

**TAILINGS AND PRODUCTION ROCK SITE  
2001 ANNUAL REPORT**

**Kennecott Greens Creek Mining Company**

**April 2002**

## TABLE OF CONTENTS

	Page
1.0 EXECUTIVE SUMMARY .....	1
2.0 TAILINGS AREA .....	2
2.1 Introduction .....	2
2.2 Placement records .....	3
2.3 Stability .....	5
2.4 Hydrology .....	18
2.5 Water quality .....	20
2.6 General site management .....	46
2.7 Site as-built .....	48
2.8 Reclamation/Closure Plan .....	52
3.0 SITE 23/D .....	55
3.1 Introduction .....	55
3.2 Placement records .....	56
3.3 Stability .....	57
3.4 Hydrology .....	65
3.5 Water quality .....	67
3.6 General site management .....	92
3.7 Site as-built .....	93
3.8 Reclamation/Closure Plan .....	98
4.0 REFERENCES .....	99

## TABLES

Table 2.1	Tailings Placement Data .....	3
Table 2.2	Miscellaneous Materials Disposal Estimates .....	4
Table 2.3	Summary Statistics for 2001 Tailings Compaction Testing Data .....	5
Table 2.4	Monthly Summary of Tailings Area Climate Data .....	18
Table 2.5	Summary Statistics of Acid-Base-Accounting Analyses for 12 Monthly, Mill-Tonnage Weighted Tailings Samples .....	45
Table 3.1	Production Rock Placement Data .....	56
Table 3.2	Summary Statistics for 2001 Site 23 Compaction Testing Data .....	57

Table 3.3	Monthly Summary of Site 23 Climate Data.....	65
Table 3.4	Acid Base Accounting and Assay Data Summary for Production Rock Samples.....	85

## FIGURES

Figure 2.1	Water Level Data for Piezometer 41.....	7
Figure 2.2	Water Level Data for Piezometer 42.....	7
Figure 2.3	Water Level Data for Piezometer 43.....	8
Figure 2.4	Water Level Data for Piezometer 44.....	8
Figure 2.5	Water Level Data for Piezometer 46.....	9
Figure 2.6	Water Level Data for Piezometer 47.....	9
Figure 2.7	Water Level Data for Piezometer 48.....	10
Figure 2.8	Water Level Data for Piezometer 50.....	10
Figure 2.9	Water Level Data for Piezometer 51.....	11
Figure 2.10	Water Level Data for Piezometer 73.....	11
Figure 2.11	Water Level Data for Piezometer 74.....	12
Figure 2.12	Water Level Data for Piezometer 75.....	12
Figure 2.13	Water Level Data for Piezometer 76.....	13
Figure 2.14	Water Level Data for Well MW-T-B2.....	13
Figure 2.15	Water Level Data for Standpipe Piezometer PZ-T-00-01.....	14
Figure 2.16	Water Level Data for Standpipe Piezometer PZ-T-00-02.....	14
Figure 2.17	Water Level Data for Standpipe Piezometer PZ-T-00-03.....	15
Figure 2.18	Water Level Data for Well MW-T-00-05A.....	15
Figure 2.19	Water Level Data for Well MW-T-00-3A.....	16
Figure 2.20	Water Level Data for Well MW-T-00-3B.....	16
Figure 2.21	Water Level Data for Well MW-T-01-3A.....	17
Figure 2.22	Water Level Data for Well MW-T-01-3B.....	17
Figure 2.23	Tailings Area Wet Well Flow Data.....	19
Figure 2.24	FWMP Site 34 Lead and Zinc Data.....	21
Figure 2.25	FWMP Sites 25, 27 and 31 Arsenic Data.....	22
Figure 2.26	FWMP Sites 25, 27 and 31 Copper Data.....	23
Figure 2.27	FWMP Sites 25, 27 and 31 Mercury Data.....	24

Figure 2.28	FWMP Sites 25, 27 and 31 Lead Data.....	25
Figure 2.29	FWMP Sites 25, 27 and 31 Zinc Data .....	26
Figure 2.30	FWMP Sites 26 and 28 Arsenic Data .....	27
Figure 2.31	FWMP Sites 26 and 28 Copper Data .....	28
Figure 2.32	FWMP Sites 26 and 28 Mercury Data .....	29
Figure 2.33	FWMP Sites 26 and 28 Lead Data.....	30
Figure 2.34	FWMP Sites 26 and 28 Zinc Data .....	31
Figure 2.35	FWMP Sites 29, 30 and 32 Arsenic Data .....	32
Figure 2.36	FWMP Sites 29, 30 and 32 Copper Data .....	33
Figure 2.37	FWMP Sites 29, 30 and 32 Mercury Data .....	34
Figure 2.38	FWMP Sites 29, 30 and 32 Lead Data.....	35
Figure 2.39	FWMP Sites 29, 30 and 32 Zinc Data .....	36
Figure 2.40	Tailings Area Internal Monitoring Plan Sites - pH Data.....	38
Figure 2.41	Tailings Area Internal Monitoring Plan Sites - Conductivity Data....	39
Figure 2.42	Tailings Area Internal Monitoring Plan Sites - Arsenic Data .....	40
Figure 2.43	Tailings Area Internal Monitoring Plan Sites - Zinc Data .....	41
Figure 2.44	Tailings Area Internal Monitoring Plan Sites - Copper Data.....	41
Figure 2.45	Tailings Area Internal Monitoring Plan Sites - Lead Data .....	42
Figure 2.46	Aerial Photograph of Tailings Facility 2001.....	48
Figure 2.47	Photograph of East Tailings Placement Area .....	49
Figure 2.48	Photograph of West Buttress Tailings Placement Area .....	50
Figure 2.49	Photograph of Compacted West Buttress Tailings .....	51
Figure 3.1	Pressure Data for Piezometer 52.....	58
Figure 3.2	Pressure Data for Piezometer 53.....	59
Figure 3.3	Pressure Data for Piezometer 54.....	59
Figure 3.4	Pressure Data for Piezometer 55.....	60
Figure 3.5	Water Level Data for Well MW-23/D-00-03 .....	60
Figure 3.6	Water Level Data for Well MW-23-A2D .....	61
Figure 3.7	Water Level Data for Well MW-23-A2S.....	61
Figure 3.8	Depth to Water Data for Well MW-23-98-01 .....	62
Figure 3.9	Water Level Data for Well MW-23-A4.....	62
Figure 3.10	Water Level Data for Well MW-23/D-00-01 .....	63
Figure 3.11	Water Level Data for Well MW-D-94-D3.....	63
Figure 3.12	Water Level Data for Well MW-D-94-D4.....	64

Figure 3.13	Pond D Flow Data.....	66
Figure 3.14	FWMP Sites 46 and 49 Arsenic Data .....	68
Figure 3.15	FWMP Sites 46 and 49 Copper Data .....	69
Figure 3.16	FWMP Sites 46 and 49 Mercury Data .....	70
Figure 3.17	FWMP Sites 46 and 49 Lead Data.....	71
Figure 3.18	FWMP Sites 46 and 49 Zinc Data .....	72
Figure 3.19	FWMP Sites 48, 6 and 54 Arsenic Data .....	73
Figure 3.20	FWMP Sites 48, 6 and 54 Copper Data .....	74
Figure 3.21	FWMP Sites 48, 6 and 54 Mercury Data .....	75
Figure 3.22	FWMP Sites 48, 6 and 54 Lead Data.....	76
Figure 3.23	FWMP Sites 48, 6 and 54 Zinc Data .....	77
Figure 3.24	Site 23/D Internal Monitoring Plan Sites – pH Data .....	79
Figure 3.25	Site 23/D Internal Monitoring Plan Sites – Conductivity Data.....	80
Figure 3.26	Site 23/D Internal Monitoring Plan Sites – Sulfate Data .....	80
Figure 3.27	Site 23/D Internal Monitoring Plan Sites – Arsenic Data .....	81
Figure 3.28	Site 23/D Internal Monitoring Plan Sites – Zinc Data .....	82
Figure 3.29	Site 23/D Internal Monitoring Plan Sites – Copper Data.....	82
Figure 3.30	Site 23/D Internal Monitoring Plan Sites – Lead Data .....	83
Figure 3.31	Site 23/D Internal Monitoring Plan Sites – Nickel Data.....	83
Figure 3.32	Site 23/D Internal Monitoring Plan Sites – Flow Data .....	84
Figure 3.33	Greens Creek Biomonitoring – Periphyton Biomass.....	86
Figure 3.34	Greens Creek Biomonitoring – Benthic Macroinvertebrate Densities.....	87
Figure 3.35	Greens Creek Biomonitoring – Dolly Varden Population and Density Estimates.....	88
Figure 3.36	Greens Creek Biomonitoring – Zinc Concentrations in Juvenile Dolly Varden.....	88
Figure 3.37	Greens Creek Biomonitoring – Silver Concentrations in Juvenile Dolly Varden.....	89
Figure 3.38	Greens Creek Biomonitoring – Cadmium Concentrations in Juvenile Dolly Varden.....	89
Figure 3.39	Greens Creek Biomonitoring – Copper Concentrations in Juvenile Dolly Varden.....	90

Figure 3.40	Greens Creek Biomonitoring – Selenium Concentrations in Juvenile Dolly Varden.....	90
Figure 3.41	Greens Creek Biomonitoring – Lead Concentrations in Juvenile Dolly Varden.....	91
Figure 3.42	Aerial Photograph of Site 23/D.....	93
Figure 3.43	Photograph of Site 23 Composite Soil Cover Plot.....	94
Figure 3.44	Photograph of Site 23 Designated Placement Zones .....	95
Figure 3.45	Photograph of Site 23 Foundation Preparation .....	96
Figure 3.46	Photograph of Site 23 Backslope and Designated Placement Zones .	97

**APPENDICES**

Appendix 1	Tailings Facility 2001 As-built and Cross Sections
Appendix 2	Site 23/D 2001 As-built and Cross Sections

## 1.0 Executive Summary

This annual report has been prepared by Kennecott Greens Creek Mining Company in accordance with Alaska Waste Disposal Permit 9911-BA006 and the mine's General Plan of Operations Appendices 3 and 11. The following itemized list indicates where in this report the information outlined in Section 6.2 of Permit 9911-BA006 is presented:

<u>Permit Section</u>	<u>Report Section</u>
6.2.1 Closure plan summary	2.8
Precipitation	2.4, 3.4
Summary of internal monitoring and fresh water monitoring plans	2.5, 3.5
Stability	2.3, 3.3
Cover performance	3.8
Pond D flow and composition	3.4
Summary of inspections	2.3, 3.3
Placement records	2.2, 3.2
6.2.2 Summary of inspections	2.3, 3.3
Monitoring results	
Visual inspections	2.3, 3.3
Groundwater, surface water	2.5, 3.5
Biological	2.5, 3.5
Post Closure	NA
6.2.3 Changes to GPO in 2001 (None)	NA
6.2.4 Location and volume of materials	2.2, 3.2, A1, A2
Test Results	
Compaction	2.3, 3.3
Acid Base Accounting	2.5, 3.5
Possible water releases (tailings perimeter waters)	2.5
6.2.5 Information regarding validity, variations, trends, exceedences	various

**The report is separated such that all aspects of the tailings facility are discussed first in Section 2 followed by discussion of Site 23/D in Section 3. Information that is pertinent to both sections is generally not repeated but is referred to by reference.**

## **2.0 Tailings area**

### **2.1 Introduction**

Kennecott Greens Creek Mining Company (KGCMC) has prepared this report in accordance with the mine's General Plan of Operations (Appendix 3) and Alaska Waste Disposal Permit 9911-BA006. A summary of all operational and monitoring activities performed in 2001 is provided. Refer to GPO Appendix 3 and permit 9911-BA006 for a detailed description of the tailings facility and associated monitoring requirements.

KGCMC operated its tailings facility continuously in 2001. Primary placement areas included the East Expansion and West Buttress (see Tailings Facility as-built in Appendix 1). Approximately 300,000 tons of tailings were placed at the tailings facility during this report period.

## 2.2 Placement records

In July 2001 KGCMC requested permission for the one-time placement of up to 10,000 tons of Class 4 production rock into the surface tailings facility. This request was felt necessary to provide underground operational flexibility necessitated by the unexpected additional volume of Class 4 type rock generated by the excavation of the underground paste backfill plant area. KGCMC concern that suitable mined out areas would not be cleared of ore quickly enough to accommodate the additional volume of waste rock generated by this project prompted this request.

Both ADEC (on 9 August), and the U.S. Forest Service (on 8 August) approved this alternate placement request. As development of the necessary excavations progressed, KGCMC was able to place all of the resultant Class 4 rock in underground sites through the use of either direct fill, or temporary storage prior to fill areas becoming available. Consequently, no Class 4 rock was placed at the surface tailings, or production rock storage areas. However, KGCMC greatly appreciates the Department's understanding in granting this request. We are equally pleased to report KGCMC diligence allowed full underground placement of these materials, and the approved relief was not implemented.

Table 2.1 contains the monthly placement records for tailings, production rock and other materials (e.g ditch sediments) at the tailings facility for 2001. Surveyed volumes (cubic yards) were converted to tons using a tonnage factor of 1.81 tons per cubic yard. Production rock used for road access and erosion control contributed approximately 9,000 tons to the facility. 12,000 tons of materials such as sediments from ditch maintenance were also placed at the facility in 2001. The calculated tonnage of tailings placed was derived by subtracting the tons of production rock and other material from the surveyed total. The pile currently contains approximately 2.7 million tons of material. Based on the survey data presented in Table 2.1 there is a remaining capacity of approximately 775,000 tons in the existing facility.

Table 2.1 Tailings Placement Data

	All Materials Monthly Total	All Materials Cumulative Total	All Materials Monthly Total	All Materials Cumulative Total	Prod Rock (Class 1) from Site 23	Other Materials (Ditch Seds)	Tailings
Date	yds <sup>3</sup> (surveyed)	yds <sup>3</sup> (surveyed)	tons (calculated)	tons (calculated)	tons (calculated)	tons (calculated)	tons (calculated)
1/31/01	11,522	1,344,448	20,874	2,435,736	0	936	19,938
2/28/01	12,628	1,357,076	22,878	2,458,615	0	784	22,094
3/31/01	13,640	1,370,716	24,711	2,483,326	1,530	918	22,263
4/30/01	14,115	1,384,831	25,572	2,508,898	495	2,401	22,676
5/31/01	14,227	1,399,058	25,775	2,534,673	570	1,638	23,567
6/30/01	8,188	1,407,246	14,835	2,549,508	416	2,176	12,243
7/31/01	18,679	1,425,925	33,841	2,583,348	2,534	0	31,306
8/31/01	16,151	1,442,076	29,260	2,612,609	1,300	1,234	26,726
9/30/01	13,792	1,455,868	24,987	2,637,596	1,184	800	23,003
10/31/01	18,422	1,474,290	33,375	2,670,971	493	1,187	31,695
11/30/01	13,916	1,488,206	25,211	2,696,183	0	0	25,187
12/31/01	16,372	1,504,578	29,661	2,725,844	765	0	28,896
Yearly Totals	171,652	1,504,578	310,980	2,725,844	9,287	12,074	289,594

Tons- calculated @ 1.81 tons/cy compacted

Table 2.2 Miscellaneous Materials Disposal Estimates

<b>Tailings Facility</b>	<b>yds<sup>3</sup></b>
Pressed Sewage Solids	55
Pressed Water Treatment Plant Sludge	1000
Incinerator Ash	16
<b>Underground Disposal</b>	<b>yds<sup>3</sup></b>
Tires	500 ea
Sump Sediments	3640
Shop Refuse	728
Mill Refuse	312
Electrical Refuse	120

### 2.3 Stability

Placed and spread tailings compaction was regularly tested throughout the year to monitor the performance goal of achieving 90 percent or greater compaction relative to a standard Proctor density. KGCMC staff utilizes a Troxler Model 3430 nuclear moisture-density gauge to measure wet density and percent moisture content of placed tailings. Typically one or more sites per placement cell are selected on a monthly basis and a series of 1 minute replicate measurements at a 12-inch depth are taken. Dry densities are calculated and compared to laboratory measured standard Proctors.

#### Compaction

Summary results for 2001 are shown in Table 2.3. Standard Proctor values were measured on four grab samples taken from the tailings-loadout facility at the 920 throughout the year and submitted to an outside materials testing lab which performed the test within the ASTM guidelines for method #D698. The mean standard Proctor value was 135.0 PCF (pounds per cubic foot) that compares closely to previous data.

Field measurement results show a high degree of achieving greater than 90% compaction with respect to an average Standard Proctor value of 135.0. Only one site measured below the 90 percent compaction at 120.4 PCF (89.2% relative compaction). At this site personnel were attempting to measure any short-range variability around a single test hole by rotating the gauge 90° and taking successive measurements. A total of three replicate measurements were taken before instrument rotation and yielded an average of 121.8 PCF or 90.3 percent compaction. After the instrument was rotated the dry density was measured twice at 118.3 PCF or 87.6 percent compaction. While rotating the instrument the probe hole may have internally eroded slightly, resulting in an air void between the probe and tailings which would result in a lower density measurement. All other measurements exceeded the 90 percent compaction criterion.

Table 2.3 Summary statistics for 2001 tailings compaction testing data

Compaction Variable	Mean	Max	Min	Std. Dev.	n
Std. Proctor (ASTM #D698)	<b>135</b>	138	132	3.43	4
Opt. Moisture (%)	14.3%	14.9%	13.8%	0.5%	
Measured Dry Density	157	187	120	16.85	52*
Measured moisture (%)	12.0%	15.8%	6.6%	2%	
Rel. Compaction %(w/r to 135 PCF)	116.3%	138.2%	89.2%	12%	

\* n=52 represents the number of individual sites at which multiple replicates are taken.

#### Inspections

Several independent inspections are carried out at the tailings area throughout the year. Operators working at the site carry out daily visual-work place inspections. The Surface Civil Engineer and or Surface Operations Manager carry out weekly visual inspections. The environmental department carries out a monthly checklist inspection of Pond 6. No visible signs of physical instability were observed at the tailings facility during this report period. During 2001 the USFS inspected the facility approximately 35 times (Site inspections #57-#91) to monitor for Best Management Practices effectiveness and compliance to the General Plan of Operations. No issues of non-compliance or poor operations practices of the surface tailings facility were noted in

the inspections. Suggestions regarding surface water management and wheel wash access were addressed and implemented where appropriate.

#### Well and piezometer water level data

Pneumatic piezometer and well water level data for the tailings site are presented in Figures 2.1 to 2.22. Well and piezometer locations and water level cross sections are shown on the tailing facility as-built (Appendix 1). Water levels remained relatively constant throughout the report period. Some piezometers (e.g. 41, 44, and 46 in Figures 2.1, 2.4, 2.5) showed a slight decrease in the latter half of the year, which is consistent with the drier than average conditions during the monitoring period. Section CC of the Tailings Facility as-built shows the inferred water table in the tailings pile. The maximum saturated thickness (approximately 42 feet) occurs near MW-T-B2 (Figure 2.14) in the center of the main portion of the pile. However, the elevated water table does not extend close to the down-slope toes of the pile. The foundation of the West Buttress and southern portion of the pile is well drained, as indicated by unsaturated conditions in the blanket drains (MW-T-00-05A, Figure 2.18) and at the base of the West Buttress (piezometers 74, 75, 76 in Figures 2.11, 2.12, 2.13). Low head elevations near the pile toe maximize the pile's geotechnical stability.

The data from standpipe piezometers completed above the blanket drain (PZ-T-00-01, PZ-T-00-02, PZ-T-00-03 in Figures 2.15, 2.16, 2.17) indicate that the water perches above the unsaturated underdrains to a thickness of approximately 12 feet. This is consistent with the low permeability of the tailings and the un-capped condition of the pile. Covering the pile will help minimize the saturated zone in the pile. This was demonstrated by the 10+ foot decrease in the water table that occurred from 1995 to 1997 when the pile was covered (see Figures 2.1 to 2.9 and 2.14).

Water levels for four wells completed east and west of the pile are shown for comparison in Figures 2.19 to 2.22. The eastern wells, MW-T-00-3A (Figure 2.19) and MW-T-00-3B (Figure 2.20), are completed in the shallow sands 12 and 17 feet, respectively, below ground surface. The shallower well shows a water table at the surface and the deeper well indicates a water elevation about three feet below ground surface throughout 2001. The water table remained close to an elevation of 228 feet in 2001. MW-T-01-03A and MW-T-01-03B water levels are shown in Figures 2.21 and 2.22, respectively. MW-T-01-03A is completed in bedrock to a depth of 20 feet and MW-T-01-03B is completed in clayey silt to a depth of 12 feet. The bedrock well indicates a water elevation of 125 feet and the clayey silt well shows a water elevation of 131 feet. Figure 2.22 suggests that it may have taken approximately six months for the water level to equilibrate after it was baled dry following a slug injection test in February 2001. If this is the case it reflects the very low permeability of the clayey silt. The bedrock well maintained a relatively steady water level of approximately 125 feet since it was completed in February 2001. The ground surface elevation is 134 feet in the proximity of the two wells.

