U.S. Army Installation
Restoration Program

Background Data Analysis
for

Arsenic, Barium, Cadmium Chromium and Lead

on
Fort Wainwright, Alaska

December 1993

US Army Corps
of Engineers
Alaska District

23352

Abbreviations

UCL . . . . . Upper Confidence Limit

MCL . . . . . Maximum Contaminant Level

RBC . . . . . Risk Based Concentration

HI . . . . . Hazard Index

HQ . . . . . Hazard Quotient

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INTRODUCTION

This report summarizes the findings of a data search and of the calculation of a 95 percent Upper Confidence Limit (UCL) for background levels of arsenic, barium, cadmium, chromium and lead using groundwater and soil samples taken on Fort Wainwright, Alaska. Analysis of the background data will provide a basis for establishing clean-up levels for the RCRA metals on Fort Wainwright. The 95% UCL is defined as a value taken from randomly drawn subsets of site data that equals or exceeds the true mean 95 percent of the time (EPA 1992). The UCL does not provide a maximum level of concentration due to background levels, it gives an estimated value for the mean background concentration. To calculate the UCL, the mean, standard deviation, an *h* or *t* statistic, and the number of samples are used. The *t* statistic is determined from the degrees of freedom (sample size minus 1) and the desired confidence level and is used for a normal distribution of data. The *h* statistic is used for a lognormal distribution and is determined from the degrees of freedom and the standard deviation. The UCL is used as the average concentration because of uncertainty in the distribution average. As the sample size increases, the UCL moves closer to the true mean. Data sets of 20 to 30 samples generally provide fairly consistent estimates of the true mean value (EPA 1992).

Methods used in obtaining and manipulating the data will be provided along with a discussion of geological formations in the area that produce the elements under consideration. The results will be presented along with graphs of the data used in the study and finally, the recommended background levels will be presented.

METHODS

Sample values were taken from various reports done on Fort Wainwright, graphed to determine distribution, analyzed statistically to determine the UCL, and then compared to background UCL's for Eielson Air Force Base (AFB). The Geochemical Atlas of Alaska was also used to compare results for soil. Dissolved and total groundwater samples were analyzed separately and the Chena River was used as a boundary to categorize the data in order to provide a more accurate analysis. Non-detect samples were recorded at half their value. Some samples were deleted because they were considered to be contaminated by an outside source. An explanation of why the sample was deleted and the value of the sample or samples deleted is furnished in the detailed descriptions that follow for each category of data. The data were graphed to show distribution by using bins to categorize the data. Bin values were chosen to best display distribution and each bin is the lower limit of the aggregate. An explanation of the charts provided in this report is given in Figure A.

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Appendix A provides additional distribution information to the graphs presented in the Results section. The 95% Upper Confidence Limit was determined according to the EPA Publication 9285.7-081: Supplemental Guidance to RAGS: Calculating the Concentration Term. The UCL was determined using both a *h* statistic for a lognormal distribution and a *t* statistic for a normal distribution. Appendix B supplies a full statistical analysis along with the formulae used to calculate the UCL. The reports used in this analysis were chosen so that a large number of samples could be used in the statistical analysis and so that a costly special sampling event would not be needed. All samples were collected useing EPA approved sampling protocol and contaminated samples were carefully screened out. The following reports were used to obtain sample values:

Ecology and Environment, Inc. Birch Hill Underground Storage Tank Site Draft Remedial Investigation. January 1993

Ecology and Environment, Inc. Fort Wainwright Landfill Report. August 1991

OHM Remediation Services Corp. Sampling & Analytical Final Report for Drummed Waste Removal. February 1993

Harding Lawson Associates. Operable Unit 2, Preliminary Source Evaluation 2, Phase 1 Draft Report. November 1992

Harding Lawson Associates. Operable Unit 2, Preliminary Source Evaluation 2, Phase 2, Defense Reutilization Marketing Office Draft Report. February 1993

Alaska District Corps of Engineers. Final Report, Power Plant Coal Yard. August 1991

Ecology and Environment, Inc. Corrective Action Plan, PX Service Station Underground Storage Tank Site. March 1993

Ecology and Environment, Inc. Progress Report for the Confirmation of Fire Training Pits at Fort Richardson, Fort Wainwright, and Fort Greely, Alaska. February 1992

Alaska District Corps of Engineers. Groundwater Monitoring Network Draft Report. August 1990

Alaska District Corps of Engineers. Groundwater Monitoring Network Report. August 1991

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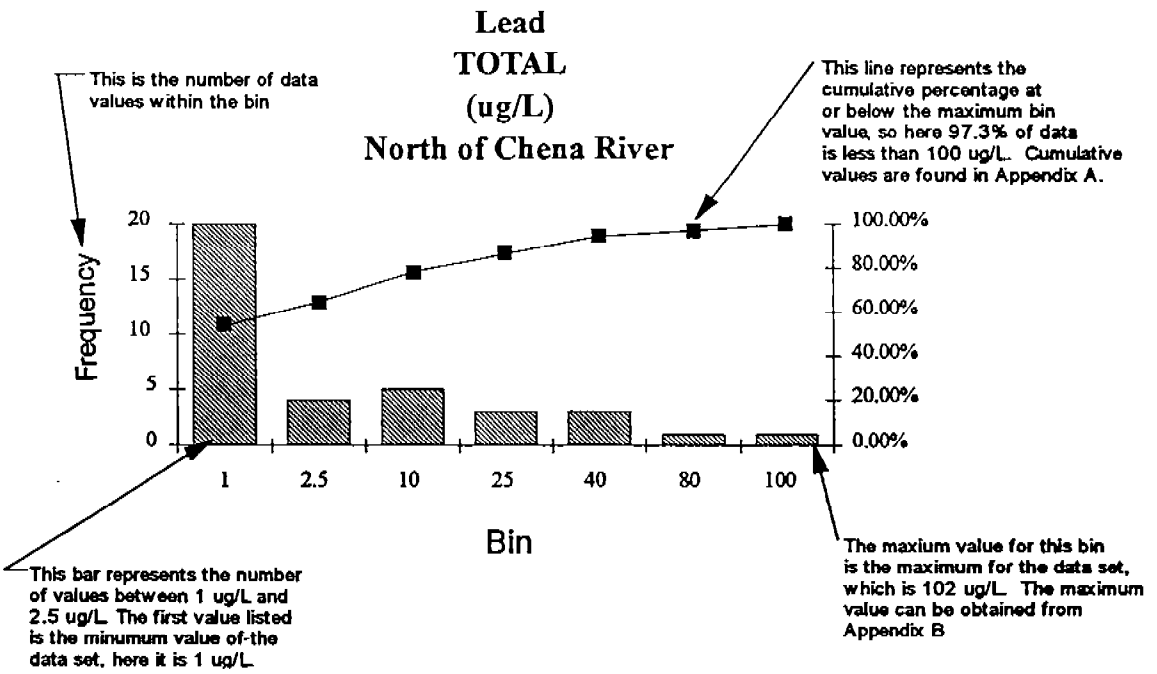
Explanation of charts:

Figure A



Background UCL's were obtained from studies done on Eielson AFB in order to compare results. Groundwater data for Eielson AFB was obtained from a December 1992 Background Ground-Water Quality report done for the United States Air Force by Battelle Laboratories. Soil data for Eielson AFB was acquired from a Background Soil Concentrations at Eielson Air Force Base report completed by Battelle Laboratories. The Eielson data is considered comparable to the Fort Wainwright data because both are in the Tanana-Chena River valley so some similarities may exist in background values. There is expected to be some variation, however, because the geology of Eielson AFB is slightly different from Fort Wainwright.

The Geochemical Atlas of Alaska provides information on the correlation between elements and geology. Correlation with results from the Atlas indicate whether the results obtained in this report are reasonable. The following is a summary of the data provided in the Geochemical Atlas:

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Table 1-1
Geochemical Data

Element	Mean Concentration for Alaska (mg/kg)	Minimum Concentration for Alaska (mg/kg)	Maximum Concentration for Alaska (mg/kg)	Area Concentration for Fort Wainwright (mg/kg)
Arsenic	17.30	5.00	1,796.00	No Value
Barium	810.98	3.00	64,350.00	983 - 1,413
Cadmium	Not included in survey			
Chromium	114.85	1.00	14,550.00	63 - 100
Lead	12.41	4.00	9,926.00	14 - 25

GEOLOGICAL EXPLANATION OF SOURCES:

Ft. Wainwright is located in the Fairbanks mining district, a historically rich and active source of placer and lode deposit minerals. Full production-mining started in 1903 with earlier prospects likely to have been fairly common.

A review of available literature shows that there are no obvious sources of cadmium or chromium. Arsenic, barium and lead are fairly common throughout the district, and are found in hydrothermal deposits in the Birch Creek Schist and in younger granitic domes. Gilmore Dome and Tungsten Hill contain several old mines and many prospects and sample joints. Steel, Columbia and Smallwood Creeks and their tributaries drain Gilmore Dome and Tungsten Hill south to the Little Chena and Chena Rivers.

Arsenopyrite (FeAsS) is one of the most common and widespread secondary minerals in the Fairbanks district, although not highly concentrated in any one locality. Arsenopyrite is associated with tungsten ores and gold, both found on Gilmore Dome and Tungsten Hill. This is the prime source of widespread background arsenic.

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Jamesonite ($Pb_4FeSb_6S_{14}$) is fairly common and is usually mixed with arsenopyrite, stibnite (SB_2S_3), and with free gold. Galena (PbS), is usually associated with Jamesonite in the district. These are the main sources for background lead.

Barium has been found at two locations on Gilmore Dome. Both sites are near the head of Nugget Creek and are found in porphyritic quartz monzonite, quartz mica schist and biotite-actinolite-quartz schist. Twenty-two samples were analyzed. Barium content ranged from 70 to 1,000 ppm, averaging 491 ppm.

RESULTS

The following section summarizes the findings of the statistical analysis and explains why certain data points were deleted from the data set. The values obtained for Eielson AFB are also summarized for both groundwater and soil. Graphs are provided to show the distribution of data and to aid in the determination of whether the distribution is lognormal or normal. The graphs were also used to recognize values that deviated from the majority of the data. Any values that were noticeably higher than the rest of the data were evaluated for possible sources of contamination. If quite a few of the samples values in a category were below detection limits, the detection limits found for that particular data set are given. It should be noted that those samples below detection limits were recorded at half their value. Categories were used to get a better idea of what areas had higher concentrations than others. The major categories are groundwater and soil. The minor categories of groundwater are total for North of the Chena River, total for South of the Chena River, and Dissolved. Total indicates that the sample includes both the particulate and dissolved phase. Dissolved is just the dissolved phase. Soil is broken down to North of the Chena River and South of the Chena River.

GROUNDWATER

GROUNDWATER - TOTAL SOUTH OF CHENA RIVER

Arsenic

An UCL of 37.55 μg/L was computed for arsenic using 115 sample values with a range of 1.90 to 230 μg/L. Eighty-four percent (84%) of the data is less than 47.5 μg/L with four values over 138.8 μg/L. Figure 1-1 is a graph of the distribution of the data. The background UCL found for Eielson AFB is 15 μg/L.

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Barium

Barium was determined to have an UCL of 507.69 μg/L using a data set of 123 samples. The data ranges from 10 to 2,000 μg/L with 77% of the data less than 552.73 μg/L. Distribution of the data can be seen in Figure 1-2. A sample value of 4200 μg/L was deleted because it was taken from a location downstream, according to groundwater flow, of a powerplant and could represent contamination from coal or coal ash. Coal or coal ash has been shown to be a source of barium. A 2700 μg/L value was deleted because it came from a sample that was also high in chromium and lead near Building 2111 and was considered to be contaminated. The contamination could be from rubber tires or road dust. The calculated UCL for barium is 119 μg/L on Eielson AFB.

Cadmium

The UCL of 5.53 μg/L for cadmium was determined using 114 samples ranging in value from 0.25 to 16 μg/L. The majority of the data was made up of non-detect samples at values of 20, 5, 2 and 0.5 μg/L. About 13% of the data consisted of values above detection limits. Distribution of the data can be seen in Figure 1-3. The UCL for Eielson AFB is < 10 μg/L.

Chromium

Sample values for chromium ranged from 1 to 390 μg/L with a total of 118 samples used. Ninety-eight percent (98%) of the data was less than 300 μg/L. The calculated UCL is 51.81 μg/L compared with < 20 μg/L for Eielson. Distribution of the data is shown in Figure 1-4. Two sample values of 500 and 620 μg/L were deleted from the data set. Both samples were high in barium and lead also. The 500 μg/L value, which was taken from near the power plant and Building 3595, could have been contaminated from used oil or cleaning solvents. The 620 μg/L sample was from an area across from the runway where paint was a possible contamination source. Chromium is often found in yellow paint.

Lead

Lead was determined to have an UCL of 38.50μg/L, while the UCL for Eielson AFB is < 5 μg/L. Sample values ranged from 0.50 to 160 μg/L and a total of 122 values were used. A histogram showing distribution of the data is provided in Figure 1-5. Two values of 76,000 and 74,000 μg/L were deleted from the data set because of their proximity to the North Post Site where POL removal occurred. Samples for dissolved and other total lead at the same monitoring well had significantly lower values, so the sample results were considered to be inaccurate and were not included in the analysis. Other sample data that

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were deleted include values of 1,800, 370, 290, and 250 μg/L. The 1,800 μg/L value was adjacent to a UST tank that held leaded fuel. The 370 μg/L sample came from a location with high values for chromium, arsenic and barium, so was determined to be contaminated from a lead-arsenic pesticide, used oil, motor vehicle particulate emissions or vehicle maintenance operations. The 290 μg/L value came from a monitoring well with floating petroleum product and the 250 μg/L sample was deleted because of it's proximity to the PX Gas Station where fuel related contamination was found.

Table 1-2

Eielson AFB Background Data for Groundwater

RCRA Metal	Upper Confidence Limit (μg/L)	Mean (μg/L)
Arsenic	15	8
Barium	119	106
Cadmium	< 10	< 10
Chromium	< 20	< 20
Lead	< 5	< 5

Table 1-3

Upper Confidence Limits for RCRA Metals in Groundwater South of the Chena River

RCRA Metal	Lognormal UCL (μg/L)	Normal UCL (μg/L)
Arsenic	*37.55	33.36
Barium	*507.69	487.30
Cadmium	*5.53	4.43
Chromium	*51.81	49.41
Lead	*38.50	26.08

* Indicates the more accurate value as determined by distribution

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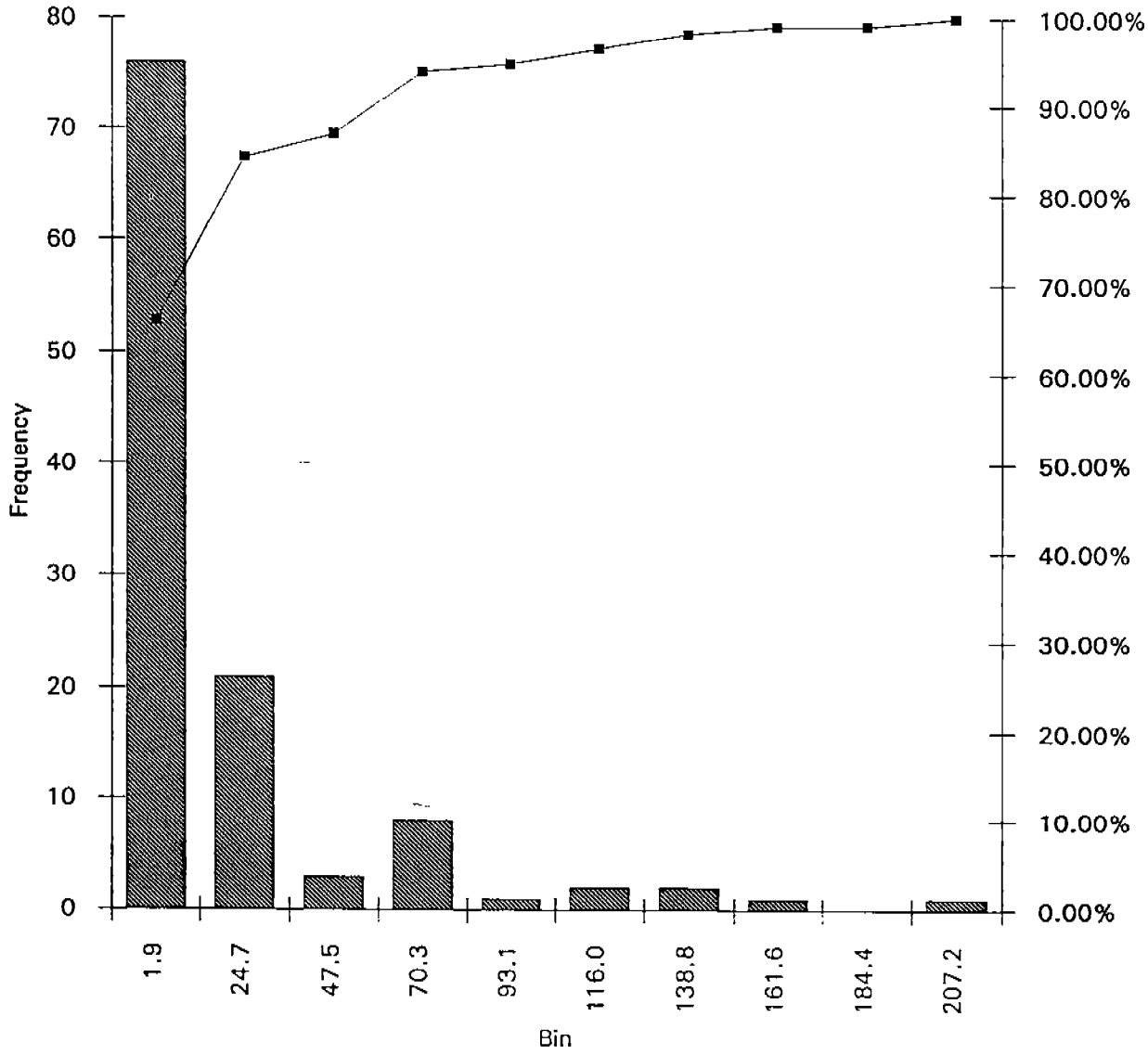
Figure 1-1

