TECHNICAL MEMORANDUM:

BACKGROUND CONCENTRATIONS OF ARSENIC IN SOIL AT CAMPUS BAY

Campus Bay Site
Richmond, California

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CONTENTS

1. INTRODUCTION

This Technical Memorandum ("Tech Memo"), prepared by Erler & Kalinowski, Inc. ("EKI"), presents an analysis of background arsenic concentrations in soil at the Campus Bay Site inRichmond, California. EKI has prepared this Tech Memo for our client, Cherokee Simeon Venture I, LLC ("CSV"), in accordance with our Agreement, dated 19 May 2005. EKI understands that CSV intends to submit this Tech Memo to the California Environmental Protection Agency, Department of Toxic Substances Control ("DTSC") on behalf of CSV, Zeneca Inc., and Bayer CropScience, Inc., collectively the "Respondents" to the Site Investigation Orders, Docket No. 04/05-006 and Docket No. IS/E-RAO 06/07-005 for the former Zeneca Property, now known as the Campus Bay Site (Cal-EPA, 2005a and Cal-EPA, 2006, respectively). In addition to the Respondents, the Regents of the University of California is also a respondent to DTSC Order No. 06/01-005.

1.1 PROJECT OBJECTIVE AND APPROACH

In an effort to develop a naturally occurring (i.e., "background") concentration for arsenic in soil at the Site, the Respondents presented in the Draft Lot 1 and Lot 2 Remedial Investigation Report ("RI"; LFR 2006) a statistical evaluation of arsenic concentrations in 96 soil samples using DTSC guidance (*Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Sites and Permitted Facilities*, February 1997). Based on this statistical analysis, the background concentration of arsenic in soil within Lot 1 and Lot 2 was estimated to be 18.7 milligrams per kilogram (mg/kg). In subsequent meetings with the DTSC and within the March 14, 2007 DTSC comment letter for the Lot 1 and 2 RI, the Respondents have been required by the DTSC to complete a different (more robust) statistical analysis to assess if more than two arsenic concentration populations exist in soil at the Site. Estimation of a background arsenic concentration in soil is necessary because human health risk-based screening levels for arsenic are typically less than background levels and regulatory agencies, such as the DTSC, recognize that it is not possible to remediate a site to less than background levels.

Therefore, the objective of this assessment is to present the multivariate statistical approach used to estimate the background arsenic concentration for soil at the Site using site-specific data from Lots 1 and 2. The general project approach was as follows:

- Using a multivariate statistical approach, (a) define a geochemical signature of cinder using samples from Lot 3, and (b) identify Lots 1 and 2 soil samples that have likely been impacted by cinders.

- After eliminating likely cinder-impacted soil samples from the Lots 1 and 2 data, characterize the background arsenic population in Lots 1 and 2 soil.

- Compare the Lots 1 and 2 background arsenic population with the background arsenic population obtained independently from the adjacent Harbor Front property.

- Estimate an effective background arsenic threshold or screening level from the background arsenic data distribution.

1.2 GUIDING PRINCIPLES

1. Use multiple metals to differentiate data that represent background versus potentially impacted soil. Background metals concentrations should be evaluated in the broadest possible geochemical context. A single metal threshold concentration should not uniquely and universally discriminate between samples in which the metals are naturally occurring from those in which anthropogenic metals have overprinted background. Different sources of contamination as well as soils derived from different types of naturally occurring materials (e.g., serpentinites, greenstones) will tend to have distinct multi-element geochemical signatures. A more comprehensive multi-element approach provides a more robust assessment of background conditions.

2. Reduce the total amount of potential noise by careful selection of sample data. The accuracy of any background population model is limited by sources of "noise" introduced by such factors as analyses done by different laboratories, different methods of analysis, differences in sample moisture content, and the presence of results "below the laboratory reporting limit." Therefore, one of the guiding principles of this study was to reduce the total amount of potential noise by the careful selection of sample data, i.e., use data analyzed by a single laboratory.

3. Use a statistical tolerance interval to estimate the upper end of the background distribution. Background metals distributions are statistical entities based on a limited amount of sample data. As such, they cannot capture the full range of concentrations that could be found if the sampling and analysis were truly exhaustive. In particular, it is impossible to know the true maximum concentration that is representative of background conditions in a given area because it can only be estimated. Estimates of the upper end background metal concentration, whether it is the 95^{th} or the 99^{th} percentile of the data distribution, are based only on the data available. If it was possible to collect and analyze other entirely independent sets of samples, the resulting estimates of the 95^{th} or 99^{th} percentile would likely be different. Hence, there is a fundamental uncertainty associated with any such estimate. As suggested by Dr. John Christopher of the DTSC, this fundamental uncertainty is addressed by associating a statistical tolerance interval with the distributional threshold selected to represent the upper end of background (Hahn and Meeker, 1991).

4. Verify that the background and potentially impacted populations identified by statistical analysis make spatial sense. Lastly, statistical data distributions are defined without reference to the spatial distribution of the samples from which they are derived.

To be meaningful, statistical distributions derived in this background analysis should verify known underlying conditions from a spatial perspective.

2. SAMPLE DATABASE

This section describes the development of the database used in the background analysis. Samples that were not included in the database are still considered in the overall characterization of the site. The initial set of Lots 1 and 2 soil samples selected for the background arsenic analysis was taken from the RI . This database included 194 samples collected during various investigations conducted between 1998 and 2006. The samples ranged in depth from the ground surface to a maximum depth of 10 feet below ground surface ("bgs"). Most of the samples were analyzed for the Title 22 suite of metals by the same laboratory, Curtis & Tompkins of Berkeley, California, using the same analytical method, EPA Method 6010B. Most of the metals analyses for the Lots 1 and 2 soil samples were reported on a dry weight basis, effectively removing the confounding effects of variable moisture contents in soil samples.

Of the 194 samples compiled from the RI, the metals analyses for 18 samples included only arsenic instead of all of the Title 22 metals suite. Because those samples did not support the multivariate statistical approach envisioned, those samples were not considered for the background arsenic study database.

The Lots 1 and 2 soil samples contained 7 samples explicitly identified as "cinder" sample IDs. This small number of samples was judged to be insufficient for deriving a robust multivariate geochemical "signature" of cinders. Hence, a set of 77 known treated cinder samples from the adjacent Lot 3 (and reported in the draft Lot 3 Remedial Investigation Report; LFR 2007) were added to the study database to add "statistical mass" to the known cinder sample type. The Lot 3 cinder samples were analyzed for the same suite of metals by the same laboratory using the same method and reported on a dry-weight basis, making them directly comparable to the selected Lots 1 and 2 soil samples.

The final background arsenic study database contained a total of 253 Lots 1, 2 and 3 soil samples. These data are tabulated in Table 1.

3. METALS SELECTIONS AND TRANSFORMATIONS

3.1 METALS SELECTIONS

As discussed above, the background arsenic study database included analyses for Title 22 metals, i.e., arsenic, antimony, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc. Of this group of metals, the following subset of eight metals was selected for inclusion in subsequent multivariate data analysis: arsenic, barium, chromium, cobalt, copper, nickel, vanadium and zinc. These metals were chosen for the following primary reasons: (1) For each of these eight metals, the background arsenic database contained less than 2% non-detects; (2) These metals do not have the same magnitude of potential spectral interferences that trace metals such as antimony, cadmium, selenium and thallium can encounter when analyzed by EPA Method 6010B; (3) The concentrations of eight selected metals are not as likely to be influenced by non-cinder anthropogenic sources as other metals; and, (4) The copper and zinc are likely to have a common source as impurities in the source pyrite material.

3.2 DATA TRANSFORMATIONS

Ultimately, a multivariate statistical procedure is a form of modeling. In general, reducing the number of variables is a desirable feature of a model. In accord with this view, the eight selected metals were reduced to four by combining related data within samples. Copper and zinc are both strongly correlated with cinders. Hence, a combined copper + zinc variable (CuZn) was created that carries the direct cinder signature in a simpler form than the two individual metals. Similarly, chromium, cobalt, nickel, and vanadium have been found to correlate strongly with grain size in San Francisco Bay sediments (Flegel et al., 1994) and, at this site, do not seem to be related to cinder impacts. Hence, a combined chromium+cobalt+nickel+vanadium variable (CrCoNiV) was created to carry a non-cinder signature in a simpler form as well as to provide an indication of grain-size effects.

Barium (Ba) was included as an independent variable because it is geochemically unrelated to any of the other metals, yet seems to show somewhat higher concentrations in treated cinder samples. Because understanding arsenic (As) distribution at the Site is the focus of this evaluation, arsenic was also included as an independent variable.

Prior to multivariate analysis, the As, Ba, the sum of Cu+Zn, and the sum of Cr+Co+Ni+V data were transformed by taking the natural logarithms.

4. DATA ANALYSIS AND RESULTS

4.1 MULTIVARIATE ANALYSIS

The multivariate statistical approach chosen for the background arsenic study was K-means cluster analysis. Cluster analysis refers to a family of statistical methods used to divide up objects into similar groups, or, more precisely, groups whose members are all close to one another in the various dimensions being measured. K-means cluster analysis is a particular kind of cluster analysis in which the data analyst specifies the number of clusters, k, and the statistical algorithm assigns each sample to one of the k clusters in a way that minimizes a measure of dispersion within the clusters (Minitab, 2005).

The K-means algorithm starts with an initial partition of the samples into k clusters. Subsequent steps iteratively modify the partition to reduce the sum of the distances from each sample from the mean of the cluster to which the sample belongs. This partitioning continues until changes in distance between the individual sample and the cluster mean are minimized. The end result of the analysis is a sample-by-sample classification into one of the k clusters.

In this background arsenic study, the K-means cluster analysis is looking for data clusters in 4-dimensional space wherein the dimensions represent As, Ba, CuZn, and CrCoNiV concentrations.

For the background arsenic study, the initial choice was to look for three clusters. Three clusters were chosen because the simplest conceptual clustering scheme logically included a Cinder Cluster, a Sediment (background) Cluster, and a Mixed Cluster representing a physical mixing of cinders and sediments in various proportions. EKI used Minitab (release 14) software to perform the K-means cluster analysis.

The cluster classification results were initially displayed on bivariate scatterplots such as Figure 1. In this particular instance, a possible fourth cluster was identified visually, a cluster that was characterized by high arsenic concentrations but low CuZn concentrations. The possibility of separate arsenic impacts that may be related to railroad operations instead of cinders had been suggested prior to the data analysis (e.g., from arsenical herbicides that are commonly used along railroad lines). Because this cluster consisted of only 8 samples, it would not be discriminated by the K-means approach even if the number of clusters were increased to four. Hence, the 8 samples in the high arsenic, low CuZn cluster were manually assigned to a distinct Railroad (RR) Cluster (see Figure 2). The other clusters were labeled Cinder, Mixed, or Sediment based on the relative concentrations of arsenic and copper-zinc.

As a check on the classification, the Cinder cluster classification was compared to the 87 field-classified cinder samples (77 from Lot 3 and 7 from Lots 1 and 2); 85% of the samples field-classified as cinders were assigned to the Cinder cluster by the cluster analysis. Ten samples classified as cinders according to their sample IDs were assigned to the Mixed cluster and three samples classified as cinders according to their field names were assigned to the Sediment cluster by the cluster analysis. Table 1 identifies which samples were assigned to each cluster in the cluster analysis.

Using the 4 cluster classification, bivariate scatterplots were made showing the relationships between variable pairs (Figures 2 through 7). Using Minitab, the arsenic concentrations associated with each of the four clusters were plotted on log-probability plots to visually assess their data distributions (Figure 8[1]). As Figure 8 shows, all four distributions are essentially single population lognormal distributions, even the RR population distribution.[2]

Hence, cluster analysis (manually modified to include a high arsenic, low copper-zinc RR population) has defined four distinct lognormal arsenic populations on site. The lowest concentration arsenic population is interpreted to represent the background distribution of arsenic in on-site soils.

4.2 SPATIAL DISTRIBUTION OF ARSENIC POPULATIONS

To assess the validity of the arsenic populations that were derived from the cluster analysis, sample arsenic results were color-coded by population and plotted on a site map (Figure 9). When multiple samples occurred at the same location due to depth distinctions, the color code corresponding to the highest arsenic concentration was shown. The spatial distribution of the sample populations shown on Figure 9 accords well with what is known about the distribution of cinders and historic site activities:

- The locations of the cinder population accords well with know areas of cinder.
- The Mixed population samples are appropriately located in the area in and around the residual cinder that extended from Lot 3 onto Lots 1 and 2, and
- The RR population accords well with the location of the former railroad spur suggesting that this high arsenic population may potentially be attributable to the use of arsenical herbicide rather than cinder impacts.

4.3 COMPARISON TO HARBOR FRONT ARSENIC DATA

To provide additional perspective on the estimated background level, the background arsenic population that has been defined at the Site has been compared to the arsenic data

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[1] The table shown on Figure 8 contains standard Minitab abbreviations: Loc refers to the mean of logarithmically transformed data; Scale refers to the standard deviation of the logarithmically transformed data; N refers to the number of samples; AD refers to the results of the Anderson-Darling test of normality; and P refers to the "P-value", a standard statistical measure of the significance of a statistical test (such as a normality test); a P-value greater than 0.05 is typically interpreted as evidence that null hypothesis of the test (e.g., that the data distribution is Normally distributed) cannot be rejected.

