APPENDIX C – ADJUSTMENT OF REMEDIAL FOOTPRINT
FS AREAS 2 AND 3

FINAL FEASIBILITY STUDY REPORT
CASMALIA RESOURCES SUPERFUND SITE
CASMALIA, CALIFORNIA

PREPARED BY: ARCADIS

TABLE OF CONTENTS

Appendix C-1 Adjustment of Remedial Footprint for FS Area 2
Appendix C-2 Residual Risk Analysis for FS Area 3

APPENDIX C-1

ADJUSTMENT OF REMEDIAL FOOTPRINT FOR FS AREA 2

Casmalia Site Remediation

Memorandum

Adjustment of the Remedial Footprint for the West Canyon Spray Area and the RCRA Canyon

Prepared for:

USEPA, Region 9
75 Hawthorne Street
San Francisco, CA 94105

TABLE OF CONTENTS

1.0 Introduction 1-1
2.0 Summary of Methodology 2-1
2.1 Identification of Locations for Adjustment of Remedial Footprint 2-1
2.2 Estimation of Adjusted Remedial Footprint Area 2-2
2.3 Estimated Residual Risks Based on Adjusted Remedial Footprint 2-2
3.0 Summary and Conclusions 3-1
4.0 References 4-1

LIST OF TABLES

Table #	Description
1	Locations Identified for Adjustment of Remedial Footprint in the WCSA and RCRA Canyon
2	Summary of Residual Exposure Point Concentrations and Residual Risks for the WCSA and RCRA Canyon
3	Residual Risk Estimates for Terrestrial Wildlife at WCSA
4	Residual Risk Estimates for Terrestrial Wildlife at RCRA Canyon

LIST OF FIGURES

Figure #	Description
1	Adjusted Remedial Footprint for WCSA and RCRA Canyon

LIST OF ATTACHMENTS

ATTACHMENT 1 Selected Figures and Tables from the Remedial Investigation and Feasibility Study

LIST OF ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
COI	chemical of interest
CSC	Casmalia Steering Committee
ERA	ecological risk assessment
FS	Feasibility Study
HQ	hazard quotient
LOAEL	lowest-observed adverse effects level
NOAEL	no-observed adverse effects level
RBC	risk-based concentration
RCRA	Resource Conservation Recovery Act
RI	Remedial Investigation
TRV	toxicity reference value
USEPA	U.S. Environmental Protection Agency
WCSA	West Canyon Spray Area

1.0 Introduction

This Memorandum (Memo) was prepared by ARCADIS for the Casmalia Steering Committee (CSC) for the Casmalia Resources Superfund Site (the site), located in Casmalia, California. The purpose of this Memo is to provide a rationale for adjusting the remedial footprint proposed for the West Canyon Spray Area (WCSA) and the Resource Conservation Recovery Act (RCRA) Canyon for use in the Feasibility Study report (FS; CSC, 2011a).

To address United States Environmental Protection Agency's (USEPA) comment (Comment No. 40 in a letter from USEPA dated May 17, 2011) on the FS report (CSC, 2011a) and specifically related to the ecological risks driven by barium, CSC re-evaluated the risks to ecological receptors exposed to soils in the WCSA and the RCRA Canyon at the site. Historical activities indicate that drilling mud containing barium sulfate was spread in these areas. Barium sulfate, which is about four times denser than water, is typically used by oil and gas industries as a weighing agent during drilling. Additionally, high-density barium sulfate is insoluble and therefore, provides stability for the drilling mud (Halliburton et al., 2007).

Barium toxicity to ecological receptors (wildlife) is due to free barium ions which can be absorbed into lungs and intestines. Barium sulfate, being insoluble, does not cause significant toxicity, as free barium ions are not released. However, soluble forms of barium (such as barium hydroxide) dissociate in water and release free barium anions, which can readily be absorbed by lungs and intestines and cause adverse toxic effects (Halliburton et al., 2007).

