Texas Custodial Trust

2301 West Paisano Drive • El Paso, Texas 79922

Conceptual Site Model, Pathway Evaluation, and Protective Concentration Level Report

Former ASARCO Smelter Site

El Paso, Texas

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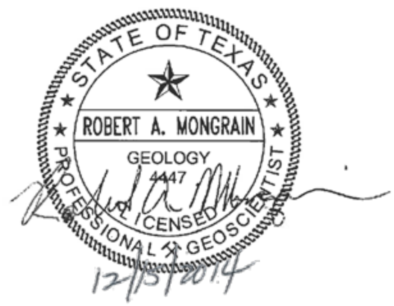

ACRONYMS AND ABBREVIATIONS

AA	Assessment Area
amsl	above mean sea level
AOC	Area of Contamination
AOI	analyte of interest
APAR	Affected Property Assessment Report
ASARCO	ASARCO, LLC
bgs	below ground surface
BMP	best management practice
BRA	baseline risk assessment
C/I	commercial/industrial
cfs	cubic feet per second
COC	constituents of concern
CSM	Conceptual Site Model
DPE	dual-phase extraction
°F	degrees Fahrenheit
I-10	U.S. Interstate 10
IA	Investigation Area
IBWC	International Boundary and Water Commission
K	potassium
LC AA	La Calavera Assessment Area
LPST	leaking petroleum storage tank
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
Na	sodium

NAPL	non-aqueous phase liquid
ORP	oxidation-reduction potential
PBA	Parker Brothers Arroyo
PCB	polychlorinated biphenyl
PCL	protective concentration level
PCLE	protective concentration level exceedence
PEF	particulate emission factor
PMZ	plume management zone
PRB	permeable reactive barrier
RAP	Response Action Plan
Report	Conceptual Site Model, Pathway Evaluation, and Protective Concentration Level Report
RI	remedial investigation
RRR	Risk Reduction Rules (30 TAC 335)
SAI-Ind	soil/air ingestion standard for industrial use
SAI-Res	soil/air ingestion standard for residential use
Site	former ASARCO, LLC Smelter Site located in El Paso, Texas
SLERA	Screening Level Ecological Risk Assessment
SO_4	sulfate
SWCRS	Stormwater Collection and Reuse System
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TDS	total dissolved solids
TI	Technical Impracticability
TNRCC	Texas Natural Resource Conservation Commission
TOC	total organic carbon
TPDES	Texas Pollutant Discharge Elimination System

TRRP	Texas Risk Reduction Program (30 TAC 350)
Trust	Texas Custodial Trust
TSCA	Toxic Substances Control Act
TSS	total suspended solids
TSWQS	Texas Surface Water Quality Standards
UCL	upper confidence limit
UPL	upper predicted limit
UPRR	Union Pacific Rail Road
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WCU	waste control unit

Executive Summary

This Conceptual Site Model (CSM), Pathway Evaluation, and Protective Concentration Level (PCL) Report (Report) has been prepared by Malcolm Pirnie for the Texas Custodial Trust (Trust) to fulfill the requirements of the Affected Property Assessment Report (APAR) under the Texas Risk Reduction Program (TRRP) that were not previously addressed in the remedial investigation (RI) under the Texas Risk Reduction Rules (RRR) for the former ASARCO LLC (ASARCO) Smelter Site located in El Paso, Texas (the Site). A checklist based on the table of contents of the APAR form is included in **Appendix A** documenting the compliance with the requirements of an Affected Property Assessment under TRRP. Substantial investigation and remediation activities have been conducted at the Site since the 1990s under Risk Reduction Standard 3 (30 Texas Administrative Code [TAC] §335, Subchapter S) as a result of the 1996 Agreed Order with the Texas Commission on Environmental Quality (TCEQ) (previously the Texas Natural Resource Conservation Commission [TNRCC]). A Corrective Action Directive was issued by the TCEQ in 2005 for the remediation of the active smelter site in accordance with requirements of the Texas RRR. The stakeholders determined that the TRRP (30 TAC §350) would provide a more appropriate regulatory program for the closure and redevelopment of the Site. The four phases of the original RI and the Revised Supplemental RI, however, were conducted under the RRR and did not include all of the elements required for a complete APAR under the TRRP. This Report, therefore, has been prepared with the following objectives:

- Fulfill all required remaining elements of the APAR for the on-site portion of the RI. Previous investigations completed by the United States Environmental Protection Agency (USEPA) and ASARCO have addressed off-site portions of the RI;

- Present a CSM update including receptor survey and ecological assessment (Section 2), pathway evaluation (Section 3), PCL development (Section 4), and PCL Exclusion (PCLE) Zone identification (Section 5); and

- Provide the basis for updating the Corrective Action Directive for the on-site property in accordance with a Response Action Plan (RAP) under the TRRP to be submitted in the near future.

The Site covers an area of approximately 430 acres within the city limits of El Paso, Texas and is bisected by U.S. Interstate 10 (I-10) and U.S. Highway 85 (Paisano Drive). There are small non-contiguous properties in the Site vicinity. The Site was divided into five general areas that account for 10 Assessment Areas (AAs), as presented in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Each area has its own characteristics with respect to historical land use, contamination sources, and potential receptors:

1. The property east of I-10 (East Property AA and East Mountain AA);

2. The Plant Site (Acid Plant Arroyo AA, Pond 5/6 Arroyo AA, Pond 1 Arroyo AA, South Terrace Arroyo AA, and Plant Entrance Arroyo AA);

3. The Parker Brothers Arroyo (PBA) AA (includes the Ephemeral Pond, Fines Pile, and Boneyard);

4. The La Calavera AA (LC AA) is adjacent to a small residential neighborhood to the north; and

5. The Floodplain AA.

Conceptual Site Model

The CSM is defined by ASTM International (ASTM 1689-95) as a representation of an environmental system and the biological, physical, and chemical processes that determine the transport of constituents of concern (COCs) from sources through environmental media (e.g., soil, groundwater, sediment, and surface water) to environmental receptors within the system. The CSM for the Site includes the following components: (1) general site characterization, (2) contamination source, (3) fate and transport of COCs from the source medium to the exposure medium, and (4) exposure of the receptor populations. The COCs at the Site are principally associated with historical smelter operations including metals such as antimony, arsenic, cadmium, copper, lead, mercury, and selenium.

The sources of contamination include aerial deposition of stack emissions and fines from slag processing and deposition of slag and other materials in stockpiles such as the Fines Pile and the boneyard, or general fill on the Site. The site characterization data indicate that although aerial deposition of COCs is available for direct contact and inhalation exposure routes, there is little evidence for vertical migration through soil to the groundwater table for areas impacted by aerial deposition. Slag and other materials do appear to serve as potential sources of COCs to groundwater. Once in groundwater, COCs can migrate and discharge to the Rio Grande. Finally, COCs in surface soil are available for entrainment in stormwater runoff for those areas not covered by the Stormwater Collection and Reuse System (SWCRS). Transport of COCs in sediment entrained in stormwater runoff is being addressed using best management practices (BMPs) under the multi-sector general permit (MSGP) for stormwater discharge from industrial facilities under the Texas Pollutant Discharge Elimination System (TPDES) permitting and monitoring process.

Receptors at the Site are largely related to current and future land use. The East Property is being evaluated for potential residential land use, while the remainder of the Site is planned for strictly commercial/industrial (C/I) land use. A water well search revealed no current groundwater users potentially exposed to COCs in groundwater, while an ecological evaluation indicated aquatic receptors in the Rio Grande and terrestrial receptors in South Arroyo of the East Property.

Exposure Pathway Evaluation

Potentially complete exposure pathways for COCs were evaluated using the tables obtained from the TCEQ APAR form (TCEQ form 10325) for each of the AAs at the Site. The site characterization data were used to evaluate whether pathways are potentially complete for COCs in each environmental media for all potential receptor populations. Each of the AAs had unique combinations of COCs, impacted media, and potentially complete pathways. **Table ES-1** provides a summary of the complete pathways for each of the AAs based on this analysis.

Protective Concentrations Levels

PCLs were calculated for each of the environmental media impacted by COC concentrations above residential screening levels and each of the complete exposure pathways described in Section 3 of this report. The direct contact PCLs for both residential and C/I land uses are based on Tier 1 $^{Tot}Soil_{Comb}$ PCLs reported by the TCEQ for all COCs except arsenic. The arsenic $^{Tot}Soil_{Comb}$ PCLs for residential (46 milligrams per kilogram [mg/kg]) and C/I (320 mg/kg) land uses are based on Tier 2 calculations using a 40% relative bioavailability factor reported by the USEPA (Agency for Toxic Substances and Disease Registry, 2003). Groundwater PCLs are based on Tier 1 $^{GW}GW_{Ing}$ PCLs based on direct potable use of Class 1/Class 2 groundwater, and fate-and-transport PCLs based on groundwater discharge to surface water (^{SW}GW) and COC adsorption to sediment from groundwater discharging to the Rio Grande (^{Sed}GW). The ^{SW}GW PCLs are based on dilution factors calculated from site-specific groundwater flux estimates and published minimum flow rates for the Rio Grande above the International Dam (Segment 2314) as published in the TCEQ Surface Water Quality Standard Implementation Procedures (RG-194). The ^{SW}GW PCL, therefore, is dependent upon groundwater gradient, which will be subject to change as part of the remedial action at the Site. As a result, the initial ^{SW}GW PCLs calculated prior to implementation of the remedial action are intended only for use in defining the PCLE Zone for this pathway. The remedial action at the Site will be designed to reduce groundwater gradients at the Site that provide the driving force for discharge of COCs in the Rio Grande.

Additional fate-and-transport PCLs have been calculated for soil. Soil-to-groundwater PCLs ($^{GW}Soil_{Ing}$) were based on Tier 2 calculations using site-specific soil characteristics, while soil-to-groundwater-to-surface water PCLs ($^{SW\text{-}GW}Soil$) were calculated based on both soil characteristics and the dilution factor for the Rio Grande. Surface water PCLs were based on both human health receptors and ecological receptors. Ecological-based PCLs in surface water were based on total concentrations of metals in surface water using site-specific values for surface water hardness and total suspended solids (TSS) in the Rio Grande. Groundwater-to-sediment PCLs (^{Sed}GW) were also calculated to address the potential accumulation of COCs from groundwater to sediment of the Rio Grande. PCLs for soil and groundwater at the Site are summarized in **Table ES-2**.

PCLE Zones

PCLE Zones were established by comparing chemical concentrations in environmental samples to the PCLs discussed in Section 4. PCLE Zone maps illustrate locations where COC concentrations in environmental media exceed their respective risk-based remediation levels and serve as the basis for developing the RAP under the TRRP. **Figure ES-1** provides a summary of the areal extent of sample locations that exceed either soil-to-groundwater PCLs ($^{GW}Soil_{Ing}$ or $^{SW\text{-}GW}Soil$) or the direct contact PCLs ($^{Tot}Soil_{Comb}$ – Res or C/I). **Figure ES-2** illustrates monitoring well locations where COC concentrations in groundwater samples exceed $^{GW}GW_{Ing}$ and ^{SW}GW PCLs. The PCLE Zones for soil and groundwater illustrate the extent of areas requiring response actions under the TRRP and will be used as the basis for developing a RAP based on Remedy Standard B for the Site. Due to the existing and proposed C/I land use at the Site, land use restrictions will result in concentrations of COCs above residential screening levels remaining in environmental media, requiring institutional and physical controls.

The overall approach for addressing individual PCLE Zones by AA and exposure pathway is summarized in **Table ES-3**. Generally, groundwater concentrations of COCs above the $^{GW}GW_{Ing}$ will be addressed by institutional controls prohibiting use of potable wells on Site, and establishment of a plume management zone (PMZ) to establish the points of compliance. Groundwater concentrations of COCs above the fate-and-transport PCLs (^{SW}GW and ^{Sed}GW) are to be addressed by soil removals, active groundwater remediation using in-situ permeable reactive barriers (PRBs) in the PBA AA and groundwater gradient control through either clean groundwater extraction on the East Property and/or capping. Direct human contact with concentrations of COCs in surface soil and subsurface soil at the Site above their respective PCLs are largely being addressed by removals, capping, and institutional controls limiting future land use to C/I. Similar to direct contact with chemicals in soil, the migration of COCs from soil to groundwater is largely being addressed by removals, capping, and institutional controls. The RAP for the Site will provide details of the remedial actions, institutional controls, monitoring requirements, and operations and maintenance requirements to achieve the Remedy Standard B response action under the TRRP.

1. Introduction

This Conceptual Site Model (CSM), Pathway Evaluation, and Protective Concentration Level (PCL) Report (Report) has been prepared by Malcolm Pirnie for the Texas Custodial Trust (Trust) to fulfill the requirements of an Affected Property Assessment Report (APAR) under the Texas Risk Reduction Program (TRRP). These requirements were not previously addressed in the remedial investigation (RI) activities completed under the Texas Risk Reduction Rules (RRR) for the former ASARCO, LLC (ASARCO) Smelter Site located in El Paso, Texas (the Site). The combined information presented in the reports for Phases I through IV of the RI (Hydrometrics, 1998, 2000, and 2001; ASARCO Consulting, Inc., 2003), the Revised Supplemental RI report (Malcolm Pirnie, 2014a), and this report fulfill all the requirements of an APAR under the TRRP. A checklist based on the table of contents of the APAR form is included in **Appendix A** documenting the compliance with the requirements of an Affected Property Assessment under TRRP. Site remedial actions are being conducted by the Trust, which is acting as the property Trustee on behalf of the Trust beneficiaries: the Texas Commission on Environmental Quality (TCEQ) and the United States Environmental Protection Agency (USEPA).

1.1. Objective

Substantial investigation and remediation activities have been conducted by ASARCO at the Site since the 1990s under Risk Reduction Standard 3 (30 Texas Administrative Code [TAC] §335, Subchapter S) as a result of the 1996 Agreed Order with the TCEQ (previously the Texas Natural Resource Conservation Commission [TNRCC]). A Corrective Action Directive was issued by the TCEQ in 2005 for the remediation of the active smelter site in accordance with requirements of the Texas RRR. In 2005, ASARCO filed for bankruptcy under Chapter 11 of the United States Bankruptcy Code. ASARCO conducted remedial actions in accordance with the Corrective Action Directive using funds from a “Prepetition ASARCO Environmental Trust” created pursuant to a Consent Decree entered in United States v. ASARCO Inc., et al. In 2009, ASARCO emerged from bankruptcy establishing a trust fund to complete remediation of the Site as defined under the Corrective Action Directive. The Trust, working in partnership with the TCEQ, determined the land use for the Site would change from a smelter operation to mixed residential and commercial/industrial (C/I) applications. The stakeholders determined that the TRRP (30 TAC §350) would provide a more appropriate regulatory program for the closure and redevelopment of the Site. However, the four phases of the RI conducted under the RRR for the Site did not include all of the elements required for a complete APAR under the TRRP. This Report, therefore, has been prepared with the following objectives:

- Fulfill all required remaining elements of the APAR for the on-site portion of the RI. Previous investigations completed by the USEPA and ASARCO have addressed off-site portions of the RI;

- Present a CSM update including receptor survey and ecological assessment (Section 2), pathway evaluation (Section 3), PCL development (Section 4), and PCL Exclusion Zone identification (Section 5); and
- Provide the basis for updating the Corrective Action Directive for the on-site property in accordance with a Response Action Plan (RAP) under the TRRP to be submitted in the near future.

1.2. Background

1.2.1. Site Description

The Site covers an area of approximately 430 acres within the city limits of El Paso, Texas (**Figure 1-1**) and is bisected by U.S. Interstate 10 (I-10) and U.S. Highway 85 (Paisano Drive). There are small non-contiguous properties in the Site vicinity. As illustrated on **Figure 1-1**, the Site was divided into five general areas that account for 10 Assessment Areas (AAs), as presented in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Each area has its own characteristics with respect to historical land use, contamination sources, and potential receptors:

1. The property east of I-10 (East Property and East Mountain);
2. The Plant Site (Acid Plant Arroyo, Pond 5/6 Arroyo, Pond 1 Arroyo, South Terrace Arroyo, and Plant Entrance Arroyo);
3. The Parker Brothers Arroyo (including the Ephemeral Pond, Fines Pile, and Boneyard);
4. The La Calavera property (adjacent to a small residential neighborhood to the north); and
5. The Floodplain.

1.2.1.1. Property East of I-10

The property east of I-10 is divided into two AAs based on geography, topography, and potential land use. The East Mountain AA occupies the southern portion of the property east of I-10 and is characterized as a bedrock outcropping with very steep, rocky slopes and sparse vegetation, isolated by I-10 and surrounding C/I land use. The rock outcropping has no natural groundwater sources. The steep, rocky slopes and brittle rock surfaces severely limit any beneficial land use other than incidental recreational use by hikers or mountain bikers. The northern portion of the property east of I-10 (East Property AA) is characterized as an alluvial basin with two intermittent arroyos, North Arroyo and South Arroyo. The South Arroyo is the only existing on-site habitat for ecological receptors based on the proposed land use presented by the Trust. The intermittent surface water dries completely between precipitation events, which typically occur during the summer rainy season from July through September. The East Property AA has a centrally located, historical waste disposal area in the upland portion of the alluvium. This area was used for disposal of materials from the smelter site as well as slag. The East Property AA was also impacted by historical deposition of smelter stack emissions. The East Property AA will be evaluated for unrestricted redevelopment for either residential or C/I land use.

1.2.1.2. Plant Site

The Plant Site is located between I-10 and Paisano Drive. It is characterized as the historical site of industrial structures supporting smelter activities. The entire Plant Site footprint is and will remain a maintained C/I site without any potential habitat areas. All major structures associated with the smelter have been demolished and removed from the site. The Plant Site is a relatively level property with up to a dozen arroyos that were historically filled with combinations of native soil and slag. The Plant Site was divided into five AAs in the Revised Supplemental RI Report based on major drainages: 1) Acid Plant Arroyo; 2) Pond 5/6 Arroyo; 3) Pond 1 Arroyo; 4) South Terrace Arroyo; and 5) Plant Entrance Arroyo. The five AAs are combined in this Report, because the land use, setting, constituent of concern (COC) sources, and transport of COCs in the environment are common to all of these areas. As a result, the exposure pathway evaluation and PCL development for these areas will also be similar. There are no habitat areas located on the Plant Site, which is planned for capping and redevelopment as a C/I business park.

1.2.1.3. Parker Brothers Arroyo

Parker Brothers Arroyo (PBA) historically has been an area used for slag storage and disposal. Similar to the Plant Site, the PBA is composed of multiple AAs as presented in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). The arroyo includes slag storage and disposal AAs such as the Boneyard and the Fines Pile/Ephemeral Pond as illustrated on **Figure 1-1**. The arroyo is an intermittent stream bed that conveys stormwater runoff from the East Property to the Rio Grande. Historically, the PBA has had large amounts of slag and runoff from slag deposition areas within the channel of the arroyo. Storage of slag and waste in the Boneyard, as well as fine-fractioned slag in the Fines Pile and Ephemeral Pond, have provided historical sources of metals to groundwater, surface water, and sediment in the arroyo from stormwater runoff. The PBA does not provide habitat for ecological receptors due to the industrial nature of the existing and future land use.

1.2.1.4. La Calavera and Floodplain

The La Calavera AA (LC AA) is located on the northern boundary of the Site, as illustrated on **Figure 1-1**. The LC AA has historically been undeveloped land that has been impacted by aerial deposition of COCs from historical smelting and slag processing activities. Although designated the LC AA, this property should not be construed as being the La Calavera residential community. The property is adjacent to the small residential area and will be developed and maintained for C/I land use.

The Floodplain AA is located west of Paisano Drive (**Figure 1-1**). Similar to other properties located away from the Plant Site, surface soil at the Floodplain has been impacted by smelter stack emissions. The Floodplain AA is used for C/I activities and will continue to be designated for those uses in the redevelopment of the Site.

1.2.2. Historical Land Use

Over the course of years, the Site has been home to several smelting operations: a lead smelting plant began operations in 1887; following a fire, the plant was reconstructed in 1902. In 1910 a plant was constructed to produce copper by smelting concentrates. Lead and copper smelting activities were expanded in the 1930s and a Godfrey roaster was added for the production of cadmium oxide. A zinc plant was added in 1948, and an antimony plant and sinter plant with unloading and bedding systems were added in the 1970s.

In 1982, ASARCO began closing plant components, starting with the zinc plant. The lead plant was closed in 1985 and some structures were remodeled as a mobile equipment shop and storage/pilot plant. The antimony plant ceased operation in 1986. In 1992, the cadmium plant closed (Hydrometrics, 1998). The copper smelter continued to operate until February 1999.

As a result of a series of compliance inspections in the early 1990s, the TNRCC issued an Agreed Order dated August 29, 1996 to address deficiencies in ASARCO's operations that may have resulted in releases of chemicals to the environment. The Agreed Order assessed fines against ASARCO and committed ASARCO to conducting a remedial investigation of potential releases of chemicals to the environment from the Site and corrective actions to address any environmental concerns.

As noted in Section 1.1 above, in 2005, ASARCO declared Chapter 11 Bankruptcy. As part of the bankruptcy proceedings between ASARCO, the United States Department of Justice, the USEPA, and the State of Texas, an agreed remedy was developed for the Site and documented in the 2009 Expert Report prepared by TCEQ (2009). The Trust was established in December 2009 to oversee the cleanup and eventual sale of the Site.

1.2.3. Remedial Investigation – Phases I through IV and Revised Supplemental RI

ASARCO conducted RI Phases I through IV between 1997 and 2003 to assess soil and groundwater impacts in response to the Agreed Order. ASARCO also conducted remedial investigations in accordance with the TCEQ Leaking Petroleum Storage Tank (LPST) cleanup program in response to the release of diesel fuel at two locations at the Site. The four phases of RI activities were completed in accordance with the Texas RRR Risk Reduction Standard 3 for nonresidential (C/I) property use (30 TAC 335, Subchapter S). Risk Reduction Standard 3 requires media cleanup to be protective of human health and the environment and provides for closure through remediation with controls (i.e., an alternative to clean closure). The following elements were adopted in completing the RI work:

- Identification of COC sources;
- Identification of potential COC pathways and receptors;
- Evaluation of risk-based critical values (risk reduction standards);

- Assessment of the exposure of human and environmental receptors to contaminants; and
- Recommendations for corrective action to achieve risk reduction standards.

The remedial investigations are summarized below.

Phase I RI:

The Phase I RI (Hydrometrics, 1998) focused on COCs in on-site soil and groundwater. The on-site areas were divided into Investigation Areas (IAs) to manage the data gathered during the investigation. The RI report identified arsenic, cadmium, lead, and selenium as the principal COCs in both media. **Figure 1-2** provides an illustration of the historical layout of structures during operation of the smelter, and the IAs identified by ASARCO. The Phase I report concluded that impacts to soil were centralized around smelting and process areas such as the Converter Baghouse; Acid Plants Nos. 1 and 2; Ponds 1, 5, and 6; the bedding and unloading buildings; and slag storage and disposal areas such as the Boneyard, Fines Pile, and arroyo that were filled in with native soil, slag, and building debris to level the surface of the Plant Site. The Phase I RI provided the first documentation of Category I, Category 2, and Category 3 materials to identify final disposal requirements. In accordance with the agreed remedy, these categories are defined below:

- Category I: soils and solids identified to contain elevated concentrations of COCs and located in an area where they have the potential to affect human health and the environment. Category I soils and solids are identified in the field from the following lines of evidence:
  - Concentrations of COCs 3 to 4 times above their respective industrial screening levels (${}^{Tot}Soil_{Comb}$ PCLs);
  - Source and location of materials based on current demolition and historical disposal practices (e.g., old waste disposal areas);
  - Debris in the form of fine-grained grey material usually combined with bricks, concrete, wood debris, and slag pieces from demolition of structures that were previously in direct contact with smelter processes; and
  - Soil and slag material with staining and, in some cases, odor.
- Category II: soils and solids identified as containing elevated concentrations of COCs but at levels that will not impact groundwater if managed properly. Category II soil and solids are identified in the field from the following lines of evidence:
  - Concentrations of COCs above their respective industrial screening levels;

  - Containing large pieces or quantities of slag, stained concrete, bricks, and rocks/boulders separated from Category I removals.