Figure 2.1 Water Level Data for Piezometer 41

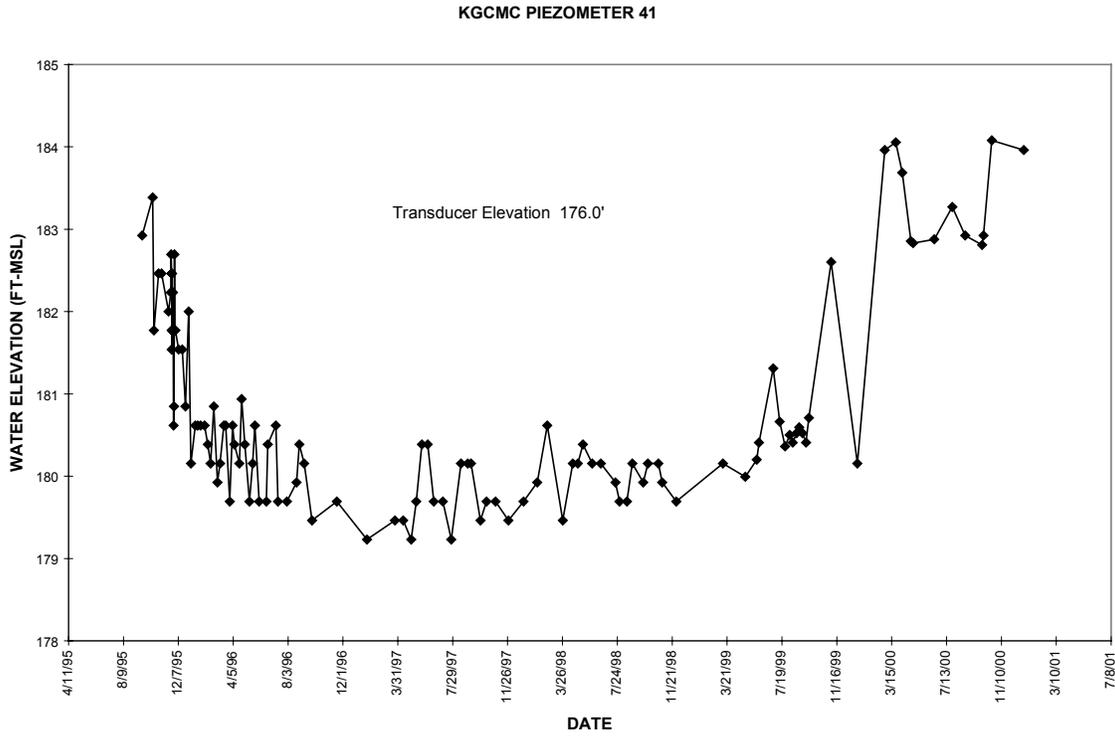


Figure 2.2 Water Level Data for Piezometer 42

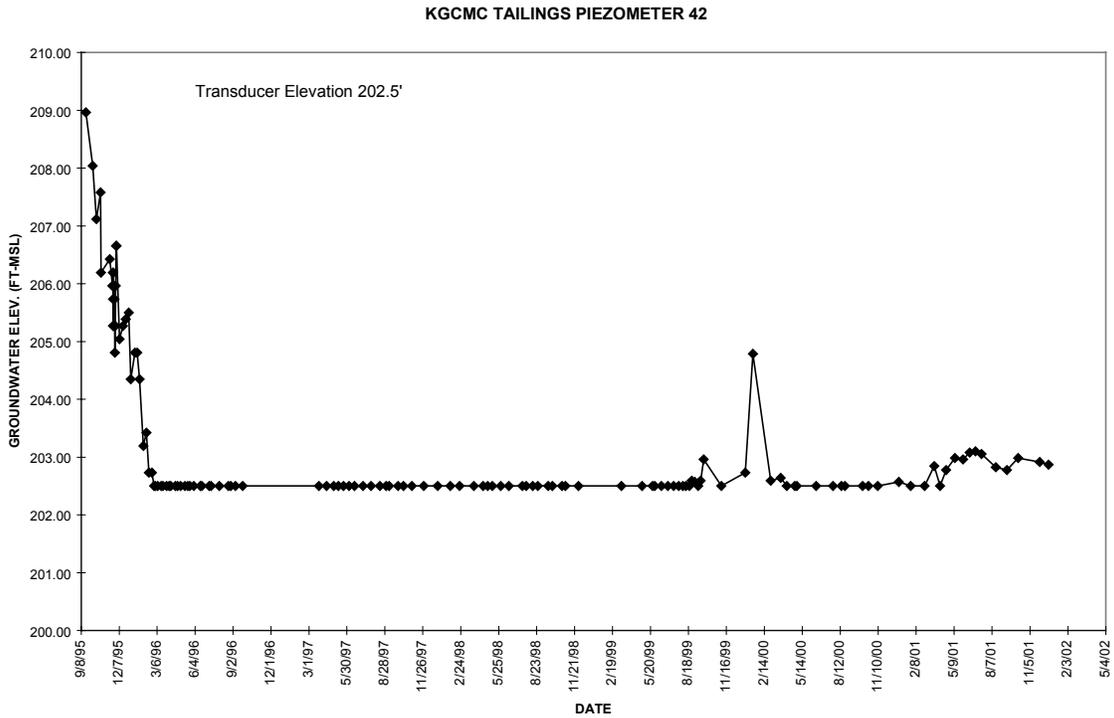




Figure 2.5 Water Level Data for Piezometer 46

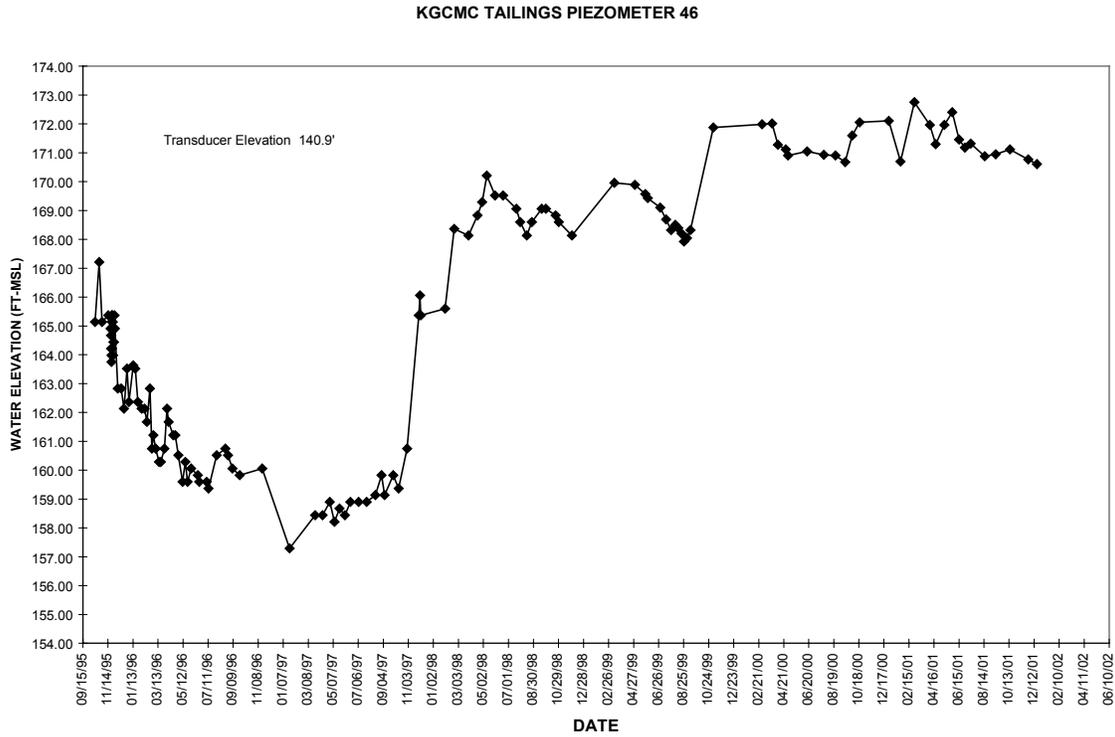


Figure 2.6 Water Level Data for Piezometer 47

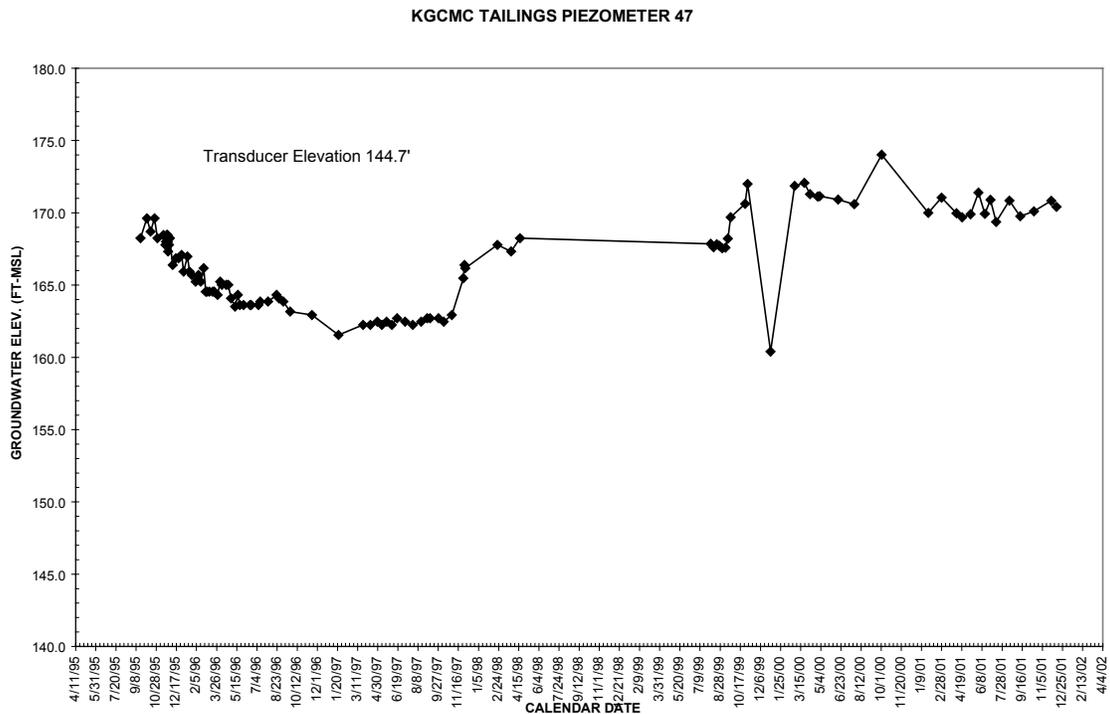


Figure 2.7 Water Level Data for Piezometer 48

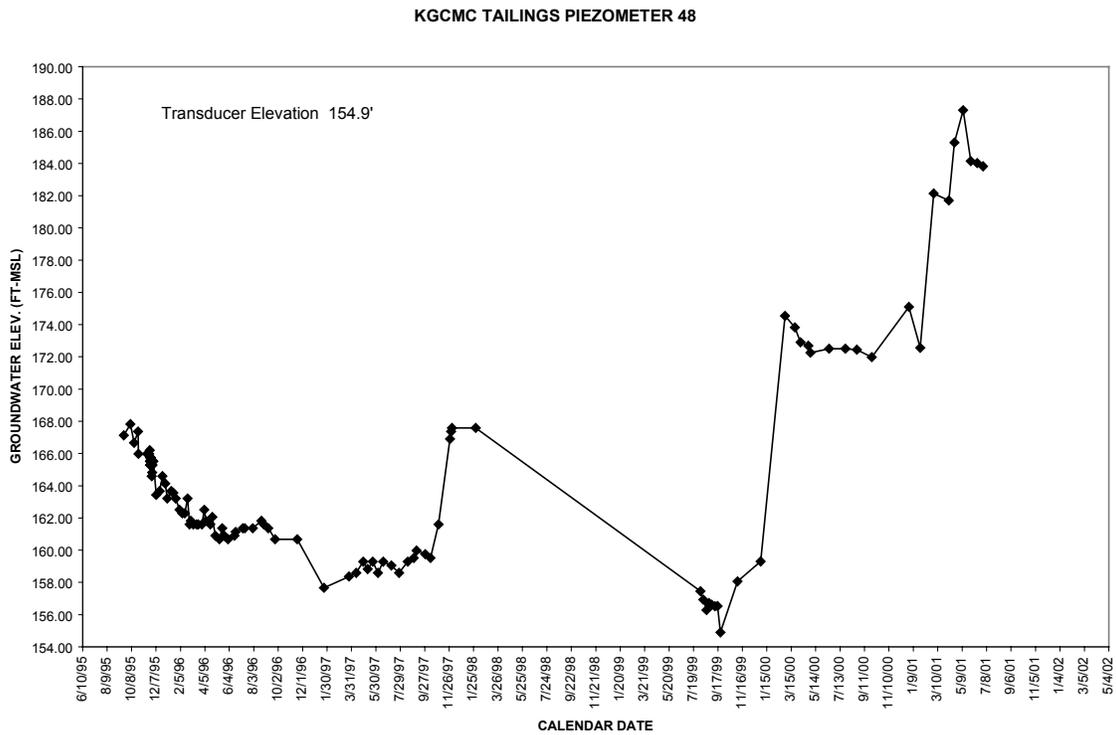


Figure 2.8 Water Level Data for Piezometer 50

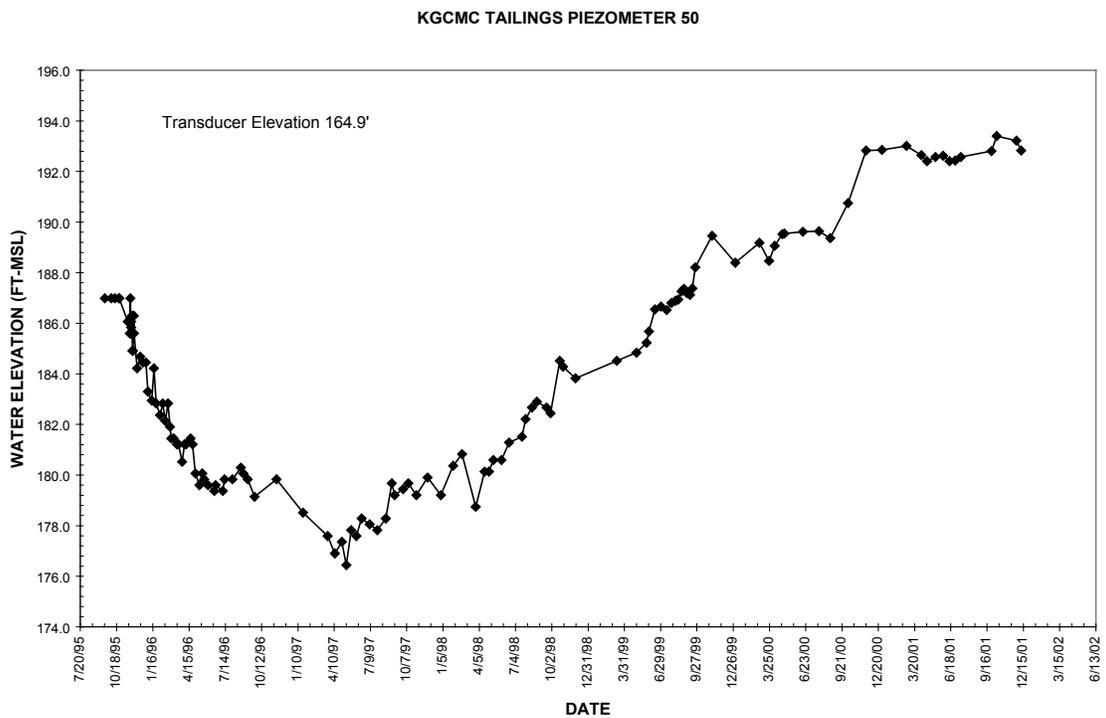


Figure 2.9 Water Level Data for Piezometer 51

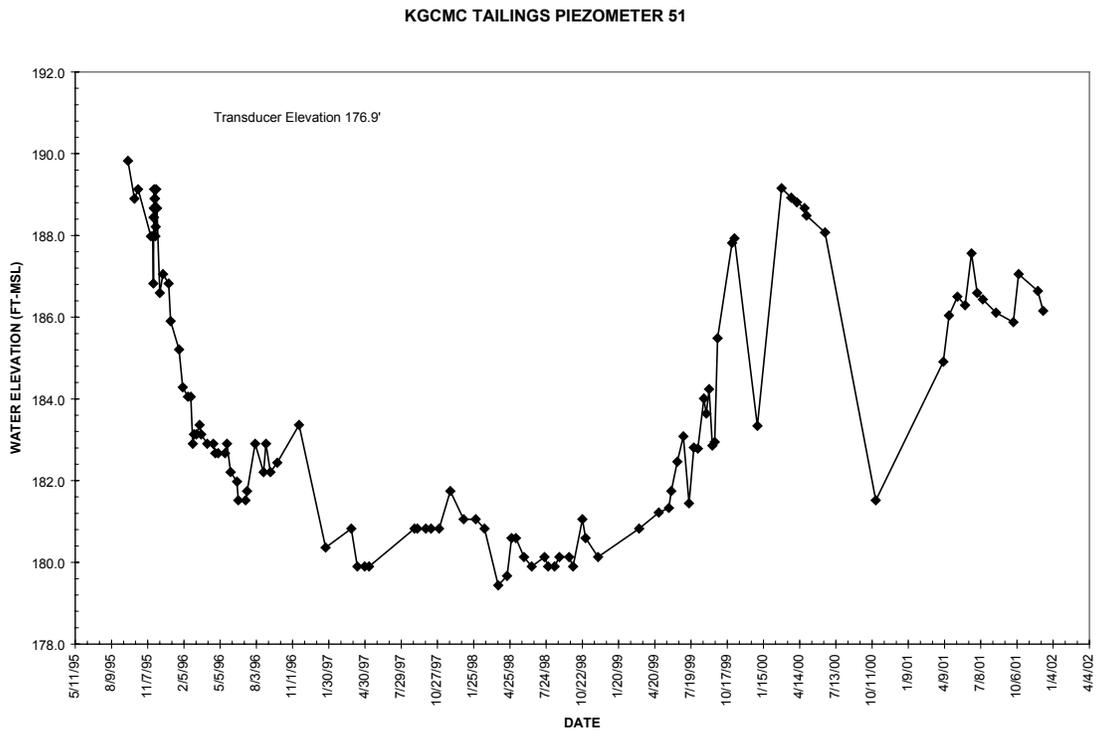


Figure 2.10 Water Level Data for Piezometer 73

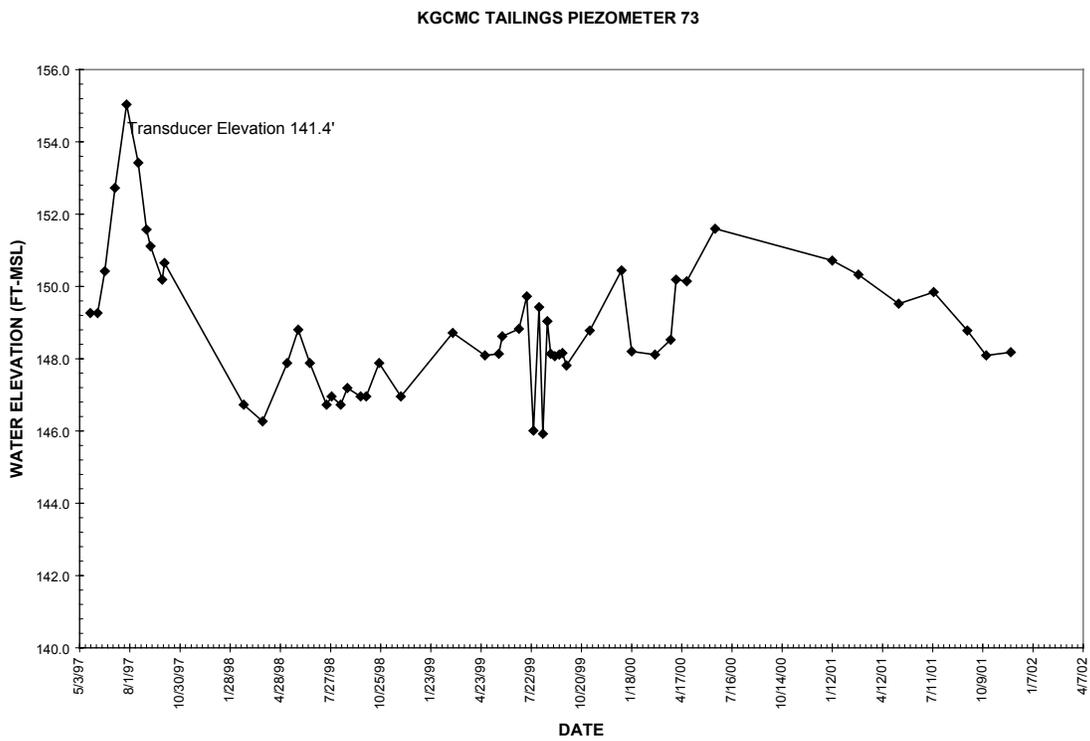


Figure 2.11 Water Level Data for Piezometer 74

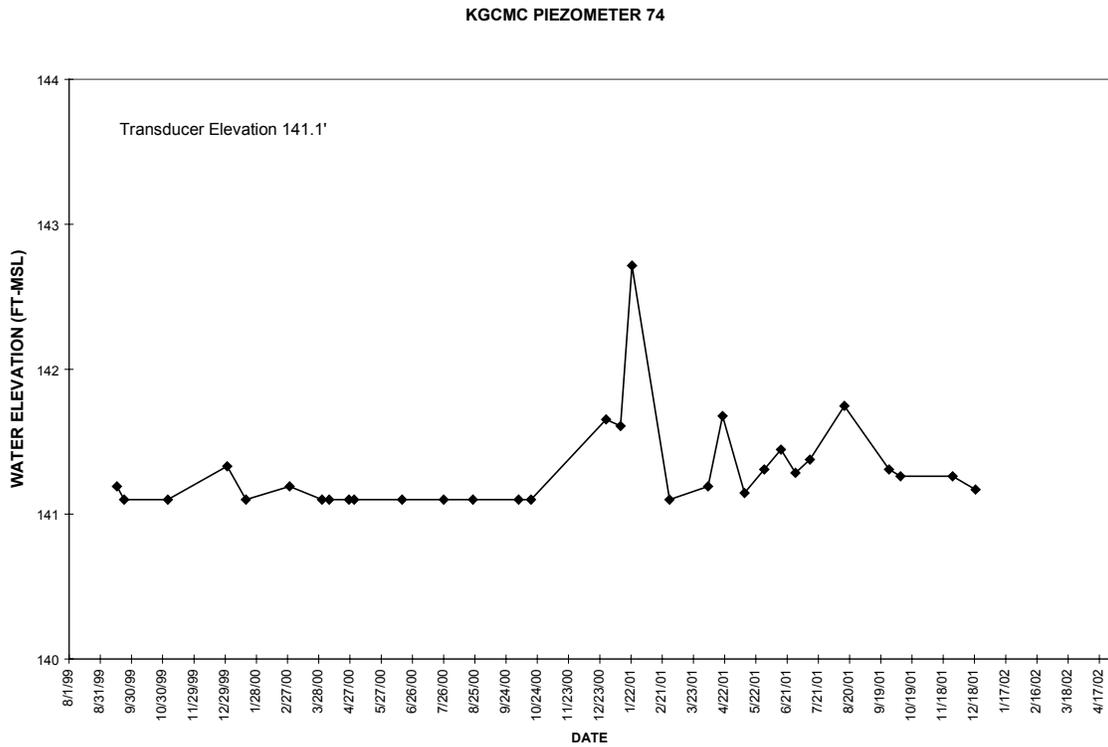


Figure 2.12 Water Level Data for Piezometer 75

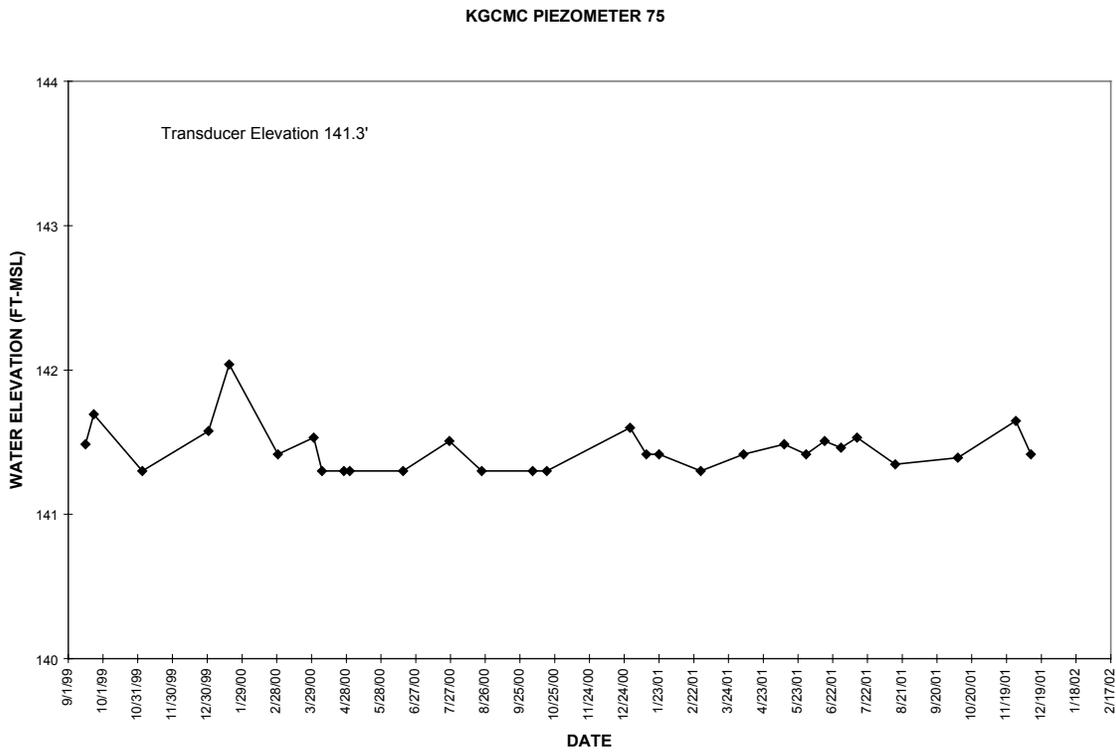


Figure 2.13 Water Level Data for Piezometer 76

KGCMC PIEZOMETER 76

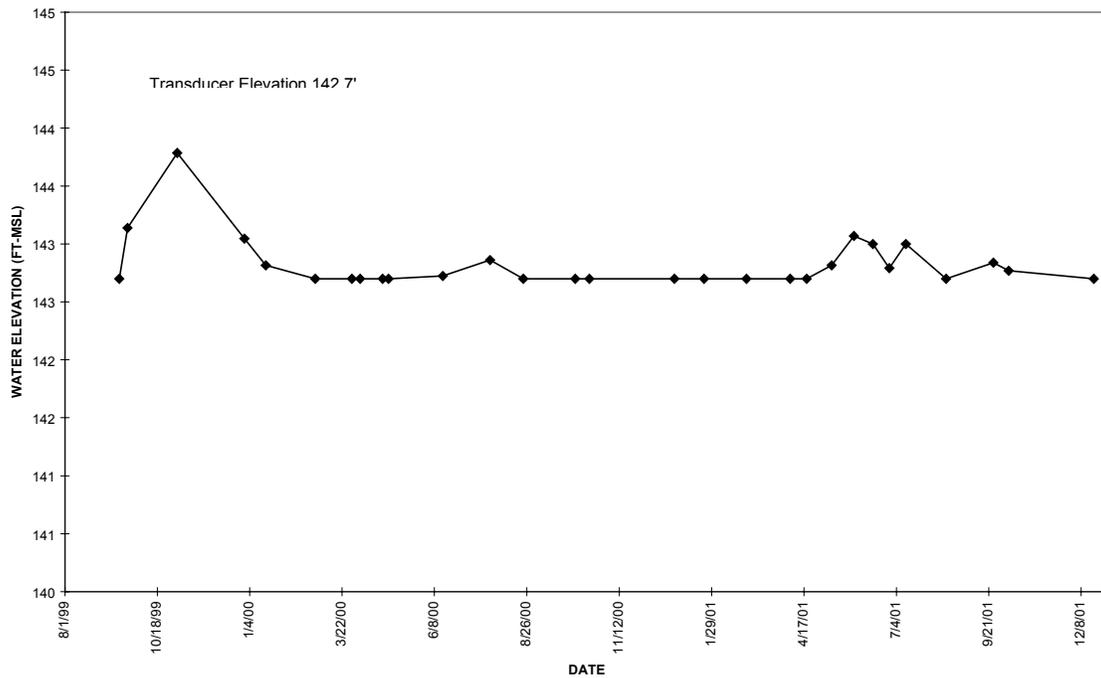


Figure 2.14 Water Level Data for Well MW-T-B2

KGCMC MONITORING WELL B2

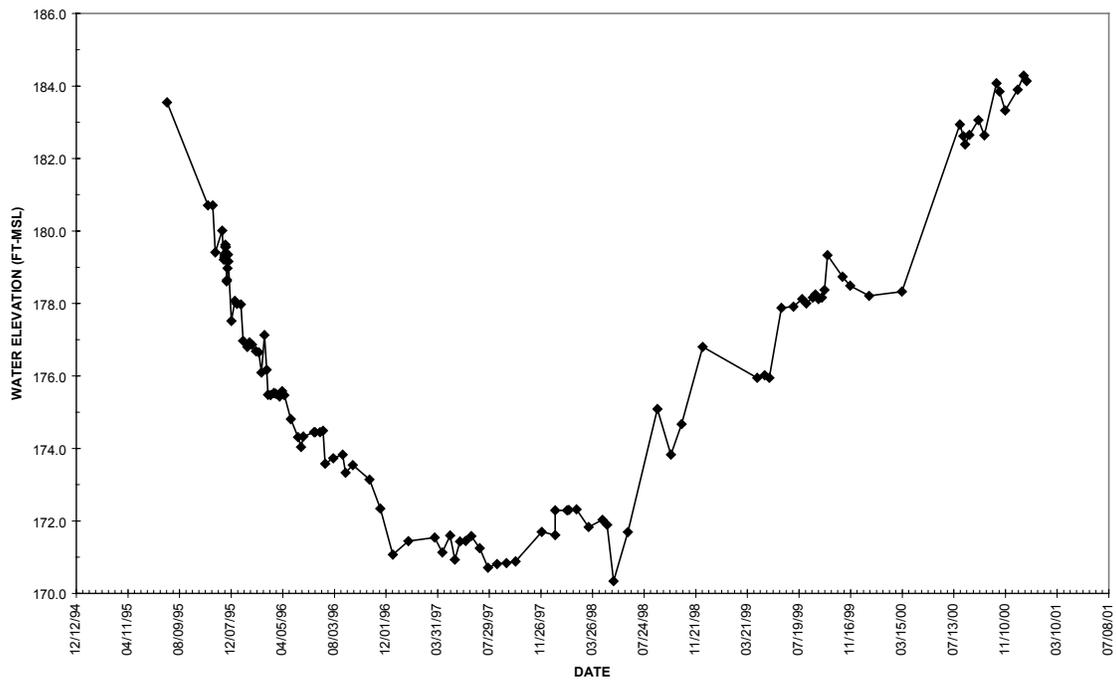


Figure 2.15 Water Level Data for Standpipe Piezometer PZ-T-00-01

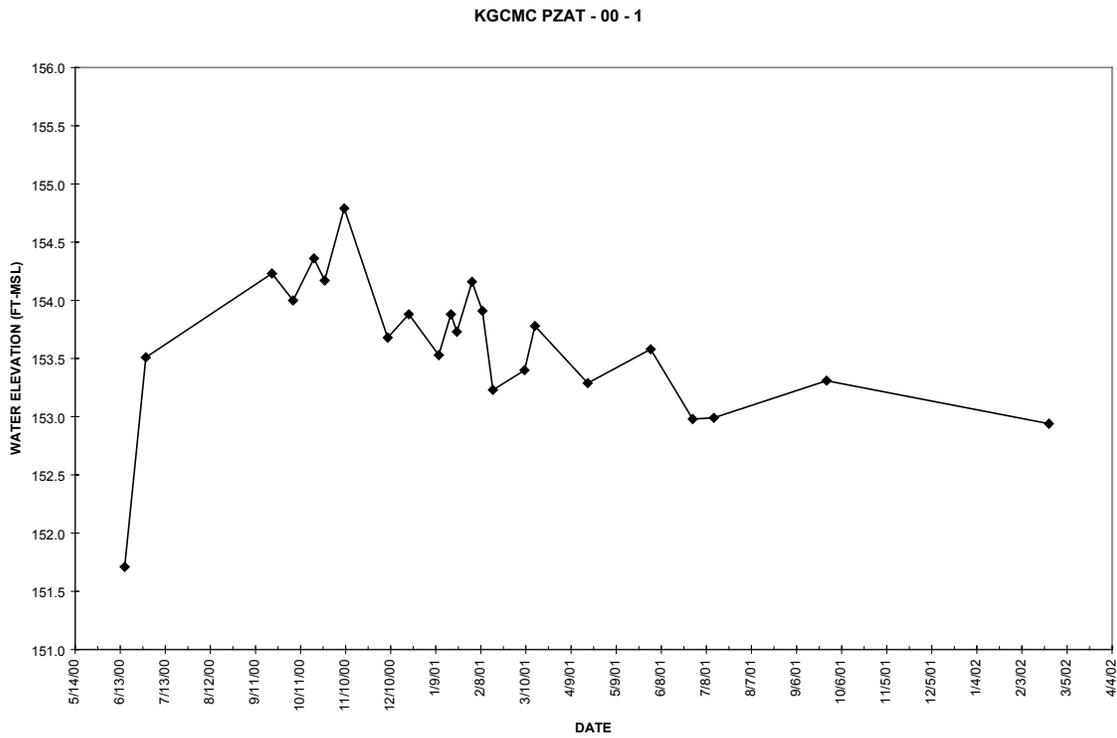


Figure 2.16 Water Level Data for Standpipe Piezometer PZ-T-00-02

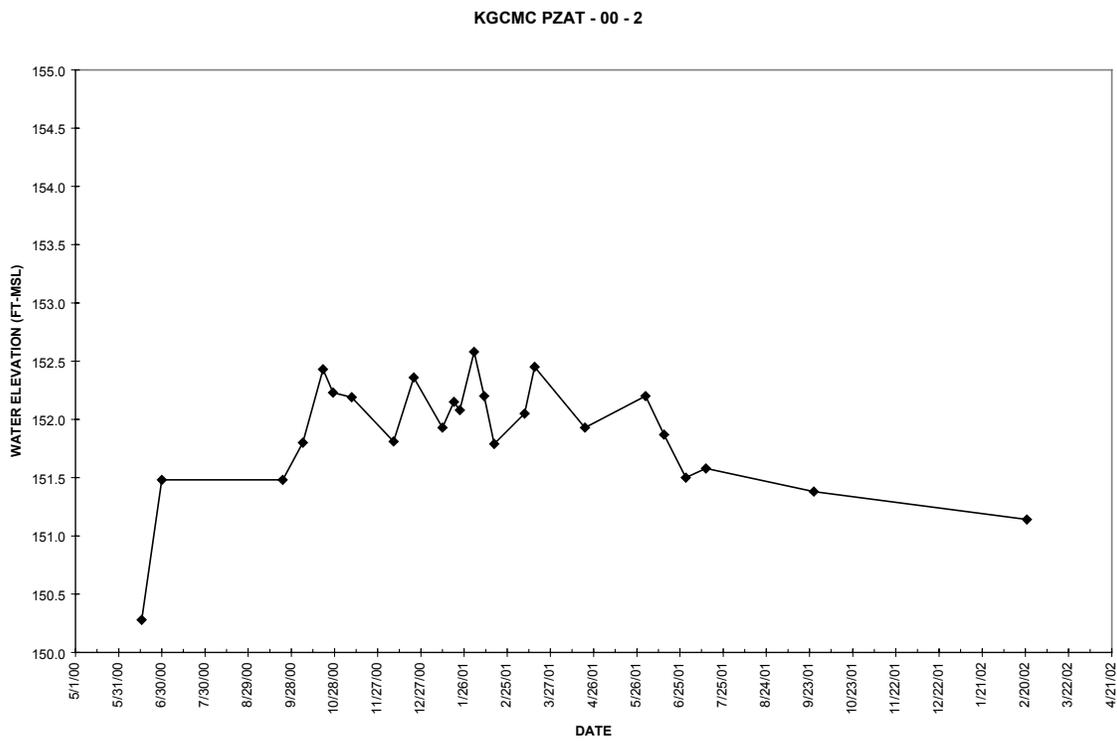


Figure 2.17 Water Level Data for Standpipe Piezometer PZ-T-00-03

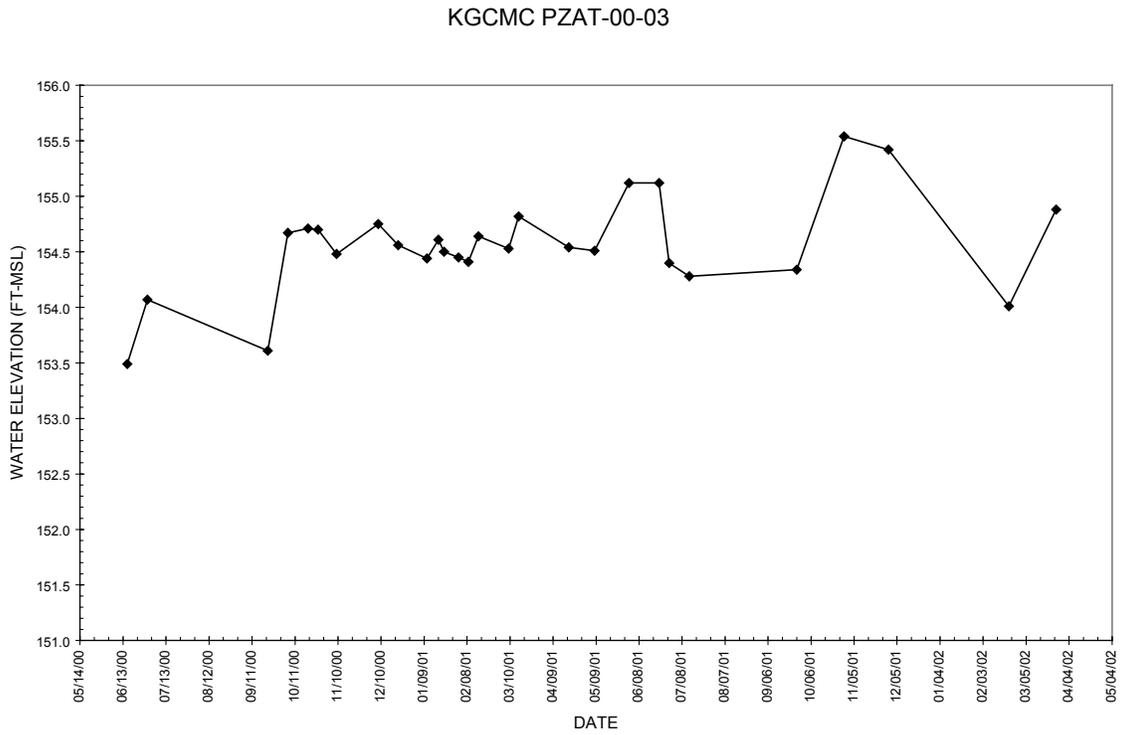


Figure 2.18 Water Level Data for Well MW-T-00-05A

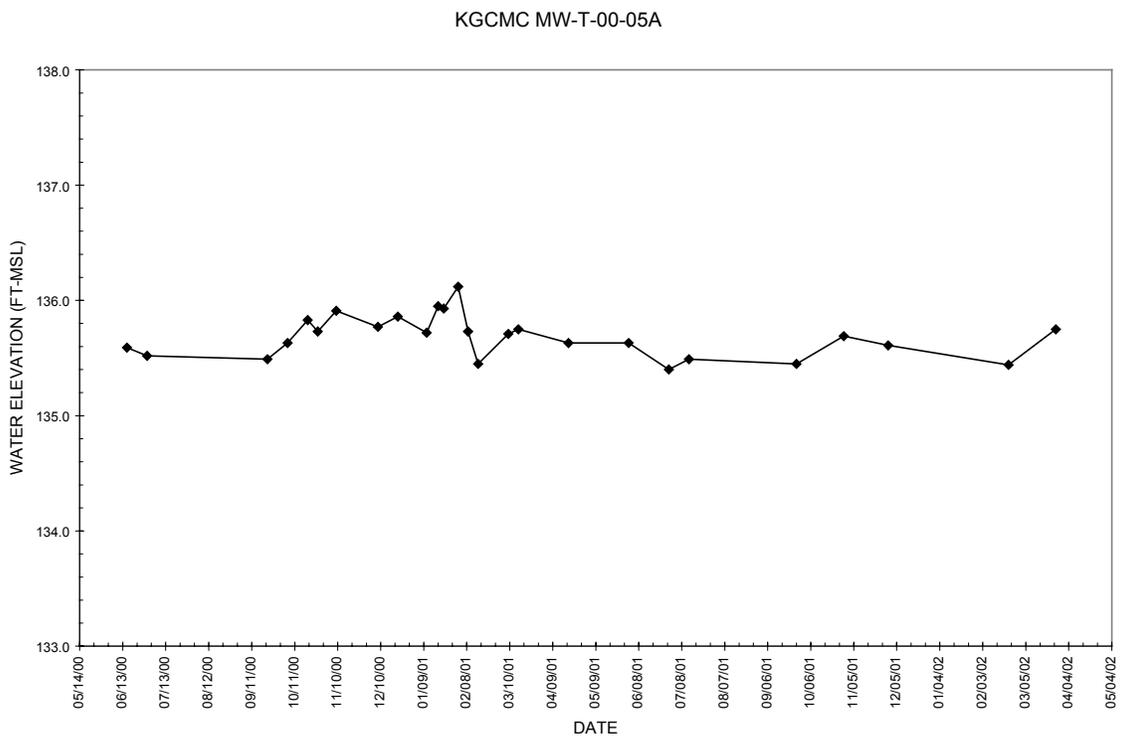




Figure 2.21 Water Level Data for Well MW-T-01-03A

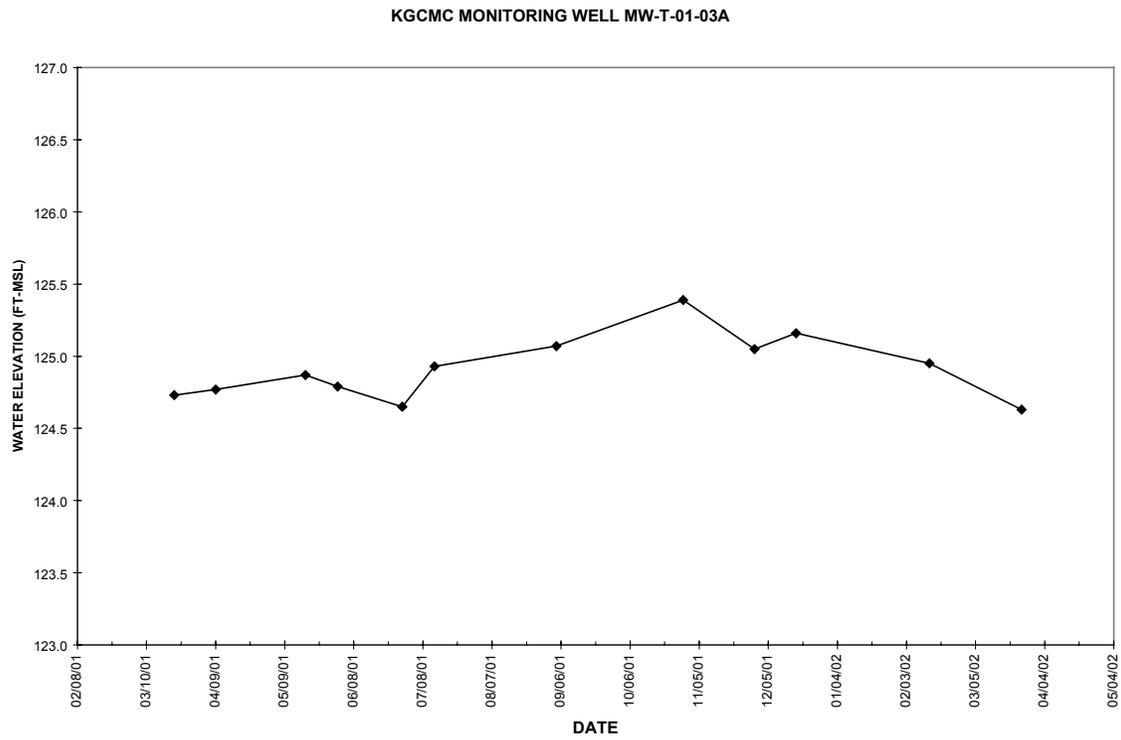
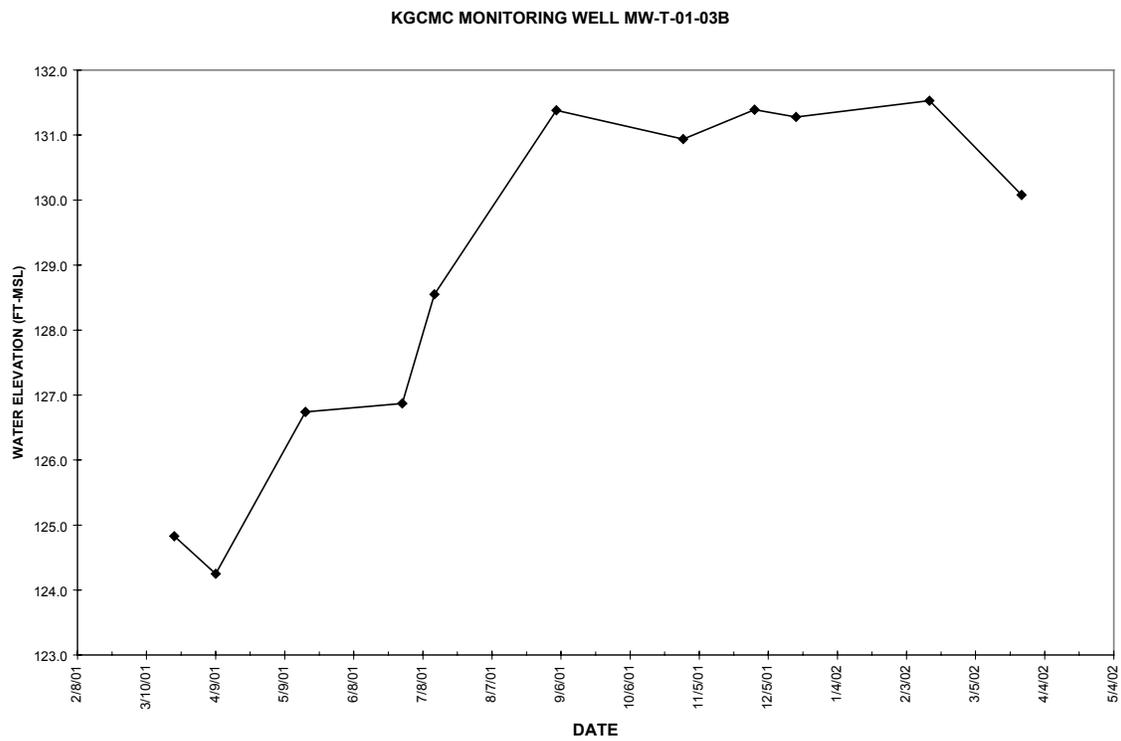


Figure 2.22 Water Level Data for Well MW-T-00-3B



## 2.4 Hydrology

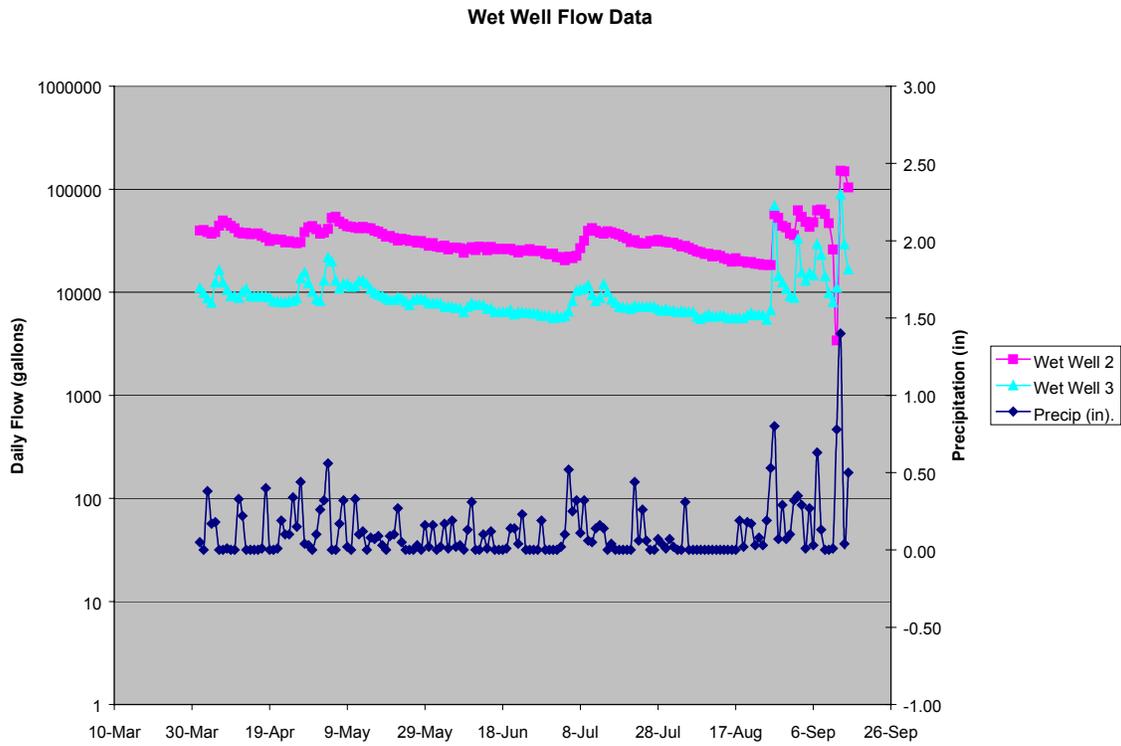
A detailed review of the hydrology of the tailings facility was performed by Environmental Design Engineering (EDE) in 2001 (EDE 2002a). The report describes the hydrogeology of the site and presents calculations of anticipated closure hydrologic conditions. Water management at the facility consists of a complex network of drains under the pile, bentonite slurry walls around the perimeter of the site, and ditches to divert upslope water and collect surface runoff. See the tailings facility as-built for locations of the site's water management components. The site is underlain by a low permeability silt/clay till and other glacial/marine deposits that minimize the potential for the downward migration of contact waters. An upward hydrologic gradient under the site further improves contact water collection.

Precipitation and temperature data are presented in Table 2.4. The wettest months were September (7.88 in) and January (5.78). June was the driest month with only 1.86 inches. Precipitation was relatively equally distributed among the other nine months of the year. Flow data from Wet Wells 1 and 2 are presented with precipitation data in Figure 2.23. The wet wells respond relatively quickly to precipitation events, suggesting a significant contribution of surface water.