In 1993, USEPA exempted barium sulfate from the reporting requirements under Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (USEPA, 1993). USEPA stated that:

> "Human and animal data show that barium sulfate is essentially non-toxic to humans or other mammalian species. This is attributable to the very low solubility of the compound in water. Barium sulfate is not expected to be absorbed through the skin and is expected to be only minimally absorbed through the lung and gastrointestinal tract. . . . Barium sulfate cannot reasonably be anticipated to cause acute or chronic toxicity in humans or adverse effects in the environment."

The toxicity values used in the ecological risk assessment (ERA) as part of the Remedial Investigation (RI) for the site (CSC, 2010) were all based on soluble forms of barium. The barium toxicity reference values (TRVs) for mammals and birds were based on toxic effects of barium chloride and barium hydroxide, respectively, both highly soluble. Similarly, for plants and soil invertebrates, soluble forms of barium were used to develop screening levels. Menzie et al. (2008) compare the solubility and toxicity of barium sulfate to the soluble forms of barium used to develop screening levels in the USEPA Ecological Soil Screening Levels (EcoSSL) guidance (USEPA, 2005). Barium sulfate is considered nontoxic to invertebrates, plants, and wildlife (Menzie et al., 2008). Kuperman et al (2006) conducted range-finding tests for barium with four barium compounds to determine which was most suitable to produce a toxicity benchmark. Of the four compounds, only barium sulfate was insoluble and it did not affect adult survival of the three soil invertebrate species tested at concentrations as high as 10,000 milligrams per kilogram (mg/kg).

Based on USEPA's exemption of barium sulfate and the knowledge of historical activities at the WCSA and the RCRA Canyon, the calculated ecological risk from exposure to barium reported in the RI (CSC, 2011b) was overestimated. Considering that barium at the WCSA and the RCRA Canyon is barium sulfate and, therefore, not toxic to ecological receptors, barium can be excluded as a risk-driving constituent or chemical of interest (COI).

The remedial footprint (Figure 1) proposed for the WCSA and the RCRA Canyon in the FS (CSC, 2011a) was based on four COIs: barium, chromium, copper, and zinc. For this Memo, the proposed remedial footprint was adjusted to exclude barium as one of the COIs. Additionally, the residual risks (i.e., risk based on exposure to soil outside of the remedial footprint) were calculated to assess whether remaining COIs in exposed soils would pose adverse effects to ecological receptor populations. The approach and methods used to adjust the remedial footprint at the WCSA and the RCRA Canyon are summarized in the following sections.

2.0 Summary of Methodology

The collocated risk figures (Figures U-67 and U-68) from the ERA (Appendix U) presented in the Final RI report (CSC, 2011b) were used for this evaluation. These figures are provided in Attachment 1 of this Draft Memo. The collocated risk figures present the locations where the hazard quotient (HQ) for each COI is greater than 1 for plants (based on plant screening levels), soil invertebrates (based on soil invertebrate screening levels), ornate shrew (protective of all mammals; based on the lowest-adverse effects level [LOAEL] or high TRVs), and the invertivorous western meadowlark (protective of all birds; based on the LOAEL/high TRVs). These figures also identify locations were soil concentrations are at or below background developed for the site.

2.1 Identification of Locations for Adjustment of Remedial Footprint

A step-wise approach was used to adjust the proposed remedial footprint for the WCSA and the RCRA Canyon based on excluding barium as a COI.

First, sample locations were identified within the proposed remedial footprint (Figure 1) for the WCSA and the RCRA Canyon with HQs greater than 1 based on barium alone. In the WCSA, no such locations were identified. In the RCRA Canyon, locations RISBRC-01, RISSRC-03, and RISBRC-08 indicate only a barium HQ greater than 1 for one or more receptors.

Second, sample locations were identified within the proposed remedial footprint (Figure 1) for the WCSA and the RCRA Canyon with low HQs (i.e., HQ greater than 1 but less than 3) for plants and soil invertebrates for COIs other than barium. In the WCSA, no such locations were identified. In the RCRA Canyon, locations RISBRC-02, RISBRC-03, RISBRC-18, and RISSRC-12 indicate zinc HQs are greater than 1 for plants and/or soil invertebrates. HQs for plants and soil invertebrates based on the maximum detected concentrations of zinc in soil at these locations are presented in Table 1. These HQs were estimated based on the ecological risk-based concentrations (RBCs) presented in Table 8-3 of the FS (CSC, 2011a), also included in Attachment 1. Zinc HQs for plants and soil invertebrates ranged from 0.8 to 2.8 at these locations.