- Category III: materials that are inert and contain low, if any, concentrations of COCs below their respective screening levels and, therefore, do not pose a threat to human health or the environment.

The results of the groundwater investigation indicated that COCs in groundwater were largely tied to source areas described for soil. The concentrations of arsenic, cadmium, selenium, and zinc were consistently reported at elevated levels significantly above Maximum Contaminant Levels (MCLs) close to the soil source areas. Generally, groundwater flows from east to west at the Site toward the Rio Grande with depths to groundwater ranging from 40 to 60 feet below ground surface (bgs) on the East Property and Plant Site, to 10 to 13 feet bgs in the Floodplain area. Concentrations of these metals in groundwater decrease with distance from the source areas. The Phase I report concluded that surrounding properties did not have a noticeable impact on groundwater quality. The Phase I RI stated that concentrations of metals in groundwater discharging to surface water (Rio Grande) were below MCLs and chronic surface water criteria.

Phase II RI:

The Phase II RI (Hydrometrics, 2000) expanded the number of on-site areas of interest and delineation of sources of COCs to on-site soil and groundwater. Soil investigations were extended to the arroyos on the East Property, the Ephemeral Pond, and the South Terrace. The additional groundwater monitoring events conducted as part of the Phase II RI supported the initial conclusion that the highest concentrations of COCs in groundwater occur and remain within the vicinity of their respective source areas; however, expanded groundwater data indicated migration of COCs from on-site source areas to downgradient receptors, including the Rio Grande and American Canal. The groundwater characterization data indicated that off-site impacts, primarily arsenic, could impact the surface water quality in the Rio Grande at low-flow periods.

Phase III RI:

The Phase III RI (Hydrometrics, 2001) continued monitoring of existing groundwater, surface water, and sediment locations, and expanded the soil investigation to four closed plant sites (former copper plant, former lead and sinter plant, former cadmium and zinc plant, and former antimony plant: see **Figure 1-2**) as well as the on-site portions of the East Property and LC AAs. Investigations of the Floodplain area, LC AA, and East Property AA indicated surface soil impacts primarily from arsenic and lead with concentrations generally decreasing to background levels within a few feet of the surface. Speciation analyses performed by ASARCO indicated that surface deposition in the LC AA consisted of slag from crushing operations performed by Oglebay-Norton. The source of elevated concentrations of arsenic and lead in surface soil around the Site were related to historical deposition of stack emissions. The USEPA and International

Boundary Water Commission (IBWC) performed parallel investigations of metals in surface soil surrounding the Site.

The baseline risk assessment (BRA) was updated as part of the Phase III RI. Conclusions of the risk assessment were that on-site risk from exposure to COCs in soil and groundwater to smelter workers could be managed with appropriate health and safety planning and procedures. The exposure of ASARCO and IBWC workers in the Floodplain area to COCs in soil was below a level that would result in an unacceptable threat to human health, while exposure to COCs in groundwater could be controlled through institutional controls. The risk assessment concluded that the potential exposure of off-site residents to COCs in soil was related to slag processing operations at Oglebay-Norton rather than smelting operations on the ASARCO property. Finally, the Phase III RI indicated that elevated concentrations of arsenic and selenium in surface water are present during low-flow events in the Rio Grande; however, these low-flow conditions are not representative of normal conditions on the river.

USEPA El Paso/Doña Ana County Metal Site:

The USEPA initiated an investigation of the extent of soil impacted by COCs, principally arsenic and lead, surrounding the Site. The delineation of the lateral extent of COCs for areas east and south of the Site is illustrated on **Figure 1-3**. Data collected in two studies overseen by the USEPA (Roy F. Weston, Inc., 2001 and Weston Solutions, Inc., 2002) indicated that locations around the smelter stacks and extending to the southeast are related to historical stack emissions. Additional data presented by both the USEPA (Roy F. Weston, Inc., 2001) and ASARCO (ASARCO Consulting, Inc., 2003) have characterized concentrations of COCs in soil at off-site locations in the LC AA (see **Appendix B**). Data presented in these reports provide lateral and vertical delineation of COCs in surface soil from historical aerial deposition of stack emissions and fine slag particulate from crushing operations. The data presented in **Appendix B** demonstrate that the extent of impacted soils are within a few feet of the surface and are not related to groundwater impacts reported at the Site.

Phase IV RI:

The Phase IV RI (ASARCO Consulting, Inc., 2003) continued reporting results of monitoring data from existing groundwater, surface water, and sediment locations and expanded the soil investigation to off-site locations around the LC AA and Floodplain (IBWC property) areas. The off-site investigation at the Floodplain demonstrated that most or all contamination is located in the first 2 to 3 feet of surface soil (see Tables 2-4 and 2-5 of **Appendix B**). These data support the position that COCs in surface soil at the Floodplain remain in surface soil and do not migrate vertically to the groundwater table.

The Phase IV RI presented a summary of results for surface soil samples collected from off-site residential properties around the LC AA. ASARCO collected 114 surface soil samples from 38 locations at 0- to 2-inch, 2- to 6-inch, and 6- to 18-inch depth intervals. Soil samples were analyzed for arsenic and lead. The data, which are presented in **Appendix B**, demonstrate generally decreasing concentrations of both COCs with increasing sampling depth. Similar to previous on-site and off-site investigations of metals in shallow soils, these data indicate that metals are not migrating vertically and are not impacting groundwater. ASARCO also contracted speciation evaluations of arsenic and lead in surface soil from the residential properties around the LC AA. Results indicate that arsenic and lead in surface soil are primarily related to fine dust from slag processing activities, rather than deposition from stack emissions.

Revised Supplemental RI Report:

The Revised Supplemental RI Report (Malcolm Pirnie, 2014a) was completed to summarize data collected during all four phases of the original RI and supplemental data collected to fill on-site data gaps presenting a comprehensive environmental dataset as the basis of decisions for future remediation activities at the Site. Land use at the Site was changed from continued use as a smelting facility to redevelopment as a mixed C/I and residential property. The land use in the vicinity of the Site remains mixed C/I and residential. Since the Site land use changed and the plant has been almost entirely demolished, it is no longer appropriate to define areas for remedial planning based on plant operational areas. Consequently, AAs were designated based on probable exposure pathways and historical arroyo boundaries. Screening standards for each medium were determined based on potential future land uses within each AA and in a manner consistent with the previous RIs approved by the TCEQ. Analyses of results from the previous four phases of the RI and Revised Supplemental RI were compared to the screening standards developed for the Site. The comparison presented in the Revised Supplemental RI Report indicates that the Site has been adequately characterized to support identification and implementation of final remedial actions.

The soils at the Site consist of fill and a mix of native alluvium and colluvium. Fill material consists of slag, native soil, and other anthropogenic materials such as concrete and asphalt. Concentrations of COCs above relevant criteria have been observed in both fill material and native soil. The nature and extent is delineated to the screening standards for all COCs.

Groundwater at the Site occurs within an unconfined alluvial aquifer with a saturated thickness ranging from approximately 8 to 60 feet underlain by a regional, low-permeability bedrock unit. Groundwater in the alluvial aquifer flows west and southwest through the Site toward the Rio Grande. There is negligible hydraulic connection between bedrock and the alluvial aquifer. Bedrock groundwater is not impacted by Site COCs. Groundwater at the Site is not used as a drinking water source. Alluvial water supply wells are not affected by impacted groundwater from the Site. Concentrations of COCs in groundwater have been delineated to below screening standards or to the physical extents of each arroyo, with the exception of arsenic concentrations. The Site surface water has been characterized and delineated site-wide and with respect to all appropriate COCs. The primary surface water bodies near the Site are the American Canal and the Rio Grande, which constitute a single AA. With the exception of arsenic in the American

Canal and arsenic and iron in the Rio Grande, concentrations of COCs at the most downstream sampling locations are below applicable screening standards.

1.2.4. Corrective Action

Consistent with the requirements of Risk Reduction Standard 3, each of the four phases of the RI included evaluations of corrective measures to achieve the remedy standard for protection of human health and the environment. The BRA originally completed as part of the Phase I RI stated that risks from COCs in soil and groundwater at the Site were limited to site workers and could be mitigated through implementation of a health and safety program. The BRA stated that the purpose of corrective measures would focus on minimizing on-site workers' exposure to COCs, minimizing transport of COCs from impacted soil to groundwater, and minimizing migration of COCs to surface waters of the American Canal and the Rio Grande. The corrective measures identified in the Phase I RI to achieve these goals generally included the following:

- Excavation of Category I material and placement in approved on-site repository(ies);
- Capping Category II material to prevent direct contact and minimize future potential transport of COCs to groundwater;
- Stormwater controls along with grading and drainage improvements; and
- Long-term monitoring of groundwater and surface water.

The Phase II RI supported the corrective measures presented above. Included in the measures was a discussion of institutional controls to limit land use, groundwater use, and access. The Phase III RI report cited data that revealed decreasing trends of COC concentrations in groundwater samples due to implementation of corrective measures at source locations including the Acid Plant and Ponds 1, 5, and 6. The report stated that evaluation of corrective measures for groundwater and surface water would be completed following 20 quarterly monitoring events (a 5-year monitoring period). The updated evaluation of corrective measures in the Phase IV RI (ASARCO Consulting, Inc., 2003) stated that concentrations of arsenic and selenium in groundwater samples from the Site could pose a potential threat to surface water quality; therefore, additional data collection was recommended.

The Agreed Order (TNRCC, 1996) cited an unauthorized discharge of stormwater from the Site to neighboring surface water bodies. In response, ASARCO designed and constructed an on-site Stormwater Collection and Reuse System (SWCRS) in 2005 to eliminate stormwater discharges from the Site. The SWCRS operates as a zero discharge facility for up to a 25-year storm event. Stormwater is collected from a network of on-site sumps and directed to three stormwater ponds that have an approximate capacity of 12 million gallons. Stormwater captured by this network is evaporated and, only if stormwater discharge limits are met, is discharged through on-site outfall SW-5, located upstream of the American Dam. If discharge limits are not met, water is treated and then discharged to the outfall.

In May 2005, the TCEQ issued a Corrective Action Directive (TCEQ, 2005) identifying the boundaries of the Area of Contamination (AOC) and the required elements of the corrective action to be completed. The required corrective actions included:

1. Construction of an on-site landfill for Category I material and installation of five downgradient monitoring wells and one upgradient monitoring well;

2. Establishment of financial assurances for closure and post-closure care of the landfill under solid waste regulations;

3. Excavation of areas with Category I material until COC concentrations are below RRR standards or equivalent TCEQ risk-based levels protective of human health and the environment;

4. Installation of an asphalt cap over areas designated as containing Category II materials;

5. Design and installation of a groundwater remediation system to prevent metals in groundwater at concentrations above MCLs from leaving the property boundary; and

6. Dust control during excavation activities.

Following ASARCO's filing for bankruptcy in 2005, funds from the "Prepetition ASARCO Environmental Trust" were used such that remediation of the Site would proceed as outlined in the TCEQ directive (TCEQ, 2005). In December 2009, the Texas Environmental Custodial Trust Agreement establishing a custodial trust for the remediation of the Site was signed, establishing a $52,080,000 trust fund to implement the corrective action described in the TCEQ 2005 Corrective Action Directive, which was determined to meet the remediation standard for protection of human health and the environment for the AOC as defined by the TCEQ. The basis for the approximately $52 million response action is presented in the *Estimation of Cost to Perform Cleanup at the ASARCO El Paso Smelter* included with the Expert Report (TCEQ, 2009). The TCEQ cost estimate included the following:

1. Demolition of structures;

2. Groundwater extraction, treatment, discharge, and containment at Paisano Road;

3. Asphalt paving;

4. Fencing;

5. Engineering and construction of repository landfill Cell No. 4 (Cell 4);

6. Long-term monitoring and engineering control maintenance; and

7. Trustee management fees.

1.3. Regulatory Approach

The RI and corrective actions for the Site were originally prepared under the Texas RRR (30 TAC §335). In 2001, the TRRP (30 TAC §350) was instituted for the characterization and cleanup of hazardous chemical releases to the environment in Texas. The TRRP provides mechanisms for achieving remedial goals including plume management zones (PMZs), Technical Impracticability (TI) assessments, and waste control units (WCUs). Off-site delineation of COCs in surface soil was previously completed by the USEPA (Roy F. Weston, 2001 and Weston Solutions, Inc., 2002) and ASARCO (ASARCO Consulting, Inc., 2003) under the RRR. Delineation of on-site sources of COCs to soil and groundwater and concentrations of COCs in groundwater are presented in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a).

The TCEQ commented on the Supplemental RI Report on March 11, 2014 and provided approval of responses to those comments on July 24, 2014. As part of the approval for comment responses, the TCEQ requested that a Revised Supplemental RI Report be submitted. The Revised Supplemental RI Report was submitted on October 19, 2014. The Site has been adequately delineated under the TRRP and, therefore, a letter and Notice of Intent to Switch to TRRP form will be sent to the TCEQ requesting a change in regulatory programs from the RRR to the TRRP in accordance with TCEQ guidance along with this report.

2. Conceptual Site Model

The CSM is defined by ASTM International (ASTM 1689-95) as a representation of an environmental system and the biological, physical, and chemical processes that determine the transport of contaminants from sources through environmental media (e.g., soil, groundwater, sediment, and surface water) to environmental receptors within the system. The CSM for the Site includes the following components: (1) general site characterization, (2) contamination source, (3) fate and transport of contaminants from the source medium to the exposure medium, and (4) exposure of the receptor populations. Each of these components is addressed individually in this section.

2.1. Site Characteristics

Characteristics of the Site and surrounding areas are described in the subsections below, including climate, geography, topography, soils, surface water and groundwater, groundwater use, and land use.

2.1.1. Environmental Setting

2.1.1.1. Climate

The climate in the El Paso area is arid, characterized by very low precipitation and relative humidity. Winters are cool; summers are hot and dry. Temperatures range from above 100 degrees Fahrenheit (°F) in the summer months to below freezing temperatures in the winter. Sand and dust storms occur during the spring, which is the windiest season.

El Paso is situated in the arid southwest, where annual precipitation averages about 8 inches, most of which occurs during the summer rainy season between April and September. The precipitation events are typically characterized as intense storms with high-intensity rainfall over relatively short time intervals. The high-intensity flow events associated with storms lead to severe erosion in upland areas with little standing water in drainage areas. Most recharge occurs at mountain-front interfaces and in established river beds. The annual pan evaporation rate for the area is approximately 72 inches per year (United States Department of Agriculture [USDA], 1971).

2.1.1.2. Geography

The Site is located in El Paso County within the Rio Grande Valley floodplain in the Basin and Range Physiographic Province of western Texas. The Site is situated in the Rio Grande (or El Paso) Canyon between the Franklin Mountains to the northeast and the Sierra de Juarez to the southwest in Mexico. The Rio Grande flows along the western boundary of the Site from the Mesilla Basin (Bolson). Approximately 2 miles upstream of the Site, the valley narrows and forms El Paso Canyon. This canyon is approximately 3 miles long and widens into the Hueco Bolson about 1 mile downstream from the Site.

2.1.1.3. Topography

The City of El Paso is located at elevations ranging from 3,600 feet above mean sea level (amsl) in the floodplain of the Rio Grande to greater than 7,000 feet amsl in the mountainous terrain of the Franklin Mountains. The Site is located within the Rio Grande Valley floodplain at an elevation of approximately 3,700 feet amsl near the river. Elevations on the Site increase from west to east, with the highest elevation of 4,140 feet amsl in the southeastern portion of the Site. **Figure 2-1** provides the U.S. Geological Survey Quadrangle map for the Site.

2.1.2. Soils

The predominant soil in the vicinity of the Site is the Delnorte-Canutillo Association hilly soil. This soil type is characterized by nearly level to steep soils that are: 1) shallow or very shallow, overlying caliche; or 2) deep and gravelly throughout (USDA, 1971).

The surface soils of the Site consist of fill and a mix of sediments generated from erosion of the Campus Andesite and the Franklin Mountains and fluvial sediments from the Rio Grande, with areas of extensive fill. Fill material is composed of slag, native soil, and other anthropogenic materials such as concrete and asphalt.

The soil survey map for the Site prepared by the USDA Natural Resource Conservation Service is presented in **Appendix C**. The soil survey shows three distinct soil units, including Delnorte-Canutillo hilly association (DCD), igneous rock (IG), and made land (fill material) – Gila soil material (MG).

Most of the Site soil is Delnorte-Canutillo except for the East Mountain AA and the Floodplain AA. The Delnorte is characterized as very gravelly loam in the first 10 inches of the soil column, cemented in the 1- to 2.5-foot depth interval, and gravelly fine sand in the 2.5- to 6-foot depth interval. The soil of the Canutillo is characterized as very gravelly to very cobbly loam. Calcium carbonate content is up to 40%, which is consistent with soil samples from across the Site—sample pH data ranged from 7.6 to 10.2, with an average of 8.4 (see **Appendix D**).

The East Mountain AA is composed of igneous rock, mostly devoid of a soil layer. The Floodplain is composed of made land – Gila soil material, which is described as inter-bedded layers of fine sandy loam and silty loam. The pH of soil samples from the Floodplain ranged from 7.4 to 9.5, with an average of 8.3 (see SSIAI-5 in **Appendix D**).

2.1.3. Surface Water

The American Canal and Rio Grande are located west of the Site. The American Canal is used to divert a portion of the surface water flow from the Rio Grande to water users in the United States. Downstream of the Site, the Acequia Madre is used to divert water from the Rio Grande and deliver water to water users in Mexico. Water is released from Elephant Butte Reservoir to the Rio Grande during spring and summer and is used for irrigation and drinking water purposes.

During fall and winter, flows in the Rio Grande decrease significantly as water is no longer released from Elephant Butte Reservoir by IBWC.

The Rio Grande is typically a gaining stream as it flows along the Site; however, it can also recharge groundwater in the floodplain during short periods when the river stage increases in response to the operation of dams along the river. The TCEQ has classified the Rio Grande above the International Dam as Segment 2314 under the Texas Surface Water Quality Standards (TSWQS) (Appendix C of 30 TAC 307.10; TCEQ, 2010). Surface water flow data from gauging stations along Segment 2314 were evaluated by the TCEQ to determine critical low-flow conditions along the river in relation to dam operations. The critical low flow established for Segment 2314 is 2.1 cubic feet per second (cfs) as presented in Appendix C of the *Procedures for the Implementation of Texas Surface Water Quality Standards* (RG-194; TCEQ, 2010). Groundwater levels in the floodplain are under the direct influence of surface water flows in the river. Groundwater levels can fluctuate seasonally by approximately 1 to 3 feet in response to stage changes in the Rio Grande.

Historically, four ephemeral arroyos (Pond 5/6, Pond 1, South Terrace Area, and Acid Plant) were dammed as part of the smelter expansion. Pond 1, Pond 5, and Pond 6 were used to manage stormwater . As noted previously, since 2005, as part of the on-site zero discharge SWCRS, stormwater has been collected from a network of on-site sumps and directed to three stormwater ponds that have an approximate capacity of 12 million gallons. These retention ponds, in addition to one active ephemeral drainage in the PBA, are typically dry except during or immediately after precipitation events (**Figure 1-1**). Stormwater captured by the SWCRS network evaporates and, only if stormwater discharge limits are met, is discharged through on-site outfall SW-5, located upstream of the American Dam. If discharge limits are not met, water is treated and then discharged to the outfall. Water quality limits are set in the Site Texas Pollutant Discharge Elimination System (TPDES) Multi-Sector General Permit No. TXR050000 as part of the Trust’s permit (Permit No. TXR05Y986).

2.1.4. Sediment

The Revised Supplemental RI Report (Malcolm Pirnie, 2014a) did not present a summary of the nature and extent of COCs in the sediment of drainages, the American Canal, or the Rio Grande, as these water courses were outside the Site boundaries. However, monitoring of COC concentrations in sediments has occurred in water bodies surrounding the Site since 1999. Semiannual samples were collected between 1999 and 2009 at seven sediment monitoring locations on the Rio Grande (SEP-2, SEP-4, SEP-9, SEP-10, SEP-11, SEP-12, and SEP-13; **Figure 2-2**), from three locations on the American Canal (SEP-3, SEP-6, and SEP-7), and from one location at the Ephemeral Pond (SEP-14). Sediment quality data collected from all sediment monitoring locations on the Rio Grande over eight semiannual sampling events from 1999 through 2003 intermittently indicated elevated concentrations of COCs compared to freshwater benchmark concentrations for arsenic, cadmium, copper, lead, and zinc (**Table 2-1**). Benchmark concentrations used for this evaluation are based on freshwater benthic organisms (TCEQ, 2014).

Benchmarks based on ecological receptors represent a more conservative endpoint for an initial evaluation compared to human health-based PCLs for recreational exposure to COCs in sediment. The results of the sediment monitoring events over this time frame of 1999 through 2003 indicate that COCs adsorbed to entrained sediment in stormwater discharges from the Site may have impacted sediment quality in the Rio Grande. Impacts of COCs on freshwater sediments in the Rio Grande served as the basis for design and construction of the SWCRS.

Since 2005, the SWCRS has been operated to eliminate stormwater discharge from the Site through the use of approximately 12 million gallons of storage capacity in lined retention ponds for the evaporation and treatment of stormwater runoff. The ponds provide a large-volume storage facility to promote the settling of fine particulate in stormwater prior to discharge. Since entrained particulate is the principal transport mechanism for impacts to sediment in the Rio Grande, the settling of particles was anticipated to be an effective treatment for high-volume storm events. Under normal 25-year storm events and smaller, stormwater runoff would be retained on Site for evaporation.

Sediment monitoring data from 2004 through 2007 (**Table 2-2)** confirmed reductions in concentrations of COCs in sediment compared to data presented for the 1999 through 2003 time frame presented in **Table 2-1**. The frequency and the magnitude of the exceedences were significantly reduced compared to the concentrations reported prior to the SWCRS implementation in 2003. Sediment monitoring data from 2008 and 2009 (**Table 2-3**) demonstrate a continued decreasing trend in the concentrations of COCs in sediment samples from each monitoring location. Over the 2008 to 2009 time frame, only a few individual sediment samples exceeded the TCEQ benchmark concentrations for COCs from three locations (SEP-2, SEP-13, and SEP-4). Concentrations of cadmium, copper, and lead were above their respective benchmark concentrations in the sediment sample from SEP-2 collected in February 2008. All concentrations of COCs in samples from location SEP-2 since February 2008 were below their respective benchmark concentrations. Concentrations of cadmium, copper, and zinc above their respective benchmarks were also detected in sediment samples from locations SEP-4 and SEP-13, both collected in February 2008. Since that time, none of the sediment samples collected from the Rio Grande had concentrations of COCs above benchmark levels. These data support the conclusion that concentrations of COCs above their respective benchmark levels in sediment samples from the Rio Grande were related to discharge of stormwater from the Site. The installation and operation of the SWCRS has effectively controlled the release of COCs to sediment in the Rio Grande.

2.1.5. Groundwater Hydrogeology

Groundwater at the Site occurs within an unconfined alluvial aquifer with a saturated thickness ranging from approximately 8 to 60 feet underlain by a regional, less-permeable bedrock unit. Groundwater in the alluvial aquifer flows west and southwest through the Site toward the Rio Grande. Groundwater from the Site ultimately discharges to the Rio Grande and sections of the American Canal.

The PBA conveys much of the groundwater flow through the Site and significantly influences transport of COCs and analytes of interest (AOIs). The other arroyos described previously convey groundwater flow but to a lesser degree. Seasonal water level fluctuations of up to 8 feet are observed along the PBA due to enhanced groundwater recharge from upgradient, ponded stormwater. High water table conditions generally occur in July and August due to increased precipitation, with low water table conditions occurring from November through February as precipitation decreases. Groundwater can be found at a depth of 8 to 10 feet bgs west of the Site in the Rio Grande floodplain and at depths of 50 to 60 feet bgs in the central and eastern portions of the Site.

2.1.5.1. Alluvial Aquifer

The alluvial aquifer is the primary hydrogeologic unit at the Site and is present in the upland portion of the Site and the Rio Grande floodplain. Ground surface elevations range from 4,140 feet amsl in the upland area to 3,700 feet amsl in the floodplain. The depth to water of the alluvial aquifer ranges from approximately 50 feet bgs in the upland portion of the Site to approximately 8 feet bgs in the floodplain. A potentiometric surface map is provided on **Figure 2-3**.

