated March 26, 2009; June 17, 2009; and September 10, 2009

HERA of Groundwater Impacted by Activities at
SWMU 1/AOC 1 and SWMU 2
Topock Compressor Station, Needles, California

November 2009

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Acronyms and Abbreviations

APE	Area of Potential Effect
BCW	Bat Cave Wash
bgs	below ground surface
COPC	constituent of potential concern
CSM	conceptual site model
DTSC	Department of Toxic Substances Conrol
ERA	ecological risk assessment
GWRA	Groundwater Risk Assessment
HERD	Human and Ecological Risk Division
LOAEC	lowest observable adverse effects concentration
mg/kg	milligrams per kilogram
mg/L	milligram(s) per liter
NOAEC	no-observable adverse effect concentration
PG&E	Pacific Gas and Electric
ppm	part(s) per million
RFI/RI	Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation
RTC	response to comment
site	Topock Compressor Station in Needles, California
UTL	Upper Tolerance Limits

1. Introduction

This appendix was prepared in response to the March 26, 2009; June 17, 2009; and September 10, 2009; comments provided by the Human and Ecological Risk Division (HERD) (California Department of Toxic Substances Control [DTSC], 2009a,b,c) on the Pacific Gas and Electric (PG&E) Response to Comments (RTCs) for the Draft Groundwater Human Health and Ecological Risk Assessment (GWRA) for Topock Compressor Station in Needles, California (the site) (ARCADIS, 2009).

A detailed description of the transport mechanisms and exposure pathways is presented in Section 5 of the GWRA main text. Consistent with the approved Risk Assessment Work Plan (ARCADIS, 2008), the focus of the ecological risk assessment (ERA) in the main text of the GWRA was on evaluating the potential transport pathway to the Colorado River. In response to agency comments on the GWRA and on the RTCs, PG&E has expanded the GWRA via this appendix to include three additional potential exposure pathways for ecological receptors. These potential pathways are:

- Shallow-rooted wetland plant exposure to chemicals in groundwater via root uptake.

- Deep-rooted phreatophyte exposure to chemicals in first encountered groundwater via root uptake. Phreatophytes identified at the site are presented in Table I-1.

- Transfer of hexavalent chromium, nitrate, molybdenum, and selenium in groundwater to plant foliage via root uptake and translocation, then potential ingestion of hexavalent chromium, nitrate, molybdenum, and selenium in plant tissue by herbivorous mammals. Of particular interest to DTSC, was potential exposure of ruminants, specifically the desert bighorn sheep (*Ovis canadensis nelsoni*), to nitrate accumulated in phreatophyte tissue.

Groundwater from two exposure areas was evaluated due to the difference in chemical concentrations as discussed below in Section 2. The two exposure areas were groundwater underlying phreatophytes and shallow-rooted plants in: 1) the east side of the National Trails Highway, and 2) Bat Cave Wash (BCW). The remainder of this appendix discusses each of the potential exposure pathways listed above.

2. Conceptual Site Model

The conceptual site model (CSM) is presented in Figure 5-1 of the GWRA report. The primary chemical source is discharge of untreated wastewater to BCW. For the potential pathways listed in Section 1, only wells with beginning screened intervals shallower than 80 feet below ground surface (bgs) in both exposure areas (i.e., the east side of the National Trails Highway and BCW) were considered; wells where groundwater occurred deeper, or that were located outside the occurrence of phreatophytes, were not included. Wells with beginning screened intervals deeper than 80 feet were considered beyond depths of interest for potential phreatophyte exposure based on the root depths shown in Table I-1. Wells included in the assessment and corresponding depths to water are presented in Figure I-1.

The following describes the components of the CSM as it relates to the potential pathways listed above in Section 1.

2.1 Chemicals of Potential Concern

The focus of this assessment was on constituents of potential concern (COPCs) from the Revised Final Resource Conservation and Recovery Act Facility Investigation/Remedial Investigation (RFI/RI) Volume 2 (CH2M HILL, 2009), consisting of hexavalent chromium, molybdenum, nitrate, and selenium.

2.2 Background Screening

The dataset for the background screening consisted of maximum detected concentrations from January 2006 through July 2008 from wells shown on Figure I-1. These wells are shallow groundwater wells potentially co-located or nearest where phreatophytes or wetland plants occur in the Area of Potential Effect (APE) (Figure I-1). Maximum detected concentrations from these wells were compared with background Upper Tolerance Limits (UTLs) (Table I-2). Background UTLs are discussed in the main report (Section 3). If the maximum detected concentration of a COPC (i.e., hexavalent chromium, molybdenum, nitrate, and selenium) was greater than or equal to the background UTL for that COPC, the COPC was retained for further evaluation.

Figure I-2 presents the maximum detected concentrations in shallow wells co-located with phreatophytes along the east side of National Trails Highway. These wells are MW-21, MW-22, MW-27-20, MW-28-25, MW-29, MW-30-30, MW-32-20, MW-33-40, MW-35-60, MW-36-20, MW-39-40, MW-42-30, MW-43-25, MW-47-55, MW-56S,

PT-1S, PT-2S, PT-3S, PT-4S, PT-5S, PT-6S, and PTI-1S. Table I-2 presents the comparison of the maximum detected concentrations of each of the four COPCs to corresponding background UTLs. The maximum detected concentrations in selected wells on the east side of National Trails Highway exceed background UTLs for three COPCs (hexavalent chromium, molybdenum, and selenium). The results of the background comparison are summarized in Table I-2.

Figure I-2 presents the maximum detected concentrations in wells co-located with phreatophytes at BCW (see wells MW-41S, MW-13, and MW-11). Table I-2 presents the comparison of the maximum detected concentrations of each of the four COPCs to corresponding background UTLs. The maximum detected concentrations are based on recent groundwater samples collected from January 2006 to July 2008. The maximum detected concentrations in selected wells in BCW exceed background UTLs for two COPCs; these are hexavalent chromium and selenium. The maximum detected concentration of molybdenum in BCW wells did not exceed the background UTL. The results of the background comparison are summarized in Table I-2.

Based on comparison with background UTLs for groundwater, hexavalent chromium, molybdenum, nitrate, and selenium each had maximum detected concentrations that exceeded background along the east side of National Trails Highway and/or BCW and, therefore, were retained for further evaluation as COPCs in shallow groundwater that may be contacted by shallow-rooted plants as well as taken up by phreatophytes. However, it should be noted that only hexavalent chromium exceeded background in both exposure areas (Table I-2), reducing the potential for exposure via plant uptake for the other COPCs (nitrate, molybdenum, and selenium) because of the relatively small area with concentrations exceeding background that underlies phreatophytic or wetland/marsh plants.

3. Exposure Assessment

Groundwater level data for water table wells were obtained from Appendix B of the Revised Final RFI/RI Volume 2 (CH2M HILL, 2009) and Appendix B of the *Monitoring Report for the Floodplain Reductive Zone In-Situ Pilot Test* (ARCADIS, 2007). Figure I-1 displays the depth-to-water data for water table wells. As mentioned earlier, only wells with beginning screened interval shallower than 80 feet bgs were considered in this assessment; wells with deeper screened intervals were considered to be monitoring groundwater beyond depths of interest for phreatophyte exposure (see below for discussion of root depths). Depths to groundwater are as shallow as approximately 4 feet bgs near the river. Well-screened intervals and, therefore, depth of groundwater monitored, as well as an understanding of plant root depths, form the basis of the exposure evaluation for plants. Exposure of plants via root uptake from groundwater and subsequent translocation of COPCs from roots to foliage must occur for exposure of herbivorous mammals, including desert bighorn sheep, to nitrate, hexavalent chromium, molybdenum, and selenium originating in groundwater.

The following sections describe the potential exposure pathways for shallow-rooted wetland plants, deep-rooted phreatophytic plants, and herbivore ingestion of plant tissue.

3.1 Shallow-Rooted Wetland Vegetation

The potential exposure pathway for shallow-rooted wetland plants was evaluated qualitatively by reviewing well-screened intervals to select wells with monitoring results representative of potential exposure, reviewing depth-to-water data, considering geochemical processes that operate in wetland environments, and reviewing COPC concentrations in groundwater. Historical depth-to-water measurements suggest that shallow groundwater may not discharge at wetland areas (Figure I-1). Shallow-rooted plants such as common reed (*Phragmites communis*), cattails (*Typha sp.*), sedges (*Carex sp.*), and bulrush (*Scirpus sp.*) may not contact groundwater given that the shallowest depth to water measured near the river is approximately 4 feet (CH2M HILL, 2009), and these plants have ready access to surface water from the river. Deeper rooted plants, such as salt cedar and arrow weed, present immediately adjacent to the river or ponded water at the mouth of BCW, also have ready access to the surface water and, therefore, surface water would be the primary source of moisture for these plants rather than groundwater. As shown on Figure I-2, wetland/marsh plants (denoted in green) lie outside the plume line defined by the background UTL for hexavalent chromium in shallow groundwater.

3.2 Deep-Rooted Phreatophytic Vegetation

The exposure pathway for deeper rooted phreatophytes was evaluated quantitatively. The following describes the types of phreatophytes present at the site and their average rooting depths obtained from various literature sources.

Potential exposure to COPCs (hexavalent chromium, nitrate, selenium, and molybdenum) depends on depth to groundwater, root depths, and chemical distribution in the groundwater. Shallow groundwater wells that best represent COPC concentrations potentially contacting phreatophytic vegetation (Figure I-2) were selected based on the following criteria:

- Concentrations detected in wells with beginning screened intervals shallower than 80 feet bgs
- Co-location with phreatophytic vegetation
- Nearest upgradient well

MW-11 and MW-21 were the only wells selected that are not co-located with phreatophytic vegetation. MW-11 is the nearest upgradient well of phreatophytes at BCW. MW-21 is also very near phreatophytic vegetation.