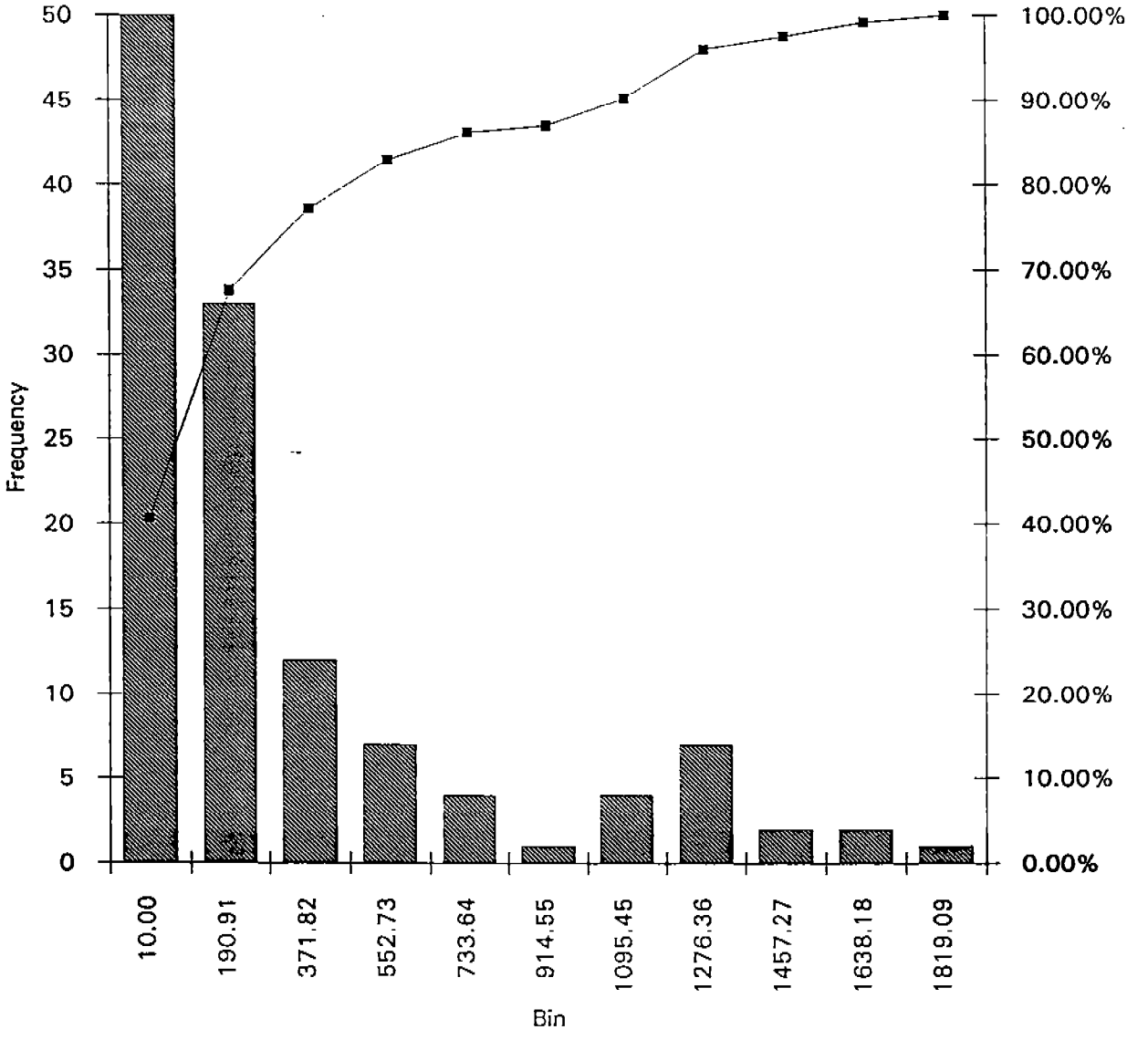
Arsenic
TOTAL
(ug/L)
South of Chena River



ARAQUSC.XLC

Figure 1-2

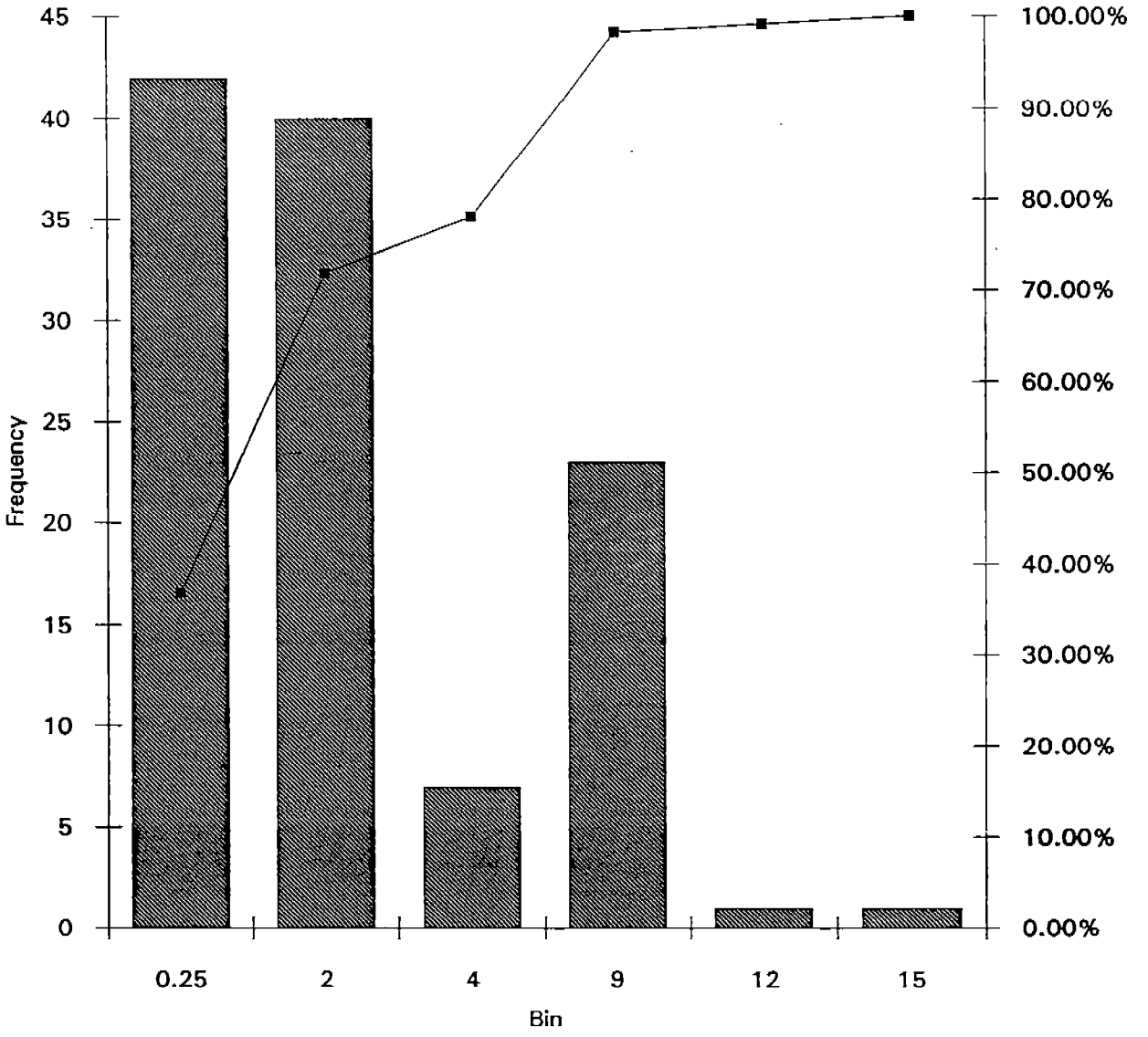
Barium
TOTAL
(ug/L)
South of Chena River



BAAQUSC.XLC

Figure 1-3

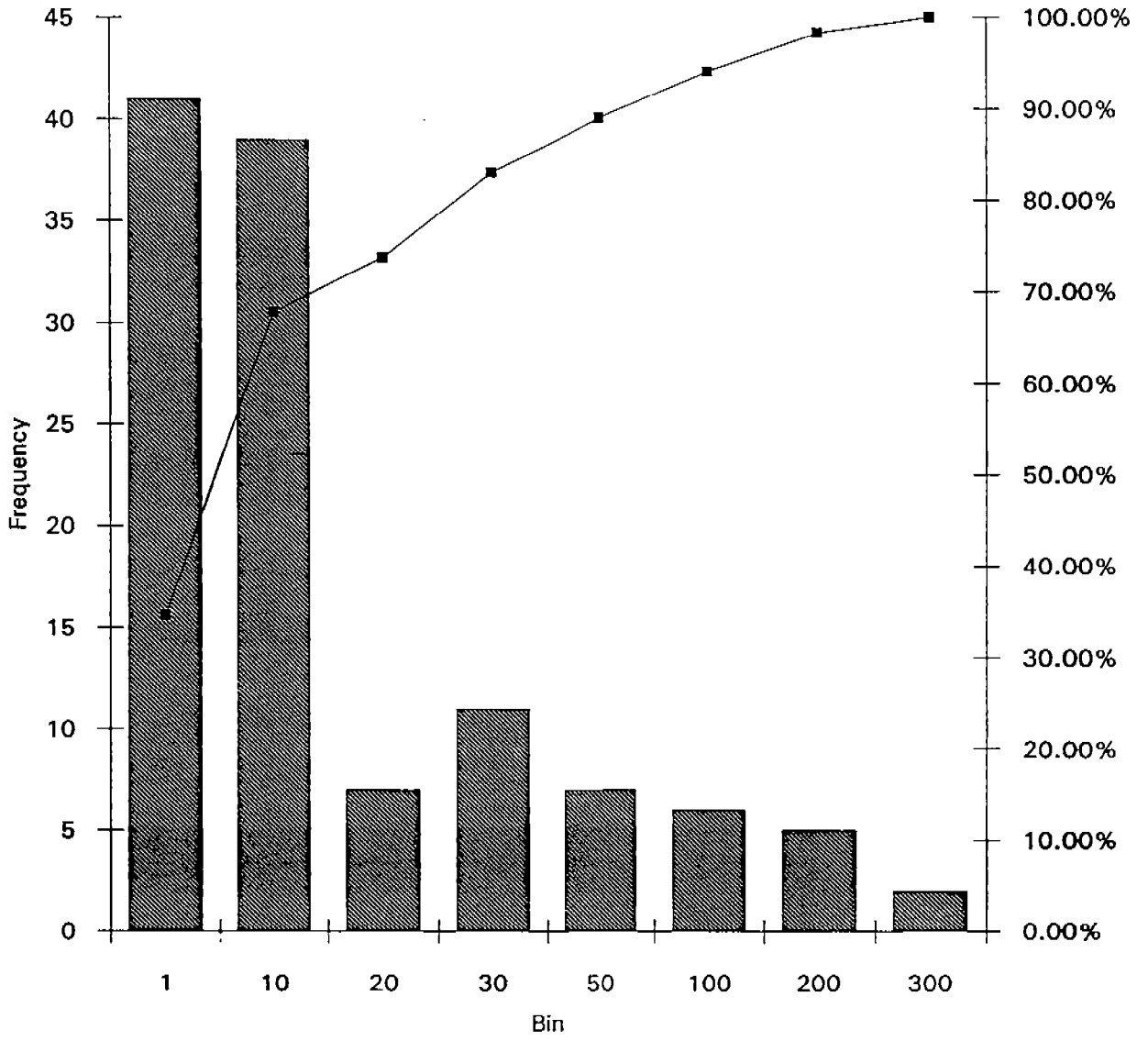
Cadmium
TOTAL
(ug/L)
South of Chena River



CAAQUSC.XLC

Figure 1-4

Chromium
TOTAL
(ug/L)
South of Chena River



CHRAQUSC.XLC

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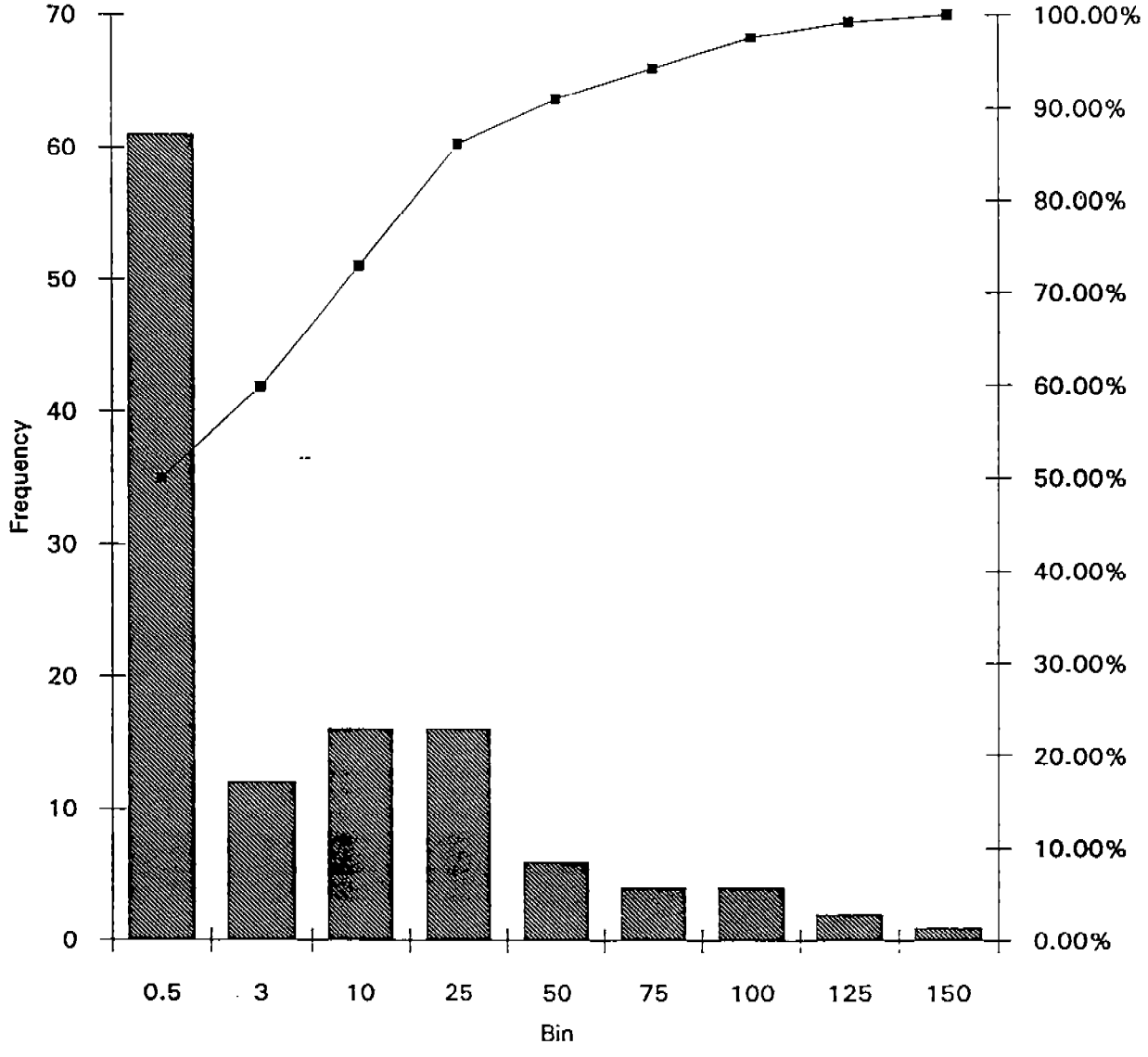
Figure 1-5

Lead -
TOTAL
(ug/L)
South of Chena River



PBAQUSC.XLC

GROUNDWATER - TOTAL NORTH OF CHENA RIVER

Arsenic

A total of 44 samples were used to determine an UCL of 52.50 μg/L for arsenic. The sample values range from 1.00 μg/L to 134.00 μg/L. Ninety-one percent (91%) of the data falls below 45.33 μg/L and there are four values over 67.50 μg/L. The distribution of the arsenic sample values can be seen from Figure 2-1. Arsenic was determined to have a background UCL of 15 μg/L for Eielson AFB.

Barium

Barium has a calculated UCL of 962.00 μg/L. The data contains 49 sample values and varies from 8 to 1,660 μg/L. Eighty-six percent (86%) of the data is less than 952 μg/L. Figure 2-2 shows the distribution of the data. The background UCL calculated for Eielson is 119 μg/L.

Cadmium

There were a total of 37 samples used in determining an UCL of 6.41 μg/L for cadmium. About 80% of the samples were non-detect values of 3 and 20 μg/L. The samples ranged in value from 0.25 to 12 μg/L. The UCL for Eielson AFB was determined to be <10 μg/L. Figure 2-3 shows the distribution of the samples.

Chromium

An UCL of 105.44 μg/L was determined for chromium using 43 samples. The samples ranged in value from 2.5 to 280 μg/L with about 60% of the samples recorded as non-detects at 5, 10, and 20 μg/L. Figure 2-4 provides an illustration of the distribution. An UCL of <20 μg/L was calculated for Eielson AFB.

Lead

Lead was determined to have an UCL of 49.30 for Fort Wainwright compared with <5 for Eielson AFB. There were a total of 37 samples used in the calculation and the values ranged from 1 to 102 μg/L. About 50% of the data are non-detect values of 2 μg/L. A distribution of the data is provided in Figure 2-5. Three samples of 170, 120 and 123 μg/L were deleted from the data set because they were taken from an area close to a landfill, where contamination from leachate could have occurred. A value of 140 μg/L was also deleted because it came from the 801 Drum Site where fuel contamination was present.