[2] The lowest arsenic population shows a "P" value of 0.016 on Figure 8; a P value less than 0.05 is usually interpreted as evidence that the data does not fit the hypothesized distribution model well. Such a lack of fit is often ascribed to the presence of more than one population within the data. However, the plot and data were evaluated by Dr. John Christopher of DTSC who concluded that the data can reasonably be ascribed to a single lognormal population.

distribution from the adjacent Harbor Front property. A total of 64 soil samples were collected from the Harbor Front Property by Weiss and Associates under DTSC direction. The soil samples were analyzed by STL Los Angeles using EPA Method 6020A and were reported on a wet-weight (as received basis). The wet weight basis and different analytical method makes a direct comparison to the Campus Bay data difficult. However, as an approximation, the Harbor Front arsenic data were corrected to a dry weight basis using the mean measured moisture content of soil samples collected in Lots 1 and 2. This mean moisture content was 16.6%.

Figure 10 shows the dry weight corrected Harbor Front arsenic data plotted on a log-probability plot with the Campus Bay background arsenic population. The two populations are very similar, and, in the judgment of the DTSC (Dr. John Christopher, personal communication, 2007), represent the same population. A non-parametric Mann Whitney test shows that the two populations are not statistically distinguishable. Given that the samples from the two populations were prepared and analyzed by different laboratories using different methods and that one set of results is reported on a dry weight basis and the other on a wet-weight basis, this correspondence is very good.

5. ARSENIC TOLERANCE INTERVAL AND BACKGROUND SCREENING LEVEL

Background metals distributions are statistical models based on a limited amount of sample data. Because the sample basis is limited, the models cannot capture the full range of concentrations that could be found if the sampling and analysis were truly exhaustive. The maximum concentration incorporated in background model is only an estimate which has a fundamental uncertainty associated with it.

In accordance with Principle #3 in Section 1.2, the definition of a meaningful upper threshold for background arsenic concentrations should include the application of a tolerance interval to account for the fundamental uncertainty associated with the population model. A tolerance interval is a calculated range of values within which an individual measurement should fall when measuring a known value. In this instance, the tolerance interval being calculated is associated with the percentile of the arsenic background population distribution which is taken to represent the upper end of background. DTSC has requested that, for this background arsenic distribution, the 95% upper confidence limit on the 95^{th} percentile be used to represent the upper end of the background arsenic distribution for the Site (Dr. John Christopher, personal communication, 2007). This statistic is also known as the 95% Upper Tolerance Limit (UTL). Functionally this limit means that we will be 95% confident that at least 95% of all future background arsenic measurements will be less than or equal to the UTL.

The 95^{th} percentile of the background arsenic distribution is estimated to be 13 mg/kg. The 95% upper tolerance limit on the 95^{th} percentile is estimated to be 16 mg/kg arsenic. The background arsenic concentration for the site is therefore recommended to be 16 mg/kg.

6. REFERENCES

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TABLE 1
Summary of Metals Data Used in the Background Arsenic Study
Campus Bay Site, Richmond, California

Location	SampleID	Cluster [(a)]	Metals Analyses in mg/kg [(b)]																	
			Sb	As	Ba	Be	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn	Cr+Co+Ni+V	Cu+Zn
Lot 2	A06-07-3.5	Mixed	<3	2.5	47	0.49	0.5	22	8.8	320	4.3	0.048	<0.99	27	<0.25	<0.49	<0.25	18	100	76	420
Lot 1	B90-6-1.0	Mixed	<3.5	66	280	<0.12	1.2	44	5.4	180	210	5	150	27	6.7	<0.29	0.44	85	210	161	390
Lot 1	B90-6-3.5	Sediment	<3.3	7.1	150	0.15	0.37	51	4.9	53	10	0.14	<1.1	20	<0.28	<0.28	0.55	52	48	128	101
Lot 1	B90-6-5.5	Mixed	<3.7	6.9	200	0.36	0.59	46	33	140	4.6	0.08	<1.2	92	<0.31	<0.31	<0.31	47	120	218	260
Lot 1	B90-6-7.5	Mixed	<3.1	8.1	160	0.79	1.4	35	13	24	5.9	0.11	<1	100	0.54	<0.26	<0.26	45	240	193	264
Lot 1	B90-6-9.5	Mixed	<2.8	11	160	0.43	0.8	36	10	38	17	1.2	5.6	81	1.1	<0.23	<0.23	40	110	167	148
Lot 1	H-67-1.5	Sediment	<2.9	2.9	68	0.42	<0.25	29	10	14	5	0.073	<0.98	75	<0.25	<0.49	0.34	21	23	135	37
Lot 1	H-67-3.5	Sediment	<3	2.8	310	0.37	<0.25	34	10	19	5	0.066	<1	46	<0.25	<0.5	<0.25	27	38	117	57
Lot 1	H-68-1.5	Mixed	<2.9	18	89	0.16	0.42	26	5.1	150	45	2	1	19	<0.24	<0.49	0.28	23	96	73	246
Lot 1	H-68-3.5	Mixed	<2.9	3.2	150	0.23	0.37	39	5	500	5	<0.039	<0.98	18	<0.25	<0.49	<0.25	28	85	90	585
Lot 1	H-69-1.5	Sediment	<2.9	3.3	190	0.33	<0.24	26	16	61	6.5	0.11	<0.98	19	<0.24	<0.49	<0.24	25	67	86	128
Lot 1	H-69-3.5	Mixed	<3	40	360	0.3	0.99	54	9.8	210	140	1.1	1	36	<0.25	<0.5	<0.25	44	340	144	550
Lot 1	LOT-1-10-5.0	Mixed	<3.4	6	110	0.87	2.1	100	23	39	4.9	0.052	<1.1	110	<0.28	<0.28	0.68	49	410	282	449
Lot 1	LOT-1-10-7.0	Sediment	<3.8	12	250	0.44	0.76	81	27	18	7	0.072	<1.3	180	0.84	<0.32	0.69	63	87	351	105
Lot 1	LOT-1-10-1.0	Sediment	<2.6	7.2	160	0.68	0.24	40	10	29	17	0.11	<0.87	54	<0.22	<0.22	0.32	39	49	143	78
Lot 1	LOT-1-11-1.0	Mixed	<3.4	21	280	0.62	1	49	14	72	24	0.37	1.4	78	0.63	<0.29	1.1	45	240	186	312
Lot 1	LOT-1-12-1.0	Mixed	<2.7	13	210	0.23	0.72	44	5.1	310	20	0.37	1.1	19	0.96	<0.23	0.49	43	70	111	380
Lot 1	LOT-1-13-1.0	Mixed	<3.1	56	210	0.3	1.1	31	9.2	230	68	1.1	4.2	29	5.5	<0.26	1.1	49	190	118	420
Lot 1	LOT-1-14-1.0	Mixed	<2.6	15	140	0.24	0.49	31	9.4	51	19	0.79	1.3	41	1.5	<0.21	0.46	60	84	141	135
Lot 1	LOT-1-15-1.0	Railroad	<3	120	180	<0.1	<0.25	21	<1	68	7	0.027	3.4	5.5	5.1	<0.25	0.6	24	19	51	87
Lot 1	LOT-1-5-1.0	Sediment	<3.4	5	250	0.43	<0.28	24	8.1	19	14	0.81	<1.1	39	<0.28	<0.28	<0.28	38	45	109	64
Lot 1	LOT-1-6-1.0	Mixed	3.5	27	250	0.41	1.4	59	14	280	66	0.72	2.3	60	5.1	<0.23	<2.3	49	230	182	510
Lot 1	LOT-1-7-1.0	Cinders	6.1	63	260	0.37	4.3	51	11	510	260	1.9	3.8	49	10	<0.31	1.3	55	540	166	1050
Lot 1	LOT-1-8-1.0	Sediment	<2.6	14	180	0.61	0.27	53	15	33	9.9	0.2	120	61	<0.21	<0.21	0.28	44	60	173	93
Lot 1	LOT-1-10-3.0	Mixed	<2.9	8.4	250	0.69	0.44	26	15	42	20	0.12	<0.96	34	0.34	<0.24	0.28	33	110	108	152
Lot 1	LOT-1-11-3.5	Mixed	<3.9	18	190	<0.13	<0.32	27	1.6	150	6.8	0.031	<1.3	9.9	0.91	<0.32	<0.32	37	26	76	176
Lot 1	LOT-1-12-3.5	Mixed	<3.8	4.4	140	0.44	0.57	35	11	190	5.3	0.025	<1.3	22	<0.31	<0.31	<0.31	34	70	102	260
Lot 1	LOT-1-13-3.5	Sediment	<3	5.4	100	0.49	0.91	39	11	32	5.8	0.056	<0.99	27	<0.25	<0.25	0.47	35	120	112	152
Lot 1	LOT-1-14-3.5	Sediment	<3	6.2	190	0.38	0.35	33	20	76	7.5	0.15	<0.99	37	<0.25	<0.25	<0.25	34	100	124	176
Lot 1	LOT-1-15-3.5	Railroad	<3.2	44	140	0.14	0.37	40	2.2	53	7.4	<0.028	<1.1	13	1.6	<0.27	0.71	50	58	105	111
Lot 1	LOT-1-5-3.5	Cinders	6.9	150	260	<0.12	1.3	<0.59	20	2,500	70	0.2	20	6.8	9.4	<0.29	3.6	39	480	66	2980
Lot 1	LOT-1-6-3.5	Mixed	<2.4	18	220	0.35	1.9	41	9	740	29	0.29	<0.81	25	<0.2	<0.2	<0.2	38	290	113	1030
Lot 1	LOT-1-6-3.5 RE	Mixed	<3	31	200	0.37	2.6	34	9.1	710	110	0.41	1.4	20	0.92	<0.25	0.51	36	350	99	1060
Lot 1	LOT-1-8-3.5	Sediment	<3	4.9	200	0.54	<0.25	58	7.2	18	7.7	0.094	27	53	<0.25	<0.25	0.65	42	34	160	52
Lot 1	LOT-1-7-4.0	Mixed	<3.5	36	200	0.21	3	38	7.1	230	60	0.78	3.2	29	2.9	<0.29	1.1	47	370	121	600
Lot 1	LOT-1-5-6.5	Mixed	<3	3.1	180	0.66	4.3	20	26	2,300	6.3	0.11	<1	69	0.58	<0.25	<0.25	17	1,300	132	3600
Lot 1	LOT1-3-1.0	Mixed	<2.5	11	180	0.3	0.44	41	7.5	52	21	0.31	1.4	40	0.79	<0.21	0.33	41	90	130	142
Lot 1	LOT1-4-1.0	Sediment	<3.4	9.9	180	0.57	0.33	54	13	36	22	0.093	<1.1	60	<0.29	<0.29	0.37	51	73	178	109
Lot 1	LOT1-9-1.0	Sediment	<2.3	6.5	210	0.35	1.1	30	15	59	9.8	0.04	<0.77	21	0.42	<0.19	<0.19	29	84	95	143
Lot 1	LOT1-35-3.0	Mixed	<3.4	5.3	180	0.54	0.56	35	6.3	690	5.7	<0.018	<1.1	23	<0.28	<0.28	<0.28	32	170	96	860
Lot 1	LOT1-36-3.0	Sediment	<2.2	6.5	210	0.98	0.21	52	12	19	6.7	0.21	<0.73	120	<0.18	<0.18	<0.18	47	34	231	53