The potential exposure pathway for phreatophytes was evaluated quantitatively by first assessing the potential for root contact with chemically affected groundwater, then considering groundwater concentrations of COPCs where contact may occur. Table I-1 provides maximum root depths for phreatophytes identified at the site showing that some species, such as honey mesquite (*Prosopis glandulosa*) can have roots up to 50 feet deep. Depths to groundwater in the BCW and on the east side of National Trails Highway where phreatophytes occur range from 30 feet bgs to 4 feet bgs. Deep-rooted phreatophytic upland plants may contact COPCs occurring in shallow groundwater. Such phreatophytes include mesquite (*Prosopis* spp.), palo verde (*Cercidium sp.*), salt cedar (*Tamarix ramosissima Ledeb.*), arrowweed (*Pluchea sericea*), and catclaw acacia, *(Acacia greggii*), which occur within upland areas near the river and in BCW where depths to water are also within potential root zones (Figure I-1). Consistent with this information, mesquite and palo verde grow in the BCW in areas with water table depths up to 50 feet bgs (Figure I-1 of this appendix and Figure 5-3 in CH2M HILL, 2009). The shallower rooted salt cedar (*Tamarix ramosissima Ledeb*.) is found where the depth to groundwater is 4 to 32 feet bgs (or where there is surface water) (Figure I-

1), which is consistent with its reported maximum rooting depths of about 25 feet (Table I-1). Therefore, it is indicated that phreatophytes may contact groundwater in the APE, and that the concentrations of COPCs in groundwater underlying the phreatophytes are of interest. These concentrations are further evaluated in Section 4.

3.3 Herbivorous Mammal Ingestion of Plant Tissue

Given that phreatophytic vegetation may contact groundwater in the APE, ingestion of chemicals in plant tissue is a potential exposure pathway to other ecological receptors. In particular, transfer of COPCs in groundwater to plant foliage via root uptake and translocation, then potential ingestion of COPCs in plant tissue by herbivorous mammals, particularly ruminants is a potential pathway of interest given:

- The presence of desert bighorn sheep in the area
- The presence of herbivorous mammals (as represented by the Merriam's kangaroo rat)
- Potential for toxicity in ruminants and other herbivorous mammals resulting from exposure to hexavalent chromium, molybdenum, and selenium, as well as nitrate in forage
- Specifically, known potential for nitrate toxicity in ruminants resulting from exposure to nitrate in feed.

Desert bighorn sheep are a federally listed sensitive species. This species is primarily associated with rugged terrain and mountainous areas but uses a variety of habitat types including desert riparian and desert scrub (Hopkins, as included in the California Wildlife Habitat Relationships System, 2009). The occurrence of this species included in the California Natural Diversity Database (CNDDB, 2009) is shown on Figure I-3. The nearest occurrence of the desert bighorn sheep to the site according to the CNDDB is in the Chemehuevi Mountains. However, desert bighorn sheep have been observed by Topock Compressor Station personnel and are a transient and infrequent visitor to the area around the APE (Russell, pers. comm. 2009). Available information indicates that the desert bighorn sheep are infrequently present and, therefore, infrequently feed on plants within the APE, but outside the area of desert bighorn sheep occurrence that is shown on Figure I-3.

The diet of the desert bighorn sheep is varied and has been reported to contain 50 percent browse with the remainder of the diet comprised of forbs, grasses, and succulents (Brewer and Harveson, 2007). In the APE, browse would include phreatophytes. Therefore, the diet composition likely further reduces the potential for exposure to COPCs in plant tissue accumulated from groundwater.

For herbivorous mammals including ruminants, plant tissue concentrations of nitrate were evaluated qualitatively based on the maximum nitrate concentration observed in shallow groundwater within the area where phreatophytes occur in the APE (Figure I-2).

Maximum nitrate concentrations between January 2006 and July 2008 exceeded background in one well of 25 wells (analyzed in 24 wells) selected to represent potential phreatophyte exposure (16.4 milligrams per liter [mg/L] in MW-11; Figure I-2). A study by McKeon et al. (2006) of nitrate uptake patterns over a nitrate-contaminated aquifer in northeast Arizona, showed that phreatophyte tissue concentrations did not exceed safe levels (see Section 4) for ruminants even when the plants were growing in the on-plume area. The phreatophyte, *Atriplex canescens*, growing over a shallow groundwater plume with high concentrations of nitrate (up to 1210 mg/L) accumulated a maximum average nitrate concentration of 727 milligrams per kilogram [mg/kg] nitrate-N in leaf tissue (plants harvested in 2000). Later analyses yielded an average nitrate concentration of 108 mg/kg nitrate-N in leaf tissue on the plume (estimated based on Figure 5 of the McKeon et al. (2006) study; plants harvested in July 2002). The on-plume area sampled was the most heavily contaminated part of the plume, presumably around the greater than 1000 mg/L contour for nitrate-N (Figure 1 of the McKeon et al. [2006] study).

The maximum nitrate-N concentration of 16.4 mg/L at Topock is well below the on-plume groundwater concentrations reported in the McKeon et al (2006) study (maximum was 1210 mg/L). Further, maximum concentrations from other wells selected to represent potential phreatophyte exposure did not exceed the background UTL. As a result, plant tissue concentrations at Topock are expected to be well below the maximum average concentrations detected in leaf tissue (951 mg/kg dry-weight for *Sarcobatus vermiculatus* and 727 mg/kg dry-weight for *A. canescens*) in the McKeon et.al. (2006) study. The reported nitrate-N concentrations in groundwater at the McKeon et.al. (2006) study site ranged from 12 to 1210 mg/L. The reported average leaf tissue nitrate-N concentrations ranged from 20 to 951 mg/kg dry-weight.

Similarly, for herbivorous mammals including ruminants, plant tissue concentrations of hexavalent chromium were evaluated qualitatively. In a study by Sorenson et al. (2009), uptake of hexavalent chromium from water to saltcedar (*Tamarix ramsissima*) was evaluated. In this study, 6-week-old saltcedar plants were placed in treatment solution containing tapwater (0.0007 mg/L) for control plants and tapwater with chromium (2 mg/L) trioxide, and results were reported as concentrations of elemental chromium. The concentration of chromium in plants grown in 2 mg/L of chromium in treatment solution contained an average of 1.89 mg/kg chromium. The accumulation factor based on this study is approximately 0.95 (i.e., concentration in plant tissue divided by the concentration in water).

The maximum hexavalent chromium concentration observed in shallow groundwater within the area where phreatophytes occur in the APE (Figure I-2), is 0.356 mg/L from MW-11 in BCW (Table I-2), which is similar to the chromium treatment solution in the study by Sorenson et al., (2009) and, therefore, the uptake at the Topock site can be conservatively assumed to be similar. Based on the uptake factor of 0.95, the maximum concentration of chromium in plants at the Topock site resulting from exposure to hexavalent chromium in groundwater is estimated to be 0.338 mg/kg. It should be noted that chromium in plants occurs primarily in the trivalent form (Eisler,1986; Aldrich et. al., 2003; Ramachandran, 1980).

Maximum selenium concentrations between January 2006 and July 2008 exceeded background in only one well of 25 wells selected to represent potential phreatophyte exposure (see MW-21 on Figure I-2). The single exceedance (0.038 mg/L in Well MW-21) only slightly exceeds the background of 0.0103 mg/L (Table I-2). Based on this observation, it can be assumed that uptake of selenium by plants from groundwater and exposure to herbivorous mammals is not a significant pathway and, therefore, does not require further evaluation.

Maximum molybdenum concentrations between January 2006 and July 2008 exceeded background in two wells of 25 wells (analyzed in 8 wells) selected to represent potential phreatophyte exposure (MW-22 with a concentration of 0.0482 mg/L and MW-21 with a concentration of 0.052 mg/L; Figure I-2). These two concentrations slightly exceed the background UTL (0.0363 mg/L) in a localized area. Based on this observation, it can be assumed that uptake of molybdenum by plants from groundwater and exposure to herbivorous mammals is not a significant pathway and, therefore, does not require further evaluation.

To summarize, given the concentrations of COPCs in groundwater underlying shallow-rooted and phreatophytic vegetation, potential exposure of ecological receptors to COPCs originating in groundwater is anticipated to be minimal. To satisfy DTSC's request for additional support for this conclusion, uptake of concentrations of hexavalent chromium and nitrate from groundwater to plants and then ingestion of plants by herbivorous mammals is further evaluated in the following section. Uptake of selenium and molybdenum from groundwater to plants and then ingestion of plants by herbivorous mammals is not considered a significant pathway and is not further evaluated.

4. Toxicity Assessment

A no-observable adverse effect concentration (NOAEC) was selected for each chemical to evaluate the toxicity of COPCs to plants. Table I-3 presents the NOAECs selected for this assessment. The following describes the plant toxicity values for hexavalent chromium, molybdenum, selenium and nitrate. Potential toxicity of hexavalent chromium and nitrate to herbivorous mammals including ruminants from ingestion of plant tissue containing these COPCs is also described.

4.1 Hexavalent Chromium

A NOAEC of 2 mg/L for hexavalent chromium was reported in Sorenson et al. (2009) for salt cedar. Mesquite (*Prosopis spp.*) tolerates hexavalent chromium in solutions of up to 125 mg/L when grown in agar and 80 mg/L when grown hydroponically (Aldrich et al., 2003) indicating a hexavalent chromium NOAEC for mesquite of 80 mg/L (Table I-3).

The USEPA (2008) reports that chromium has been shown to be an essential nutrient for animals. Trivalent chromium has been shown to have antioxidative properties in vivo, and it is integral to activating enzymes and maintaining the stability of proteins and nucleic acids. Its primary metabolic role is to potentiate the action of insulin through its presence in an organometallic molecule called the glucose tolerance factor. For example, studies with guinea pigs fed trivalent chromium for 21 weeks at concentrations up to 50 parts per million dietary trivalent chromium showed no adverse effects (Preston et al. 1976; as cited in Eisler, 1986).

4.2 Nitrate

Plants: An NOAEC of 1210 mg/L for nitrate was reported in McKeon et al. (2006) for fourwing saltbush and black greasewood (Table I-3).