Third, locations were identified within the proposed remedial footprint (Figure 1) for the WCSA and the RCRA Canyon with low HQs (i.e., HQ greater than 1 but less than 3) for mammals and birds for COIs other than barium. In the WCSA, no such locations were identified. In the RCRA Canyon, locations RISBRC-12, RISSRC-15, RISSRC-12, RISSRC-02, and RISSRC-14 indicate copper HQs are greater than 1 for mammals. Also, location RISBRC-03 indicates a copper HQ equal to 1 for birds (see Figure U-68 in Attachment 1). HQs based on the maximum detected concentrations of copper in soil at these locations are presented in Table 1. These HQs were estimated based on the ecological RBCs presented in Table 8-3 of the FS (CSC, 2011a), also included in Attachment 1. Copper HQs for mammals ranged from 1.3 to 1.7 at these locations.

Fourth, locations with soil concentrations at or below background that were included in the proposed remedial footprint (Figure 1) for the WCSA and the RCRA Canyon were evaluated for this adjustment. One such location, RISBRC-13 was identified in the RCRA Canyon.

Finally, location RISSSA-09 was not originally included in the proposed remedial footprint (Figure 1) for the WCSA. HQs for chromium at this location are greater than 1 for most of the ecological receptors except for mammals. HQs for ecological receptors based on the maximum detected concentrations of chromium in soil at this location are presented in Table 1.

Sample locations within the proposed remedial footprint in the WCSA include RISBSA-04, RISBSA-05, RISSSA-02, RISSSA-05, RISSSA-06, and RISSSA-09 through RISSSA-11 (Figure 1). Data associated with these samples were simply excluded from the residual risk dataset for the WCSA (see Section 2.3 below).

Sample locations within the proposed remedial footprint in the RCRA Canyon include RISBRC-05, RISBRC-06, RISBRC-11, RISBRC-14, RISBRC-19 through RISBRC-23, RISSRC-01, and RISSRC-04 through RISSRC-11 (Figure 1). Data associated with these samples were simply excluded from the residual risk dataset for the RCRA Canyon (see Section 2.3 below).

2.2 Estimation of Adjusted Remedial Footprint Area

For the purpose of this Memo, the Thiessen polygons constructed for the ERA (CSC, 2010) were used here to estimate the boundaries of the proposed remedial footprint and the adjusted remedial footprint based on the locations identified in Section 2.1.

The approximate area for the proposed remedial footprint in the WCSA is 5.2 acres. The polygon for location RISSSA-09 is approximately 0.3 acre. Including RISSSA-09 within the proposed remedial footprint will increase the total remedial footprint for the WCSA to approximately 5.5 acres.

The approximate area for the proposed remedial footprint in the RCRA Canyon is 15 acres. The polygons representing the locations identified in Section 2.1 (and Table 1) is approximately 6.6 acres. Excluding the locations/polygons from the proposed remedial footprint will decrease the total remedial footprint for the RCRA Canyon to approximately 8.4 acres.

Please note, the boundaries for the remedial areas in the WCSA and RCRA Canyon will likely be adjusted to follow topographical contours and to address other Remedial Action Objectives of the FS when defining the final areas for remediation. The final boundaries will be presented and discussed in the Revised FS but will not be less than the areas defined by this Memo.

2.3 Estimated Residual Risks Based on Adjusted Remedial Footprint

Residual risks were estimated for ecological receptors potentially exposed to COIs other than barium in soil outside the boundary of the adjusted remedial footprint in the WCSA and the RCRA Canyon. Residual exposure point concentrations (EPCs) and residual risks were estimated following the approach used in the ERA presented in the RI (CSC, 2011b).