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Table 1-4

Upper Confidence Levels for RCRA Metals in Groundwater North of the Chena River

RCRA Metal	Lognormal UCL (μg/L)	Normal UCL (μg/L)
Arsenic	*52.50	32.76
Barium	*962.00	541.33
Cadmium	*6.41	5.45
Chromium	*105.44	65.96
Lead	*49.30	23.67

*Indicates the more accurate value as determined by distribution

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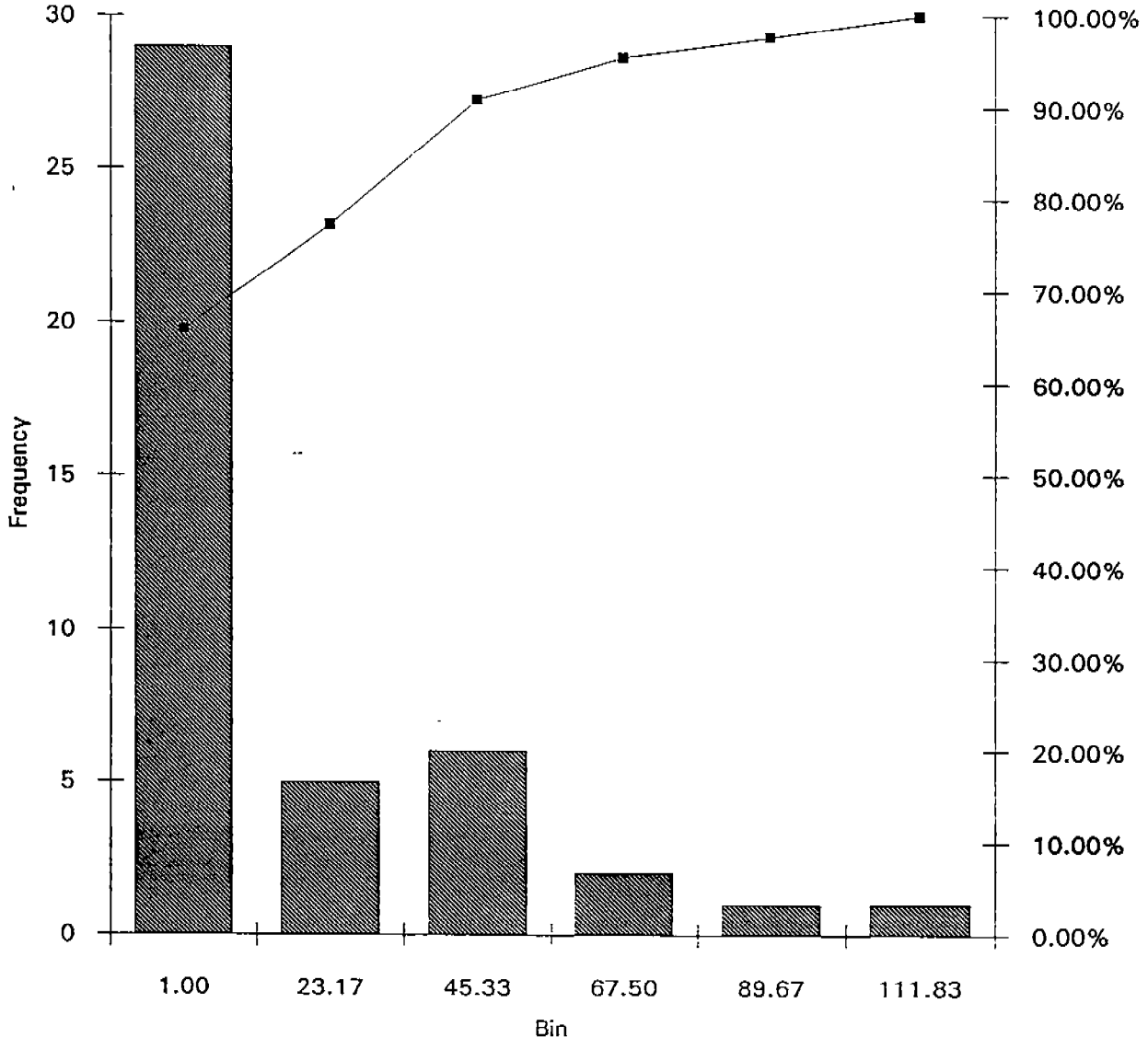
Figure 2-1

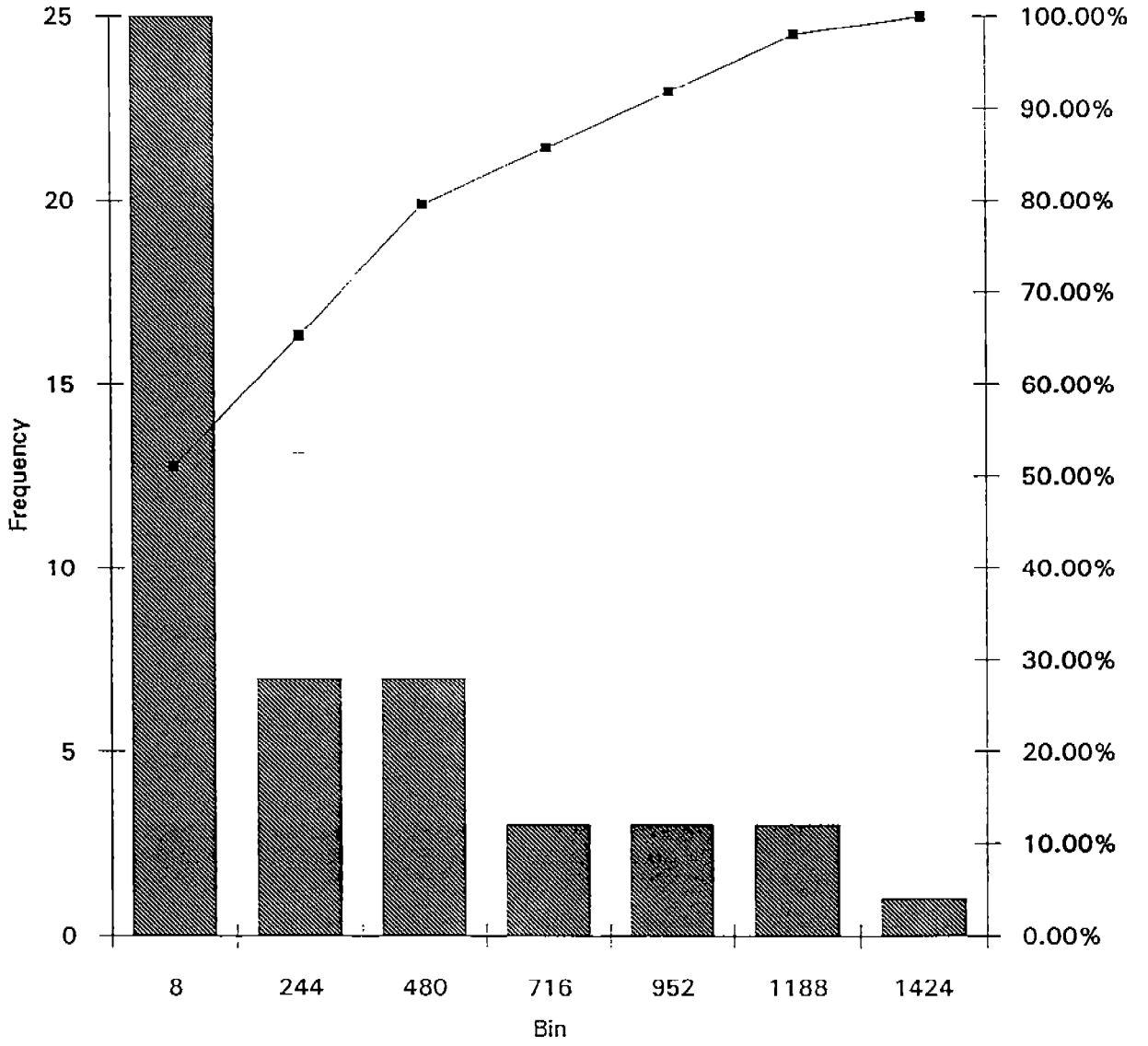
Arsenic
TOTAL
(ug/L)
North of Chena River



ARAQUNC.XLC

Figure 2-2

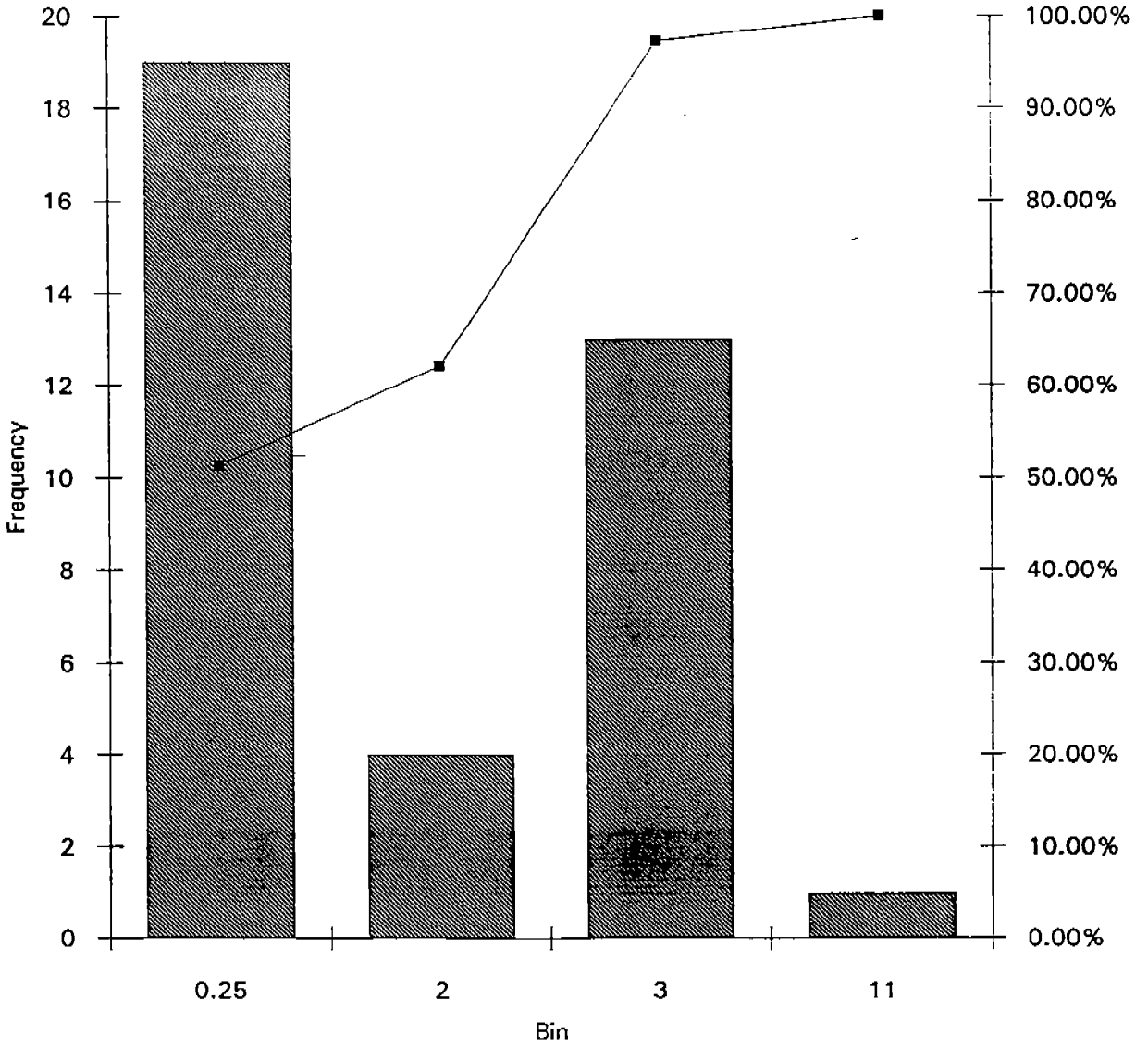
Barium
TOTAL
(ug/L)
North of Chena River



BAAQUNC.XLC

Figure 2-3

Cadmium
TOTAL
(ug/L)
North of Chena River



CAAQUNC.XLC

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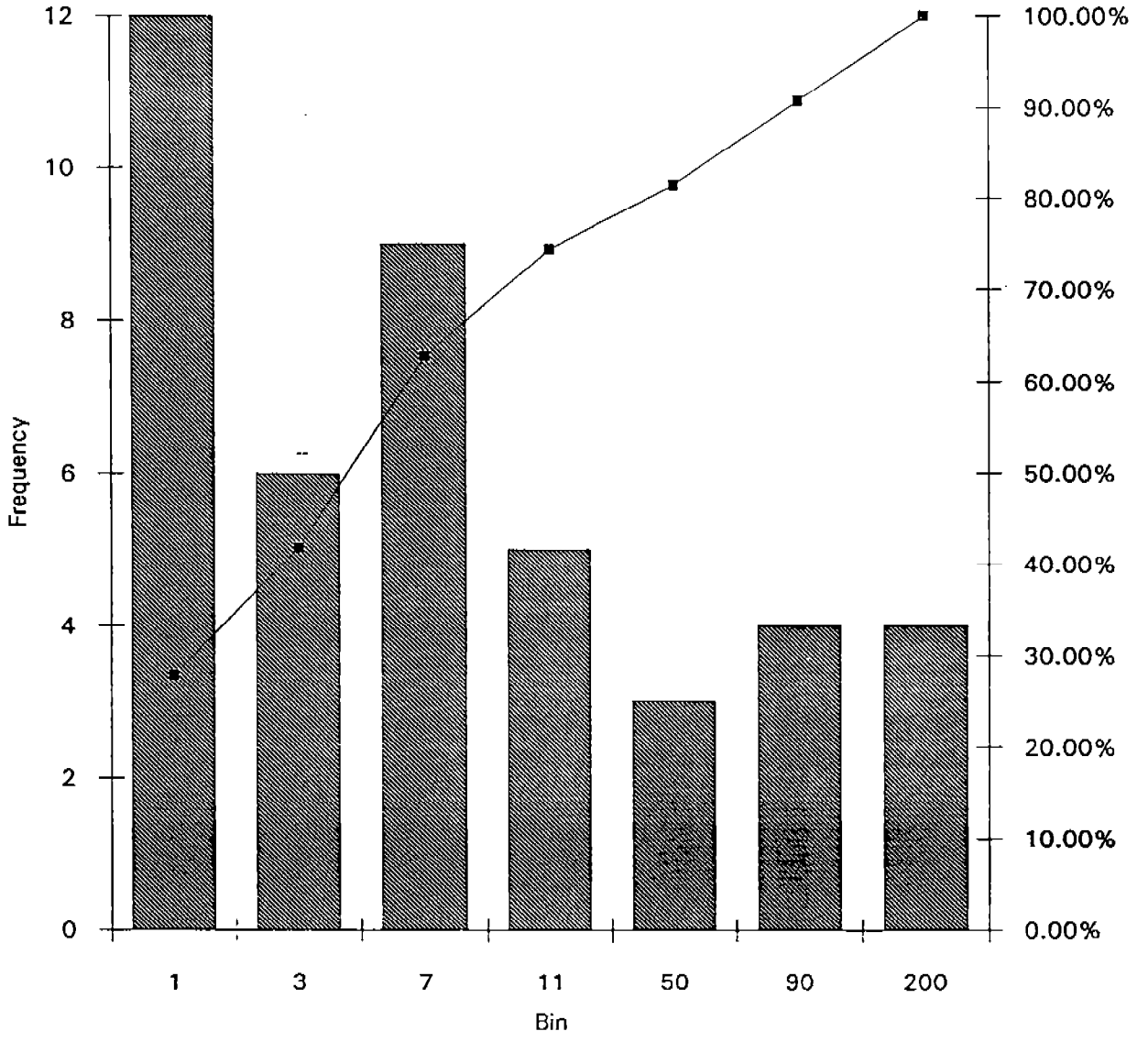
Figure 2-4

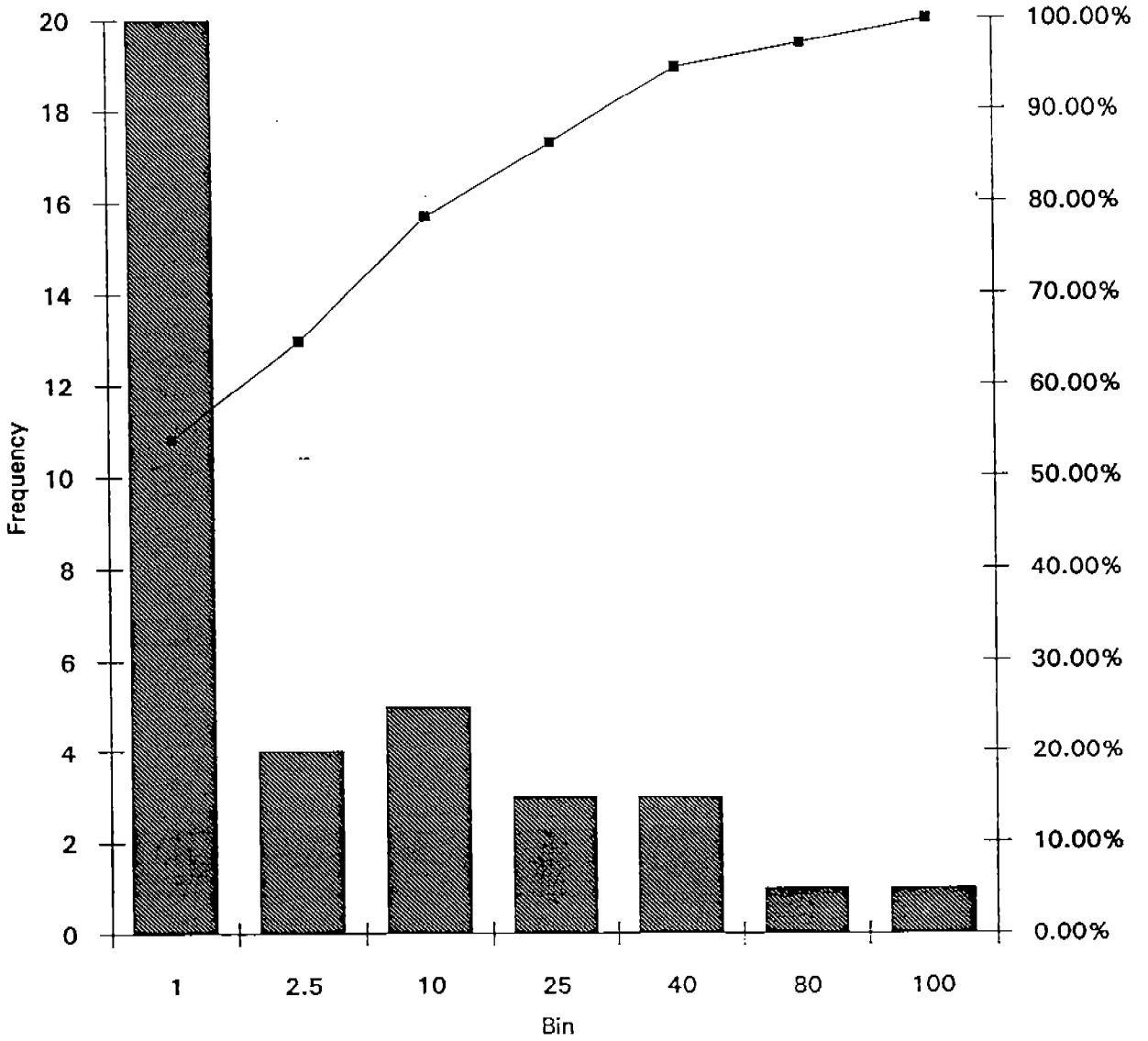
Chromium
TOTAL
(ug/L)
North of Chena River



CHRAQUNC.XLC

Figure 2-5

Lead
TOTAL
(ug/L)
North of Chena River



PBAQUNC.XLC

GROUNDWATER - DISSOLVED

Arsenic

An UCL of 8.99 μg/L was calculated for arsenic using 40 sample values. Sample values range from 1 to 56 μg/L and 95% of the data is less than 10.17 μg/L. Figure 3-1 shows a graph of the distribution. The reported background UCL for arsenic on Eielson AFB is 15 μg/L.

Barium

Barium has a computed UCL of 231.73 μg/L. Thirty-nine (39) sample values were used in the calculations and the data varied from 25 to 520 μg/L. Seventy-four percent (74%) of the data is less than 272.5 μg/L. A graph of the distribution is provided in Figure 3-2. The UCL for barium is 119 μg/L on Eielson AFB.

Cadmium

Forty (40) samples were used to determine an UCL of 3.14 μg/L for cadmium. The samples ranged in value from 0.25 to 10 μg/L. Ninety-three percent (93%) of the samples were non-detects at < 0.5, < 2, 5 and <20 μg/L. The detected values were 1, 2.5 and 3 μg/L. Figure 3.3 is a histogram showing the distribution of the data. The UCL for Eielson AFB is < 10 μg/L.

Chromium

An UCL of 4.30 μg/L was calculated for chromium using 40 samples. All but one value of 2.4 μg/L used in the calculations were non-detects. Non-detects were < 2, <8, <10, and <20 μg/L. A histogram of the data is provided in Figure 3-4. The UCL for chromium on Eielson AFB was determined to be <20.

Lead

The UCL computed for lead is 4.51 μg/L. Thirty-nine (39) samples were used and 50% of the data was made up of non-detect values of 4 and 2 μg/L. The UCL for lead on Eielson was determined to be < 5 μg/L. Figure 3-5 provides an illustration of the distribution of the data. Two values of 9300 and 6900 μg/L were deleted from the data set due to their proximity to a fuel pipeline break.

