5.0 BACKGROUND CONCENTRATIONS OF METALS AND ANIONS

This section contains an analysis of background data for both the soil and groundwater media at SWMU 13 and SWMU 17. This section describes the data sources and summarizes the methodologies for selecting the background values for metals and anions in the soil and groundwater at the two SWMUs.

5.1 SOILS

As part of the Phase II RFI field investigation program, sampling sites were selected to serve as background locations for metals, anions, and alkalinity in soils for SWMUs 13 and 17. The sites were selected on the basis of being upgradient or cross-gradient from any known contamination or downgradient a considerable distance in order to avoid potential influence by waste sites at TEAD-S.

During the 1991 field effort, Rust E&I collected 12 soil samples for SWMU 13 and 2 for SWMU 17 to serve as background data. However, these data were not used in the background calculations as many of the detection limits were unacceptably high (Appendix D). As part of the 1993 field effort, Rust E&I collected 12 additional background soil samples from 4 locations: 13 BG-09, 13 BG-10, S-103-93, and S-104-93 (Figure 5-1). Three samples were collected from each of these soil boring locations and were analyzed for metals, anions, alkalinity, and pH. In order to obtain a larger population of background values for SWMUs 13 and 17, background data from soil samples collected by Ebasco were used in addition to Rust E&I data collected during the 1993 field investigation. These Ebasco background soil-boring locations are S-SS-05-BK, S-SS-08-BK, S-SS-10-BK, S-SS-14-BK, S-SS-19-BK, S-SS-22-BK, S-SS-26-BK, S-SS-27-BK, S-SS-29-BK, and S-SS-36-BK (Ebasco 1991) and are presented in Figure 5-1. Table 5-1 provides a summary of the background sample identification numbers and collection depths. The analytical suite for metals includes the following analytes: silver, arsenic, beryllium, cadmium, chromium, copper, mercury, nickel, lead, antimony, selenium, thallium, and zinc. The analytical suite for anions includes bromide, chloride, fluoride, nitrate/nitrite, and sulfate, and the alkalinity analysis includes alkalinity, alkalinity bicarbonate, alkalinity carbonate, alkalinity hydroxide, and pH. Ebasco did not include alkalinity in their background analysis. Appendix D provides the analytical results for the above-mentioned samples.

The upper bound concentration for the background population for these analytes was estimated by tolerance intervals calculated according to procedures outlined in the RCRA guidance document on statistical methods (USEPA 1989a). Tolerance interval statistical analyses were run on all analytes that met the following two criteria: (1) analyte values within the data set were detected at a frequency greater than or equal to 85 percent, and (2) the data set for a given analyte passed the Shapiro and Wilk test (W test) for normality. The W test is a statistical method designed for use with small data populations and determines whether the values from a sample population are normally distributed (USEPA 1989a).