TABLE 1

Summary of Metals Data Used in the Background Arsenic Study

Campus Bay Site, Richmond, California

Location	SampleID	Cluster [a]	Metals Analyses in mg/kg [b]																		
			Sb	As	Ba	Be	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn	Cr+Co+Ni+V	Cu+Zn
Lot 1	LOT1-3-3.5	Sediment	<3.5	4.6	270	0.69	<0.29	71	10	21	6.3	0.047	<1.2	72	<0.29	<0.29	0.41	51	50	204	71
Lot 1	LOT1-9-3.5	Sediment	<2.7	4.8	140	0.54	0.37	71	11	22	6.7	0.061	<0.91	46	<0.23	<0.23	<0.23	52	69	180	91
Lot 1	LOT1-4-4.0	Sediment	<2.5	6.7	280	0.5	0.38	55	9.6	48	21	0.14	<0.85	36	<0.21	<0.21	0.37	41	82	142	130
Lot 1	LOT1-36-5.0	Sediment	<2.7	6.9	160	0.71	0.33	73	17	28	8.9	0.031	<0.91	73	<0.23	<0.23	0.49	61	69	224	97
Lot 1	LOT1-35-6.0	Sediment	<2.5	9	300	0.49	0.29	60	9.4	27	5	0.08	<0.83	60	<0.21	<0.21	<0.21	44	58	173	85
Lot 1	LOT1-1-1.0	Sediment	<3.6	14	590	0.75	<0.3	74	29	27	8.5	0.17	<1.2	150	0.9	<0.3	0.74	60	44	313	71
Lot 1	LOT1-2-1.0	Sediment	<2.5	6.9	180	0.55	0.23	54	12	24	13	0.034	<0.83	140	<0.21	<0.21	0.6	45	47	251	71
Lot 1	LOT1-1-3.5	Sediment	<4.1	6.5	110	0.59	<0.34	76	9.4	25	5.9	0.066	<1.4	100	<0.34	<0.34	1.7	53	48	238	73
Lot 1	LOT1-2-3.5	Sediment	<2.9	8.5	160	0.64	0.31	73	18	29	9.8	0.081	<0.98	100	<0.24	<0.24	0.62	58	56	249	85
Lot 1	LOT-1-5-2.0	Cinders	4.9	120	200	<0.13	0.81	<0.67	18	2,100	75	0.14	20	5.9	10	<0.33	2.4	34	320	58	2420
Lot 1	LOT-1-B90-1-1	Railroad	<2.9	77	340	0.1	0.69	32	3.7	130	19	0.13	1.2	14	2.4	<0.24	<0.24	65	38	115	168
Lot 1	LOT-1-B90-2-1	Mixed	<3.2	6.2	180	0.58	0.88	88	11	47	8.1	0.039	<1.1	45	<0.27	<0.27	1.8	74	170	218	217
Lot 1	LOT-1-B90-3-1	Mixed	<2.9	7.3	150	0.46	0.42	47	15	27	16	0.085	<0.96	33	0.66	<0.24	0.44	42	160	137	187
Lot 1	LOT-1-B90-5-1	Mixed	<3.8	9.6	220	0.31	0.56	44	9.7	59	28	0.28	<1.3	47	<0.31	<0.31	0.84	51	91	152	150
Lot 1	LOT-1-B90-2-3	Mixed	<2.5	17	130	0.42	0.62	30	7.5	70	14	1	55	28	0.48	<0.2	<0.2	33	88	99	158
Lot 1	LOT-1-B90-5-3	Mixed	<2.6	11	160	0.28	0.77	41	7.8	82	29	0.55	1.2	43	0.74	<0.21	0.51	38	110	130	192
Lot 1	LOT-1-B90-1-5	Sediment	<3	3.1	49	0.46	0.37	66	17	19	6.2	0.061	<0.99	37	<0.25	<0.25	0.9	42	140	162	159
Lot 1	LOT-1-B90-2-5	Mixed	<3.9	7.1	89	0.58	0.73	80	14	34	6.4	0.086	1.4	63	<0.33	<0.33	0.86	59	190	216	224
Lot 1	LOT-1-B90-3-5	Sediment	<2.5	7.1	220	0.42	0.31	66	8.2	22	4.3	0.13	<0.84	50	<0.21	<0.21	<0.21	51	43	175	65
Lot 1	LOT-1-B90-4-5	Sediment	<3	12	220	0.51	0.49	67	14	26	6.5	0.08	<1	88	<0.25	<0.25	<0.25	56	52	225	78
Lot 1	LOT-1-B90-5-5	Mixed	<3.2	4.3	130	1.1	0.88	71	42	28	8.1	0.08	<1.1	150	<0.26	<0.26	0.68	55	410	318	438
Lot 1	LOT-1-B90-1-7	Sediment	<2.9	9.9	370	0.46	0.46	56	32	21	6.9	0.14	<0.97	150	0.57	<0.24	<0.24	62	42	300	63
Lot 1	LOT-1-B90-2-7	Mixed	<3.1	12	310	0.72	0.99	63	20	79	4.9	0.086	1.4	96	<0.25	<0.25	0.4	64	170	243	249
Lot 1	LOT-1-B90-3-7	Sediment	<3.7	7.8	220	0.55	0.42	55	15	31	7.6	0.13	<1.2	82	<0.3	<0.3	<0.3	56	65	208	96
Lot 1	LOT-1-B90-4-7	Mixed	<3.2	4.6	180	0.93	0.34	70	19	19	7.5	<0.022	<1.1	58	<0.27	<0.27	0.56	53	230	200	249
Lot 1	LOT-1-B90-1-9	Sediment	<2.8	7.8	210	0.43	0.42	67	14	31	5.1	0.067	<0.95	74	<0.24	<0.24	<0.24	67	54	222	85
Lot 1	LOT-1-B90-2-9	Sediment	<2.7	8.1	180	0.51	0.58	50	16	50	6.8	0.16	<0.91	66	<0.23	<0.23	0.77	49	100	181	150
Lot 1	LOT-1-B90-3-9	Mixed	<3.5	14	300	0.83	0.56	84	13	39	8.7	0.14	<1.2	88	<0.29	<0.29	1.3	70	80	255	119
Lot 1	LOT-1-B90-4-9	Sediment	<3	10	280	0.66	0.41	80	12	31	7.2	0.11	<1	76	<0.25	<0.25	0.74	59	65	227	96
Lot 1	LOT-1-B90-5-9	Sediment	<3.5	12	150	0.73	0.41	75	20	34	10	0.11	<1.2	95	<0.29	<0.29	0.63	68	71	258	105
Lot 1	LOT-1-CINDER-3-1.3	Cinders	4.9	84	400	0.24	2	29	9.6	860	130	0.88	5.8	28	11	<0.29	1.9	45	550	112	1410
Lot 1	LOT-1-CINDER-2-2.0	Mixed	<3.5	15	220	0.24	0.55	23	5.6	120	69	0.75	1.5	25	3.3	<0.29	0.98	35	100	89	220
Lot 1	LOT-1-TREE-1	Sediment	<3.4	8.6	130	0.61	0.37	36	15	27	22	0.21	<1.1	46	<0.28	<0.28	<0.28	41	76	138	103
Lot 1	LOT-1-TREE-2	Sediment	<3.4	8.5	140	0.57	0.38	67	12	35	27	0.19	<1.1	64	<0.28	<0.28	<0.28	45	90	188	125
Lot 1	LOT-1-TREE-3	Sediment	<3.8	7.8	120	0.49	0.42	28	11	28	18	0.2	<1.3	34	<0.32	<0.32	<0.32	37	96	110	124
Lot 1	LOT-1-TREE-4	Sediment	<3.8	6.1	120	0.46	<0.31	34	9.6	16	15	0.19	<1.3	44	<0.31	<0.31	<0.31	33	55	121	71
Lot 2	LOT2-27-1.0	Sediment	<3	2.5	37	0.13	<0.25	27	5.1	5.1	2.1	<0.02	<0.99	23	<0.25	<0.25	<0.25	43	20	98	25
Lot 2	LOT2-28-1.0	Sediment	<3.1	5.1	130	0.58	0.28	57	12	26	13	0.092	<1	42	<0.26	<0.26	<0.26	42	45	153	71
Lot 2	LOT2-27-3.5	Sediment	<3.3	7.2	140	0.6	0.33	100	17	26	8.6	0.071	<1.1	88	<0.28	<0.28	0.51	62	37	267	63
Lot 2	LOT2-28-3.5	Sediment	<3.3	4.7	88	0.63	<0.28	64	15	17	7.1	<0.026	<1.1	67	<0.28	<0.28	<0.28	46	28	192	45
Lot 2	LOT-2-18-1.0	Sediment	<2.5	5.6	200	0.092	1.1	52	8.3	40	18	0.19	0.84	56	<0.21	<0.21	<0.21	36	68	152	108

TABLE 1

Summary of Metals Data Used in the Background Arsenic Study

Campus Bay Site, Richmond, California

Location	SampleID	Cluster [a]	Metals Analyses in mg/kg [b]																		
			Sb	As	Ba	Be	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn	Cr+Co+Ni+V	Cu+Zn
Lot 2	LOT-2-19-1.0	Mixed	<3.9	16	200	<0.13	2.1	46	7.5	210	58	0.77	1.4	46	<0.32	0.39	<0.32	41	320	141	530
Lot 2	LOT-2-18-3.5	Mixed	<2.8	30	170	0.15	2.4	49	7.5	160	94	1.1	1.5	34	<0.24	<0.24	<0.24	48	140	139	300
Lot 2	LOT-2-19-3.5	Mixed	<2.5	15	190	0.13	1.6	33	7	180	73	1.2	1.5	35	<0.21	0.37	<0.21	34	160	109	340
Lot 2	LOT-2-16-1.0	Mixed	<2.4	38	170	0.28	1.3	44	8.4	240	130	4.2	1.6	37	6.1	<0.2	0.57	43	200	132	440
Lot 2	LOT-2-17-1.0	Mixed	2.9	27	220	0.47	1.1	53	12	240	150	2	1.6	75	8.4	<0.23	0.71	99	200	239	440
Lot 2	LOT-2-20-1.0	Mixed	<2.3	15	160	0.34	0.58	28	8	88	55	0.64	1.6	43	0.44	<0.19	0.31	38	85	117	173
Lot 2	LOT-2-21-1.0	Mixed	4.9	18	170	0.33	1.1	41	8.7	140	43	0.49	1.6	40	1.1	<0.27	0.56	46	140	136	280
Lot 2	LOT-2-22-1.0	Railroad	<2.9	100	270	0.38	0.44	49	17	46	19	0.35	<0.95	36	<0.24	<0.24	<0.24	44	76	146	122
Lot 2	LOT-2-24-1.0	Mixed	<2.3	29	200	0.29	1.2	47	9.3	210	120	1.7	1.6	41	3	<0.19	0.44	48	160	145	370
Lot 2	LOT-2-26-1.0	Sediment	<3.2	11	140	0.39	0.4	62	8.9	31	7.4	0.12	<1.1	48	<0.26	<0.26	<0.26	59	56	178	87
Lot 2	LOT-2-29-1.0	Mixed	<2.5	10	140	0.36	0.66	34	8.5	73	27	0.63	0.91	35	<0.21	<0.21	<0.21	36	95	114	168
Lot 2	LOT-2-30-1.0	Sediment	<2.8	7.3	260	0.2	0.58	76	10	31	9.5	0.048	<0.94	42	<0.23	<0.23	0.35	73	71	201	102
Lot 2	LOT-2-16-3.5	Mixed	<2.9	6.4	160	0.71	0.68	80	28	470	8.5	0.14	<0.95	140	<0.24	<0.24	0.62	55	270	303	740
Lot 2	LOT-2-17-3.5	Mixed	<3	11	210	0.54	0.71	33	10	570	17	0.12	1.1	25	<0.25	<0.25	<0.25	39	150	107	720
Lot 2	LOT-2-20-3.5	Mixed	<3.1	17	280	0.56	0.73	56	20	120	31	0.78	2	67	0.52	<0.26	<0.26	67	140	210	260
Lot 2	LOT-2-21-3.5	Mixed	<3.3	5.4	250	0.56	1.1	51	13	700	11	0.041	<1.1	37	<0.28	<0.28	0.72	43	370	144	1070
Lot 2	LOT-2-24-3.5	Mixed	<3	24	220	0.28	0.87	41	7.8	210	230	0.53	1.4	37	6.3	<0.25	0.44	50	140	136	350
Lot 2	LOT-2-29-3.5	Mixed	<3.5	25	210	0.33	1.7	56	7.9	210	75	1.5	2	36	1.6	<0.29	0.8	43	210	143	420
Lot 2	LOT-2-30-3.5	Sediment	<3.3	5.3	190	0.67	0.37	110	11	22	4.7	0.11	<1.1	170	<0.27	<0.27	0.43	60	40	351	62
Lot 2	LOT-2-22-4.0	Railroad	<2.5	59	280	0.47	0.43	77	13	19	6.7	0.098	<0.83	80	0.8	<0.21	<0.21	61	41	231	60
Lot 2	LOT-2-26-4.0	Sediment	<3.6	7.7	180	0.38	0.62	46	10	52	26	0.35	<1.2	50	<0.3	<0.3	<0.3	44	100	150	152
Lot 2	LOT-2-22-6.5	Sediment	<3.4	8.7	180	0.23	<0.28	52	7	15	3.3	0.087	<1.1	39	<0.28	<0.28	<0.28	33	34	131	49
Lot 2	LOT2-29-8.0	Sediment	<3.5	10	190	0.52	0.36	58	15	30	7.5	0.17	<1.2	70	0.85	<0.29	<0.29	60	55	203	85
Lot 2	LOT-2-25-1.0	Mixed	<3.4	15	150	0.39	2	41	11	620	61	4.6	2	37	1.6	<0.29	0.33	46	310	135	930
Lot 2	LOT-2-23-2.5	Mixed	<3.5	12	150	0.38	1.7	37	11	350	54	4.7	1.7	35	1.2	<0.29	<0.29	39	260	122	610
Lot 2	LOT-2-25-5.5	Mixed	<3.6	29	200	0.26	2.2	33	8.2	360	68	1.2	2.5	27	3.7	<0.3	0.95	39	200	107	560
Lot 2	LOT-2-23-6.0	Sediment	<3.4	6.2	190	0.41	0.3	60	8.9	25	6	0.16	<1.1	52	<0.28	<0.28	<0.28	60	51	181	76
Lot 2	LOT-2-25-8.0	Sediment	<3.6	12	200	0.63	0.32	66	14	20	9.1	0.049	<1.2	46	<0.32	<0.32	<0.32	63	45	189	65
Lot 2	LOT-2-23-8.5	Sediment	<3.8	8.7	180	0.62	0.39	68	14	30	7.7	0.11	<1.3	81	<0.32	<0.32	<0.32	59	57	222	87
Lot 2	LOT-2-23-11.5	Sediment	<3.7	6.1	220	0.54	0.4	74	15	37	8.6	0.19	<1.2	82	0.44	<0.31	<0.31	55	59	226	96
Lot 2	LOT-2-25-12.0	Sediment	<3.6	11	240	0.56	0.87	72	31	32	6.7	0.13	<1.2	130	<0.3	<0.3	<0.3	61	61	294	93
Lot 2	LOT2-CINDER-8-1.5	Mixed	3	33	320	0.29	1.3	34	8.9	440	78	1.2	3.4	31	2.9	<0.23	4	47	270	121	710
Lot 2	LOT2-CINDER-7-2.1	Cinders	8.4	200	580	<0.1	1.6	25	2.6	950	270	4.5	5.1	11	5	<0.25	5.9	26	480	65	1430
Lot 2	LOT2-CINDER-9-2.1	Cinders	6.9	110	370	0.13	1.8	16	8.1	1,100	210	0.97	12	13	7	<0.24	10	48	410	85	1510
Lot 2	LOT-2-CINDER-6-5.0	Cinders	7	56	120	0.15	6.1	34	3.4	490	110	0.97	9.5	10	<0.3	2	1.1	50	290	97	780
Lot 2	LOT-2-CINDER-7-A-3.5	Cinders	21	70	360	0.18	1.2	27	4.9	1,300	270	1.3	4.7	15	1.4	3	<0.29	37	540	84	1840
Lot 1	MW-25-1.5-2.0	Railroad	<2.9	29	140	<0.095	0.6	380	2.1	73	30	0.019	420	19	3.5	<0.24	1.5	24	55	83	128
Lot 1	MW-25-3.5-4.0	Sediment	<3.1	2.9	85	0.44	0.89	45	7.8	15	5.5	<0.018	1.2	27	<0.26	<0.26	<0.26	35	110	115	125
Lot 1	MW-25-6.5-7.0	Sediment	<2.6	4.8	210	0.43	<0.22	39	11	31	3.8	0.039	<0.87	96	<0.22	<0.22	0.4	30	33	176	64
Lot 1	MW-26-1.5-2.0	Railroad	<3.1	48	140	0.11	1.9	38	4.5	80	55	0.45	1.3	24	2.1	<0.26	0.56	41	73	108	153
Lot 1	MW-26-3.5-4.0	Sediment	<2.8	4.8	100	0.38	0.52	37	34	12	5.4	0.038	<0.93	35	0.86	<0.23	<0.23	31	130	137	142