Saturated alluvium is discontinuous across the Site due to variations in bedrock elevation. In general, alluvial saturated thickness is greatest in the arroyos and is either very limited or nonexistent in upland areas where bedrock is less than 15 feet bgs or where it outcrops. A bedrock surface contour map illustrating the variations in bedrock elevation surrounding the PBA is provided on **Figure 2-4** and a saturated thickness extent map for the PBA is provided on **Figure 2-5**.

Alluvial groundwater is largely recharged by seasonally variable precipitation from upgradient drainage basins and from surficial flow from the Franklin Mountains. The East Mountain AA has no alluvial aquifer, as discussed in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a; **Figure 1-1**). Therefore, groundwater is not monitored in the East Mountain Area.

Alluvial groundwater flows predominantly through the PBA and to a lesser extent through the other former arroyos to the south of the PBA that were buried during historical Site operations and re-grading. The buried arroyos are generally east-west oriented features that result in focused groundwater flow toward the Rio Grande (**Figure 2-3**). The depositional environment has resulted in coarse-grained sediments in the former arroyos with high hydraulic conductivity, and sediments with lower conductivity outside of the primary flow paths of the former arroyos. Site characterization results indicate that variable flow occurs through the arroyos, resulting in focused groundwater flow through a relatively narrow central channel.

The amount of groundwater flow and channel size generally corresponds to the watershed size of the former arroyo drainage. The historical topography and arroyo structure is illustrated on **Figure 2-6**. Lithology within the buried arroyos generally consists of coarse-grained alluvial sediment in the arroyo center and fine-grained alluvial sediment outside the buried arroyos.

Geologic cross section locations are presented on **Figure 2-7** and in **Appendix E.** The cross sections in **Appendix E-1** depict the historical lithology of the Site and more recent conditions resulting from slag removal and permeable reactive barrier (PRB) installation in the PBA (**Appendix E2**).

A majority of the groundwater flux from the upland area toward the Rio Grande (approximately 75% of Site groundwater flux) is through the PBA, the northernmost arroyo on the Site. The groundwater flux has been estimated for each of the Plant Site arroyos including the PBA, Acid Plant, Pond 5/6, Pond 1, South Terrace, and Plant Entrance arroyos. Groundwater flow estimates were developed based on conservative estimates of hydraulic conductivity, gradient, and dimensions for each of the groundwater units. **Table 2-4** provides a summary of the groundwater flow estimates for the Plant Site arroyos.

Remedial activities at the Site have focused on the PBA due to the impacted groundwater flux relative to other Site arroyos. The PBA area includes the Boneyard Area, Fines Pile, and Ephemeral Pond (**Figure 1-1**). Slag was produced as a byproduct of smelting operations at the Site and poured as a molten material in the Boneyard Area immediately east of the Plant Site. The Boneyard Area is located in the footprint of a historical backfilled arroyo; however, groundwater from beneath the Boneyard flows into the PBA. The Fines Pile Area is an accumulation of slag fines generated by historical third-party crushing and screening operations and is located to the northeast of the Plant Site. The Ephemeral Pond Area is adjacent to the Fines Pile to the south. The Ephemeral Pond Area underlies the surface water drainage of a portion of the PBA and retains surface water after significant rainfall events, which infiltrates to recharge alluvial groundwater.

The remaining groundwater flux toward the Rio Grande (approximately 25% of Site groundwater flux) primarily occurs through the other plant arroyos and through infiltration of surface water runoff, which flows down the slag and gravel slope positioned along the western boundary of the plant. As illustrated on **Figure 1-1**, the slope is located along the entire Plant Site on the east side of Paisano Drive. The plant arroyos include the Acid Plant Arroyo, Pond 5/6 Arroyo, Pond 1 Arroyo, South Terrace Arroyo, and Plant Entrance Arroyo. As illustrated on **Figure 2-3**, groundwater discharged from the PBA, Acid Plant Arroyo, and Pond 5/6 Arroyo flows to the Floodplain. Groundwater discharged from the Pond 1, South Terrace, and Plant Entrance arroyos flows directly to the Rio Grande; groundwater discharge to the American Canal occurs seasonally, not throughout the year. The current, cumulative groundwater flow from the Pond 1, South Terrace, and Plant Entrance arroyos is estimated to be approximately 0.005 cfs, which is insignificant compared to the 7Q2 flow rate for Segment 2314 of the Rio Grande at 2.1 cfs.

The slag and gravel slope along the western boundary of the plant is approximately 46 to 50 feet high and is most pronounced between the Acid Plant, Pond 5/6, and Pond 1 areas. Although the groundwater flux contribution off the slope has not been specifically quantified, the COC flux contribution is anticipated to be important due to the presence of surficial slag and runoff along the slope, and infiltration into the floodplain due to ponding at the toe of the slope. Arsenic soil concentrations along the slope ranged from 600 milligrams per kilogram (mg/kg) to 18,000 mg/kg in the slag materials.

The LC AA is located north of the PBA. The area borders the Smeltertown cemetery and a residential area, located to the south and west, respectively (**Figure 1-1**). The groundwater beneath the LC AA is not hydraulically connected to groundwater in the PBA and, therefore, is not impacted by on-site activities.

The Floodplain Area is a portion of the Rio Grande floodplain that traverses the western perimeter of the Site. Floodplain materials are unconsolidated, generally fine-grained sands, silts, and clays. The floodplain of the Rio Grande is hydraulically downgradient from all Plant Site arroyos. Groundwater in the Floodplain is influenced by surface water conditions during periods of recharge and influences surface water quality during low-flow periods in the river. Groundwater flux from the Floodplain Area is conservatively estimated by the sum of estimated groundwater flows from the PBA (0.039 cfs), Acid Plant Arroyo (0.0023 cfs), and Pond 5/6 Arroyo (0.0059 cfs) for an estimated total flux of 0.047 cfs. The total groundwater flux from all arroyos at the Site is estimated at 0.052 cfs based on the sum of groundwater flow rates from the individual arroyos.

The alluvial aquifer also interacts with surface water in the Rio Grande and American Canal in the Floodplain Area; during periods of high water levels in the river and canal stage, surface water recharges groundwater, and during low surface water stage, the alluvial groundwater discharges to surface water where a hydraulic connection exists. Alluvial groundwater is hydraulically disconnected from the underlying bedrock (as demonstrated in Appendix B2 of the Revised Supplemental RI Report; Malcolm Pirnie, 2014a).

2.1.5.2. Bedrock Groundwater

Bedrock at the Site is composed of shales, sandstones, and limestones with andesite. The bedrock surface occurs at elevations ranging from 3,652 to 3,720 feet amsl under the plant area, and is largely covered by alluvium/colluvium. Generally, the bedrock surface was eroded by the former arroyos in the upland areas of the Site and the Rio Grande floodplain geomorphology. This has resulted in alluvial groundwater flow on top of these incised bedrock channels, where the bedrock top acts as an aquitard. Cross sections (**Appendix E**) illustrate the extent to which the historical arroyos eroded the bedrock surface. The largest bedrock incisions are observed in the PBA, which can reach a depth of approximately 75 feet into the bedrock (Cross Section B-B', **Appendix E**).

Site bedrock generally yields very little water and is of very low hydraulic conductivity (Alvarez and Buckner 1980; Malcolm Pirnie, 2014a). Alluvial and bedrock groundwater elevations, as measured in co-located alluvial and bedrock monitoring wells, are separated by up to 20 feet (e.g., paired wells EM-5 and EM-6; **Figure 2-7**). The difference in water levels indicates limited hydraulic connection between the bedrock unit and the alluvial aquifer. Additional discussion of the bedrock conceptual model is provided in Appendices B1 and B2 of the Revised Supplemental RI Report (Malcolm Pirnie, 2014a).

2.1.6. Aquifer Characteristics

2.1.6.1. Hydraulic Gradient

The alluvial hydraulic gradient is generally from east to west, ranging from approximately 0.006 to 0.03 feet per foot (**Figure 2-3**). Hydraulic gradients are greatest in the PBA and plant arroyos and decrease to the south and in the floodplain. Historical groundwater elevation measurements in wells at the Site fluctuate seasonally by approximately 3 to 4 feet. Higher water levels at wells located in the floodplain are generally observed during high river stage periods.

2.1.6.2. Hydraulic Conductivity

Alluvial hydraulic conductivity values vary from approximately 0.4 foot/day in the fine-grained sediment located between the arroyos, to as high as approximately 400 feet/day in the PBA. Bedrock hydraulic conductivity is significantly lower than the overlying alluvium. The estimated hydraulic conductivity of the three Site bedrock wells is 0.00001, 0.0002, and 0.004 foot/day. **Figure 2-8** provides a summary of the hydraulic conductivity distribution on the Site; further details regarding the hydraulic conductivity estimation methods and results are provided in Appendix B1 of the Revised Supplemental RI Report (Malcolm Pirnie, 2014a).

Based on data indicating primarily high transmissivity within the alluvium, low transmissivity within the bedrock, and an approximately 20-foot difference in water elevations between the two units, it can be determined that there is negligible hydraulic connection between bedrock and the alluvial aquifer, with the majority of the groundwater flow occurring in the alluvium (Malcolm Pirnie, 2014a).

2.1.6.3. Potential COC Migration

Alluvial groundwater flow and subsequent COC migration within each arroyo can be characterized by arroyo-specific hydraulic gradient (**Figure 2-3**), hydraulic conductivity (**Figure 2-8**), estimated flow channel dimensions (**Appendix F**), and observed COC concentrations. Comparison of estimated COC mass flux between arroyos indicates that the PBA contributes approximately 90% of the arsenic mass flux toward the floodplain, while the remainder of the Site accounts for approximately 10% of the arsenic mass flux.

COC migration in the underlying bedrock is expected by be minimal due to the very low hydraulic conductivity, low COC concentrations, limited hydraulic connection with adjacent units, and low potential for meaningful groundwater flow conveyance in the bedrock. Further discussion is provided in Appendix B1 of the Revised Supplemental RI Report (Malcolm Pirnie, 2014a).

2.1.7. Groundwater Geochemistry

Major ion chemistry in the Site groundwater displays sodium (Na) + potassium (K)-cation/ sulfate (SO_4)-anion facies, and although this may be attributed to Site impacts, data from all assessment areas overlap in some cases. Piper plots presented on **Figure 2-9** display the time-averaged major ion chemistry from groundwater samples collected in spring and fall 2011. The high SO_4 abundance potentially suggests a strong gypsum-dissolution control on groundwater chemistry. These observations are consistent with the geology of the region, which is dominated by sandstone and shale deposits. While the surface water chemistry of the Rio Grande and American Canal is similar to alluvial groundwater chemistry, it tends to be of a slightly more mixed-cation/mixed-anion type. The surface water displays less sulfate dominance than what is observed in the groundwater, suggesting that the local geology influencing Site groundwater chemistry deviates slightly from the average Rio Grande watershed conditions. Data points for wells within or immediately downgradient of historical source areas fall outside of the main cluster of points in the Piper diagram, which is likely a result of historical source areas affecting groundwater geochemistry.

Site groundwater pH ranges between 6.9 and 8.4. Regional downgradient groundwater data and recent Site groundwater data are also within this pH range, demonstrating negligible pH impacts relative to background conditions. The average total organic carbon (TOC) in Site groundwater is 5.3 milligrams per liter (mg/L) (as provided in the 2013 Annual Groundwater Monitoring Report; Malcolm Pirnie, 2014b). Wells that exhibit the highest TOC concentrations are located downgradient of the Acid Plant Arroyo and within the historical diesel plume. Groundwater from wells in locations impacted by historical diesel spills exhibit dissolved oxygen and oxidation-reduction potential (ORP) values substantially lower than wells located outside the area affected by the presence of diesel impacts. Other samples that exhibit low ORP values include wells along the Rio Grande river bank (**Figure 2-10)**. The areas on the ASARCO Plant Site impacted by diesel releases have been closed under the Texas LPST program.

Site values for total dissolved solids (TDS) range from 972 to 4,480 mg/L. Most TDS values at the Site measured in 2013 fall within this range (Malcolm Pirnie, 2014b). Exceptions include groundwater wells downgradient of historical source areas that exhibit higher TDS, with values of 5,800 to 11,200 mg/L. The high TDS in source area groundwater is consistent with elevated sulfate concentrations. **Table 2-5** shows the most recent groundwater metals concentrations in samples collected from three wells (EP-84, EP-95, and EP-129) that are considered to represent background conditions. The TDS values range from 966 to 2,610 mg/L in the background wells.

The major ion chemistry is relatively consistent across the Site, with the exception of locations immediately downgradient of historical source areas, which tend to exhibit the highest deviations from background. Locations nearest to the Rio Grande also exhibit deviations from typical conditions at the Site, but to a lesser extent. Overall, the groundwater can be characterized as mildly alkaline, with relatively high SO_4 and high TDS.

2.2. COC Sources

The principal COCs identified in soil and groundwater at the Site include arsenic, cadmium, chromium, copper, lead, mercury, selenium, and zinc. A complete list of COCs and AOIs identified for Site soils, groundwater, and surface water is presented in **Table 2-6**. Sources of COCs and AOIs to soil and groundwater are discussed below.

2.2.1. Industrial Sites

The RI reports (Phases I through IV and the Revised Supplemental RI Report) investigated the original industrial facilities associated with historical operations of the Site. **Figure 1-2** provides an illustration of the locations of these former industrial areas. The industrial structures include:

- Acid Plants No. 1 and No. 2
- Sinter Plant and Sample Mill
- Unloading and Bedding Buildings
- Convertor Building and Baghouse
- Plant Entrance (stormwater drainage)
- Former Lead Plant
- Former Cadmium Plant
- Former Zinc Plant
- Former Antimony Plant

All of the structures were investigated for concentrations of metals in soil and groundwater. They are all within the footprint of the Plant Site and, therefore, have similar issues with regard to soil geochemistry, the presence of slag fill in former arroyo channels, the presence and character of groundwater, and the nature of the COCs themselves. As a result, the pathway evaluation and PCL development for these area sources are combined under the Plant Site AAs.

2.2.2. Slag and Smelter Waste Storage and Disposal Sites

The second category of source areas at the Site includes storage and disposal sites for slag and waste material. Waste storage areas include the Boneyard and Fines Pile/Ephemeral Pond in the PBA and the East Category I disposal area on the East Property. The PBA also is the site of the newly constructed Cell 4 for on-site disposal of Category I materials where slag materials were removed, including from the arroyo bottom and placed on the west plant area.

2.2.3. Pond Sites

Three pond sites, Pond 1, Pond 5, and Pond 6, have been closed and characterized during the RI. **Figure 1-2** presents the locations of the three ponds. Sediment from the ponds was characterized as contributing to groundwater impacts. Each of the ponds was excavated and lined, converting the ponds into landfills, and filled with Category I materials.

2.2.4. Slag Processing

Oglebay-Norton operated a slag processing facility that crushed slag for use in a variety of products including railroad ballast, asphalt, and sand paper. The processing facility was located on the northwest corner of the PBA within the right-of-way for the Union Pacific Railroad track located southeast of the LC AA. The crushing operation resulted in production of fine slag material that was disposed of in the Fines Piles. The Phase IV RI Report (ASARCO Consulting, Inc., 2003) included speciation data indicating that airborne dusts from crushing operations have impacted surface soil quality in the LC AA and Floodplain AA. Vertical delineation data presented by both the USEPA (Weston Solutions, Inc., 2002) and ASARCO (ASARCO Consulting, Inc., 2003) demonstrated that impacts were limited to the first few feet of the soil column, and groundwater impacts in the area were unlikely to occur as a result of the dust deposition.

2.2.5. Stack Emissions

The USEPA investigation of the El Paso/Doña Ana County Metals Site (Weston Solutions, Inc., 2002) characterized arsenic and lead contamination in shallow surface soil (0- to 2-inch depth interval) from deposition of smelter stack emissions. **Figure 1-3** illustrates the extent of the impact of surface soil in the study area. Vertical delineation data presented by the USEPA (Weston Solutions, Inc., 2002) indicate that COCs are limited to the first few inches of the soil column.

The USEPA performed bioavailability testing of soil samples from residential properties surrounding the El Paso/Doña Ana County Metals Site and reported the relative bioavailability of arsenic in site-specific soil to be 40% of the assumed 100% availability (Agency for Toxic Substances and Disease Registry, 2003). The TCEQ used this relative bioavailability to calculate a site-specific PCL for arsenic of 46 mg/kg for residential soil (see **Appendix F**). As part of the PCL calculation, the TCEQ reduced the plant uptake of arsenic by a factor of five to account for the very low solubility of arsenic in the deposition of arsenic from airborne stack emissions. The groundwater impacts, therefore, are not a consideration for shallow soil contamination from stack emissions at the Site.

2.2.6. Other Sites

Other sources of COCs released to the environment have been reported at the Site including the Diesel Spill No. 1 LPST site, the Diesel Spill No. 2 LPST site, and the polychlorinated biphenyl (PCB) sites located at the powerhouse and north of the converter building as illustrated on

Figure 1-1. Diesel Spill No. 1 was reported in February 1990 following a report of an oil sheen at the American Canal emanating from weep holes in the canal approximately 300 feet west of three diesel underground storage tanks on the Site. A product recovery system was installed along with a groundwater containment and treatment system. The treatment system applied air stripping for removal of volatile organic compounds (VOCs), and the water was then used in plant processes. Between 1992 and 1998, approximately 22,000 gallons of product were recovered and 7.5 million gallons of water treated. A Plan A Risk Assessment under the Texas LPST Program (30 TAC §334) was completed in 1997, indicating that COCs in groundwater were below target cleanup levels and the site could apply for closure once product levels dropped below 0.1 foot in thickness on the water table. On November 15, 2000, the TNRCC concurred that closure requirements were met for Diesel Spill No. 1 and stated that no further action was required.

Diesel Spill No. 2 was reported in 1990 as a release associated with underground piping at an 18,000-gallon diesel aboveground storage tank located adjacent to the former Zinc Fuming Plant. The investigation to delineate the diesel plume was conducted from 1990 through 1994 and included installation of a product recovery trench and an air sparge and soil vapor extraction trench to prevent the plume from migrating to the Floodplain AA. In 1999, the recovery system was upgraded with a dual-phase extraction (DPE) system at the Floodplain AA and a total fluid recovery system at the main Plant Site. Operation of the fluid recovery and DPE systems continued through May 2011. In February 2012, a pilot test was conducted to determine whether high-pressure vacuum extraction would be an appropriate technology for removing the remaining non-aqueous phase liquid (NAPL). The results indicated that limited recovery of NAPL was possible under this method. Diesel Spill No. 2 was closed in October 2013 with approval from the TCEQ (2013).

The final additional source area at the Site is the PCB-impacted soil at sites located at the former Powerhouse and north of the former Converter. The investigation of PCB-impacted soil at the Powerhouse Site has delineated the extent of impacted soil to levels below 1.1 mg/kg, the residential Tier 1 PCL for total PCBs by direct contact (${}^{Tot}Soil_{Comb}$), which has been used as an assessment level for the Plant Site. All PCB-impacted soils characterized in place as having a total PCB concentration greater than 50 mg/kg are being managed as Toxic Substance Control Act (TSCA) waste being excavated, transported, and disposed of off site at a TSCA disposal facility. All PCB-impacted soil with total PCB concentrations between 7.1 mg/kg and 50 mg/kg are excavated and temporarily stored in one roll-off bin (Bin # 929), disposed of on site in Cell 4, and managed as non-TSCA PCB-containing remediation waste. Management of PCB remediation waste is evaluated in the RAP with remedial activities at the Pond 5/6 Arroyo AA and the Acid Plant Arroyo AA.

2.3. Fate and Transport

Fate-and-transport evaluations are performed as part of the CSM to assess the relationship between the concentrations of COCs in source media compared to the anticipated concentrations of COCs in exposure media. Under the TRRP, many PCLs are calculated based on fate-and-transport pathways and assumptions. The PCL name is written as follows to reflect the fate-and-transport pathway: $^{\text{Exposure Media}}\text{Source Medium}_{\text{Exposure Pathway}}$. For example, the PCL for the soil-to-groundwater pathway has the identifier of $^{GW}Soil_{Ing}$, indicating the PCL for soil as the source medium is derived for the protection of groundwater as the exposure medium by the ingestion (abbreviated “Ing”) route of exposure. The evaluation of fate and transport of COCs at the Site is based on PCL calculations, standard assumptions under the TRRP, and site-specific characteristics that may impact the fate and transport of COCs at the Site.

2.3.1. Stack Emissions and Slag Processing Impacts on Deposition

One historical fate-and-transport pathway for COCs at the Site that has not been specifically addressed in PCL calculations and assumptions is the deposition of air-borne particulate from historical stack emission and slag crushing activities. Although these historical activities have largely dictated the distribution of arsenic and lead in surface soil across the Site, they no longer occur and are not applicable for development of fate-and-transport PCLs. The historical deposition of COCs from stack emissions and dust from slag crushing activities is currently evaluated by direct contact PCLs ($^{Tot}Soil_{Comb}$).

2.3.2. Soil-to-Air

The soil-to-air exposure pathway is considered complete for all AAs at the Site. Potential exposure to volatile COCs that can be emitted from soil as a vapor to air or non-volatile COCs adsorbed to fine soil particulate that can be emitted to air in the form of dust are accounted for in the TRRP PCL calculations for this pathway. COCs at the Site are principally metals, which tend to be adsorbed to particulates. The inhalation exposure to COCs adsorbed to soil particulate is principally based on the particulate emission factor (PEF) under the TRRP (30 TAC 350.75(b)(1)). The Tier 1 default PEF is assumed for all inhalation exposures to particulate at the Site. For areas projected for current and future C/I or residential land use, the direct contact PCLs ($^{Tot}Soil_{Comb}$) will be used to evaluate potential inhalation exposure. The East Mountain AA, which is too rugged for any continuous land use, will be evaluated for potential off-site impacts from inhalation of COCs adsorbed to fugitive dusts by comparison of COC concentrations in surface soil to the chemical-specific soil-to-air PCL ($^{Air}Soil_{Inh\text{-}VP}$).

2.3.3. Soil-to-Groundwater

The soil-to-groundwater pathway is evaluated on an area-by-area basis. The East Mountain AA does not contain any groundwater, so the pathway is incomplete in this location. Consistent with requirements under the TRRP (30 TAC §350.75(i)(7)(C)), other AAs such as the LC AA and the Floodplain AA have sufficient data to demonstrate that COCs in soils are adequately protective of groundwater in these areas. Detailed evaluations of these pathways are presented in Section 3. For portions of the East Property, PBA, and Plant Site where impacts to groundwater have been characterized, the soil-to-groundwater pathway was evaluated based on equations and assumptions presented in the Tier 1 PCL Equation: $^{GW}Soil$ (30 TAC §350.75(b)(1)). Soil pH is the principal site-specific parameter affecting the migration of metallic COCs from soil to groundwater. Tier 2 ^{GW}Soil PCLs based on site-specific soil pH are presented in Section 4.

2.3.4. Soil-to-Sediment

The soil-to-sediment pathway was historically identified as a pathway of concern based on the discharge of stormwater runoff from the Site to the Rio Grande prior to the construction and operation of the SWCRS. **Figure 2-2** provides an illustration of sediment monitoring locations on the Rio Grande and a summary of principal concentrations in sediment samples collected between 2004 and 2009. These data demonstrate that historical discharges of stormwater to the Rio Grande were likely to have been responsible for historical levels of COCs in sediment of the river. Since 2005, the construction and operation of the SWCRS have remedied the impacts to sediment in the river from Site stormwater discharge. The evaluation and treatment of potential soil-to-sediment pathways for all AAs will be performed assuming the application of best management practices (BMPs), which have been successfully employed at the Plant Site. No numeric PCLs are recommended for addressing the soil-to-sediment pathway. Because operation of the SWCRS removes the exposure pathway, thus providing protection of human health and ecological receptors for the soil-to-sediment scenario, a modeling effort to calculate numeric PCLs has not been performed.