Because desert plant communities are typically limited by nitrogen during growing periods (Zak and Whitford, 1988), nitrate uptake from the groundwater is expected to have beneficial rather than adverse effects on the plants. For example, in a desert system in Arizona the phreatophyte, *Atriplex canescens*, growing over a shallow groundwater plume with high concentrations of nitrate (maximum nitrate-N concentration = 300 mg/L), accumulated 5 times more nitrate in its leaves during summer than plants growing off the plume (up to 500 mg/kg nitrate-N in leaf tissue; McKeon et al., 2006). The study estimated that at the McKeon site, 40 kg of plume water would supply sufficient nitrogen for production of 1 kg of plant biomass. Isotope analysis indicated most of the nitrate came from the groundwater plume. The increased nitrate in the plant tissues produced no phytotoxicity (McKeon et al., 2006).

Mammals: Under normal conditions, nitrate is converted to nitrite by microorganisms in ruminants (such as sheep and cattle), which is then converted to ammonia and on to proteins and other compounds. Nitrate can be toxic to animals if the rate of conversion of nitrate to nitrite is greater than the conversion of nitrite to ammonia, resulting in a buildup of nitrite in the animal (A&L Great Lakes Laboratories, 2002). Various factors can affect the nitrite accumulation including the plant species, section of the plant (e.g., stalks are higher in nitrate content), plant age, and weather conditions (conditions that reduce plant growth increase nitrate production). A&L Great Lakes Laboratories (2002) provide safety guidelines for nitrate in ruminant feed and 4,400 ppm dry weight is listed as a safe level to feed under all conditions. Further, using a generalized interpretation for laboratory forage nitrate tests, 0 to 3,000 parts per million (ppm dry weight) in feed is considered safe for all cattle; 3,000 to 5,000 ppm (dry weight) in feed is considered safe for non-pregnant beef cattle; 5,000 to 10,000 ppm (dry weight) in feed is a small risk for some cattle; and greater than 10,000 ppm (dry weight) in feed is considered toxic for all cattle (Denman et al., undated).

5. Risk Characterization

The following describes the risk characterization for the exposure pathways evaluated above.

5.1 Shallow-Rooted Vegetation

As HERD stated (DTSC, 2009a), sampling has not demonstrated movement of the groundwater plume with COPCs into the Colorado River (see Figure I-2). Hexavalent chromium was not detected in shallow wells nearest the river (MW-28-25, MW-29, and MW-27-20; Figure I-2). Further, the reducing conditions in wetland areas would result in precipitation of hexavalent chromium, selenium, and molybdenum binding the metals to soil/sediment particles and reducing bioavailability. Further, shallow-rooted vegetation in the riparian area has ready access to surface water as a source of moisture. The data suggest wetland/riparian plants along the river are unlikely to be impacted by COPCs from the groundwater. Therefore, this shallow-rooted wetland/riparian plant pathway is considered insignificant and will not be evaluated further.

5.2 Deep-Rooted Phreatophytic Vegetation and Risk to Ruminants from Nitrate in Plants

Hazard quotients were calculated for potential exposure of phreatophytes to COPCs in groundwater (Table I-4). All hazard quotients for phreatophytes were well below one indicating no significant risk of phytotoxicity.

The maximum nitrate-N concentration is 16.4 mg/L (at MW-11), much lower than the maximum concentration in the McKeon et. al. (2006) study (1210 mg/L). No phytotoxicity was reported in the McKeon et.al. (2006) study. Given that nitrate concentrations in groundwater at Topock were orders of magnitude lower than those observed at the McKeon et.al. (2006) study site, concentrations in leaf tissue at Topock are expected to be well below 951 mg/kg dry-weight, the maximum average nitrate-N concentration observed in the McKeon et.al. (2006) study.[1] Levels assumed to be safe in feed for ruminants are up to 3,000 mg/kg dry-weight [Denman et al., undated]. Therefore, toxicity due to nitrate would also not be predicted for ruminants. Further,

[1] Average leaf tissue nitrate-N concentrations ranged from approximately 20 mg/kg to 951 mg/kg dry-weight depending on the plant species, sampling event, and grazing pressure.

given the limited distribution of nitrate greater than background (see Section 3.3), toxicity due to nitrate would not be predicted for herbivorous small mammals.

The maximum hexavalent chromium concentration in the BCW (within or bounding the area occupied by phreatophytes) is below levels found to be toxic to phreatophytic plants such as salt cedar and mesquite (Table I-3). Hexavalent chromium concentrations in shallow groundwater in the upland east of National Trails Highway are many times lower than those observed in the BCW at MW-11; therefore, phytotoxicity due to hexavalent chromium would not be predicted in either area. The estimated maximum concentration of chromium in plant tissue (0.338 mg/kg) from uptake from groundwater is considered low. For example, studies with guinea pigs fed trivalent chromium for 21 weeks at concentrations up to 50 mg/kg dietary trivalent chromium showed no adverse effects (Preston et al. 1976; as cited in Eisler, 1986). This is as would be expected for trivalent chromium, an essential nutrient that is well-regulated in mammalian systems. Therefore, toxicity due to chromium would also not be predicted for herbivorous mammals or for ruminants.

As discussed in Section 3.3, the concentrations of selenium and molybdenum in groundwater are not considered significant and, therefore, toxicity would not be predicted for herbivorous mammals or for ruminants.

The maximum COPC concentrations in groundwater described above are not associated with phytotoxicity and, therefore, effects would not be predicted in the study area where phreatophytic vegetation is potentially exposed. Therefore, the exposure pathway from chemically affected groundwater to phreatophytes is insignificant because maximum concentrations in shallow groundwater underlying these plant communities are very low relative to concentrations known to be phytotoxic. Further, toxicity to herbivorous mammals resulting from potential exposure to COPCs is not predicted given the low concentrations in groundwater of molybdenum and selenium and the low concentrations of chromium and nitrate predicted in plant tissue.

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Tables

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Tables

Table I-1. Maximum Rooting Depths of Site-Specific Phreatophytes

Species of Phreatophyte	Maximum Root Depth (feet)	Reference
Honey Mesquite (*Prosopis glandulosa*)	49	Glenn and Nagler (2005), Alth et al. (1991)
Palo Verde (*Cercidium* sp.)	50	Deep roots, not as deep as mesquite, Barth and Klemmedson (1982), MW-21 well near pure Palo Verde has about 50' depth to groundwater
Tamarisk (*Tamarix* sp.) (esp. Salt Cedar)	25	Glenn and Nagler (2005), Shrader (1977)
Arrowweed (*Pluchea sericea*)	20	Alth et al. (1991)
Catclaw Acacia (*Acacia greggii*)	>18	Zimmerman (1969)

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Table I-2. Maximum Groundwater Concentrations in Wells Co-Located with or Near Phreatophytes

		East of National Trails Highway[1]			Bat Cave Wash[2]			
COPC	Background UTL (mg/L)	Maximum Concentration (mg/L)	Location of Maximum	Exceeds Background?	Maximum Concentration (mg/L)	Location of Maximum	Exceeds Background?	COPC for Further Evaluation?
Hexavalent Chromium	0.0318	0.0619	MW-47-55	YES	0.356	MW-11	YES	YES
Molybdenum	0.0363	0.052	MW-21	YES	0.00928	MW-11	NO	YES
Nitrate	5.03	3.7	PT-5S	NO	16.4	MW-11	YES	YES
Selenium	0.0103	0.038	MW-21	YES	0.00617	MW-11	NO	YES

Notes:
COPC = constituent of potential concern
mg/L = milligram(s) per liter
UTL = upper tolerance limit

Footnotes:
(1) Figure I-2 presents the maximum detected concentrations in shallow wells co-located with phreatophytes along the east side of National Trails Highway. These wells are MW-21, MW-22, MW-27-20, MW-28-25, MW-29, MW-30-30, MW-32-20, MW-33-40, MW-35-60, MW-36-20, MW-39-40, MW-42-30, MW-43-25, MW-47-55, MW-56S, PT-1S, PT-2S, PT-3S, PT-4S, PT-5S, PT-6S, and PTI-1S
(2) Figure I-2 presents the maximum detected concentrations in wells co-located with phreatophytes at BCW (see wells MW-41S, MW-13, and MW-11).

Table I-3. Groundwater No-Observed Adverse Effects Concentrations

COPC	Maximum Concentration (mg/L)[1]	NOAEC (mg/L)	Source
Hexavalent Chromium	0.356	2	salt cedar; Sorenson et al. 2009
		80	mesquite; Aldrich et al. 2003
Molybdenum	0.052	9.6 [2]	bush bean; Adriano, 2001
Nitrate	16.4	1210	fourwing saltbush and black greasewood; McKeon, 2006
Selenium	0.038	2	salt cedar; Sorenson et al. 2009

Notes:
COPC = Chemical of potential concern
LOAEC = lowest observed adverse effects concentration
mg/L = milligrams per liter
NOAEC = no observed adverse effects concentration

Footnotes:
(1) Maximum concentration for all monitoring wells from Figure I-2.
(2) Extrapolated from LOAEC to NOAEC assuming a factor of 10 reduction.

References:

Adriano, D.C. 2001. *Trace Elements in Terrestrial Environments: Biogeochemistry, Bioavailability, and Risks of Metals*. Pp. 607. Springer.

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Table I-4. Hazard Quotients - Protection of Plant Health

COPC	Maximum Concentration (mg/L)[1]	NOAEC (mg/L)	Hazard Quotient
Hexavalent Chromium	0.356	2	0.2
		80	0.00
Molybdenum	0.052	9.6 [2]	0.01
Nitrate	16.4	1210	0.01
Selenium	0.038	2	0.02

Notes:
COPC = Chemical of potential concern
LOAEC = lowest observed adverse effects concentration
mg/L = milligrams per liter
NOAEC = no observed adverse effects concentration

Footnotes:
(1) Maximum concentration for all monitoring wells from Figure I-2.
(2) Extrapolated from LOAEC to NOAEC assuming a factor of 10 reduction.