First, the locations identified to be within the proposed remedial footprint (Section 2.1) were simply excluded from the soil datasets for surface soil (0 to 2 feet below ground surface [bgs]) and shallow soil (0 to 6 feet bgs) in the WCSA and RCRA Canyon and then non-spatial residual EPCs were calculated based on the soil data outside of the proposed remedial footprint for chromium, copper, and zinc using USEPA's ProUCL Version 4.00.02 (USEPA, 2007).

Residual risks to plants and soil invertebrates were estimated by comparing the residual EPCs to the soil screening levels for plants and soil invertebrates, respectively, and are summarized in Table 2. The same screening values used in the ERA (Table U-15 of the ERA) were also used for these comparisons. Residual HQs for copper and zinc are equal to or less than 1 for plants and soil invertebrates in the WCSA and in the RCRA Canyon (Table 2). Residual HQs for chromium in the WCSA and in the RCRA Canyon are greater than 1; however, the residual EPCs are less than background (Table 2).

Residual risks to mammals and birds were estimated using the residual EPCs, the exposure parameters for terrestrial wildlife (from Table U-11 of the ERA [CSC, 2011b]), bioaccumulation factors (from Tables U-13a through U-13c of the ERA [CSC, 2011b]), and LOAEL TRVs (from Table U-18 of the ERA [CSC, 2011b]). The area use factor was assumed to be 1. Residual LOAEL/high TRV and no-observed adverse effects levels (NOAEL/low TRV) based HQs for the ornate shrew and the invertivorous western meadowlark are summarized in Table 2. Residual LOAEL/high TRV and NOAEL/low TRV based HQs for all the terrestrial receptors including the ornate shrew (invertivorous mammal), California vole (herbivorous mammal), striped skunk (carnivorous mammal), western meadowlark (invertivorous bird and herbivorous bird), and American kestrel (carnivorous bird) are presented in Table 3.

For the ornate shrew, as summarized in Table 2, residual LOAEL/high TRV and NOAEL/low TRV-based HQs for chromium and copper are equal to or less than 1 in the WCSA and the RCRA Canyon. The LOAEL/high TRV-based HQs for zinc are less than 1 in both the areas but the NOAEL/low TRV-based HQs are greater than 1. However, the residual EPCs for zinc are less than background.

For the invertivorous western meadowlark, as summarized in Table 2, residual LOAEL/high TRV and NOAEL/low TRV-based HQs for chromium are less than 1 in the WCSA and the RCRA Canyon. The LOAEL/high TRV-based HQs for chromium and zinc are less than 1 in both the areas but the NOAEL/low TRV-based HQs are greater than 1. However, the residual EPCs for chromium and zinc are less than background.

3.0 Summary and Conclusions

The remedial footprint for proposed for the WCSA and the RCRA Canyon was re-evaluated to address USEPA's comment (Comment No. 40 in a letter from USEPA dated May 17, 2011) on the FS report (CSC, 2011a). Based on the toxicity information available for barium sulfate, the form of barium likely to be present in these areas, barium was not considered toxic to ecological receptors and, therefore, was excluded as a COI in soil in the WCSA and the RCRA Canyon. Locations were identified where barium alone was a COI and other COIs at concentrations slightly above the ecological RBCs, and the proposed remedial footprint in the WCSA and the RCRA Canyon were adjusted accordingly. Additionally, residual risks were estimated for ecological receptors that could potentially be exposed to soils outside the boundary of the adjusted remedial areas in the WCSA and the RCRA Canyon to assess if risks would be acceptable.

The WCSA adjusted remedial footprint was increased from the proposed 5.2 acres by approximately 0.3 acre, making it a total of approximately 5.5 acres. The RCRA Canyon adjusted remedial footprint was reduced from the proposed 15 acres by approximately 6.6 acres, making it a total of approximately 8.4 acres.

The residual HQs calculated for the WCSA and the RCRA Canyon indicate that post-remedial risks to plant, soil invertebrate, mammal, and bird populations will be acceptable.

In conclusion, excluding barium from the list of COIs and adjusting the proposed remedial footprint is expected to result in acceptable post-remedial risks to ecological receptor populations at the WCSA and the RCRA Canyon.

