Appendix J:
Halaco IA Technical Addendum

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1.0 INTRODUCTION

This Technical Addendum to the IA report presents and analyzes data collected to characterize waste materials at the Halaco site. It contains the data description, statistical rendering, and calculated waste characteristics of the contents of the WMU, as well as other technical information and data.

A detailed description and history of the Halaco site are presented in the body of IA Report. A brief digest of the origin and disposition of the waste is presented for review purposes only; references for the information here may be found in the text of the IA Report. The target analytes described in this report include total metals, leachable metals under RCRA and California Title 22 waste laws, and radionuclides.

2.0 SITE DESCRIPTION

2.1 Location

The Halaco Site is located at 6200 Perkins Road, Oxnard, Ventura County, California. The geographic coordinates for the Site are 34º 8' 20" North latitude, 119º 10' 55" West longitude (Appendix D). The Halaco facility abuts the Ormond Beach wetlands and is in close proximity to the Ormond Beach Lagoon, Ormond Beach, and the Pacific Ocean. The location of the Site is shown in Figure 2-1.

2.2 Site Description

The Site consists of two separate parcels on either side of the Oxnard Industrial Drain (OID). The Smelter Area is approximately 11 acres and situated on the west side of the OID. It is jointly owned by the Clarence W. Haack Living Trust, John M. Haack, and Robert D. Haack. The Waste Management Area (WMA), which includes the Waste Disposal Area (WDA) and the Waste Management Unit (WMU), is approximately 27 acres and situated on the east side of the OID. It was recently acquired by Alpha and Omega Development, LLC.

The Site encompasses the following areas:

- Smelter Area – 11-acre parcel where smelting/recycling operations commenced, on the west side of the OID. The Smelter Area is paved in the southern portion and unpaved in the northern portion. There are several metal, brick, and concrete buildings in this area, as well as a cinder block fence that encloses three sides of the Site.
- Waste Management Unit (WMU) – an unlined surface impoundment capped with an evaporation or settling pond; the WMU encompasses the 14-acre, bermed area on the east side of the OID.
- Waste Disposal Area (WDA), north of the WMU – area covering approximately 13 acres to the north of the WMU where dried material from the WMU was historically spread.
- Nature Conservancy Land - East (NCL-east) - parcel directly east of the site owned by the Nature Conservancy.
- Nature Conservancy Land - North (NCL-north) - parcel due north of the WDA owned by the Nature Conservancy.
- Oxnard Industrial Drain (OID) – water body that bisects the Site.
- Ormond Beach - the public beach adjacent to the Site.

Halaco Engineering, Inc. operated an aluminum and magnesium recycling operation at the site from 1965 until 2004. Scrap metal materials were partially melted in the presence of a salt flux (typically magnesium, sodium, or potassium chloride). Target metals, usually aluminum and/or magnesium were then physically separated and decanted to make ingots for resale, The waste material underwent secondary recovery processes, which typically entailed further heating and mechanical separation. The resulting waste consists of a medium- to dark-gray material with a fine sand to silt grain size and high metals content.

The waste was slurried to a surface impoundment at the WMU for most of Halaco's operational history. The impoundment was constructed by building berm walls out of compacted waste material, then depositing the waste slurry in the impoundment. The WMU appears to have been constructed generally from the south to the north. The current configuration of the WMU covers 14 acres, has three containment ponds in the surface, and stands approximately 25 feet above grade.

From 1965 to 1977, Halaco processed magnesium-thorium scrap. Thorium, Potassium-40, and Cesium-137 have been detected in solid and/or leachate waste at the Halaco facility.

2.3 Previous Sampling

2.3.1 Metals

This section of the historical sampling summary discusses soil and waste material sampling and metals analysis activities between 1979 and 2004. The investigations that generated the data described below were performed by regulatory agencies and Halaco's consultants. Extensive data were available for areas east of the OID representing Halaco waste material. Limited data have been collected on areas west of the OID representing smelter operations. Soil and waste material concentrations are compared to appropriate hazardous waste determining and health-based action levels.

2.3.1.1 Soluble Threshold Limit Concentration (STLC) Metals

In October 1985, a total of 23 soil samples were collected by the DHS from background, foundry, WDA, and WMU locations. Samples were analyzed for STLC aluminum, cadmium, chromium, copper, lead, magnesium, and zinc. There are no STLC criteria for aluminum and magnesium. Aluminum STLC concentrations ranged from less than 10 to 3,900 miligrams per liter (mg/l). Magnesium concentrations ranged from 27 to 3,900 mg/l. Chromium, lead, and zinc did not exceed the STLC criteria. Cadmium concentrations exceeded the STLC of 1 mg/l in one sample collected from powder found in the foundry area at a concentration of 1.1 mg/l. Copper concentrations exceeded the STLC of 25 mg/l in two samples, both collected from the WMU, at concentrations of 30 and 650 mg/l (1).

In August 2002, Padre Associates, Inc., on behalf of Halaco, collected 73 samples from 28 borings within the WMU at depths varying from 2 to 30 feet bgs. Select samples were analyzed for STLC barium, copper, lead and zinc. Barium and zinc concentrations were reported for 20 of the samples and did not exceed the STLC criteria of 100 and 250 mg/l, respectively. Copper concentrations, ranging from 3.8 to 480 mg/l, exceeded the STLC limit of 25 mg/l in 44 of the 73 samples analyzed. The highest concentration was detected at 12 feet bgs in the WMU. Seven of the 28 boring locations had copper concentrations that exceeded the STLC in the top ten feet. The average STLC copper concentration for the WMU during this investigation was 45.5 mg/l, which is nearly twice the STLC for copper. Lead exceeded the STLC limit of 5 mg/l in 3 of the 73 samples analyzed, at 56, 6.3 and 5.2 mg/l. All three samples were collected between 12 and 14 feet bgs (2).

In October 2004, the DTSC collected five samples related to filter press operations from the foundry area. Samples were analyzed for STLC arsenic, barium, beryllium, cadmium, chromium, copper, lead, nickel, and zinc. Only beryllium concentrations exceeded the STLC criteria of 0.75 mg/l. Sample location maps were not provided for this data set. Filter cake has reportedly been shipped off-site to a waste facility in Arizona, but no manifests or bills of lading have been made available to confirm the waste disposition. Beryllium concentrations exceeded STLC criteria of 0.75 mg/l in 3 filter cake related samples at concentrations of 0.92, 1.4 and 2.2 mg/l (3).

2.3.1.2 Total Threshold Limit Concentration (TTLC) Metals

In December 1979, the California Department of Fish and Game (DFG) collected seven soil samples from the WMU, OID, and WDA. Soil samples were analyzed for arsenic, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc. Only copper and zinc exceeded TTLC criteria (4).

In December 1979, 18 soil samples were collected by the DHS and analyzed for TTLC metals. Samples were collected from in and around the WMU. Barium, chromium, lead, nickel and zinc concentrations were below TTLC criteria. Copper exceeded the TTLC criteria of 2,500 mg/kg in four of the five samples analyzed, ranging in concentration from 3,000 to 7,440 mg/kg. The highest copper concentration was located in the WMU, on the north side (5, 6).

Twelve soil samples were collected in and around the WMU by the National Enforcement Information Center for the EPA in December 1980 and were analyzed for total metals. Only copper and zinc exceeded TTLC criteria (7).

In August 1985, the DFG collected five soil samples from the WMU for heavy metals analysis. Only chromium, copper and zinc exceeded TTLC criteria (8).

In October 1985, the DHS collected and analyzed 38 soil samples from background, WMU, WDA, Ormond Beach, and foundry locations. Only copper and zinc exceeded TTLC criteria (9, 10).

In September 1991, Ecology and Environment, Inc., while performing a Listing Site Inspection (LSI) for the EPA, collected 30 soil samples east of the WMU, 49 soil samples north of the WMU using a 50 by 100 foot grid, and 7 background samples. Barium, beryllium and copper exceeded TTLC criteria. The LSI report concluded that hazardous substances, pollutants and contaminants exist within Halaco wastes and appear to have migrated off-site, to the area east of the WMU (11).

- Barium exceeded TTLC criteria of 10,000 mg/kg in one soil sample collected east of the WMU at a concentration of 21,800 mg/kg.
- Beryllium exceeded TTLC criteria of 75 mg/kg in one sample collected east of the WMU at 202 mg/kg and one soil sample from north of the WMU at 92.4 mg/kg.
- Copper exceeded TTLC criteria of 2,500 mg/kg with concentrations ranging from 2,880 to 5,050 mg/kg in five soil samples collected east of the WMU. Eleven soil samples from north of the WMU exceeded copper TTLC criteria with concentrations ranging from 2,630 to 8,740 mg/kg (28).

In October 2004, the DTSC collected five samples related to filter press operations from the foundry area. Samples were analyzed for select total metals. Only beryllium exceeded TTLC criteria. Sample location maps were not provided for this data set (4).