TABLE 1
Summary of Metals Data Used in the Background Arsenic Study
Campus Bay Site, Richmond, California

Location	SampleID	Cluster [a]	Metals Analyses in mg/kg [b]																		
			Sb	As	Ba	Be	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn	Cr+Co+Ni+V	Cu+Zn
Lot 1	MW-27-1.5-2.0	Mixed	<3.2	16	360	0.52	1.6	33	24	560	270	0.45	2.6	37	1.4	<0.26	<0.26	53	170	147	730
Lot 1	MW-27-3.5-4.0	Sediment	<2.5	3.8	99	0.3	0.67	54	11	23	5.8	0.075	<0.84	41	0.35	<0.21	<0.21	38	25	144	48
Lot 1	MW-30-1.0	Sediment	<2.8	5.1	270	0.64	<0.23	50	10	22	8.3	0.27	<0.92	98	<0.23	<0.23	0.8	38	36	196	58
Lot 1	MW-30-3.5	Sediment	<3.3	7.1	84	0.62	<0.28	58	14	30	6.4	0.035	<1.1	97	<0.28	<0.28	0.87	45	53	214	83
Lot 1	MW-31-1.0	Sediment	<3.3	2.1	100	0.53	<0.28	28	10	14	5.8	0.053	<1.1	26	<0.28	<0.28	<0.28	17	16	81	30
Lot 1	MW-31-3.5	Sediment	<3.1	2.7	76	0.62	<0.26	36	11	16	6.2	0.02	<1	36	<0.26	<0.26	<0.26	24	22	107	38
Lot 1	SB-1E 3.5-4	Sediment	1	8	150	<0.1	<0.4	43	23	17	<1	<0.1	<1	77	2	<0.5	7	42	32	185	49
Lot 1	SB-1E 6-6.5	Sediment	2	8	160	<0.1	<0.4	44	18	26	<1	<0.1	<1	70	2	<0.5	8	41	43	173	69
Lot 1	SB-2E 3.5-4	Mixed	<1	5	180	<0.1	<0.4	26	18	220	5	<0.1	<1	19	1	<0.5	5	28	64	91	284
Lot 1	SB-2E 5.5-6	Sediment	<1	8	290	<0.1	<0.4	40	11	18	<1	0.2	<1	63	<1	<0.5	7	36	37	150	55
Lot 1	SB-3@3.0-3.5	Sediment	2	3	140	<0.1	<0.4	42	5	32	<1	0.1	<1	26	1	<0.5	3	31	28	104	60
Lot 1	SB-3@5.5-6	Sediment	2	5	130	<0.1	<0.4	34	13	19	<1	0.1	<1	55	2	<0.5	2	31	33	133	52
Lot 1	SB-4@3.0-3.5	Sediment	2	3	120	<0.1	<0.4	61	11	52	38	<0.1	<1	39	1	<0.5	2	30	65	141	117
Lot 1	SB-4@5.5-6	Sediment	2	6	200	<0.1	<0.4	46	12	25	<1	0.2	<1	71	<1	<0.5	3	35	41	164	66
Lot 1	SB-5@3.0-3.5	Sediment	2	4	180	0.1	<0.4	49	11	14	<1	<0.1	<1	65	1	<0.5	2	29	26	154	40
Lot 1	SB-5@5.5-6	Sediment	2	5	150	<0.1	<0.4	50	10	21	<1	0.3	<1	51	2	<0.5	2	37	38	148	59
Lot 1	SB-6@2.5-3	Sediment	<1	3	120	0.1	<0.4	21	10	19	2	<0.1	<1	25	<1	<0.5	<1	24	51	80	70
Lot 1	SB-6@5.5-6	Sediment	2	5	160	<0.1	<0.4	43	10	16	<1	<0.1	<1	66	<1	<0.5	1	35	33	154	49
Lot 1	SB-7@2.5-3	Mixed	4	24	73	<0.1	<0.4	<1	4	590	41	<0.1	5	2	<1	2	8	7	81	13	671
Lot 1	SB-7@5.5-6	Sediment	2	4	180	<0.1	0.5	46	11	92	<1	0.6	<1	41	2	<0.5	2	36	82	134	174
Lot 1	SB-8@3.0-3.5	Mixed	2	5	160	<0.1	0.6	<26	11	170	25	<0.1	<1	18	<1	<0.5	2	24	120	53	290
Lot 1	SB-8@5.5-6	Mixed	1	6	160	<0.1	0.7	40	11	530	<1	<0.1	<1	49	1	<0.5	2	30	170	130	700
Lot 2	SB-9@3.0-3.5	Mixed	1	10	120	<0.1	0.5	14	5	76	33	<0.1	<1	17	1	<0.5	<1	22	75	58	151
Lot 2	SB-9@5.5-6	Sediment	2	7	290	<0.1	<0.4	46	12	57	3	<0.1	<1	65	1	<0.5	3	32	76	155	133
Lot 2	SB-10@3.0-3.5	Mixed	<1	4	280	<0.1	<0.4	27	6	400	7	<0.1	<1	19	<1	<0.5	2	29	110	81	510
Lot 2	SB-10@5.5-6	Sediment	<1	3	140	<0.1	<0.4	31	7	14	2	0.3	<1	27	<1	<0.5	2	21	53	86	67
Lot 2	SB-11@3.0-3.5	Mixed	1	19	260	<0.1	0.7	27	9	1,500	66	0.2	<1	19	<1	<0.5	4	30	350	85	1850
Lot 2	SB-11@5.5-6	Mixed	<1	6	190	<0.1	1	39	18	80	5	<0.1	<1	50	<1	<0.5	2	33	380	140	460
Lot 2	SB-12@3.0-3.5	Mixed	<1	2	140	<0.1	0.4	23	6	940	4	<0.1	<1	14	<1	<0.5	1	21	130	64	1070
Lot 2	SB-12@5.5-6	Mixed	<1	10	210	<0.1	0.6	39	13	450	3	<0.1	<1	51	<1	<0.5	3	36	200	139	650
Lot 2	SB-13@3.0-3.5	Mixed	<1	3	150	<0.1	0.5	26	6	370	4	<0.1	<1	23	<1	<0.5	2	23	190	78	560
Lot 2	SB-13@5.5-6	Mixed	<1	7	150	<0.1	<0.4	34	6	120	4	0.1	<1	40	<1	<0.5	2	30	250	110	370
Lot 1	WRC-10-1.5	Sediment	<3	9.2	130	0.52	<0.25	29	9.8	38	14	0.15	<1	34	<0.25	<0.5	0.62	24	53	97	91
Lot 1	WRC-10-3.5	Sediment	<2.9	4.9	140	0.52	<0.24	28	6.9	32	8.6	<0.04	<0.96	25	<0.24	<0.48	0.44	22	19	82	51
Lot 1	WRC-11-1.5	Mixed	<3	11	130	0.42	0.85	52	12	37	170	0.19	<1	70	<0.25	<0.5	<0.25	30	140	164	177
Lot 1	WRC-11-3.5	Sediment	<2.9	3	140	0.52	<0.24	48	11	14	5.3	0.059	<0.98	120	<0.24	<0.49	<0.24	26	24	205	38
Lot 1	WRC-12-1.5	Sediment	<3	3.5	170	0.42	<0.25	46	9.5	22	17	0.11	<1	50	<0.25	<0.5	<0.25	28	35	134	57
Lot 1	WRC-12-3.5	Sediment	<2.9	4	200	0.38	<0.24	29	21	16	6.3	0.048	<0.97	30	<0.24	<0.49	<0.24	29	34	109	50
Lot 1	WRC-13-1.5	Sediment	<2.9	1.5	74	0.32	<0.24	11	7.5	20	8.6	0.39	<0.96	17	<0.24	<0.48	<0.24	14	63	50	83
Lot 1	WRC-13-3.5	Mixed	<3	1.9	110	0.27	2.6	23	8.5	300	4.2	<0.039	<1	18	<0.25	<0.5	<0.25	23	160	73	460
Lot 1	WRC-14-1.5	Sediment	<3	4.8	150	0.65	<0.25	33	12	23	20	0.52	<1	43	<0.25	<0.5	0.55	32	56	120	79

TABLE 1
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Campus Bay Site, Richmond, California