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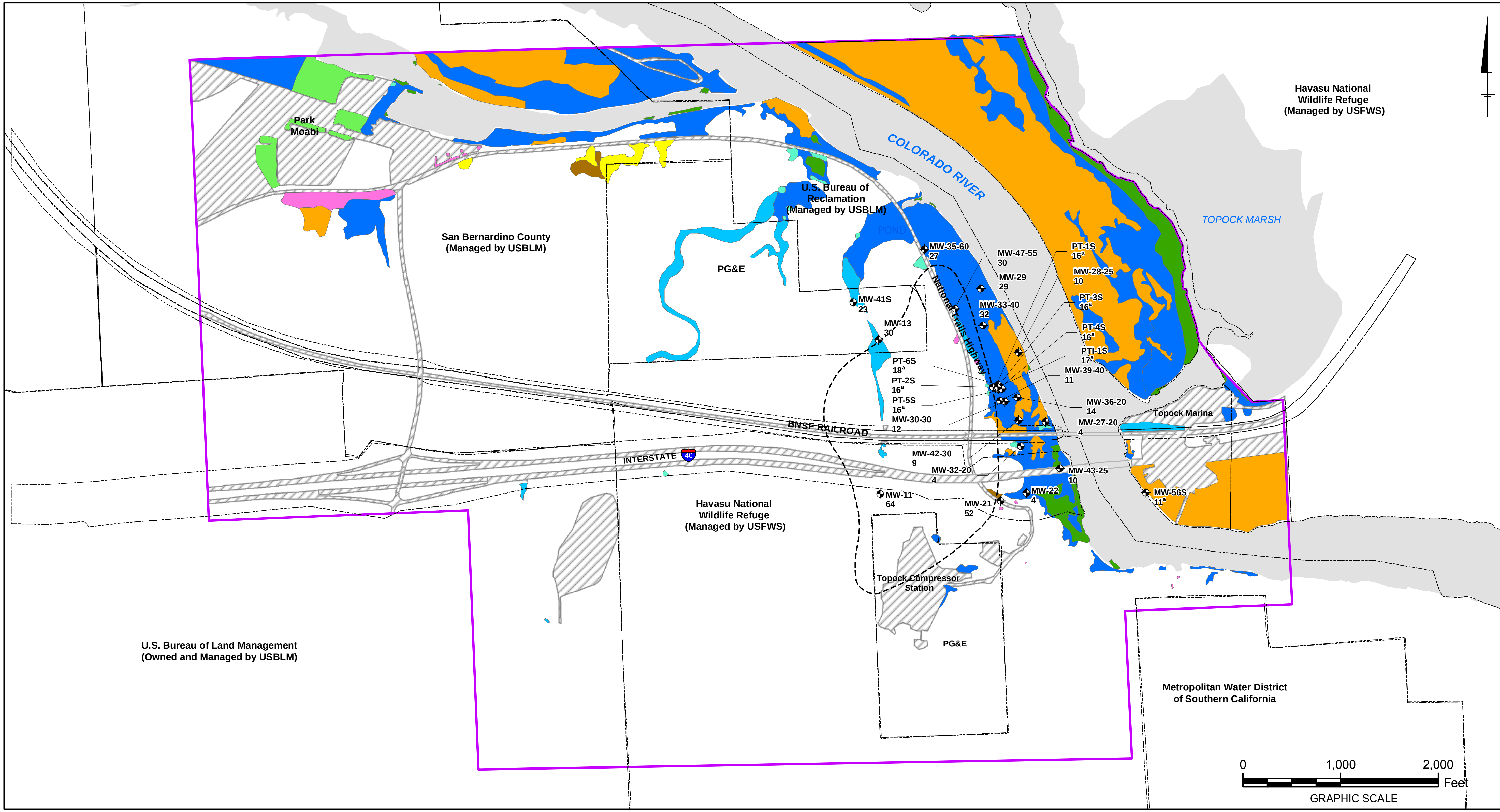
Figures



LEGEND:

- Arroweed
- Landscaped
- Mesquite
- Mesquite/Palo Verde
- Palo Verde
- Salt Bush
- Salt Cedar
- Salt Cedar/Mesquite
- Wetland/Marsh
- Developed Area
- Monitoring Wells
- Approximate 32 µg/L Hexavalent Chromium Contour in the Alluvial Aquiver (October 2007)
- Property Boundaries
- Area of Potential Effects

MW-16 — Well ID
199 — Depth to Groundwater (ft bgs)

NOTES:

1. Figure includes all active wells found in the Shallow Zone of the Alluvial Aquifer in which groundwater was encountered within 80 ft bgs. Well ID list from Table B-1 - Drilling and Well Construction Summary for the RFI/RI Characterization (Appendix B, RFI/RI Vol. 2, CH2HILL, 2008).
2. Approximate depth to groundwater calculated from data presented in Table B-1 - Drilling and Well Construction Summary for RFI/RI Characterization, Appendix B. RFI/RI Volume 2. (CH2MHILL, 2008)
3. Extent of vegetation communities from Figure 6 of the Programmatic Biological Assessment for Pacific Gas and Electric Topock Compressor Station Remedial and Investigative Actions report (CH2MHILL, 2007).

[a] Depth to water data from Appendix B of the May 2007 Monitoring Report for the Floodplain Reductive Zone In-Situ Pilot Test (ARCADIS, 2007).

ft bgs = feet below ground surface

PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

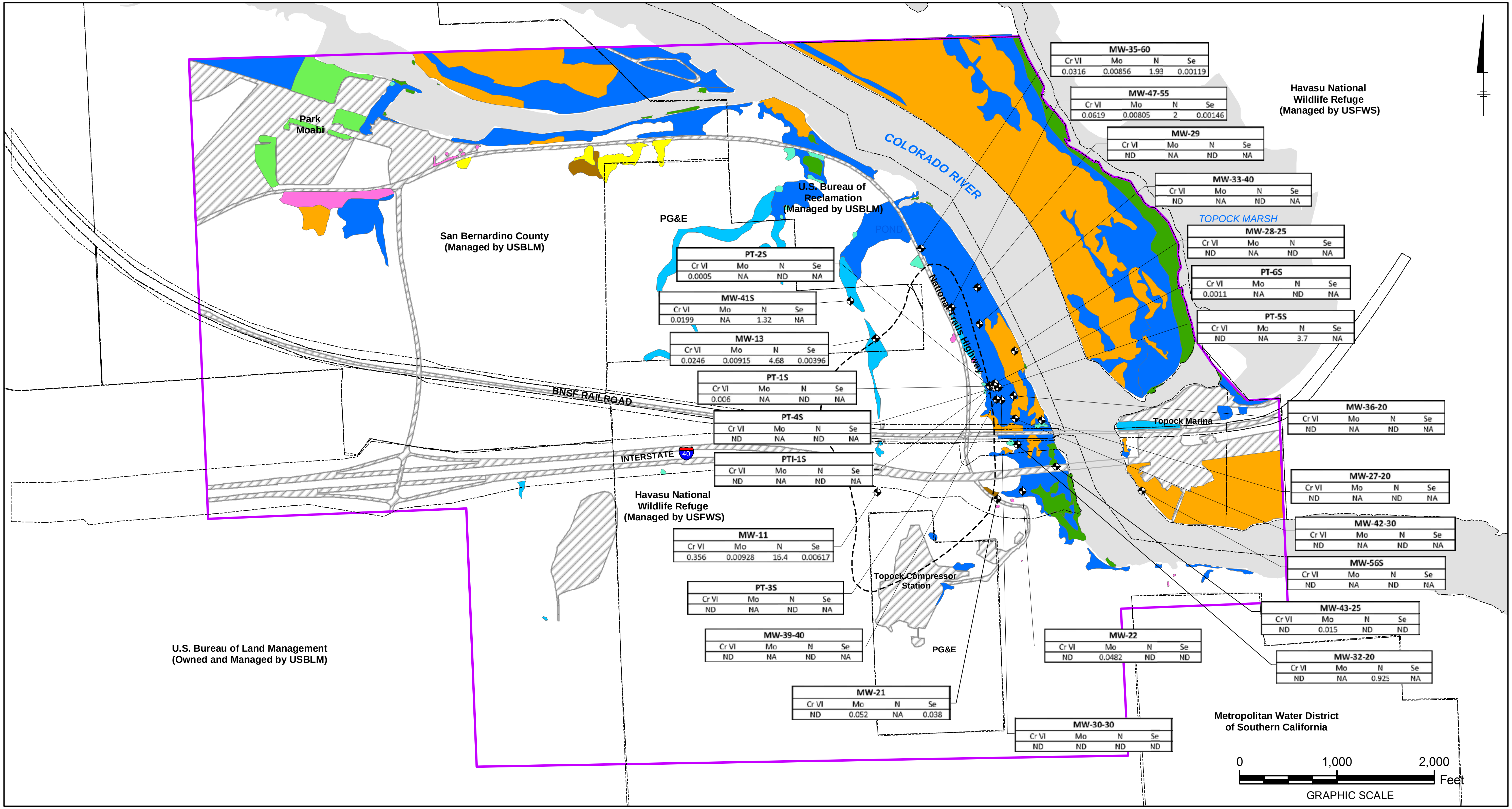
HERA OF GROUNDWATER IMPACTED BY ACTIVITIES AT SWMU 1/AOC 1 AND SWMU 2

DEPTH TO GROUNDWATER IN WATER TABLE WELLS AND VEGETATION OF INTEREST

ARCADIS

FIGURE
I-1

[WC-85 VJR] SANF-85 EGH
Project (RC000689.0002 Task 2)
Q:\PGE\Topock\GW_Risk\MXD\Fig I-1_Plume_Veg_Wells.mxd



[WC-85 VJR] SANF-85 EGH
Project (RC000689.0002 Task 2)
Q:\PGE\Topock\GW_Risk\MXD\Fig I-2_MaxDetectedCOPECs.mxd

LEGEND:

- Arrowweed
- Landscaped
- Mesquite
- Mesquite/Palo Verde
- Palo Verde
- Salt Bush
- Salt Cedar
- Salt Cedar/Mesquite
- Wetland/Marsh
- Developed Area
- Monitoring Wells
- Approximate 32 μg/L Hexvalent Chromium Contour in the Alluvial Aquiver (October 2007)
- Property Boundaries
- Area of Potential Effects

MW-11			
Cr VI	Mo	N	Se
0.356	0.00928	16.4	0.00617

Well ID

Maximum Detected Concentration (mg/L)