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Table 1-5

Upper Confidence Limits for Dissolved RCRA Metals in Groundwater

RCRA Metal	Lognormal UCL (μg/L)	Normal UCL (μg/L)
Arsenic	*8.99	9.56
Barium	249.61	*231.73
Cadmium	*3.14	2.23
Chromium	*4.30	3.72
Lead	*4.51	4.79

* Indicates the more accurate value as determined by distribution

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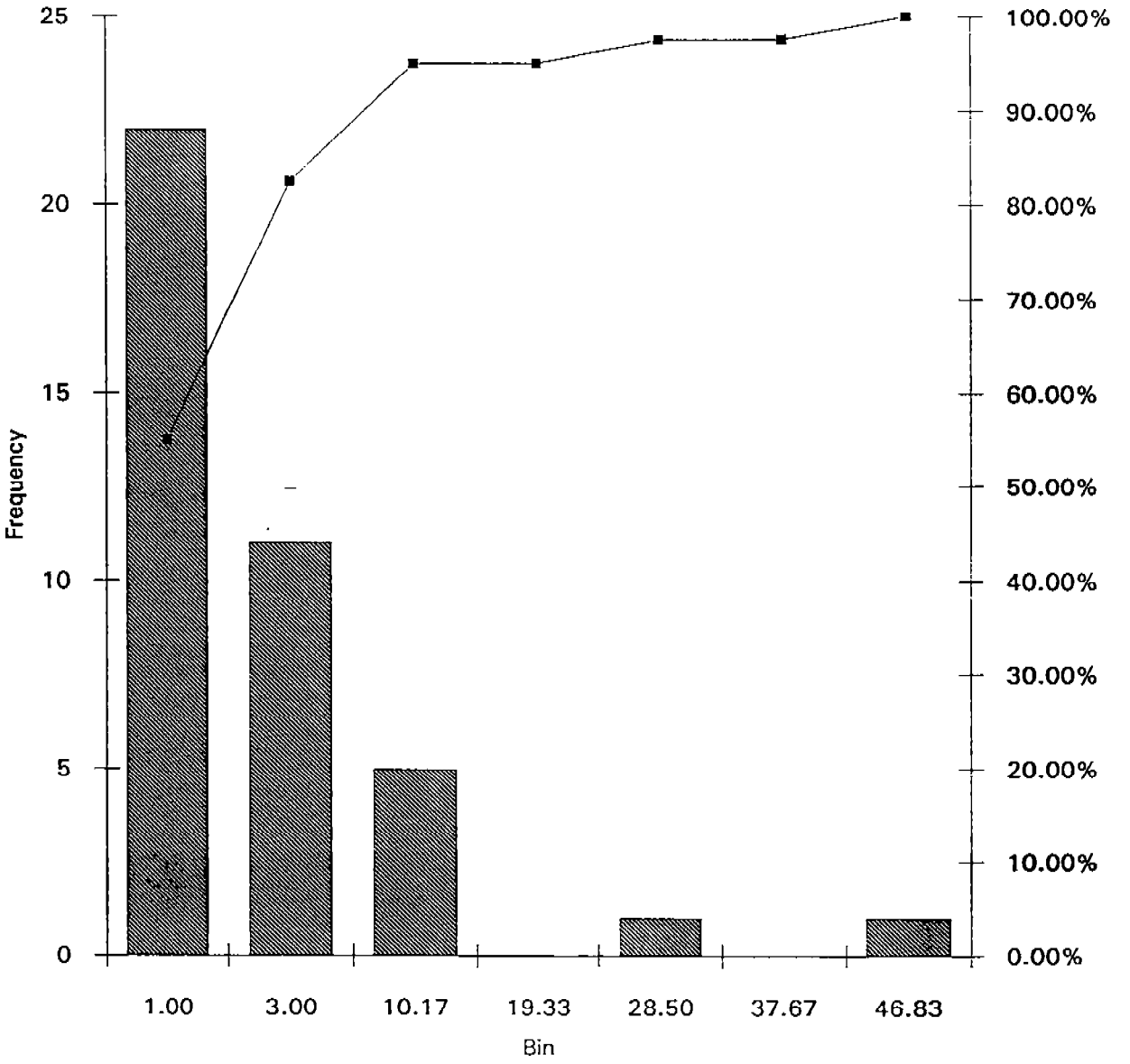
Figure 3-1

Arsenic
DISSOLVED
(ug/L)

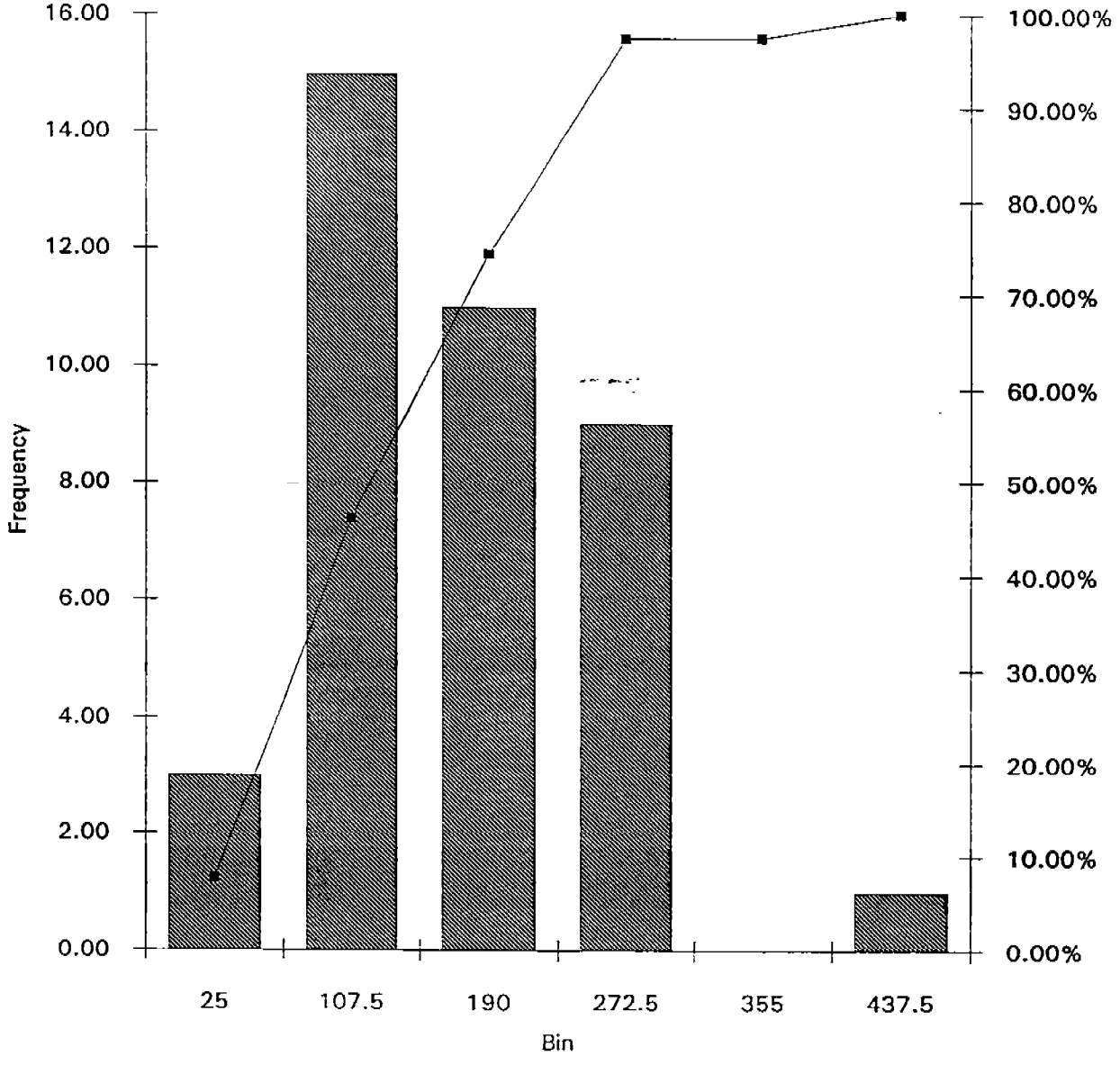


ARAQDSC.XLC

23377

Figure 3-2

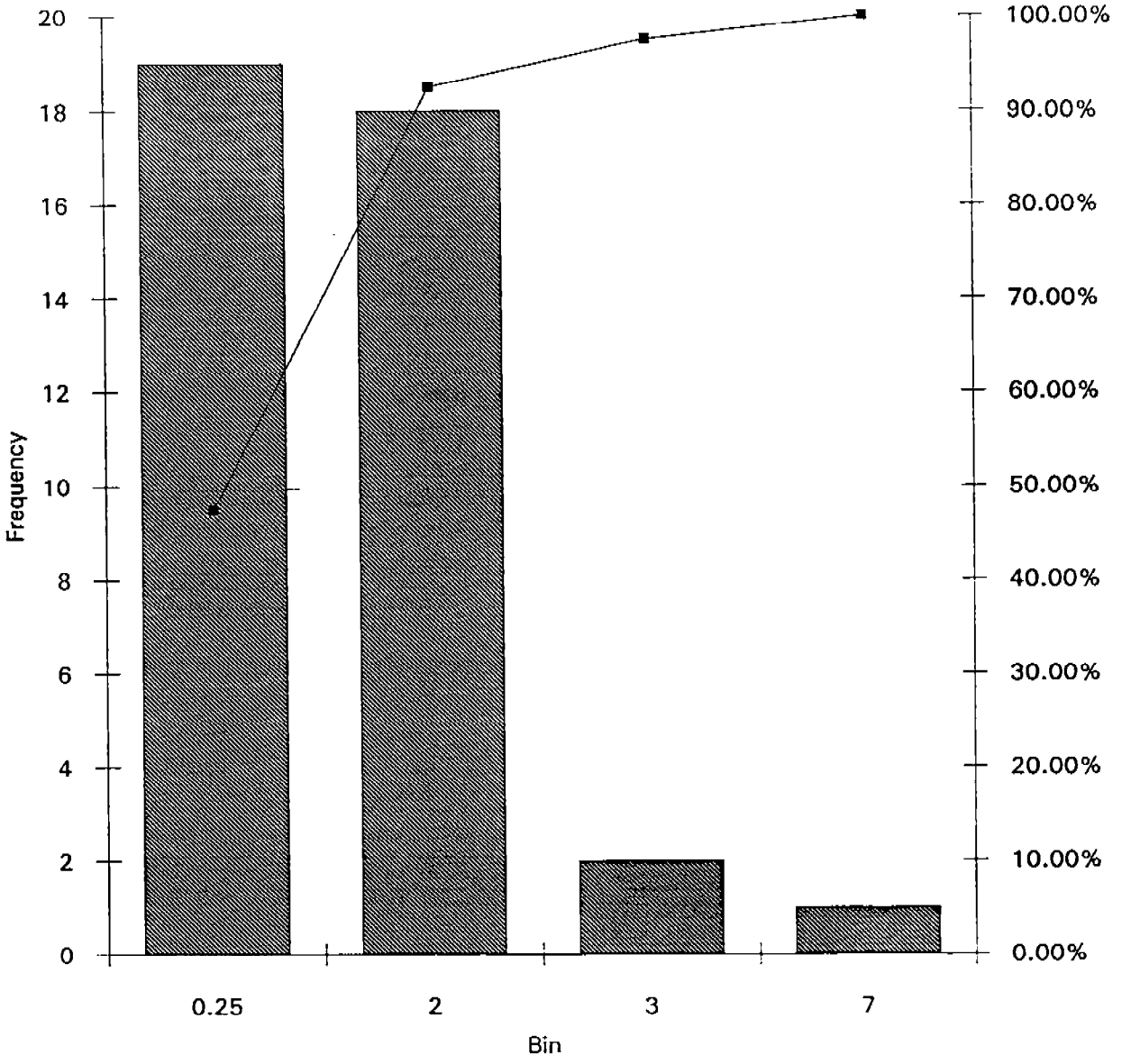
Barium
DISSOLVED
(ug/L)



BAAQDSC.XLC

Figure 3-3

Cadmium
DISSOLVED
(ug/L)

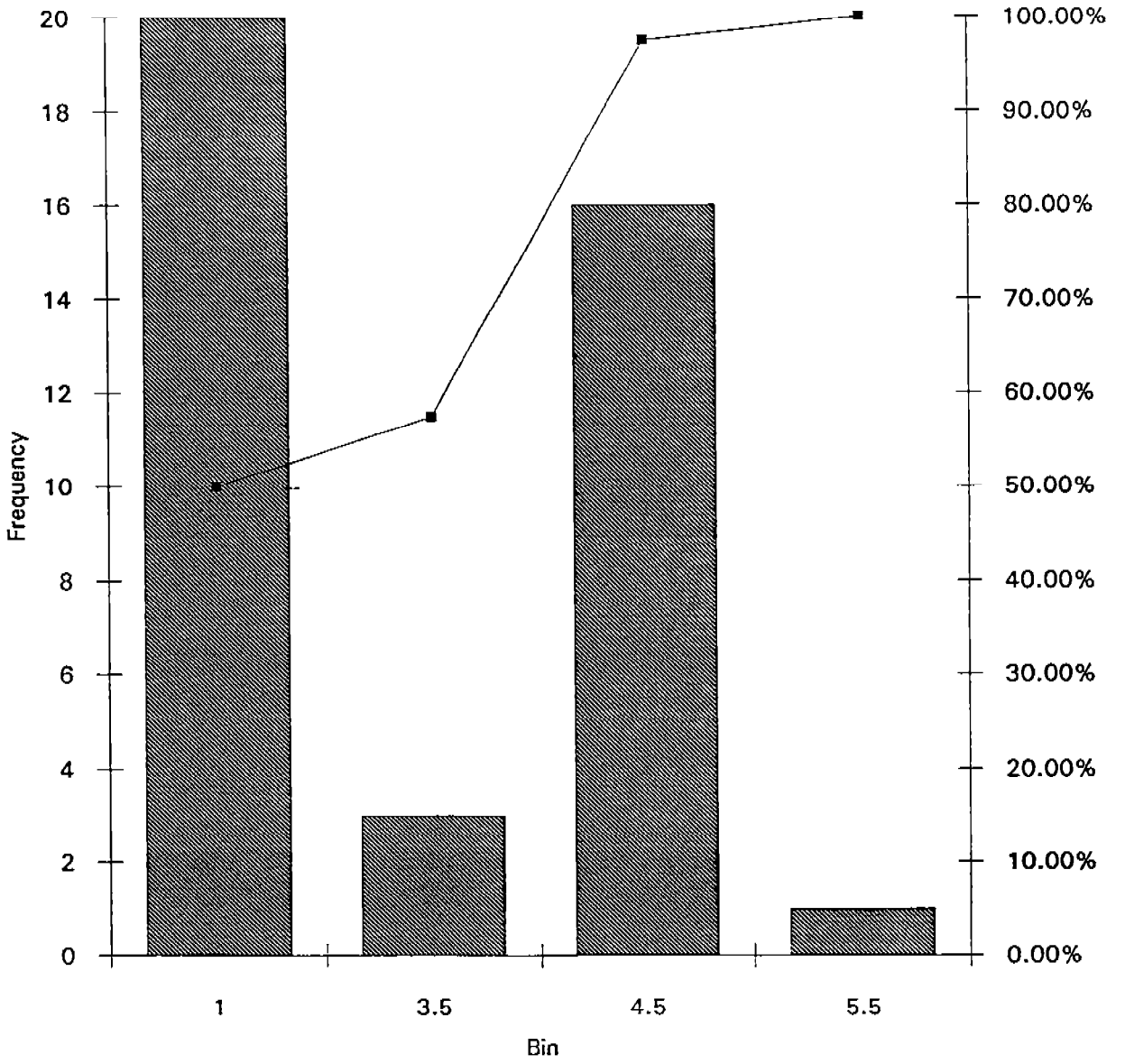


CAAQDSC.XLC

23379

Figure 3-4

Chromium
DISSOLVED
(ug/L)

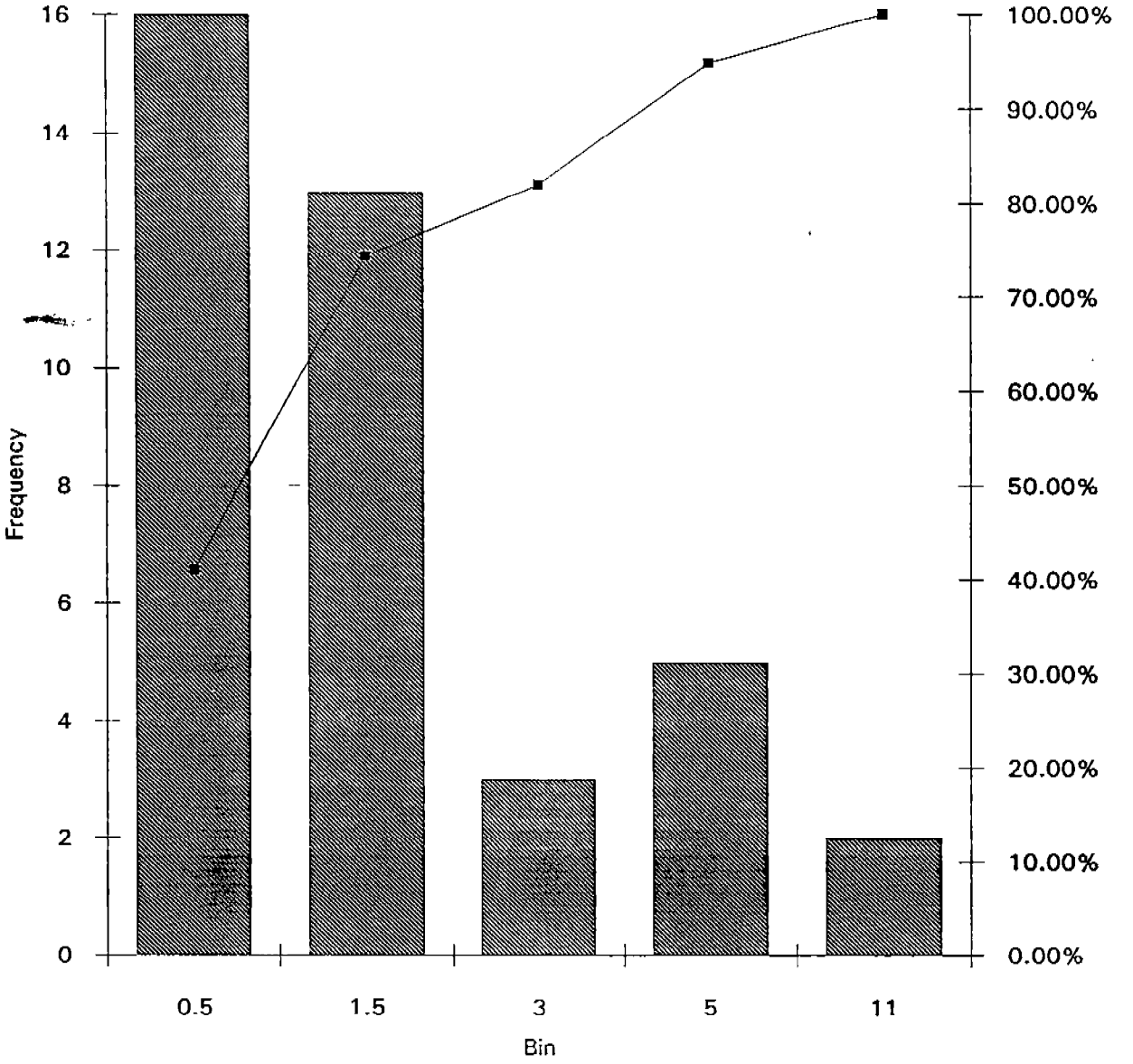


CHRAQDSC.XLC

23380

Figure 3-5

Lead -
DISSOLVED
(ug/L)



PBAQDSC.XLC

SOIL

SOIL - SOUTH OF CHENA RIVER

Arsenic

A background UCL of 8.40 mg/kg was computed for arsenic using 59 sample values. The data ranges from 0.14 to 29 mg/kg and 89% of the values are under 12.51 mg/kg. Figure 4-1 shows a graph of the distribution of sample values and Table 1-6 displays the background UCL found for Eielson AFB. The mean concentration for Alaska is 17.30 mg/kg according to the Geochemical Atlas of Alaska.