2.3.5. Groundwater-to-Surface Water

The groundwater-to-surface water pathway (^{SW}GW) is applicable for AAs with groundwater directly discharging to either the American Canal or the Rio Grande, which include the Plant Site (Plant Entrance, South Terrace, and Pond 1 Arroyos) and the Floodplain. The Plant Site AAs including the Pond 5/6, Acid Plant, and PBA Arroyos are considered complete for the ^{SW}GW pathway, because groundwater from these AAs discharges to the Floodplain AA. The direct ingestion of groundwater pathway by human receptors is considered complete for all AAs under either a residential scenario (East Property and LC AA) or C/I scenario (Plant Site, PBA, and Floodplain).

2.3.6. Groundwater-to-Sediment

The groundwater-to-sediment pathway (^{Sed}GW), similar to the ^{SW}GW pathway, is applicable for AAs with groundwater directly discharging to either the American Canal or the Rio Grande including the Plant Site (Plant Entrance, South Terrace, and Pond 1 Arroyos) and the Floodplain. The Plant Site AAs including the Pond 5/6, Acid Plant, and PBA Arroyos are considered complete for the ^{Sed}GW pathway, because groundwater from these AAs discharges to the Floodplain AA.

2.4. Receptors

Receptors have been determined based on existing and projected future land use, the water well survey (**Appendix G**), the site receptor survey (**Appendix H**), and results of the ecological Tier 1

Exclusion Checklist (**Appendix I**) and Tier 2 Screening Level Ecological Risk Assessment (SLERA; **Appendix J**).

2.4.1. Land Use

The Site is no longer an active industrial facility: structures have been demolished and remedial activities are being conducted. Upon completion of remedial activities, the Site will be available for redevelopment. Land use in the vicinity of the Site includes mixed industrial, commercial, and residential, as indicated below (and shown on **Figure 1-1**):

- East of the Site: Residential, light industrial, and commercial land owned by the University of Texas El Paso;
- South of the Site: Railroad tracks, American Canal, and light industrial and commercial land;
- West of the Site: Railroad tracks, IBWC American Dam office, industrial (brick manufacturer), and U.S.-Mexico border; and
- North of the Site: Commercial, industrial (former concrete plant), and residential (LC AA) land.

The agreed remedy presented in the 2009 Expert Report (TCEQ, 2009) was based on the assumption that the smelter would not remain operational, and buildings would be demolished, but the Site would be fenced. The potential for redevelopment of selected areas of the Site, therefore, was not considered. In consideration that the smelter was closed permanently, the Trust was obliged to reconsider the scope and purpose of the agreed remedy. Also, the Trust determined the Site had potential for redevelopment under residential and/or C/I land use scenarios. This determination was made in consultation with the City of El Paso, Texas (City of El Paso, 2012). Conclusions from the reevaluation will be used to guide decision-making and evaluate the revised remedial strategy. **Figure 2-11** provides an illustration of the proposed land use associated with the redevelopment of the Site that will be considered in the application of revised remedial strategies and development of the RAP.

2.4.2. Groundwater Use

Groundwater at the Site is not used as a drinking water source or for any other use. Alluvial water supply wells (Section 2.4.3) are not affected by impacted groundwater from the Site.

2.4.3. Receptor Survey and Water Well Search

A Texas Water Well Report was requested from Environmental Data Resources, Inc. to provide a list of water wells with a 0.5-mile search radius from the Site. **Figure 2-12** provides an illustration of the well locations identified around the Site. A copy of the report is included in **Appendix G**. A summary of the water well report is provided in **Table 2-7**.

Only one water well was physically located during the survey and identified in the report. The well, which is flush mounted, was located with the help of the IBWC American Dam staff. The staff indicated this well is for monitoring the groundwater levels adjacent to the American Dam and is not used for groundwater production or consumption.

A receptor survey was performed by Mr. Garett Ferguson, P.G. of Malcolm Pirnie on March 28, 2014 by driving and walking through the Site and adjacent areas to identify surface water features and any other receptors that may be visible. A photolog of the receptor survey is presented as **Appendix H**. There are no surface water bodies on the Site. The closest surface water body is the American Canal, which is a 20-foot-deep by 45-foot-wide concrete-lined channel approximately 210 feet from the Site to the west. The Rio Grande is located west of the American Canal and is approximately 625 feet from the Site. The American Canal and the Rio Grande are considered potential receptors based on hydraulic connectivity and surface water/stormwater outfalls. Surface/stormwater drainage features and their flow pathways are described below.

East Property:

The East Property consists of two natural arroyos flowing from east to west. In the north arroyo, water flows down the unlined arroyo to a water detention structure upstream from I-10. This structure directs water under I-10 via three box culverts to the Ephemeral Pond. Water flows through the Ephemeral Pond until it converges with flow from the South Arroyo and then flows through a culvert directed under and then parallel to rail tracks owned by Union Pacific Rail Road (UPRR) to the head of the PBA. In the South Arroyo, water flows down the unlined arroyo to another water detention structure with a low-flow 36-inch corrugated metal pipe that conveys water under I-10 via a box culvert. There is a high-flow inlet at a higher elevation on the structure that also connects to the box culvert. From the box culvert, water flows to a confluence with the North Arroyo to flow under the UPRR tracks. The two arroyos combine to flow parallel to the tracks and then down the PBA and eventually discharge through a concrete-reinforced pipe that connects to stormwater outfall SW-5. The surface water is then conveyed to the Rio Grande through a concrete-lined channel.

East Mountain:

On the East Mountain, numerous rock gabion structures were installed to limit the amount of sediment flowing off the mountain during heavy rain events. The rock gabions were installed in selected drainages to convey water into a drop drain feature within the Texas Department of Transportation right-of-way. These drainages convey water from the mountain property as well as runoff from I-10. Once into the drains, water flows under I-10, enters UPRR property, and then flows to an outflow at the very south end of the property (SW-1). SW-1 is not part of the facility stormwater permit.

Plant Site:

As part of the SWCRS, four operational stormwater sumps collect and convey water through piping to two retention ponds on the southern end of the Site. Pond A has a capacity of 1 million gallons; Pond B is an overflow pond with a capacity of 7 million gallons. These ponds are a controlled outflow system with pumps and piping to outfall SW-5, which is at the west end of the PBA. Stormwater is tested and compared to concentrations outlined in the Site stormwater permit. If the water in the retention ponds meets the criteria in the permit, it may be discharged to outfall SW-5 by way of a 2-inch polyvinyl chloride line connecting the pond pumps to outfall SW-5.

Stormwater that flows off the western slope of the Plant Site is collected by ditches and directed to three outflows that discharge into the American Canal (SW-2, SW-3, and SW-4). In addition to outfall SW-5, these outfalls are still active on the Site stormwater permit.

Filled historical arroyos are present throughout the Site and are shown on **Figure 2-6**. The historical arroyos were filled to allow for additional plant expansion during the early years of operation. Arroyos may have been filled with native material and slag material, which is a waste product from the smelting process. Since the arroyos were filled with this material, they have been considered for possible flow pathways for COCs.

Utilities:

The Site and adjacent properties are served by municipal water services. The current water supplier is El Paso Water Utilities, which has a 36-inch water line running parallel to West Paisano Drive, with a service line entering the Site just west of the 828-foot stack. Utilities on the Site are illustrated on **Figure 2-13**. These water lines are not receptors due to their buried depth and because the depth to water in this portion of the Site is 9 to 16 feet bgs. Stormwater inlets were observed along West Paisano Drive just east of the Site. Based on conversations with IBWC personnel, the storm drains are grouted near Paisano Drive and do not flow to either the American Canal or Rio Grande. Based on field measurements, the drains are approximately 3 feet bgs. Due to the grout that prevents flow and the shallow depth of the drainage, the drains are not considered receptors.

A natural gas line is located on the Site along the east haul road, which parallels the UPRR property. This gas line varies in depth from 2 to 8 feet, which is well above groundwater in this area of the Site. One additional natural gas line is connected to the line described above but is directed across I-10 to the east. Once on the East Property, this second line is located above the North Arroyo by approximately 20 to 30 feet and is only 10 to 15 feet bgs, well above groundwater in this area of the Site. Due to the depth of these utilities and the Site depth to groundwater (50 to 60 feet bgs), the natural gas lines are not considered receptors.

2.4.4. Ecological Receptors

A Tier 1 Exclusion Checklist was completed for the Site and is included as **Appendix I**. The Site can be divided into five general areas: (1) the property east of I-10 (East Property and East Mountain Area); (2) the Plant Site; (3) the PBA (including the Ephemeral Pond, Fines Pile, and Boneyard); (4) the LC AA (adjacent to the small residential neighborhood to the north); and (5) the Floodplain. Potential ecological receptors in these areas are discussed in the sections below.

2.4.4.1. Property East of I-10

The East Mountain Area occupies the southern portion of the property east of I-10 and is characterized as a bedrock outcropping with very steep, rocky slopes; no groundwater; sparse vegetation; and poor, isolated habitat surrounded by I-10 and C/I land use, which limits access to this portion of the property and its attractiveness to ecological receptors. The East Mountain Area has no historical land use and little potential land use due to the steep rocky slopes and jagged rock surfaces. The source of COCs in the East Mountain Area is historical deposition of smelter emissions (from stack and wind-blown dust) including arsenic, cadmium, copper, lead, mercury, and zinc.

The northern portion of the East Property is characterized by two alluvial basins serving as the only potentially sensitive habitat along intermittent stream beds with medium to extensive vegetation (**Figure 1-1**). The habitat is within the 100-year floodplain, which excludes the two areas from future development.

The East Property had a centrally located, historical waste disposal area in the upland portion of the alluvium between the two arroyos. This area was used for disposal of demolition materials and slag from the smelter site. The waste materials provided a source of metals to soil and groundwater in the northern portion of the East Property. As part of Site operations, waste materials were generally covered with soil, providing a source of metals to groundwater but little potential for direct contact with ecological receptors. There are no groundwater seeps to the surface in the East Property; all surface water flow comes from precipitation runoff. Intermittent surface water in the channel dries completely between precipitation events, which typically occur during the summer rainy season from July through September. The East Property was also impacted by historical deposition of smelter stack emissions and wind-blown dust. With the exception of the North and South Arroyos within the 100-year floodplain and portions of the East Mountain, the East Property will be redeveloped for either residential or C/I land use. The North Arroyo is being remediated to residential land use PCLs, while the South Arroyo will be retained as an open space habitat for ecological receptors and recreational use.

2.4.4.2. Plant Site

The Plant Site is located between I-10 and Paisano Drive. It is characterized as the historical site of industrial structures supporting smelter activities. The entire Plant Site footprint is and will remain a maintained C/I site without any existing or potential habitat areas. All major structures associated with the smelter have been demolished and removed. The Plant Site has historically been built on a leveled foundation of fills and slag with elevated concentrations of metals, as compared to native soil, with principally arsenic, cadmium, copper, lead, mercury, and selenium. The Plant Site is planned for capping and redevelopment as a C/I business park.

2.4.4.3. Parker Brothers Arroyo

The PBA is located west of I-10 on the north end of the Plant Site. The PBA historically has been used for slag storage, processing, and disposal. The arroyo includes stockpile/disposal sites such as the Boneyard, the Fines Pile, and the Ephemeral Pond. The arroyo is an intermittent stream bed that conveys stormwater runoff from upstream of the East Property to the Rio Grande. Historically, the PBA has had large amounts of slag and runoff from slag deposition areas within the channel of the arroyo. Metals in the slag material provide a source of COCs to groundwater, surface water, and sediment of the arroyo. Intermittent standing water in the Boneyard and Ephemeral Pond have provided a source of metals and a mechanism of transport to groundwater, while storage of slag in the Boneyard and fine-grained slag in the Fines Pile have also provided historical sources of metals to sediment and surface water in the arroyo from stormwater runoff and infiltration. The PBA does not provide habitat for ecological receptors due to the industrial nature of the existing and future land use; however, it does serve as a potential source of metals to surface water and sediment in the Rio Grande at the point of discharge.

2.4.4.4. La Calavera Assessment Area

The LC AA is located on the northern boundary of the Site. The LC AA has historically been undeveloped land that has been impacted by aerial deposition of fine–grained slag associated with historical slag processing activities. The principal COCs in surface soil at the LC AA include arsenic and lead. The property is adjacent to a small residential area, which was previously remediated by the USEPA (Weston Solutions, Inc. 2002), and will be developed and maintained for either residential or C/I land use. The area does not serve as habitat for ecological receptors under current or future land use.

2.4.4.5. Floodplain

The Floodplain portion of the Site is located west of Paisano Drive. Similar to other properties located away from the Plant Site, surface soil at the Floodplain has been impacted by smelter stack emissions, principally arsenic, cadmium, copper, lead, and zinc. The Floodplain area is used for C/I activities and will remain for those uses in the redevelopment of the Site. No habitat for ecological receptors is present on the Floodplain property.

Groundwater beneath the Floodplain has been impacted by storage and disposal of slag and wastes principally in the PBA (Fines Pile, Boneyard, and Ephemeral Pond). To a lesser extent, groundwater beneath the Floodplain has been impacted by slag and other plant materials in the Acid Plant area of the Plant Site, along the foot of the slope along Paisano Drive from the South Entrance north to the Acid Plant Arroyo, and in the waste disposal site in the East Property east of I-10. The impacts to groundwater are principally driven by the inundation of slag and waste materials by ponded and infiltrating stormwater. Impacted groundwater flows east to west across the Site to the Rio Grande where it discharges. The location of the Rio Grande with respect to the affected property required the ecological evaluation to proceed to a Tier 2 SLERA. The SLERA for the Floodplain is strictly related to the discharge of COCs in groundwater from the Floodplain to the Rio Grande for potential exposure to ecological receptors and not for terrestrial receptors in the Floodplain AA.

The Tier 2 SLERA was performed on COCs in surface soil (0 to 6 inches bgs) and subsurface soil (6 inches to 5 feet bgs) of the 20-acre habitat located in the South Arroyo drainage on the East Property as illustrated on **Figure 2-14**. The SLERA is presented in **Appendix J**. The SLERA was modeled based on quantitative evaluation of exposure to COCs in soil and the food chain for six receptors including mammalian (omnivore – short-tail shrew, herbivore – cottontail, and carnivore – red fox) and avian (omnivore – American robin, herbivore – mourning dove, and carnivore – red-tailed hawk). Hazard quotients in shrews and robins exceeded unity (1) for both No Observable Adverse Effect Level and Lowest Observable Adverse Effect Level endpoints, Ecological-based PCLs in surface soil (defined as 0 to 0.5 foot bgs for ecological risk assessment) and subsurface soil (defined as 0.5 to 5 foot bgs for ecological risk assessment) were calculated for arsenic, cadmium, copper, lead, and zinc. These ecological-based PCLs for soil are only applicable to soil in the intermittent stream habitat along the South Arroyo in the East Property.

Groundwater discharge to the Rio Grande was compared to surface water quality criteria based on chronic exposure to aquatic receptors. Concentrations of arsenic, cadmium, chromium, copper, lead, selenium, thallium, and zinc in groundwater from the Site exceed the chronic surface water quality criteria for aquatic receptors in the Rio Grande. The ecological endpoints will be considered for establishing groundwater PCLs (^{SW}GW) for discharge to the Rio Grande.

3. Pathway Evaluation

The exposure pathway evaluation for the Site was performed using Table 2C from the TCEQ APAR template. The TRRP establishes a process for setting human health-based and ecological PCLs based on exposure pathways associated with each affected environmental medium (surface soil, subsurface soil, groundwater, sediment, and surface water). The exposure pathways for each medium type considered for PCL development are described in this section using TRRP terminology and acronyms. Each of these exposure pathways is then addressed for each AA.

3.1. Groundwater

Exposure pathways considered for groundwater at the Site include:

- Direct ingestion of COCs in groundwater as a potable water supply (${}^{GW}GW_{Ing}$)
- Discharge of COCs in groundwater to surface water bodies such as the American Canal or Rio Grande (${}^{SW}GW$) and sediment (${}^{Sed}GW$)
- Inhalation of volatile COCs from groundwater after volatilization at the groundwater capillary fringe, migrating vertically through soil gas, and emitting into the breathing zone (${}^{Air}GW_{Inh\text{-}V}$)

COCs in Site groundwater include metals from smelting operations and fuel components in the groundwater at the Diesel No. 1 and Diesel No. 2 sites. Both of the diesel sites have been closed under the Texas LPST program (30 TAC §334). As a result, no VOCs are present in groundwater at the Site and the ${}^{Air}GW_{Inh\text{-}V}$ pathway is not considered complete for analytes. Groundwater resources at the Site have been classified as Class 2 under Texas regulations. The complete or "reasonably anticipated to be complete" exposure pathways for COCs in groundwater include the ingestion of COCs in Class 2 groundwater (${}^{GW}GW_{Ing}$), the discharge to surface water (${}^{SW}GW$), and adsorption to sediment in the Rio Grande of COCs from groundwater (${}^{Sed}GW$).

3.2. Soil

Exposure pathways considered for surface soil at the Site include:

- Direct contact with COCs in surface soil by total combined dermal absorption, incidental soil ingestion, inhalation of vapors or particulate, and ingestion of COCs taken up in home-grown fruit and vegetable routes of exposure (${}^{Tot}Soil_{Comb}$)
- Inhalation of COCs adsorbed to fine particulate in wind-blown dust (${}^{Air}Soil_{Inh\text{-}VP}$)
- Leaching of COCs from soil to groundwater (${}^{GW}Soil_{Ing}$)
- Leaching from soil to groundwater then discharging to surface water (${}^{SW\text{-}GW}Soil$)

- Conveyance of COCs adsorbed to fine particles entrained in stormwater runoff (^{Sed}Soil)
- Direct exposure of ecological receptors to COCs in soil and food chain (^{Eco}Soil)

COCs in Site soil include metals and PCBs at the Powerhouse location in the Pond 5/6 Arroyo AA. These COCs are not considered volatile, so volatilization of COCs from surface soil is not considered a complete pathway. Direct contact PCLs for surface soils ($^{Tot}Soil_{Comb}$) incorporates the inhalation exposure to COCs in fugitive dusts. A separate evaluation of the inhalation of COCs in airborne dust is not required because the pathway is included in the $^{Tot}Soil_{Comb}$ PCL. No ecological-based PCLs are presented, except for the South Arroyo within the East Property, because habitat for ecological receptors is not present on other AAs within the Site boundaries. The soil-to-sediment PCLs (^{Sed}Soil) are applied only to areas identified with direct stormwater discharges to the Rio Grande.

Because COCs at the Site are not volatile, the exposure pathway for COCs in subsurface soils at the Site is limited to: 1) the leaching of COCs from soil to Class 2 groundwater ($^{GW}Soil_{Ing}$), or 2) soil-to-groundwater-to-surface-water leaching of COCs to Class 2 groundwater, which ultimately discharges to surface water or adsorption to sediment ($^{SW\text{-}GW}$Soil).

3.3. Surface Water

The American Canal is a concrete-lined channel that diverts water from the Rio Grande to the City of El Paso, where it is used for drinking water and irrigation. The state-designated water uses of the Rio Grande are domestic water supply, non-contact recreation, and limited aquatic life. The screening standards for the American Canal are based on either USEPA MCLs or groundwater ingestion PCLs ($^{GW}GW_{Ing}$), while screening standards for the Rio Grande are based on USEPA MCLs and $^{GW}GW_{Ing}$ PCLs, as well as the aquatic life criteria for freshwater (evaluated by 30 TAC §307, TSWQS).

3.4. Sediment

With the exception of the Rio Grande, all of the surface water features at the Site are intermittent stream beds and stormwater drainage conveyances. The American Canal represents a concrete-lined surface water conveyance feature used to transport water from the Rio Grande to the point of use for potable services or agriculture applications. Sediment in the intermittent stream beds and stormwater drainages are evaluated as surface soil with respect to exposure. Sediment in the American Canal is not available for direct exposure to COCs in sediment as other true environmental media. As a result, the Rio Grande represents the only true surface water feature at the Site with sediment as an exposure medium for human health-based and ecological receptors. The exposure pathways for sediment in the Rio Grande are based on total combined direct contact ($^{Tot}Sed_{Comb}$) assuming incidental ingestion and dermal absorption as potentially complete routes of exposure. Inhalation of COCs adsorbed to fine particles of sediment as fugitive dust is not considered a complete pathway for COCs in sediments assumed to be saturated and unavailable for dust generation. The $^{Tot}Sed_{Comb}$ PCL is based on a recreational scenario developed by the TCEQ in 2006. Direct contact for ecological receptors with COCs in sediment is also evaluated using benchmark and secondary effect levels for benthic receptors published by the TCEQ (2014).

3.5. Pathway Evaluation

3.5.1. East Mountain AA

Table 3-1 lists the complete or reasonably anticipated to be complete exposure pathways that must be taken into consideration when establishing the assessment level for environmental media for the East Mountain AA. Each exposure pathway is discussed below.

$^{Tot}Soil_{Comb}$. The East Mountain AA is a rugged outcropping of bedrock that is not readily usable for development for either residential or C/I land use except in select locations as illustrated on **Figure 2-11**. The area is currently undeveloped and projected to be restricted to limited recreational land use over the majority of the area. The direct contact pathways are considered complete; however, residential land use will be restricted. $^{Tot}Soil_{Comb}$ PCLs based on C/I land use will be applied.

$^{Air}Soil_{Inh\text{-}VP}$. The East Mountain AA is adjacent to property owned by the University of Texas El Paso. Direct contact exposure to COCs in surface soil could potentially be controlled through land use and/or access restrictions to the East Mountain AA. Such institutional controls would allow existing levels of COCs to remain in surface soil. Fugitive dusts from impacted areas on the East Mountain AA could migrate off site without removals or capping of surface soil with COCs in excess of $^{Tot}Soil_{Comb}$ PCLs. The $^{Air}Soil_{Inh\text{-}VP}$ PCL, therefore, is considered complete regardless of whether the AA is remediated to direct contact PCLs.

$^{Air}Soil_{Inh\text{-}V}$. COCs at the East Mountain AA are not volatile; therefore, this pathway is considered incomplete.

$^{GW}Soil_{Ing}$. The East Mountain AA is an outcropping of bedrock and does not have any groundwater resources. The soil-to-groundwater exposure pathways are considered incomplete.

$^{SW\text{-}GW}Soil$. The East Mountain AA is an outcropping of bedrock and does not have any groundwater resources. The soil-to-groundwater exposure pathways are considered incomplete.

$^{Eco}Soil$. The East Mountain AA is an undeveloped property that may serve as habitat for ecological receptors. The area is characterized as a bedrock outcropping with very steep, rocky slopes; no groundwater; sparse vegetation; and poor, isolated habitat surrounded by I-10 and C/I land use, which limits access to this portion of the property, making it unattractive to ecological receptors. No $^{Eco}Soil$ PCLs are recommended for the East Mountain AA.

^{Sed}Soil. The East Mountain AA is an undeveloped area with steep slopes and high erosion potential during precipitation events. Surface soils contain elevated concentrations of COCs. Stormwater runoff from the East Mountain AA is directed to culverts across I-10 and discharged to the American Canal at outfall SW-1. The soil-to-sediment pathway, therefore, is considered complete for the East Mountain AA.

3.5.2. East Property AA

Table 3-2 lists the complete or reasonably anticipated to be complete exposure pathways that must be taken into consideration when establishing the assessment level for environmental media for the East Property AA. Each exposure pathway is discussed below.

3.5.2.1. Groundwater

Groundwater is present at the East Property AA; however, there are no surface seeps of groundwater and there is negligible hydraulic connection between bedrock and the alluvial aquifer. The bedrock groundwater is not impacted by Site COCs.

$^{GW}GW_{Ing}$. Groundwater at the Site is not used as a drinking water source, and the nearby alluvial water supply wells are not affected by impacted groundwater from the Site. The groundwater resource at the AA, therefore, is considered Class 2. Class 2 groundwater can be used as a potable water source. Thus, the ingestion of COCs in the groundwater pathway ($^{GW}GW_{Ing}$) is considered complete at the East Property AA.

$^{Air}GW_{Inh\text{-}V}$. COCs at the East Property AA are not volatile; therefore, this pathway is considered incomplete.

^{SW}GW. Groundwater from the East Property discharges to the PBA AA. There are no surface water discharges of groundwater from the East Property AA; therefore, the groundwater-to-surface-water exposure pathway is considered incomplete.

^{Sed}GW. Groundwater from the East Property discharges to the PBA AA. There are no surface water discharges of groundwater from the East Property AA to adversely impact sediment. The groundwater-to-sediment exposure pathway is considered incomplete.