NOTES:
1. Figure includes active wells found in the Shallow Zone of the Alluvial Aquifer with an initial screened interval of 80 ft bgs and which occur in or within close proximity to phreatophyte or wetland vegetation.
2. All results presented are in mg/L.
3. Extent of vegetation from Figure 6 of the Programmatic Biological Assessment for Pacific Gas and Electric Topock Compressor Station Remedial and Investigative Actions report (CH2MHILL, 2007).
4. Maximum detected concentrations from groundwater samples collected from January 2006 through July 2008.
5. Nitrate (N) was analyzed with three methods. The maximum of nitrate as nitrogen, nitrite as nitrogen, and converted from NO3 is presented.

ft bgs = feet below ground surface
mg/L = milligrams per liter
NA = Not Analyzed
ND = Non Detect

PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

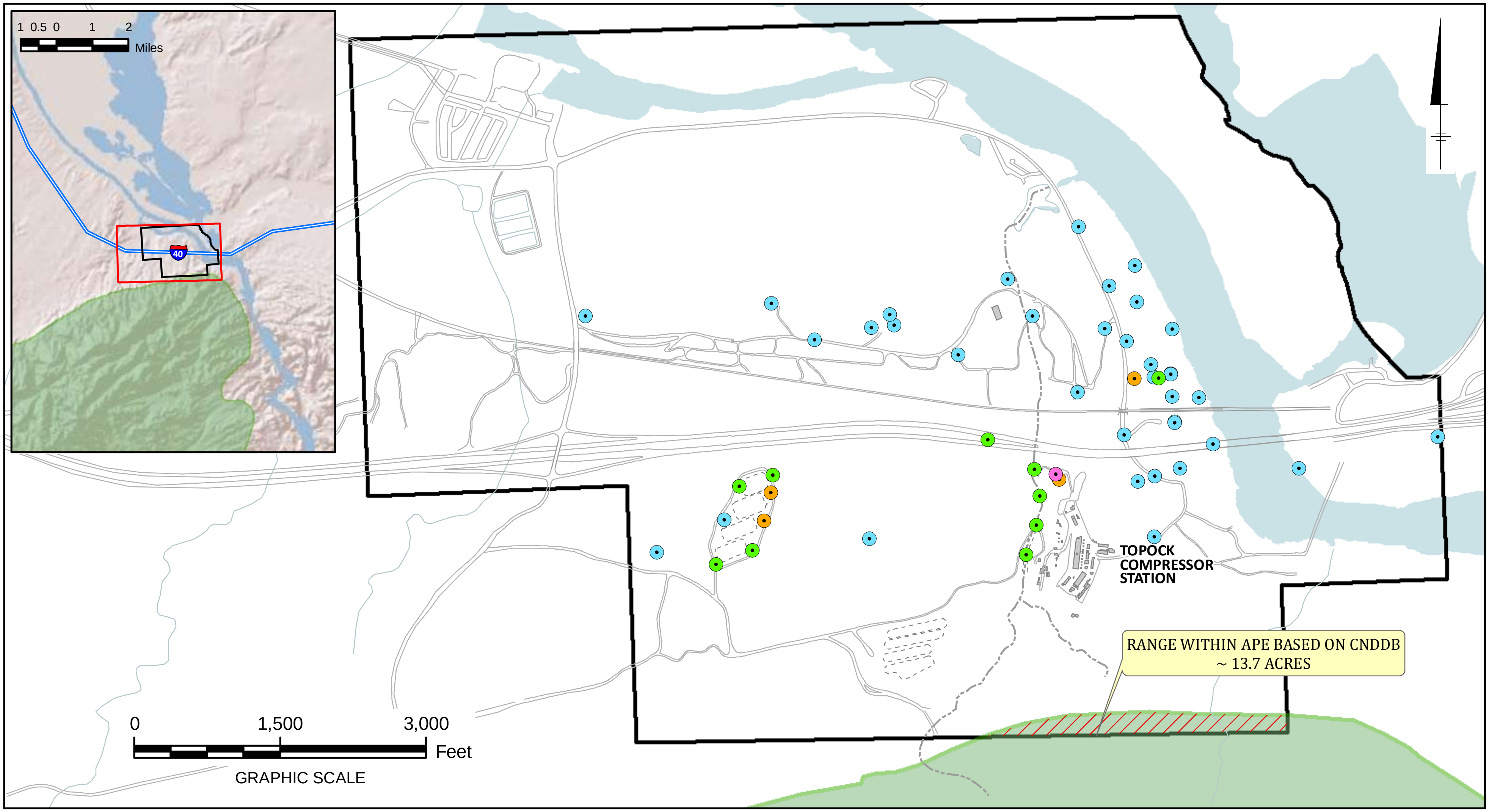
HERA OF GROUNDWATER IMPACTED BY ACTIVITIES AT SWMU 1/AOC 1 AND SWMU 2

MAXIMUM COPC CONCENTRATIONS IN WATER TABLE WELLS AND VEGETATION OF INTEREST

ARCADIS

FIGURE
I-2

CITY: DIV/GROUP: DB: LD: PIC: PM: TM: TR:
Project (Project #)
Q:\PGE\Topock\GW_Risk\MXD\Fig I-3_BighornSheep.mxd - 10/5/2009 @ 10:21:46 AM



LEGEND:

DISSOLVED NITRATE CONCENTRATIONS IN SHALLOW AQUIFER

- <5.03 mg/L (or ND)
- 5.03 - 10 mg/L
- 10.1 - 19.9 mg/L
- >20 mg/L

NELSON'S BIGHORN SHEEP (*O. CANADENSIS NELSONI*) OCCURRENCE

AREA OF POTENTIAL EFFECTS

BUILDINGS

NOTES:
HOME RANGE DATA OBTAINED FROM THE CALIFORNIA NATURAL DIVERSITY DATABASE (CNDDB, CALIFORNIA DEPARTMENT OF FISH & GAME)

PG&E TOPOCK COMPRESSOR STATION
NEEDLES CALIFORNIA

HERA OF GROUNDWATER IMPACTED BY ACTIVITIES AT SWMU 1/AOC 1 AND SWMU 2

NELSON'S BIGHORN SHEEP OCCURRENCE AND NITRATE IN SHALLOW GROUNDWATER

ARCADIS

FIGURE
I-3

ARCADIS

Appendix J

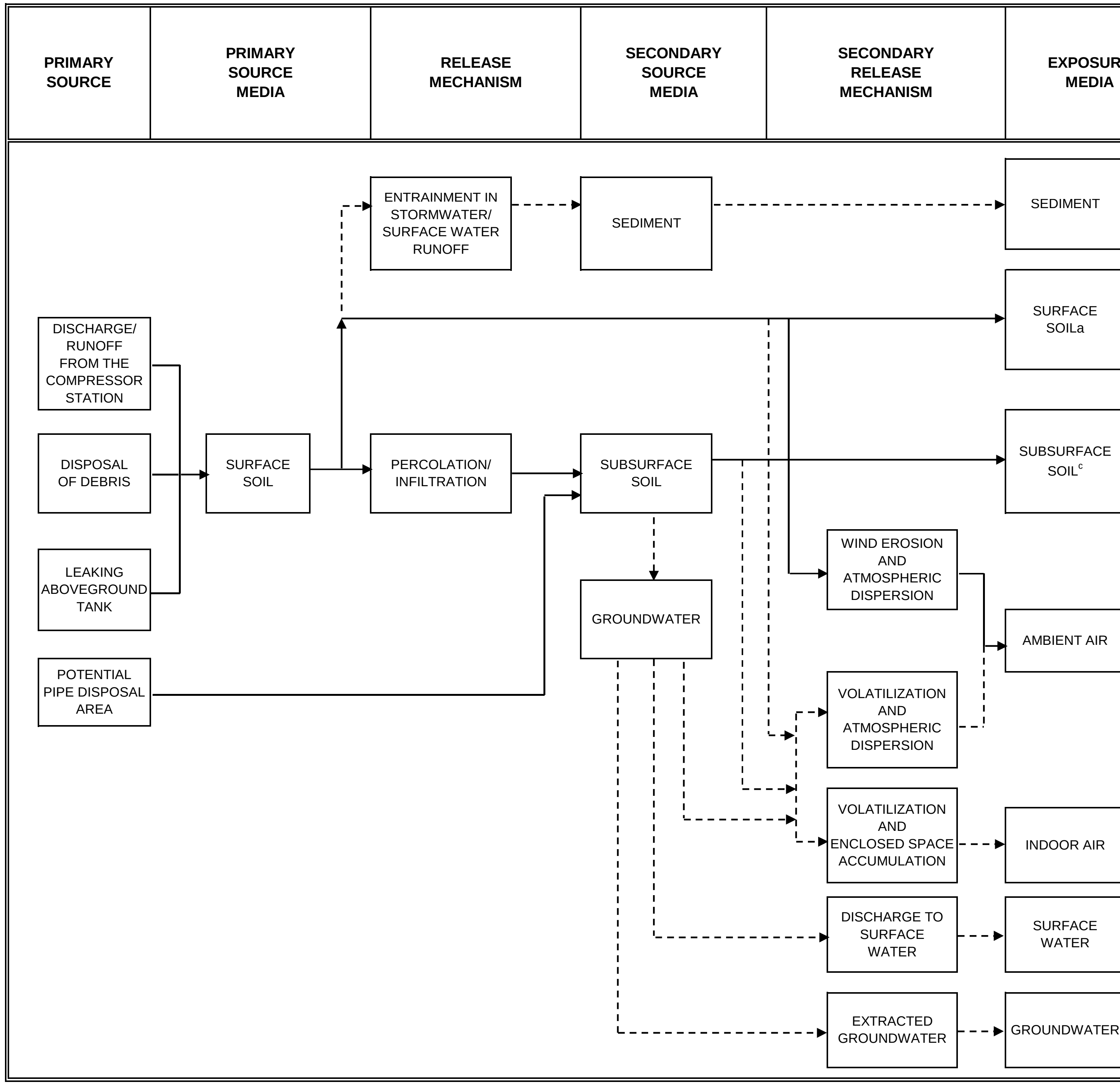
Conceptual Site Models
(Figures 4-2 and 4-3 from RAWP
[ARCADIS, 2008])

FIGURE 4-2

PRELIMINARY HUMAN HEALTH CSM FOR AOCS 4, 9, 10, 11, 12, 14, and POTENTIAL PIPELINE DISPOSAL AREA (OUTSIDE THE COMPRESSOR STATION) [a]