Barium

Barium has a calculated UCL of 85.40 mg/kg with 97% of the data less than 92.14 mg/kg. Fifty-nine samples were used in the analysis and the values range from 35.40 to 234.00 mg/kg. Figure 4-2 shows the distribution of the data and Table 1-6 gives the UCL found for Eielson AFB. The area concentration for Fort Wainwright from the Geochemical Atlas ranges from 983 to 1, 413 mg/kg with a mean for Alaska of 810 mg/kg.

Cadmium

Forty-three samples were used to determine an UCL of 1.27 mg/kg for cadmium. The samples ranged from 0.24 to 5.10 mg/kg with about 34% of the samples non-detects of <1 mg/kg. Ninety-five percent (95%) of the data was less than 3.48 mg/kg. Figure 4-3 provides a histogram of the data. An UCL for cadmium in soil was not determined for Eielson AFB.

Chromium

An UCL of 17.18 mg/kg was calculated for chromium in soil using 71 samples. The data ranged in value from 6 to 46 mg/kg. Ninety-seven percent (97%) of the data was less than 36 mg/kg. A histogram showing the distribution of the data is provided in Figure 4-4. An UCL of 28.3 mg/kg in fluvial soil and 37.8 mg/kg in loess were calculated for Eielson AFB. The Geochemical Atlas provides a Fort Wainwright area concentration of 63 to 100 mg/kg and a mean concentration for Alaska of 114.85 mg/kg.

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Lead

Lead was determined to have an UCL of 10.43 mg/kg using 75 samples. The data ranged in value from 2.3 to 118 mg/kg with 95% of the samples less than 30 mg/kg. Distribution of the data can be seen in the histogram provided in Figure 4-5. At Eielson AFB, the UCL in fluvial soil is 11.6 mg/kg and is 9 mg/kg in loess. The concentration range for Fort Wainwright is 14 to 25 mg/kg with a mean concentration for Alaska of 12.41 mg/kg.

Table 1-6
Eielson AFB Background Data
for
Soil

RCRA Metal	Fluvial Soil (mg/kg)		Loess (mg/kg)	
	UCL	Mean	UCL	Mean
Arsenic	15.5	13.9	16.7	14.1
Barium	153.2	141.2	195.4	184.4
Cadmium	Not considered in report			
Chromium	28.3	26.0	37.8	35.2
Lead	11.6	10.6	9.0	8.5

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Table 1-7

Upper Confidence Limits for RCRA Metals South of the Chena River

RCRA Metal	Lognormal UCL (mg/kg)	Normal UCL (mg/kg)
Arsenic	*8.40	7.39
Barium	*85.40	85.88
Cadmium	*1.27	1.27
Chromium	*17.18	17.06
Lead	*10.43	13.50

* Indicates the more accurate value as determined by distribution

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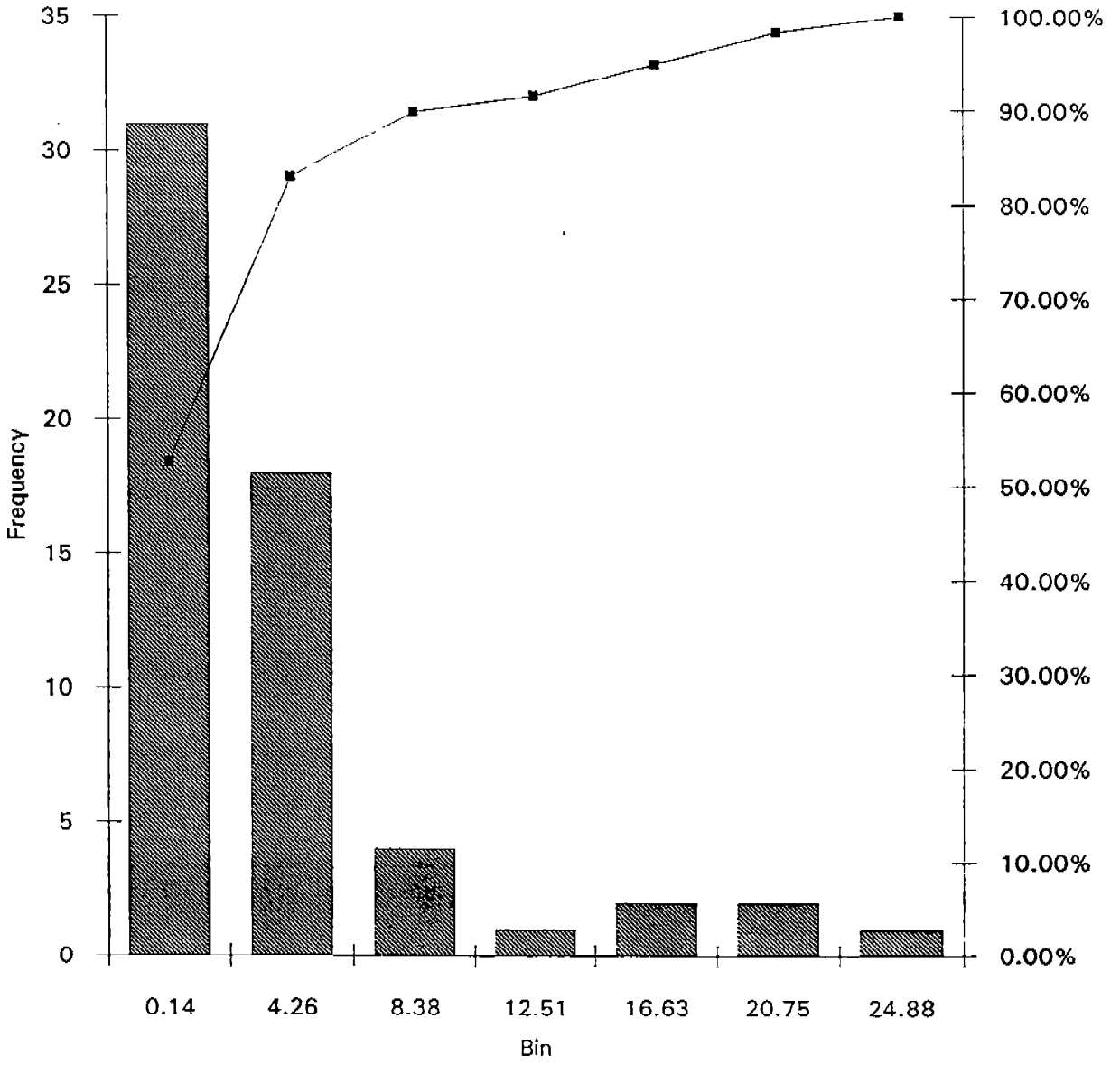
Figure 4-1

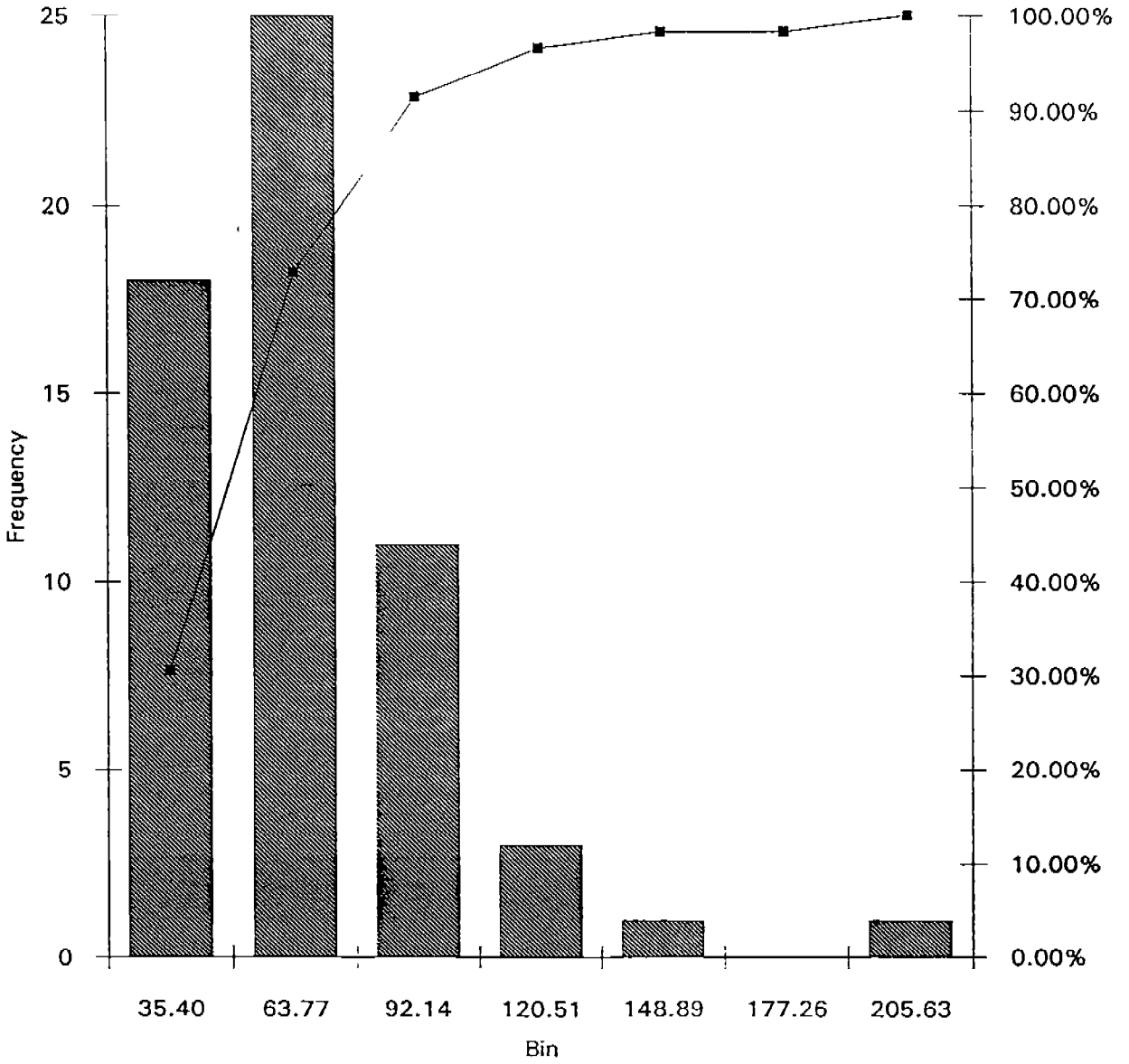
Arsenic
(mg/kg)
South of Chena River



ARSOSC.XLC

Figure 4-2

Barium -
(mg/kg)
South of Chena River



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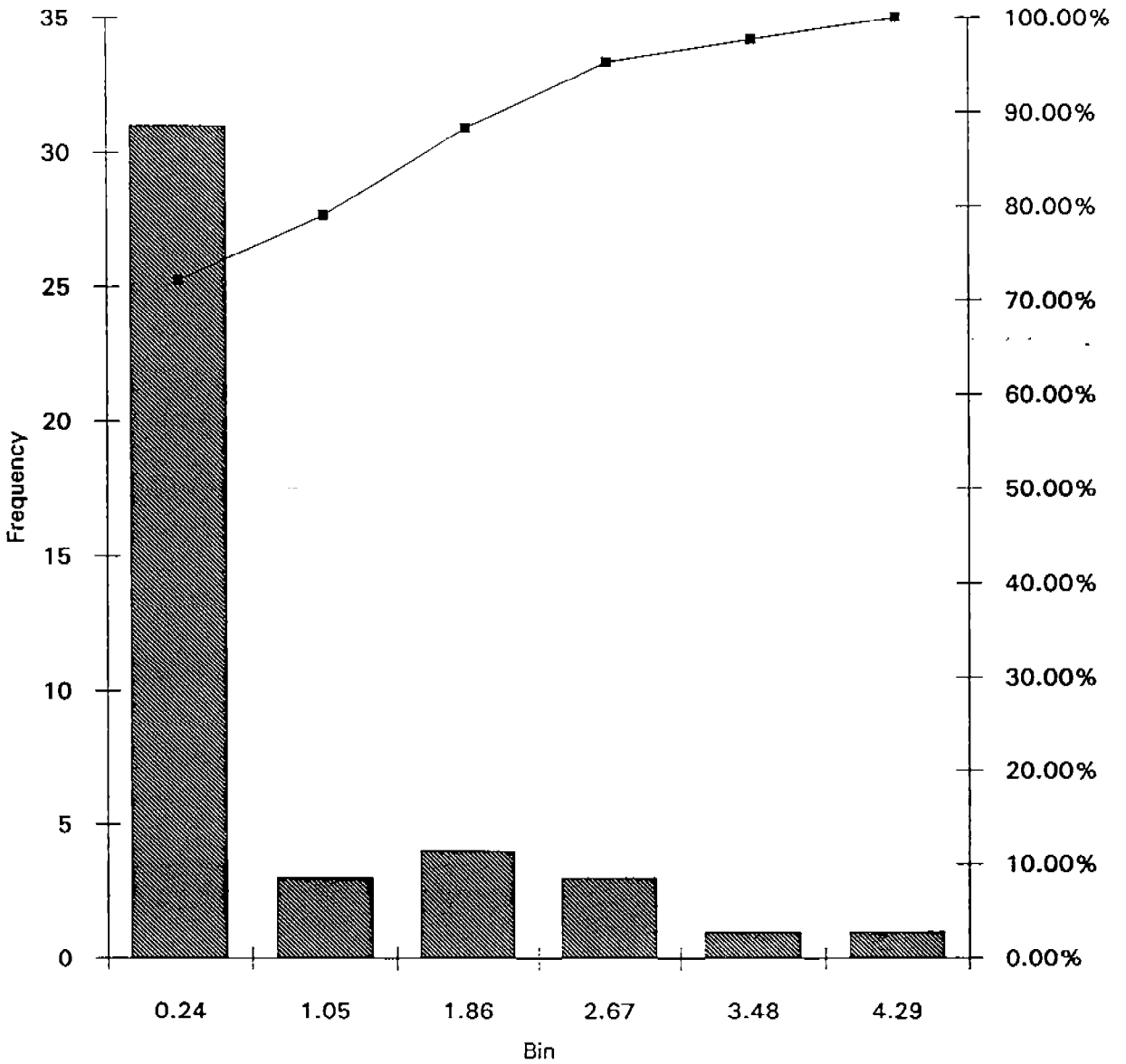
BASOLSC.XLC

Figure 4-3

Cadmium
(mg/kg)
South of Chena River



CASOLSC.XLC

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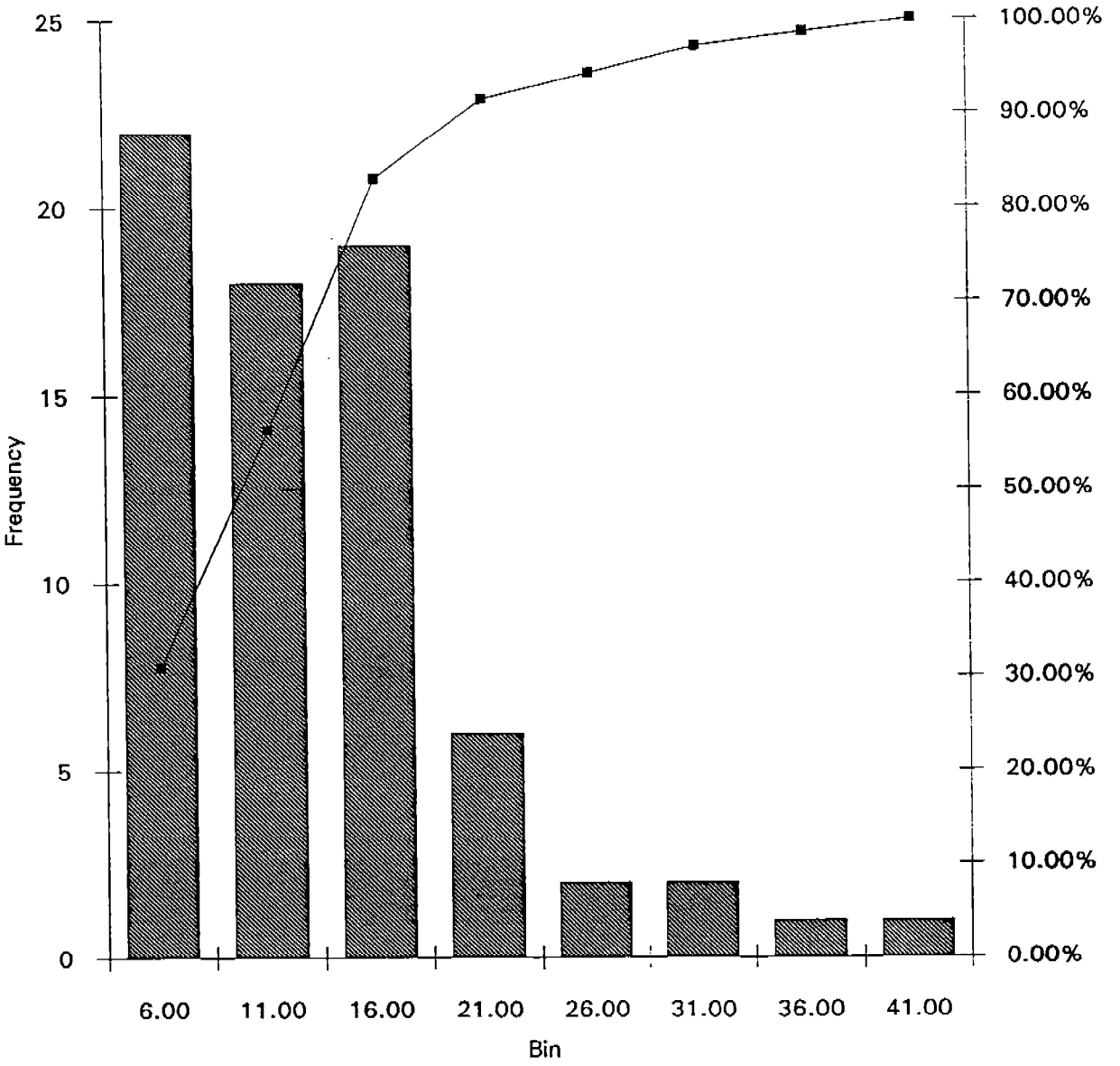
Figure 4-4