Location	SampleID	Cluster [a]	Metals Analyses in mg/kg [b]																		
			Sb	As	Ba	Be	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn	Cr+Co+Ni+V	Cu+Zn
Lot 1	WRC-14-3.5	Sediment	<3	3.1	120	0.45	<0.25	35	7.2	17	5.3	0.062	<1	55	<0.25	<0.5	0.43	28	32	125	49
Lot 1	WRC-15-1.5	Sediment	<2.9	2.2	120	0.47	<0.24	37	12	14	8.1	0.057	<0.96	30	<0.24	<0.48	0.5	31	28	110	42
Lot 1	WRC-15-3.5	Sediment	<2.9	2.1	42	0.63	<0.24	35	8.8	13	4.7	0.048	<0.96	41	<0.24	<0.48	<0.24	28	16	113	29
Lot 1	WRC-16-1.5	Sediment	<2.9	3.5	120	0.39	<0.24	35	13	17	6.6	0.049	<0.95	71	<0.24	<0.48	<0.24	26	32	145	49
Lot 1	WRC-16-3.5	Sediment	<3	1.9	130	0.43	<0.25	32	8.7	17	4.5	0.046	<1	48	<0.25	<0.5	<0.25	20	38	109	55
Lot 1	WRC-17-1.5	Sediment	<3	1.3	100	0.35	<0.25	7	3.4	8.4	5	0.63	<0.99	11	<0.25	<0.49	<0.25	9.2	21	31	29
Lot 1	WRC-17-3.5	Sediment	<3	2.3	90	0.37	<0.25	30	13	8.6	5.3	0.041	<1	25	<0.25	<0.5	<0.25	26	15	94	24
Lot 1	WRC-19-3.5	Sediment	<2.9	2.6	44	0.29	0.24	27	11	12	4.2	0.099	<0.96	31	<0.24	<0.48	<0.24	16	25	85	37
Lot 1	WRC-20-1.5	Railroad	<3	22	130	0.23	<0.25	28	2.4	58	12	0.5	<1	9.7	<0.25	<0.5	0.32	32	27	72	85
Lot 1	WRC-20-3.5	Sediment	<3	2.8	38	0.45	<0.25	38	5.6	27	4.7	0.055	<1	23	<0.25	<0.5	0.31	29	74	96	101
Lot 2	WRC-30-1.5	Sediment	<3	1.1	97	0.47	<0.25	9.5	5	6.8	8.6	0.11	<1	12	<0.25	<0.5	<0.25	17	24	44	31
Lot 2	WRC-30-3.5	Sediment	<2.9	1.7	81	0.22	<0.24	30	3.9	11	4.2	0.061	<0.96	20	<0.24	<0.48	<0.24	21	17	75	28
Lot 3	MW-29-1.0	Sediment	<3.2	11	140	0.31	1.5	49	12	40	14	3.8	1.2	57	<0.27	<0.27	<0.27	45	97	163	137
Lot 3	MW-29-3.5	Mixed	<2.7	20	160	0.25	7.7	52	11	750	27	1.8	2.3	45	<0.23	0.99	<0.23	44	610	152	1360
Lot 3	LOT-3-13-1.0	Cinders	11	81	310	0.16	2.1	21	6.4	1000	190	2.6	9.8	15	11	<0.26	<0.26	34	350	76	1350
Lot 3	LOT-3-13-3.5	Cinders	12	130	440	0.15	2.9	19	8.5	3200	260	1.4	15	16	15	<0.28	<0.28	46	430	90	3630
Lot 3	LOT-3-23-1.0	Cinders	7.2	83	220	0.22	3.2	26	9.1	340	100	2.6	5.6	18	5	6.3	<0.23	58	440	111	780
Lot 3	LOT-3-23-3.5	Mixed	4.2	35	340	0.26	0.82	79	7.1	580	180	1.6	2.7	26	2.3	1.1	<0.28	41	180	153	760
Lot 3	LOT-3-28-1.0	Mixed	8.3	30	300	0.6	2.7	59	11	240	300	1.4	3	51	5.2	1.5	<0.31	62	340	183	580
Lot 3	LOT-3-28-3.5	Cinders	8.1	65	560	0.16	3.2	39	8.6	1600	280	0.56	8.1	21	5.8	3.9	<0.34	38	1000	107	2600
Lot 3	LOT-3-29-1.0	Cinders	12	140	370	0.3	10	53	11	1300	340	7	8.6	40	25	6.3	<0.28	73	1400	177	2700
Lot 3	LOT-3-29-3.5	Cinders	11	130	590	0.21	7.6	36	9.1	870	180	3.4	10	26	19	9.1	<0.23	59	1200	130	2070
Lot 3	LOT-3-47-1.0	Cinders	10	130	420	0.15	1.6	34	7.1	1100	400	2.4	9.3	19	7.4	4.9	<0.25	37	420	97	1520
Lot 3	LOT-3-47-3.5	Cinders	9.5	97	410	0.13	2.2	21	7.8	4000	130	0.86	13	24	5.8	8.2	<0.28	33	410	86	4410
Lot 3	LOT-3-9-1.0	Cinders	8.6	130	170	0.16	9	21	11	2000	310	430	11	24	18	7.2	<0.19	37	1600	93	3600
Lot 3	LOT-3-9-3.5	Cinders	16	180	240	0.18	16	25	12	1900	380	8	14	28	27	12	<0.25	54	2500	119	4400
Lot 3	LOT-3-14-1.0	Cinders	7.3	180	180	0.15	27	24	23	13000	390	12	11	36	27	<0.26	4.3	60	2500	143	15500
Lot 3	LOT-3-14-3.5	Cinders	13	160	190	0.19	13	23	14	2700	200	4.5	14	26	26	<0.26	3.4	63	2000	126	4700
Lot 3	LOT-3-15-1.0	Cinders	16	390	170	0.22	19	41	14	3800	360	59	8.2	37	66	<0.33	2.8	57	2300	149	6100
Lot 3	LOT-3-15-3.5	Cinders	13	180	150	0.18	12	25	16	3300	4600	300	13	30	600	<0.32	2.4	42	1800	113	5100
Lot 3	LOT-3-53-1.0	Cinders	7.8	200	81	<0.1	22	3.3	11	2800	120	2.8	10	6.5	4.3	<0.25	1.9	23	2600	44	5400
Lot 3	LOT-3-53-3.5	Cinders	22	400	330	<0.13	9	24	9.6	1300	580	8.7	12	15	16	<0.31	2.6	52	1400	101	2700
Lot 3	LOT-3-30-1.0	Sediment	<3.1	6.4	100	0.22	0.42	25	3.9	21	34	0.33	<1	24	0.73	<0.26	0.65	27	100	80	121
Lot 3	LOT-3-30-3.5	Cinders	5.9	95	280	0.33	4.1	54	8.3	620	1000	4	4	38	15	<0.22	1.1	46	590	146	1210
Lot 3	LOT-3-50-1.0	Cinders	5.4	130	140	0.31	9.9	27	8.8	1800	100	12	4.9	43	8.6	0.46	<2.8	54	1300	133	3100
Lot 3	LOT-3-50-3.5	Cinders	<3.4	71	150	0.46	5	37	10	530	68	6.1	2.3	68	7.1	<0.28	0.35	82	550	197	1080
Lot 3	LOT-3-11-1.0	Cinders	110	220	280	0.2	10	34	12	1900	3200	10	13	26	36	<0.25	1.6	64	1500	136	3400
Lot 3	LOT-3-11-3.5	Cinders	22	280	140	<0.12	19	1.1	18	2000	760	6.4	20	9.1	16	<0.3	0.82	53	2900	81	4900
Lot 3	LOT-3-3-1.0	Cinders	25	160	230	0.24	18	41	10	2600	250	10	8.8	32	8.6	7.1	<0.26	50	1800	133	4400
Lot 3	LOT-3-3-3.5	Mixed	6	12	220	0.61	0.88	52	17	260	18	0.21	<1	59	<0.26	<0.26	<0.26	46	540	174	800
Lot 3	LOT-3-4-1.0	Cinders	22	190	270	0.14	5.8	42	12	1000	900	13	8.1	55	15	6.8	<0.24	42	880	151	1880

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Campus Bay Site, Richmond, California

Location	SampleID	Cluster [a]	Metals Analyses in mg/kg [b]																		
			Sb	As	Ba	Be	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn	Cr+Co+Ni+V	Cu+Zn
Lot 3	LOT-3-4-3.5	Cinders	27	160	260	0.24	8.1	37	7.5	820	470	13	8.1	22	17	7.7	<0.27	64	950	131	1770
Lot 3	LOT-3-5-1.0	Cinders	32	260	330	0.17	21	41	7.9	1700	510	13	8.9	24	32	10	<0.32	65	2600	138	4300
Lot 3	LOT-3-5-3.5	Cinders	28	110	84	<0.09	14	7	9	2000	120	3.4	10	6.6	2.4	9.9	<0.22	18	2000	41	4000
Lot 3	LOT-3-6-1.0	Cinders	32	130	320	<0.1	1.4	6.3	4	2200	340	1.2	16	6.4	5.9	9	<0.25	25	330	42	2530
Lot 3	LOT-3-6-3.5	Cinders	20	110	250	0.21	1.4	19	6.1	1100	160	1.1	7.3	19	<0.23	5.5	<0.23	43	530	87	1630
Lot 3	LOT-3-7-1.0	Cinders	29	150	160	<0.098	1.6	5.3	5.5	8100	83	0.6	17	6.7	9	7.2	<0.25	25	300	43	8400
Lot 3	LOT-3-7-3.5	Mixed	5	13	150	0.24	0.87	31	6.7	130	200	0.56	1.3	30	2.6	0.39	<0.24	41	120	109	250
Lot 3	LOT-3-12-1.0	Cinders	24	170	350	0.24	5.1	43	9.2	1400	6800	8.9	11	29	26	<0.28	2.9	58	900	139	2300
Lot 3	LOT-3-12-3.5	Cinders	18	250	190	0.099	12	11	10	980	840	5.3	16	14	19	<0.21	2.8	40	830	75	1810
Lot 3	LOT-3-51-3.5	Cinders	7.7	180	220	0.23	5.5	37	7.2	1200	1400	7.3	7.1	24	22	<0.26	2.3	48	660	116	1860
Lot 3	LOT-3-52-1.5	Cinders	8.4	160	260	0.15	7.3	35	6.7	950	470	9.6	8.1	19	36	<0.27	2.3	50	770	111	1720
Lot 3	LOT-3-54-1.0	Cinders	4.4	72	270	0.23	12	27	11	990	130	5.8	8	26	18	<0.29	1.8	50	1200	114	2190
Lot 3	LOT-3-54-3.5	Cinders	7.4	120	220	0.22	11	34	9.7	1100	230	3.9	7.1	31	16	<0.18	3.4	53	1400	128	2500
Lot 3	LOT-3-16-1.0	Cinders	10	70	250	0.36	3.8	52	10	660	230	5.8	3.7	49	12	3	<0.26	51	430	162	1090
Lot 3	LOT-3-16-3.5	Cinders	13	52	130	0.29	5.5	42	6.3	1000	290	2.4	2.5	35	10	2.6	<0.28	36	490	119	1490
Lot 3	LOT-3-17-1.0	Cinders	19	120	300	<0.095	4.8	18	13	850	780	4.6	13	12	27	7	<0.24	40	720	83	1570
Lot 3	LOT-3-17-3.5	Cinders	29	260	140	<0.11	6	27	7.8	1300	310	4.1	12	12	36	9.4	<0.28	36	1000	83	2300
Lot 3	LOT-3-18-1.0	Cinders	33	160	200	0.14	8.3	20	6.1	920	860	8.1	8.2	15	23	9.9	<0.28	38	1000	79	1920
Lot 3	LOT-3-18-3.5	Cinders	27	300	180	<0.12	3.7	13	9.5	1500	4100	4.6	14	9.5	25	8.7	<0.29	44	570	76	2070
Lot 3	LOT-3-19-1.0	Cinders	19	200	320	0.21	7.6	29	8.2	880	800	7.2	12	24	29	<0.3	2.5	61	940	122	1820
Lot 3	LOT-3-19-3.5	Cinders	9.2	150	270	0.15	4	41	7.6	880	620	7.3	10	17	20	<0.23	3.3	44	600	110	1480
Lot 3	LOT-3-44-1.0	Cinders	16	120	150	0.18	23	26	14	5100	280	50	8.1	27	47	7	<0.2	33	2200	100	7300
Lot 3	LOT-3-44-3.5	Cinders	15	71	110	0.25	5.5	25	12	850	73	2.3	5.5	32	12	11	<0.19	30	980	99	1830
Lot 3	LOT-3-8-1.0	Cinders	19	180	190	0.22	13	42	11	2000	580	150	8.5	32	110	7.2	<0.23	51	1600	136	3600
Lot 3	LOT-3-8-3.5	Cinders	16	300	200	0.29	8.9	63	9.9	860	200	19	5.1	38	33	4.7	<0.24	61	1400	172	2260
Lot 3	LOT-3-24-1.0	Cinders	68	270	260	0.23	4.4	26	9.5	950	870	5.7	15	17	14	8	<0.27	43	900	96	1850
Lot 3	LOT-3-24-3.5	Cinders	94	640	120	0.1	6.2	6.7	8	390	340	5.1	11	6.9	7.5	15	<0.21	47	1400	69	1790
Lot 3	LOT-3-25-1.0	Cinders	92	210	72	<0.13	22	1.7	16	3000	52	3.4	22	<1.3	10	13	<0.33	30	4200	48	7200
Lot 3	LOT-3-25-3.5	Cinders	45	160	230	0.18	2.4	25	8.1	1000	670	5.6	9.6	18	14	5.6	<0.26	44	450	95	1450
Lot 3	LOT-3-26-1.0	Mixed	5.7	20	170	0.35	0.79	50	8.4	63	35	0.97	2.1	79	0.99	0.52	<0.27	45	130	182	193
Lot 3	LOT-3-26-3.5	Sediment	7.6	4.7	110	0.51	<0.27	83	13	23	23	0.21	<1.1	75	<0.27	<0.27	<0.27	75	62	246	85
Lot 3	LOT-3-31-1.0	Cinders	42	100	300	0.24	2.1	47	9.3	1900	340	4.4	14	35	14	5.5	<0.25	40	570	131	2470
Lot 3	LOT-3-31-3.5	Cinders	22	36	420	0.24	0.88	39	5.6	1400	150	1.2	4.6	24	2.6	1.9	<0.29	46	280	115	1680
Lot 3	LOT-3-48-1.0	Cinders	23	41	120	0.46	11	39	12	640	40	13	5.5	40	2.6	1.5	<0.22	40	1100	131	1740
Lot 3	LOT-3-48-3.5	Cinders	43	220	260	0.27	6.2	130	14	1100	590	16	9.6	29	16	6.3	<0.22	61	870	234	1970
Lot 3	LOT-3-21-1.0	Cinders	23	120	210	0.38	36	30	13	950	85	88	8.3	31	3.2	3.2	<0.3	36	2600	110	3550
Lot 3	LOT-3-21-3.5	Cinders	39	290	180	0.32	22	46	13	1900	310	60	10	39	35	6.8	<0.32	66	2200	164	4100
Lot 3	LOT-3-27-1.0	Cinders	29	220	130	0.41	13	39	12	860	120	20	8.8	39	11	4.4	<0.33	43	2000	133	2860
Lot 3	LOT-3-27-3.5	Cinders	36	320	220	0.34	13	46	11	1500	350	36	9	59	99	6.2	<0.34	89	1700	205	3200
Lot 3	LOT-3-45-1.0	Cinders	21	170	130	0.38	10	44	11	690	110	34	6	40	11	2.7	<0.32	45	1400	140	2090
Lot 3	LOT-3-45-3.5	Cinders	24	270	140	0.3	8.6	57	8.6	780	240	32	5.5	34	43	3.7	<0.28	52	1000	152	1780