Table 2.4 Monthly summary of tailings area climate data

Month	AvgTemp (°C)	Precipitation (inches)
January	2.37	5.78
February	-0.91	3.27
March	0.77	2.67
April	4.08	3.15
May	6.82	3.65
June	11.63	1.86
July	12.51	3.24
August	13.83	3.08
September	10.27	7.88
October	5.33	4.97
November	0.90	3.16
December	-1.24	3.39
2001	5.57	46.10

Figure 2.23 Tailings Area Wet Well Flow Data



## 2.5 Water Quality

### Compliance Monitoring

Water sites around the surface tailings storage facility have been monitored continuously since 1988. This sampling pre-dates the placement of tailings at this facility. The multi-agency review team led revision of the Fresh Water Monitoring Program (FWMP - Appendix 1 - General Plan of Operations) received approval from the Forest Service on 27 April 2001. At this date KGCMC was preparing for the 8<sup>th</sup> month (May) of sampling for water year 2001. Sampling on the more comprehensive, prior schedule was thus continued for continuity over the remaining 4 months (June-September) of water year 2001. Monitoring under the revised FWMP schedule and sites began with October 2001 sampling, the first month of water year 2002. The FWMP Annual Report for water year 2001 is being prepared separately, and will be submitted to the Forest Service.

The results of all FWMP sampling at the surface Tailings facility during calendar year 2001 are summarized below. These sites are now monitored twice a year, Spring and Fall. Dissolved analytical results for arsenic, copper, mercury, lead, and zinc are presented as representative constituents. Each figure presents data covering the past 5 years of sampling at each site to allow determination of trends. Analytical results below the laboratory instrument detection level are plotted as zero on the figures. All other monitored constituents from these FWMP monitoring wells remain consistent with previous years' results, and far below compliance levels.

One common thread among the data Figures, very little data apparent in 1997 and early 1998, represents an artifact of laboratory analyses and the data plotting procedure noted above. Through this period laboratory instrument capabilities and new techniques provided lower detection levels. The previously undetectable constituent levels in the monitored waters became documentable, leaving the graphs appearing to show no metals data present over the first year and a half of the five-year graphed period. In fact those historic constituent levels were just below the laboratory instrument detection levels giving laboratory results of "non-detectable". For clarity they were therefore plotted as zero on the figures as noted above. Once the constituent levels were reached by the ever-more-sensitive laboratory instruments/techniques, it became possible to document those actual data levels.