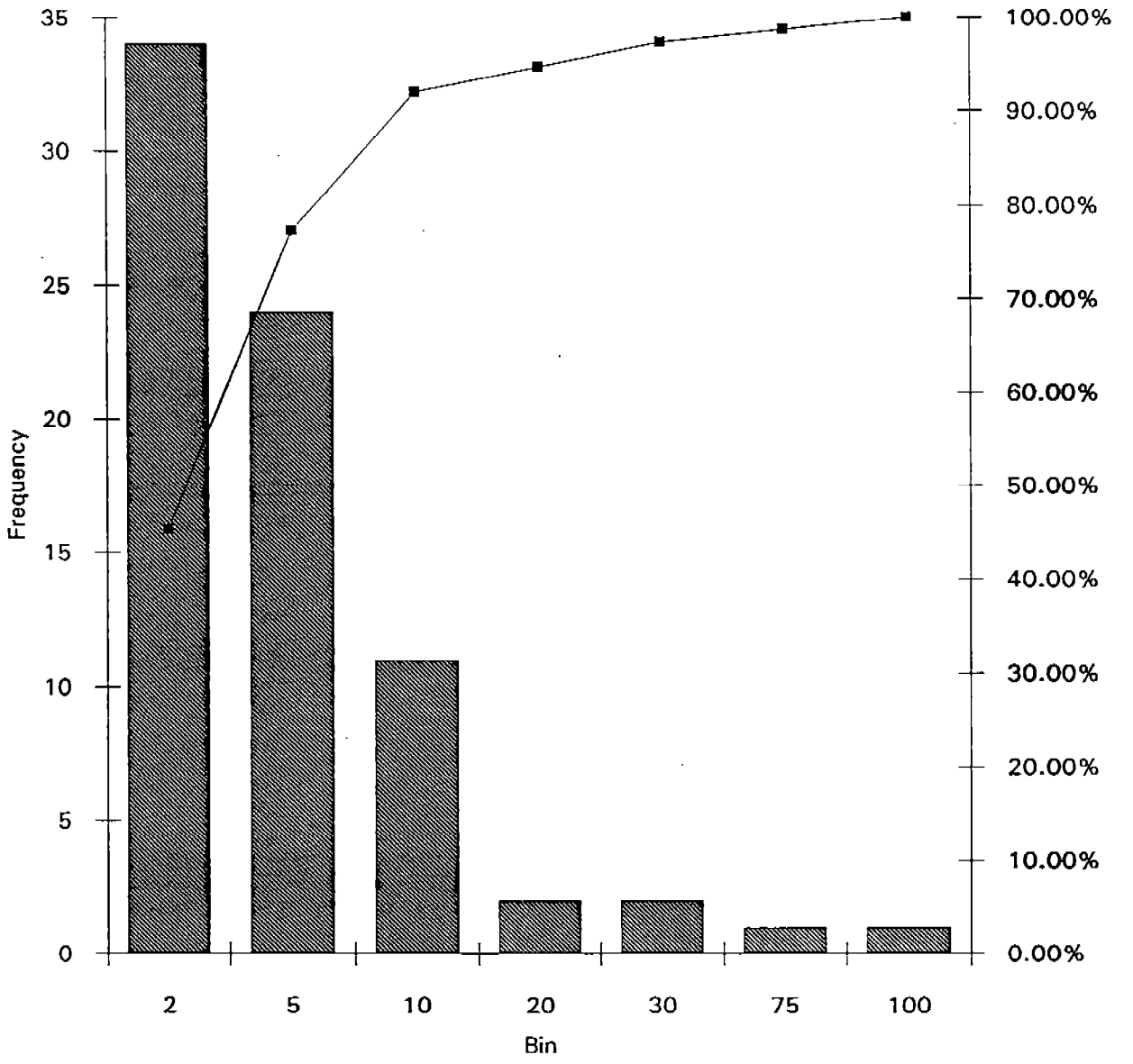
Chromium
(mg/kg)
South of Chena River



CHRSOLSC.XLC

Figure 4-5

Lead -
(mg/kg)
South of Chena River



PBSOLSC.XLC

SOIL - NORTH OF CHENA RIVER

Arsenic

A UCL of 11.47 was calculated for arsenic using 125 sample values. The minimum value is 1.20 mg/kg and the maximum is 38 mg/kg. Eighty-six percent (86%) of the data is less than 14.58 mg/kg and there are three values over 24.62. Figure 5-1 provides a graph of the data distribution and Table 1-6 shows the background UCL and mean values calculated for Eielson AFB. The mean concentration for Alaska found in the Geochemical Atlas is 17.30 mg/kg.

Barium

Barium has a computed background UCL of 154.31 mg/kg. The values vary from 27.50 to 1,350.00 mg/kg and there are a total of 126 sample values. Ninety-nine percent (99%) of the data is less than 267.95 mg/kg and there is one value over 267.95 mg/kg. Three surface sample values (4,380, 4,100, 6,418 mg/kg) taken near the landfill were not included in the data set because coal ash is used to cover the landfill and coal ash is considered a source of barium. Table 1-6 displays the background UCL levels calculated for Eielson AFB and a distribution of the data is shown in Figure 5-2. The Geochemical Atlas shows an area concentration of 983 to 1,413 mg/kg and a mean for Alaska of 810.98 mg/kg.

Cadmium

Eighty-six samples were used to calculate an UCL of 0.70 mg/kg for cadmium. The data ranged in value from 0.50 to 2.10 mg/kg and 96% of the samples were non-detects of < 1, < 2.2, and < 2.5 mg/kg. Detected values were 2 and 2.1 mg/kg. An UCL was not determined for cadmium in the study done on Eielson AFB. Figure 5-3 provides a histogram showing the distribution of the data.

Chromium

An UCL of 27.76 mg/kg was calculated for chromium using 100 samples that were made up of detectable values. The samples ranged in value from 6.30 to 40 mg/kg with 87% of the data less than 33.26. The UCL's calculated for Eielson AFB are 28.3 mg/kg in fluvial soil and 37.8 mg/kg in loess. Figure 5-4 provides an illustration of the distribution of the data. The area concentration for Fort Wainwright is 63 to 100 mg/kg and the mean concentration for Alaska is 114.85 mg/kg.

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Lead

Ninety-five (95) samples were used to compute an UCL of 14.68 mg/kg for lead on Fort Wainwright, while the UCL for Eielson AFB is 11.6 mg/kg in fluvial soil and 9 mg/kg in loess. The data ranged in value from 2.5 to 97 mg/kg with 65% of the data composed of non-detect values of < 20 mg/kg. Figure 5-5 illustrates the distribution of the data. Three values of 170, 140 and 106 mg/kg were deleted from the data set because they were surface samples taken from around a leaded gasoline tank. The mean concentration for Alaska is 12.41 and the area concentration for Fort Wainwright is 14 to 25 mg/kg.

Table 1-8

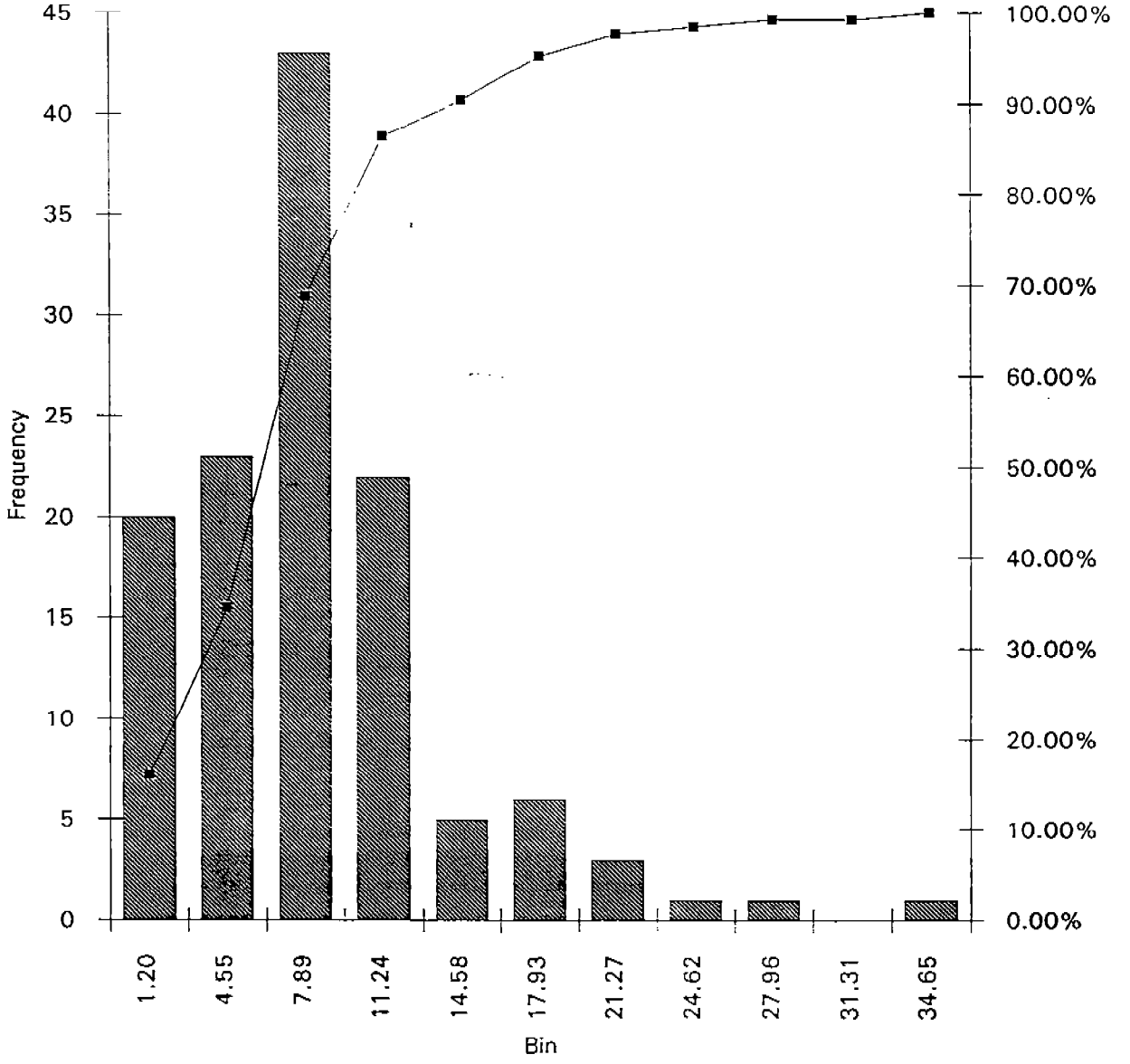
Upper Confidence Limits for RCRA Metals North of the Chena River

RCRA Metal	Lognormal UCL (mg/kg)	Normal UCL (mg/kg)
Arsenic	*11.47	10.91
Barium	*154.31	161.07
Cadmium	*0.70	0.73
Chromium	27.76	*26.98
Lead	*14.68	16.17

* Indicates the more accurate value as determined by distribution

Figure 5-1

Arsenic
(mg/kg)
North of Chena River



ARSOLNC.XLC

Figure 5-2

Barium
(mg/kg)
North of Chena River

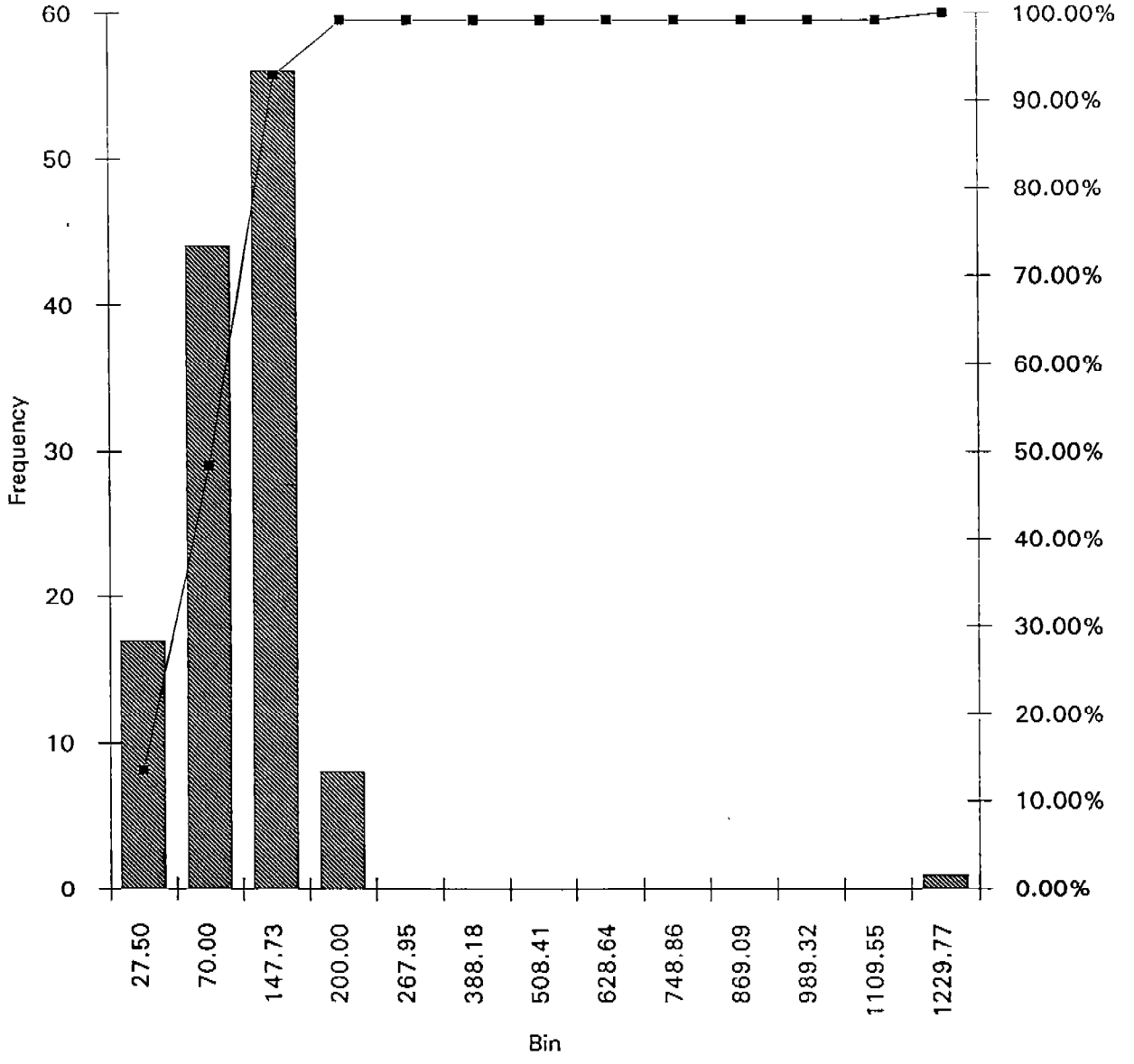
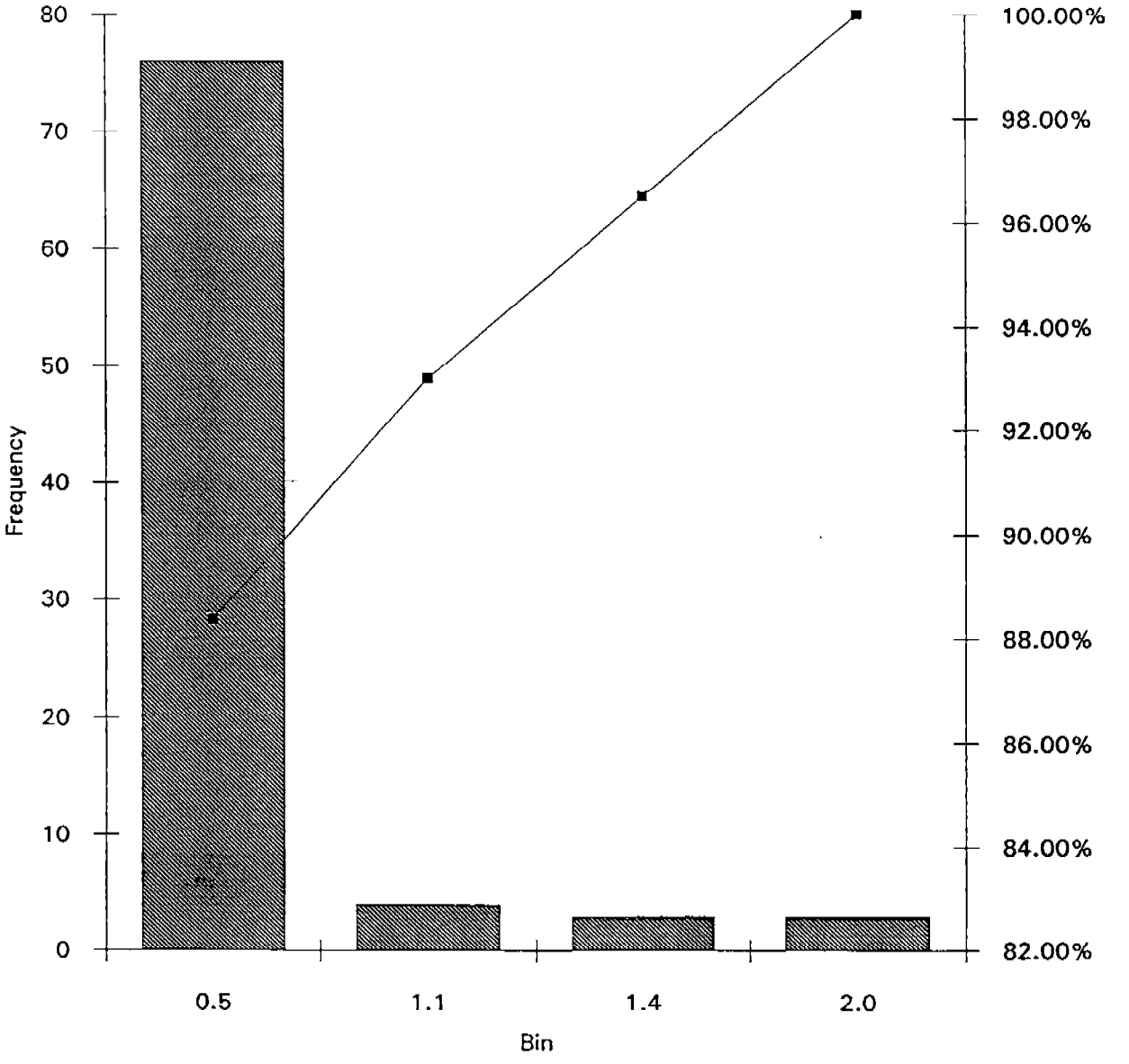