PACIFIC GAS AND ELECTRIC COMPANY

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT WORK PLAN



	AOCs 4, 9, 10, 11, 12, AND 14 AND POTENTIAL PIPE DISPOSAL AREA[a]				
EXPOSURE MEDIA	**EXPOSURE ROUTES**	**RECREATIONAL USER**	**TRIBAL USER**	**MAINTENANCE WORKER**	**HYPOTHETICAL FUTURE GROUNDWATER USER**
SEDIMENT	INGESTION	*	*	*	
	DERMAL CONTACT	*	*	*	
SURFACE SOILa	INGESTION	X	X	X	
	DERMAL CONTACT	X	X	X	
SUBSURFACE SOIL[c]	INGESTION			X	
	DERMAL CONTACT			X	
AMBIENT AIR	INHALATION	X	X	X	
INDOOR AIR	INHALATION				
SURFACE WATER	INGESTION	*	*	*	
	DERMAL CONTACT	*	*	*	
GROUNDWATER	INGESTION				*
	DERMAL CONTACT				*

NOTES:

a The Former 300B Pipeline Liquids Tank Area outside the compressor station has already been closed (CH2MHILL, 2007i), but DTSC has requested additional investigation (CalEPA, 2007d). If complete pathways are identified based on the results, the Former 300B Pipeline Liquids Tank Area will also be included in the HHRA.

b Defined as soils collected at depths between 0 and 3 feet below ground surface (bgs). A subset of this depth interval is near surface soil collected from 0 to 0.5 feet bgs.

c Defined as soils collected at depths between 3 and 10 feet bgs.

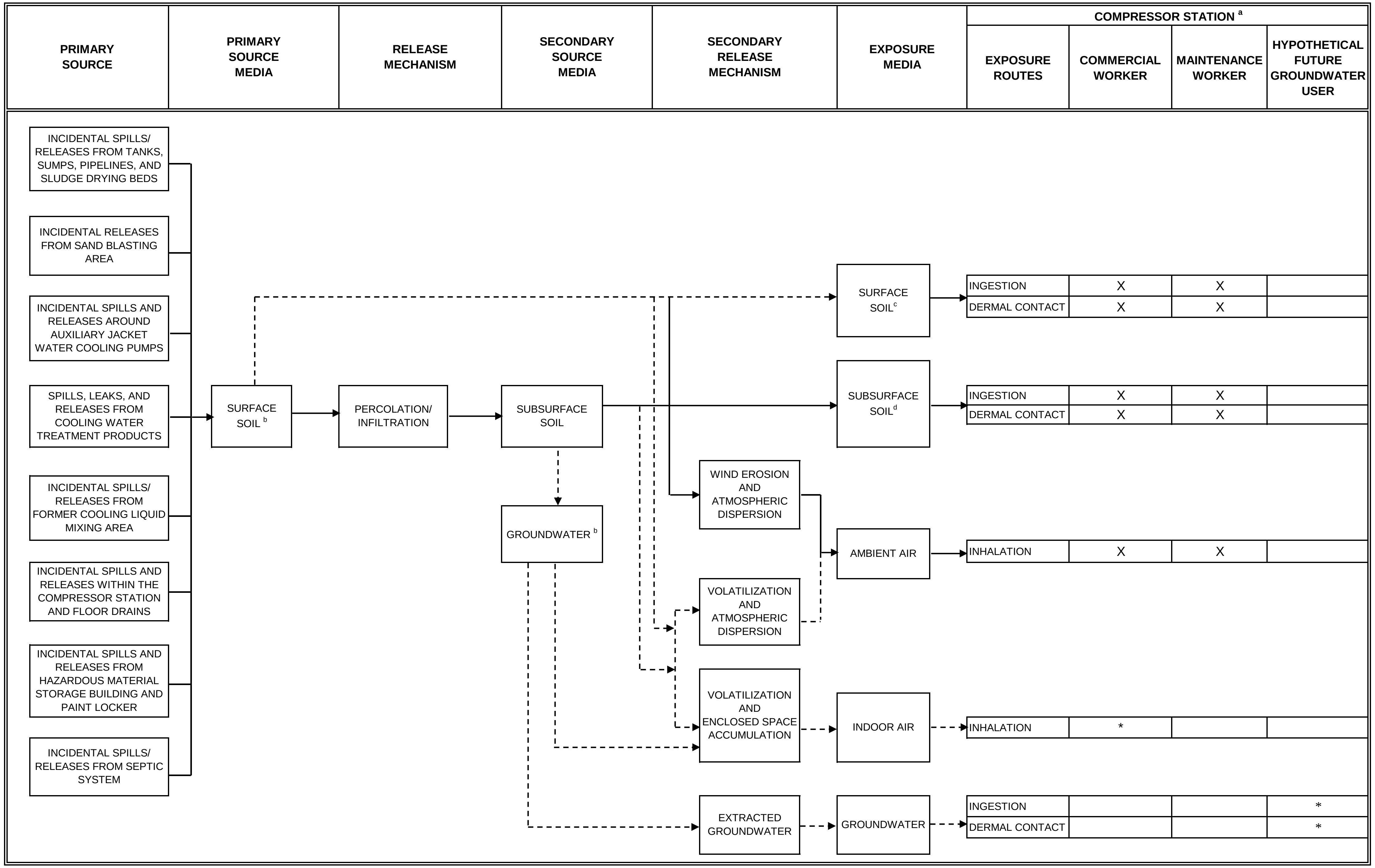
→ Potentially complete transport pathway to be included in the quantitative risk assessment.

- - → Potentially complete transport pathway to be further evaluated in the risk assessment.

X Potentially complete exposure route to be included in the quantitative risk assessment.

* Potentially complete exposure route to be further evaluated in the risk assessment.

FIGURE 4-3
PRELIMINARY HUMAN HEALTH CSM FOR INSIDE THE COMPRESSOR STATION
PACIFIC GAS AND ELECTRIC COMPANY
HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT



NOTES:

a The former sludge drying beds, chromate reduction tank, process pump tank, transfer sump, oil holding water tank, oil water separator, and wastewater transference pipelines inside the compressor station have already been closed (CH2MHILL, 2007i), but DTSC has requested additional investigation (CalEPA, 2007d). If complete pathways are identified based on the results, any of these areas will also be included in the HHRA.

b Potentially complete transport pathway from primary and secondary source media within the compressor station to exposure media outside of the compressor station and potentially complete exposure pathways will be further evaluated in the risk assessment in the context of areas outside of the compressor station (See Figures 4-1 and 4-2).

c Defined as soils collected at depths between 0 and 3 feet below ground surface (bgs).

d Defined as soils collected at depths between 3 and 10 feet bgs. A subset of this depth interval is near surface soil collected from 0 to 0.5 feet bgs.

——▶ Potentially complete transport pathway to be included in the quantitative risk assessment.

- - -▶ Potentially complete transport pathway to be further evaluated in the risk assessment.

X Potentially complete exposure route to be included in the quantitative risk assessment.

* Potentially complete exposure route to be further evaluated in the risk assessment.

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Appendix K

Evaluation of Secondary Exposure Pathways

Imagine the result

Pacific Gas and Electric Company

Appendix K – Evaluation of Secondary Exposure Pathways

HERA of Groundwater Impacted by Activities at
SWMU 1/AOC 1 and SWMU 2
Topock Compressor Station, Needles, California

November 2009

Table of Contents

Acronyms and Abbreviations

AOC	Area of Concern
ATSDR	Agency for Toxic Substances and Disease Registry
CalEPA	California Environmental Protection Agency
COPC	constituent of potential concern
CSM	conceptual site model
HI	hazard index
NCP	National Contingency Plan
OEHHA	Office of Environmental Health Hazard Assessment
RBC	risk-based concentration
SWMU	Solid Waste Management Unit
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
WHO	World Health Organization

1. Introduction

The Human and Ecological Risk Assessment of Groundwater Affected by Activities at Solid Waste Management Unit (SWMU) 1/Area of Concern (AOC) 1 and SWMU 2 is based on the conceptual site model (CSM) presented on Figure 5-1 of the main text. Potential direct exposure pathways to humans include: direct dermal exposure to and ingestion of contaminated groundwater. A concern raised by the U.S. Department of the Interior (USDOI) is the possibility that secondary exposure pathways (e.g., ingestion of plants or animals that are exposed to polluted groundwater) could contribute materially to the overall exposure to humans. As requested by USDOI, presented in this appendix is a preliminary evaluation of the magnitude of human exposure to constituents in groundwater from these potentially complete secondary exposure pathways.

2. Evaluation of Secondary Exposure Pathways

An analysis of the ingestion of plant and animal products as a pathway for exposure to contaminated groundwater was conducted based on the California Environmental Protection Agency (CalEPA) Office of Environmental Health Hazard Assessment (OEHHA) in the *Air Toxics Hot Spots Guidelines* (CalEPA, 2003) to assess the potential relative magnitude of this pathway as compared to direct dermal exposure to and ingestion of contaminated groundwater.

Section 5 of the Hot Spots Guidance provides equations for calculating the exposure of humans to constituents of potential concern (COPCs) through ingestion of plants and animals impacted by COPCs. First, uptake of COPCs by plants and animals is estimated. Second, the ingestion of these plant and animal products is calculated to estimate human exposure to COPCs. Plant COPC concentrations are based on uptake from soil impacted by irrigation. Animal COPC concentrations are based the following:

- Uptake from ingestion of groundwater
- Uptake from ingestion of soil impacted by irrigation water (i.e., groundwater used for irrigation purposes)
- Uptake from ingestion of plants impacted by irrigation water (i.e., groundwater used for irrigation purposes).

Throughout the analysis, the most conservative assumptions are made to quantify the magnitude of the dose resulting from this pathway. The Hot Spots Guidance calculates the concentration of the contaminant in soil from the deposition of the pollutant from some concentration in air. Because this is a groundwater risk assessment, potential deposition of the pollutant occurs through theoretical irrigation and not through aerial deposition.