Results of compliance well monitoring around the Tailings facility are grouped logically. Results of the two shallow (peat) wells (Sites 25 & 27) south of the facility in the Tributary Creek headwater area are compared and contrasted with the prior "upgradient" shallow well (Site 31). Deep (till) wells (Sites 26 & 28) are co-located respectively with the above shallow wells. As with the shallow wells, the deep wells' data are presented together. Results for the three wells to the west of the facility are presented together. Sites 29 and 32 are shallow (Peat) wells some 50 yards apart. Site 30 is a deep (till) well co-located with the Site 29 shallow well. Waters from these wells flow to the west toward Hawk Inlet, and are chemically distinct from the southerly wells.

As the tailings pile encompassed Site 31 in 2001, it no longer represents an upgradient, comparison well, the purpose for which it served for over ten years. If possible during continuing pile development to maintain this well's integrity, it will serve as a monitoring point for future internal monitoring purposes. New FWMP sites 58 and 59 will now serve as deep and shallow upgradient wells for analytical reference monitoring.

The year 2001 sampling continues to show no evidence of contamination from the facility at the compliance points around the KGCMC surface Tailings facility. Prior analyses had shown high levels of zinc at Site 34, the Seepage Control Structure below the Pond 6 dam. These results were attributed to the disintegration of a corrugated metal standpipe in the sample pool. This rusting metal piece was removed in late 1998. Zinc levels have dropped steadily since then, returning to earlier levels, well below Alaska Water Quality Standard FWMP target level of 45.6 for surface water (Figure 2.24). As can also be seen from this figure, lead levels have remained low and stable through this period. These results help to substantiate the source of the high zinc results as not being from the tailings facility.

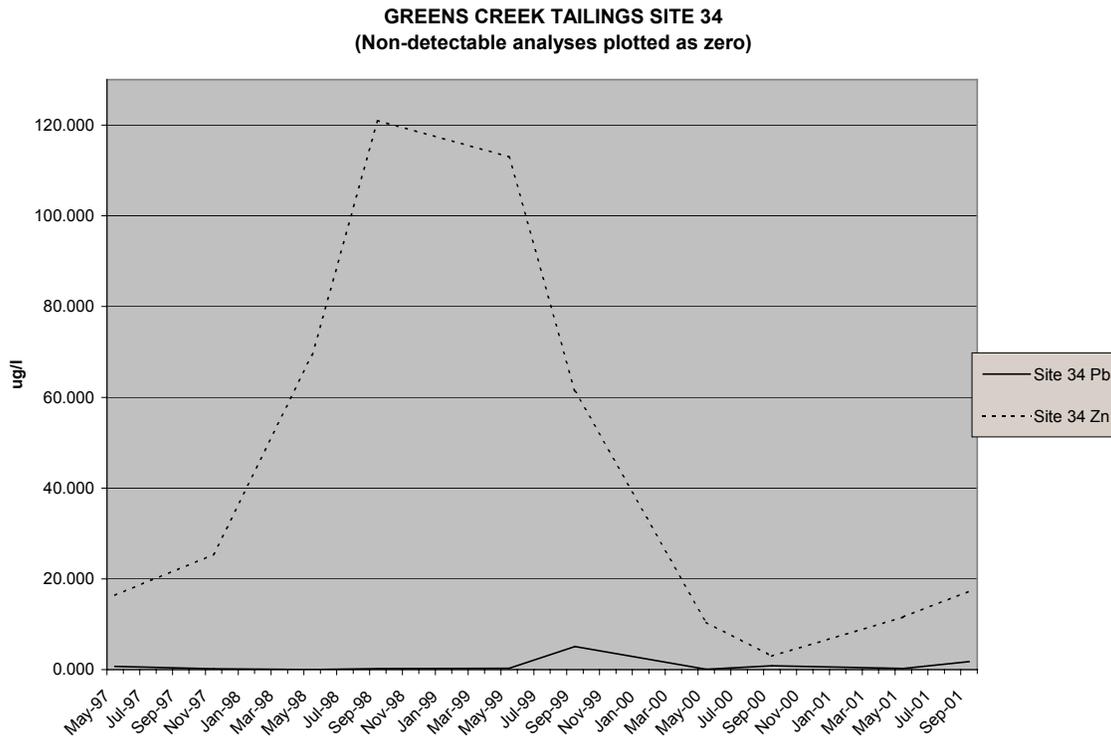


Figure 2.24 FWMP Site 34 Lead and Zinc Data

South, Shallow Wells:

Arsenic results of the downgradient wells and the upgradient well appear to interchange in a random manner over time (Figure 2.25). However the magnitude of these fluctuations are quite small, some 5 micrograms per liter. These wells' arsenic levels remain far below the Alaska Water Quality Standard FWMP target level of 50 ug/l.

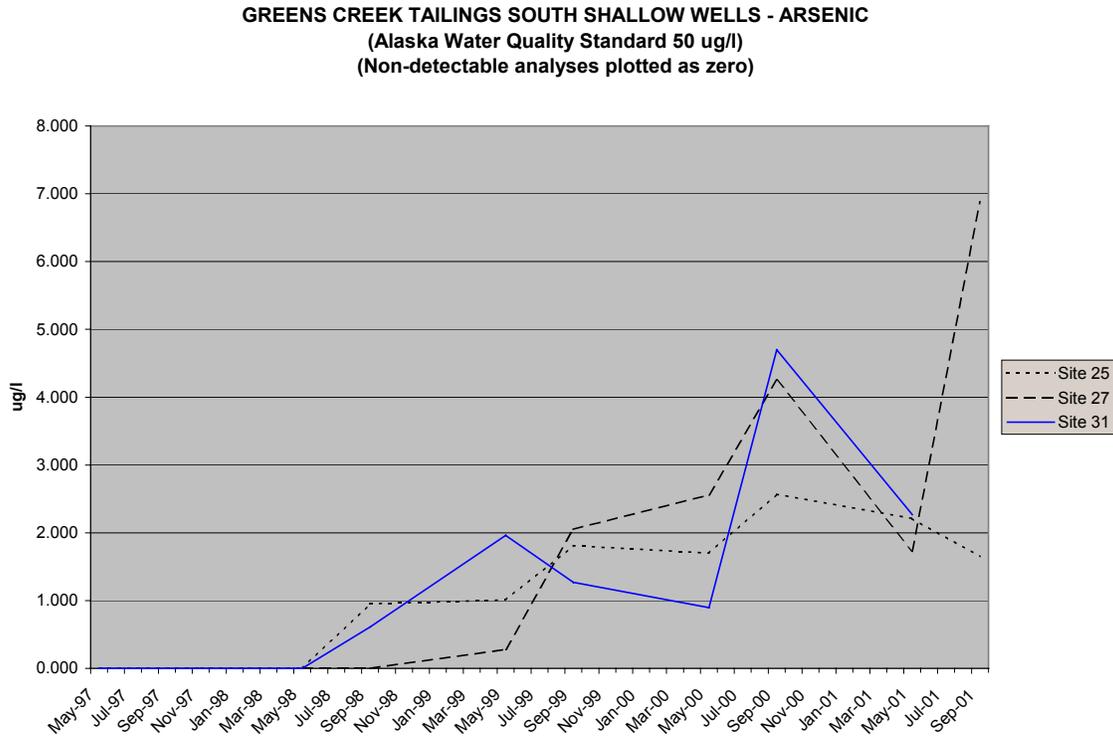


Figure 2.25 FWMP Sites 25, 27 and 31 Arsenic Data

Copper results show consistency over the 5-year period, generally fluctuating between 0.2 and 0.8 ug/l (Figure 2.26). As with arsenic, results of the up- and down-gradient wells do not present consistent comparative results. An apparent spike in September 1999 analytical results at Site 27 was followed by subsequent analyses dropping back into line with prior years' results. Site 31 shows evidence of the encroaching tailings pile with a spike of copper showing up in the Spring 2001 sample. Also as with the arsenic results, these copper results remain well below the Alaska Water Quality Standard FWMP target level of 3.6 ug/l.