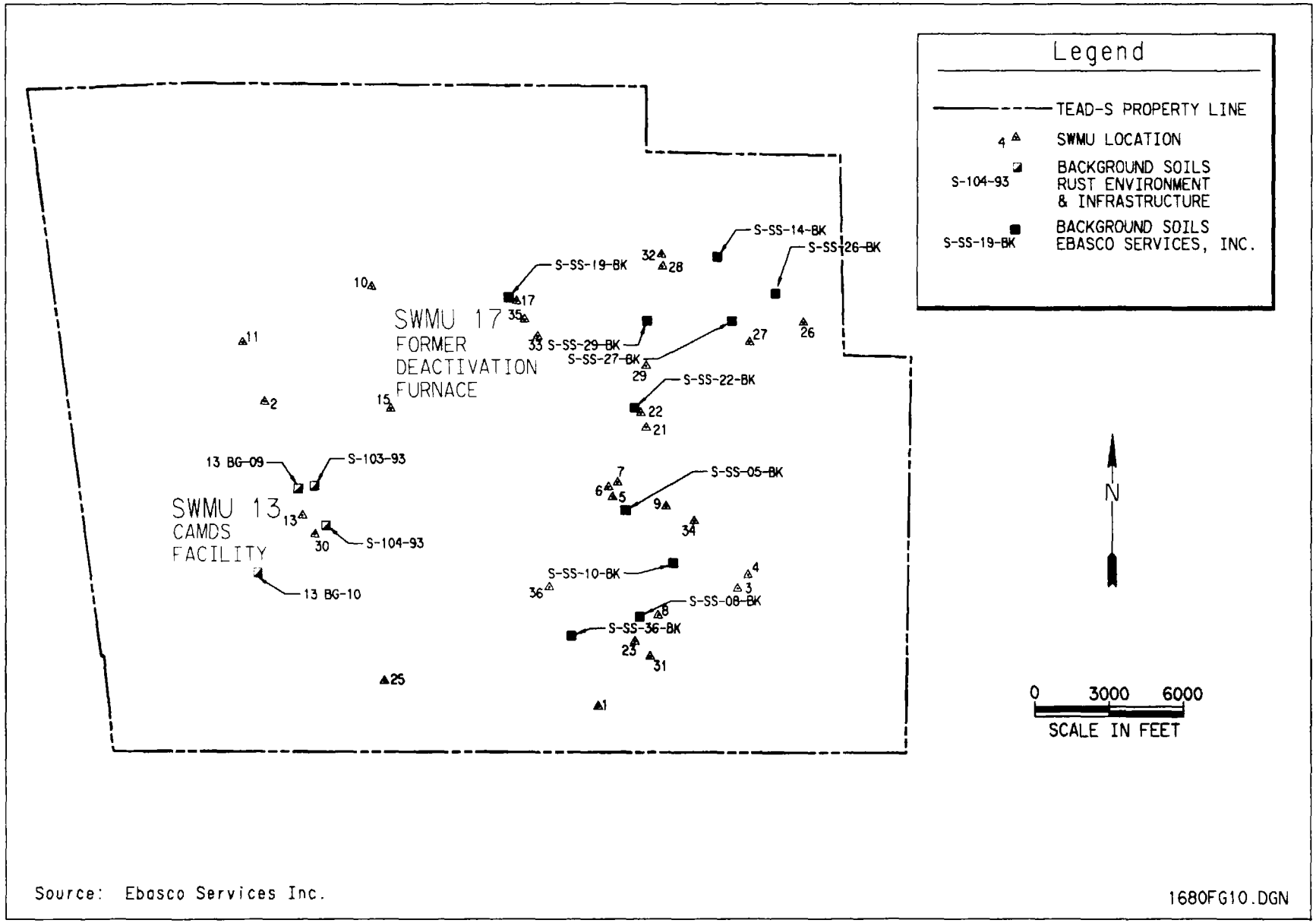

Figure 5-1. TEAD-S Background Soil Sample Locations

Table 5-1. SWMU 13 Background Soil Samples and Collection Depths

Sample Number	Sample Depth (feet below ground surface)
13 BG-09-1	2.0
13 BG-09-2	5.0
13 BG-09-3	10.0
13 BG-10-1	2.0
13 BG-10-2	5.0
13 BG-10-3	10.0
S-103-93-1	2.0
S-103-93-2	5.0
S-103-93-3	10.0
S-104-93-1	2.0
S-104-93-2	6.0
S-104-93-3	10.0
S-SS-05-BK	1.5
S-SS-08-BK	1.5
S-SS-10-BK	1.5
S-SS-14-BK	1.5
S-SS-19-BK	1.5
S-SS-22-BK	1.5
S-SS-26-BK	1.5
S-SS-27-BK	1.5
S-SS-29-BK	1.5
S-SS-36-BK	1.5

S-SS = Ebasco background soil sample location.
Source: Ebasco, 1991

Any data point that was below the CRL or below the MDL (a non-detect) and was part of a data population that had a detection frequency greater than or equal to 85 percent was still used in the W test.