It is conservatively assumed that 100% of the irrigation water is impacted groundwater. Furthermore, it is assumed that all of the impacted groundwater stays within the root zone where plants could be exposed. These assumptions likely result in a conservative estimate for the concentration of COPCs in soil. Regardless, the calculation of the soil concentration is unlikely to impact the overall conclusions. Human uptake of COPCs from assumed ingestion of plants and animals is dominated by ingestion of animals. Moreover, the predicted COPC concentration in animals resulting from ingestion of groundwater is much larger than that resulting from uptake of soil (either through direct ingestion or via plant uptake), as quantified below. Accordingly, only the potential animal uptake of drinking impacted groundwater is significant in the context of this analysis.

The analysis is conducted for hexavalent chromium, the primary COPC at the site. As noted above, the theoretical dominant contributor to the overall pathway is animal uptake from ingestion of drinking water, in particular, beef cattle. It is conservatively assumed that 100% of the water ingested by the animals is impacted groundwater. Ingestion of groundwater by animals contributes nearly 100% to the dose of the contaminant to animals. The assumed ingestion of animal products contributes nearly 100% to the overall dose to humans from the ingestion of animal and plant products. Calculations for these pathways are presented in Table K-1.

To evaluate the overall significance of the assumed plant and animal ingestion exposure pathway, the contributions of direct dermal exposure and groundwater ingestion (the pathways considered in the risk assessment) are added to the contribution calculated for ingestion of plant and animal products. Using conservative assumptions to calculate the exposure dose to humans from the ingestion of plant and animal products, this theoretical pathway contributes 3.2% and 1.4% to the estimated total hexavalent chromium exposure for adults and children, respectively, as presented in Table K-1. It is expected that conducting this analysis for other COPCs will produce similar results. Therefore, inclusion of these secondary pathways is highly unlikely to affect the overall conclusions of the groundwater risk assessment, across all COPCs.

Moreover, specifically for hexavalent chromium, there is some uncertainly as to the uptake of the hexavalent form. In this analysis, hexavalent chromium is conservatively assumed to remain in its oxidized form throughout the pathway. However, some studies have indicated that chromium accumulation in plants is predominately in roots and only a small fraction is translocated to the above-ground part of edible plants (Cary, 1982; World Health Organization [WHO], 1988). Hexavalent chromium is reduced to trivalent chromium at the surface of plant root cells (Ramachandran et al., 1980; Aldrich et al., 2003), indicating plant uptake/translocation of hexavalent chromium would be minimal. There has been no evidence of chromium biomagnification along the terrestrial food chain (soil-plant-animal) (Agency for Toxic Substances and Disease Registry [ATSDR], 2008). Furthermore, the metabolism of animals has been shown to reduce hexavalent chromium to trivalent chromium (Petrilli and DeFlora, 1978). Therefore, the exposure dose estimated in Table K-1 for ingestion of plants and animals is expected to be overestimated, and the percentage of the overall dose is also expected to be overestimated.

3. Conclusion

Based on the quantification of assumed human exposure to impacted groundwater through ingestion of plants and animals exposed to impacted groundwater, it is highly unlikely that secondary exposure pathways are significant to the overall conclusions of the groundwater health risk assessment. As indicated in this appendix, potential human exposure to contaminated groundwater is dominated by the assumed direct exposure routes that are included in the groundwater risk assessment: direct dermal exposure to and ingestion of contaminated groundwater.

4. References

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Table

Table K-1. Exposure of Humans to COPCs Through Ingestion of Plants and Animals Impacted by COPCs

Parameter	Symbol	Value				Units	Source/notes
Equation 5.3.2 C – Concentration in soil							
Irrigation rate	Irr	5.62E-04				m/d	Estimate / http://www.ces.ncsu.edu/depts/hort/hil/hil-33-e.html
Assumed hexavalent chromium concentration in water	Cw	1				mg/L	The assumed concentration of hexavalent chromium does not affect the percentage contribution of the secondary pathways.
Deposition of affected soil	Dep	5.62E-04				$\mu g/m^2/d$	Dep = Cw [$\mu g/m^3$] * Irr [m/d]
Chemical-specific soil half-life	t1/2	1.00E+08				d	Table 5.3 in CalEPA, 2003
Soil elimination constant	Ks	6.93E-09				1/d	Default CalEPA, 2003
End of evaluation period	Tf	25550				d	Default CalEPA, 2003
Beginning of evaluation period	To	0				d	Default CalEPA, 2003
Total days of evaluation period	Tt	25550				d	Default CalEPA, 2003
Integral function	X	2.26					([exp(-Ks*Tf)-exp(-KsTo)]/Ks)+Tt
Soil mixing depth	SD	0.15				m	Default for agricultural setting (produce and meat pathways) CalEPA, 2003
Soil bulk density	BD	1333				kg/m^3	Default CalEPA, 2003
Average concentration in soil	**Cs**	**3.59E-02**				**µg/kg**	See equations in CalEPA, 2003
Equation 5.3.4.1 A – Concentration in vegetation		Exposed	Leafy	Protected	Root		
Interception fraction	IF	0.1	0.2	0	0		Default CalEPA, 2003
Weathering constant	k	0.1	0.1	0.1	0.1	1/d	Default CalEPA, 2003
Yield	Y	2	2	2	2	kg/m^2	Default CalEPA, 2003
Growth period	T	90	45	NA	NA	d	Default CalEPA, 2003
Concentration due to direct deposition	Cdep,v	2.81E-04	5.56E-04	0.00E+00	0.00E+00	µg/kg	No deposition on root or protected crops per CalEPA, 2003
Uptake factor based on soil concentration	UF2	7.00E-04	8.00E-04	7.00E-04	1.00E-03		Default CalEPA, 2003
Concentration due to root translocation or uptake	Ctrans	2.52E-05	2.87E-05	2.52E-05	3.59E-05	µg/kg	See equations in CalEPA, 2003
Gastrointestinal relative absorption fraction	GRAF	1	1	1	1		Default CalEPA, 2003
Average concentration in and on specific types of vegetation	**Cv**	**3.06E-04**	**5.85E-04**	**2.52E-05**	**3.59E-05**	**µg/kg**	See equations in CalEPA, 2003

Table K-1. Exposure of Humans to COPCs Through Ingestion of Plants and Animals Impacted by COPCs

Parameter	Symbol	Value					Units	Source/notes
Equation 5.3.4.2 E – Concentration in animals and animal products		Beef Cattle	Lactating Dairy Cattle	Pigs	Poultry - Meat	Poultry - Egg		
Inhalation rate for animal	BRa	100	100	7	0.4	0.4	m^3/d	Default CalEPA, 2003
Ground-level concentration	GLC	0	0	0	0	0	$\mu g/m^3$	Assumed, contaminated groundwater present as a result of irrigation only
Inhalation exposure	Inh_dose	0	0	0	0	0	µg/d	See equations in CalEPA, 2003
Water ingestion for animal	WIRa	40	80	8	0.2	0.2	kg/d	Default CalEPA, 2003
Fraction of water ingested from a contaminated body of water	FSW	1	1	1	1	1		Conservatively assumed
Average concentration in water	Cw	1000	1000	1000	1000	1000	µg/kg	See equations in CalEPA, 2003
Water ingestion exposure	Water_ingestion	40000	80000	8000	200	200	µg/d	See equations in CalEPA, 2003
Fraction of diet provided by grazing	FG	0.5	0.5	0.5	0.5	0.5		Default CalEPA, 2003
Feed ingestion rate	FIR	8	16	2	0.1	0.1	kg/d	Default CalEPA, 2003
Fraction of locally grown (source impacted) feed that is not pasture	L	1	1	0.1	0.05	0.05		Default CalEPA, 2003
Concentration in feed	Cf	5.85E-04	5.85E-04	2.38E-04	2.38E-04	2.38E-04	µg/kg	See note under Table 5.2 in CalEPA, 2003
Feed ingestion exposure		2.34E-03	4.68E-03	2.38E-05	5.95E-07	5.95E-07	µg/d	See equations in CalEPA, 2003
Concentration in pasture/grazing material	Cv	5.85E-04	5.85E-04	2.38E-04	2.38E-04	2.38E-04	µg/kg	See equations in CalEPA, 2003
Pasture/grazing ingestion exposure	Grazing_ingest	2.34E-03	4.68E-03	2.38E-04	1.19E-05	1.19E-05	µg/d	See equations in CalEPA, 2003
Soil ingested as a fraction of feed ingested	FSf	0.01	0.01	0	0	0		Default CalEPA, 2003
Soil ingested as a fraction of pasture ingested	FSp	0.05	0.05	0.04	0.02	0.02		Default CalEPA, 2003
Soil ingestion rate	SIa	0.24	0.48	0.04	0.001	0.001	kg/d	Default CalEPA, 2003
Soil ingestion exposure	Soil _ingest	0.008623694	0.017247389	0.00143728	3.5932E-05	3.5932E-05	µg/d	Default CalEPA, 2003
Transfer coefficient of contaminant from diet to animal product	Tco	9.20E-03	1.00E-05	9.20E-03	9.20E-03	9.20E-03	d/kg	Chemical-specific default CalEPA, 2003
Average concentration in farm animals and their products	**Cfa**	**3.68E+02**	**8.00E-01**	**7.36E+01**	**1.84E+00**	**1.84E+00**	**µg/kg**	See equations in CalEPA, 2003
Equation 5.4.3.3a C – Exposure dose through ingestion of plant products		Exposed	Leafy	Protected	Root			
Concentration in plant type	Cf	3.06E-04	5.85E-04	2.52E-05	3.59E-05		µg/kg	See equations in CalEPA, 2003
Consumption of produce	IP	3.56	2.9	1.39	3.16		g/kg BW-day	Default average 70-year exposure numbers used. High end numbers also available, CalEPA, 2003
Gastrointestinal relative absorption fraction	GRAF	1	1	1	1			Default CalEPA, 2003
Fraction of produce homegrown	L	0.15	0.15	0.15	0.15			Default for nonurban sites used, CalEPA, 2003
Exposure frequency	EF	350	350	350	350		d/yr	Default based on CalEPA guidance, see Section 5 of the main text
Exposure duration	ED	30	30	30	30		yr	Default based on CalEPA guidance, see Section 5 of the main text
Averaging time	AT	10950	10950	10950	10950		d	Default based on CalEPA guidance, see Section 5 of the main text
Conversion factor	CF	1.00E-06	1.00E-06	1.00E-06	1.00E-06		µg/kg to mg/g	
Exposure dose through ingestion of plant products	**Dose-p**	**1.57E-10**	**2.44E-10**	**5.03E-12**	**1.63E-11**		**mg/kg/d**	See equations in CalEPA, 2003