4.0 References

CSC. 2011a. Draft Feasibility Study. Casmalia Resources Superfund Site. Casmalia Steering Committee. February.

CSC. 2011b. Final Draft Remedial Investigation Report. Casmalia Resources Superfund Site. Casmalia Steering Committee. April.

Halliburton, J.M., McHugh, T.E., and Higgins, E.A. 2007. Barium Sulfate: A Protocol for Determining Higher Site-Specific Barium Cleanup Levels. Society of Petroleum Engineers. March.

Kuperman, R.G., Checkai, R.T., Simini, M., Phillips, C.T., Speicher, J.A., Barclift, D.J. 2006. Toxicity benchmarks for antimony, barium, and beryllium determined using reproduction endpoints for Folsomia candida, Eisenia fetida and Enchytraeus crypticus. Environmental Toxicology and Chemistry 25:754-762.

Menzie, C.A., Southworth, B., Stephenson, G. and Feisthauer, N. 2008. The importance of understanding the chemical form of a metal in the environment: The case of barium sulfate (barite). Human and Ecological Risk Assessment 14:974-991.

USEPA. 1993. Barium Sulfate; Toxic Chemical Release Reporting Community Right-to-Know. 40 CFR Part 372, Federal Register. 58, No. 111, 32622-32628. United States Environmental Protection Agency. June 10.

USEPA. 2005. Ecological Soil Screening Levels for Barium. United States Environmental Protection Agency. Office of Soild Waste and Emergency Response. February.

USEPA. 2007. ProUCL Version 4.00 Technical Guide. United States Environmental Protection Agency. EPA/600/R-07/041. April

USEPA. 2011. Comments on the Draft Feasibility Study, Casmalia Resources Superfund Site. United States Environmental Protection Agency. Letter dated May 11, 2011.

TABLES

Table 1
Locations Identified for Adjustment of the Remedial Footprint in the WCSA and RCRA Canyon

Area	Location[a]	Include/Exlude from Proposed Remedial Footprint	COI	Backgound UTL for COIs other than Barium[b] (mg/kg)	Maximum Detected Concentration for COIs other than Barium[b] (mg/kg)	Receptors with HQ > 1 for COIs other than Barium[b]	Hazard Quotients Based on Ecological RBCs			
							Plant	Soil Invertebrate	Mammal	Bird
WCSA	RISSSA-09	Include	Cr	47	330	Plant + Birds	**330**	**825**	Not a RD	**4.5**
RCRA Canyon	RISBRC-01	Exclude	Ba	--	--	--	--	--	--	--
RCRA Canyon	RISBRC-08	Exclude	Ba	--	--	--	--	--	--	--
RCRA Canyon	RISSRC-03	Exclude	Ba	--	--	--	--	--	--	--
RCRA Canyon	RISBRC-02	Exclude	Ba + Zn	104	110	Plants + Inverts	**2.2**	**1.1**	0.3	0.6
			Ba + Zn	104	140	Plants + Inverts	**2.8**	**1.4**	0.4	0.7
RCRA Canyon	RISBRC-03	Exclude	Ba + Cu	19	26	Birds + Mammals	0.4	0.3	**1.7**	1.0
RCRA Canyon	RISBRC-12	Exclude	Ba + Cu	19	20	Mammal	0.3	0.3	**1.3**	0.8
RCRA Canyon	RISBRC-18	Exclude	Ba + Zn	104	120	Plants + Inverts	**2.4**	**1.2**	0.3	0.6
RCRA Canyon	RISSRC-02	Exclude	Ba + Cu	19	20	Mammal	0.3	0.3	**1.3**	0.8
			Ba + Zn	104	77	Plants	**1.5**	0.8	0.2	0.4
RCRA Canyon	RISSRC-12	Exclude	Ba + Cu	19	21	Mammal	0.3	0.3	**1.4**	0.8
RCRA Canyon	RISSRC-14	Exclude	Ba + Cu	19	21	Mammal	0.3	0.3	**1.4**	0.8
RCRA Canyon	RISSRC-15	Exclude	Ba + Cu	19	21	Mammal	0.3	0.3	**1.4**	0.8
RCRA Canyon	RISBRC-13	Exclude	none (bkg)		--	--	--	--	--	--

Notes:

[a] Location identified for inclusion/exclusion from the Remedial Footprint proposed in the Feasibility Study report (CSC, 2011).