2.3.1.3 Toxicity Characteristic Leaching Procedure (TCLP) Metals

In December 1980, the EPA collected a total of fourteen samples from the WMU, OID, WDA, and east of the WMU, and analyzed for TCLP metals. None of the samples analyzed exceeded the TCLP criteria (5).

2.3.1.4 Preliminary Remediation Goals

Many metals, including some of those discussed in the paragraphs above, exceed the EPA Residential Preliminary Remediation Goals (PRG_rs). PRGs are "screening level" guidelines used by EPA to evaluate risks from chemical contaminants. PRGs are available for various media (soil, water, air) and for different exposure scenarios (e.g. soil in a residential area, soil in an industrial area, water used as drinking water supply). In most, but not all cases, no further action or study is warranted if contaminant concentrations are less than PRGs. If a contaminant concentration exceeds a PRG, further evaluation is usually appropriate. Exceeding a PRG does not necessarily imply that risks are at unacceptable levels and that cleanup is needed.

Of the over 190 samples collected between 1979 and 2004, described in the TTLC section above, metals data indicate that aluminum, arsenic, chromium, barium, cadmium, copper, lead, iron, manganese and vanadium exceeded their PRG_rs for one or more samples (12).

2.3.2 Radionuclides

In December 1979, Halaco collected and analyzed one composite sample from the WMU for radioactivity; no measurable radioactivity was detected (18). During the September 1991 E&E LSI, one sample was collected from east of the WMU and analyzed for alpha and beta radiation. Analytical results were less than 10 picoCuries per gram (pCi/g) for both samples (13). In December 1991, the DHS Radiologic Health Branch performed a walk-through survey for radiation with handheld instruments. The survey did not detect any radiation, however, it was noted that if radiation was present, it would be buried under 20 years of slag material (11).

In August 1999, LARWQCB staff inspected the site and collected environmental samples. Leachate was observed seeping out of the east side of Halaco's waste pile and flowing into the wetland area east of the WMU. A sample was collected in the immediate vicinity of a leachate seep and analyzed for thorium. This sample contained Thorium 232 (^{232}Th) and Thorium 228 (^{228}Th) at concentrations that were reported to be approximately 20 times that of background. A sediment sample was also collected from the bank surface of the OID and contained ^{232}Th and ^{228}Th at approximately 100 times that of the reported background level. The reported background level was approximately 1.0 pCi/g for both ^{232}Th and ^{228}Th (14).

In March 2000, the LARWQCB participated in a joint sampling event with Halaco. Results indicated Halaco's leachate was being discharged to groundwater as evidenced by the presence of Potassium 40 (^{40}K) in groundwater adjacent to the WMU. The groundwater sample collected adjacent to the WMU contained 15,190 picoCuries per liter (pCi/l) of ^{40}K. The background concentration in the OID was reported to be 44.7 pCi/l of ^{40}K. Halaco's effluent concentration was 10,610 pCi/l of ^{40}K. Results also indicated that leachate may have been discharged to surface water as evidenced by the presence of ^{40}K at concentrations ranging from 739 to 780 pCi/l of ^{40}K.

In October 2000, TetraTech reported the results of a limited Multi-Agency Radiation Site Survey and Investigation Manual (MARSSIM) survey for Halaco. The highest reading encountered was 15,000 counts per minute, located along the bank of the OID near the northeast bridge. This level was approximately five times the reported background radiation level. In a March 29, 2001 letter to Halaco regarding this report, the DHS indicated that the type of MARSSIM survey was not adequate to characterize radioactive contamination at the Halaco site. This letter references a sample collected by the DHS from Halaco in August 1999 that contained source material in excess of 0.05% by weight. The letter also reports that Halaco was a user as defined by California Code of Regulations Title 17 Section 30100 and subject to DHS licensing and regulation (16).

In August 2002, Padre Associates collected 20 waste samples from the WMU from depths ranging from 3 to 28 feet bgs. Samples were analyzed for ^{228}Th, ^{230}Th, and ^{232}Th. ^{228}Th concentrations ranged from 0.235 to 9.17 pCi/g, and exceeded the Rad-PRG for residential soil. ^{228}Th concentrations were less than the Rad-PRG for outdoor worker soil. ^{230}Th concentrations ranged from 0.358 to 9.52 pCi/g, and exceeded the Rad-PRG for residential soil. ^{230}Th concentrations were less than the Rad-PRG for outdoor worker soil. ^{232}Th concentrations ranged from 0.19 to 6.92 piC/g, and exceeded the Rad-PRG for residential soil. ^{232}Th concentrations were less than the Rad-PRG for outdoor worker soil. The highest concentrations were detected at 25 feet bgs, and elevated concentrations were also detected at the maximum explored depth of 28 feet bgs (16).

Previous industrial process wastewater sampling indicated detectable levels of Cesium-137 (^{137}Cs) at Halaco. A follow-up screening survey was performed by DHS staff to identify a source. Only elevated levels of ^{40}K were identified in areas where potash was used or stored. A subsequent wastewater sample was collected in June 2003 and indicated ^{40}K at 21,970 pCi/l and ^{137}Cs at 13.4 pCi/l. Both the ^{40}K and ^{137}Cs concentrations exceeded the Rad-PRGs for tap water. The levels of ^{137}Cs were approximately the same as earlier results indicating that there may have been a source of ^{137}Cs in Halaco's process system which was slowly being leached out during routine operations (17).

The Brash Industries Halaco Engineering WMU Data Analysis document reported that the highest thorium concentration detected in well water was ^{230}Th at 12 +/- 8.49 pCi/l collected in November 2003 (17). This concentration exceeds the Rad-PRG for ^{230}Th at 0.52 pCi/l.

3.0 DATA DESCRIPTION

3.1 Field Work

Samples were collected from the WMU, as well as other locations at the Site. Weston conducted 35 borings into the WMU waste pile. The purpose was to determine the vertical distribution of waste and degree of heterogeneity in the WMU. Weston advanced soil borings using a GeoProbe direct-push device with a two-inch diameter. Samples were collected in dedicated acetate sleeves that were pushed through the sampling interval to produce a 1.25-inch soil core. Weston logged the soils in these cores and collected the requisite sample volume, as directed by the SAP.

The WMU was divided into five populations, based on the historical growth of the waste pile. Borings were randomly located in each of the five populations. Weston advanced seven borings at randomly selected locations from within each population. Weston collected soil samples from 5, 10, 15, and 20-foot depths. All samples were screened for metals by EPA Method 6200. Seven samples from each population were submitted to a laboratory for total metals, TCLP, STLC, and radionuclide analyses.

3.2 Analytical Results

3.2.1 XRF Metals Results

Solid matrix samples were prepared in the manner described in EPA Method 6200. The samples were dried and sieved to remove gravel then placed in an XRF cup. The samples were analyzed using an EPA-owned Niton XLP 233 XRF unit. Samples were analyzed under controlled conditions in a former office within the Halaco facility.

The results of the XRF analysis for the WMU are presented in Appendix H of the IA Report; a summary of the XRF data is provided in Table 3-1 of the IA Report. Data are reported for antimony (Sb), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu) iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), selenium (Se), silver (Ag), and zinc (Zn). Of the target metals, aluminum (Al), magnesium (Mg), and beryllium (Be) could not be analyzed by XRF due to their low mass.

In order to provide the most comprehensive data set, a correlation between the XRF and definitive laboratory metals analyses is presented Appendix E. The correlations between individual analytes overlapping between the XRF and laboratory data are calculated using the Least Squares Regression function in Microsoft Excel. Data regressions with R values greater than or equal to 0.8 are considered acceptable; R values less than 0.8 may be useful as screening data, but with a significantly lower level of confidence. The R correlation values for overlapping data sets are presented in Table 3-1 of the IA Report. R values for Ba, Cu, Fe, Mn, and Zn are above 0.8 and are acceptable for use without qualification. R values for Pb, Mo, and Ni are between 0.8 and 0.6, and should be used with a modified level of confidence. R values for Sb, As, Cd, Co, and Ag are low primarily because of the low population of detected results in the XRF and/or laboratory data. The low R value for Cr indicates that the XRF results do not correlate with the laboratory data; therefore, the XRF data for this analyte were not used in the statistical analysis below.

3.2.2 Definitive Metals Results

The laboratory results for solid matrix samples are presented in Table 3-2 of the IA Report.

The definitive metals results for soils include samples collected from the Smelter (six samples), the NCL (eight samples) located directly east of the site, Agricultural soils (two samples), Residential soils (two samples), and a Background area (Bkgd; six samples) located west of the site. All soil metals data are compared with the California Title 22 TTLC values. None of the background soil samples exceed TTLC values; in addition, none of the metals results for the residential or agricultural soils exceed TTLC values. Of the soils collected in the NCL area directly east of the site, three samples exceed the TTLC for Cu and/or Zn.

Three subsurface soil samples collected in the Smelter area exceed the TTLC for Pb and/or Zn.