Table K-1. Exposure of Humans to COPCs Through Ingestion of Plants and Animals Impacted by COPCs

Parameter	Symbol	Value					Units	Source/notes
Equation 5.4.3.3 – Exposure dose through ingestion of animal products		Beef Cattle	Lactating Dairy Cattle	Pigs	Poultry - Meat	Poultry - Egg		
Concentration in animal product	Cfa	3.68E+02	8.00E-01	7.36E+01	1.84E+00	1.84E+00	µg/kg	See equations in CalEPA, 2003
Consumption of animal product	If	2.25	5.46	1.46	1.39	1.8	g/kg BW-day	Default average 70-year exposure numbers used. High end numbers also available
Gastrointestinal absorption factor	GI	1	1	1	1	1		Default CalEPA, 2003
Fraction of animal product homegrown	L	1	1	1	1	1		Conservatively assumed
Exposure frequency	EF	350	350	350	350	350	d/yr	Default based on CalEPA guidance, see Section 5 of the main text
Exposure duration	ED	30	30	30	30	30	yr	Default based on CalEPA guidance, see Section 5 of the main text
Averaging time	AT	10950	10950	10950	10950	10950	d	Default based on CalEPA guidance, see Section 5 of the main text
Conversion factor	CF	1.00E-06	1.00E-06	1.00E-06	1.00E-06	1.00E-06	µg/kg to mg/g	
Exposure dose through ingestion of animal products	**Dose-ap**	**7.94E-04**	**4.19E-06**	**1.03E-04**	**2.45E-06**	**3.18E-06**	**mg/kg-BW/d**	See equations in CalEPA, 2003
Total dose from ingestion of animal and plant products	**Dose-total**	**9.07E-04**					**mg/kg-BW/d**	Summed
Exposure through dermal contact		Adult	Child					
Concentration in water	Cw	1	1				mg/L	The assumed concentration of hexavalent chromium does not affect the percentage contribution of the secondary pathways.
Surface area	SA	18000	6600				cm^2	Default based on CalEPA guidance, see Section 5 of the main text
Dermal permeability coefficient	PC	0.002	0.002				cm/hr	Default based on CalEPA guidance, see Section 5 of the main text
Exposure time	ET	0.58	1				hr/d	Default based on CalEPA guidance, see Section 5 of the main text
Exposure duration	ED	30	6				yr	Default based on CalEPA guidance, see Section 5 of the main text
Exposure frequency	EF	350	350				d/yr	Default based on CalEPA guidance, see Section 5 of the main text
Conversion factor	CF	0.001	0.001				L/cm^3	
Body weight	BW	70	15				kg	Default based on CalEPA guidance, see Section 5 of the main text
Averaging time	AT	10950	2190				d	Default based on CalEPA guidance, see Section 5 of the main text
Chronic daily intake from dermal exposure to groundwater	**CDIderm**	**2.86E-04**	**8.44E-04**				**mg/kg/d**	Calculated, see Sections 5, 6, and 7 of the main text
Exposure through ingestion		Adult	Child					
Ingestion rate	IR	2	1				L/d	Default based on CalEPA guidance, see Section 5 of the main text
Chronic daily intake from ingestion of groundwater	**CDIing**	**2.74E-02**	**6.39E-02**				**mg/kg/d**	Calculated, see Sections 5, 6, and 7 of the main text
		Adult	Child					
Total chronic daily intake from dermal and ingestion	CDItot	2.77E-02	6.48E-02				**mg/kg/d**	Summed
Total dose from ingestion of animal and plant products		9.07E-04					**mg/kg/d**	From above
Percentage of exposure from ingestion of animal and plant products		**3.2%**	**1.4%**					Calculated

Table K-1. Exposure of Humans to COPCs Through Ingestion of Plants and Animals Impacted by COPCs

Parameter	Symbol	Value	Units	Source/notes

Notes:

(1) The equations used are from the Air Toxics Hot Spots Program Risk Assessment Guidelines (CalEPA, 2003).

(2) Default assumptions are used when available. Conservative or best-judgment assumptions are made in other cases.

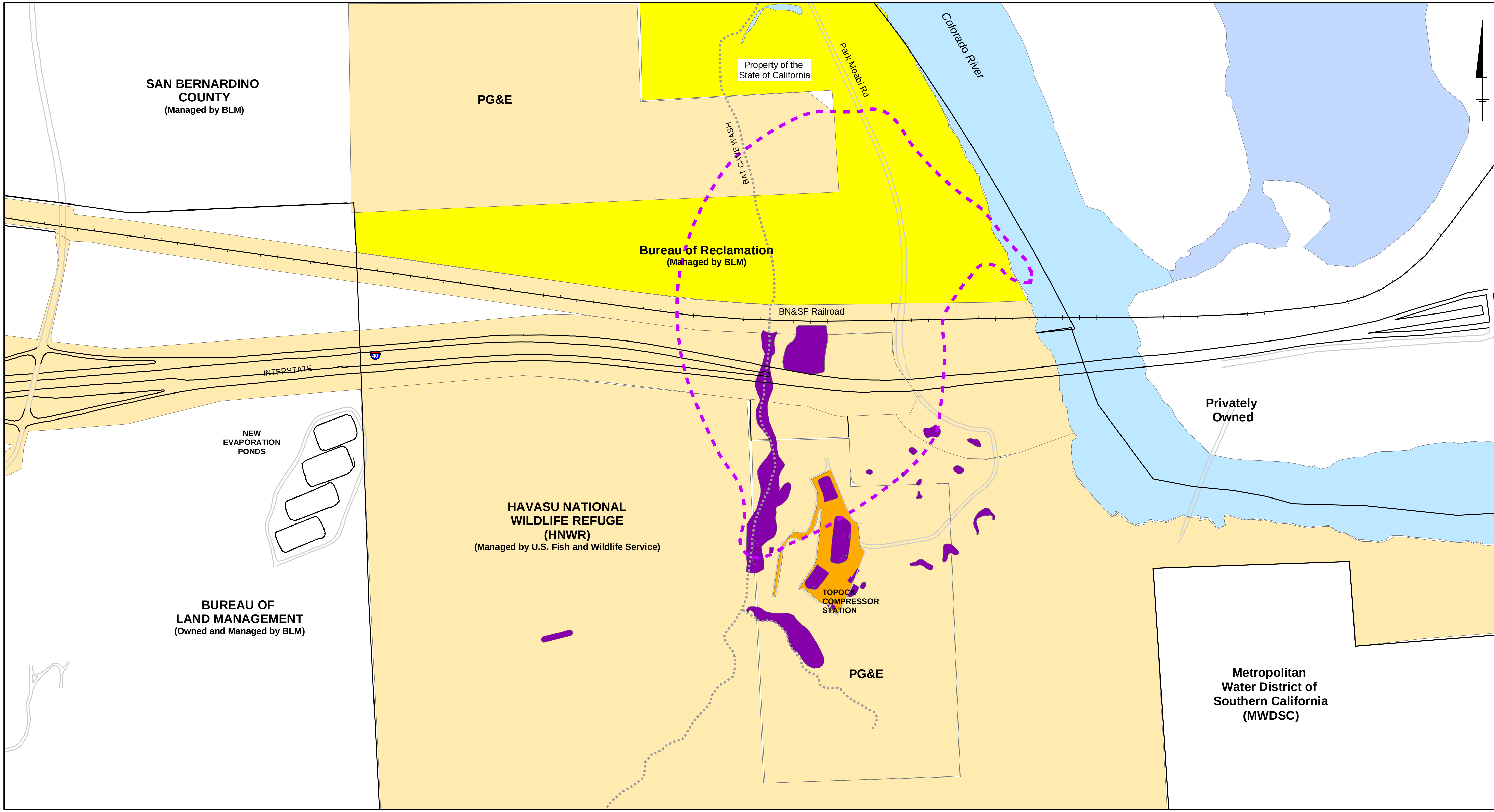
References:

CalEPA. 2003. Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment (OEHHA). August.

cm/hr = centimeter per hour
cm^2 = square centimeter
COPC = constituent of potential concern
d = day
d/kg = day per kilogram
d/yr = days per year
g/kg BW-day = gram per kilogram body weight per day
hr/d = hour per day
kg = kilogram
kg/d = kilogram per day
kg/m^2 = kilogram per square meter
kg/m^3 = kilogram per cubic meter
L/cm^3 = liters per cubic centimeter
L/d = liters per day
m = meter
m/d = meter per day
m^3/d = cubic meter per day
mg/g = milligram per gram
mg/kg BW/d = milligram per kilogram body weight per day
mg/kg/d = milligram per kilogram per day
mg/L = milligram per liter
µg/d = microgram per day
µg/kg = microgram per kilogram
$\mu g/m^2/d$ = microgram per square meter per day
$\mu g/m^3$ = microgram per cubic meter
yr = year

ARCADIS

ATTACHMENT 2



LEGEND:

- PAVED ROAD
- HIGHWAY
- ESTIMATED GROUNDWATER CRVI PLUME
- RAVINE
- RAILROAD
- AOC/SWMU AREA
- COLORADO RIVER
- PROPERTY BOUNDARY
- INDUSTRIAL USE
- RECREATIONAL, TRIBAL, AND PIPELINE MAINTENANCE USES
- RECREATIONAL, TRIBAL, PIPELINE MAINTENANCE, AND UNRESTRICTED USES

NOTES:

1. SOURCE: CH2M HILL (2005-2008)

0 500 1,000 Feet

GRAPHIC SCALE

PACIFIC GAS AND ELECTRIC COMPANY
NEEDLES, CALIFORNIA

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT WORK PLAN

ANTICIPATED FUTURE LAND USE

ARCADIS

FIGURE **2-28**

[WC-85 VJR] SANF-85 EGH
Project (RC000689.0002 Task 2)
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