3.5.2.2. Soil

$^{Tot}Soil_{Comb}$. The East Property AA is an undeveloped area that is highly valued for either residential or C/I land use. The land use in this area is currently projected to become unrestricted. The direct contact pathways, therefore, are considered complete. $^{Tot}Soil_{Comb}$ PCLs based on residential land use will be applied.

$^{Air}Soil_{Inh\text{-}VP}$. The exposure pathway for inhalation of COCs adsorbed to fugitive dusts is considered complete for the East Property AA; however, consideration of the direct contact exposure pathway ($^{Tot}Soil_{Comb}$) accounts for the inhalation exposure to fugitive dust.

$^{Air}Soil_{Inh\text{-}V}$. COCs at the East Property AA are not volatile; therefore, this pathway is considered incomplete.

$^{GW}Soil_{Ing}$. Groundwater at the Site is considered Class 2 and can be used as a potable water source. Thus, the ingestion of COCs in the groundwater pathway ($^{GW}GW_{Ing}$) is considered complete at the East Property AA. The East Property includes the East Category I material disposal area, which serves as a source for groundwater contamination along with discarded slag materials located in saturated areas of the South Arroyo on the East Property AA. The soil-to-groundwater exposure pathway, therefore, is considered complete for the East Property AA.

$^{SW\text{-}GW}Soil$. There are no surface water discharges of groundwater from the East Property AA; therefore, the groundwater-to-surface-water exposure pathway is considered incomplete. The soil-to-groundwater-surface-water discharge exposure pathway is also considered incomplete.

$^{Eco}Soil$. Habitat area in the South Arroyo includes vegetation and an intermittent water source as a result of precipitation events that are considered attractive habitat for ecological receptors. The conclusions of the Tier 2 SLERA (**Appendix J**) indicate that concentrations of arsenic, cadmium, copper, lead, selenium, and zinc in surface soil of the South Arroyo of the East Property AA could pose a threat to ecological receptors.

$^{Sed}Soil$. Stormwater runoff from the North Arroyo and South Arroyo drainages enters detention basins prior to discharging from the AA at the culvert crossing I-10. The detention basins allow for the settling of entrained sediment in stormwater runoff prior to flowing to the PBA AA on the west side of I-10. The soil-to-sediment exposure pathway for the East Property AA is considered incomplete.

3.5.3. Plant Entrance Arroyo

Table 3-3 lists the complete or reasonably anticipated to be complete exposure pathways that must be taken into consideration when establishing the assessment level for environmental media for the Plant Entrance Arroyo AA. Each exposure pathway is discussed below.

3.5.3.1. Groundwater

$^{GW}GW_{Ing}$. Groundwater at the Site is not used as a drinking water source and the nearby alluvial water supply wells are not affected by impacted groundwater from the Site. The groundwater resource at the Plant Entrance AA, therefore, is considered Class 2. Class 2 groundwater can be used as a potable water source. Thus, the ingestion of COCs in groundwater pathway ($^{GW}GW_{Ing}$) is considered complete at the Plant Entrance Arroyo AA.

$^{Air}GW_{Inh\text{-}V}$. COCs at the Plant Entrance Arroyo AA are not volatile; therefore, this pathway is considered incomplete.

^{SW}GW. Groundwater from the Plant Entrance Arroyo AA discharges directly to the Rio Grande. The groundwater-discharge-to-surface-water exposure pathway is considered complete for this AA.

^{Sed}GW. Groundwater from the Plant Entrance Arroyo AA discharges directly to the Rio Grande; therefore, the groundwater-discharge-to-sediment exposure pathway is considered complete for this AA.

3.5.3.2. Soil

$^{Tot}Soil_{Comb}$. The Plant Entrance Arroyo AA is completely developed based on the previous land use as a smelter site. The Plant Entrance Arroyo AA will remain C/I land use under all future land use planning scenarios. The direct contact pathways, therefore, are considered complete. The $^{Tot}Soil_{Comb}$ PCL based on C/I land use will be applied.

$^{Air}Soil_{Inh\text{-}VP}$. The exposure pathway for inhalation of COCs adsorbed to fugitive dusts is considered complete for the Plant Entrance Arroyo AA; however, consideration of the direct contact exposure pathway ($^{Tot}Soil_{Comb}$) accounts for the inhalation exposure to fugitive dust.

$^{Air}Soil_{Inh\text{-}V}$. COCs at the Plant Entrance Arroyo AA are not volatile; therefore, this pathway is considered incomplete.

$^{GW}Soil_{Ing}$. Groundwater at the Site is considered Class 2 and can be used as a potable water source. Thus, the ingestion of COCs in groundwater pathway ($^{GW}GW_{Ing}$) is considered complete for the Plant Entrance Arroyo AA. There are no slag storage piles, process areas, or process material disposal areas within the Plant Entrance Arroyo AA. The source of COCs to surface soil in the Plant Entrance Arroyo AA has been from historical deposition from stack emissions and material historically falling from hauling trucks.

As previously discussed in the CSM, deposition of stack emissions from smelter operations does not provide a source of metals to surface soil that readily migrate vertically through the soil column. For the Plant Entrance Arroyo AA, analytical data for surface soil samples (Appendix F of the Revised Supplemental RI [Malcolm Pirnie, 2014a]) demonstrate that elevated concentrations of COCs are limited to surface soil within 1 to 2 feet bgs. These data suggest the soil-to-groundwater pathway for COCs in surface soil is incomplete.

Groundwater monitoring wells EP-89 and EP-110 are located in the Plant Entrance Arroyo AA. Groundwater quality samples have not been collected from these wells since 2009. Concentrations of arsenic in groundwater samples from these wells were below the reporting limit of 0.00448 mg/L. Arsenic is the most significant COC in groundwater and soil at the AA. Arsenic concentrations in soil range from less than 2 mg/kg to 1,300 mg/kg, while groundwater concentrations remain below the reporting limit.

The depth to groundwater in the Plant Entrance Arroyo AA ranges from 6 to 13 feet bgs (Figure E1-9, **Appendix E1**). The soil type in the AA is a similar alkaline loam as reported for the rest of the Site (see Section 2.1.2). The soil type and arid conditions do not promote vertical migration of arsenic. Based on cumulative monitoring and site characterization data, the soil-to-groundwater pathway is considered incomplete for the Plant Entrance Arroyo AA.

$^{SW\text{-}GW}$Soil. Similar to the $^{GW}Soil_{Ing}$ pathway, the soil-to-groundwater-to-surface-water exposure pathway is incomplete for the AA.

^{Eco}Soil. The Plant Entrance Arroyo AA does not have any habitat areas attractive to ecological receptors. The exposure pathway for direct contact of ecological receptors to COCs in soil at the AA is considered incomplete.

^{Sed}Soil. Stormwater runoff from the Plant Entrance Arroyo AA is directed to either lined retention ponds,or the SWCRS, or the Santa Fe Railroad right-of-way. The ponds provide a large-volume storage facility to promote evaporation and the settling of fine particulate in stormwater prior to discharge at outfall SW-5. Monitoring data for sediment quality in the Rio Grande demonstrate that the SWCRS effectively controls discharge of COCs in stormwater runoff (see Section 2.1.4). The soil-to-sediment exposure pathway for the Plant Entrance Arroyo AA is considered incomplete.

3.5.4. Plant Site (South Terrace, Pond 1, Pond 5/6, and Acid Plant Arroyos)

The Plant Site AAs include the South Terrace Arroyo AA, Pond 1 Arroyo AA, Pond 5/6 Arroyo AA, and Acid Plant Arroyo AA. **Table 3-4** lists the complete or reasonably anticipated to be complete exposure pathways that must be taken into consideration when establishing the assessment level for environmental media for the Plant Site. Each exposure pathway is discussed below.

3.5.4.1. Groundwater

$^{GW}GW_{Ing}$. Groundwater at the Site is not used as a drinking water source and the nearby alluvial water supply wells are not affected by impacted groundwater from the Site. The groundwater resource at the AAs, therefore, is considered Class 2. Class 2 groundwater can be used as a potable water source. Thus, the ingestion of COCs in groundwater pathway ($^{GW}GW_{Ing}$) is considered complete at the Plant Site AAs.

$^{Air}GW_{Inh\text{-}V}$. COCs at the Plant Site AAs are not volatile; therefore, this pathway is considered incomplete.

^{SW}GW. Groundwater from the Plant Site AAs discharges directly to the Rio Grande (South Terrace Arroyo AA and Pond 1 Arroyo). Groundwater from the Pond 5/6 Arroyo AA and the Acid Plant AA discharges to the Rio Grande by way of the Floodplain AA. The groundwater-discharge-to-surface-water exposure pathway is considered complete for all the AAs at the Plant Site.

^{Sed}**GW.** Groundwater from the Plant Site AAs discharges directly to the Rio Grande (South Terrace Arroyo AA and Pond 1 Arroyo AA) or indirectly via the Floodplain AA (Pond 5/6 Arroyo AA and Acid Plant AA). The groundwater-discharge-to-sediment exposure pathway is considered complete for all the AAs at the Plant Site.

3.5.4.2. Soil

^{Tot}**Soil**$_{Comb}$**.** The Plant Site (South Terrace Arroyo, Pond 1 Arroyo, Pond 5/6 Arroyo, and Acid Plant Arroyo) is completely developed based on the previous land use as a smelter site. The Plant Site will remain C/I land use under all future land use planning scenarios. The direct contact pathways, therefore, are considered complete. The $^{Tot}Soil_{Comb}$ PCL based on C/I land use will be applied.

^{Air}**Soil**$_{Inh\text{-}VP}$**.** The exposure pathway for inhalation of COCs adsorbed to fugitive dusts is considered complete for the Plant Site AAs; however, consideration of the direct contact exposure pathway ($^{Tot}Soil_{Comb}$) accounts for the inhalation exposure to fugitive dust.

^{Air}**Soil**$_{Inh\text{-}V}$**.** COCs at the Plant Site AAs are not volatile; therefore, this pathway is considered incomplete.

^{GW}**Soil**$_{Ing}$**.** Groundwater at the Site is considered Class 2 and can be used as a potable water source. Thus, the ingestion of COCs in groundwater pathway ($^{GW}GW_{Ing}$) is considered complete at the Plant Site AAs. The Plant Site AAs include arroyos filled with slag and industrial materials to level the overall Plant Site surface. Fill areas, pond sites, and materials in arroyos serve as sources for groundwater contamination. The soil-to-groundwater exposure pathway, therefore, is considered complete for the Plant Site AAs.

$^{SW\text{-}GW}$**Soil.** Groundwater from several of the Plant Site AAs, including the South Terrace Arroyo AA and the Pond 1 Arroyo AA, discharges to the Rio Grande. Groundwater flow from the Pond 5/6 Arroyo AA and the Acid Plant AA discharges to groundwater in the Floodplain AA. These Plant Site AAs include arroyos filled with slag and industrial materials to level the overall Plant Site surface. Fill areas, pond sites, and materials in arroyos serve as potential sources for groundwater contamination. The initial PCL calculations for the ^{SW}GW PCLs presented in Section 4.1 were calculated based on the entire groundwater flux from the Site including Plant Site AAs that discharge to the Floodplain AA. The approach for initial calculation of the ^{SW}GW PCLs was strictly for the purpose of defining the PCL Exceedence (PCLE) Zones as described in Section 4.1. The soil-to-groundwater-to-surface-water pathway ($^{SW\text{-}GW}Soil$), therefore, is considered complete for all Plant Site AAs that have a complete soil-to-groundwater pathway.

^{Eco}Soil. The Plant Site AAs do not have any habitat areas attractive to ecological receptors. The exposure pathway for direct contact of ecological receptors to COCs in soil at the Plant Site AAs is considered incomplete.

^{Sed}Soil. Stormwater runoff from the Plant Site AAs is directed to lined retention ponds that are part of the SWCRS. The ponds provide a large-volume storage facility to promote evaporation and the settling of fine particulate in stormwater prior to discharge at outfall SW-5. Monitoring data for sediment quality in the Rio Grande demonstrate that the SWCRS effectively controls discharge of COCs in stormwater runoff (see Section 2.1.4). The soil-to-sediment exposure pathway for the Plant Site AAs is considered incomplete.

3.5.5. Parker Brothers Arroyo

Table 3-5 lists the complete or reasonably anticipated to be complete exposure pathways that must be taken into consideration when establishing the assessment level for environmental media for the PBA. Each exposure pathway is discussed below.

3.5.5.1. Groundwater

$^{GW}GW_{Ing}$. Groundwater at the Site is not used as a drinking water source and the alluvial water supply wells are not affected by impacted groundwater from the Site. The groundwater resource at the AA, therefore, is considered Class 2. Class 2 groundwater can be used as a potable water source. Thus, the ingestion of COCs in groundwater pathway ($^{GW}GW_{Ing}$) is considered complete at the PBA AA.

$^{Air}GW_{Inh\text{-}V}$. COCs at the PBA AA are not volatile; therefore, this pathway is considered incomplete.

^{SW}GW. Groundwater from the PBA AA flows to the Rio Grande and American Canal by way of the Floodplain AA. The discharge of groundwater flow from the PBA AA is to the Floodplain AA, which discharges directly to the surface water. The groundwater-discharge-to-surface-water exposure pathway is considered complete for the PBA AA.

^{Sed}GW. As previously stated, the discharge of groundwater flow from the PBA AA is to the Floodplain AA, which discharges directly to the surface water. The groundwater-discharge-to-sediment exposure pathway is considered complete for the PBA AA.

3.5.5.2. Soil

$^{Tot}Soil_{Comb}$. The PBA AA is completely developed based on the previous land use as a slag and material stockpile/disposal area including sites such as the Boneyard and Fines Pile. The PBA AA will remain C/I or open space land use under all future land use planning scenarios. The direct contact pathways, therefore, are considered complete. The $^{Tot}Soil_{Comb}$ PCL based on C/I land use will be applied.

$^{Air}Soil_{Inh\text{-}VP}$. The exposure pathway for inhalation of COCs adsorbed to fugitive dusts is considered complete for the PBA AA; however, consideration of the direct contact exposure pathway ($^{Tot}Soil_{Comb}$) accounts for the inhalation exposure to fugitive dust.

$^{Air}Soil_{Inh\text{-}V}$. COCs at the PBA AA are not volatile; therefore, this pathway is considered incomplete.

$^{GW}Soil_{Ing}$. Groundwater at the Site is considered Class 2 and can be used as a potable water source. Thus, the ingestion of COCs in groundwater pathway ($^{GW}GW_{Ing}$) is considered complete at the PBA AA. The AA includes slag and stockpile/disposal areas including the Boneyard, Fines Pile, and Ephemeral Pond. These fill areas serve as sources for groundwater contamination. The soil-to-groundwater exposure pathway, therefore, is considered complete for the PBA AA.

$^{SW\text{-}GW}Soil$. Groundwater at the PBA AA discharges to the Floodplain AA, which in turn discharges to the Rio Grande, making the ^{SW}GW pathway complete for the PBA AA. The soil-to-groundwater-to-surface-water exposure pathway, therefore, is also considered complete for the PBA AA.

$^{Eco}Soil$. The PBA AA does not have any habitat areas attractive to ecological receptors. The exposure pathway for direct contact of ecological receptors to COCs in soil at the PBA AA is considered incomplete.

$^{Sed}Soil$. The PBA AA includes the channel that conveys stormwater runoff from the East Property arroyos as well as surface runoff from the Boneyard, Fines Pile, and Cell 4. The channel has a high erosion potential during precipitation events. The stormwater runoff from the PBA AA is directed to the Rio Grande by outfall SW-5. The soil-to-sediment pathway, therefore, is considered complete for the PBA AA.

3.5.6. La Calavera AA

Table 3-6 lists the complete or reasonably anticipated to be complete exposure pathways that must be taken into consideration when establishing the assessment level for environmental media for the LC AA. Each exposure pathway is discussed below.

3.5.6.1. Groundwater

$^{GW}GW_{Ing}$. Groundwater at the Site is not used as a drinking water source and the alluvial water supply wells are not affected by impacted groundwater from the Site. The groundwater resource at the AA, therefore, is considered Class 2. Class 2 groundwater can be used as a potable water source. Thus, the ingestion of COCs in groundwater pathway ($^{GW}GW_{Ing}$) is considered complete for the LC AA.

$^{Air}GW_{Inh\text{-}V}$. COCs at the LC AA are not volatile; therefore, this pathway is considered incomplete.

^{SW}GW. Groundwater from the LC AA does not discharge directly to the Rio Grande; therefore, the groundwater-to-surface-water exposure pathway is considered incomplete.

^{Sed}GW. As previously stated, groundwater from the LC AA does not discharge directly to the Rio Grande; therefore, the groundwater-to-sediment-exposure pathway is considered incomplete.

3.5.6.2. Soil

$^{Tot}Soil_{Comb}$. The LC AA is an undeveloped area that is projected for C/I land use. The direct contact pathways, therefore, are considered complete. The $^{Tot}Soil_{Comb}$ PCL based on C/I land use will be applied.

$^{Air}Soil_{Inh-VP}$. The exposure pathway for inhalation of COCs adsorbed to fugitive dusts is considered complete for the LC AA; however, consideration of the direct contact exposure pathway ($^{Tot}Soil_{Comb}$) accounts for the inhalation exposure to fugitive dust.

$^{Air}Soil_{Inh-V}$. COCs at the LC AA are not volatile; therefore, this pathway is considered incomplete.

$^{GW}Soil_{Ing}$. The exposure pathway for COCs from Site soils to groundwater is considered incomplete for the LC AA, because the contamination is related strictly to the aerial deposition of fine-grained slag material from slag processing operations and from stack emission of the operating smelter. There are disposal areas or locations for disposal of process materials at the LC AA. However, remedial investigation work performed by the USEPA for the El Paso County Metal Survey described in Section 1.2.3 (Weston Solutions, Inc., 2002) reported that elevated concentrations of arsenic and lead in surface soil from aerial deposition were limited to the first few inches of the surface regardless of the time frame over which the deposition occurred. USEPA data indicated arsenic and lead concentrations at background levels or detection limits within a few (3 to 6) inches of the surface. The dramatic decrease in concentration was observed regardless of the surficial concentrations reported in the samples from the 0- to 2-inch sampling interval.

The lack of vertical migration for arsenic and lead from surficial deposition in the La Calavera neighborhood reported by the USEPA was supported by soil characterization data collected by ASARCO. As summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a), vertical delineation of arsenic and lead in the surface soil of the LC AA occurred within the first few feet of the soil column, indicating vertical migration is not occurring.

Only one groundwater monitoring well, EP-86, is located in the LC AA. Groundwater quality samples collected from this well had lead concentrations below the 0.015 mg/L MCL, and arsenic concentrations consistent with other background wells between 0.01 mg/L and 0.02 mg/L. The presence of lead in surface soil at concentrations up to 1,820 mg/kg did not lead to groundwater impacts. The average concentration of lead in soil samples reported from the LC AA is 217 mg/kg, which is significantly above the Tier 1 ^{GW}Soil PCL for lead of 1.5 mg/kg, as well as the Tier 2 ^{GW}Soil PCL of 90 mg/kg calculated for the Site assuming a loam soil type and a pH of 8.0. Similar results are evident for arsenic concentrations in soil samples from the LC AA compared to the groundwater concentrations of arsenic in samples from EP-86. Arsenic concentrations in surface soil samples ranged from non-detect to 655 mg/kg, which is significantly above the Tier 1 $^{GW}Soil_{Ing}$ PCL of 2.5 mg/kg. The average concentration of arsenic in soil samples from the LC AA is 88 mg/kg, which is also much greater than the Tier 1 soil-to-groundwater PCL.

The investigation results are supported by site characterization data demonstrating the depth to groundwater between 20 and 30 feet bgs, and soil characteristics with alkaline soil with an average soil pH above 8. The arid weather conditions of El Paso present little precipitation for infiltration, removing a driving force for the vertical migration of soil-bound metals. Taken together, the site characterization and monitoring data collected over the past 15 years provide sufficient support to conclude that the soil-to-groundwater pathway is considered incomplete for the LC AA.

$^{SW\text{-}GW}$Soil. As described above, the soil-to-groundwater pathway is considered incomplete for the LC AA.

^{Eco}Soil. The LC AA does not have any habitat areas attractive to ecological receptors. The exposure pathway for direct contact of ecological receptors to COCs in soil at the LC AA is considered incomplete.

^{Sed}Soil. Sheet-flow stormwater runoff from the LC AA does not discharge directly to the Rio Grande; therefore, the soil-to-sediment-exposure pathway is considered incomplete. Stormwater runoff from the area flows onto Paisano Drive and is managed with stormwater runoff from the roadway.

3.5.7. Floodplain

Table 3-7 lists the complete or reasonably anticipated to be complete exposure pathways that must be taken into consideration when establishing the assessment level for environmental media for the Floodplain. Each exposure pathway is discussed below.

3.5.7.1. Groundwater

$^{GW}GW_{Ing}$. Groundwater at the Site is not used as a drinking water source and the alluvial water supply wells are not affected by impacted groundwater from the Site. The groundwater resource at the AA, therefore, is considered Class 2. Class 2 groundwater can be used as a potable water source. Thus, the ingestion of COCs in groundwater pathway ($^{GW}GW_{Ing}$) is considered complete for the Floodplain AA.

$^{Air}GW_{Inh\text{-}V}$. COCs at the Floodplain AA are not volatile; therefore, this pathway is considered incomplete.

^{SW}GW. Groundwater from the Floodplain AA discharges directly to the Rio Grande. The groundwater-discharge-to-surface-water exposure pathway is considered complete for the Floodplain AA.

^{Sed}GW. Groundwater from the Floodplain AA discharges directly to the Rio Grande; therefore, the groundwater-to-sediment exposure pathway is considered complete.

3.5.7.2. Soil

^{Tot}Soil$_{Comb}$. The Floodplain AA is completely developed based on the previous land use. The Floodplain AA will remain C/I land use under all future land use planning scenarios. The direct contact pathways, therefore, are considered complete. The ^{Tot}Soil$_{Comb}$ PCL based on C/I land use will be applied.

^{Air}Soil$_{Inh\text{-}VP}$. The exposure pathway for inhalation of COCs adsorbed to fugitive dusts is considered complete for the Floodplain AA; however, consideration of the direct contact exposure pathway (^{Tot}Soil$_{Comb}$) accounts for the inhalation exposure to fugitive dust.

^{Air}Soil$_{Inh\text{-}V}$. COCs at the Floodplain AA are not volatile; therefore, this pathway is considered incomplete.

^{GW}Soil$_{Ing}$. As described for the LC AA, there are no slag storage piles or process material disposal areas within the Floodplain AA. The source of COCs to surface soil in the Floodplain AA has been from historical deposition from stack emissions and fugitive dusts from slag processing activities. Much of the Floodplain AA has imported fill, which may have also served as a source of COCs to the Floodplain AA.

As previously discussed for the LC AA, deposition of stack emissions from smelter operations and fugitive dust emissions from slag crushing activities does not provide a source of metals to surface soil that readily migrate vertically through the soil column. The vertical distribution of COCs in surface soil at the Floodplain AA and analytical data for surface soil samples provided in the Revised Supplemental RI (Malcolm Pirnie, 2014a) support this conclusion. For the Floodplain AA, additional data suggest the lack of a soil-to-groundwater pathway for this media by comparing concentrations of arsenic, copper, and lead in surface soil across the AA compared to the distribution of chemicals in groundwater.

Concentrations of lead and copper are elevated in the surface soil samples from the Floodplain AA, ranging from 6 mg/kg to 4,200 mg/kg and from 10 mg/kg to 7,200 mg/kg, respectively. The highest concentrations are associated with samples collected from 0 to 3 feet bgs. These concentrations are significantly higher than the Tier 1 ^{GW}Soil PCLs. The groundwater concentrations for lead and copper in samples from wells within the Floodplain AA, however, do not exhibit elevated levels. Concentrations of lead in groundwater samples from wells in the Floodplain AA are typically below the method reporting limit of 0.0007 mg/L, which is an order of magnitude below the critical groundwater PCL of 0.009 mg/L based on surface water protection. Copper concentrations in groundwater samples are also very low, with the highest reported concentration in the sample collected during spring 2012 at 0.0403 mg/L, which is below the critical groundwater PCL of 0.07 mg/L based on protection of surface water quality.