[b] Barium excluded as a risk driver/COI. See Draft Memorandum for details.

[c] Hazard quotients > 1 are in bold and shaded in grey.

Ecological RBCs (mg/kg) from Feasibility Study report (Table 8-3 [CSC, 2011]).

COI	Surface RBC (based on birds)	Subsurface (based on small mammals)	Plant Screening Level	Invertebrate Screening Level
Zinc	192	353	50	100
Copper	25.5	14.9	70	80
Chromium	73.9	Not a RD	1	0.4

Abbreviations:
COI = chemical of interest (Ba = barium, Cu = copper, Cr = chromium, Zn = zinc)
mg/kg = milligrams per kilogram
Not a RD = not a risk driver
RBC = risk-based concentration
WCSA = West Canyon Spray Area

References:
CSC. 2011. Feasibility Study, Casmalia Resources Superfund Site. Casmalia Steering Committee. February.

Table 2

Summary of Residual Exposure Point Concentrations and Residual Risks at the WCSA and RCRA Canyon

			Exposure Concentrations		Ecological Receptors					
							Ornate Shrew		Western Meadolark (Invertivore)	
Exposure Area	COI	Background UTL (mg/kg)	Surface EPC (mg/kg)	Subsurface EPC (mg/kg)	Plant HQ	Soil Invertebrate HQ	Low (LOAEL) HQ	High (NOAEL) HQ	Low (LOAEL) HQ	High (NOAEL) HQ
WCSA	Chromium	47	40.0	36.2	**36**	**100**	0.2	0.7	0.6	0.6
WCSA	Copper	19	16.9	15.2	0.2	0.2	0.7	**1.1**	0.7	**2.0**
WCSA	Zinc	104	52.7	53.8	**1.1**	0.5	0.1	**3.9**	0.3	**2.8**
RCRA Canyon	Chromium	47	35.0	34.4	**34**	**88**	0.2	0.6	0.5	0.5
RCRA Canyon	Copper	19	17.6	15.5	0.2	0.2	0.7	**1.2**	0.7	**2.1**
RCRA Canyon	Zinc	104	84.9	69.8	**1.4**	0.8	0.1	**6.3**	0.4	**4.4**

Notes:
COI = Chemical of Interest
EPC = Exposure Point Concentration
LOAEL = Lowest observed adverse effect level
NOAEL = No observed adverse effect level
HQ = Hazard Quotient (unitless); HQ≥1 based on exposure area EPCs less than background concentrations are in bold and shaded grey.
UTL = upper tolerance limit
mg/kg = milligrams per kilogram

Table 3
Residual Risk Estimates (Hazard Quotients) for Terrestrial Wildlife at WCSA

	WCSA Residual Risk											
	Terrestrial Invertivorous Mammal		Terrestrial Herbivorous Mammal		Terrestrial Carnivorous Mammal		Terrestrial Invertivorous Bird		Terrestrial Herbivorous Bird		Terrestrial Carnivorous Bird	
	Ornate Shrew		California Vole		Striped Skunk		Western Meadowlark		Western Meadowlark		American Kestrel	
COI	Low HQ	High HQ	Low HQ	High HQ	Low HQ	High HQ	Low HQ	High HQ	Low HQ	High HQ	Low HQ	High HQ
Chromium	0.2	0.7	0.0	0.1	0.02	0.06	0.6	0.6	0.5	0.5	0.1	0.1
Copper	0.7	**1.1**	0.1	0.2	0.1	0.1	0.7	**2.0**	0.2	0.7	0.3	0.9
Zinc	0.1	**3.9**	0.0	0.5	0.01	0.5	0.3	**2.8**	0.1	0.8	0.1	**1.5**

COI = Chemical of Interest

HQ = Hazard Quotient (unitless) = Sum of Intakes (mg/kg-d) / Toxicity Reference Value (mg/kg-d)

Low HQ = Hazard Quotient based on LOAEL-based toxicity reference value.