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Location	SampleID	Cluster [a]	Metals Analyses in mg/kg [b]																		
			Sb	As	Ba	Be	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn	Cr+Co+Ni+V	Cu+Zn
Lot 3	LOT-3-20-1.0	Cinders	6.2	200	110	0.33	16	31	14	1100	100	45	11	40	15	<0.31	1.1	47	2700	132	3800
Lot 3	LOT-3-20-3.5	Cinders	<3.6	150	120	0.33	7.5	26	11	940	100	46	8.8	33	11	<0.3	1.7	40	1200	110	2140
Lot 3	LOT-3-46-1.0	Cinders	<3.5	56	310	0.18	1.3	28	8	1400	280	4.4	7.6	23	15	<0.29	2.1	38	260	97	1660
Lot 3	LOT-3-46-3.5	Mixed	<3.4	41	190	0.18	0.93	32	10	430	100	0.66	11	47	5.1	<0.31	2	36	190	125	620
Lot 3	LOT-3-46-4.0	Mixed	<3.4	22	250	0.2	0.45	35	6.1	400	42	0.34	2.1	26	1.5	<0.28	0.37	37	99	104	499
Lot 3 PCE Area	LOT-3-10-1.0	Cinders	15	260	390	0.35	14	51	13	1400	330	22	9.4	56	35	<0.36	1.4	110	1500	230	2900
Lot 3 PCE Area	LOT-3-10-3.5	Cinders	14	160	460	0.51	9	54	11	1400	290	9.7	8.4	52	22	<0.32	1.6	97	1200	214	2600

Notes:

(a) Arsenic populations assigned by cluster analysis (see text for explanation).
(b) All results reported in mg/kg (dry weight). Samples analyzed by EPA Method 6010.

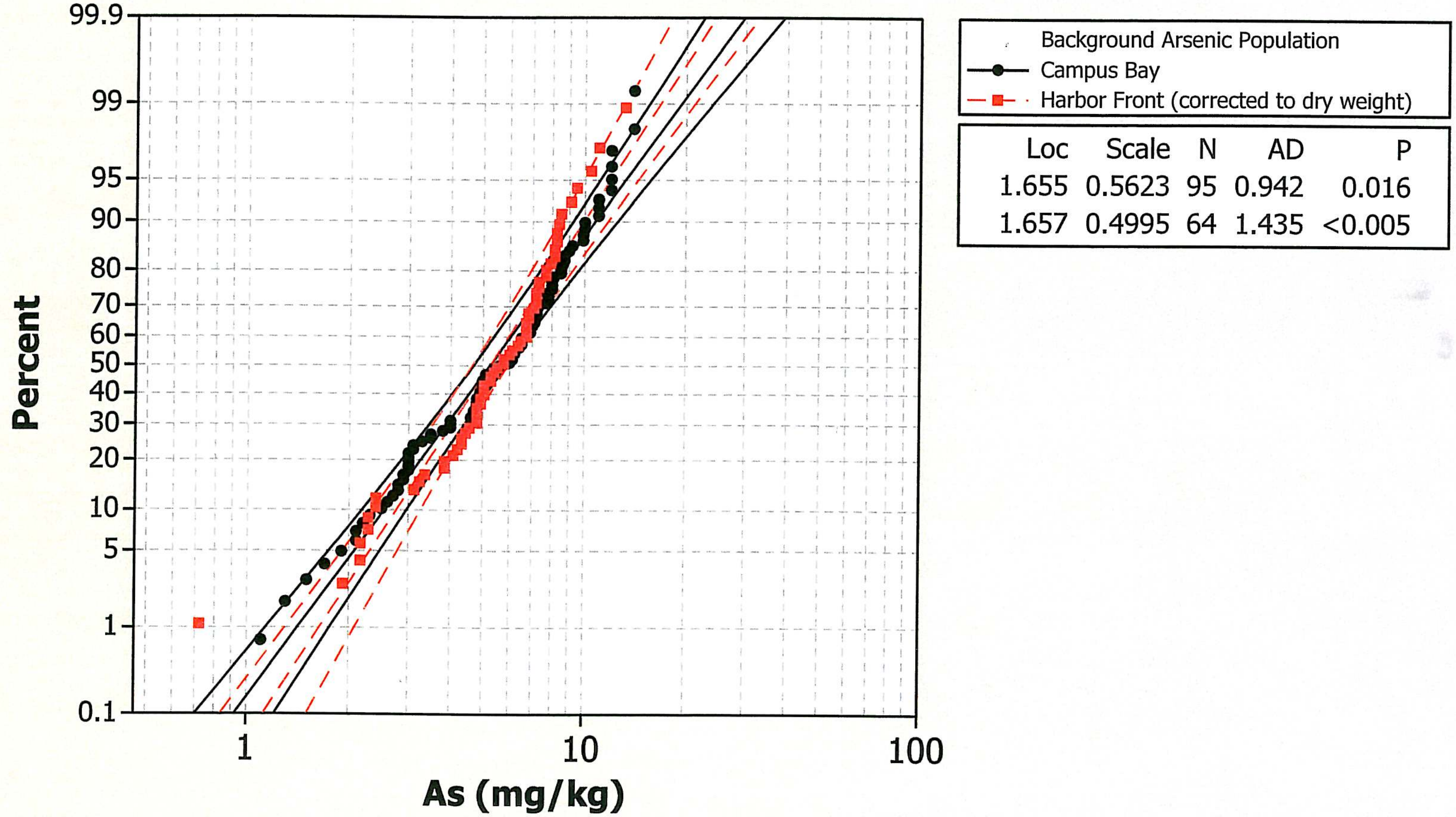
Abbreviations:

"<" indicates that analytical results are less than the corresponding laboratory reporting limit.

Sb = Antimony
As = Arsenic
Ba = Barium
Be = Beryllium
Cd = Cadmium
Cr = Chromium
Co = Cobalt
Cu = Copper
Pb = Lead
Hg = Mercury
Mo = Molybdenum
Ni = Nickel
Se = Selenium
Ag = Silver
Tl = Thallium
V = Vanadium
Zn = Zinc
Cr+Co+Ni+V = The sum of the chromium, cobalt, nickel and vanadium analyses for a given sample.
Cu+Zn = The sum of the copper and zinc analyses for a given sample.

Figure 10: Comparison of Site Background Arsenic Populations

Campus Bay and Harbor Front Sites



N

300 0 300

(Approximate Scale in Feet)

Legend:

Arsenic Populations

- Sediment/Background
- Mixed
- Cinders
- Railroad
- Lot or Subarea Boundary
- Campus Bay Site Boundary

Notes:

1. All locations are approximate.
2. Arsenic population shown represents the soil sample with the highest arsenic concentration present at each location.

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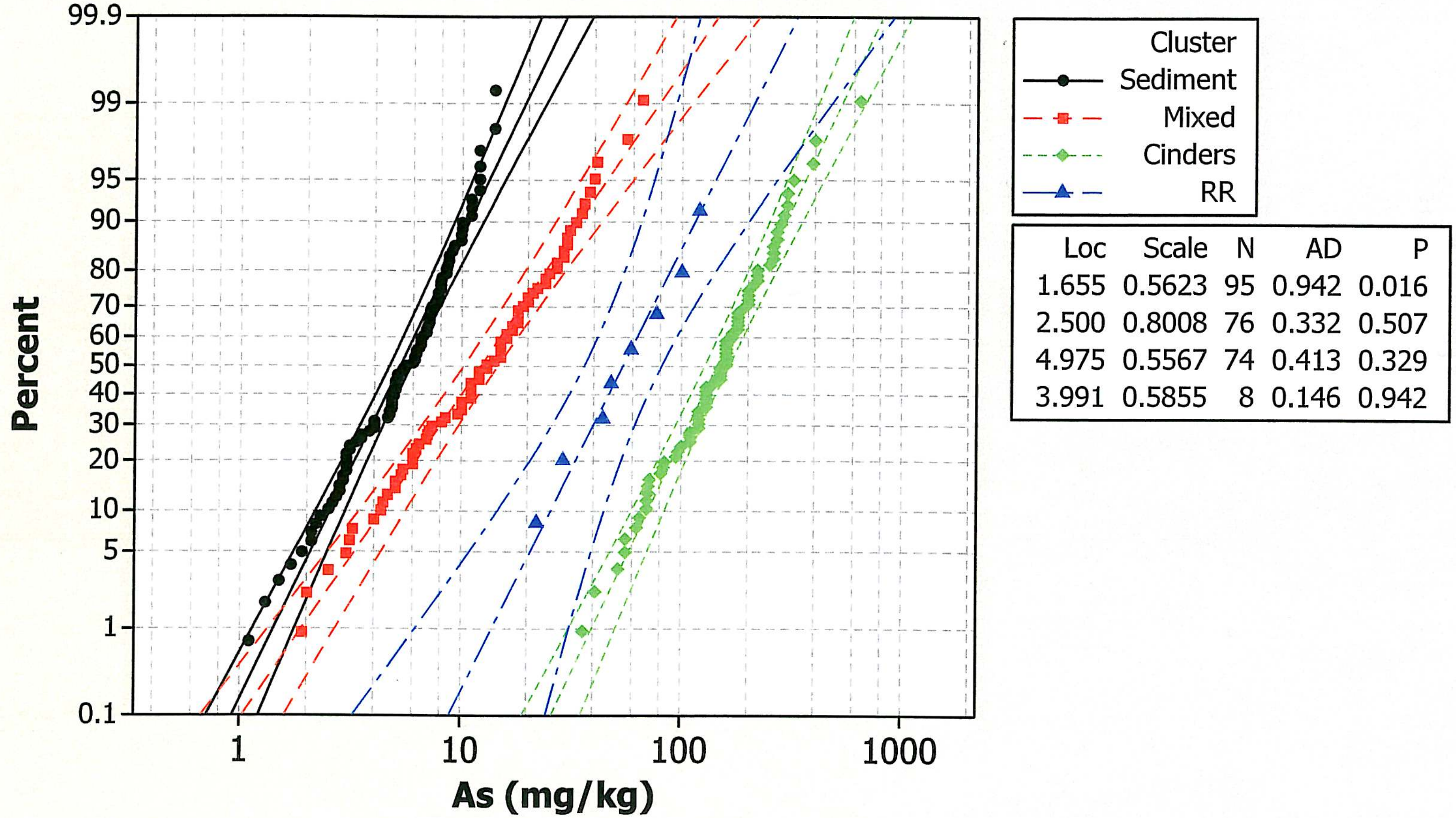
Spatial Distribution of Arsenic Populations