Arsenic is the most significant COC in groundwater and soil at the Floodplain AA. Arsenic concentrations in soil range from 4 mg/kg to 240 mg/kg, while groundwater concentrations range from 1.17 mg/L to 13.8 mg/L. The groundwater concentration contour maps for arsenic are presented on **Figures 3-1 and 3-2**. **Figure 3-1** provides an illustration of arsenic concentrations in the spring of 2012 and reflects groundwater conditions during low-flow periods when groundwater discharge to the Rio Grande is likely to occur. **Figure 3-2** provides an illustration of arsenic contours in the fall of 2012 during high flow conditions. As illustrated on these figures, groundwater impacts in the Floodplain AA are continuous with plumes extending from source areas in the PBA AA and the Acid Plant Arroyo AA. Arsenic concentrations in groundwater samples decrease across the Floodplain AA, indicating that arsenic in soil from the Floodplain AA is not providing an additional source.

The depth to groundwater in the Floodplain AA ranges from 10 to 13 feet bgs. The soil type in the Floodplain AA is a similar alkaline loam as reported for the rest of the Site; however, it is characterized as a silty loam rather than sandy loam (see Section 2.1.2). The soil type and arid conditions do not promote vertical migration of arsenic. Based on cumulative monitoring and site characterization data, the soil-to-groundwater pathway is considered incomplete for the Floodplain AA.

$^{\mathbf{SW\text{-}GW}}$**Soil**. As described above, the soil-to-groundwater pathway is considered incomplete at the Floodplain AA.

$^{\mathbf{Eco}}$**Soil.** The Floodplain AA does not have any habitat areas attractive to ecological receptors. The exposure pathway for direct contact of ecological receptors to COCs in soil at the Floodplain AA is considered incomplete.

$^{\mathbf{Sed}}$**Soil.** Sheet-flow stormwater runoff from the Floodplain AA is directed to roadside stormwater drainage swales of Paisano Drive. Monitoring data for sediment quality in the Rio Grande demonstrate that the SWCRS effectively controls discharge of COCs in stormwater runoff (see Section 2.1.4). The site characterization data for the Floodplain AA presented in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a) indicate elevated concentrations of arsenic, lead, and copper in surfaces soil at the Floodplain AA. Historical sediment monitoring data demonstrate reductions in COC concentrations from control of Plant Site stormwater discharges. The reduction of metals in sediment of the Rio Grande following completion of stormwater drainage improvements demonstrates that stormwater discharge from the Plant Site, not sheet-flow runoff from the Floodplain AA, has the greatest influence on sediment quality. The soil-to-sediment exposure pathway for the Floodplain AA is considered incomplete.

3.6. Exposure Pathway Summary

Potentially complete exposure pathways for COCs were evaluated using the tables obtained from the TCEQ APAR form (TCEQ form 10325) for each of the AAs at the Site. The site characterization data were used to evaluate whether pathways are potentially complete for COCs in each environmental media for all potential receptor populations. Each of the AAs had unique combinations of COCs, impacted media, and potentially complete pathways. **Table 3-8** provides a summary of the complete pathways for each of the AAs based on this analysis.

4. Protective Concentration Level Development

PCLs are risk-based remediation levels derived using algorithms and exposure assumptions (30 TAC §350.74), chemical and physical parameters (30 TAC §350.73), and toxicity factors updated annually with Tier 1 PCL updates. PCLs have been derived for site-specific exposure media and land use scenarios consistent with current and future land uses.

4.1. Groundwater PCLs

Groundwater PCLs have been derived based on exposure pathways including direct potable use ($^{GW}GW_{Ing}$), groundwater discharge to surface water (^{SW}GW) in the Rio Grande, and adsorption of COCs from discharging groundwater to sediment (^{Sed}GW) in the Rio Grande. Three monitoring wells were identified as being upgradient from contamination sources at the Site. Groundwater quality sample results from semiannual monitoring events conducted between 2003 and 2013 were used to establish background concentrations of metals with regularly detected concentrations. The upper predicted limit (UPL) was calculated at a 95% confidence limit for a one-tail test. The average and UPL concentrations of metals in groundwater samples are summarized in **Table 4-1** and presented in detail in **Appendix K**.

The most significant background concentrations reported are for arsenic and selenium. Both of these COCs have background concentrations in excess of regulatory levels. The UPL for arsenic is 0.02 mg/L, which is higher than its MCL of 0.01 mg/L. The UPL for selenium is 0.035 mg/L, which is below its MCL of 0.05 but higher than the surface water quality criterion of 0.005 mg/L.

The groundwater PCLs for the Site were derived by taking the higher of the Tier 1 $^{GW}GW_{Ing}$ PCLs and the calculated background concentrations. The ^{GW}GW PCLs for the Site are summarized in **Table 4-2**. Additional PCLs for groundwater are based on the groundwater-to-surface water pathway (^{SW}GW). The calculation of ^{SW}GW PCLs is based on site-specific information used to calculate groundwater-to-surface water dilution factors. The calculation of the dilution factor for groundwater discharge to surface water at the Site is discussed below.

Groundwater from the PBA, Acid Plant Arroyo, and Pond 5/6 Arroyo AAs discharges to the Floodplain, while significantly lesser flows from the Plant Entrance Arroyo, South Terrace Arroyo, Pond 1 Arroyo, and Floodplain AAs discharge directly to the Rio Grande. The TCEQ publishes critical low stream channel flow rates for listed segments of waters of the State in the *Procedures for the Implementation of Texas Surface Water Quality Standards* (TCEQ, 2010). The Rio Grande in the vicinity of Site is identified as Segment 2314 in the TSWQS (30 TAC §307). Segment 2314 has a reported 7Q2 flow rate of 2.1 cfs under low-flow conditions during winter and spring months when the IBWC restricts flow on the Rio Grande (TCEQ, 2010). The groundwater flow from the combined Plant Site arroyos and PBA AAs is estimated to be 0.052 cfs (see Section 2.1.5.1). TCEQ guidance allows for a Tier 2 PCL calculation of ^{SW}GW PCLs based on site-specific dilution factors (30 TAC §350.75(i)(4)(E)). Site-specific dilution factors can be calculated using the relative surface water critical low-flow rate (7Q2) and the groundwater flow rate using the following equation (RG-366, TRRP-24):

$$Dilution\ Factor = \frac{GW\ F}{GW\ F + 7Q2}$$

where:

GW F = Groundwater Flow (cfs)

7Q2 = Critical Low Surface Water Flow Rate (cfs)

The corresponding combined dilution factor for all of the arroyos at the Site is 0.02441 based on a 7Q2 flow rate in the Rio Grande of 2.1 cfs and a groundwater flow from the AAs of 0.052 cfs. **Table 4-3** presents a summary of the ^{SW}GW PCLs using the site-specific dilution factor. The dilution factor is based on site-specific measurements of groundwater flow. The groundwater flow is largely based on groundwater gradient, which will be subject to controls associated with the remedial response at the Site. The initial calculation of the dilution factor and subsequent ^{SW}GW PCLs are subject to change following implementation of the remedial action. As a result, the PCLs calculated for the ^{SW}GW pathway will be used only to identify PCLE Zones; they will not be used as cleanup goals or action attenuation levels. New ^{SW}GW PCLs will be calculated based on groundwater gradients following implementation of gradient control measures described in the RAP.

Finally, PCLs were calculated for COCs in groundwater discharging to the Rio Grande that can potentially adsorb to sediment. The ^{Sed}GW PCLs for the Site are summarized in **Table 4-4**. The groundwater-to-sediment PCL was calculated using equations presented in TCEQ guidance (RG-366/TRRP-24) as follows:

$$^{Sed}GW = \ ^{Sed}PCL \times K_{Sed-w} \times SWMF$$

where:

^{Sed}GW = Groundwater-to-sediment PCL
SWMF = Surface water mixing factor (assumed to be 1)
K_{Sed-w} = Sediment-groundwater partitioning coefficient [(mg/L-groundwater)/(mg/kg-sediment)]

$$K_{Sed-w} = \frac{\rho_{Sed}}{\theta + K_d \rho_{Sed}}$$

where:

ρ_{Sed} = Sediment bulk density (1.67 g/cm^3 – TRRP-24)
θ = Sediment porosity (0.37 cm^3- pore space/cm^3 – sediment – TRRP-24)
K_d = Sediment-water sorption coefficient [g-H_2O/g-sediment – (30 TAC 350.73(f)]

4.2. Soil PCLs

Similar to the discussion for groundwater PCL derivation, soil PCLs are derived using algorithms and assumptions published in the TRRP regulations. As described in Section 2.1.2, the soils at the Site are very alkaline in nature. Based on soil pH data presented in **Appendix D**, the soil-to-groundwater ($^{GW}Soil_{Ing}$) PCLs were calculated assuming a site-specific soil pH of 8. The soil-to-groundwater equation is published in the TRRP rule (30 TAC 350.75(b)(1)):

$$^{GW}Soil = \frac{Groundwater\ PCL\ \times LDF}{K_{SW}}$$

where:

$^{GW}Soil$	=	Soil-to-groundwater PCL
LDF	=	Leachate dilution factor [assumed to be 10 based on 30-acre affected property – 30 TAC 350.75(b)(1)]
K_{SW}	=	Soil-leachate partitioning coefficient [(mg/L-groundwater)/(mg/kg-soil)]

$$K_{SW} = \frac{\rho_b}{\theta_{ws} + K_d\rho_b + H'\theta_{as}}$$

where:

ρ_b	=	Soil bulk density [1.67 g/cm^3 – 30 TAC 350.75(b)(1)]
θ_{ws}	=	Water content of vadose zone [0.16 cm^3 – water/cm^3 – soil – 30 TAC 350.75(b)(1)]
Θ_{as}	=	Air content of vadose zone [0.21 cm^3 – water/cm^3 – soil – 30 TAC 350.75(b)(1)]
H′	=	Henry's constant – dimensionless [30 TAC 350.73(f)]
K_d	=	Soil-water sorption coefficient [g-H_2O/g-soil – (30 TAC 350.73(f)]

The calculations of Tier 2 $^{GW}Soil_{Ing}$ PCLs and $^{SW\text{-}GW}Soil$ PCLs are presented in **Appendix L**. **Table 4-5** provides a summary of the soil PCLs for residential land use, while **Table 4-6** provides a summary of soil PCLs calculated for C/I land use.

The $^{GW}Soil$ and $^{SW\text{-}GW}Soil$ PCLs for lead were calculated assuming a loam soil type as described for Site soils in Section 2.1.2. Soil-to-groundwater-to-surface water PCLs ($^{SW\text{-}GW}Soil$) were calculated using the same equations and assumptions applied to the $^{GW}Soil$, except the use of the surface water PCL (^{SW}SW) was used as the groundwater concentration input. The $^{SW\text{-}GW}Soil$ PCLs are summarized in **Table 4-7**. The $^{SW\text{-}GW}Soil$ PCLs for chromium, copper, mercury, and zinc are based on groundwater PCLs for the ^{Sed}GW pathway.

The soil-to-sediment ($^{Sed}Soil$) exposure pathway was based on the entrainment of impacted surface soil in stormwater runoff and the conveyance of these impacted soils to a surface water body such as the Rio Grande (PBA AA) or the American Canal (East Mountain AA). No numeric

PCLs are presented in this Report for this exposure pathway; the mitigation of entrained sediments in stormwater runoff is to be addressed for the two previously mentioned AAs using BMPs as described in the Multi-sector General Permit for stormwater discharge under the TPDES. The RAP for the East Mountain AA and the PBA AA will include addressing the ^{Sed}Soil exposure pathway through application of the appropriate BMPs to control the entrainment of sediment in stormwater discharges at the Site.

4.3. Surface Water PCLs

Surface water PCLs (^{SW}SW) are derived based on the use classification of the water body published in the TSWQS (30 TAC §307). Segment 2314 of the Rio Grande is classified as being used as a potable water source and a highly valued ecological habitat. As a result, the ^{SW}SW PCLs were derived from a comparison of aquatic life criteria (acute and chronic criteria) and human health-based criteria (consumption of water and aquatic organisms and consumption of organisms only). The aquatic life criteria for arsenic, cadmium, chromium, copper, lead, nickel, and zinc have hardness-dependent toxicity criteria and are based on dissolved concentrations of metals. The calculated aquatic life criteria for these metals are presented in **Appendix M**. The hardness and total suspended solids (TSS) data used to calculate aquatic life criteria for these metals were obtained from the *Procedures for the Implementation of Texas Surface Water Quality Standards* (TCEQ, 2010). A comparison of aquatic life criteria and human health-based criteria is presented in **Table 4-8**.

4.4. Sediment PCLs

Sediment PCLs for metals in the Rio Grande are based on direct contact with human receptors under a recreational scenario and ecological receptors based on benthic organisms. The human health-based Tier 1 PCLs for recreational exposure ($^{Tot}Sed_{Comb}$) are based on incidental ingestion and dermal absorption routes of exposure. **Appendix N** presents a summary of the TCEQ Tier 1 $^{Tot}Sed_{Comb}$ PCLs. The ecological PCLs for sediment in the Rio Grande (^{Eco}Sed) are based on the midpoint concentration between benchmark levels and secondary effect levels published in the TCEQ *Guidance for Conducting Ecological Risk Assessments at Hazardous Waste Sites in Texas* (RG-263;TCEQ, 2014). A summary of sediment PCLs for the Rio Grande is presented in **Table 4-9**.

The maximum concentrations of COCs in sediment samples collected from monitoring locations in 2008 and 2009 (**Table 2-3**) are below their respective sediment PCLs. These results demonstrate that the SWCRS described in Section 2.1.4 has been effective in protecting sediment quality in the Rio Grande. No further evaluations of sediment are presented in this Report. All remedial alternatives evaluated as part of the RAP will include evaluation of the soil-to-sediment (^{Sed}Soil) exposure pathway to ensure future protection of sediment quality in the river.

4.5. PCL Summary by Assessment Area

The PCLs that have been developed for soil and groundwater at the Site are based on exposure pathways as described in Section 3. The specific exposure pathways and corresponding PCLs for each AA within the Site are summarized in the sections below.

4.5.1. East Mountain AA

The complete exposure pathways identified for soil in the East Mountain AA include C/I $^{Tot}Soil_{Comb}$ and residential $^{Air}Soil_{Inh\text{-}VP}$. The chemical-specific PCLs for the potentially complete pathways at the East Mountain AA are summarized in **Table 4-10**. The $^{Sed}Soil$ pathway for the East Mountain AA also must be addressed based on the entrainment of surface soil in stormwater runoff that discharges to the American Canal through stormwater drainage outfall SW-1.

4.5.2. East Property AA

The complete exposure pathways identified for the East Property AA include residential $^{Tot}Soil_{Comb}$, residential $^{GW}Soil_{Ing}$, $^{Air}Soil_{Inh\text{-}VP}$, and $^{GW}GW_{Ing}$. The $^{Air}Soil_{Inh\text{-}VP}$ pathway is included in the multiple pathways contained in the $^{Tot}Soil_{Comb}$ calculation. The $^{Air}Soil_{Inh\text{-}VP}$ pathway, therefore, is accounted for through application of the $^{Tot}Soil_{Comb}$ PCL. The $^{Tot}Soil_{Comb}$ PCL is applicable solely to surface soil defined as 0 to 15 feet bgs for residential soil, while the $^{GW}Soil_{Ing}$ PCL is applicable to both the surface soil and subsurface soil defined as 15 feet bgs to the groundwater table. The chemical-specific PCLs for the potentially complete pathways at the East Property AA are summarized in **Table 4-11**.

The East Property AA is the only AA at the Site for which ecological receptors were determined to be at potential hazard from exposure to COCs in soil of the South Arroyo. Ecological-based ($^{Eco}Soil$) PCLs were derived for arsenic, cadmium, copper, lead, and zinc in surface soil (0 to 0.5 foot bgs for ecological receptors) and subsurface soil (0.5 to 5 feet bgs for ecological receptors). **Figure 2-14** presents the outline of the South Arroyo area that will be designated as an open-space set-aside. The response action for this area will be based on the $^{Eco}Soil$ PCLs. As part of the RAP, an institutional control will be established restricting the area from residential or C/I land use. **Table 4-12** provides a summary of the $^{Eco}Soil$ for soil in the South Arroyo.

4.5.3. Plant Site: Plant Entrance Arroyo AA

The complete exposure pathways identified for the Plant Entrance Arroyo AA include C/I $^{Tot}Soil_{Comb}$, $^{Air}Soil_{Inh\text{-}VP}$, $^{GW}GW_{Ing}$, ^{Sed}GW, and ^{SW}GW due to its proximity to the Rio Grande. The $^{Air}Soil_{Inh\text{-}VP}$ PCL is accounted for through the application of the $^{Tot}Soil_{Comb}$. The ^{SW}GW and ^{Sed}GW PCLs are considered complete pathways due to groundwater discharge to the Rio Grande. The soil-to-groundwater pathways are not considered complete due to the vertical distribution of COCs in surface soil at the Plant Entrance AA and unimpacted groundwater in the AA. The chemical-specific PCLs for the potentially complete pathways at this AA are summarized in **Table 4-13**.

4.5.4. Plant Site: South Terrace Arroyo AA and Pond 1 Arroyo AA

The complete exposure pathways identified for the South Terrace Arroyo AA and Pond 1 Arroyo AA include C/I $^{Tot}Soil_{Comb,}$ $^{Air}Soil_{Inh\text{-}VP}$, $^{GW}Soil_{Ing}$, $^{SW\text{-}GW}Soil$, $^{GW}GW_{Ing}$, ^{Sed}GW, and ^{SW}GW due to their proximities to the Rio Grande. The $^{Air}Soil_{Inh\text{-}VP}$ PCL is accounted for through the application of the $^{Tot}Soil_{Comb}$. The ^{SW}GW PCL and subsequent calculation of the $^{SW\text{-}GW}Soil$ PCL account for the $^{GW}GW_{Ing}$ and $^{GW}Soil$ pathways, because the Rio Grande is evaluated as a drinking water source. The chemical-specific PCLs for the potentially complete pathways at these AAs are summarized in **Table 4-14**.

4.5.5. Plant Site: Acid Plant Arroyo AA and Pond 5/6 Arroyo AA

The complete exposure pathways identified for the Acid Plant Arroyo AA and Pond 5/6 Arroyo AA include C/I $^{Tot}Soil_{Comb,}$ $^{Air}Soil_{Inh\text{-}VP}$, $^{SW\text{-}GW}Soil$, $^{GW}Soil_{Ing}$, ^{Sed}GW, ^{SW}GW, and $^{GW}GW_{Ing}$ due to groundwater from these AAs discharging to the Floodplain AA. Groundwater from these two AAs does not discharge to the Rio Grande. The $^{Air}Soil_{Inh\text{-}VP}$ pathway is generally addressed by the application of the $^{Tot}Soil_{Comb}$ PCL; however, site characterization data indicate locations within these two AAs with concentrations of PCBs and mercury above their respective $^{Air}Soil_{Inh\text{-}VP}$ PCLs. Both PCBs and mercury have the ability to volatilize and migrate through soil caps. As a result, areas with PCB concentrations above 47 mg/kg and mercury concentrations above 22 mg/kg would need to be excavated prior to capping activities. The Pond 5/6 Arroyo and Acid Plant Arroyo AAs are the only areas within the Site that have been impacted by PCBs. The PCB-impacted soils are localized to areas near the former Powerhouse building and the former converter building. The ^{SW}GW and ^{Sed}GW PCLs and subsequent calculation of the $^{SW\text{-}GW}Soil$ PCL are included in addition to the $^{GW}GW_{Ing}$ and $^{GW}Soil$ pathways, because the Rio Grande is evaluated as a drinking water source and for high ecological habitat use. The chemical-specific PCLs for the potentially complete pathways at the Acid Plant Arroyo AA and Pond 5/6 Arroyo AA are summarized in **Table 4-15**.

4.5.6. Parker Brothers Arroyo AA

The complete exposure pathways identified for the PBA AA include C/I $^{Tot}Soil_{Comb,}$ $^{Air}Soil_{Inh\text{-}VP}$, $^{GW}Soil_{Ing}$, $^{SW\text{-}GW}Soil$, ^{Sed}GW, ^{SW}GW, and $^{GW}GW_{Ing}$ due to groundwater from these AAs discharging to the Floodplain AA. The ^{SW}GW and ^{Sed}GW PCLs and subsequent calculation of the $^{SW\text{-}GW}Soil$ PCL are included in addition to the $^{GW}GW_{Ing}$ and $^{GW}Soil_{Ing}$ pathways, because the Rio Grande is evaluated as a drinking water source as well as a high ecological habitat use. The chemical-specific PCLs for the potentially complete pathways at the PBA AA are summarized in **Table 4-16**. The $^{Sed}Soil$ pathway for the PBA AA also must be addressed based on the entrainment of surface soil in stormwater runoff that discharges to the Rio Grande through stormwater drainage outfall SW-5.

4.5.7. La Calavera AA

The complete exposure pathways identified for the LC AA include residential $^{Tot}Soil_{Comb,}$ $^{Air}Soil_{Inh\text{-}VP}$, and $^{GW}GW_{Ing}$. The $^{Air}Soil_{Inh\text{-}VP}$ is accounted for by the application of the $^{Tot}Soil_{Comb}$.

The chemical-specific PCLs for the potentially complete pathways at the LC AA are summarized in **Table 4-17**.

4.5.8. Floodplain AA

The complete exposure pathways identified for the Floodplain AA include C/I $^{Tot}Soil_{Comb}$, $^{GW}GW_{Ing}$, and ^{SW}GW. The $^{GW}GW_{Ing}$ pathway is accounted for in the ^{SW}GW PCL because the Rio Grande is evaluated as a potable water source. The chemical-specific PCLs for the potentially complete pathways at the Floodplain AA are summarized in **Table 4-18**.

4.6. PCL Development Summary

PCLs were calculated for each of the environmental media impacted by COC concentrations above residential screening levels and for each of the complete exposure pathways described in Section 3 of this Report. The direct contact PCLs for both residential and C/I land uses are based on Tier 1 $^{Tot}Soil_{Comb}$ PCLs reported by the TCEQ for all COCs except arsenic. The arsenic $^{Tot}Soil_{Comb}$ PCLs for residential (46 mg/kg) and C/I (320 mg/kg) land uses are based on Tier 2 calculations using a 40% relative bioavailability factor reported by the USEPA. Groundwater PCLs are based on Tier 1 $^{GW}GW_{Ing}$ PCLs based on direct potable use of Class 1/Class 2 groundwater, and fate-and-transport PCLs based on groundwater discharge to surface water (^{SW}GW). The ^{SW}GW PCLs are based on dilution factors calculated from site-specific groundwater flux estimates and published minimum flow rates for the Rio Grande above the International Dam (Segment 2314) as published in the TCEQ Surface Water Quality Standard Implementation Procedures (RG-194; TCEQ, 2010). The ^{SW}GW is considered an initial PCL used strictly for establishing PCLE Zones. The ^{SW}GW PCLs are based on groundwater gradients for individual AAs. These gradients will be that will be addressed as part of the remedial action at the Site. As a result, the ^{SW}GW PCLs will be recalculated based on groundwater gradient controls as part of the RAP for the Site.

Additional fate-and-transport PCLs have been calculated for soil. Soil-to-groundwater PCLs ($^{GW}Soil_{Ing}$) are based on Tier 2 calculations that consider site-specific soil characteristics, while soil-to-groundwater-to-surface-water PCLs were calculated based on both soil characteristics and the dilution factor for the Rio Grande. Surface water PCLs are based on both human health receptors and ecological receptors. Ecological-based PCLs in surface water are based on total concentrations of metals in surface water using site-specific values for surface water hardness and TSS in the Rio Grande. A summary of PCLs for soil, groundwater, and surface water at the Site is presented in **Table 4-19**.

5. Protective Concentration Level Exceedence Zones

5.1. Current Distribution of COCs in Soil

The distribution of COCs in soil at the Site is based on the data presented in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). PCLE Zones were established by comparing chemical concentrations in environmental samples to the PCLs discussed in Section 4. PCLE Zone maps (**Figures 5-1 through 5-81**) that illustrate locations where exceedences of risk-based remediation levels occur will serve as the basis for developing the RAP.