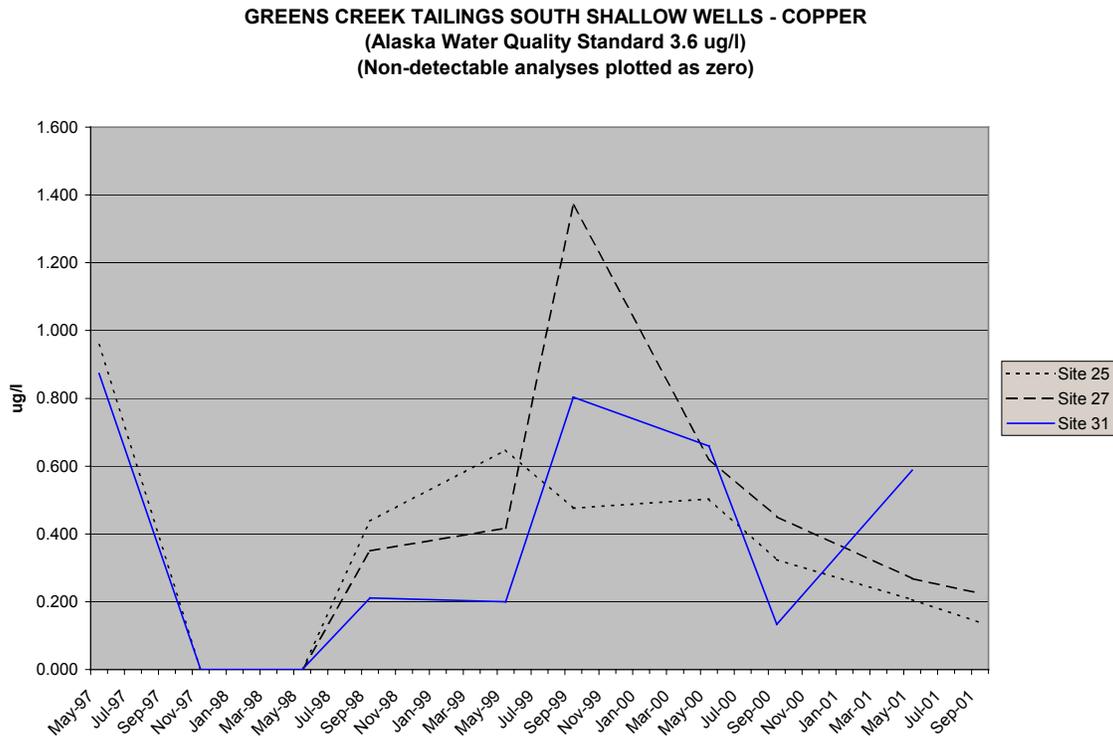


Figure 2.26 FWMP Sites 25, 27 and 31 Copper Data

Mercury results, as with the above constituents, remain far below the Alaska Water Quality Standard FWMP target level of 0.012 ug/l (Figure 2.27). For mercury however, even though the magnitude of difference is small (0.0005 to 0.003 ug/l), the upgradient well results consistently remain below the downgradient well results. The downgradient wells showed higher analytical results in late 1999 and early 2000 monitoring, but have since returned to levels below 0.0015 ug/l.

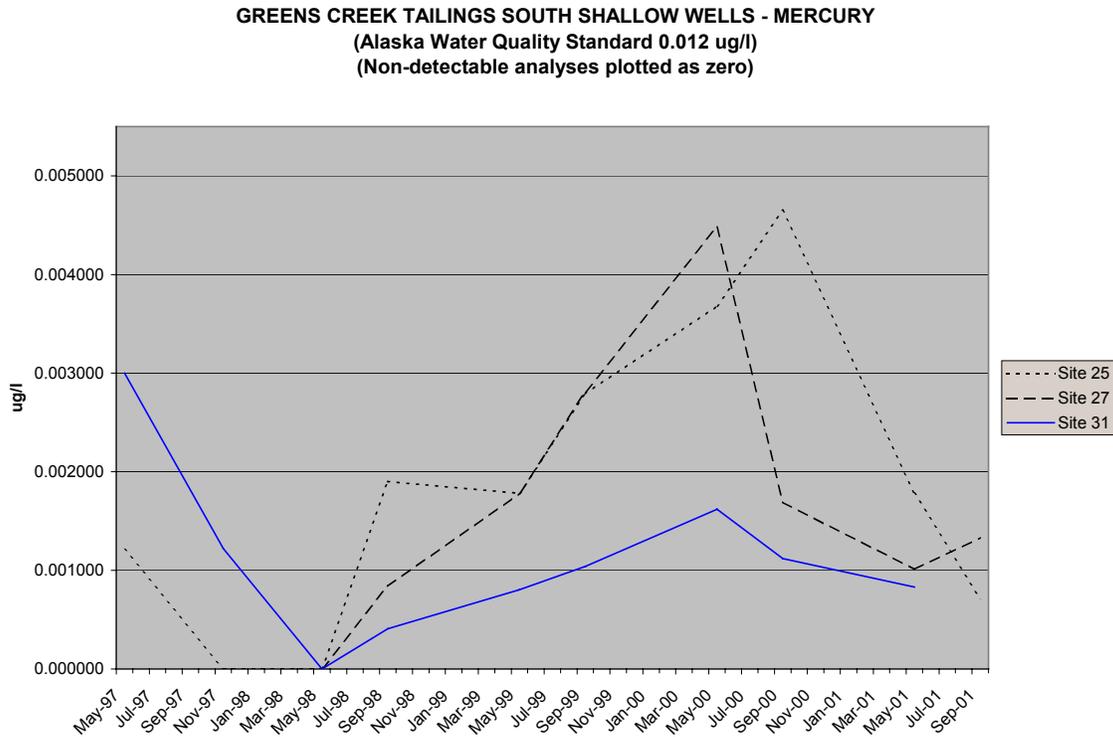


Figure 2.27 FWMP Sites 25, 27 and 31 Mercury Data

Lead results show an interesting increase at Site 27 during the Fall 2000 and Spring 2001 analyses, the furthest site from the Tailings facility (Figure 2.28). The Fall 2001 results show the level having peaked, and beginning to drop back with the other well results. As with Mercury, the upgradient well results consistently remain below the downgradient well results. Both Southern shallow wells' lead analytical results have generally been above the Alaska Water Quality Standard FWMP target level of 0.54 ug/l. Site 31 analytical lead results remain stable and well below the Alaska Water Quality Standard FWMP target level of 0.54 ug/l.

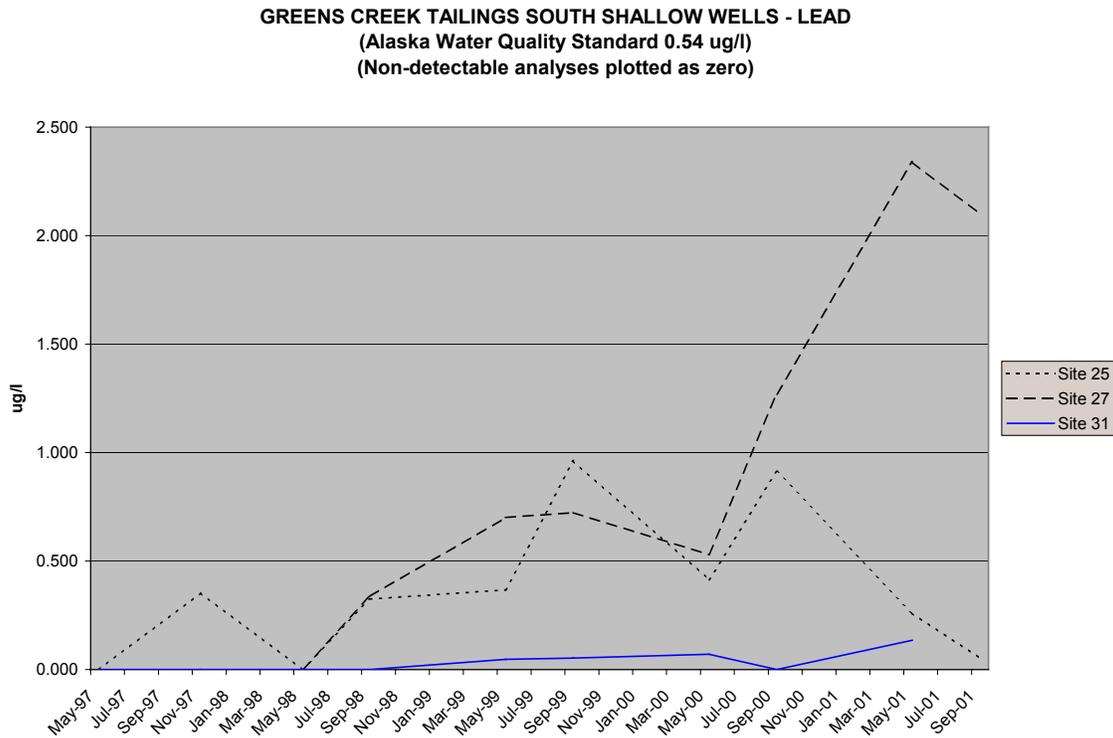


Figure 2.28 FWMP Sites 25, 27 and 31 Lead Data

Zinc results also show consistent, or explainable analytical results (Figure 2.29). The upgradient well results generally remain lower than the downgradient well results. As with the copper analytical results, zinc shows a response to the encroaching tailings pile expansion to the east with a Spring 2001 analytical result increase appearing at Site 31. The Fall 1998 zinc result from Site 25 has proven to be anomalous, with the subsequent years' results showing consistent low levels. Undoubtedly this result was an artifact of the previous pumping method, a method changed in the above referenced FWMP revision. For zinc, as with the above constituents, analytical results remain well below the Alaska Water Quality Standard FWMP target level of 32.7 ug/l.

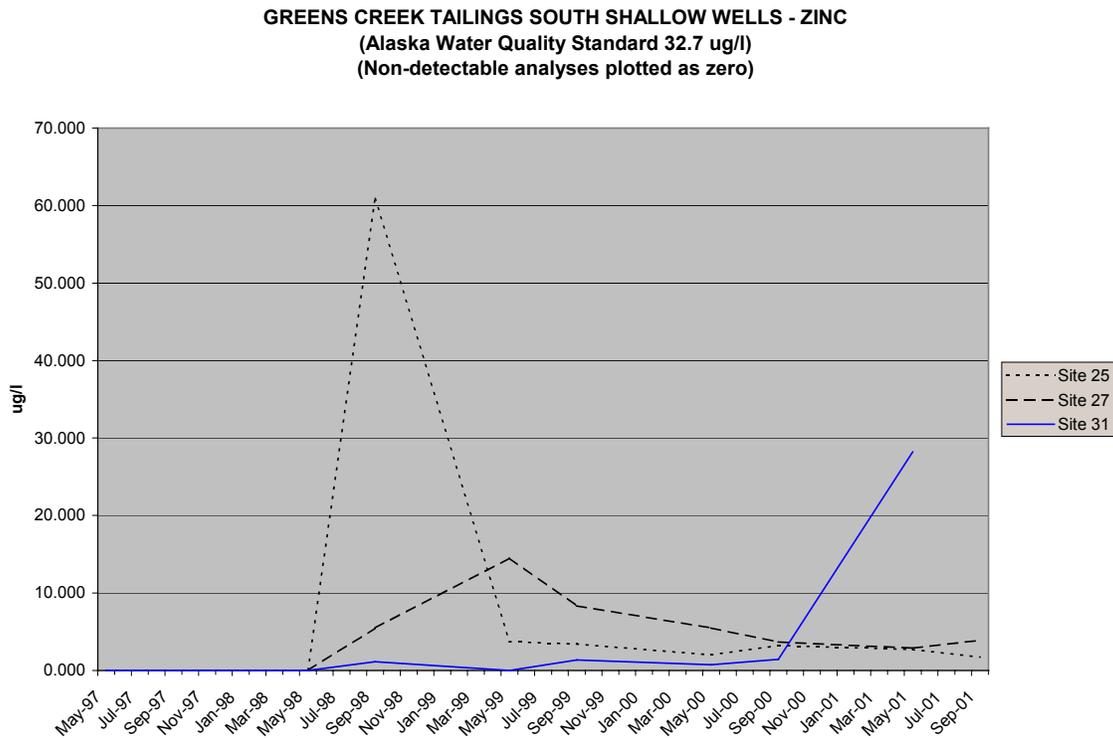


Figure 2.29 FWMP Sites 25, 27 and 31 Zinc Data

South, Deep Wells:

Arsenic analytical levels in the Southern deep wells are distinctly different than those in the co-located shallow aquifer wells, averaging some 20 times greater analytical results (Figure 2.30). However, these sites' analytical results have remained consistent, and relatively stable throughout the over ten years of monitoring. The site closer to the Tailings facility generally has produced the lower analytic result. Arsenic analytical results for the Southern deep wells remain well above the Alaska Water Quality Standard FWMP target level of 50 ug/l.

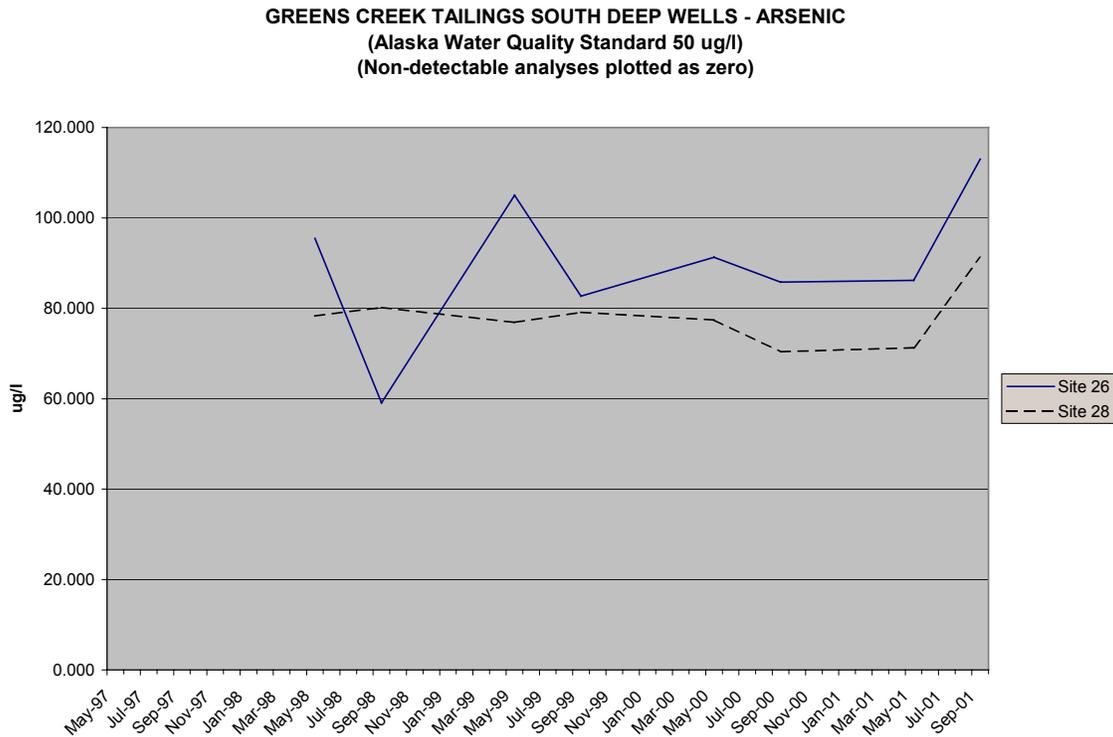


Figure 2.30 FWMP Sites 26 and 28 Arsenic Data

Copper results for the Southern deep wells show a different comparative result from their arsenic results (Figure 2.31). That is, one well (Site 28) consistently produces results similar to the co-located shallow wells. Conversely, Site 26 has traditionally produced copper levels some ten times higher than the co-located shallow wells. Over the last two years' monitoring Site 26 copper analytical results have been dropping down into the range of these other three wells' results. Since 1998 all copper analytical results for these Southern deep wells have been well below the Alaska Water Quality Standard FWMP target level of 3.6 ug/l.

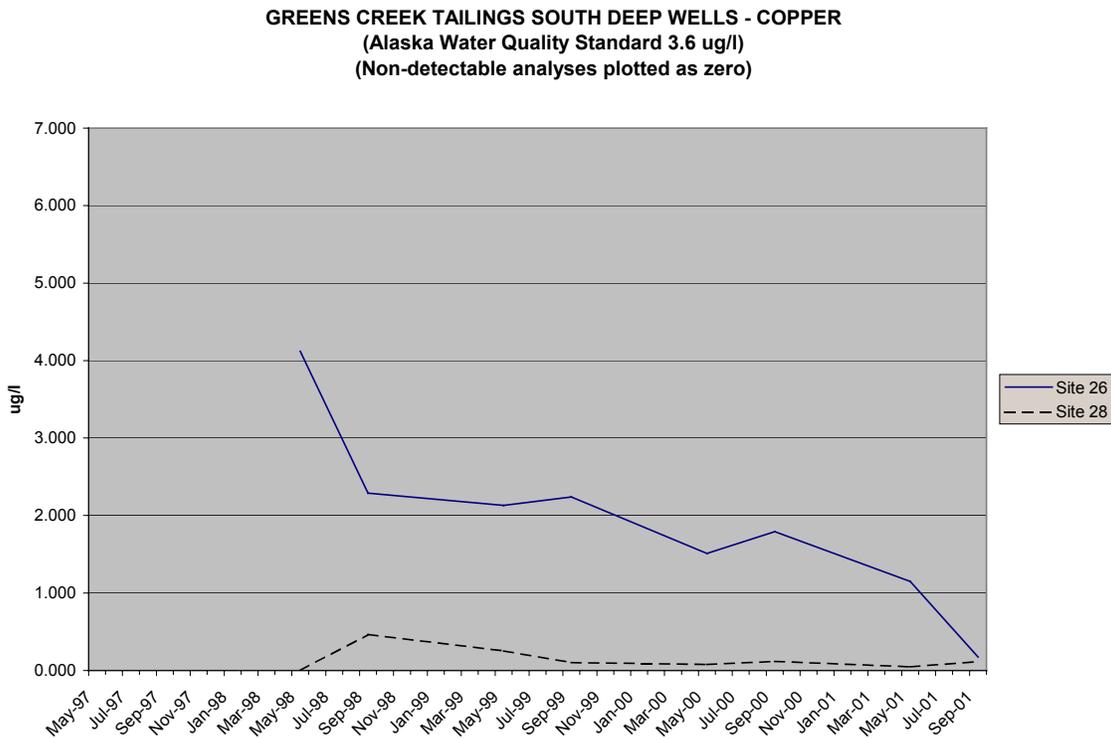


Figure 2.31 FWMP Sites 26 and 28 Copper Data

Mercury results for the Southern deep wells remain generally below the co-located shallow well's results (Figure 2.32). All southern well's mercury analytical results remain stable and well below the Alaska Water Quality Standard FWMP target level of 0.012 ug/l.

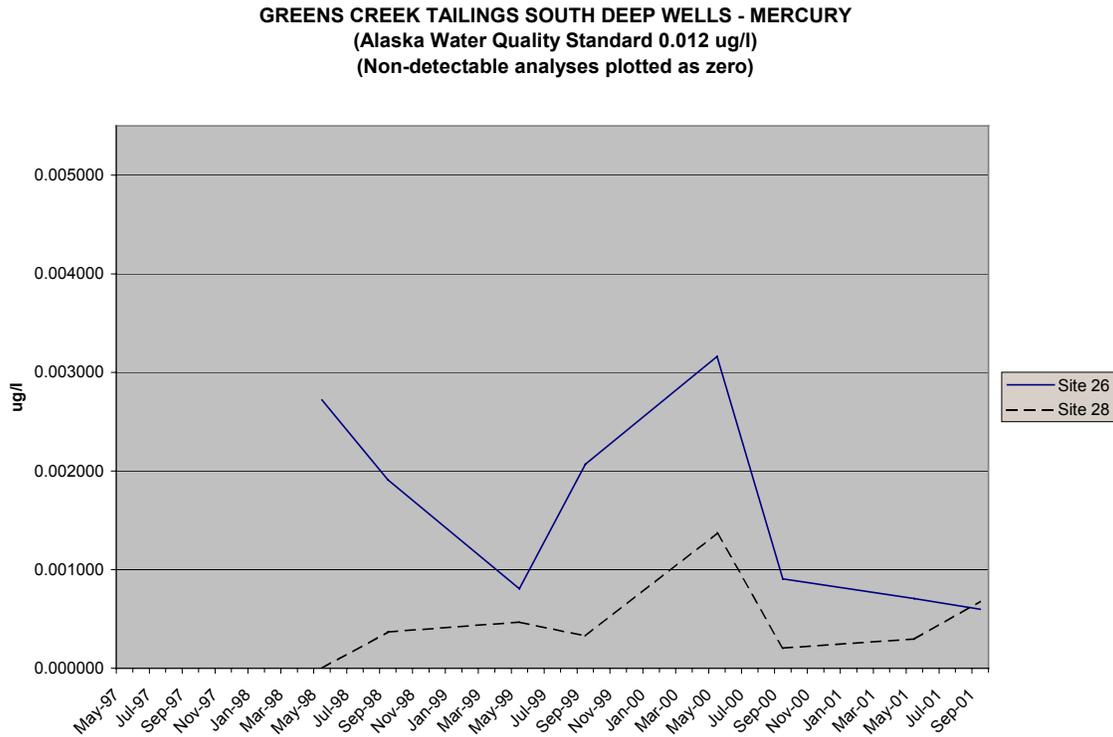


Figure 2.32 FWMP Sites 26 and 28 Mercury Data

Lead results for the Southern deep wells show disparity between their comparisons to the shallow co-located well results (Figure 2.33). As with the copper results, Site 26 has produced analytical results consistently above the shallow wells, but demonstrating a steady decline over time. Conversely, Site 28 has produced analytical results consistently below the shallow wells, generally still below the laboratory detection levels. Both Southern deep wells have recently produce results below the Alaska Water Quality Standard FWMP target level of 0.012 ug/l.