If the sample population was determined to be normally distributed (i.e., the data passed the W test), the tolerance interval was calculated. If the data failed the test for normality, the data were transformed by taking the natural log of each value and a lognormal W test was run. If the data met the criteria for lognormal distribution, the tolerance interval was calculated. For

both normally and lognormally distributed data, the tolerance interval was calculated using the following equation:

(Equation 1)

$$Tolerance\ Interval = \bar{x} + (s*k)$$

where

x = the arithmetic mean of the values within the data set
s = the standard deviation of the values within the data set
k = tolerance factor based on the population size for a one-sided normal tolerance interval with a probability level (confidence factor) of 0.95 and coverage of 95 percent (USEPA 1989a).

If the data did not satisfy the test for normal or lognormal distribution, then a nonparametric probability plot was used to estimate the upper bound concentration for the background population. This method involved ordering the data set in ascending order, then assigning a cumulative frequency and ranking for each distinct value. The distinct pairs, concentration (x axis) and cumulative frequency (y axis), were plotted. A best fit, least squares, linear regression line was then calculated using these x and y values, and the 95th percentile was determined from the line of best fit. The 95 percentile intercept value was used as the upper bound background concentration. Appendix E presents the plots for the nonparametric analyses.

Where the detection frequency was less than 85 percent and there were detectable concentrations, the highest detected concentration was used as the upper bound background concentration and no statistical analysis was performed. If the specific analyte was not detected in any of the background samples within the data set, the highest CRL was used as the upper bound background concentration.

Table 5-2 provides a summary of background concentrations of metals and anions detected in soils. The background threshold value represents the upper bound concentration at a confidence level of 95 percent for each analyte that is indicative of background conditions. Soil samples with concentrations above background threshold values indicate possible soil contamination.

5.2 GROUNDWATER

The data collected by previous contractors (Ebasco 1991) were reviewed to determine the background concentrations of metals and anions in the groundwater at SWMU 13 (SWMU 17 groundwater was not investigated as part of this RFI).

Table 5-2. TEAD-S Background Soil Sample Results, Phase II RFI

Analyte	Detection Frequency, Detections / Samples	Minimum (µg/g)	Maximum (µg/g)	Arithmetic Mean (µg/g)	Standard Deviation (µg/g)	Upper Bound Background Threshold (µg/g)	Method
Metals							
Silver	11/22	0.095	7.61	0.589	1.555	7.61	<85%
Arsenic	22/22	3.89	39.0	12.3	1.72	16.4	Lognormal Tolerance Limit
Beryllium	17/22	0.228	1.11	0.498	0.320	1.11	<85%
Cadmium	2/22	0.894	21.1	1.55	4.27	21.1	<85%
Chromium	22/22	8.44	56.2	19.6	1.66	23.5	Lognormal Tolerance Limit
Mercury	2/22	0.026	0.319	0.034	0.061	0.319	<85%
Copper	22/22	3.88	58.1	13.9	1.80	18.1	Lognormal Tolerance Limit
Nickel	12/22	4.92	30.0	9.73	8.22	30.0	<85%
Lead	22/22	7.3	254	36.4	61.4	69.8	Nonparametric
Antimony	7/22	0.500	15.8	3.95	7.67	15.8	< 85%
Selenium	0/19	0.449	5.76	1.62	2.72	5.76	No detections
Thallium	0/22	33.4	68.6	17.7	7.42	68.6	No detections
Zinc	22/22	21.4	232.0	58.8	1.75	62.9	Lognormal Tolerance Limit

Table 5-2. TEAD-S Background Soil Sample Results, Phase II RFI (continued)