The definitive metals results for six downgradient marine sediment samples are presented in Table 3-2, along with an additional six background marine sediment samples. None of the downgradient marine sediment samples exceed the TTLC action levels.

The definitive metals results for six downgradient beach sediment samples are presented in Table 3-2, along with an additional six background beach sediment samples. None of the downgradient beach sediment samples exceed the TTLC action levels.

The definitive metals results for ten downgradient surface water sediment samples from the OID are presented in Table 3-2, along with an additional six background OID sediment samples. None of the downgradient surface water sediment samples from the OID exceed TTLC action levels.

The definitive metals results for six wetland sediment samples are presented in Table 3-2, along with an additional six background wetland sediment samples. Four of the six wetlands sediment samples exceed the TTLC for Cu and/or Zn.

The definitive metals results for waste samples collected from the Smelter area (two samples), WDA (four samples), and WMU (35 samples) are presented in Table 3-2 of the IA Report. Twenty-two of the 35 WMU samples exceed the TTLC for at least one target analyte. In the WMU, thirteen samples exceeded the TTLC for Ba (10,000 mg/kg), eight samples exceeded the TTLC for Be (75 mg/kg), eight samples exceeded the TTLC for Cu (2,500 mg/kg), and one sample exceeded the TTLC for Pb (1000 mg/kg). In the WDA, one sample exceeded the TTLC for Ba (10,000 mg/kg), two samples exceeded the TTLC for Be (75 mg/kg), and one sample exceeded the TTLC for Cu (2,500 mg/kg). In the Smelter Area, one waste sample exceeded the TTLC for Be (75 mg/kg). A discussion of the waste characteristics for the WMU is presented in Section 3.3 below.

3.2.3 Radionuclides

A full description of the radionuclide analysis is presented in the IA Report. The results in Figure 3-3 of the IA Report are compared to the second standard deviation (2nd StDev) from the mean of the background samples for each matrix. The calculation for determining the 2nd StDev begins by calculating the mean (X_{avg}) of the background results for each analyte using the formula:

$$X_{avg} = (X_{01}+X_{02}+X_{03}+ \ldots\ldots\ldots X_N)/N \quad \text{(J-1)}$$

The standard deviation of the background suite is then calculated by taking the square root of the averaged sum of squares as follows:

$$\text{StDev} = [((X_{01}-X_{avg})^2 + (X_{02}-X_{avg})^2 + (X_{03}-X_{avg})^2 + \cdots + (X-X_{avg})^2)/(N-1)]^{1/2} \quad \text{(J-2)}$$

The 2ndStDev is defined as the interval from the mean in which 95.4 percent of the data are expected to fall. The Upper Confidence Interval calculation, based on 95.4% confidence can be used to calculate the 2ndStDev; the formula used is:

$$2^{nd}\text{StDev} = +/-2(\text{StDev}/N^{1/2}) \quad \text{(J-3)}$$

Because we are concerned only with values exceeding two standard deviations above the mean of the background values, only the Upper Confidence Interval (UCI) is calculated for each analyte:

$$\text{UCI}_X = X_{avg} + 2^{nd}\text{StDev} \quad \text{(J-4)}$$

The resulting UCI for each analyte was used as the basis of comparison to determine whether radionuclide results in target solids are significantly above background levels. These values are calculated and presented in Table 3-3 of the IA Report beneath the background samples for each matrix.

3.2.4 Leachability In Waste Samples By TCLP

Thirty-five samples from the WMU, three samples from the WDA, and two samples from the Smelter area were analyzed by the TCLP to determine whether any of the samples may be considered hazardous wastes under RCRA. In addition, several soil and waste samples from the Smelter Area were analyzed. The samples were extracted via EPA Method 1311and analyzed by EPA Method 6010B.

One sample from the WDA, SSN49, exceeded the TCLP threshold for Ba (100 mg/L); barium is detected in the leachate of this sample at 270 mg/L. The total concentration of barium in this sample is measured at 49,000 mg/kg. TCLP results, as well as the calculated averages and standard deviations for the five WMU populations, are presented in Appendix E. No TCLP results from the WMU area exceed the TCLP action level.

3.2.5 Leachability In Waste Samples By STLC

Thirty-five samples from the WMU were extracted according to the California Title 22 Waste Extraction Test (WET) method and analyzed for STLC metals. The results are presented in Table J-1 and compared with the California Title 22 STLC thresholds. Twenty-five of the 35 samples from the WMU exceed the STLC for at least one of the following metals: Be, Cr, Cu, and Pb. Twelve samples exceed the STLC for Be (0.75 mg/L), two samples exceed the STLC for Cr (5 mg/L), twelve samples exceed the STLC for Cu (25 mg/L), and one sample exceeds the STLC for Pb. These data are treated statistically below.

3.3 Determination of Waste Characteristics

Waste characteristics for the site are determined based on three criteria: 1) RCRA characteristic thresholds (TCLP), as delineated under 40 CFR Part 264.2, 2) State of California TTLC, as delineated under CCR22, and 3) State of California STLC action levels, as delineated under CCR22. The determination of the waste characteristic is based on the waste material's excedence of one of the three regulatory thresholds. The waste determination is based on a representative suite of samples from the population and assumes a degree of homogeneity within that population.

The determination of the waste characteristic is based on 1) whether the mean of the data population exceeds the regulatory threshold, 2) how variable the data are when the mean is close to the regulatory threshold, and 3) the Upper Confidence Interval (UCI) of the data set with respect to the regulatory threshold. The waste material may be considered a hazardous waste if: 1) the mean exceeds the Regulatory Threshold (RT), and/or 2) the UCI exceeds the RT. If the mean is elevated because of one anomalous sample, then further investigation may be required. In addition, if the variance of the sample suite is greater than the mean, then further statistical rendering of the data may be required to adequately correlate the results with the RT; the Arcsine Transformation is recommended in SW-846 to address this issue.

3.3.1 Statistical Analysis of the Data

Twenty-two of the 35 WMU samples exceed the TTLC for at least one of the following analytes: Ba, Be, Cu, Pb, and Zn. In addition, 25 out of 35 samples exceed the STLC for at least one target analyte. Data are presented in Table J-2 for all results of any analyte exceeding either the TTLC for total concentration, or STLC for leachates; these analytes are Ba, Be, Cu, Pb, and Zn for the total metals, and Be, Cr, Cu, and Pb for the STLC metals analysis. Because of the variability of the results, an arcsine statistical rendering is conducted to determine whether the wastes meet the criteria as a California Hazardous Waste, based on the mean and the upper confidence interval of the data set. The calculations are included in Table J-2.

The overall mean (Formula J-1) and variance values for the target TTLC and STLC analytes for the WMU are presented in Table J-2. The formula used to calculate the variance is:

$$\text{Variance } (S^2) = [((X_{01}-X_{avg})^2 + (X_{02}-X_{avg})^2 + (X_{03}-X_{avg})^2 + \cdots + (X-X_{avg})^2)/(N-1)] \qquad \text{(J-5)}$$

3.3.2 Arcsine Transformation

For each analyte, the resulting variance is significantly greater than the mean, indicating a non-normal distribution. The mean value for STLC Be (0.83 mg/L) exceeds the STLC of 0.75 mg/L, and mean values for total Cu (2,169 mg/kg) and STLC Cu (23.2 mg/L) are slightly below their respective action levels (2,500 mg/kg and 25 mg/L, respectively). Because there is a non-normal distribution of these data, Weston performed an Arcsine transformation on the data and the action level, as discussed in SW846, Chapter 9 (OSWER, 1985) before calculating an Upper Confidence Interval. The Arcsine transformation involves normalizing the individual results to a proportion of the maximum value in the data set. This is done by:

$$X_P = X_n/X_{max} \qquad \text{(J-6)}$$

Where X_P is the normalized value for each data point, X_n is the original result, and X_{max} is the highest result within that data set. From this proportional value, the arcsine is calculated for each data point:

$$X_{asin} = \text{Arcsine } X_P \qquad \text{(J-7)}$$

All subsequent calculations are performed on these normalized numbers, and they are compared to an action level that has also been normalized in this manner. From these values, the mean (formula J-1), Variance (formula J-5), Standard Deviation (formula J-2), and UCI (formula J-4) are calculated. These calculated results are presented in Table J-2, adjacent to the non-transformed data set for each analyte of concern. Results utilized to make the determination, either transformed or not, are highlighted.

The results of the arcsine transformation indicate that: 1) the mean value for STLC Be exceeds the STLC value, 2) the transformed mean for STLC Cu exceeds the transformed action level, and 3) the UCI for both total copper and STLC copper exceed their respective action levels. The result is that the WMU wastes may be considered hazardous under Title 22 for Be and Cu.

3.3.3 Analysis By Population

The sampling strategy called for dividing the WMU into five populations based on the historical growth of the pile. The purpose was to attempt to assess the gross variability of the waste pile over the 40-year history of the site. The populations consist of: Population 1: the southern bermwall, Population 2: the northern bermwall, Population 3: the southern retaining pond, Population 4: the central retaining pond, and Population 5: the northern retaining pond. WESTON advanced seven borings in each population, collecting samples at 5-, 10-, 15-, and 20- foot depths. Each of these samples was analyzed by XRF in order to examine possible stratigraphic populations. One sample from each boring was randomly selected for laboratory analysis.