Campus Bay Site
Richmond, CA
July 2007
EKI A50014.06

Figure 9

Figure 8: Probability Plot of Arsenic Populations

Lognormal - 95% CI



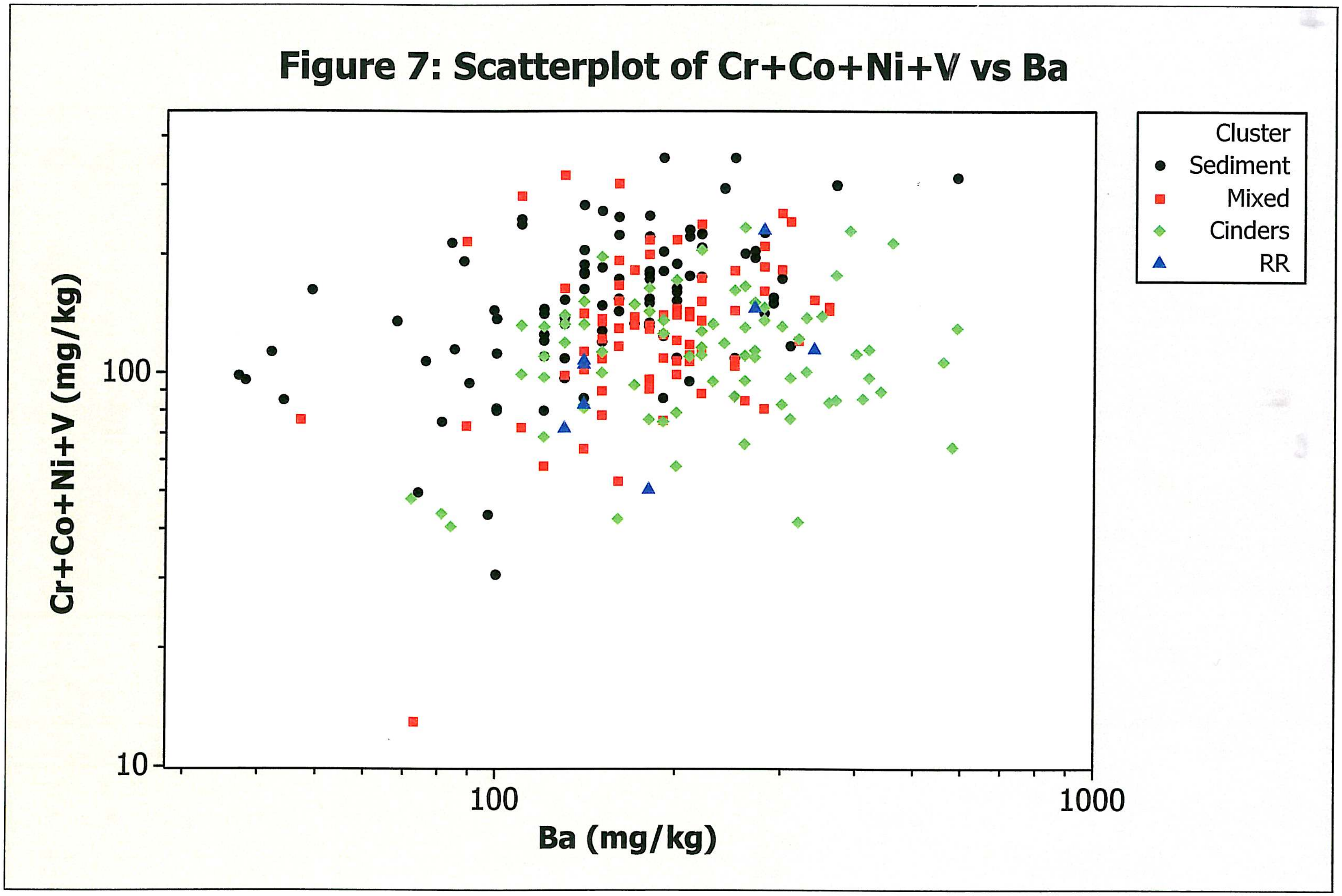


Figure 7: Scatterplot of Cr+Co+Ni+V vs Ba
Cr+Co+Ni+V (mg/kg)
100
10
100
1000
Ba (mg/kg)
Cluster
Sediment
Mixed
Cinders
RR

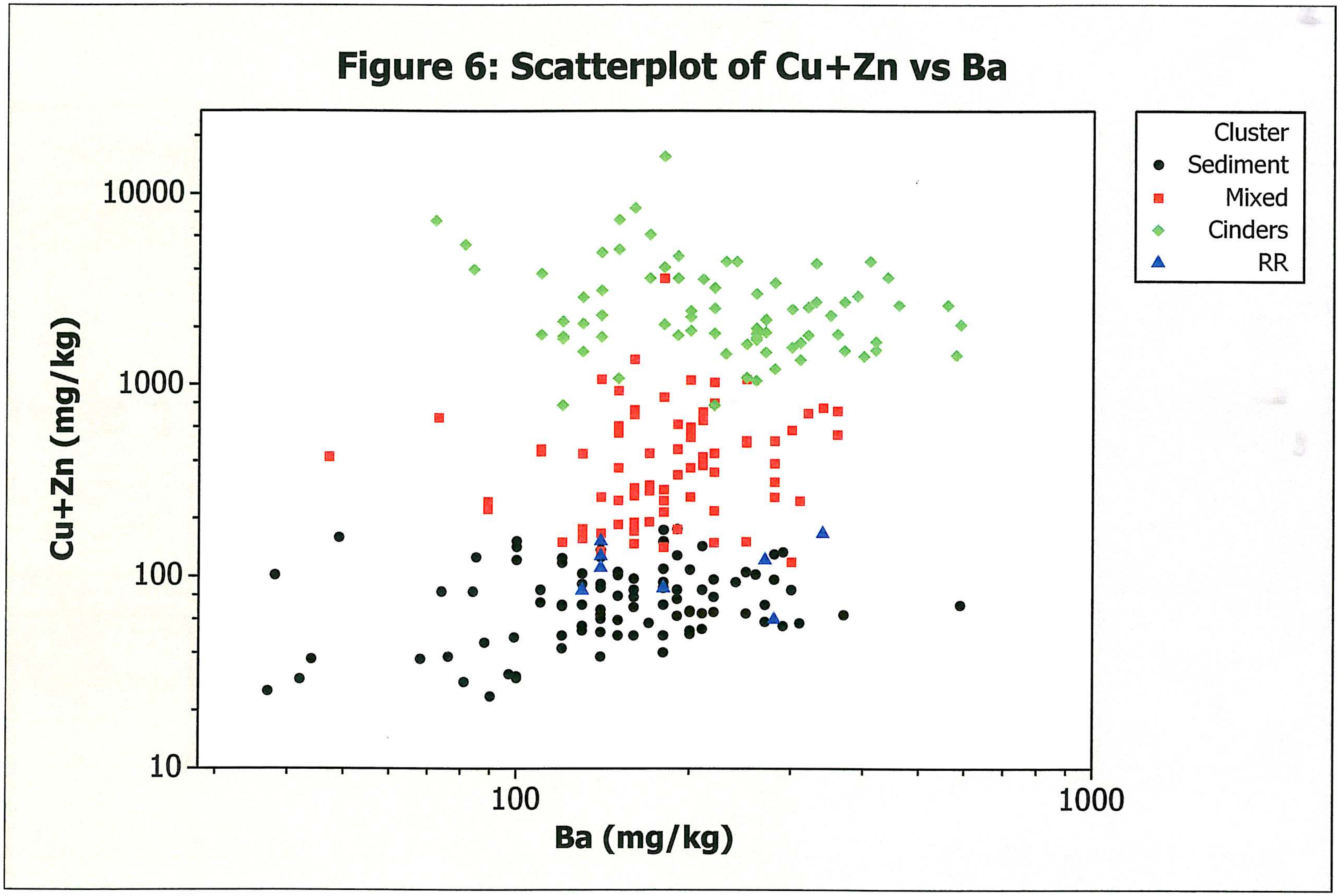


Figure 6: Scatterplot of Cu+Zn vs Ba
Cu+Zn (mg/kg)
10000
1000
100
10
100
1000
Ba (mg/kg)
Cluster
Sediment
Mixed
Cinders
RR

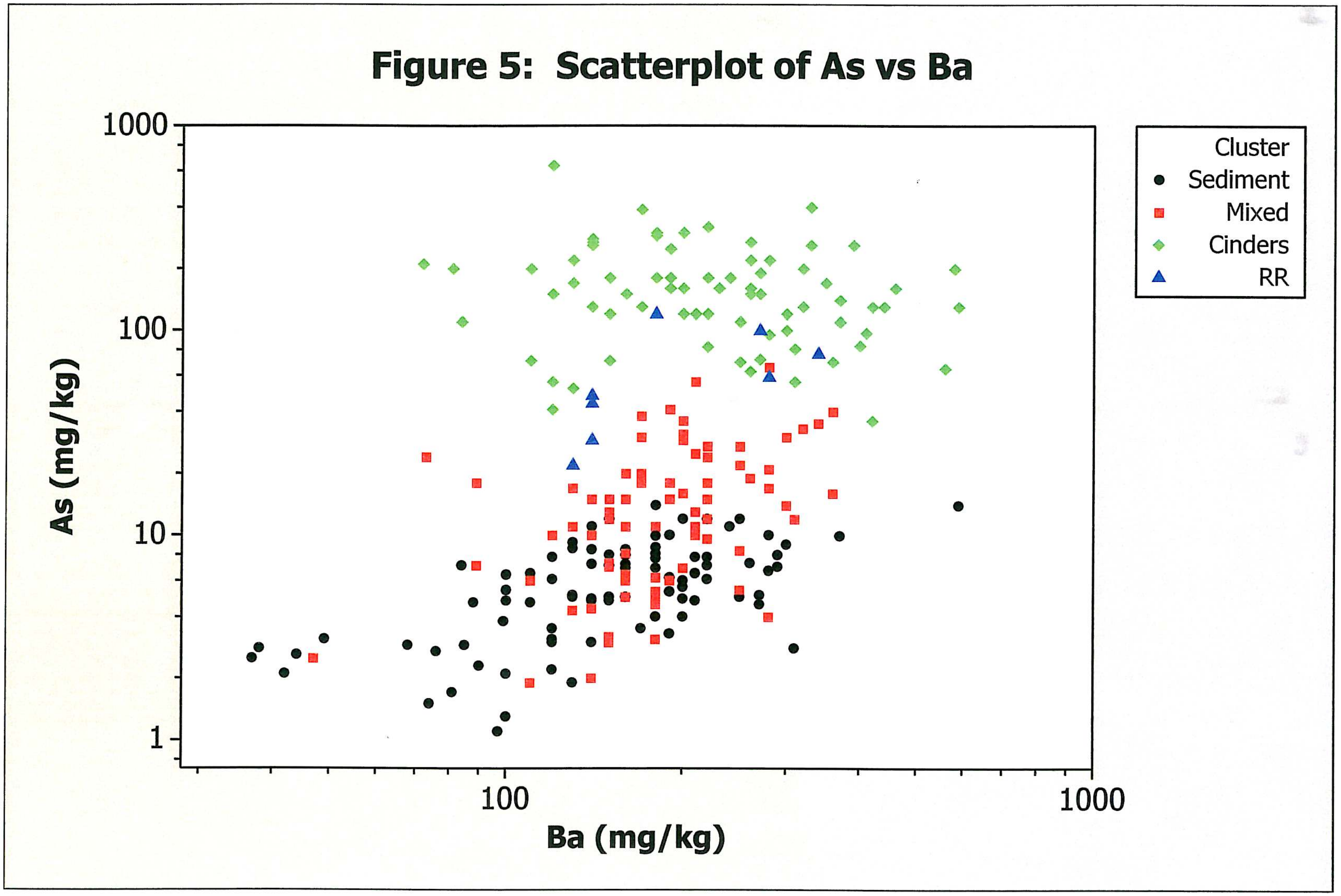


Figure 5: Scatterplot of As vs Ba
1000
100
10
1
As (mg/kg)
100
1000
Ba (mg/kg)
Cluster
Sediment
Mixed
Cinders
RR

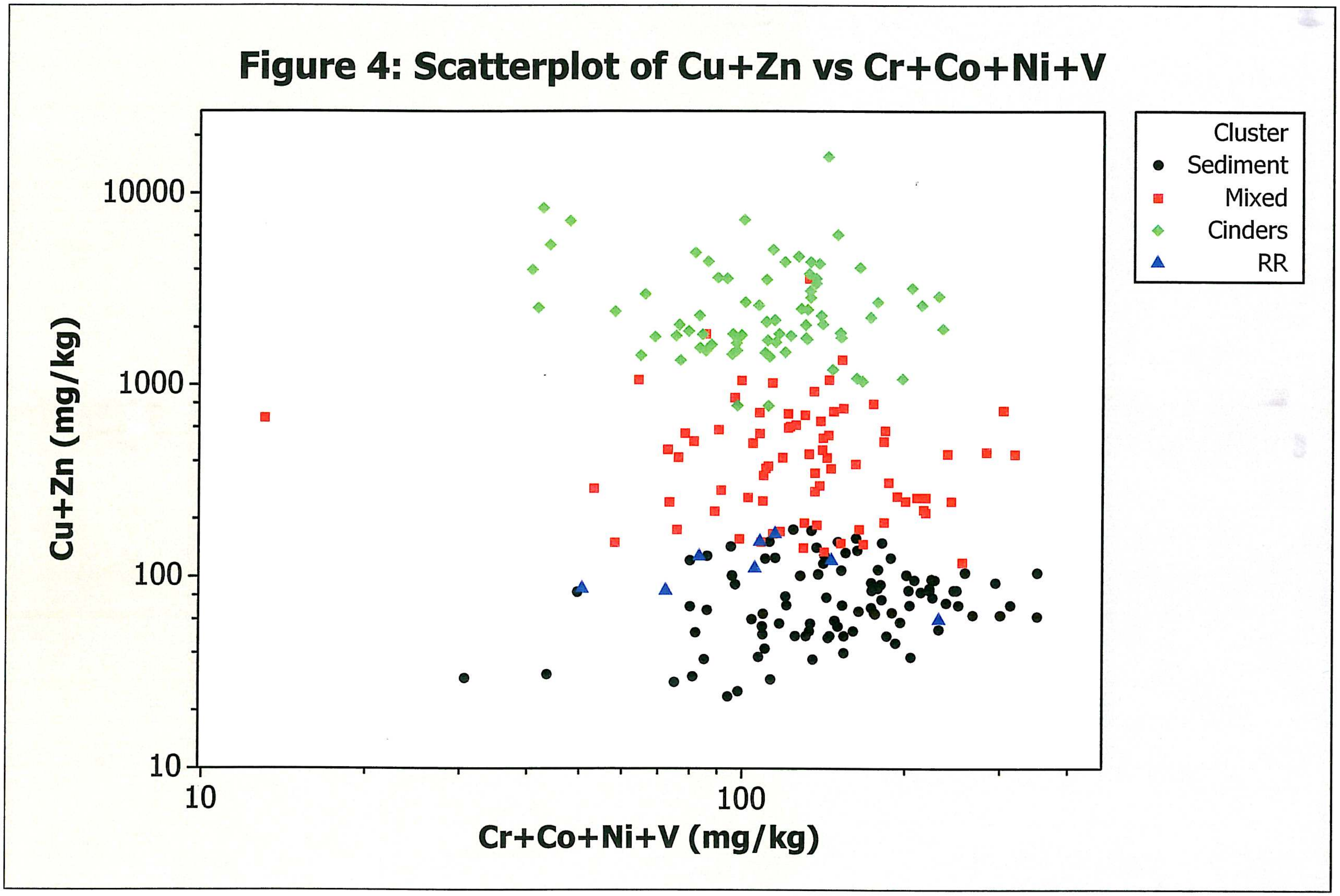


Figure 4: Scatterplot of Cu+Zn vs Cr+Co+Ni+V
Cu+Zn (mg/kg)
10000
1000
100
10
10
100
Cr+Co+Ni+V (mg/kg)
Cluster
Sediment
Mixed
Cinders
RR