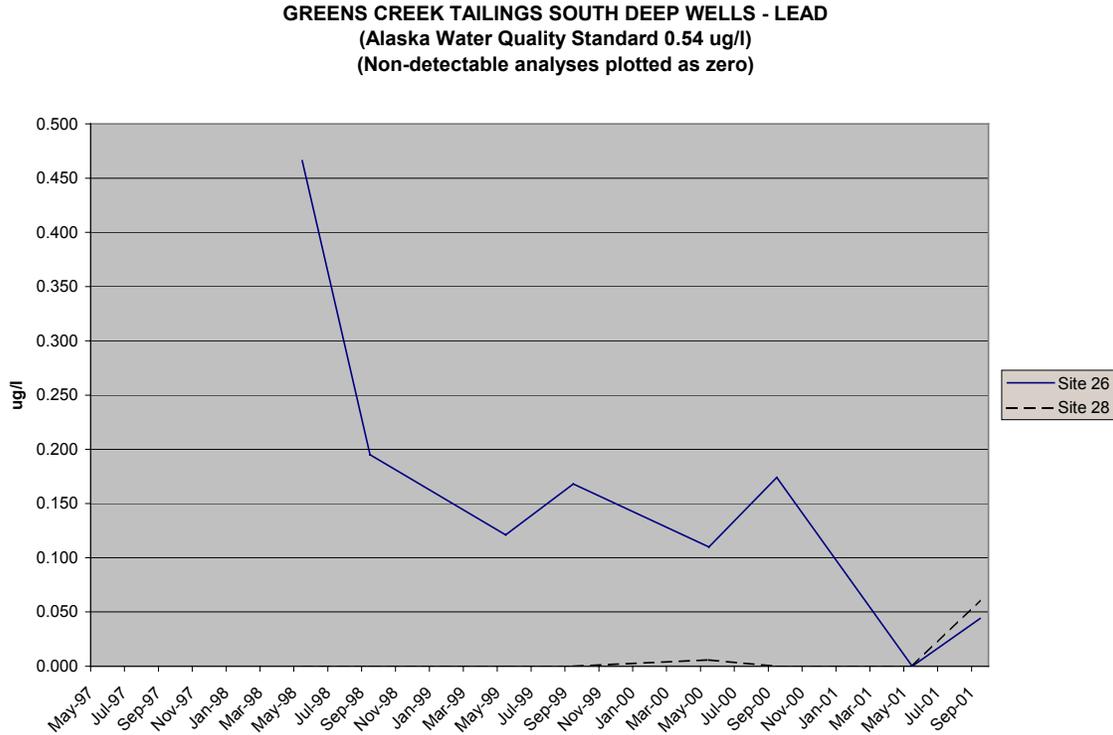


Figure 2.33 FWMP Sites 26 and 28 Lead Data

Zinc results for the Southern deep wells generally track with their co-located shallow wells' analytical results (Figure 2.34). All southern wells' zinc analytical results remain stable and well below the Alaska Water Quality Standard FWMP target level of 32.7 ug/l.

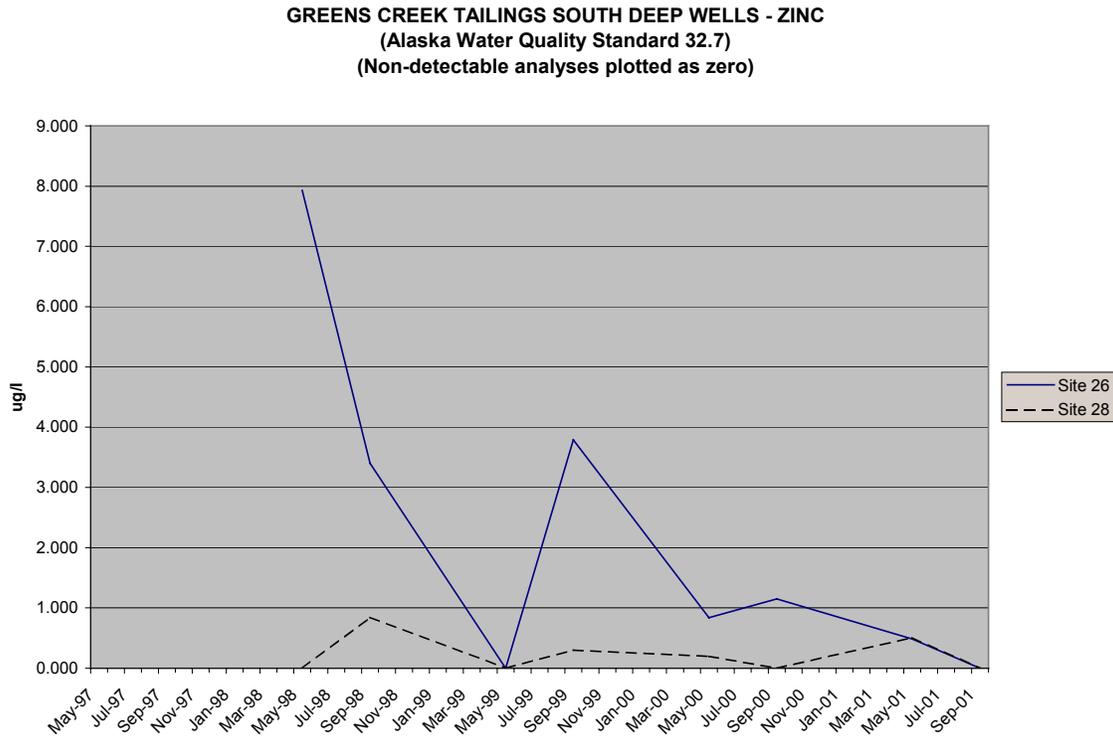


Figure 2.34 FWMP Sites 26 and 28 Zinc Data

West Wells;

The wells to the West of the surface Tailings facility show characteristically different water analytical results than those downgradient to the south within the upper Tributary Creek drainage. This data presentation grouping is composed of three wells; Site 29 and 30 are co-located shallow and deep wells respectively. Site 32 is a separate, additional shallow well some 50 yards south of the co-located pair.

Arsenic results for these three West wells show three distinct and relatively stable sets of analyses (Figure 2.35). The two shallow wells show the highest and lowest results while the deep well results consistently falls between. While Site 29 remains below the Alaska Water Quality Standard FWMP target level of 50 ug/l, it has traditionally fluctuated in the 30-40 ug/l range. Sites 30 and 32 analytical results remain stable and well below that Alaska Water Quality Standard FWMP target level of 50 ug/l.

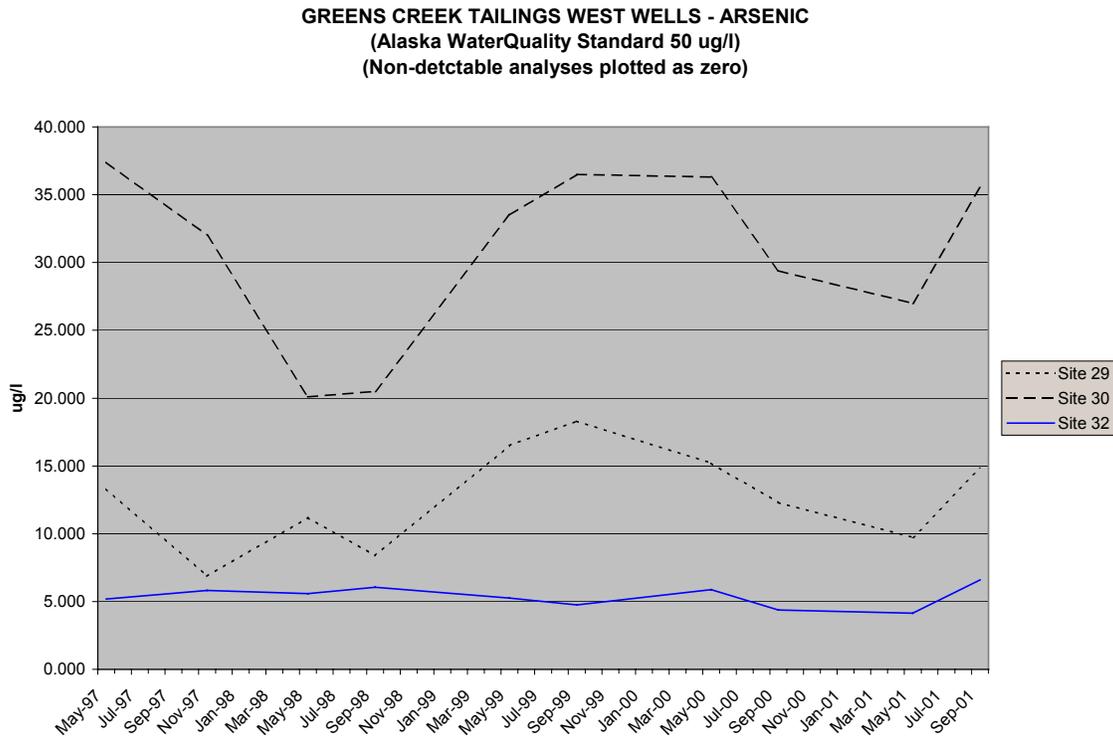


Figure 2.35 FWMP Sites 29, 30 and 32 Arsenic Data

Copper results for the West wells show fluctuating analytical results (Figure 2.36). Site 32 generally produces highest analytical results while the other shallow well (Site 29) results are generally the lowest copper levels. The West wells' copper analytical results tend to mimic the Southern shallow well results, that is fluctuating at or below 1 ug/l. All West wells' copper analytical results remain well below the Alaska Water Quality Standard FWMP target level of 3.6 ug/l.

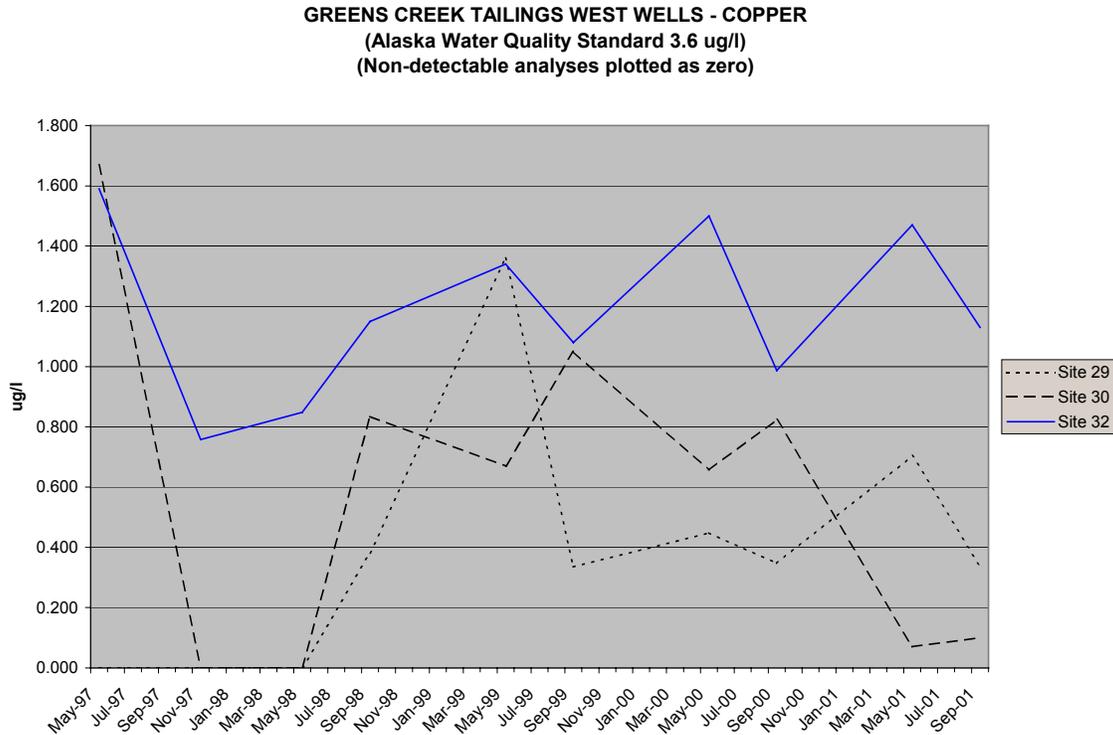


Figure 2.36 FWMP Sites 29, 30 and 32 Copper Data

Mercury results for the West wells show the deep well (Site 32) generally producing the highest analytical results (Figure 2.37). However, as with the Southern shallow and deep wells, the West well mercury analytical results predominantly remain below 0.003 ug/l, well below the Alaska Water Quality Standard FWMP target level of 0.012 ug/l.

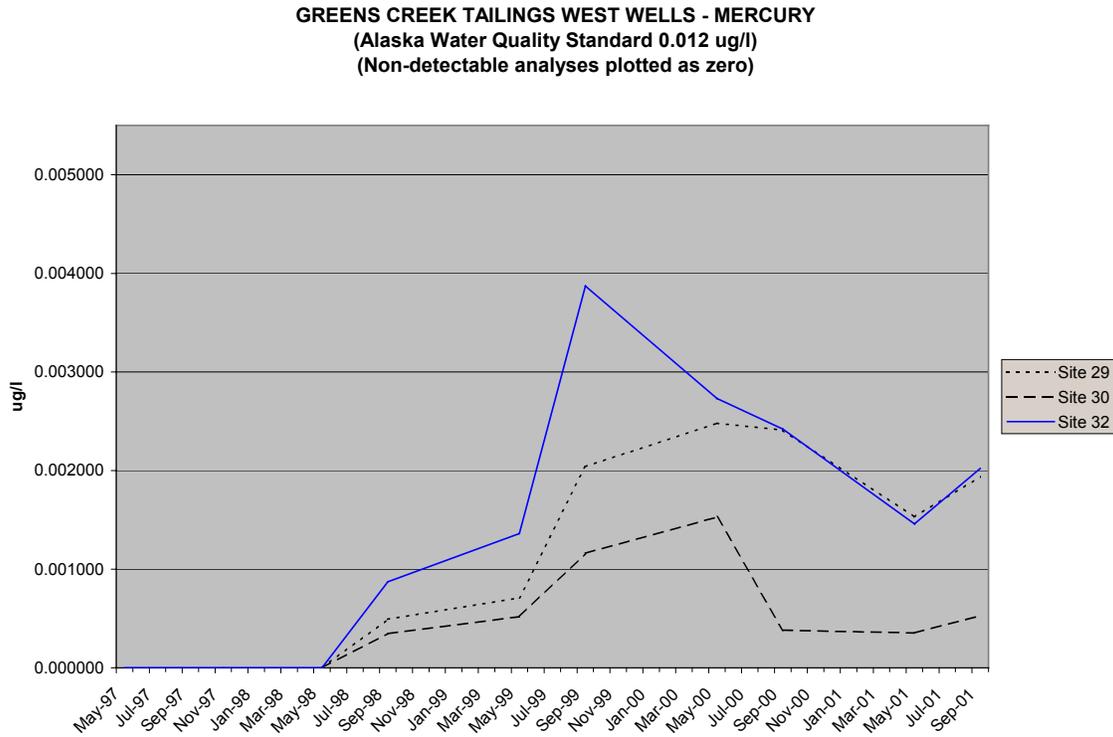


Figure 2.37 FWMP Sites 29, 30 and 32 Mercury Data

Lead results for the West wells show differing comparative results (Figure 2.38). The West co-located wells (Sites 29 & 30) show very stable analytical lead results with the deep well (Site 30) consistently producing the lower results, below the Alaska Water Quality Standard FWMP target level of 0.54 ug/l. However, Site 29 analytical lead levels although stable, remain consistently above the Alaska Water Quality Standard FWMP target level of 0.54 ug/l. The separate shallow well (Site 32) analytical results fluctuate dramatically and produce higher lead results than the other two West wells, also consistently above the Alaska Water Quality Standard FWMP target level of 0.54 ug/l. The Site 32 analytical results are comparable to the Southern deep well Site 26.

**GREENS CREEK TAILINGS WEST WELLS - LEAD**  
 (Alaska Water Quality Standard 0.54 ug/l)  
 (Non-detectable analyses plotted as zero)

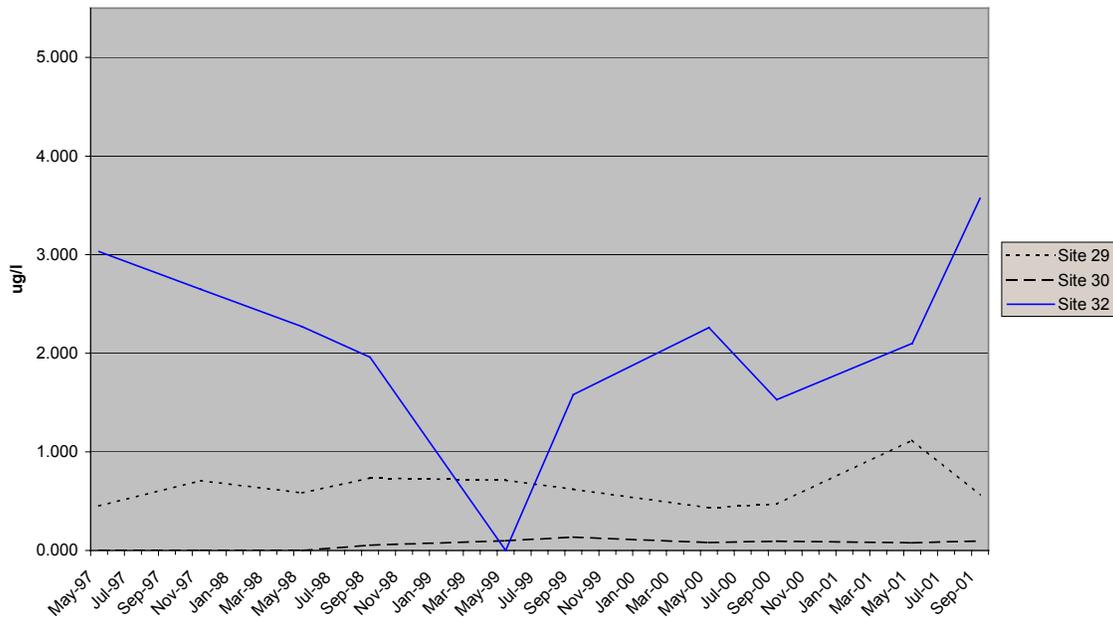


Figure 2.38 FWMP Sites 29, 30 and 32 Lead Data

Zinc results for the West wells show very consistent analytical results over the course of the past three and one-half years (Figure 2.39). The two co-located West wells (Sites 29 & 30) produce the lowest results, with the deep well (Site 30) consistently producing the lowest zinc analytical results. The separate West shallow well (Site 32) consistently has produced the higher zinc analytical result for this three-well grouping. The anomalous 1997-8 high zinc levels found from Site 29 have since stabilized back to levels between the other two West wells. The 1997-8 analytical results for Site 29 are likely a result of the pumping technique of that time producing excessive sediments. Over the past three and one-half years all of the West well zinc analytical results remain well below the Alaska Water Quality Standard FWMP target level of 32.7 ug/l.