3.3.3.1 Population Analysis Using the XRF Data

As a test of the heterogeneity of the WMU, the XRF data for the metals, Ba, Cu, Pb, and Zn are presented as a function of population and depth in Table J-3. Results that exceed the TTLC are reported in boldface. Mean values are calculated for each boring, each population, and each depth, for all analytes. In addition, variances are calculated for each depth and population. The purpose is primarily to determine whether either an alternate approach to the data, or another approach to the sampling strategy might identify subpopulations within the waste pile that might be segregated to decrease the volume of Hazardous Wastes.

All populations exhibited individual analyses that exceed the TTLC. Population 1 had eleven results exceed the TTLC for Cu and Ba; the mean Cu value for the 10-foot interval also exceeds the TTLC. Population 2 had eleven results exceed the TTLC for Cu and Ba; the mean of the Cu results for boring SW2-3 exceeds the TTLC. Population 3 had 26 results exceed the TTLC for Ba and Cu; the mean of the Ba results for all but one of the borings, all of the strata, and the entire population, exceed the TTLC. Population 4 had seven results exceed the TTLC for Cu and Ba; XRF analyses of two borings were not completed in the field. The means for Cu exceed the TTLC for borings SW4-1, SW4-2, and the 5-foot strata for this population; The mean for Ba in SW4-4 exceeds the TTLC. Population 5 had eight results exceed the TTLC for Ba, Cu, and Zn. The mean values for borings SW5-1 (Cu), SW5-4 (Ba), and SW5-5 (Ba) exceed the TTLC; in addition, the 5-foot interval exceeds the TTLC for Ba.

In all cases, the variances are greater than the mean values, indicating considerable heterogeneity within each population of the waste. The variability within and across all populations indicates that there is little heterogeneity within the WMU. The data indicate that the southern waste pond of the WMU, from which the Population 3 samples were collected, contains the most elevated concentrations of Ba.

3.3.3.2 Population Analysis Using the Definitive Data

A statistical analysis, by population, of the target analytes exceeding TTLC and STLC is presented in Table J-4; these analytes are Ba, Be, and Cu for total metals, and Be and Cu for STLC metals. Arcsine transformations are calculated by analyte for each population where the variance is greater than the mean, as calculated using the formulae above.

Calculated variance values among total metals results are similar to those measured for the entire data set, which suggests that much of the heterogeneity in the WMU is pervasive on the micro-, as well as the macro-scale. Variance values in the Be and Cu STLC data are generally lower than in the population overall, indicating a tighter clustering of results within the populations. Arcsine transformations were not necessary for Be STLC data for populations 1, 2, and 4. Calculations used to make the final determination of waste characteristics are highlighted; results exceeding the TTLC are boldfaced.

The analysis of Population 1 indicates that it may be classified as a California Hazardous Waste based on total Ba, total Cu, and both STLC Cu and Be. While the mean values for total Ba (8,069 mg/kg) and total Cu (1,926 mg/kg) do not exceed the TTLC, the UCI (arcsine transformed) values exceed the TTLC. The mean value for STLC Be (0.61 mg/L) does not exceed the action level; however, the calculated UCI does exceed. The mean value for both the transformed STLC Cu exceeds the action level.

The analysis of Population 2 indicates that it may be classified as a California Hazardous Waste based on both total and STLC Cu. The UCI (arcsine transformed) for Cu exceeds the TTLC, and the mean value (arcsine transformed) for STLC Cu exceeds the action level.

The analysis of Population 3 indicates that it may be classified as a California Hazardous Waste based on total Ba and Be, as well as STLC Be. The mean values (arcsine transformed) for each of these analytes exceeds their respective action levels.

The analysis of Population 4 indicates that it may be classified as a California Hazardous Waste based on total Ba and Cu, as well as STLC Be and Cu. The mean values for total Ba and STLC Be do not exceed their respective action levels, but the calculated UCIs (the Ba calculations are arcsine transformed) do exceed the action levels. The mean values for total Cu and STLC Cu (arcsine transformed) exceed their respective action levels.

The analysis of Population 5 indicates that it may be classified as a California Hazardous Waste based on total Ba, Be, and Cu, as well as STLC Be and Cu. The mean value for STLC Be exceeds the action level. The mean values for total Ba, Be, and Cu, as well as STLC Cu do not exceed the action levels, but the calculated UCIs do exceed the action levels. All waste determinations for Population 5 are based on arcsine transformation calculations.

4.0 REMOVAL CONCERNS

CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan authorize EPA to consider removal actions at those sites that pose a threat to public health or welfare or the environment. The data goals for this IA investigation are designed to also meet the needs of the EPA Emergency Response Section's evaluation of the Site for removal criteria. Waste, surface water, surface sediment, beach sediment, adjacent soil, and wetlands sediment samples provide data that can be used to compare with matrix-specific action levels in order to assess the threat posed by wastes at the Site to human health and the environment. Based on this data and other information, EPA is currently evaluating the need for additional removal activities at the Halaco Site.

4.1 Waste Characterization

Weston collected waste samples from the WMU, the WDA, and the Smelter Area. Samples were analyzed in the field for metals, and a subset of the samples was submitted to laboratories for metals, target radionuclides, VOCs, as well as both TCLP and STLC leach tests. Statistical rendering of the laboratory results indicates that the waste materials at the Site may not be considered RCRA hazardous wastes. Waste materials in the WMU may be considered California Hazardous Waste under CCR 22 based on results exceeding TTLC and STLC thresholds for Ba, Be, and Cu. An initial examination of the WMU waste by population indicates that, while the waste is heterogeneous, each population exceeds at least one of the determining factors for a California Hazardous Waste.

5.0 REFERENCES (reference numbers in parentheses are EPA ERS file numbers)

1. DHS, 1985. Sampling Notes and Analytical Results; State of California, Department of Health Services, October 17, 1985. (D35)

2. Padre and Associates 2002. Report of Findings, Characterization/Waste Sampling of Waste Management Unit, Halaco Engineering Co Facility. November 2002. (R21)

3. Interagency, 2004. Sample Results from Report of Interagency sampling. State of California, Department of Toxic Substances Control, Los Angeles Regional Water Quality Control Board, Oxnard Fire Department, October 14, 2004. (D71)

4. DFG, 1980. Memorandum to Department of Health Services, Re: Sampling Results; State of California, Department of Fish and Game, April 11, 1980. (D14)

5. DHS 1979b. Hazardous Waste Surveillance and Enforcement Report regarding Investigation of Halaco; State of California Department of Health Services, October 5, 1979. (D11)

6. DHS 1979a. Hazardous Waste Surveillance and Enforcement Report regarding Inspection of On-site Disposal Operation of Possibly Hazardous Waste; State of California Department of Health Services, October 4, 1979. (D10)

7. RWQCB 1998. Results of 8/14/1998 RWQCB Environmental Sampling at Halaco - Draft Confidential. (D57)

8. DFG, 1985. Investigation Report for August 23, 1985 Sampling; State of California, Department of Fish and Game, August 23, 1985. (D33)

9. DHS 1985. Notice of Violation and Directive to Comply State of California, Department of Health Services, October 17, 1985. (D36)

10. DTSC Order, Case Number CV-93 5600 R; State of California, Department of Toxic Substances Control, June 20, 1994. (D55)

11. E & E, 1991. Contact Report David Stuck to Steve Woods of the CA Department of Health Services Radiological Branch; Ecology & Environment, Inc. December 11, 1991. (D48)

12. Historical File Review Summary, Halaco Recycling; Ecology and Environment, Inc. February 20, 2006. Enforcement Confidential.