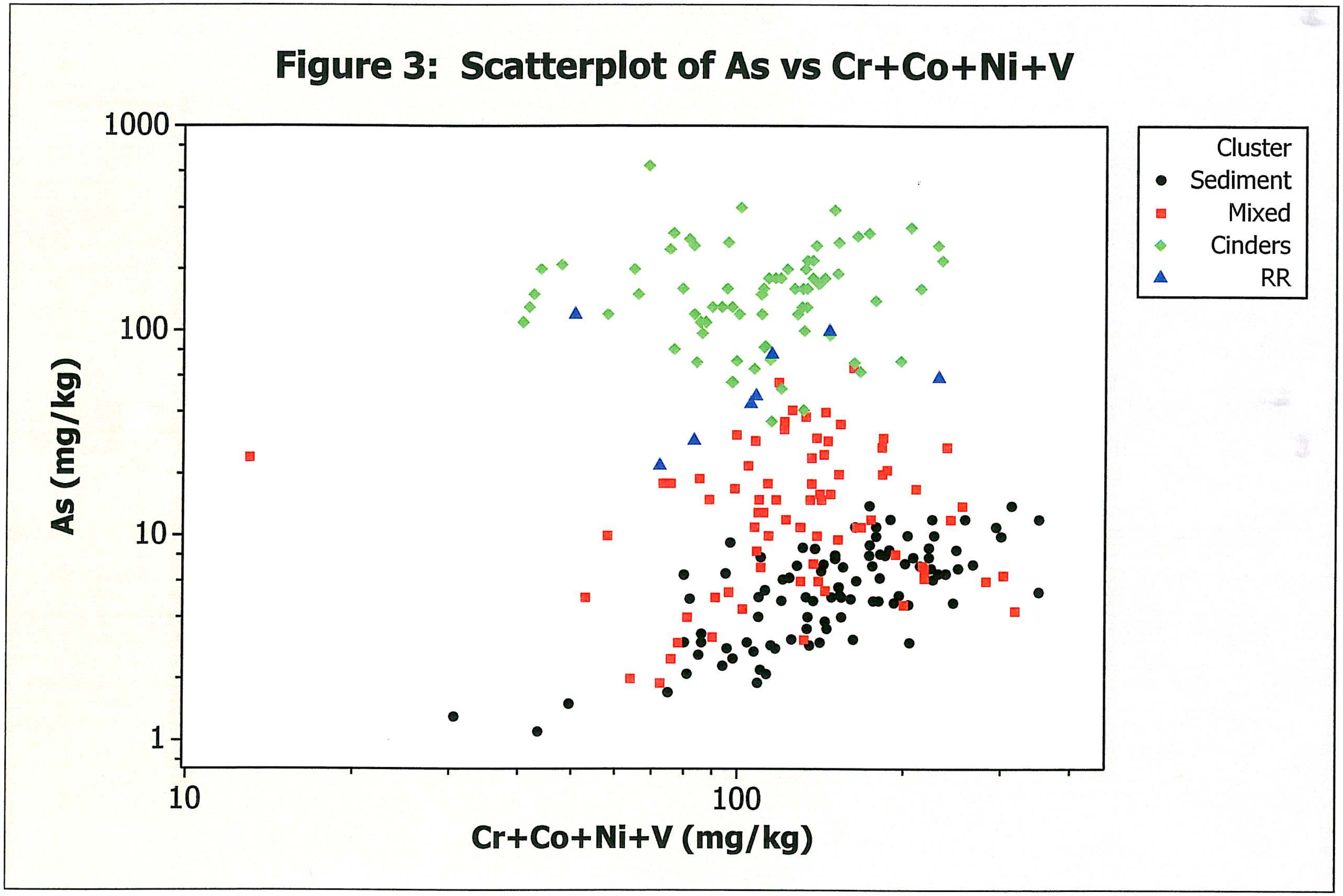


Figure 3: Scatterplot of As vs Cr+Co+Ni+V
1000
100
10
1
As (mg/kg)
10
100
Cr+Co+Ni+V (mg/kg)
Cluster
Sediment
Mixed
Cinders
RR

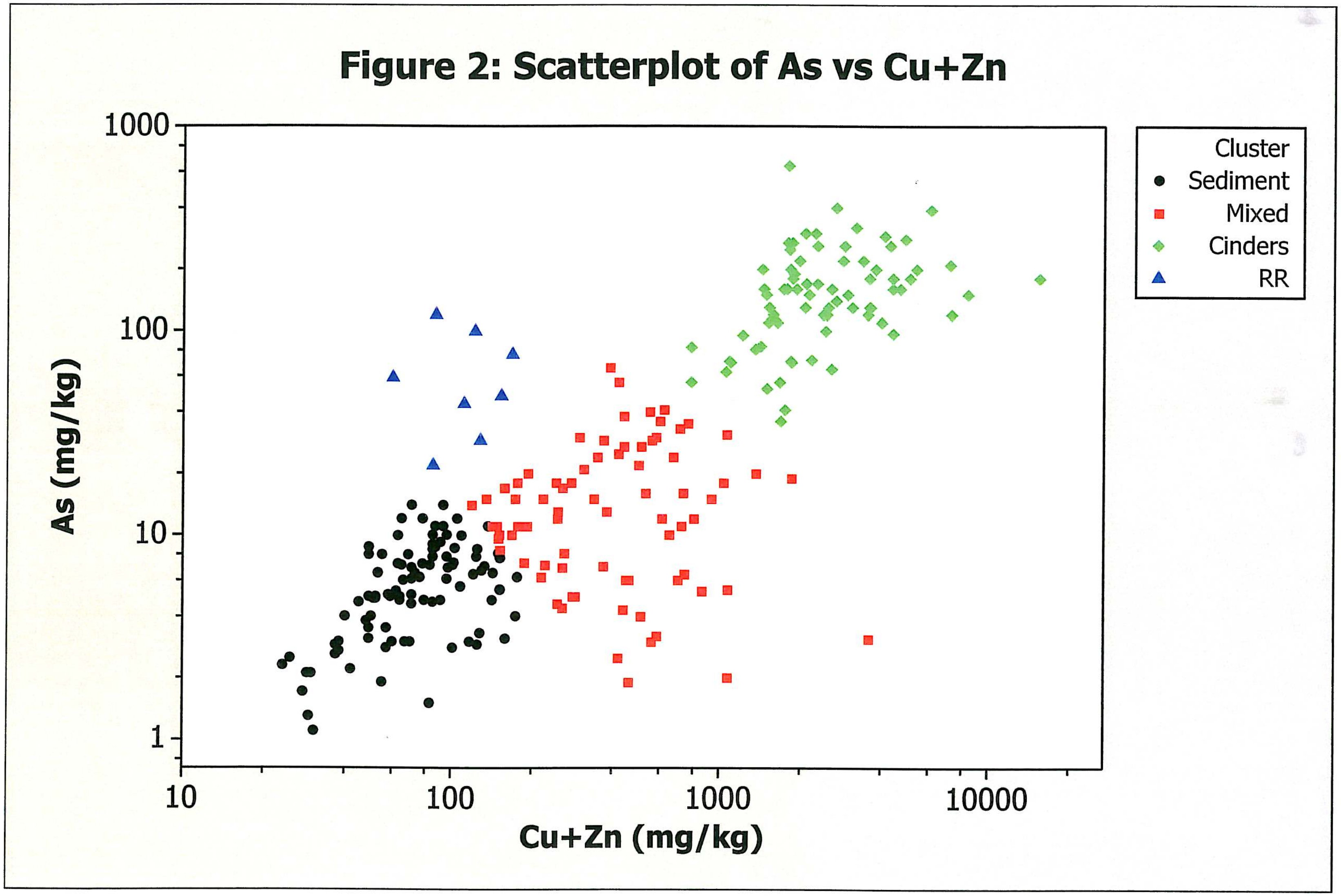


Figure 2: Scatterplot of As vs Cu+Zn
1000
100
10
1
As (mg/kg)
10
100
1000
10000
Cu+Zn (mg/kg)
Cluster
Sediment
Mixed
Cinders
RR

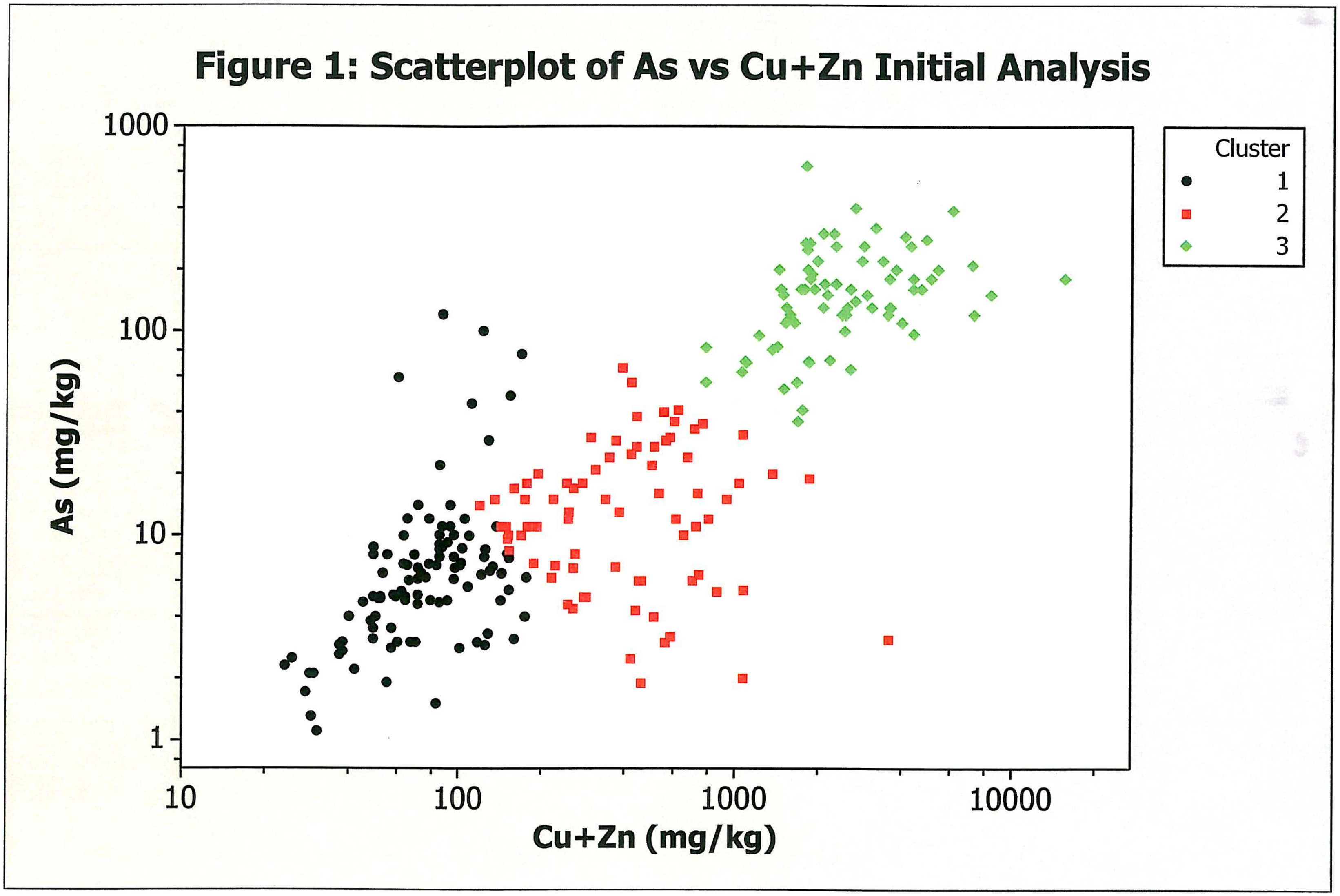


Figure 1: Scatterplot of As vs Cu+Zn Initial Analysis
As (mg/kg)
1000
100
10
1
Cu+Zn (mg/kg)
10
100
1000
10000
Cluster
1
2
3