Analyte	Detection Frequency, Detections / Samples	Minimum (µg/g)	Maximum (µg/g)	Arithmetic Mean (µg/g)	Standard Deviation (µg/g)	Upper Bound Background Threshold (µg/g)	Method
Anions							
Bromide	0/12	5.0	5.0	2.50	0.00	5.0	No detections
Chloride	11/12	3.56	5,600	570	9.51	596	Lognormal Tolerance Limit
Floride	4/12	6.36	11.5	5.03	1.54	11.5	<85%
Nitrate/Nitrite	5/12	1.0	4.67	1.65	1.38	4.67	<85%
Sulfate	12/12	9.67	1,400	501	437	1,697	Normal Tolerance Limit
Alkalinity							
Alkalinity	12/12	75.0	71,000	21,125	20,696	48,428	Nonparametric
Alkalinity Bicarbonate	7/12	50.0	18,000	7,021	6,656	18,000	< 85%
Alkalinity Carbonate	7/12	50.0	53,000	12,526	16,599	53,000	< 85%
Alkalinity Hydroxide	4/12	50.0	17,000	4,111	4,693	17,000	< 85%
pH	12/12	7.8	8.4	8.07	0.231	8.07	Mean

Note.—Upper bound background threshold for analytes not detected is the highest certified reporting limit and is the number presented in the maximum column.

Upper bound background threshold for detection frequencies less than 85% is the largest data value.

Upper bound background threshold for detection frequencies greater than or equal to 85% is the Tolerance Limit calculated by taking the mean value+(standard deviation * k) (USEPA 1989a).

Ebasco (1991) identified three groundwater quality zones ranging from relatively fresh (Zone I) to brackish (Zone III) with a transition zone between the two (Zone II). These zones and background wells are presented in Figure 5-2. The division is based on total dissolved solids (TDS). From these zones, Ebasco sampled and analyzed groundwater samples from wells completed in the surficial aquifer. These samples were analyzed for metals and anions.

The analyses of the 31 Zone I wells that Ebasco sampled, located hydraulically upgradient from SWMU 13, were selected to provide data on background concentrations of metals and anions entering SWMU 13 (Figure 5-2). SWMU 13 is located in groundwater quality zone II; however, wells within this zone were not used to estimate background at SWMU 13 for the following reasons: (1) some of these wells do not lie hydraulically upgradient from SWMU 13; (2) some of the metals detected within these wells exceeded their respective MCLs; and (3) since regional groundwater flow is generally to the west, Zone I groundwater quality is considered to be the background conditions that are entering SWMU 13.

Results from groundwater samples for the metals silver, arsenic, beryllium, cadmium, chromium, copper, mercury, nickel, lead, antimony, selenium, thallium, and zinc and from the anions bromide, chloride, and fluoride will be used to compare with the results from the SWMU 13 monitoring wells. Because the detection frequency for all of the above-mentioned analytes but chloride was less than 85 percent, tolerance intervals were not calculated (USEPA 1989a) except for chloride. Consequently, Ebasco gave a range of values for the these analytes. In order to facilitate establishing background groundwater data, the maximum values of the ranges given by Ebasco will be considered qualitative estimates of background concentrations for these analytes in groundwater. These ranges and background estimates are presented in Table 5-3.