5.1.1. East Mountain AA

Results for soil samples collected in the East Mountain AA during all phases of RI activities are summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Concentrations of all COCs, AOIs, and thallium were either below detection limits or the Risk Reduction Standard 3 soil/air ingestion standard for residential use (SAI-Res) with the exception of:

- Antimony
- Arsenic
- Lead
- Mercury

All surface soil samples collected from the East Mountain AA had concentrations of these four COCs below their respective ${}^{Air}Soil_{Inh\text{-}VP}$ PCLs for residential soil. These comparisons mean that concentrations of COCs in surface soil of the East Mountain AA are below a level of concern for inhalation of wind-blown dust for hypothetical residences constructed on the East Mountain property. As a result, it is concluded that wind-blown dust from the East Mountain AA does not pose a potential risk to off-site receptors. No further evaluation of this pathway for the East Mountain AA is required.

A total of 35 samples were collected for antimony analysis. Concentrations ranged from non-detect to a maximum value of 137 mg/kg observed at AMSS-05. **Figure 5-1** provides a PCLE Zone map of antimony in surface soil between 0 and 5 feet bgs. All of the reported concentrations of antimony are below the ${}^{Tot}Soil_{Comb}$ PCL for C/I soil, indicating there is no PCLE Zone for antimony in the East Mountain AA. No further analysis of antimony in the East Mountain AA is required.

A total of 42 samples were collected for arsenic analysis with concentrations of arsenic ranging from 4.25 mg/kg to a maximum of 615 mg/kg. Elevated arsenic concentrations are primarily within the 0- to 0.5-foot-bgs interval. **Figure 5-2** provides a PCLE Zone map for arsenic in surface soil between 0 and 5 feet bgs. Concentrations for all but two sampling locations were below the ${}^{Tot}Soil_{Comb}$ PCL for C/I soil. The 95% upper confidence limit (UCL) on the average arsenic concentration in surface soil of the East Mountain AA is 126 mg/kg, which is below the C/I PCL of 320 mg/kg. No further analysis of arsenic in surface soil of the East Mountain AA is required since the representative concentration for arsenic based on the 95% UCL is below the critical PCL.

A total of 42 samples were collected for lead analysis with concentrations ranging from 2.51 mg/kg to a maximum value of 5,570 mg/kg at AM-SS05. Concentrations of lead in soil in the East Mountain AA are less widespread than arsenic concentrations, and are primarily present within the 0- to 0.5-foot-bgs interval. **Figure 5-3** provides a PCLE Zone map for lead in surface soil between 0 and 5 feet bgs. Four of 42 locations had concentrations of lead in surface soil above the C/I PCL. The 95% UCL for lead in surface soil at the East Mountain AA is 1,046 mg/kg, which is below the 1,600 mg/kg C/I PCL for lead in soil. No further analysis of lead in surface soil of the East Mountain AA is required.

A total of 35 samples were collected for mercury analysis with mercury concentrations ranging from 0.02 mg/kg to a maximum of 1.82 mg/kg observed at E140-44 in the 0- to 0.5-foot-bgs interval. The distribution of mercury is less widespread than arsenic and lead. **Figure 5-4** provides a PCLE Zone map for mercury in surface soil between 0 and 5 feet bgs. All of the reported concentrations of mercury are below the ${}^{Tot}Soil_{Comb}$ PCL for C/I soil. No further analysis of mercury in the East Mountain AA is required.

5.1.2. East Property AA

Results for soil samples collected in the East Property AA during all phases of RI activities are summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Concentrations of all COCs, AOIs, and thallium were either below detection limits or the SAI-Res standard with the exception of:

- Antimony
- Arsenic
- Cadmium
- Copper
- Lead
- Mercury
- Selenium

Zinc was added to the COC list based on ecological receptors in the South Arroyo. The distribution of the chemicals exceeding the residential standards is associated with the at least one of the following:

- Slag or other waste material;
- Deposition of chemicals from emissions caused by smelter operations; and/or
- Deposition of wind-blown ores or concentrates from the Site.

Antimony concentrations were reported for 73 samples, all from the 0- to 5-foot-bgs soil interval and all associated with waste piles or historical slag placement within this AA. **Figure 5-5** provides a PCLE Zone map for antimony in surface soil between 0 and 15 feet bgs. Five locations had antimony concentrations above the ${}^{GW}Soil_{Ing}$ PCL, of which two locations also exceeded the ${}^{Tot}Soil_{Comb}$ PCL. These locations will be evaluated in developing the PCLE Zones for each of these pathways.

Concentrations of arsenic in 354 samples ranged from 1.19 mg/kg to 15,600 mg/kg. Elevated concentrations of arsenic are associated with waste piles, slag disposal areas, and the former landfill area on the East Property AA. Additional areas with elevated concentrations of arsenic were also observed in surface soil intervals less than 1 foot bgs outside these areas, due to the deposition of airborne dust. **Figure 5-6** provides a PCLE Zone map for arsenic in surface soil between 0 and 15 feet bgs prior to removals conducted by the Trust, and **Figure 5-7** provides a PCLE Zone map for arsenic in subsurface soil between 15 feet bgs and the groundwater table. A total of 63 surface soil samples had arsenic concentrations greater than the ${}^{GW}Soil_{Ing}$ PCL of 5.9 mg/kg. Of these, 27 surface soil samples also exceeded the direct contact PCL (${}^{Tot}Soil_{Comb}$) of 46 mg/kg. The surface footprint of the PCLE Zone for the ${}^{Tot}Soil_{Comb}$ pathway is illustrated in red on **Figures 5-6 and 5-7** (also, the open space that will be preserved as habitat is illustrated by a green boundary line).

Arsenic in South Arroyo soil was evaluated based on comparisons to a site-specific ${}^{Eco}Soil$ PCL for arsenic of 82 mg/kg in surface soil 0 to 0.5 foot bgs. A total of 15 sampling locations, primarily in the western portion of the South Arroyo, have concentrations of arsenic above the ${}^{Eco}Soil$ PCL and represent the PCLE Zone for this pathway.

Several outliers with concentrations of arsenic above its 46 mg/kg residential ${}^{Tot}Soil_{Comb}$ PCL are reported in historical soil samples from locations BL-39 (62 mg/kg), BL-40 (54 mg/kg), BL-49 (62 mg/kg), and BL-50 (187 mg/kg). These samples were collected as part of the ASARCO Phase III RI (Hydrometrics, 2001) described in Section 1.2.3. The historical sampling locations were resampled in 2011 as part of the East Property surface soil investigation, and were determined not to be representative of current conditions. Arsenic concentrations in 2011 soil samples from locations corresponding to the historical BL- sample locations range from 1.19J mg/kg (E140-1) to 29 mg/kg (E140-30).

Concentrations of cadmium in soil samples from the East Property ranged from 0.28 mg/kg to 3,500 mg/kg with exceedences of the ^{GW}Soil PCL primarily associated with surface soil (0 to 15 feet bgs) from slag deposits, waste piles, and the landfill in this AA. Cadmium concentrations exceeding the PCL correspond to areas of elevated arsenic concentrations. **Figure 5-8** provides a PCLE Zone map for cadmium in surface soil between 0 and 15 feet bgs, and **Figure 5-9** provides a PCLE Zone map for cadmium in subsurface soil between 15 feet bgs and the groundwater table.

To evaluate ecological endpoints, South Arroyo soil samples were compared to the site-specific ^{Eco}Soil PCL for cadmium of 20 mg/kg in surface soil 0 to 0.5 foot bgs. A total of 11 sampling locations, primarily in the western portion of the South Arroyo, had concentrations of cadmium above the ^{Eco}Soil PCL and represent the PCLE Zone for this pathway.

Concentrations of copper ranged from 1.96 mg/kg to 150,000 mg/kg in soil samples, with most PCL exceedences associated with the former landfill and waste piles on the East Property. **Figure 5-10** provides a PCLE Zone map for copper in surface soil between 0 and 15 feet bgs, and **Figure 5-11** provides a PCLE Zone map for copper in subsurface soil between 15 feet bgs and the groundwater table.

To evaluate ecological receptors, South Arroyo soil samples were compared to the site-specific ^{Eco}Soil PCL for copper of 560 mg/kg in surface soil 0 to 0.5 foot bgs. A total of 15 sampling locations, primarily in the western portion of the South Arroyo, had concentrations of copper above the ^{Eco}Soil PCL and represent the PCLE Zone for this pathway. Three sample locations had copper concentrations above the ^{Eco}Soil PCL (1,263 mg/kg) for subsurface soil (0.5 to 5 feet bgs). All exceedences of the subsurface PCL for copper occurred in the depth interval from 0.5 to 2 feet bgs.

Similar to arsenic, several outliers were reported in historical samples with concentrations of copper above its $^{Tot}Soil_{Comb}$ PCL at locations BL-39 (668 mg/kg), BL-40 (771 mg/kg), and BL-50 (1,940 mg/kg). Copper concentrations in 2011 soil samples from locations corresponding to the historical BL- sample locations ranged from 8.27 mg/kg (E140-4) to 510 mg/kg (E140-30), indicating the historical data were no longer representative.

Concentrations of lead in soil samples ranged from 3.4 mg/kg to 106,000 mg/kg. Waste piles, the landfill, and slag placement are primary sources of lead in soil. Some exceedences within the surface soils (0- to 0.5-foot-bgs interval) are also due to the deposition of airborne dusts. **Figure 5-12** provides a PCLE Zone map for lead in surface soil between 0 and 15 feet bgs, and **Figure 5-13** provides a PCLE Zone map for lead in subsurface soil between 15 feet bgs and the groundwater table.

To evaluate effects on ecological receptors, concentrations of lead in South Arroyo soil samples were compared to the site-specific ^{Eco}Soil PCL for lead of 370 mg/kg in surface soil 0 to 0.5 foot bgs. A total of 15 sampling locations, primarily in the western portion of the South Arroyo, had concentrations of lead above the ^{Eco}Soil PCL and represent the PCLE Zone for this pathway.

Concentrations of mercury in samples ranged from less than 0.000721 mg/kg to 458 mg/kg. **Figure 5-14** provides a PCLE Zone map for mercury in surface soil between 0 and 15 feet bgs. No exceedences of mercury concentrations in surface soil or subsurface soil samples were reported for mercury; therefore, no PCLE Zone is established for mercury in the East Property.

Concentrations of selenium ranged from 0.19 mg/kg to 1,880 mg/kg. **Figure 5-15** provides a PCLE Zone map for selenium in surface soil between 0 and 15 feet bgs, and **Figure 5-16** provides a PCLE Zone map for selenium in subsurface soil between 15 feet bgs and the groundwater table.

Concentrations of zinc exceeding the ^{Eco}Soil standard were observed in soil samples at the South Arroyo. Zinc concentrations exceeding the ^{Eco}Soil PCL are limited to surface soil (0 to 0.5 foot bgs) in soil of the intermittent drainage in the western portion of the South Arroyo. **Figure 5-17** provides a PCLE Zone map for zinc in surface soil between 0 and 0.5 foot bgs, and **Figure 5-18** provides a PCLE Zone map for zinc in subsurface soil between 0.5 and 5 feet bgs.

5.1.3. Plant Site

5.1.3.1. Plant Entrance Arroyo AA

Results for soil samples collected in the Plant Entrance Arroyo AA during all phases of RI activities are summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Concentrations of all COCs were either below detection limits or the Risk Reduction Standard 3 soil/air ingestion standard for industrial use (SAI-Ind) with the exception of:

- Arsenic
- Lead

All reported concentrations of arsenic and lead exceeded their respective $^{GW}Soil_{Ing}$ PCLs in both surface soil (0 to 5 feet bgs) and subsurface soil (5 feet bgs to groundwater table). The $^{GW}Soil_{Ing}$ pathway will be addressed in the RAP for the Plant Entrance Arroyo AA. The $^{Tot}Soil_{Comb}$ PCL for arsenic under C/I land use is 320 mg/kg.

The maximum concentration of arsenic in soil within the Plant Entrance Arroyo AA is 1,300 mg/kg with nine of 51 samples exceeding the 320 mg/kg $^{Tot}Soil_{Comb}$ PCL. These concentrations correlate to areas of historical ore and concentrate or slag placement and are present in the 0- to 2-foot-bgs interval. **Figure 5-19** provides a PCLE Zone map for arsenic in surface soil between 0 and 5 feet bgs, and **Figure 5-20** provides a PCLE Zone map for arsenic in subsurface soil between 5 feet bgs and the groundwater table.

The maximum concentration of lead in soil within the Plant Entrance Arroyo AA was 9,600 mg/kg with 10 of 11 samples within the 0- to 5-foot-bgs interval having lead concentrations above the 1,600 mg/kg $^{Tot}Soil_{Comb}$ PCL. Concentrations of lead exceeding the PCLs are associated with the historical placement of ores and concentrates or slag. **Figure 5-21** provides a PCLE Zone map for lead in surface soil between 0 and 5 feet bgs, and **Figure 5-22** provides a PCLE Zone map for lead in subsurface soil between 5 feet bgs and the groundwater table.

5.1.3.2. South Terrace Arroyo AA

Results for soil samples collected in the South Terrace Arroyo AA during all phases of RI activities are summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Concentrations of all COCs and AOIs were either below detection limits or the SAI-Ind standard with the exception of:

- Arsenic
- Cadmium
- Copper
- Lead
- Mercury

Based on the boring logs and the evaluation of historical aerial photographs, the concentrations of these chemicals are primarily associated with the historical placements of ores and concentrates or slag over native material. All concentrations of arsenic, copper, and lead in surface soil samples exceeded their respective $^{GW}Soil_{Ing}$ PCLs. The soil-to-groundwater pathway will be addressed in the RAP for the South Terrace Arroyo AA.

Concentrations of arsenic in soil samples ranged from 2.58 mg/kg to a maximum of 15,000 mg/kg. The South Terrace Arroyo AA is in direct communication with the American Canal and Rio Grande; therefore, the $^{SW\text{-}GW}Soil$ PCL is the critical PCL for surface soil. Of 69 surface soil samples collected, 31 had arsenic concentrations above the $^{SW\text{-}GW}Soil$ PCL for arsenic of 130 mg/kg.

Arsenic concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL are distributed along the central portion of the South Terrace AA in the vicinity of the railroad tracks, which correspond to areas of historical ore and concentrate placement. Exceedences are present in the 0- to 5-foot-bgs interval; however, one location (EP-70) had elevated concentrations at depths of 35 to 41 feet bgs. This area is thought to be located within or close to an arroyo that was subsequently filled with slag and waste material. **Figure 5-19** provides a PCLE Zone map for arsenic in surface soil between 0 and 5 feet bgs, and **Figure 5-20** provides a PCLE Zone map for arsenic in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of cadmium range from 0.212 mg/kg to a maximum of 2,200 mg/kg. The $^{Tot}Soil_{Comb}$ PCL for cadmium under C/I land use is 820 mg/kg, while the $^{SW\text{-}GW}Soil$ PCL is

2,900 mg/kg. The $^{Tot}Soil_{Comb}$ PCL is the critical PCL. Cadmium concentrations exceed the $^{Tot}Soil_{Comb}$ PCL in the 0- to 2-foot-bgs interval in the vicinity of the former railroad tracks, which is associated with historical ore and concentrate placement. **Figure 5-23** provides a PCLE Zone map for cadmium in surface soil between 0 and 5 feet bgs, and **Figure 5-24** provides a PCLE Zone map for cadmium in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of copper in soil samples ranged from 3.08 mg/kg to a maximum of 190,000 mg/kg. The $^{Tot}Soil_{Comb}$ PCL for copper under C/I land use is 39,000 mg/kg, while the $^{SW\text{-}GW}Soil$ PCL is 890 mg/kg. The $^{SW\text{-}GW}Soil$ PCL, therefore, is the critical PCL. A total of 37 surface soil samples of the 74 sample collected had copper concentrations above the 890 mg/kg $^{SW\text{-}GW}Soil$ PCL.

Copper concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL are limited to intervals less than 1 foot bgs in the vicinity of the former railroad tracks, which is associated with historical ore and concentrate placement. **Figure 5-25** provides a PCLE Zone map for copper in surface soil between 0 and 5 feet bgs, and **Figure 5-26** provides a PCLE Zone map for copper in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of lead in soil samples ranged from 4.25 mg/kg to a maximum of 51,000 mg/kg. Lead concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL follow a distribution similar to arsenic concentrations and are restricted to the 0- to 5-foot-bgs interval in the vicinity of the former railroad tracks. **Figure 5-21** provides a PCLE Zone map for lead in surface soil between 0 and 5 feet bgs, and **Figure 5-22** provides a PCLE Zone map for lead in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of mercury in soil samples ranged from 0.01 mg/kg to a maximum of 10.8 mg/kg. The $^{Tot}Soil_{Comb}$ PCL for mercury under C/I land use is 20 mg/kg, while the $^{SW\text{-}GW}Soil$ PCL is 16 mg/kg. The $^{Tot}Soil_{Comb}$ PCL, therefore, is the critical PCL for mercury in surface soil. All mercury concentrations in surface soil samples were below the site-specific C/I $^{Tot}Soil_{Comb}$ PCL of 20 mg/kg. **Figure 5-27** provides a PCLE Zone map for mercury in surface soil between 0 and 5 feet bgs, and **Figure 5-28** provides a PCLE Zone map for mercury in subsurface soil between 5 feet bgs and the groundwater table.

5.1.3.3. Pond 1 Arroyo AA

Results for soil samples collected in the Pond 1 Arroyo AA during all phases of RI activities are summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Concentrations of all COCs, AOIs, and cyclohexanone were either below detection limits or the SAI-Ind standard with the exception of:

- Arsenic
- Cadmium

- Copper
- Lead
- Mercury

Concentrations of arsenic in soil samples ranged from 0.7 mg/kg to a maximum of 6,600 mg/kg (observed at SS-IAB22 in the 0- to 1-foot-bgs interval). The Pond 1 Arroyo AA is also in direct communication with the American Canal and Rio Grande, so the $^{SW\text{-}GW}$Soil PCL is the critical PCL for surface soil. Of 134 surface soil samples collected, 45 had arsenic concentrations above the $^{SW\text{-}GW}$Soil PCL. Arsenic concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL are within the 0- to 5-foot-bgs interval and are associated with the historical placement of slag or fill material. **Figure 5-19** provides a PCLE Zone map for arsenic in surface soil between 0 and 5 feet bgs, and **Figure 5-20** provides a PCLE Zone map for arsenic in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of cadmium in soil samples ranged from 0.22 mg/kg to a maximum of 2,600 mg/kg in the 0- to 1-foot-bgs interval. Only two locations in surface soil of the Pond 1 Arroyo AA had cadmium concentrations that exceed the $^{Tot}Soil_{Comb}$ PCL. **Figure 5-23** provides a PCLE Zone map for cadmium in surface soil between 0 and 5 feet bgs.

Distribution of copper in surface soil at the Pond 1 Arroyo is illustrated on the PCLE Zone map presented on **Figure 5-25**, while copper concentrations above their respective PCLs in subsurface soil between 5 feet bgs and the groundwater table are illustrated on **Figure 5-26**. Of 134 surface soil samples collected, 60 had copper concentrations above the $^{SW\text{-}GW}$Soil PCL.

Concentrations of lead in soil samples ranged from 6.02 mg/kg to a maximum of 29,000 mg/kg. Lead concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL in the Pond 1 Arroyo are within the 0- to 5-foot-bgs interval and show a distribution similar to arsenic. **Figure 5-21** provides a PCLE Zone map for lead in surface soil between 0 and 5 feet bgs, and **Figure 5-22** provides a PCLE Zone map for lead in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of mercury in soil samples ranged from 0.01 mg/kg to a maximum of 5.35 mg/kg. All mercury concentrations were below the site-specific C/I $^{Tot}Soil_{Comb}$ PCL for mercury. Mercury concentrations did exceed the $^{SW\text{-}GW}$Soil PCL within the 0- to 5-foot-bgs interval, concurrent with elevated arsenic and lead concentrations. **Figure 5-27** provides a PCLE Zone map for mercury in surface soil between 0 and 5 feet bgs.

Concentrations of arsenic, copper, and lead in subsurface soil of the Pond 1 Arroyo AA were above their respective $^{SW\text{-}GW}$Soil PCLs and can be attributed to historical plant activities; this area was used for receiving, handling, and storing incoming feed material and slag. Slag was placed to level the slope along the western boundary of the Site, which has contributed to elevated lead and arsenic concentrations at these locations.

5.1.3.4. Pond 5/6 Arroyo AA

Results of soil samples collected in the Pond 5/6 Arroyo AA during all phases of RI activities are summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Concentrations of all COCs, AOIs, and thallium were either below detection limits or the SAI-Ind standard with the exception of:

- Antimony
- Arsenic
- Cadmium
- Copper
- Lead
- Mercury

Concentrations of antimony in soil samples from the Pond 5/6 Arroyo AA ranged from 0.367 mg/kg to a maximum of 738 mg/kg. The ${}^{Tot}Soil_{Comb}$ PCL for antimony in C/I surface soil is 310 mg/kg compared to the ${}^{SW\text{-}GW}Soil$ PCL of 56 mg/kg. The Pond 5/6 Arroyo AA is partially in direct communication with the American Canal and Rio Grande; therefore, the ${}^{SW\text{-}GW}Soil$ PCL is the critical PCL for surface soil. Nine of the 21 surface soil samples collected had antimony concentrations above the ${}^{SW\text{-}GW}Soil$ PCL of 56 mg/kg.

Only one reported antimony concentration exceeds the ${}^{Tot}Soil_{Comb}$ PCL of 310 mg/kg in surface soil (0- to 0.5-foot-bgs interval) from an isolated location impacted by historical smelter activities. **Figure 5-29** provides a PCLE Zone map for antimony in surface soil between 0 and 5 feet bgs, and **Figure 5-30** provides a PCLE Zone map for antimony in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of arsenic in soil samples from the Pond 5/6 Arroyo AA ranged from 3.01 mg/kg to a maximum of 20,000 mg/kg. Arsenic concentrations in 49 surface soil samples out of a total of 116 samples collected exceeded the ${}^{SW\text{-}GW}Soil$ PCL of 130 mg/kg. Arsenic concentrations exceeding the ${}^{Tot}Soil_{Comb}$ PCL were found at 20 sampling location in surface soil with variable distribution and depth across this AA. Arsenic concentrations at depths greater than 10 feet bgs are associated with the former pond areas and the historical arroyos where slag was used to even out the topographic surface and process waters stored in the ponds. Outside of these areas, arsenic concentrations are primarily restricted to surface soil (less than 5 feet bgs). Arsenic concentrations exceeding the ${}^{SW\text{-}GW}Soil$ PCL for arsenic along and immediately adjacent to the western boundary of the Pond 5/6 Arroyo AA are associated with historical placement of slag material used to level the topographic surface. **Figure 5-31** provides a PCLE Zone map for arsenic in surface soil between 0 and 5 feet bgs, and **Figure 5-32** provides a PCLE Zone map for arsenic in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of cadmium in soil samples ranged from 0.306 mg/kg to a maximum of 11,000 mg/kg in the Pond 5/6 Arroyo AA. Cadmium concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL are restricted to five sample locations from two primary areas: the center of the Pond 5/6 Arroyo AA at BH9-6-22 and BH-9-6-23 within the 0- to 2-foot-bgs interval, and the southwestern corner of the AA at BH13-1, BH13-2, and EP-101 within depths up to 21 feet bgs. **Figure 5-33** provides a PCLE Zone map for cadmium in surface soil between 0 and 5 feet bgs, and **Figure 5-34** provides a PCLE Zone map for cadmium in subsurface soil between 5 feet bgs and the groundwater table.

Copper concentrations in 56 of a total of 116 surface soil samples exceeded the copper $^{SW\text{-}GW}Soil$ PCL of 890 mg/kg in this AA. The distribution of copper concentrations in surface soil at the Pond 5/6 Arroyo is illustrated on **Figure 5-35**, and concentrations in subsurface soil between 5 feet bgs and the groundwater table are illustrated on **Figure 5-36**.