Figure 5-3

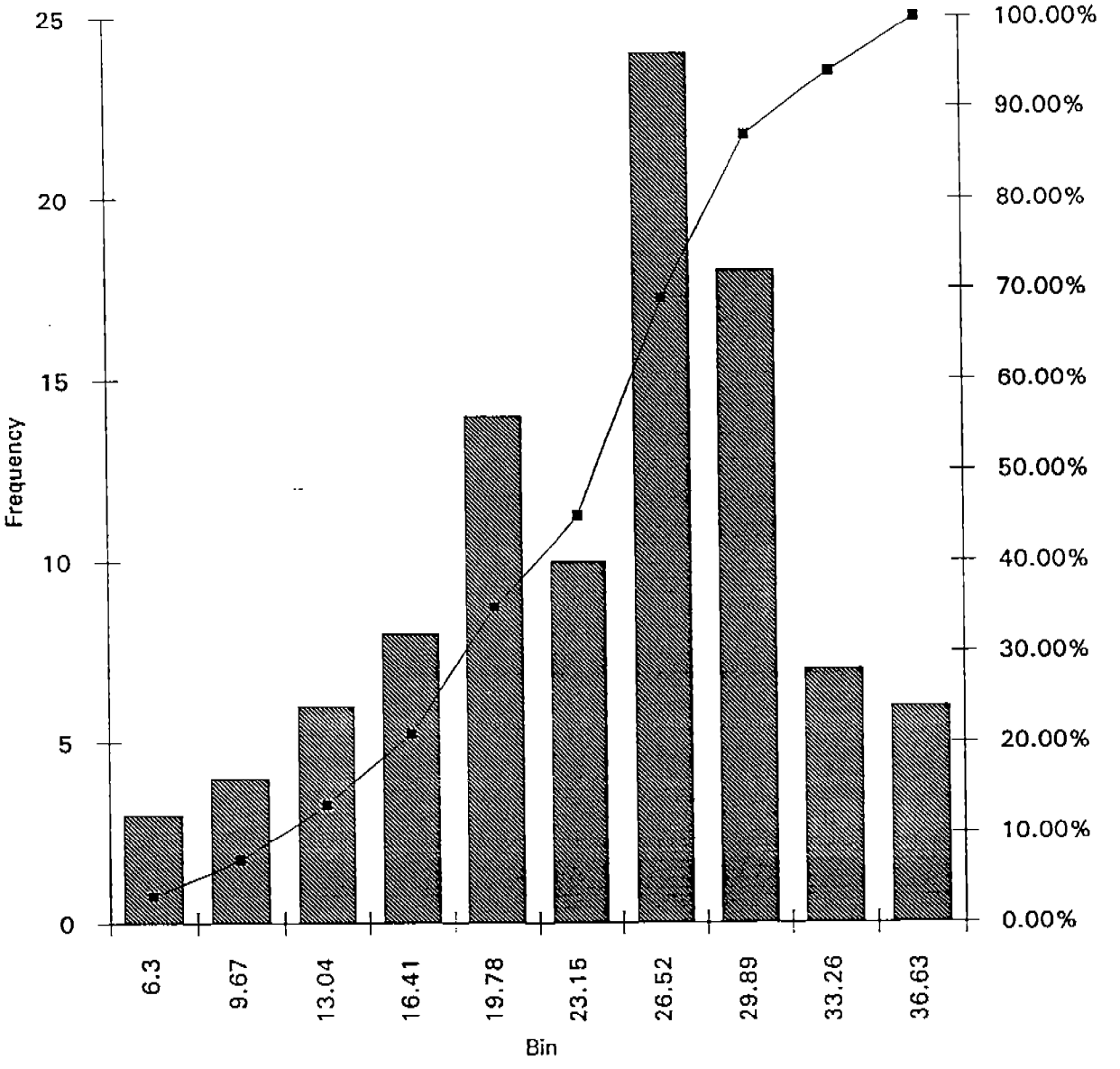
Cadmium
(mg/kg)
North of Chena River



CDSOLNC.XLC

Figure 5-4

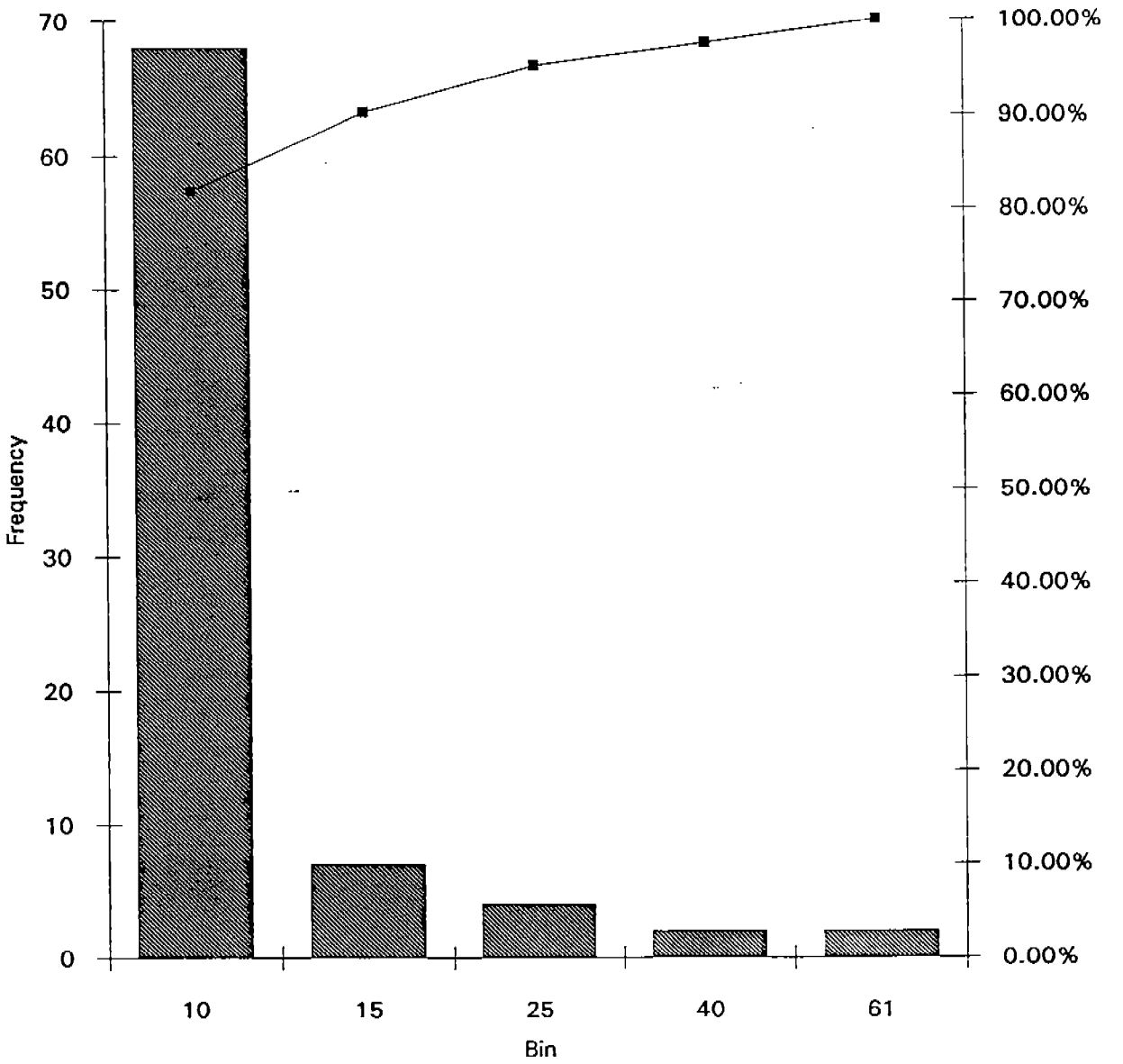
Chromium
(mg/kg)
North of Chena River



CHRSOLNC.XLC

Figure 5-5

Lead -
(mg/kg)
North of Chena River



PBSOLNC.XLC

CONCLUSION

Upper Confidence Limits for Fort Wainwright were higher for groundwater and lower for soil than UCL's for Eielson AFB. The UCLs for soil were most likely different because a 90 percent UCL was used for the Eielson AFB data and a 95% UCL was used for Fort Wainwright. A 95 percent UCL would be more conservative. Variations in the computed UCLs for groundwater may be due to differences in sample sizes. Data for Eielson was taken from 17 locations compared to 40 locations for Fort Wainwright. Another reason for the difference in value is the Eielson AFB UCL's were calculated using only a *t* statistic for normal distribution. The differences in the geology of Eielson and Fort Wainwright may have also caused the differences in background values. The groundwater samples taken on Fort Wainwright are typically quite turbid. The large difference in background values for total and dissolved metals is evidence that much of the inorganic load is due to particulate in the water. The total inorganic load of arsenic, barium, cadmium and lead in Fort Wainwright groundwater approaches Maximum Contamination Levels (MCLs) and exceeds Risk Based Concentration (RBC) limits for arsenic (see Table 1-9). Chromium exceeds the MCL and approaches the RBC. The dissolved arsenic load also exceeds the RBC carcinogens. The mean concentrations found in this study are most likely due to drainage of the creeks that flow through the Birch Creek Schist, Gilmore Dome and Tungsten Hill. Mean concentrations approximated in this analysis are below mean concentrations found from the geochemical survey, which indicates the recommended values are reasonable.

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Table 1-9
Maximum Contamination Levels and Risk-Based Concentrations for Water

RCRA Metal	* MCL (μg/L)	** RBC (μg/L) Risk =		
		10^{-6}	10^{-4}	HI=1
Arsenic	50	0.05	5	10
Barium	1,000	N/A	N/A	3000
Cadmium	10	N/A	N/A	20
Chromium (III)	50	N/A	N/A	40,000
Chromium (VI)		N/A	N/A	200
Lead	50	N/A	N/A	N/A

* Source: State of Alaska Drinking Water Regulation, 18 AAC 80, Department of Environmental Conservation, 1991

** Source: EPA Region 10, Supplemental Risk Assessment Guidance for Superfund, August 1991

RECOMMENDATIONS

Apparent inorganic contamination of groundwater and soil on Fort Wainwright may be due to natural background levels. Recommended levels for background values of arsenic, barium, cadmium, chromium and lead are given in Table 1-10. Action levels should be set sufficiently above the background values to avoid expending resources to investigate samples within normal laboratory variation of the background value.

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Table 1-10

Recommended Background Values

RCRA Metal	Matrix	Value
South of Chena River		
Arsenic	Soil	8 mg/kg
Barium	Soil	90 mg/kg
Cadmium	Soil	1 mg/kg
Chromium	Soil	17 mg/kg
Lead	Soil	10 mg/kg
Arsenic	Water - total	40 μg/L
Barium	Water - total	510 μg/L
Cadmium	Water - total	6 μg/L
Chromium	Water - total	52 μg/L
Lead	Water - total	39 μg/L
North of the Chena River		
Arsenic	Soil	11 mg/kg
Barium	Soil	150 mg/kg
Cadmium	Soil	1 mg/kg
Chromium	Soil	30 mg/kg
Lead	Soil	15 mg/kg
Arsenic	Water - total	50 μg/L
Barium	Water - total	960 μg/L
Cadmium	Water - total	6 μg/L

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Chromium	Water - total	105 μg/L
Lead	Water - total	50 μg/L
All of Fort Wainwright		
Arsenic	Water - dissolved	9 μg/L
Barium	Water - dissolved	230 μg/L
Cadmium	Water - dissolved	3 μg/L
Chromium	Water - dissolved	4 μg/L
Lead	Water - dissolved	5 μg/L

References

United States Environmental Protection Agency. Supplemental Guidance to RAGS: Calculating the Concentration Term, Publication 9285.7-081, Volume 1, Number 1; May 1992

Battelle Pacific Northwest Laboratories. Background Ground-Water Quality, Eielson Air Force Base, Alaska; December 1992

Battelle Pacific Northwest Laboratories. Background Soil Concentrations at Eielson Air Force Base; August 1992

Geochemistry Group, Earth and Space Sciences Division, Los Alamos National Laboratory. The Geochemical Atlas of Alaska; October 1983

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Chapman, R.M. and Foster, R.L. Locations and Descriptions of Lode Mines and Prospects in the Fairbanks, District, Alaska; U.S.G.S. open file report.

Cobb, E.H. Summary of References to Mineral Occurrences (Other Than Mineral Fuels and Construction Materials) in the Fairbanks Quadrangle, Alaska. U.S.G.S. OF 76-662; 1976.

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Appendix A

Data Distribution Tables

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DATA DISTRIBUTION
Ft. Wainwright
TOTAL
(ug/L)
South of Chena River

Arsenic

Bin	Frequency	Cumulative %
1.9	76	66.09%
24.7	21	84.35%
47.5	3	86.96%
70.3	8	93.91%
93.1	1	94.78%
116.0	2	96.52%
138.8	2	98.26%
161.6	1	99.13%
184.4	0	99.13%
207.2	1	100.00%

Barium

Bin	Frequency	Cumulative %
10.00	50	40.65%
190.91	33	67.48%
371.82	12	77.24%
552.73	7	82.93%
733.64	4	86.18%
914.55	1	86.99%
1095.45	4	90.24%
1276.36	7	95.93%
1457.27	2	97.56%
1638.18	2	99.19%
1819.09	1	100.00%

DATA DISTRIBUTION
Ft. Wainwright
TOTAL
(ug/L)
South of Chena River

Cadmium

Bin	Frequency	Cumulative %
0.25	42	36.84%
2	40	71.93%
4	7	78.07%
9	23	98.25%
12	1	99.12%
15	1	100.00%

Chromium

Bin	Frequency	Cumulative %
1	41	34.75%
10	39	67.80%
20	7	73.73%
30	11	83.05%
50	7	88.98%
100	6	94.07%
200	5	98.31%
300	2	100.00%

Lead

Bin	Frequency	Cumulative %
0.5	61	50.00%
3	12	59.84%
10	16	72.95%
25	16	86.07%
50	6	90.98%
75	4	94.26%
100	4	97.54%
125	2	99.18%
150	1	100.00%

DATA DISTRIBUTION
Ft. Wainwright
TOTAL
(ug/L)
North of Chena River

Arsenic

Bin	Frequency	Cumulative %
1.00	29	65.91%
23.17	5	77.27%
45.33	6	90.91%
67.50	2	95.45%
89.67	1	97.73%
111.83	1	100.00%

Barium

Bin	Frequency	Cumulative %
8	25	51.02%
244	7	65.31%
480	7	79.59%
716	3	85.71%
952	3	91.84%
1188	3	97.96%
1424	1	100.00%

DATA DISTRIBUTION

Ft. Wainwright

TOTAL

(ug/L)

North of Chena River

Cadmium

Bin	Frequency	Cumulative %
0.25	19	51.35%
2	4	62.16%
3	13	97.30%
11	1	100.00%

Chromium

Bin	Frequency	Cumulative %
1	12	27.91%
3	6	41.86%
7	9	62.79%
11	5	74.42%
50	3	81.40%
90	4	90.70%
200	4	100.00%

Lead

Bin	Frequency	Cumulative %
1	20	54.05%
2.5	4	64.86%
10	5	78.38%
25	3	86.49%
40	3	94.59%
80	1	97.30%
100	1	100.00%

DATA DISTRIBUTION

Ft. Wainwright

DISSOLVED

(ug/L)

Arsenic

Bin	Frequency	Cumulative %
1.00	22	55.00%
3.00	11	82.50%
10.17	5	95.00%
19.33	0	95.00%
28.50	1	97.50%
37.67	0	97.50%
46.83	1	100.00%

Barium

Bin	Frequency	Cumulative %
25	3.00	7.69%
107.5	15.00	46.15%
190	11.00	74.36%
272.5	9.00	97.44%
355	0.00	97.44%
437.5	1.00	100.00%

DATA DISTRIBUTION

Ft. Wainwright

DISSOLVED

(ug/L)

Cadmium

Bin	Frequency	Cumulative %
0.25	19	47.50%
2	18	92.50%
3	2	97.50%
7	1	100.00%

Chromium

Bin	Frequency	Cumulative %
1	20	50.00%
3.5	3	57.50%
4.5	16	97.50%
5.5	1	100.00%

Lead

Bin	Frequency	Cumulative %
0.5	16	41.03%
1.5	13	74.36%
3	3	82.05%
5	5	94.87%
11	2	100.00%

DATA DISTRIBUTION

Ft. Wainwright

(mg/kg)

South of Chena River

Arsenic

Bin	Frequency	Cumulative %
0.14	31	52.54%
4.26	18	83.05%
8.38	4	89.83%
12.51	1	91.53%
16.63	2	94.92%
20.75	2	98.31%
24.88	1	100.00%

Barium

Bin	Frequency	Cumulative %
35.40	18	30.51%
63.77	25	72.88%
92.14	11	91.53%
120.51	3	96.61%
148.89	1	98.31%
177.26	0	98.31%
205.63	1	100.00%

DATA DISTRIBUTION
Ft. Wainwright
(mg/kg)
South of Chena River

Cadmium

Bin	Frequency	Cumulative %
0.24	31	72.09%
1.05	3	79.07%
1.86	4	88.37%
2.67	3	95.35%
3.48	1	97.67%
4.29	1	100.00%

Chromium

Bin	Frequency	Cumulative %
6.00	22	30.99%
11.00	18	56.34%
16.00	19	83.10%
21.00	6	91.55%
26.00	2	94.37%
31.00	2	97.18%
36.00	1	98.59%
41.00	1	100.00%

Lead

Bin	Frequency	Cumulative %
2	34	45.33%
5	24	77.33%
10	11	92.00%
20	2	94.67%
30	2	97.33%
75	1	98.67%
100	1	100.00%

DATA DISTRIBUTION

Ft. Wainwright

(mg/kg)

North of Chena River

Arsenic

Bin	Frequency	Cumulative %
1.20	20	16.00%
4.55	23	34.40%
7.89	43	68.80%
11.24	22	86.40%
14.58	5	90.40%
17.93	6	95.20%
21.27	3	97.60%
24.62	1	98.40%
27.96	1	99.20%
31.31	0	99.20%
34.65	1	100.00%

Barium

Bin	Frequency	Cumulative %
27.50	17	13.49%
70.00	44	48.41%
147.73	56	92.86%
200.00	8	99.21%
267.95	0	99.21%
388.18	0	99.21%
508.41	0	99.21%
628.64	0	99.21%
748.86	0	99.21%
869.09	0	99.21%
989.32	0	99.21%
1109.55	0	99.21%
1229.77	1	100.00%

DATA DISTRIBUTION

Ft. Wainwright

(mg/kg)

North of Chena River

Cadmium

Bin	Frequency	Cumulative %
0.5	76	88.37%
1.1	4	93.02%
1.4	3	96.51%
2.0	3	100.00%

Chromium

Bin	Frequency	Cumulative %
6.3	3	3.00%
9.67	4	7.00%
13.04	6	13.00%
16.41	8	21.00%
19.78	14	35.00%
23.15	10	45.00%
26.52	24	69.00%
29.89	18	87.00%
33.26	7	94.00%
36.63	6	100.00%

Lead

Bin	Frequency	Cumulative %
10	68	81.93%
15	7	90.36%
25	4	95.18%
40	2	97.59%
61	2	100.00%