13. EPA, 1992. Listing Site Inspection of Halaco Engineering Company, Summary of Field Activities; prepared by Ecology and Environment, Inc. For US EPA, January 15, 1992. (D49)

14. RWQCB, 2000a. Notice of Violation - Non-compliance with Waste Discharge Requirements, Order Number 80-58; State of California, Los Angeles Regional Water Quality Control Board, February 14, 2000. (D58)

15. DHS 2001. Letter to Halaco Council Re Radiation at the site. Department of Health Services, Radiological Health Branch, March 29, 2001. (R18)

16. DHS 2003. Letter Re: Results of samples collected June 2003 at the Halaco Site. Department of Health Services, Radiological Health Branch, November 14, 2003. (R35)

17. Halaco Engineering Waste Management Unit Data Analysis Report. Brash Engineering, June, 2005. (R3)

18. NOAA National Data Centers METAR Data archive for station KOXR for the dates June 19, 2006 through June 28, 2006.

Table J-1: STLC Data (in mg/L)

analyte	BERYLLIUM		COPPER		LEAD	
STLC value	0.75		25		5	
Data	Result	MDL	Result	MDL	Result	MDL
SW1-1/20-240606-1720	0.443	0.005	**29.5**	0.025	1.22	0.015
SW1-2/15-250606-1212	0.0998	0.005	0.228	0.025	2.64	0.015
SW1-4/10-250606-1028	0.18	0.005	**121**	0.025	4.73	0.015
SW1-4/5-250606-1024	**1.29**	0.005	3.23	0.025	1.46	0.015
SW1-5/5-250606-0941	**1.54**	0.005	11.7	0.025	0.613	0.015
SW1-6/20-250606-0920	0.21	0.005	**31.4**	0.025	0.855	0.015
SW1-7/15-250606-0825	0.474	0.005	16.9	0.025	1.22	0.015
Population 1 Average	0.6		**30.6**		1.8	
SW2-1/20-230606-1703	0.0065	0.005	0.38	0.025	0.174	0.015
SW2-2/20-230606-1615	0.0065	0.005	0.266	0.025	0.144	0.015
SW2-3/15-240606-1203	0.106	0.005	15.5	0.025	0.19	0.015
SW2-4/15-240606-0838	0.187	0.005	**53.9**	0.025	1.76	0.015
SW2-5/15-240606-0926	0.194	0.005	**105**	0.025	3.83	0.015
SW2-6/20-240606-1030	0.108	0.005	0.073	0.025	0.0797	0.015
SW2-7/5-240606-1044	0.198	0.005	**49.9**	0.025	1.17	0.015
Population 2 Average	0.1		**32.1**		1.0	
SW3-1/10-270606-1628	**2.18**	0.005	**ND**	0.025	0.208	0.015
SW3-2/20-280606-1028	0.127	0.005	0.419	0.025	0.999	0.015
SW3-3/10-280606-0904	**3.79**	0.005	**ND**	0.025	0.179	0.015
SW3-4/5-270606-1523	**1.12**	0.005	6.1	0.025	0.199	0.015
SW3-5/20-270606-1415	**1.27**	0.005	6.81	0.025	0.0594	0.015
SW3-6/10-270606-1309	**4.25**	0.005	5.68	0.025	1.05	0.015
SW3-7/20-270606-1230	**1.34**	0.005	7.65	0.025	0.1	0.015
Population 3 Average	**2.0**		5.3		0.4	
SW4-1/5-220606-1545	0.218	0.005	**40.2**	0.025	3.12	0.015
SW4-2/5-220606-1655	0.265	0.005	0.874	0.025	**5.57**	0.015
SW4-3/5-240606-1537	0.677	0.005	**70.8**	0.025	0.913	0.015
SW4-4/10-220606-1255	**0.925**	0.005	**49**	0.025	1.63	0.015
SW4-5/20-220606-1355	0.212	0.005	21.1	0.025	2.28	0.015
SW4-6/20-270606-0945	0.653	0.005	19.3	0.025	0.742	0.015
SW4-7/15-270606-0845	**0.77**	0.005	17.3	0.025	0.331	0.015
Population 4 Average	0.5		**31.2**		2.1	
SW5-1/5-260606-1046	0.325	0.005	4.6	0.025	0.372	0.015
SW5-2/15-260606-1012	0.278	0.005	**29.4**	0.025	0.233	0.015
SW5-3/20-260606-0935	0.089	0.005	0.415	0.025	3.71	0.015
SW5-4/15-260606-0851	0.459	0.005	**25.4**	0.025	0.452	0.015
SW5-5/5-260606-1130	**2.12**	0.005	13.2	0.025	0.955	0.015
SW5-6/5-260606-1414	**2.46**	0.005	5.45	0.025	0.258	0.015
SW5-7/10-260606-1708	0.421	0.005	**50.2**	0.025	2.05	0.015
Population 5 Average	**0.9**		**18.4**		1.1	
total average	**0.8**		24.6		1.3	

Table J-2: Waste Characteristics Calculations
Statistical rendering of whole WMU population with arcsine transformations

Sample ID	Total Metals Data										STLC Metals Data							
	Barium		**Beryllium**		**Copper**		**Lead**		**Zinc**		**Be STLC**		**Cr STLC**		**Cu STLC**		**Pb STLC**	
	Result	arcsine	Result	arcsine	Result	arcsine	Result	arcsine	Result	arcsine	Result	arcsine	Result	arcsine	Result	arcsine	Result	arcsine
Action Level	**10,000**	**0.554**	**75**	**0.457**	**2,500**	**0.210**	**1,000**	**1.141**	**5000**	**0.826**	**0.75**	**0.177**	**5**	**1.006**	**25**	**0.208**	**5**	**1.114**
units	mg/kg	-	mg/kg	-	mg/kg	-	mg/kg	-	mg/kg	-	mg/L	-	mg/L	-	mg/L	-	mg/L	-
SW1-1-20	9700	0.536	23.0	0.136	1700	0.142	280	0.257	1500	0.222	0.443	0.104	1.83	0.314	**29.5**	0.246	1.22	0.221
SW1-2-15	380	0.020	4.0	0.024	**2500**	0.210	220	0.201	2000	0.299	0.100	0.023	4.52	0.869	0.2	0.002	2.64	0.494
SW1-4-10	3100	0.164	10.0	0.059	**4000**	0.340	390	0.362	2600	0.392	0.180	0.042	1.95	0.336	**121.0**	1.571	4.73	1.014
SW1-4-5	**13000**	0.754	48.0	0.286	880	0.073	210	0.192	1000	0.148	**1.290**	0.308	0.63	0.106	3.2	0.027	1.46	0.265
SW1-5-5	**12000**	0.684	41.0	0.244	1300	0.109	210	0.192	1200	0.177	**1.540**	0.371	1.00	0.169	11.7	0.097	0.61	0.110
SW1-6-20	8300	0.452	21.0	0.124	1800	0.151	210	0.192	1600	0.238	0.210	0.049	1.15	0.195	**31.4**	0.263	0.86	0.154
SW1-7-15	**10000**	0.554	25.0	0.148	1300	0.109	240	0.220	1100	0.162	0.474	0.112	1.44	0.246	16.9	0.140	1.22	0.221
SW2-1-20	130	0.007	0.4	0.002	18	0.002	5.3	0.005	42	0.006	0.007	0.002	0.31	0.052	0.4	0.003	0.17	0.031
SW2-2-20	140	0.007	0.4	0.002	15	0.001	4	0.004	40	0.006	0.007	0.002	0.07	0.012	0.3	0.002	0.14	0.026
SW2-3-15	**11000**	0.617	14.0	0.082	1600	0.134	180	0.164	2000	0.299	0.106	0.025	1.53	0.261	15.5	0.128	0.19	0.034
SW2-4-15	2500	0.132	15.0	0.088	1900	0.159	250	0.229	1600	0.238	0.187	0.044	1.98	0.341	**53.9**	0.462	1.76	0.321
SW2-5-15	3200	0.169	10.0	0.059	**3400**	0.287	330	0.305	2700	0.408	0.194	0.046	1.97	0.339	**105.0**	1.051	3.83	0.758
SW2-6-20	800	0.042	8.2	0.048	**3800**	0.322	190	0.174	4400	0.704	0.108	0.025	0.91	0.155	0.1	0.001	0.08	0.014
SW2-7-5	5100	0.272	17.0	0.100	2200	0.184	330	0.305	1700	0.253	0.198	0.047	2.09	0.361	**49.9**	0.425	1.17	0.212
SW3-1-10	**12000**	0.684	**85.0**	0.524	390	0.033	120	0.109	1000	0.148	**2.180**	0.539	0.39	0.066	0.0	0.000	0.21	0.037
SW3-2-20	970	0.051	7.3	0.043	2300	0.193	190	0.174	1500	0.222	0.127	0.030	2.44	0.425	0.4	0.003	1.00	0.180
SW3-3-10	4600	0.245	**170.0**	1.571	850	0.071	90	0.082	1200	0.177	**3.790**	1.101	0.27	0.046	0.0	0.000	0.18	0.032
SW3-4-5	**12000**	0.684	54.0	0.323	840	0.070	160	0.146	940	0.139	**1.120**	0.267	0.68	0.116	6.1	0.050	0.20	0.036
SW3-5-20	**13000**	0.754	72.0	0.437	670	0.056	140	0.128	1000	0.148	**1.270**	0.303	1.07	0.182	6.8	0.056	0.06	0.011
SW3-6-10	**14000**	0.828	**150.0**	1.081	550	0.046	83	0.076	690	0.102	**4.250**	1.571	0.25	0.043	5.7	0.047	1.05	0.190
SW3-7-20	**15000**	0.910	36.0	0.213	620	0.052	120	0.109	810	0.119	**1.340**	0.321	1.08	0.183	7.7	0.063	0.10	0.018
SW4-1-5	380	0.020	9.3	0.055	**6500**	0.572	230	0.211	4000	0.629	0.218	0.051	3.76	0.688	**40.2**	0.339	3.12	0.595
SW4-2-5	490	0.026	18.0	0.106	**8700**	0.811	480	0.452	4900	0.805	0.265	0.062	**5.59**	1.235	0.9	0.007	**5.57**	1.571
SW4-3-5	**19000**	1.571	**95.0**	0.593	**2600**	0.218	81	0.074	1200	0.177	0.677	0.160	2.40	0.417	**70.8**	0.625	0.91	0.165
SW4-4-10	**11000**	0.617	**76.0**	0.463	1000	0.083	80	0.073	1100	0.162	**0.925**	0.219	1.64	0.281	**49.0**	0.417	1.63	0.297
SW4-5-20	2400	0.127	14.0	0.082	1700	0.142	230	0.211	2000	0.299	0.212	0.050	0.86	0.145	21.1	0.175	2.28	0.422
SW4-6-20	7700	0.417	38.0	0.225	1300	0.109	200	0.183	1400	0.207	0.653	0.154	2.10	0.363	19.3	0.160	0.74	0.134
SW4-7-15	6600	0.355	50.0	0.299	1800	0.151	200	0.183	1700	0.253	0.770	0.182	1.08	0.183	17.3	0.143	0.33	0.059
SW5-1-5	530	0.028	7.7	0.045	**12000**	1.571	**1100**	1.571	**6800**	1.571	0.325	0.077	3.82	0.701	4.6	0.038	0.37	0.067
SW5-2-15	1400	0.074	31.0	0.183	1300	0.109	130	0.118	1200	0.177	0.278	0.065	2.27	0.394	**29.4**	0.245	0.23	0.042
SW5-3-20	2100	0.111	9.0	0.053	2100	0.176	350	0.324	1700	0.253	0.089	0.021	**5.92**	1.571	0.4	0.003	3.71	0.729
SW5-4-15	4500	0.239	28.0	0.165	1200	0.100	170	0.155	1400	0.207	0.459	0.108	2.10	0.363	**25.4**	0.211	0.45	0.081
SW5-5-5	**18000**	1.245	**96.0**	0.600	350	0.029	39	0.035	760	0.112	**2.120**	0.522	0.28	0.047	13.2	0.109	0.96	0.172
SW5-6-5	**16000**	1.001	**92.0**	0.572	730	0.061	86	0.078	940	0.139	**2.460**	0.617	0.18	0.031	5.5	0.045	0.26	0.046
SW5-7-10	3500	0.185	24.0	0.142	2000	0.167	390	0.362	1300	0.192	0.421	0.099	1.80	0.309	**50.2**	0.428	2.05	0.377
mean	6986.3	0.417	40.0	0.262	2168.942857	0.201	220.5	0.219	1743	0.280	**0.828**	**0.221**	1.75	0.330	23.2	**0.217**	1.30	0.261
variance	33878548	0.153	1711.7	0.105	5959276.173	0.082	35563.2	0.066	1877335	0.079	1.063	0.107	2.12	0.112	861.4	0.105	1.98	0.110
stdev	5820.5	0.391	41.4	0.324	2441.162873	0.286	188.6	0.257	1370	0.282	1.031	0.327	1.45	0.335	29.4	0.324	1.41	0.332
alpha	0.05	0.050	0.05	0.050	0.05	0.050	0.05	0.050	0.05	0.050	0.05	0.050	0.05	0.050	0.05	0.050	0.05	0.050
n	35	35.000	35	35.000	35	35.000	35	35.000	35	35.000	35	35.000	35	35.000	35	35.000	35	35.000
CI	1928.308255	0.130	13.706496	0.107	808.7435408	0.095	62.476201	0.085	454	0.093	0.342	0.108	0.48	0.111	9.7	0.107	0.47	0.110
UCI	8914.593969	0.546	53.68621	0.370	2977.686398	**0.296**	282.99906	0.304	2197	0.373	**1.170**	**0.329**	2.24	0.441	32.9	**0.324**	1.77	0.371
Action Level	**10,000**	**0.554**	**75**	**0.457**	**2,500**	**0.210**	**1,000**	**1.141**	**5000**	**0.826**	**0.75**	**0.177**	**5**	**1.006**	**25**	**0.208**	**5**	**1.114**