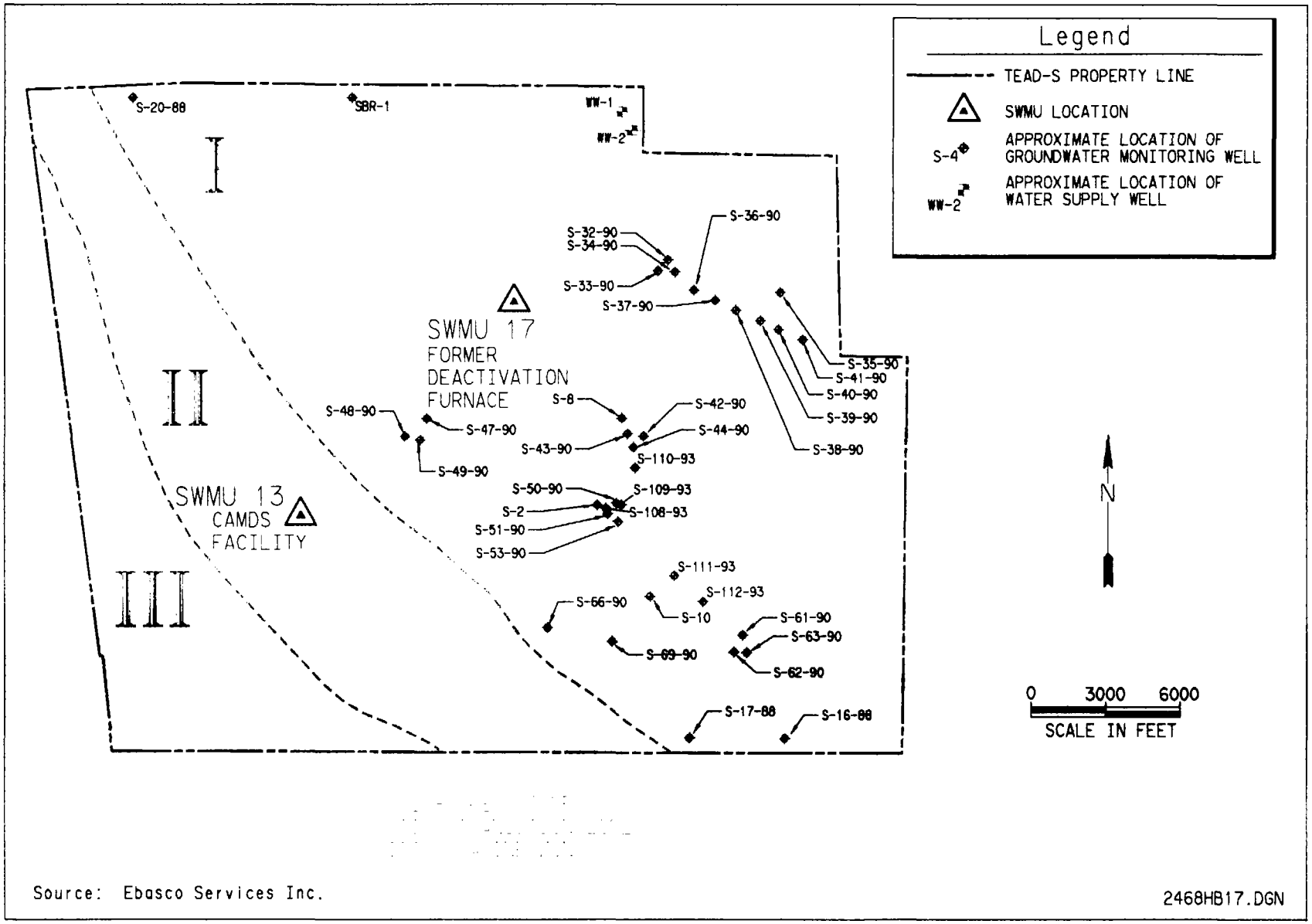

Figure 5-2. TEAD-S Groundwater Quality Zones (Modified from Ebasco, 1991)

Table 5-3. SWMU 13 Qualitative Estimate of Background Concentrations of Metals and Anions in Groundwater, Phase II RFI

Analyte	Detected/ Number of Samples	CRL[a] (µg/L)	Range (µg/L)	Background Estimate (µg/L)
Antimony	0/31	38.0	NA[b]	38.0
Arsenic	13/31	2.54	CRL-50	50.0
Beryllium	0/31	5.0	NA	5.0
Cadmium	0/31	4.01	NA	4.01
Chromium	9/31	6.02	CRL-27	27.0
Copper	2/31	8.09	CRL-31	31.0
Lead	14/31	1.26	CRL-39	39.0
Mercury	0/31	0.243	CRL-0.27	0.27
Nickel	0/31	34.3	NA	34.3
Selenium	4/31	3.02	CRL-36	36.0
Silver	0/31	4.6	NA	4.6
Thallium	0/31	6.99	NA	6.99
Zinc	8/31	21.1	CRL-270	270
Bromide	18/31	5.0	CRL-1,500	1,500
Chloride	29/31	273	CRL-2,300,000	4,100,000[c]
Fluoride	13/31	71	CRL-14,000	14,000

[a]CRL=certified reporting limit.
[b]NA=not applicable.
[c]Tolerance interval calculated for chloride.

Source: Modified from Ebasco 1991