Appendix B

Statistical Analysis Tables

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Formula Used for calculating UCL:

Lognormal Distribution:

$$UCL = e^{\bar{x}+0.5s^2+sH\sqrt{n-1}}$$

UCL = upper confidence limit
e = constant (base of the natural log, equal to 2.718)
x = mean of transformed data
s = standard deviation of the transformed data
H = H-statistic
n = number of samples

Normal Distribution:

$$UCL = \bar{x} + t\left(\frac{s}{\sqrt{n}}\right)$$

UCL = Upper Confidence Limit
x = mean of untransformed data
s = standard deviation of the untransformed data
t = Student-t statistic
n = number of samples

GROUND WATER: TOTAL SOUTH OF CHENA RIVER (IF APPLICABLE) (ug/L)

Lognormal Arsenic	
Mean	2.55
Standard Error	0.12
Median	2.40
Mode	0.92
Standard Deviation	1.26
Variance	1.58
Kurtosis	-0.90
Skewness	0.21
Range	4.80
Minimum	0.64
Maximum	5.44
Sum	293.10
Count	115
H-Statistic	2.440
UCL 95%	37.55

Lognormal Barium	
Mean	5.59
Standard Error	0.09
Median	5.44
Mode	4.87
Standard Deviation	0.95
Variance	0.90
Kurtosis	0.34
Skewness	0.11
Range	5.30
Minimum	2.30
Maximum	7.60
Sum	687.79
Count	123
H-Statistic	2.200
UCL 95%	507.69

Normal Arsenic	
Mean	27.41
Standard Error	3.59
Median	11.00
Mode	2.50
Standard Deviation	38.51
Variance	1,483.34
Kurtosis	8.58
Skewness	2.70
Range	228.10
Minimum	1.90
Maximum	230.00
Sum	3,151.60
Count	115
t-statistic	1.658
UCL 95%	33.36

Normal Barium	
Mean	421.02
Standard Error	39.98
Median	230.00
Mode	130.00
Standard Deviation	443.39
Variance	196,599.00
Kurtosis	2.17
Skewness	1.74
Range	1,990.00
Minimum	10.00
Maximum	2,000.00
Sum	51,785.00
Count	123
t-statistic	1.658
UCL 95%	487.30

GROUND WATER: TOTAL SOUTH OF CHENA RIVER (IF APPLICABLE) (ug/L)

Lognormal Cadmium	
Mean	0.81
Standard Error	0.11
Median	0.92
Mode	0.92
Standard Deviation	1.15
Variance	1.33
Kurtosis	-0.40
Skewness	-0.44
Range	4.16
Minimum	-1.39
Maximum	2.77
Sum	91.82
Count	114
H-Statistic	2.210
UCL 95%	5.53

Lognormal Chromium	
Mean	2.54
Standard Error	0.13
Median	2.30
Mode	0.92
Standard Deviation	1.45
Variance	2.10
Kurtosis	-0.47
Skewness	0.47
Range	5.97
Minimum	0.00
Maximum	5.97
Sum	299.31
Count	118
H-Statistic	2.712
UCL 95%	51.81

Lognormal Lead	
Mean	1.73
Standard Error	0.15
Median	1.15
Mode	0.00
Standard Deviation	1.70
Variance	2.91
Kurtosis	-1.31
Skewness	0.39
Range	5.77
Minimum	-0.69
Maximum	5.08
Sum	211.57
Count	122
H-Statistic	2.994
UCL 95%	38.50

Normal Cadmium	
Mean	3.84
Standard Error	0.35
Median	2.50
Mode	2.50
Standard Deviation	3.74
Variance	14.00
Kurtosis	0.01
Skewness	1.15
Range	15.75
Minimum	0.25
Maximum	16.00
Sum	438.17
Count	114
t-statistic	1.659
UCL 95%	4.43

Normal Chromium	
Mean	38.41
Standard Error	6.63
Median	10.00
Mode	2.50
Standard Deviation	72.03
Variance	5,188.37
Kurtosis	9.21
Skewness	3.03
Range	389.00
Minimum	1.00
Maximum	390.00
Sum	4,532.60
Count	118
t-statistic	1.658
UCL 95%	49.41

Normal Lead	
Mean	21.04
Standard Error	3.04
Median	3.25
Mode	1.00
Standard Deviation	33.54
Variance	1,124.74
Kurtosis	4.25
Skewness	2.15
Range	159.50
Minimum	0.50
Maximum	160.00
Sum	2,567.30
Count	122
t-statistic	1.658
UCL 95%	26.08

GROUND WATER: TOTAL NORTH OF CHENA RIVER (IF APPLICABLE) (ug/L)

Lognormal Arsenic	
Mean	2.43
Standard Error	0.21
Median	2.59
Mode	0.92
Standard Deviation	1.37
Variance	1.87
Kurtosis	-1.19
Skewness	0.01
Range	4.90
Minimum	0.00
Maximum	4.90
Sum	106.72
Count	44
H-Statistic	2.886
UCL 95%	52.50

Lognormal Barium	
Mean	5.47
Standard Error	0.19
Median	5.44
Mode	7.24
Standard Deviation	1.34
Variance	1.80
Kurtosis	0.46
Skewness	-0.89
Range	5.34
Minimum	2.08
Maximum	7.41
Sum	267.84
Count	49
H-Statistic	2.582
UCL 95%	962.00

Normal Arsenic	
Mean	24.99
Standard Error	4.63
Median	13.50
Mode	2.50
Standard Deviation	30.68
Variance	941.44
Kurtosis	3.30
Skewness	1.82
Range	133.00
Minimum	1.00
Maximum	134.00
Sum	1,099.75
Count	44
t-statistic	1.679
UCL 95%	32.76

Normal Barium	
Mean	439.31
Standard Error	60.87
Median	230.00
Mode	1,400.00
Standard Deviation	426.12
Variance	181,581.80
Kurtosis	0.60
Skewness	1.21
Range	1,652.00
Minimum	8.00
Maximum	1,660.00
Sum	21,526.00
Count	49
t-statistic	1.676
UCL 95%	541.33

GROUND WATER: TOTAL NORTH OF CHENA RIVER (IF APPLICABLE) (ug/L)

Lognormal Cadmium	
Mean	1.06
Standard Error	0.15
Median	0.41
Mode	0.41
Standard Deviation	0.94
Variance	0.88
Kurtosis	-0.43
Skewness	0.11
Range	3.87
Minimum	-1.39
Maximum	2.48
Sum	39.08
Count	37
H-Statistic	2.300
UCL 95%	6.41

Lognormal Chromium	
Mean	2.60
Standard Error	0.24
Median	2.30
Mode	0.92
Standard Deviation	1.60
Variance	2.58
Kurtosis	-1.07
Skewness	0.61
Range	4.72
Minimum	0.92
Maximum	5.63
Sum	111.93
Count	43
H-Statistic	3.100
UCL 95%	105.44

Lognormal Lead	
Mean	1.42
Standard Error	0.28
Median	0.00
Mode	0.00
Standard Deviation	1.73
Variance	2.99
Kurtosis	-1.35
Skewness	0.63
Range	4.62
Minimum	0.00
Maximum	4.62
Sum	52.37
Count	37
H-Statistic	3.437
UCL 95%	49.30

Normal Cadmium	
Mean	4.36
Standard Error	0.65
Median	1.50
Mode	1.50
Standard Deviation	3.95
Variance	15.58
Kurtosis	-1.23
Skewness	0.82
Range	11.75
Minimum	0.25
Maximum	12.00
Sum	161.25
Count	37
t-statistic	1.689
UCL 95%	5.45

Normal Chromium	
Mean	47.08
Standard Error	11.23
Median	10.00
Mode	2.50
Standard Deviation	73.65
Variance	5,424.86
Kurtosis	1.96
Skewness	1.74
Range	277.50
Minimum	2.50
Maximum	280.00
Sum	2,024.50
Count	43
t-statistic	1.681
UCL 95%	65.96

Normal Lead	
Mean	16.44
Standard Error	4.28
Median	1.00
Mode	1.00
Standard Deviation	26.04
Variance	677.94
Kurtosis	2.90
Skewness	1.89
Range	101.00
Minimum	1.00
Maximum	102.00
Sum	608.30
Count	37
t-statistic	1.690
UCL 95%	23.67

GROUND WATER: DISSOLVED (ug/L)

Lognormal Arsenic	
Mean	1.29
Standard Error	0.16
Median	0.92
Mode	0.92
Standard Deviation	1.01
Variance	1.03
Kurtosis	0.37
Skewness	0.85
Range	4.03
Minimum	0.00
Maximum	4.03
Sum	51.75
Count	40
H-Statistic	2.390
UCL 95%	8.99

Lognormal Barium	
Mean	5.22
Standard Error	0.08
Median	5.30
Mode	5.19
Standard Deviation	0.52
Variance	0.27
Kurtosis	4.83
Skewness	-1.45
Range	3.03
Minimum	3.22
Maximum	6.25
Sum	203.76
Count	39
H-Statistic	1.920
UCL 95%	249.61

Normal Arsenic	
Mean	6.76
Standard Error	1.66
Median	-2.50
Mode	2.50
Standard Deviation	10.53
Variance	110.85
Kurtosis	13.25
Skewness	3.43
Range	55.00
Minimum	1.00
Maximum	56.00
Sum	270.20
Count	40
t-statistic	1.684
UCL 95%	9.56

Normal Barium	
Mean	207.13
Standard Error	14.61
Median	200.00
Mode	180.00
Standard Deviation	91.23
Variance	8,322.33
Kurtosis	2.30
Skewness	0.93
Range	495.00
Minimum	25.00
Maximum	520.00
Sum	8,078.00
Count	39
t-statistic	1.684
UCL 95%	231.73

GROUND WATER: DISSOLVED (ug/L)

Lognormal Cadmium	
Mean	-0.02
Standard Error	0.19
Median	0.92
Mode	0.92
Standard Deviation	1.19
Variance	1.41
Kurtosis	-1.63
Skewness	-0.13
Range	3.69
Minimum	-1.39
Maximum	2.30
Sum	-0.68
Count	40
H-Statistic	2.400
UCL 95%	3.14

Lognormal Chromium	
Mean	0.85
Standard Error	0.13
Median	1.24
Mode	0.00
Standard Deviation	0.80
Variance	0.65
Kurtosis	-1.86
Skewness	-0.04
Range	2.30
Minimum	0.00
Maximum	2.30
Sum	34.19
Count	40
H-Statistic	2.180
UCL 95%	4.30

Lognormal Lead	
Mean	0.71
Standard Error	0.15
Median	0.69
Mode	0.00
Standard Deviation	0.94
Variance	0.89
Kurtosis	0.40
Skewness	0.88
Range	3.99
Minimum	-0.69
Maximum	3.30
Sum	27.60
Count	39
H-Statistic	2.300
UCL 95%	4.51

Normal Cadmium	
Mean	1.75
Standard Error	0.29
Median	2.50
Mode	2.50
Standard Deviation	1.81
Variance	3.28
Kurtosis	10.18
Skewness	2.50
Range	9.75
Minimum	0.25
Maximum	10.00
Sum	70.00
Count	40
t-statistic	1.684
UCL 95%	2.23

Normal Chromium	
Mean	3.14
Standard Error	0.35
Median	3.50
Mode	1.00
Standard Deviation	2.19
Variance	4.81
Kurtosis	0.36
Skewness	0.65
Range	9.00
Minimum	1.00
Maximum	10.00
Sum	125.40
Count	40
t-statistic	1.684
UCL 95%	3.72

Normal Lead	
Mean	3.46
Standard Error	0.79
Median	2.00
Mode	1.00
Standard Deviation	4.92
Variance	24.21
Kurtosis	13.66
Skewness	3.37
Range	26.50
Minimum	0.50
Maximum	27.00
Sum	134.90
Count	39
t-statistic	1.685
UCL 95%	4.79

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SOIL CONTAMINATION AT FORT WAINWRIGHT

South of Chena River (mg/kg)

Lognormal Arsenic	
Mean	1.45
Standard Error	0.12
Median	1.44
Mode	0.00
Standard Deviation	0.91
Variance	0.84
Kurtosis	2.50
Skewness	-0.67
Range	5.37
Minimum	-2.00
Maximum	3.37
Sum	85.34
Count	59
H-Statistic	2.190
UCL 95%	8.40

Lognormal Barium	
Mean	4.31
Standard Error	0.04
Median	4.33
Mode	4.33
Standard Deviation	0.34
Variance	0.12
Kurtosis	1.09
Skewness	0.45
Range	1.89
Minimum	3.57
Maximum	5.46
Sum	254.25
Count	59
H-Statistic	1.755
UCL 95%	85.40

Normal Arsenic	
Mean	6.13
Standard Error	0.75
Median	4.20
Mode	1.00
Standard Deviation	5.79
Variance	33.57
Kurtosis	4.65
Skewness	2.12
Range	28.87
Minimum	0.14
Maximum	29.00
Sum	361.84
Count	59
t-statistic	1.671
UCL 95%	7.39

Normal Barium	
Mean	79.10
Standard Error	4.06
Median	76.00
Mode	76.00
Standard Deviation	31.18
Variance	972.31
Kurtosis	9.64
Skewness	2.33
Range	198.60
Minimum	35.40
Maximum	234.00
Sum	4,666.80
Count	59
t-statistic	1.671
UCL 95%	85.88

SOIL CONTAMINATION AT FORT WAINWRIGHT

South of Chena River (mg/kg)

Lognormal Cadmium	
Mean	-0.48
Standard Error	0.14
Median	-0.69
Mode	-0.69
Standard Deviation	0.90
Variance	0.80
Kurtosis	-0.49
Skewness	0.87
Range	3.08
Minimum	-1.45
Maximum	1.63
Sum	-20.43
Count	43
H-Statistic	2.250
UCL 95%	1.27

Lognormal Chromium	
Mean	2.64
Standard Error	0.05
Median	2.71
Mode	2.77
Standard Deviation	0.45
Variance	0.20
Kurtosis	-0.28
Skewness	0.18
Range	2.04
Minimum	1.79
Maximum	3.83
Sum	187.69
Count	71
H-Statistic	1.840
UCL 95%	17.18

Lognormal Lead	
Mean	1.83
Standard Error	0.09
Median	1.67
Mode	1.13
Standard Deviation	0.81
Variance	0.65
Kurtosis	2.77
Skewness	1.51
Range	3.94
Minimum	0.83
Maximum	4.77
Sum	137.04
Count	75
H-Statistic	2.040
UCL 95%	10.43

Normal Cadmium	
Mean	0.98
Standard Error	0.17
Median	0.50
Mode	0.50
Standard Deviation	1.12
Variance	1.24
Kurtosis	3.89
Skewness	2.01
Range	4.87
Minimum	0.24
Maximum	5.10
Sum	42.22
Count	43
t-statistic	1.680
UCL 95%	1.27

Normal Chromium	
Mean	15.57
Standard Error	0.90
Median	15.00
Mode	16.00
Standard Deviation	7.54
Variance	56.92
Kurtosis	3.33
Skewness	1.52
Range	40.00
Minimum	6.00
Maximum	46.00
Sum	1,105.60
Count	71
t-statistic	1.667
UCL 95%	17.06

Normal Lead	
Mean	10.10
Standard Error	2.04
Median	5.30
Mode	3.10
Standard Deviation	17.70
Variance	313.41
Kurtosis	26.64
Skewness	4.97
Range	115.70
Minimum	2.30
Maximum	118.00
Sum	757.60
Count	75
t-statistic	1.665
UCL 95%	13.50

SOIL CONTAMINATION AT FORT WAINWRIGHT

North of Chena River (mg/kg)

Lognormal Arsenic	
Mean	2.13
Standard Error	0.06
Median	2.22
Mode	2.30
Standard Deviation	0.63
Variance	0.40
Kurtosis	0.94
Skewness	-0.73
Range	3.46
Minimum	0.18
Maximum	3.64
Sum	266.46
Count	125
H-Statistic	1.890
UCL 95%	11.47

Lognormal Barium	
Mean	4.81
Standard Error	0.05
Median	5.01
Mode	5.19
Standard Deviation	0.53
Variance	0.28
Kurtosis	2.83
Skewness	-0.01
Range	3.89
Minimum	3.31
Maximum	7.21
Sum	606.64
Count	126
H-Statistic	1.828
UCL 95%	154.31

Normal Arsenic	
Mean	10.04
Standard Error	0.53
Median	9.20
Mode	10.00
Standard Deviation	5.87
Variance	34.49
Kurtosis	4.22
Skewness	1.55
Range	36.80
Minimum	1.20
Maximum	38.00
Sum	1,254.50
Count	125
t-statistic	1.658
UCL 95%	10.91

Normal Barium	
Mean	143.27
Standard Error	10.74
Median	149.50
Mode	179.00
Standard Deviation	120.52
Variance	14,524.85
Kurtosis	81.38
Skewness	8.10
Range	1,322.50
Minimum	27.50
Maximum	1,350.00
Sum	18,051.60
Count	126
t-statistic	1.658
UCL 95%	161.07

SOIL CONTAMINATION AT FORT WAINWRIGHT

North of Chena River (mg/kg)

Lognormal Cadmium	
Mean	-0.51
Standard Error	0.04
Median	-0.69
Mode	-0.69
Standard Deviation	0.39
Variance	0.15
Kurtosis	2.55
Skewness	1.94
Range	1.44
Minimum	-0.69
Maximum	0.74
Sum	-43.87
Count	86
H-Statistic	1.776
UCL 95%	0.70

Lognormal Chromium	
Mean	3.19
Standard Error	0.04
Median	3.33
Mode	3.37
Standard Deviation	0.37
Variance	0.14
Kurtosis	2.39
Skewness	-1.45
Range	1.85
Minimum	1.84
Maximum	3.69
Sum	318.99
Count	100
H-Statistic	1.777
UCL 95%	27.76

Lognormal Lead	
Mean	2.42
Standard Error	0.06
Median	2.30
Mode	2.30
Standard Deviation	0.56
Variance	0.32
Kurtosis	4.10
Skewness	1.31
Range	3.66
Minimum	0.92
Maximum	4.57
Sum	229.74
Count	95
H-Statistic	1.891
UCL 95%	14.68

Normal Cadmium	
Mean	0.66
Standard Error	0.04
Median	0.50
Mode	0.50
Standard Deviation	0.37
Variance	0.14
Kurtosis	6.15
Skewness	2.53
Range	1.60
Minimum	0.50
Maximum	2.10
Sum	56.80
Count	86
t-statistic	1.662
UCL 95%	0.73

Normal Chromium	
Mean	25.71
Standard Error	0.77
Median	28.00
Mode	29.00
Standard Deviation	7.65
Variance	58.52
Kurtosis	-0.25
Skewness	-0.48
Range	33.70
Minimum	6.30
Maximum	40.00
Sum	2,571.20
Count	100
t-statistic	1.660
UCL 95%	26.98

Normal Lead	
Mean	13.85
Standard Error	1.39
Median	10.00
Mode	10.00
Standard Deviation	13.58
Variance	184.37
Kurtosis	19.26
Skewness	4.09
Range	94.50
Minimum	2.50
Maximum	97.00
Sum	1,316.00
Count	95
t-statistic	1.661
UCL 95%	16.17