Notes:
mg/kg - miligrams per kilogram
mg/L - miligrams per liter.
mean = average value of results or transformed results; see formula J-1 in text.
variance = deviation from the mean of the results or transformed results; see formula J-4 in text.
StDev = Standard deviation; see formula J-2 in text.
alpha = 1-confidence, or 1-95%.
n = number of samples in the population.
CI = Confidence Interval; the calculated value for which 95% of the population will deviate from the mean value.

UCI = Upper Confidence Interval - see formula J-3 in text.
Arcsine = Data results normalized to the arcsine of the proportion to the highest result. The arcsine transformation of data is recommended when the variance of the data is significantly greater than the mean (see text).
Boldface = all results exceeding the **Action Level** are reported in boldface; all transformed data exceeding the **transformed action level** are in boldface.

Metals data are the results of analysis by EPA Method 6200: X-Ray Fluorescence.
Action Level - State of California regulatory thresholds for total metals (TTLC - reported in mg/kg) and leachable metals (STLC - reported in mg/L). Arcsine-transformed mean and UCI data are compared to an arcsine-transformed action level.

Table J-3: XRF Waste Data By Population

TTLC	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**
Population 1																								
XRF ID	**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**
SW1-1-4	5002	1060	155.2	992	SW1-2-5	4609	1971	294.9	1614	SW1-3-5	6916	1232	181.1	1117	SW1-4-5	8796	697	159.4	720	SW1-5-5	6790	977	186.6	805
SW1-1-10	3533	1279	175.5	1190	SW1-2-10	3066	**3185**	332.4	2171	SW1-3-10	1980	**3871**	444.4	2578	SW1-4-10	2320	**4560**	379.1	2581	SW1-5-10	3372	2075	339.7	1633
SW1-1-15	4543	988	151.8	994	SW1-2-15	582	**2959**	275.7	2284	SW1-3-15	1334	2258	331.5	1597	SW1-4-15	1056	**2800**	237.1	2139	SW1-5-15	1874	**3299**	292.9	2309
SW1-1-20	7252	1263	198.7	1052	SW1-2-20	868	79	21.5	38	SW1-3-20	665	1870	289.8	1086	SW1-4-20	383	1053	142.9	628	SW1-5-20	**10939**	1011	149.3	655
Boring Avg	5083	1148	170	1057	Boring Avg	2281	2049	231	1527	Boring Avg	2724	2308	312	1595	Boring Avg	3139	2277	230	1517	Boring Avg	5744	1841	242	1351
Population 2																								
XRF ID	**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**
SW2-1-5	4159	**2827**	276.5	2134	SW2-2-5	3645	**2903**	267.3	2211	SW2-3-5	4068	1211	203.3	1246	SW2-4-5	6511	1503	221.2	1191	SW2-5-5	4277	1326	204.6	1035
SW2-1-10	689	2285	191.0	2073	SW2-2-10	1130	**3083**	267.5	2007	SW2-3-10	2178	**2716**	248.9	2071	SW2-4-10	6106	1253	219.7	1036	SW2-5-10	4492	1444	194.8	1111
SW2-1-15	515	**3883**	361.1	2734	SW2-2-15	842	**2778**	264.6	2186	SW2-3-15	**11490**	1412	151.6	1824	SW2-4-15	1470	1621	199.6	2476	SW2-5-15	2144	**3566**	280.1	2603
SW2-1-20	736	85	21.2	57	SW2-2-20	782	82	16.9	39	SW2-3-20	357	**5064**	127.8	2559	SW2-4-20	1261	1758	205.6	1082	SW2-5-20	360	770	167.1	605
Boring Avg	1525	2270	212	1750	Boring Avg	1600	2212	204	1611	Boring Avg	4523	**2601**	183	1925	Boring Avg	3837	1534	212	1446	Boring Avg	2818	1776	212	1338
Population 3																								
XRF ID	**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**
SW3-1-5	3550	1851	139.2	2111	SW3-2-5	3164	**2665**	337.8	3404	SW3-3-5	**12450**	940	115.5	1362	SW3-4-5	**11865**	947	171.0	1129	SW3-5-5	**10540**	829	116.5	1276
SW3-1-10	**18074**	507	130.6	1160	SW3-2-10	4235	2393	310.8	2063	SW3-3-10	4199	910	116.4	1502	SW3-4-10	**16513**	399	72.9	555	SW3-5-10	**17010**	647	90.0	800
SW3-1-15	**11378**	350	78.5	962	SW3-2-15	5834	**2759**	364.4	1903	SW3-3-15	**15304**	858	148.4	1278	SW3-4-15	**26209**	453	89.8	827	SW3-5-15	**25203**	323	38.9	502
SW3-1-20	**39667**	428	111.8	820	SW3-2-20	1145	1806	152.6	1405	SW3-3-20	**12708**	972	162.2	1396	SW3-4-20	6890	1594	229.2	1503	SW3-5-20	**13001**	905	222.2	1261
Boring Avg	**18167**	784	115	1263	Boring Avg	3594	2406	291	2194	Boring Avg	**11165**	920	136	1385	Boring Avg	**15369**	848	141	1003	Boring Avg	**16438**	676	117	960
Population 4																								
XRF ID	**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**
SW4-1-5	289	**5251**	176.8	3046	SW4-2-5	407	**7941**	385.9	4640	SW4-3-5	**22625**	790	47.8	732	SW4-4-5	9023	1340	98.3	1612	SW4-5-5	5166	919	88.9	698
SW4-1-10	1495	2485	154.7	2097	SW4-2-10	1732	2257	147.1	1946	SW4-3-10	4250	687	72.7	865	SW4-4-10	**15393**	1320	104.1	1096	SW4-5-10	7285	914	115.0	838
SW4-1-15	2139	1231	187.3	1477	SW4-2-15	3826	1078	154.2	1546	SW4-3-15	6703	748	61.1	667	SW4-4-15	**14826**	246	32.5	675	SW4-5-15	1497	1212	146.3	1304
SW4-1-20	1603	**4302**	173.7	2620	SW4-2-20	5733	1285	201.7	1503	SW4-3-20	3487	1006	154.6	1568	SW4-4-20	2373	1318	137.4	1495	SW4-5-20	2307	1499	186.6	2040
Boring Avg	1382	**3317**	173	2310	Boring Avg	2925	**3140**	222	2409	Boring Avg	9266	808	84	958	Boring Avg	**10403**	1056	93	1220	Boring Avg	4064	1136	134	1220
Population 5																								
XRF ID	**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**
SW5-1-5	1065	**9660**	380.8	**6654**	SW5-2-5	2282	574	52.8	872	SW5-3-5	7715	829	75.3	896	SW5-4-5	**18945**	680	92.3	886	SW5-5-5	**29784**	694	85.5	970
SW5-1-10	7197	**3421**	531.5	1913	SW5-2-10	7842	282	22.1	773	SW5-3-10	3761	986	151.0	879	SW5-4-10	2744	1123	169.4	1490	SW5-5-10	3404	1316	522.3	1725
SW5-1-15	2093	1352	155.8	1019	SW5-2-15	1110	1246	114.8	1272	SW5-3-15	2770	1114	237.6	1264	SW5-4-15	5823	1255	150.6	1757	SW5-5-15	9218	**3741**	433.0	1573
SW5-1-20	6152	450	129.4	764	SW5-2-20	3617	471	102.6	775	SW5-3-20	2328	2245	351.7	2244	SW5-4-20	545	1440	151.9	1806	SW5-5-20	**15122**	516	171.6	1355
Boring Avg	4127	**3721**	299	2587	Boring Avg	3713	643	73	923	Boring Avg	4144	1293	204	1321	Boring Avg	7014	1125	141	1485	Boring Avg	**14382**	1567	303	1406
TTLC	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**