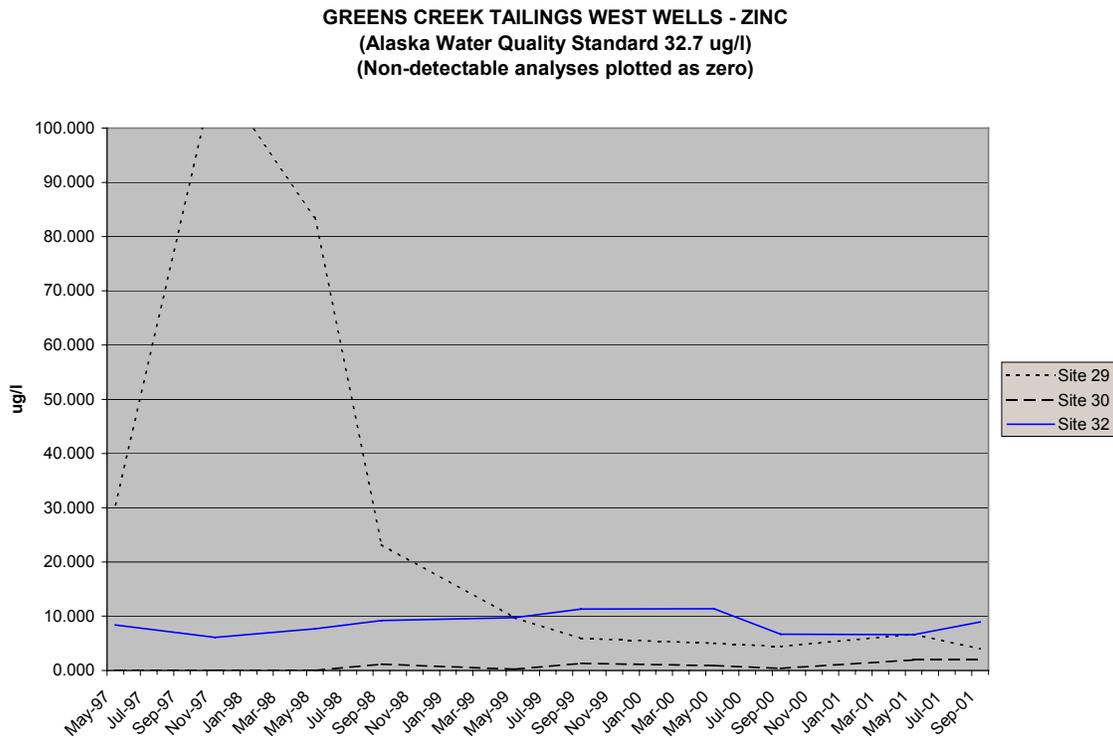


Figure 2.39 FWMP Sites 29, 30 and 32 Zinc Data

### Internal Monitoring

On 31 May 2001 Kennecott Greens Creek Mining Company (KGCMC) submitted an Internal Monitoring Plan to the Alaska Department of Environmental Quality – Solid Waste Management Program. This submittal satisfied Section 2.8.3.1 of the KGCMC Solid Waste Permit Number 9911-BA006.

As described in permit Section 2.8.3.1, the internal plan addressed monitoring at both the surface tailings facility and the surface production rock storage areas covered by the permit. The Internal Monitoring Plan describes monitoring within the pile areas, in contrast to the compliance monitoring (under the Fresh Water Monitoring Plan) at peripheral facility boundary sites. As such, data generated by the Internal Monitoring Plan effort are "... not for compliance purposes..." as noted in the above referenced permit Section 2.8.3.1.

While the Internal Monitoring Plan sets minimal monitoring standards, KGCMC generally conducts additional monitoring over and above those requirements. As the opportunity arises, or the need is seen, such additional sampling may include sampling of different media, more frequent samples from the monitoring plan-specified locations, or perhaps analyses of samples for additional constituents. Instances also arise where sampling of different locations/sites is conducted. While not required to present these additional data, KGCMC has chosen to generally include much of such extra data in this report as it is felt to help better understand conditions at the permitted areas. Collection of these extra data may or may not continue, based upon changing conditions and/or need of KGCMC.

The results of KGCMC's internal site monitoring plan are summarized in Figures 2.40 to 2.45. Figure 2.40 shows the pH of waters collected from Wet Well 2, Wet Well 3, MW-T-B2, and MW-4 (see as-built in Appendix 1 for locations). An in-depth evaluation of the hydrology and geochemistry of the tailings facility was performed by Environmental Design Engineering (EDE) and KGCMC in 2001 (EDE 2002a, EDE 2002b, KGCMC 2002). The observations made under the internal monitoring plan are consistent with the findings of the EDE and KGCMC reports.

All internal monitoring waters are captured and treated prior to discharge to the ocean floor under KGCMC's National Pollutant Discharge Elimination System Permit (AK 004320-6).

Values of pH were between 6 and 8 for all internal monitoring site samples in 2001. MW-T-B2, which screens the lower ten feet of tailings in the oldest portion of the pile, has the highest pH of the four internal monitoring sites. This is likely a result of microbial sulfate reduction and equilibration with carbonate in the saturated zone of the pile. The wet wells and MW-4 produce water with slightly lower pH (generally between 6.5 and 7), reflecting minor influences from groundwater (organic acids) and oxidized surface waters (acidity from thiosalt, sulfide and iron oxidation). The fact that these internal waters are near-neutral to alkaline indicates that the buffering capacity of the tailings is sufficient to prevent acidification of site drainage in the near-term (tens of years).

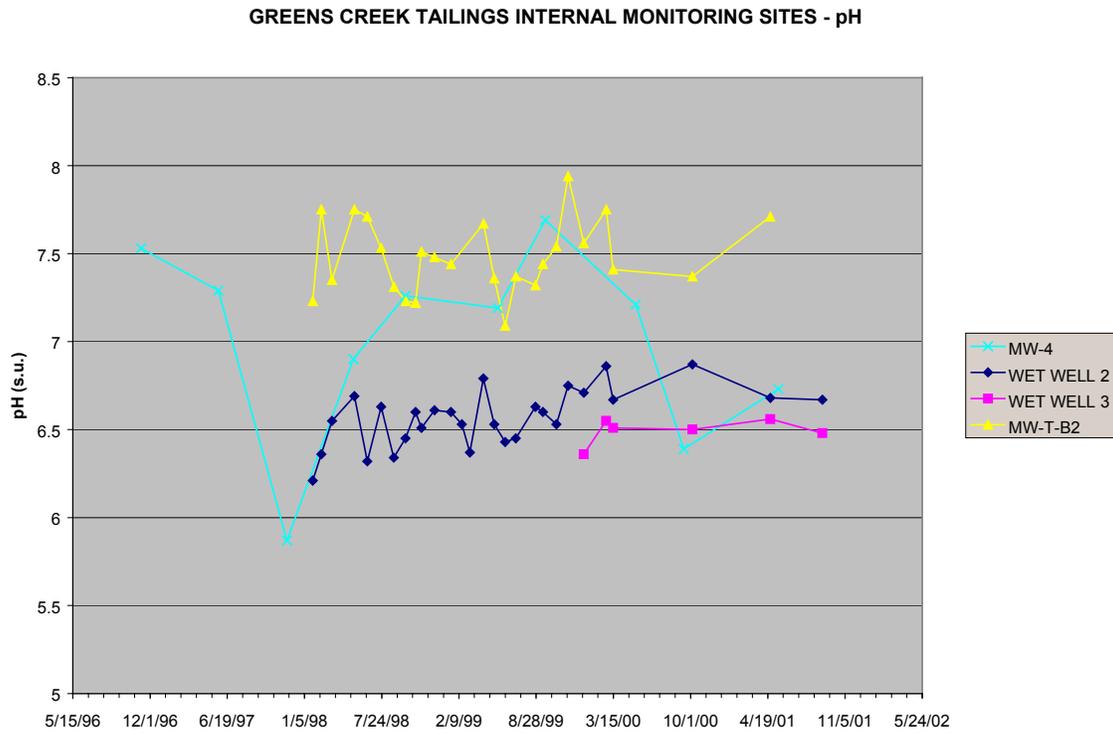


Figure 2.40 Tailings Area Internal Monitoring Plan Sites - pH Data

The conductivity results from internal monitoring site waters are presented in Figure 2.41. 2001 conductivity measurements are between 1000 and 3500 uS/cm. MW-4 (previously FWMP Site 31) is completed in the shallow sand beneath the East Tailings placement area and shows the lowest conductivity. This likely reflects a larger contribution from groundwater relative to tailings contact water than in the other monitoring sites. The significant increase in conductivity in MW-4 that occurred in 2000 is the result of advancement of the tailings pile over the well's capture area. This was an anticipated response and does not reflect a failure of the site's water collection system. The silt/clay till layer that serves as a natural liner beneath the tailings pile underlies the peat and sand that the well samples.

The higher conductivity of the site contact waters reflects a larger dissolved load caused by weathering of the tailings. Pyrite oxidation and carbonate dissolution contribute dissolved ions such as sulfate, bicarbonate, calcium and magnesium to the contact waters, increasing their conductivity. Wet Well 2 generally has a lower conductivity than MW-T-B2 because it has a greater contribution from groundwater. However, both waters show similar responses to seasonal loading/flushing cycles. Wet Well 3 has a different capture area and shows a different pattern with respect to conductivity. The changes in conductivity observed in Wet Well 3 probably reflect changes in the relative contributions from runoff, infiltration and groundwater as the West Buttress was constructed.

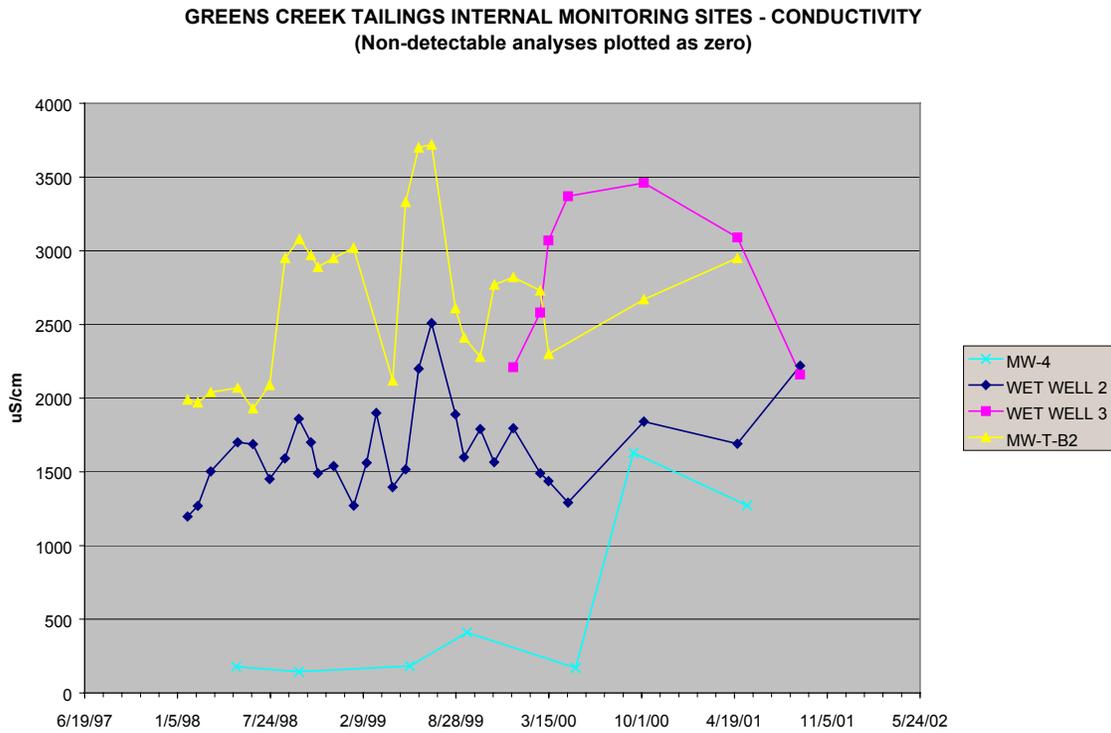


Figure 2.41 Tailings Area Internal Monitoring Plan Sites – Conductivity Data

Arsenic data are presented in Figure 2.42. The data for Wet Well 2 (and other sites to a lesser extent) show a distinct increasing trend. The data for MW-T-B2 appears to be cyclical. As arsenic-bearing minerals such as arsenopyrite and tetrahedrite/tennantite weather, the arsenic that is produced is typically co-precipitated with iron oxy-hydroxides. As the pile grows, reducing conditions overtake areas that were once oxidizing. This was particularly true as the water table rose following removal of the temporary PVC cover that was placed on the pile in 1995 (removal began in 1997). Dissolution of oxyhydroxides (and possibly sulfates) should occur as the waters respond to the changing redox conditions. This will contribute arsenic (and iron) to the drainage water. Arsenic concentrations in the drainage will decrease when redox conditions in the pile stabilize.

Figure 2.43 shows the concentration of zinc in the four internal monitoring sites. Zinc levels remained relatively constant in 2001. The initially high zinc concentrations in Wet Well 3 in 1999-2000 were a result of flushing of argillite used in the early construction of the West Buttress. The wet well system also received a greater component of zinc-bearing runoff during early stages of development. The low concentration of zinc in MW-T-B2 is caused by sulfate reduction, which promotes zinc sulfide precipitation. The same processes may be keeping the zinc concentrations in MW-4 low as well, despite the fact that the conductivity of the water in the shallow sand has increased with the construction of East Tailings. In contrast, the wet wells receive a significant component of oxidized near-surface water that has higher zinc concentrations.

The concentrations of lead and copper are considerably lower than that of zinc. In 2001 the concentration of both metals is less than 5 ppb in water from each site (Figures 2.44 and 2.45).

Copper and lead loading is considerably reduced relative to samples taken in 1998 and 1999, indicating that the mobility of metals is greatest when the tailings are first placed but decreases with time.