High HQ = Hazard Quotient based on NOAEL-based toxicity reference value.

WCSA = West Canyon Spray Area

HQ > 1

Table 4
Residual Risk Estimates (Hazard Quotients) for Terrestrial Wildlife at RCRA Canyon

	RCRA Canyon Residual Risk											
	Terrestrial Invertivorous Mammal		Terrestrial Herbivorous Mammal		Terrestrial Carnivorous Mammal		Terrestrial Invertivorous Bird		Terrestrial Herbivorous Bird		Terrestrial Carnivorous Bird	
	Ornate Shrew		California Vole		Striped Skunk		Western Meadowlark		Western Meadowlark		American Kestrel	
COI	Low HQ	High HQ	Low HQ	High HQ	Low HQ	High HQ	Low HQ	High HQ	Low HQ	High HQ	Low HQ	High HQ
Chromium	0.2	0.6	0.0	0.1	0.0	0.1	0.5	0.5	0.4	0.5	0.1	0.1
Copper	0.7	**1.2**	0.1	0.2	0.1	0.1	0.7	**2.1**	0.3	0.8	0.3	0.9
Zinc	0.1	**6.3**	0.0	0.7	0.0	0.8	0.4	**4.4**	0.1	**1.3**	0.2	**2.4**

COI = Chemical of Interest

HQ = Hazard Quotient (unitless) = Sum of Intakes (mg/kg-d) / Toxicity Reference Value (mg/kg-d)

Low HQ = Hazard Quotient based on LOAEL-based toxicity reference value.

High HQ = Hazard Quotient based on NOAEL-based toxicity reference value.

HQ > 1

FIGURE

LAKEWOOD DB: MLM TM: MP
Project (B00 01224.00001)
Q:\Casmalia\GIS\ArcMap_MXD\Remedial_Footprint_070611.mxd

LEGEND

- Landfills
- Ponds
- Other Features
- Presumptive Remedy Areas
- Property Boundary
- Previous Remedial Footprint
- Adjusted Remedial Footprint
- Thiessen Polygons of Sample Locations

GRAPHIC SCALE
0 175 350 Feet

NOTES

BASE IMAGERY FROM STATE OF CALIFORNIA, UNIVERSAL TRANSVERSE MERCATOR PROJECTION (UTM) ON THE NORTH AMERICAN DATUM OF 1983. SOURCE IMAGE DATE IS 1994.

CASMALIA RESOURCES SUPERFUND SITE

ADJUSTED REMEDIAL FOOTPRINT FOR WSCA AND RCRA CANYON

ARCADIS

FIGURE 1

ATTACHMENT 1

SELECTED FIGURES AND TABLES FROM THE REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

Q:\Casmalia\GIS\ArcMap_MXD\CO-LOCATES_U67_11X17.mxd

RISKS TO SOIL INVERTEBRATES

RISKS TO TERRESTRIAL PLANTS

LEGEND

- Landfills
- Ponds
- Other Features
- Presumptive Remedy Areas
- Property Boundary
- Roadway Samples Outside Presumptive Remedy Area
- Roadway Samples Inside Presumptive Remedy Area

RISKS ASSOCIATED WITH SOIL INVERTEBRATES OR TERRESTRIAL PLANTS

- ▲, ● OR ⬟ SOIL CONCENTRATION <= UTL OR $HQ_{LOWEST\text{-}EFFECT\ LEVEL}$ < 1
- COPPER $HQ_{LOWEST\text{-}EFFECT\ LEVEL}$ >= 1
- CHROMIUM $HQ_{LOWEST\text{-}EFFECT\ LEVEL}$ >= 1
- ZINC $HQ_{LOWEST\text{-}EFFECT\ LEVEL}$ >= 1
- BARIUM $HQ_{LOWEST\text{-}EFFECT\ LEVEL}$ >= 1

GRAPHIC SCALE

0 325 650 Feet

NOTES

BASE IMAGERY FROM STATE OF CALIFORNIA, UNIVERSAL TRANSVERSE MERCATOR PROJECTION (UTM) ON THE NORTH AMERICAN DATUM OF 1983. SOURCE IMAGE DATE IS 1994.