Table J-3: XRF Waste Data By Population (continued)

TTLC	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**				
Population 1											Strata and Population averages				variance			
	Ba	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**	**Ba**	**Cu**	**Pb**	**Zn**
SW1-6-5	4609	1281	180.0	1215	SW1-7-5	4303	1205	183.7	1143	average	5861	1203	192	1087	2815341	154126	2227	86794
SW1-6-10	5599	1448	237.1	1309	SW1-7-10	2265	**3103**	370.0	2292	average	3162	**2789**	325	1965	1506931	1524768	8259	340895
SW1-6-15	3407	1911	213.4	1369	SW1-7-15	3818	859	192.0	676	average	2373	2154	242	1624	2356389	913885	3870	421907
SW1-6-20	3199	**2924**	248.1	2307	SW1-7-20	**10641**	777	125.1	569	average	4849	1283	168	905	22074003	811489	7748	503877
Boring Avg	4203	1891	220	1550	Boring Avg	5257	1486	218	1170	Pop avg	4061	1857	232	1395	6949043	984687	7215	393327
Population 2																		
	Ba	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**	**Ba**	**Cu**	**Pb**	**Zn**
SW2-6-5	1947	1162	167.2	1070	SW2-7-5	2797	1429	228.4	1068	average	3915	1766	224	1422	2024894	578018	1449	268820
SW2-6-10	788	1990	187.6	1713	SW2-7-10	2522	1452	221.0	1097	average	2558	2032	219	1587	4189542	488187	934	238882
SW2-6-15	604	1605	165.2	1724	SW2-7-15	650	1499	150.2	1100	average	2531	2338	225	2092	15951119	1116628	6387	336739
SW2-6-20	472	**3050**	163.4	4752	SW2-7-20	323	2473	141.9	2298	average	613	1897	121	1627	116136	3259204	5394	2902681
Boring Avg	953	1952	171	2315	Boring Avg	1573	1713	185	1391	Pop avg	2404	2008	197	1682	5391980	1021863	4159	733712
Population 3																		
	Ba	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**	**Ba**	**Cu**	**Pb**	**Zn**
SW3-6-5	**13128**	730	94.2	1138	SW3-7-5	**22148**	376	45.8	750	average	**10978**	1191	146	1596	41459596	622863	8660	806070
SW3-6-10	**10972**	767	112.6	1023	SW3-7-10	**12306**	1115	227.3	1193	average	**11901**	963	152	1185	34098762	455882	7381	240582
SW3-6-15	**11584**	853	143.3	1042	SW3-7-15	**10823**	1006	170.9	1136	average	**15191**	943	148	1093	59306706	715771	11252	188737
SW3-6-20	**21611**	610	145.4	1582	SW3-7-20	**32776**	817	115.2	1131	average	**18257**	1019	163	1300	193474706	253744	2201	66854
Boring Avg	**14324**	740	124	1196	Boring Avg	**19513**	829	140	1052	Pop avg	**14082**	1029	152	1293	69804261	435430	5928	291184
Population 4																		
	Ba	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**	**Ba**	**Cu**	**Pb**	**Zn**
	NA	**NA**	**NA**	**NA**		**NA**	**NA**	**NA**	**NA**	average	7502	**3248**	160	2146	84710676	10285452	18187	2852158
	NA	**NA**	**NA**	**NA**		**NA**	**NA**	**NA**	**NA**	average	6031	1533	119	1368	32858523	643527	1112	368492
	NA	**NA**	**NA**	**NA**		**NA**	**NA**	**NA**	**NA**	average	5798	903	116	1134	29522533	172433	4363	186286
	NA	**NA**	**NA**	**NA**		**NA**	**NA**	**NA**	**NA**	average	3101	1882	171	1845	2621025	1861430	648	238593
										Pop avg	5608	1891	141	1623	29713575	3026021	5090	815570
Population 5																		
	Ba	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**		**Ba**	**Cu**	**Pb**	**Zn**	**Ba**	**Cu**	**Pb**	**Zn**
SW5-6-5	**48316**	820	90.8	1014	SW5-7-5	2617	990	168.3	700	average	**15818**	2035	135	1713	316963533	11321574	13017	4756027
SW5-6-10	4283	1314	171.9	1292	SW5-7-10	1675	2362	423.5	1497	average	4415	1544	285	1367	5207965	1063173	41582	175695
SW5-6-15	2362	1199	187.9	1149	SW5-7-15	2916	1485	236.1	1552	average	3756	1627	217	1369	7915306	882594	11148	69563
SW5-6-20	4975	2118	200.7	2737	SW5-7-20	4519	1293	211.4	2252	average	5323	1219	188	1705	22030533	593015	6632	589512
Boring Avg	**14984**	1363	163	1548	Boring Avg	2932	1532	260	1500	Pop avg	7328	1606	206	1539	86922122	2686061	16480	1056037
TTLC	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**	**TTLC**	**10,000**	**2500**	**1000**	**5,000**				