Lead concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL are widely distributed across the Pond 5/6 Arroyo AA. Concentrations of lead in soil samples ranged from 1.56 mg/kg to a maximum of 71,000 mg/kg. The locations correlate with areas where arsenic concentrations exceed the SAI-Ind; however, there is a greater density of elevated lead concentrations in the central to western portion of the Pond 5/6 Arroyo AA in the vicinity of the former lead plant. Lead concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL are generally present at a more shallow depth interval than arsenic concentrations and are also typically within the 0- to 5-foot-bgs interval. **Figure 5-37** provides a PCLE Zone map for lead in surface soil between 0 and 5 feet bgs, and **Figure 5-38** provides a PCLE Zone map for lead in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of mercury in soil samples from the Pond 5/6 Arroyo AA ranged from 0.01 mg/kg to a maximum of 9.37 mg/kg. No reported mercury concentrations exceed the site-specific C/I $^{Tot}Soil_{Comb}$ PCL of 20 mg/kg. **Figure 5-39** provides a PCLE Zone map for mercury in surface soil between 0 and 5 feet bgs.

In addition to the COCs and AOIs described above, eight samples from two locations (APA-SB01 and APA-SB02) were also collected for pH analysis. The pH values ranged from 6.97 to 8.74, suggesting that the soils tested were not impacted by historical acid spills.

Concentrations of metal COCs at the Pond 5/6 Arroyo AA are widely distributed. Antimony, cadmium, copper, and lead concentrations are present at depth and also occur in surface soils, less than 5 feet bgs, and are linked to historical plant operations, process water pond locations, and slag placement. Arsenic concentrations are present at depths greater than 5 feet bgs and can be attributed to areas where slag was used as fill material, such as in the historical arroyos.

5.1.3.5. Acid Plant Arroyo AA

Results for soil samples collected in the Acid Plant Arroyo AA during all phases of RI activities are summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Concentrations of all COCs, AOIs, and other analytes were either below detection limits or the SAI-Ind standard with the exception of:

- Antimony
- Arsenic
- Cadmium
- Copper
- Lead
- Mercury
- Selenium

Concentrations of antimony in soil samples from the Acid Plant Arroyo AA ranged from 4.59 mg/kg to a maximum of 1,760 mg/kg, observed at CON-SS03 in the 0- to 0.5-foot-bgs interval. Elevated antimony concentrations are restricted to surface soils (less than 0.5 foot bgs) in the former Contop-Reverb-Converter Building/Baghouse IA and Electrostatic Precipitation Area (Contop-Reverb area) and the former Zinc Plant. A total of 10 of 20 surface soil samples had antimony concentrations above the 56 mg/kg $^{SW\text{-}GW}$Soil PCL. **Figure 5-29** provides a PCLE Zone map for antimony in surface soil between 0 and 5 feet bgs, and **Figure 5-30** provides a PCLE Zone map for antimony in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of arsenic in soil samples from the Acid Plant Arroyo AA ranged from 10 mg/kg to a maximum of 25,300 mg/kg observed at CON-SS03 in the 0- to 0.5-foot-bgs interval. Arsenic concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL are widely distributed across the central to western portion of this AA at depths up to 57 feet bgs (BH3-6). Elevated arsenic concentrations are associated with historical slag deposition across the western portion of this AA. A total of 59 of 91 surface soil samples had arsenic concentrations above the $^{SW\text{-}GW}$Soil PCL. **Figure 5-31** provides a PCLE Zone map for arsenic in surface soil between 0 and 5 feet bgs, and **Figure 5-32** provides a PCLE Zone map for arsenic in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of cadmium in soil samples ranged from 10 mg/kg to a maximum of 3,460 mg/kg observed at CON-SS03 in the 0- to 0.5–foot-bgs interval in the Acid Plant Arroyo AA. Cadmium concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL are restricted to the 0- to 1.5-foot-bgs interval. **Figure 5-33** provides a PCLE Zone map for cadmium in surface soil between 0 and 5 feet bgs.

A total of 58 of 91 surface soil samples had copper concentrations above the critical PCL of 890 mg/kg. The distribution of copper in surface soil at the Acid Plant Arroyo AA is illustrated on the PCLE Zone map presented as **Figure 5-35**, and concentrations in subsurface soil between 5 feet bgs and the groundwater table are illustrated on **Figure 5-36**.

Concentrations of lead in soil samples ranged from 11 mg/kg to a maximum of 43,700 mg/kg observed at CON-SS03 in the 0- to 0.5-foot-bgs interval within the Acid Plant Arroyo AA. Lead concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL are primarily distributed across the western portion of this AA, where historical slag was placed, and correspond to areas where elevated arsenic concentrations are also found. Lead concentrations exceeding the $^{Tot}Soil_{Comb}$ PCL are restricted to the 0- to 5-foot-bgs interval. The distribution of lead in surface soil at the Acid Plant Arroyo AA is illustrated on the PCLE Zone map presented as **Figure 5-37**, and concentrations in subsurface soil between 5 feet bgs and the groundwater table are illustrated on **Figure 5-38**.

Concentrations of mercury in soil samples ranged from 0.0103 mg/kg to a maximum of 24.5 mg/kg and 43.2 mg/kg observed at CON-SS03 and CON-SS05, respectively, in the former Contop-Reverb area in the southern portion of the Acid Plant Arroyo AA. Mercury concentrations at these two locations exceeded both the $^{Tot}Soil_{Comb}$ PCL (20 mg/kg) and $^{Air}Soil_{Inh\text{-}VP}$ (22 mg/kg). Since the mercury concentration in the soil sample from CON-SS05 exceeds the $^{Air}Soil_{Inh\text{-}VP}$ PCL, this area must be considered for soil removal rather than capping to control exposure to mercury in industrial soil. This will be addressed in the RAP. The areas with mercury concentrations above the C/I PCLs also correspond to areas of elevated arsenic and lead concentrations and locations of historical slag placement. **Figure 5-39** provides a PCLE Zone map for mercury in surface soil between 0 and 5 feet bgs, and **Figure 5-40** provides a PCLE Zone map for mercury in subsurface soil between 5 feet bgs and the groundwater table.

Selenium has a $^{Tot}Soil_{Comb}$ PCL of 4,900 mg/kg and a $^{SW\text{-}GW}Soil$ PCL of 4 mg/kg. The $^{SW\text{-}GW}Soil$ PCL is the critical PCL for soil at the Acid Plant Arroyo AA. The method reporting limit for soil samples from the Acid Plant Arroyo AA generally range from 10 mg/kg to 40 mg/kg. All surface soil samples had either detectable concentrations or non-detected reporting levels for selenium above the 4 mg/kg $^{sw\text{-}gw}Soil$ PCL. The distribution of selenium in surface soil at the Acid Plant Arroyo AA is illustrated on the PCLE Zone map presented as **Figure 5-41**, and concentrations in subsurface soil between 5 feet bgs and the groundwater table are illustrated on **Figure 5-42**.

Arsenic, lead, and mercury concentrations exceeding their respective $^{Tot}Soil_{Comb}$ PCLs are associated with historical slag placement, particularly at depths greater than 5 feet bgs and along the western boundary of the AA. Antimony and cadmium concentrations exceeding their respective $^{Tot}Soil_{Comb}$ PCLs are limited in extent and are restricted to surface soils (less than 1.5 feet bgs). Selenium concentrations exceeding the $^{SW\text{-}GW}Soil$ PCL are also present in surface soil within the Acid Plant Arroyo AA.

5.1.4. Parker Brothers Arroyo AA

Results of soil samples collected in the PBA AA during all phases of RI activities are summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Concentrations of all COCs and AOIs were either below detection limits or the SAI-Ind standard with the exception of:

- Antimony
- Arsenic
- Cadmium
- Copper
- Lead
- Mercury
- Selenium

The distribution of these COCs above their respective C/I PCLs is primarily associated with the placement of slag materials above the native material within arroyos as part of the historical leveling of the Plant Site. Additional details are provided below.

Concentrations of antimony in soil samples from the PBA ranged from non-detect to a maximum of 1,990 mg/kg observed at TPBY-3 in the 3- to 3.5-foot-bgs interval within the PBA AA. The presence of antimony in the PBA AA is associated with historical slag and debris placement in the Boneyard sub-area. **Figure 5-43** provides a PCLE Zone map for antimony in surface soil between 0 and 5 feet bgs, and **Figure 5-44** provides a PCLE Zone map for antimony in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of arsenic ranged from non-detect to a maximum of 4,830 mg/kg at TPBY-1 located in the Boneyard area in the 12-foot-bgs interval within the PBA AA. Concentrations of arsenic greater than the C/I $^{Tot}Soil_{Comb}$ PCL are associated with the Fines Pile and Boneyard sub-areas, and other areas within the PBA where historical slag placement occurred. **Figure 5-45** provides a PCLE Zone map for arsenic in surface soil between 0 and 5 feet bgs, and **Figure 5-46** provides a PCLE Zone map for arsenic in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of cadmium in soil samples ranged from 0.15 mg/kg to a maximum of 2,100 mg/kg within the PBA AA. Concentrations of cadmium in soil samples that exceed the PCLs are typically found in the Fines Pile and Boneyard sub-areas or areas of historical deposition of slag. The highest cadmium concentration (2,100 mg/kg) was observed at RI1-BH1 in the 40-foot-bgs interval. **Figure 5-47** provides a PCLE Zone map for cadmium in surface soil between 0 and 5 feet bgs, and **Figure 5-48** provides a PCLE Zone map for cadmium in subsurface soil between 5 feet bgs and the groundwater table.

No concentrations of copper exceeding the C/I $^{Tot}Soil_{Comb}$ PCL were observed in the 457 samples collected from the PBA. **Figure 5-49** provides a PCLE Zone map for copper in surface soil between 0 and 5 feet bgs, and **Figure 5-50** provides a PCLE Zone map for copper in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of lead in soil samples ranged from 2.32 mg/kg to a maximum of 24,400 mg/kg at TPBY-1 in the 12-foot-bgs interval within the Fines Pile and Boneyard sub-areas and/or areas of historical slag deposition within the PBA AA. **Figure 5-51** provides a PCLE Zone map for lead in surface soil between 0 and 5 feet bgs, and **Figure 5-52** provides a PCLE Zone map for lead in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of mercury in all soil samples from the PBA were below the site-specific C/I $^{Tot}Soil_{Comb}$ PCL except for two locations in the Boneyard including one of 458 mg/kg observed at WP-SS2A. Concentrations of mercury in all subsurface soil samples were below the $^{GW}Soil_{Ing}$ PCL associated with slag deposition and dust emissions. **Figure 5-53** provides a PCLE Zone map for mercury in surface soil between 0 and 5 feet bgs, and **Figure 5-54** provides a PCLE Zone map for mercury in subsurface soil between 5 feet bgs and the groundwater table.

Concentrations of selenium exceeding the groundwater protection standards were included in the Boneyard sub-area evaluation where molten slag and debris placement occurred within the PBA AA. **Figure 5-55** provides a PCLE Zone map for selenium in surface soil between 0 and 5 feet bgs, and **Figure 5-56** provides a PCLE Zone map for selenium in subsurface soil between 5 feet bgs and the groundwater table.

The distribution of COCs exceeding the C/I PCLs within the PBA AA and its sub-areas (the Boneyard, Fines Pile, and Ephemeral Pond) is characterized and the soil sampling network is sufficient to understand the distribution of COC and AOI concentrations. Concentrations exceeding the PCLs are primarily located in the Fines Pile and Boneyard and are associated with the molten and processed slag deposition activities that occurred in these areas. Within these areas, the concentrations of metals have been delineated to the groundwater table or to bedrock.

5.1.5. La Calavera AA

Results for soil samples collected in the LC AA during all phases of RI activities are summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Concentrations of all COCs and AOIs were either below detection limits or the SAI-Res standard with the exception of:

- Arsenic
- Lead

- Mercury

Concentrations of arsenic in soil samples collected in the LC AA ranged from 18 mg/kg to a maximum of 655 mg/kg. Concentrations of arsenic exceeding the $^{Tot}Soil_{Comb}$ PCL are present in surface soils (less than 0.5 foot bgs), and are associated with airborne dust emissions. **Figure 5-57** provides a PCLE Zone map for arsenic in surface soil between 0 and 15 feet bgs.

Concentrations of lead in soil samples in the LC AA ranged from 14 mg/kg to a maximum of 1,820 mg/kg. Concentrations of lead exceeding the $^{Tot}Soil_{Comb}$ PCL are present at depths in surface soils (less than 0.5 foot bgs), and are associated with airborne dust emissions. **Figure 5-58** provides a PCLE Zone map for lead in surface soil between 0 and 15 feet bgs.

One sample (WP-SS5) was collected from the 0- to 0.5-foot-bgs interval in the eastern part of the LC AA and analyzed for mercury. This sample had a mercury concentration below its site-specific residential $^{Tot}Soil_{Comb}$ PCL of 8.5 mg/kg. The sampling location is associated with the waste pile that has been removed from this location.

5.1.6. Floodplain AA

Results for soil samples collected in the Floodplain AA during all phases of RI activities are summarized in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Concentrations of all COCs and AOIs were either below detection limits or the SAI-Ind standard with the exception of:

- Arsenic
- Copper
- Lead

Concentrations of arsenic in soils samples from the Floodplain AA ranged from 2.9 to a maximum of 240 mg/kg. **Figure 5-59** provides a PCLE Zone map for arsenic in surface soil between 0 and 5 feet bgs, and **Figure 5-60** provides a PCLE Zone map for arsenic in subsurface soil between 5 feet bgs and the groundwater table.

The distribution of copper in surface soil at the Floodplain AA is illustrated on the PCLE Zone map presented on **Figure 5-61**, while copper concentrations above their respective PCLs in subsurface soil between 5 feet bgs and the groundwater table is illustrated on **Figure 5-62**.

Concentrations of lead in soil samples collected from the Floodplain AA ranged from 6.05 mg/kg to a maximum of 4,200 mg/kg at SSIA5-1. Lead concentrations in soil exceeding the C/I $^{Tot}Soil_{Comb}$ PCL are distributed across the Floodplain AA, but are primarily restricted to depths less than 3 feet bgs. **Figure 5-63** provides a PCLE Zone map for lead in surface soil between 0 and 5 feet bgs, and **Figure 5-64** provides a PCLE Zone map for lead in subsurface soil between 5 feet bgs and the groundwater table.

The distribution of arsenic and lead concentrations exceeding the SAI-Ind standard within the Floodplain AA has been characterized as being present at depths less than 1 foot bgs. The presence of arsenic and lead in surface soil are likely associated with airborne emissions or construction debris.

5.2. Current Distribution of COCs and AOIs in Groundwater

Groundwater at the Site is present within an unconfined alluvial aquifer, which is underlain by a regional, generally non-permeable bedrock unit. Groundwater in the alluvial aquifer flows west into the Rio Grande floodplain, ultimately discharging to the Rio Grande; however, there is also some seasonal groundwater discharge to sections of the American Canal.

Groundwater data from the five semiannual monitoring events completed since September 2010 are presented in the groundwater evaluation included in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). Monitoring was completed during:

- Fall 2010: August through September 2010
- Spring 2011: February through March 2011
- Fall 2011: August through September 2011
- Spring 2012: February through March 2012
- Fall 2012: August through September 2012

Based on the groundwater screening data presented in the Revised Supplemental RI Report, the metal COCs and AOIs described in the subsections below were detected above groundwater screening standards and are summarized in **Table 5-1**.

5.2.1. East Mountain AA

No alluvial aquifer exists on the East Mountain AA, and groundwater data are not collected for this AA.

5.2.2. East Property AA

The East Property AA includes the two former arroyos on the eastern side of I-10, which comprised the upper part of the drainage for the PBA (**Figure 1-1**). These two arroyos have been altered by Site activities on the East Property AA. The northern arroyo includes a concrete stormwater basin adjacent to I-10 to collect and route stormwater under I-10 and into the PBA. The southern drainage also includes a stormwater basin, which exits through a culvert and passes beneath I-10. During precipitation events, stormwater collects in these arroyo drainages and infiltrates to the alluvial groundwater system.

5.2.3. Plant Site

5.2.3.1. Plant Entrance Arroyo AA

Although monitoring wells EP-89 and EP-110 are located in the Plant Entrance Arroyo AA, these locations are not included in the interim site monitoring program. Historically, concentrations in samples collected from these monitoring wells have been below detection limits for all COCs and AOIs. While arsenic concentrations are observed at nearby monitoring locations EP-71 and EP-7 and exceed the screening standard of 0.01 mg/L, the historical data from EP-89 and EP-110 provide delineation to the south.

5.2.3.2. South Terrace Arroyo AA

The South Terrace Arroyo (**Figure 1-1**) was backfilled with clean fill and slag materials during the operational period of the Site. The major surface feature in this AA is the stormwater pond, which is lined and does not influence groundwater.

The following COCs and AOIs exceed screening standards in the South Terrace Arroyo AA:

- Metals: Arsenic, Cadmium, Selenium, and Thallium
- Water Quality Parameters: Nitrate

5.2.3.3. Acid Plant Arroyo AA

The Acid Plant Arroyo AA is located in the central portion of the Site (**Figure 1-1**) where numerous process operations occurred during the smelter operational history. As an outcome, a number of COCs and AOIs exceeding screening standards are within this AA:

- Metals: Antimony, Arsenic, Cadmium, Chromium, Lead, Mercury, Molybdenum, Nickel, Selenium, and Thallium
- Water Quality Parameters: Fluoride, Nitrate, and Nitrite

In the Acid Plant Arroyo AA, ongoing groundwater monitoring is conducted at monitoring wells EP-49, EP-51, and EP-52; due to historical operations, these wells exhibit the highest concentrations of antimony, arsenic, chromium, and mercury. Further, the elevated concentrations of chromium, lead, mercury, and nickel are very limited in extent, suggesting these higher concentrations are isolated “hotspots.”

5.2.3.4. Pond 1 Arroyo AA

The Pond 1 Arroyo AA is located in the central portion of the Site (**Figure 1-1**). Within the Pond 1 Arroyo AA, groundwater samples are collected from monitoring wells EP-68 and EP-12. Monitoring well EP-4 is located immediately west of the Pond 1 Arroyo AA at the downgradient slope of this AA and within the former arroyo flow path. Therefore, this location provides an indication of COC and AOI concentrations discharging from the AA. In addition, EP-14, EP-35, and EM-02 were sampled and analyzed for COCs and AOIs during spring and fall 2012 to further delineate the extent of impacts. The following COCs and AOIs exceed screening standards in the Pond 1 Arroyo AA:

- Metals: Arsenic, Selenium, and Thallium
- Water Quality Parameters: Nitrate

5.2.3.5. Pond 5/6 Arroyo AA

The Pond 5/6 Arroyo AA is located in the central portion of the Site (**Figure 1-1**). The monitoring well network includes EP-77 and EP-13. Monitoring well EP-116 is located immediately west of the Pond 5/6 Arroyo AA at the toe of the AA boundary slope and within the former Pond 5/6 Arroyo flow path. In addition to EP-116, downgradient off-site monitoring well EP-117 was sampled and analyzed for COCs and AOIs during spring and fall 2012. The following COCs and AOIs exceed screening standards in the Pond 5/6 Arroyo AA:

- Metals: Antimony, Arsenic, Cadmium, Copper, Lead, Mercury, Molybdenum, Selenium, and Thallium
- Water Quality Parameters: Fluoride and Nitrate

Cadmium, copper, and lead groundwater concentrations at EP-116 were the highest observed during the interim site monitoring. These isolated groundwater impacts at this location are associated with soil impacts observed at the toe of the slope in the immediate vicinity and not associated with groundwater from the upgradient areas of Ponds 5 and 6.

5.2.4. Parker Brothers Arroyo AA

The PBA AA is located at the northern end of the Site (**Figure 1-1**). The PBA was backfilled with fill and slag materials during the operational period of the Site. This AA has been the focus of remedial activities conducted to date including slag material removal, channel construction, and installation of two zero valent iron PRBs.

The PBA includes two of the primary areas of groundwater impacts at the Site: the Fines Pile/Ephemeral Pond area and the Boneyard sub-area. The distribution of COCs and AOIs in these two areas are discussed in detail in the Revised Supplemental RI Report (Malcolm Pirnie, 2014a). The following COCs and AOIs exceed screening criteria in the PBA AA:

- Metals: Antimony, Arsenic, Cadmium, Lead, Molybdenum, Selenium, Thallium, and Zinc
- Water Quality Parameters: Fluoride and Nitrate

Additionally, EP-75, located in the Boneyard sub-area, is a localized “hotspot” and exhibited the highest molybdenum, selenium, and thallium concentrations observed during the interim site monitoring.

5.2.5. La Calavera AA

The LC AA is an area north of the PBA that is proposed for future C/I use (**Figure 1-1**). Monitoring location EP-86 is the only monitoring well located in the LC AA. This monitoring well has historically been sampled as a background well, but has not been part of the ongoing groundwater sampling program.

5.2.6. Floodplain AA

The Floodplain AA is on the western, downgradient side of the Site (**Figure 1-1**). The Floodplain AA is located between Paisano Drive and the American Canal. The following COCs and AOIs exceed screening standards in the Floodplain AA:

- Metals: Antimony, Arsenic, Chromium, Molybdenum, Selenium, and Thallium
- Water Quality Parameters: Fluoride and Nitrate

As stated for the soils, there is poor correlation between the chemical concentrations in soil with high levels of copper and lead, which are accompanied by low concentrations of lead and copper in groundwater samples from wells located in the Floodplain AA. Most of the impacted groundwater in the Floodplain appears to be related to groundwater flows emanating from the PBA AA and the Acid Plant AA.

5.2.7. PCLE Zones in Groundwater

Groundwater PCLE Zones extend beyond individual AA boundaries; therefore, PCLE Zone maps have been prepared based on site-wide distribution of COCs in groundwater. **Figures 5-65 through 5-79** present PCLE Zones for the following COCs, respectively:

- Antimony – **Figure 5-65**
- Arsenic – **Figure 5-66**
- Cadmium – **Figure 5-67**
- Chromium – **Figure 5-68**

- Copper – **Figure 5-69**
- Lead – **Figure 5-70**
- Mercury – **Figure 5-71**
- Molybdenum – **Figure 5-72**
- Nickel – **Figure 5-73**
- Selenium – **Figure 5-74**
- Thallium – **Figure 5-75**
- Zinc – **Figure 5-76**
- Fluoride – **Figure 5-77**
- Nitrate – **Figure 5-78**
- Nitrite – **Figure 5-79**

5.3. PCLE Zone Summary

PCLE Zones were established by comparing chemical concentrations in environmental samples to the PCLs discussed in Section 4. PCLE Zone maps illustrate locations where COC concentrations in environmental media exceed their respective risk-based remediation levels and serve as the basis for developing the RAP under the TRRP. **Figure 5-80** provides a summary of the areal extent of sample locations that exceed either soil-to-groundwater PCLs ($^{GW}Soil_{Ing}$ or $^{SW\text{-}GW}Soil$) or the direct contact PCLs ($^{Tot}Soil_{Comb}$ – Res or C/I). **Figure 5-81** provides an illustration of monitoring well locations where COC concentrations in groundwater samples exceed $^{GW}GW_{Ing}$ and $^{SW\text{-}GW}GW$ PCLs. The PCLE Zones for soil and groundwater illustrate the extent of areas requiring response actions under the TRRP and will be used as the basis for developing a RAP based on Remedy Standard B for the Site. Due to the existing and proposed C/I land use at the Site, land use restrictions will result in concentrations of COCs above residential screening levels remaining in environmental media and requiring institutional and physical controls.

The overall approach for addressing individual PCLE Zones by AA and exposure pathway is summarized in **Table 5-2**. Generally, groundwater concentrations of COCs above the $^{GW}GW_{Ing}$ PCL will be addressed by institutional controls prohibiting the use of potable wells on the Site and establishment of a PMZ to move the points of compliance. Groundwater concentrations of COCs above the fate-and-transport PCLs (^{SW}GW and ^{Sed}GW) are to be addressed by soil removal, active groundwater remediation using in-situ PRBs in the PBA AA and groundwater gradient control through groundwater extraction and capping. Direct human contact with concentrations of COCs in surface soil and subsurface soil at the Site above their respective PCLs is largely being addressed by removals, capping, and institutional controls limiting future land use. Similar to direct contact with chemicals in soil, the migration of COCs from soil to groundwater is largely being addressed by removals, capping, and institutional controls. The RAP for the Site will provide details of the remedial actions, institutional controls, monitoring requirements, and operations and maintenance requirements to achieve the Remedy Standard B response action under the TRRP.

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