CASMALIA RESOURCES SUPERFUND SITE

FINAL REMEDIAL INVESTIGATION REPORT

CO-LOCATED RISKS TO ECOLOGICAL COMMUNITIES

ARCADIS

FIGURE U-67

Q:\Casmalia\GIS\ArcMap_MXD\CO-LOCATES_U68_11X17.mxd

RISKS TO ORNATE SHREW

RISKS TO WESTERN MEADOWLARK (INVERTIVORE)

LEGEND

- Landfills
- Ponds
- Other Features
- Presumptive Remedy Areas
- Property Boundary
- ○ Roadway Samples Outside Presumptive Remedy Area
- △ Roadway Samples Inside Presumptive Remedy Area

RISKS ASSOCIATED WITH ORNATE SHREW OR WESTERN MEADOWLARK (INVERTIVORE)

- ▲, ● OR ⬟ SOIL CONCENTRATION <= UTL OR $HQ_{LOWEST\text{-}EFFECT\ LEVEL}$ < 1
- COPPER $HQ_{LOWEST\text{-}EFFECT\ LEVEL}$ >= 1
- CHROMIUM $HQ_{LOWEST\text{-}EFFECT\ LEVEL}$ >= 1
- ZINC $HQ_{LOWEST\text{-}EFFECT\ LEVEL}$ >= 1
- BARIUM $HQ_{LOWEST\text{-}EFFECT\ LEVEL}$ >= 1

GRAPHIC SCALE
0 325 650
Feet

NOTES

BASE IMAGERY FROM STATE OF CALIFORNIA, UNIVERSAL TRANSVERSE MERCATOR PROJECTION (UTM) ON THE NORTH AMERICAN DATUM OF 1983. SOURCE IMAGE DATE IS 1994.

CASMALIA RESOURCES SUPERFUND SITE

FINAL REMEDIAL INVESTIGATION REPORT

CO-LOCATED RISKS TO WILDLIFE RECEPTORS

ARCADIS

FIGURE
U-68

Table 8-6
Risk-Driving Chemicals and Risk-Based Concentrations in Soil
Casmalia Resources Superfund Site Feasibility Study

Risk-Driving Chemicals	Eco-RBC mg/kg		HH RBC mg/kg
	Surface Soil	Subsurface Soil	
Inorganics			
Barium	900	2448	1.90E+05
Chromium	73.9	NA	6.80E+04
Copper	25.5	14.9	3.80E+04
Zinc	191.5	353	2.90E+05
Organics			
DDT, total	0.0259	0.0275	63
Dioxin, Tot. Mam TEQ	6.00E-06	6.00E-06	1.80E-04
PCB, sum congener	0.12	0.11	NA
MCPP	347	246	770
TCE	0.01	NA	50
PCE	194	194	110

Notes:

1. Derivation of the RBC values are described in Sections 7 and 8 and Appendices T and U of the RI document.

APPENDIX C-2

RESIDUAL RISK ANALYSIS FOR FS AREA 3

Table C-2
Residual Risk Analysis - Former Ponds and Pads Casmalia Feasibility Study

Scenario	Scenario Summary	CPEC	Surface EPC	Soil Invertebrates	
				Hazard Quotient	Surface RBSL[1]
1	Location 3 remediated	Barium	318	0.96	330
2	Location 4 remediated	Barium	611	**1.85**	330
3	Location 5 remediated	Barium	228	0.69	330
4	Locations 3 and 4 remediated	Barium	224	0.68	330
5	Locations 3, 4, and 5 remediated	Barium	163	0.49	330

Notes:

[1] Equivalent to soil invertebrate toxicity value from Tier 1 Ecological Risk Assessment

CPEC = Constituent of Potential Ecological Concern EPC = Exposure point concentration RBSL = Risk-based screening level