Table J-4: Waste Characteristic Determination by Population

	Barium		Beryllium		Copper		Be STLC		Cu STLC	
	Result mg/kg	arcsine	Result mg/kg	arcsine	Result mg/kg	arcsine	Result mg/L	Arcsine	Result mg/L	Arcsine
Population 1										
TTLC	**10,000**	**0.8776**	**75**	**1.5708**	**2,500**	**0.6751**	**0.75**		**25**	**0.2081**
SW1-1-20	9700	0.8423	23.0	0.3117	1700	0.4390	0.44		**29.5**	0.2463
SW1-2-15	380	0.0292	4.0	0.0534	**2500**	0.6751	0.10		0.228	0.0019
SW1-4-10	3100	0.2408	10.0	0.1337	**4000**	1.5708	0.18		**121**	1.5708
SW1-4-5	**13000**	1.5708	48.0	0.6945	880	0.2218	**1.29**		3.23	0.0267
SW1-5-5	**12000**	1.1760	41.0	0.5784	1300	0.3310	**1.54**		11.7	0.0968
SW1-6-20	8300	0.6925	21.0	0.2838	1800	0.4668	0.21		**31.4**	0.2625
SW1-7-15	**10000**	0.8776	25.0	0.3398	1300	0.3310	0.47		16.9	0.1401
mean	8069	0.7756	24.6	0.3422	1926	0.5765	0.61		**30.57**	**0.3350**
variance	21670248	0.2763	245.0	0.0519	1095962	0.2126	0.33		1731.75	0.3068
stdev	4655	0.5256	15.7	0.2277	1047	0.4611	0.57		41.61	0.5539
alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.05	0.05
n	7	7	7	7	7	7	7		7	7
CI	3449	0.3894	12	0.1687	776	0.3416	0.43		30.83	0.4103
UCI	**11517**	**1.1650**	36	0.5109	**2701**	**0.9181**	**1.03**		**61.39**	**0.7454**
Population 2										
TTLC	**10000**	**1.1411**	**75**	**1.5708**	**2,500**	**0.7180**	**0.75**		**25**	**0.2404**
SW2-1-20	130	0.0118	0.4	0.0052	18	0.0047	0.01		0.38	0.0036
SW2-2-20	140	0.0127	0.4	0.0053	15	0.0039	0.01		0.266	0.0025
SW2-3-15	**11000**	1.5708	14.0	0.1878	1600	0.4346	0.11		15.5	0.1482
SW2-4-15	2500	0.2293	15.0	0.2014	1900	0.5236	0.19		**53.9**	0.5391
SW2-5-15	3200	0.2952	10.0	0.1337	**3400**	1.1078	0.19		**105**	1.5708
SW2-6-20	800	0.0728	8.2	0.1096	**3800**	1.5708	0.11		0.073	0.0007
SW2-7-5	5100	0.4821	17.0	0.2287	2200	0.6174	0.20		**49.9**	0.4952
mean	3267	0.3821	9.3	0.1245	1848	0.6090	0.12		**32.15**	**0.3943**
variance	14909490	0.3039	45.7	0.0082	2185985	0.3238	0.01		1571.22	0.3228
stdev	3861	0.5512	6.8	0.0908	1479	0.5690	0.08		39.64	0.5682
alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.05	0.05
n	7	7	7	7	7	7	7		7	7
CI	2860	0.4083	5	0.0673	1095	0.4215	0.06		29.36	0.4209
UCI	6128	0.7904	14	0.1918	**2943**	**1.0305**	0.18		**61.51**	**0.8152**
Population 3										
TTLC	**10000**	**0.7297**	**75**	**0.4569**	**2,500**	**1.5708**	**0.75**	**0.1774**	**25**	**1.5708**
SW3-1-10	**12000**	0.9273	**85.0**	0.5236	390	0.1566	**2.18**	0.5386	**ND**	**-**
SW3-2-20	970	0.0647	7.3	0.0430	2300	1.1681	0.13	0.0299	0.419	0.0168
SW3-3-10	4600	0.3117	**170.0**	1.5708	850	0.3469	**3.79**	1.1012	**ND**	**-**
SW3-4-5	**12000**	0.9273	54.0	0.3232	840	0.3427	**1.12**	0.2667	6.1	0.2465
SW3-5-20	**13000**	1.0485	72.0	0.4373	670	0.2713	**1.27**	0.3035	6.81	0.2759
SW3-6-10	**14000**	1.2036	**150.0**	1.0808	550	0.2218	**4.25**	1.5708	5.68	0.2292
SW3-7-20	**15000**	1.5708	36.0	0.2134	620	0.2506	**1.34**	0.3208	7.65	0.3110
mean	**10224**	**0.8648**	**82.0**	**0.5989**	889	0.3940	**2.01**	**0.5902**	5.33	0.2159
variance	28058129	0.2668	3492.8	0.2904	413181	0.1209	2.26	0.2998	8.10	0.0134
stdev	5297	0.5165	59.1	0.5389	643	0.3478	1.50	0.5475	2.85	0.1156
alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
n	7	7	7	7	7	7	7	7	7	7
CI	3924	0.3826	44	0.3992	476	0.2576	1.11	0.4056	2.11	0.0856
UCI	**14148**	**1.2475**	126	**0.9981**	1365	0.6516	**3.12**	**0.9958**	7.44	0.3015

See next page for notes.

Table J-4: Waste Characteristic Determination by Population

	Barium		Beryllium		Copper		Be STLC		Cu STLC	
	Result	arcsine	Result	arcsine	Result	arcsine	Result	Arcsine	Result	Arcsine
Population 4										
TTLC	**10000**	**0.5543**	**75**	**0.9100**	**2,500**	**0.2915**	**0.75**		**25**	**0.3609**
SW4-1-5	380	0.0200	9.3	0.0547	**6500**	0.8437	0.22		**40.2**	0.6038
SW4-2-5	490	0.0258	18.0	0.1061	**8700**	1.5708	0.27		0.874	0.0123
SW4-3-5	**19000**	1.5708	**95.0**	0.5930	**2600**	0.3035	0.68		**70.8**	1.5708
SW4-4-10	**11000**	0.6174	**76.0**	0.4635	1000	0.1152	**0.93**		**49**	0.7644
SW4-5-20	2400	0.1267	14.0	0.0824	1700	0.1967	0.21		21.1	0.3026
SW4-6-20	7700	0.4173	38.0	0.2254	1300	0.1500	0.65		19.3	0.2761
SW4-7-15	6600	0.3548	50.0	0.2985	1800	0.2084	**0.77**		17.3	0.2468
mean	6796	0.4475	42.9	0.2605	**3371**	**0.4840**	0.53		**31.22**	**0.5396**
variance	44620395	0.2940	1078.1	0.0420	8992381	0.2915	0.09		553.75	0.2679
stdev	6680	0.5422	32.8	0.2051	2999	0.5399	0.29		23.53	0.5176
alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.05	0.05
n	7	7	7	7	7	7	7		7	7
CI	4948	0.4016	24	0.1519	2221	0.4000	0.22		17.43	0.3834
UCI	**11744**	**0.8492**	67	0.4124	**5593**	**0.8840**	**0.75**		**48.66**	**0.9230**
Population 5										
TTLC	**10000**	**0.5890**	**75**	**0.8967**	**2,500**	**0.2099**	**0.75**	**0.3098**	**25**	**0.5213**
SW5-1-5	530	0.0294	7.7	0.0803	**12000**	1.5708	0.33	0.1325	4.6	0.0918
SW5-2-15	1400	0.0779	31.0	0.3288	1300	0.1085	0.28	0.1133	**29.4**	0.6257
SW5-3-20	2100	0.1169	9.0	0.0939	2100	0.1759	0.09	0.0362	0.415	0.0083
SW5-4-15	4500	0.2527	28.0	0.2960	1200	0.1002	0.46	0.1877	**25.4**	0.5305
SW5-5-5	**18000**	1.5708	**96.0**	1.5708	350	0.0292	**2.12**	1.0388	13.2	0.2661
SW5-6-5	**16000**	1.0949	**92.0**	1.2811	730	0.0609	**2.46**	1.5708	5.45	0.1088
SW5-7-10	3500	0.1957	24.0	0.2527	2000	0.1674	0.42	0.1720	**50.2**	1.5708
mean	6576	0.4769	41.1	0.5576	2811	0.3161	**0.88**	**0.4645**	18.38	0.4574
variance	52745129	0.3662	1386.1	0.3678	16811081	0.3089	0.95	0.3555	314.98	0.2945
stdev	7263	0.6051	37.2	0.6064	4100	0.5558	0.98	0.5962	17.75	0.5427
alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
n	7	7	7	7	7	7	7	7	7	7
CI	5380	0.4483	28	0.4493	3037	0.4117	0.7232	0.4417	13.15	0.4020
UCI	**11956**	**0.9252**	69	**1.0069**	5849	**0.7278**	**1.6020**	**0.9061**	**31.53**	**0.8594**

Notes: mg/kg = miligrams per kilogram - analysis by EPA Method 6010 for total metals.
mg/L = miligrams per liter - analysis by EPA Method 6010 after Cal WET extraction for STLC metals.
mean = average value of results or transformed results; see formula 3-1 in text.
variance = deviation from the mean of the results or transformed results; see formula J-4 in text.
StDev = Standard deviation; see formula 3-2 in text.
alpha = 1-confidence, or 1-95%.
n = number of samples in the population.
CI = Confidence Interval; the calculated value for which 95% of the population will deviate from the mean value.
UCI = Upper Confidence Interval - see formula 3-3 in text.
Arcsine = Data results normalized to the arcsine of the proportion to the highest result. The arcsine transformation of data is recommended when the variance of the data is significantly greater than the mean (see text).
Boldface = all results exceeding the **Action Level** are reported in boldface; all transformed data exceeding the **transformed action level** are in boldface.

Action Level - State of California regulatory thresholds for total metals (TTLC - reported in mg/kg) and leachable metals (STLC - reported in mg/L). Arcsine-transformed mean and UCI data are compared to an arcsine-transformed action level.