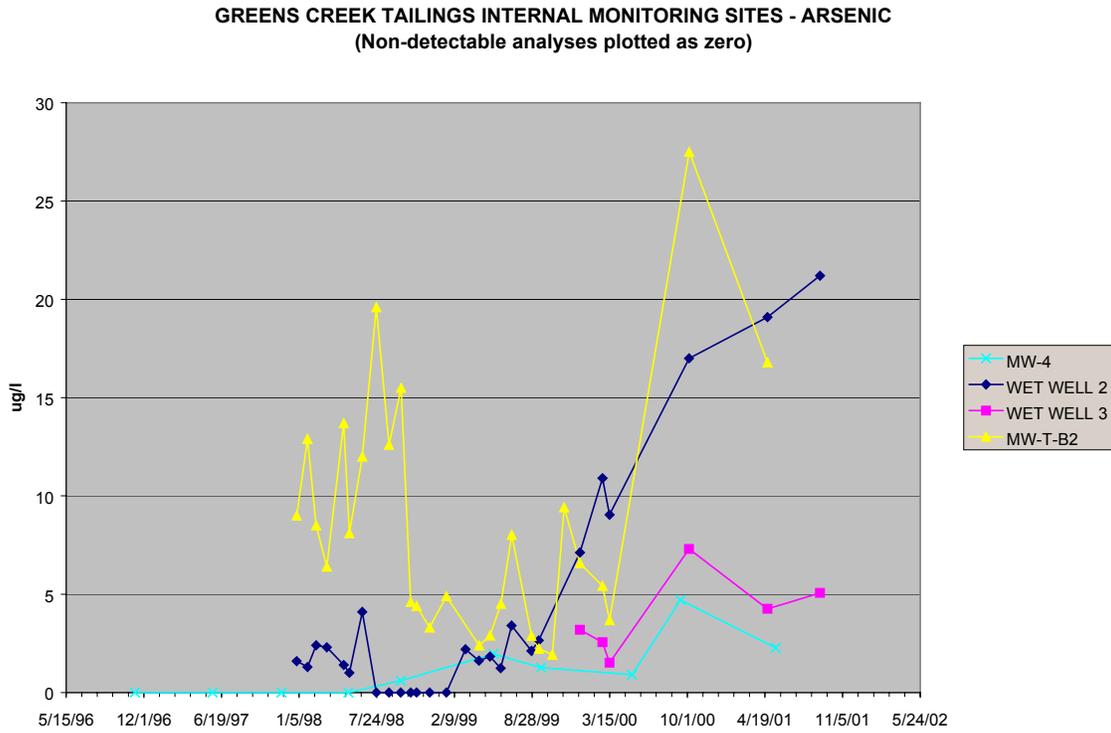


Figure 2.42 Tailings Area Internal Monitoring Plan Sites – Arsenic Data

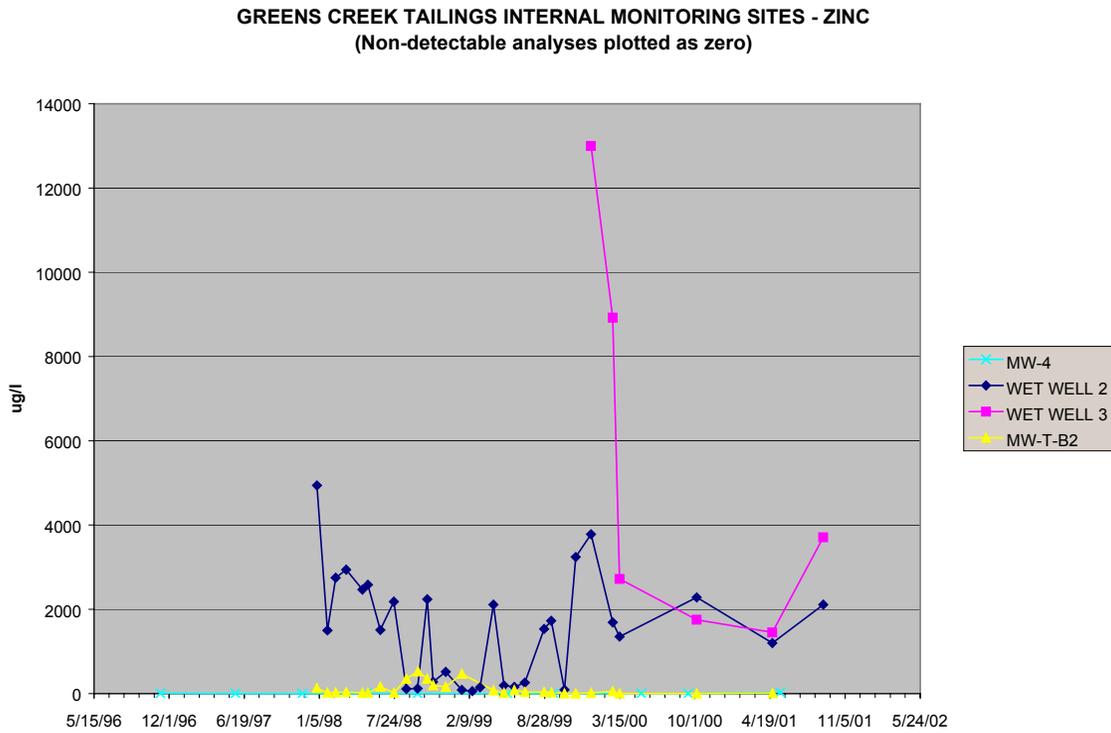


Figure 2.43 Tailings Area Internal Monitoring Plan Sites – Zinc Data

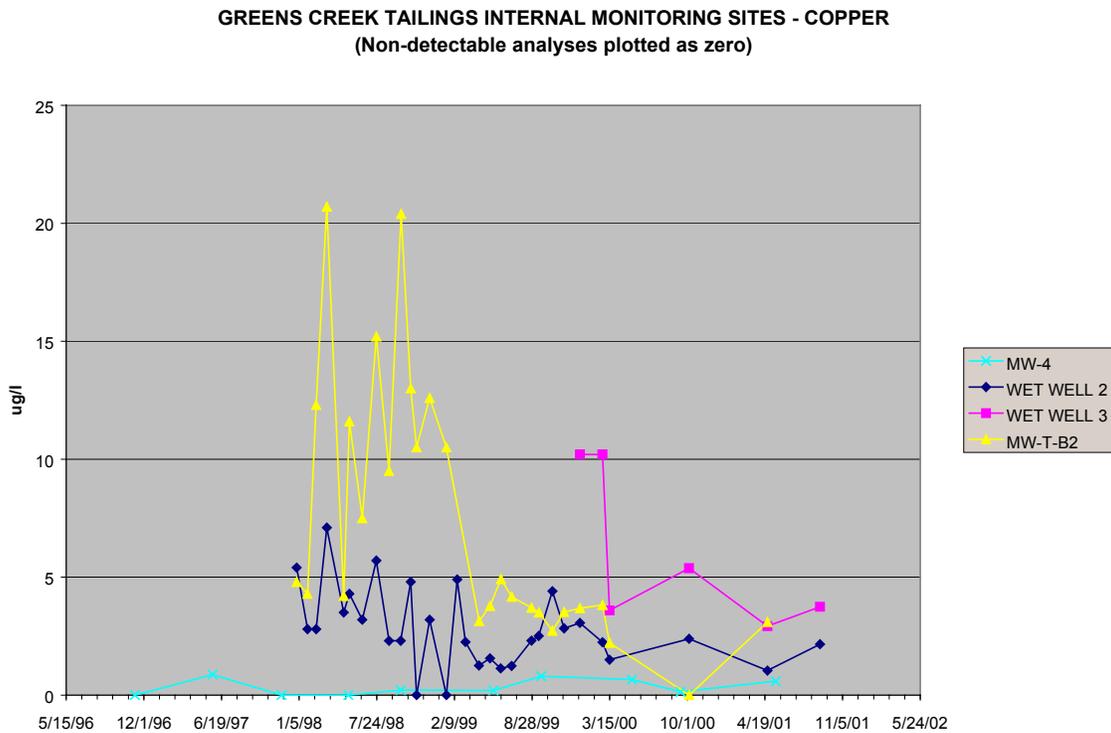


Figure 2.44 Tailings Area Internal Monitoring Plan Sites – Copper Data

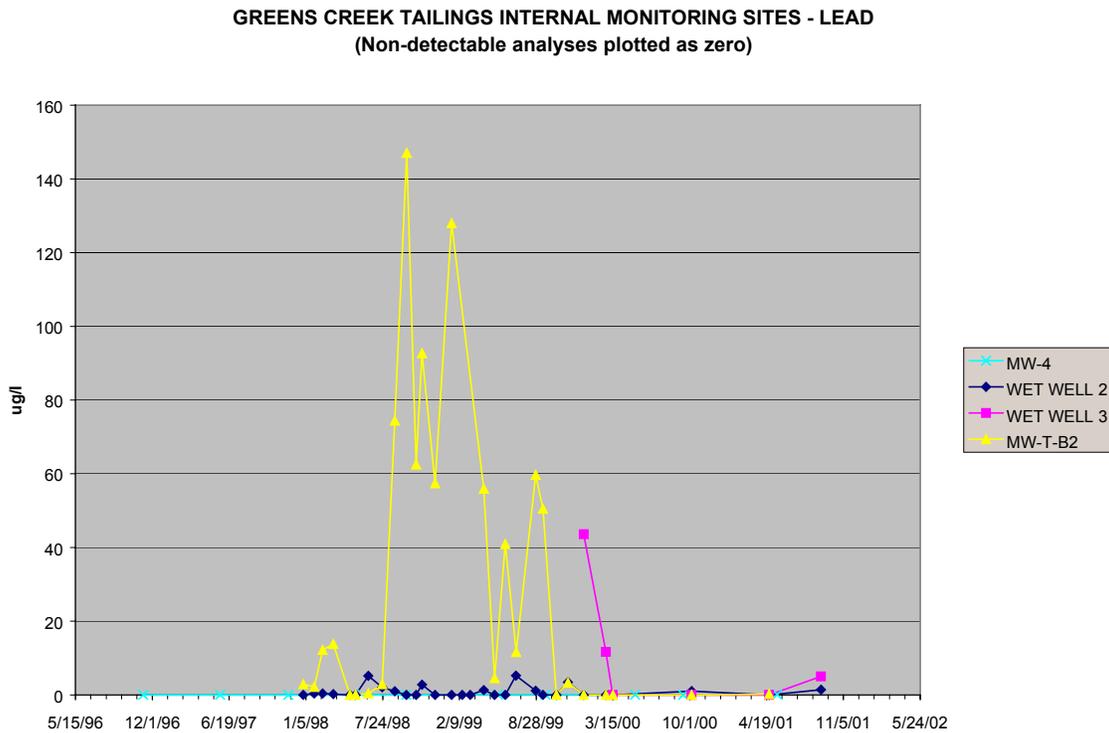


Figure 2.45 Tailings Area Internal Monitoring Plan Sites – Lead Data

KGCMC identified anomalous sulfate concentrations in a few areas along the perimeter of the tailings facility in 2001 and performed an in-depth evaluation of the occurrences. The findings of the investigation are presented in KGCMC, 2002. A summary of the report findings, conclusions and proposed actions follows:

**Summary and conclusions**

Comparison of sulfate versus combined calcium and magnesium for site waters indicates that many of the down-gradient samples have compositions consistent with background waters. However, some down-gradient samples suggest localized communication (either ongoing or past) with contact waters or other sulfate sources.

Background pH values of site waters range from acidic to alkaline. Waters with pH values as low as 4.0 are not unusual for background muskeg areas. The low pH of muskeg waters is a result of acids produced by decomposition of organic compounds in the peat. Alkaline waters derived from uplifted marine sediments yield pH values in excess of 8.5. The pH of tailings contact waters is between 6.5 and 8.5, which indicates any acidity produced by sulfide oxidation is effectively neutralized in-situ by carbonate dissolution.

Acidic drainage observed in a small area west of the tailings pile (Further Seep) was likely caused by weathering of pyritic rock in an access road on the western perimeter of the site. The road was removed during construction of the West Buttress and observations of water compositions

suggest that the quality of the water is improving. The acidity of the seep (32 mg/l CaCO<sub>3</sub>) is not significantly higher than the acidity of typical muskeg water (up to 25 mg/l CaCO<sub>3</sub>). The maximum concentration of some metals, such as copper, lead and zinc in the seep water are equal to or above background surface water concentrations but below maximum background concentrations observed in the peat, sand, silt and bedrock near the site.

Water compositions and field observations in the area west of the pile indicate that there are other sources of dissolved loading in surface waters than those that produced Further Seep. These sources include residual contact water that existed in the area prior to slurry wall installation in 1996, pyritic construction rock and small amounts of tailings that reside inside the facility boundary but outside of primary containment structures. Water compositions suggest that contact water up-gradient of the slurry wall is not a significant contributor to dissolved loading in the western drainages.

Of the 13 wells west of the facility from which quality samples were obtained, three produced anomalous sulfate concentrations. Data from two of the three wells (both completed in shallow sand in the Further Creek drainage) are consistent with the suspected sources of dissolved loading to surface drainages. The composition of water from MW-T-01-03A, a bedrock completion, suggests two possible sources of loading. Potential sources include the knob near the northwest corner of the tailings pile and the northern terminus of West Buttress slurry wall where it keys into bedrock. The low concentrations of zinc and sulfate relative to tailings contact waters suggest that either contact water is not the source or that its contribution is small. If contact water were a significant source of the sulfate, then considerable zinc attenuation via sulfate reduction or ion exchange is required to explain the observed water compositions. In any case, the low permeability of the bedrock would preclude all but a low overall water flux.

Analysis of monitoring well data in the vicinity of Pit 5 suggests a source of sulfate loading in bedrock waters either in Pit 5 or near the northwest corner of the tailings facility. Low zinc concentrations in the well waters are not consistent with sources such as oxidized production rock and tailings surface waters. The abundance of iron and manganese in MW-T-96-4 and MW-T-01-09 suggest that the tailings saturated zone, which has low concentrations of those elements, is not the source of the sulfate loading. In order for the saturated zone to be the source, significant mixing with an iron and manganese-rich, sulfate-deficient water would be required. The bedrock knob in the northwestern corner of the facility cannot be ruled out as a potential recharge area for down-gradient bedrock zones. However, unmineralized, pyritic rock fill in the Pit 5 area alone could also be the sulfate source. Low sodium and potassium concentrations suggest the contributing source rock has had time to weather. A mixture of two or more of these sources could also account for the observed water compositions.

Conductivity measurements in the muskeg area just north of the Pit 5 access road suggest that artesian flow of water from MW-T-96-4 is contributing sulfate to surface water in that area. The lack of sulfate in wells completed in the peat and marine/glacial units above the MW-T-96-4 bedrock well screen implies the marine/glacial units are an effective barrier to vertical flow. Observations from these shallower wells also suggest that the slurry wall is an effective barrier to flow.

There are two areas of sulfate loading south of the tailings pile. The sulfate concentration of 78.6 mg/l observed in MW-T-00-04A is above typical background concentrations; however, all other major and trace element concentrations are consistent with background sources. Rock exposed at the Wide Corner area east of Tank 6 contains pyritic zones that could produce sulfate loading observed in MW-T-00-04A and bedrock wells MW-T-01-06A, MW-T-01-6B, MW-T-01-05.

Surface or sub-surface contributions from the tailings have not been identified, and the lack of zinc, calcium and magnesium loading suggests such contributions do not exist.

Sulfate loading occurred in the muskeg area south of the Main Embankment prior to the start of tailings placement in 1989. Rock used to construct a portion of the access road below the Main Embankment contains abundant pyrite and lacks carbonate mineralization. Drainage from these road materials appears to be the source of sulfate observed in the samples.

The fact that most down-gradient waters do not show a contact water component indicates that the slurry walls and clay/silt sedimentary “natural liner” units are performing well with respect to capturing site waters. The cases where anomalous sulfate concentrations occur appear to be places where pyritic material (quarry rock, production rock or tailings) lies (or once lay) outside the capture area of the slurry walls and clay/silt “natural liner” units.

### Proposed Actions

The interpretations presented above are based on field observations and analysis of data collected to date. The data indicate that there are multiple, localized sources of sulfate loading in down-gradient waters at the tailings facility. KGCMC will continue to monitor these sites to verify that the effects from the identified sources are consistent with the magnitude of the observed loading and that mitigation efforts are effective. The following actions are proposed to verify initial interpretations and to minimize influences from confirmed sources:

- Monitoring and Analysis
  - Continue sampling and interpretation of site waters
  - Define extent of Duck Blind Drain sulfate source (standpipes and test pits)
  - Confirm removal of acidity source in Further Seep (standpipes, test pits)
  - Identify source for Pit 5 sulfate loading (test pits)
  - Collect additional water elevation data on either side of slurry walls (standpipes)
  - Cap MW-T-96-4 to determine its influence on surface waters
- Route NW Diversion Ditch into West Buttress Ditch
- Remove accessible tailings residue from the toe of the West Buttress berm
- Remove access road below Main Embankment
- Install pump in Duck Blind Drain and route water to Wet Well 1
- Lower inlet to North Retention Pond to improve drainage to pond
- Evaluate water control systems, and evaluate need to improve containment structures along the western and northern perimeters of the facility.

KGCMC will continue monitoring and analysis and plans to utilize the 2002 construction season to complete the proposed actions. Information obtained from the proposed actions will be summarized in future progress reports.

### Acid Base Accounting Analyses

The results of ABA analyses on 12 monthly composites of tailings are presented in Table 2.5. The average neutralization potential (NP) of the 12 composites was 321 tons CaCO<sub>3</sub>/1000t, which indicates a significant carbonate content in the tailings (approximately 30%). The acid potential (AP) of the tailings was calculated using the iron assay for the materials, yielding an average of 602 tons CaCO<sub>3</sub>/1000t. The resulting net neutralization potential (NNP) was -282 tons CaCO<sub>3</sub>/1000t, which confirms that the tailings are potentially acid generating. These results are consistent with previous studies of the mine’s tailings. The high carbonate content supports a long lag time to potential acid generation, which allows time for construction and closure of the

site (including covering the pile with a composite soil cover that minimizes oxygen ingress). The ABA analyses were performed on-site following the standard Sobek method for determination of neutralization potential. Using the iron assay to determine a theoretical pyrite content (and associated AP) allows KGCMC to perform analyses on-site and minimizes the uncertainty associated with barite contributions to the sulfur analysis (AP is traditionally determined based on sulfur speciation). Assigning all the iron to the AP value over-estimates the acid potential because other iron-bearing minerals comprise the tailing.

Table 2.5 Summary statistics of acid-base-accounting analyses for 12 monthly, mill-tonnage weighted tailings samples

<b>n=12</b>	<b>NP</b>	<b>AP</b>	<b>ABA</b>
Avg	321	602	-282
Max	543	676	10
Min	218	532	-459

-lab technique NP by Standard Sobek Method  
AP by iron assay

### Biomonitoring

For presentation optimization, results from the Tailings and Site 23/D areas' biomonitoring are presented together. With the majority of the biomonitoring data discussion for sites around the Site 23/D area, the full biomonitoring discussion has been placed in this report's Site 23/D Section 3.5.

## **2.6 General Site Management**

### Tailings Operation and Management

In January 2001, Kennecott Greens Creek Mining Company (KGCMC) received approval for an updated General Plan of Operations – Appendix 3 Tailings Impoundment (GPO Appendix 3), dated August 2000, as part of the State of Alaska, Department of Environmental Conservation Waste Disposal Permit #9911-BA006. GPO Appendix 3 includes the general operating and management goals to achieve site stability and satisfy regulatory requirements.

As per GPO Appendix 3, Section 2.1.4, KGCMC Operations place tailings within the impoundment using specific criteria that were established by Klohn-Crippen Engineering in 1999 for the placement of tailings in cellular configurations with compaction standards. KGCMC has continued to place tailings in this manner through 2001.

In 2001, KGCMC's main placement area for tailings became the East Side Tailings – Northeast area. This area was developed in 2000 and added approximately 2 years of tailings storage capacity to the existing impoundment site. KGCMC focused on placing in this area to even out the pile height with the existing north end of the pile and to give operations a broader extent of cell availability. Approximately, 60-70% of the 2001 tailings production went into this area.

The remainder of the tailings was placed in the West Buttress area. KGCMC continues to place in this area with consideration of the purpose of the buttress installation, which is to structurally support the portion of the existing tailings pile constructed in the earlier stages of the mine life.

No changes to the methodology of tailings placement occurred in 2001, as KGCMC continues the use of off-highway lidded trailered trucks to transport the tailings to the impoundment. The material is end dumped, spread and compacted using a bulldozer, followed by a vibratory compactor. Regular compaction checks using a Troxler density and moisture gauge confirms the resultant performance in the placement area, as per the GPO Appendix 3.

In 2002, KGCMC will develop an additional placement area with an approximate capacity of 2-3 years in the Southeast area of the existing tailings pile. This area development will differ from prior site development, in that an HDPE liner system will be installed over the shallow fractured bedrock areas (caused by rock quarry blasting) of the site. This will minimize the potential for downward migration of contact waters in the areas that do not have the natural aquatard (silt/clay till) layer underneath the tailings placement footprint area. A liner design plan was submitted in December 2001 with approvals granted for installation from the USFS and ADEC in 2002. Liner installation and construction activities are scheduled to begin in late April 2002, with completion scheduled for late June. This Southeast area lies within the current lease permit boundary. Tailings placement will follow after construction approval conditions are met. KGCMC does not expect any changes to the placement methodology for the new area in 2002 and will continue placement according to the established criteria in GPO Appendix 3. Continued development of placement areas for the remaining mine life are a part of the Stage 2 Expansion Project.

### Stage 2 Tailings: Environmental Impact Statement Update

In January 2001, KGCMC applied for an expansion of tailings surface storage capacity that can satisfy the current production requirements and reasonable anticipated reserve increases. That application initiated a National Environmental Policy Act (NEPA) process with the U.S. Forest Service as lead agency due to their land management responsibility for the proposed expansion

area. For the KGCMC application the USFS established an inter-agency regulatory team with memoranda of understanding, which act as guides for the involvement of additional Federal, State and Local regulatory agencies. A third party EIS contractor, Michael Baker Inc. (MB) was selected to coordinate the EIS review of the project proposal.

In March 2001, MB began baseline study reviews, and KGCMC started additional site investigation projects, such as surface drilling, geotechnical and hydrology studies, sensitive plant surveys and detail topographic mapping. In the following month of April, MB organized public project review meetings in Juneau and Angoon to establish the project issue lists, as baseline studies continued throughout the summer.

In late July 2001, in the process of investigating the surface drainages around the tailings site, KGCMC discovered water issues that initiated a report submittal to ADEC and the USFS in July 2001 per GPO and Solid Waste Permit requirements. KGCMC focused efforts on the determination of the suspect water sources and established an action plan to address those areas. Results of the actions taken under this plan and results of continuing monitoring are discussed in Section 2.5 of this report.

Final water quality at closure was identified as a significant scoping issue surrounding the proposed tailings storage area expansion. An extensive review of historic and current water monitoring information from within and surrounding the existing tailings area was accomplished by Environmental Design Engineering (EDE). Their efforts resulted in the submittal of a hydrologic analysis report (EDE 2002a) and a geochemistry report (EDE 2002b) as baseline studies of the expansion proposal. These documents updated previous analyses, discussing the predicted water quantities and qualities as well as the conditions which influence those topics. This report process started in June 2001 and was finalized in early 2002.

During early 2002, Michael Baker, Inc, the EIS contractor for the USFS will have completed review of the baseline studies and will prepare a potential alternatives screening proposal for USFS consideration. This comprehensive review of the potential alternatives is an integral part of the USFS NEPA process. No schedule past this review process has been established for the EIS completion.

## 2.7 Site as-built

An as-built for the tailings facility is presented in Appendix 1. The as-built shows the year-end topography, water management features, monitoring device locations and other significant features of the site. The as-built also includes cross sections that show the following information:

- existing topographic surface
- prepared ground upon which the pile was constructed
- water levels

Representative photographs taken during routine site inspections are presented in Figures 2.46 to 2.49.

Figure 2.46 Aerial Photograph of Tailings Facility 2001



This aerial view of the Tailings Facility shows the West Buttriss (foreground), Pit 5 water treatment facility (left, north), East Tailings placement area and B Road (back), Tank 6 and Pond 6 (right, south), and NPDES outfall pipeline (foreground right).

Figure 2.47 Photograph of East Tailings Placement Area



This photograph shows wet weather cellular tailings placement in the East Tailings placement area. Tailings are spread in thin lifts with a bulldozer (right) and compacted with a vibratory roller. Disturbed areas are hydroseeded to minimize erosion (foreground). The Pit 5 water treatment facility is visible in the background. Ramps (center) provide access to the wheel wash located near Tank 6 (Figure 2.46).

Figure 2.48 Photograph of West Buttrass Tailings Placement Area



This photograph is a view of the West Buttrass placement area from the South Tailings placement area. Tailings are placed in cells and the 3H:1V outer slope is covered with Class 1 production rock or native materials to minimize erosion.

Figure 2.49 Photograph of Compacted West Buttress Tailings



This photograph is a view of compacted tailings in the West Buttress placement area. The tailings are spread and compacted in thin, inclined lifts in a cell that has an overall thickness of approximately five feet. This promotes drainage and dissipation of pore pressures that rise as the material is compacted.

## **2.8 Reclamation/Closure Plan**

### Reclamation Plan

In January 2001, Kennecott Greens Creek Mining Company (KGCMC) received approval for an updated General Plan of Operations – Appendix 14 Reclamation Plan (Appendix 14), dated October 2000, as part of the State of Alaska, Department of Environmental Conservation Waste Disposal Permit #9911-BA006. Appendix 14 includes the goals and regulatory requirements to achieve the closure measures identified in the Final Environmental Impact Statement (FEIS).

In July 2001, as part of the Waste Disposal Permit requirements, KGCMC submitted a “Detail Reclamation Plan with Cost Estimates” as an attachment to the Appendix 14. This attachment to Appendix 14 was approved by an inter-agency team as the basis of current site reclamation bonding levels in November 2001. The Detail Reclamation Plan includes all estimated costs (labor, materials, equipment, consumables, monitoring and long term maintenance) for task specific work associated with the final closure of the property under a default scenario. KGCMC detailed a scope of work to accommodate the physical reclamation projects and the reclamation monitoring and maintenance of all site facilities by segmenting the overall project work at the mine into 7 elements:

- Roads
- Production Rock Sites
- Tailings Area
- Site General
- Water Systems
- Maintenance and Monitoring
- Administration

Each of the above elements of the Detail Reclamation Plan include narrative and cost estimates to define the closure of the property by discipline (type of work) and area. The elements of the plan encompass the entire mine site, and also include reclamation performance monitoring and facility maintenance after final closure according to the Waste Disposal Permit standards.

Concurrent reclamation opportunities were also covered in the detail plan to establish a timetable for reclamation projects that could occur to certain areas of the KGCMC facilities as they become available during the operational period.

After a comprehensive inter-agency and public review period, the Detail Reclamation Plan was revised and resulted in a final closure reclamation cost estimate totaling approximately \$24.4 million.

The two final versions of the KGCMC reclamation documents are titled “General Plan of Operations – Appendix 14 Reclamation Plan”, dated October 2000 and “General Plan of Operations – Appendix 14 Attachment A – Detailed Reclamation Plan Cost Estimates”, dated November 2001.

Other ongoing reclamation planning is in progress for the Stage 2 Tailings Expansion EIS process, which will address the proposed expanded tailings footprint alternatives. No detail work has been completed for this report issue, as the project is currently being processed through a National Environmental Policy Act (NEPA) review by the United States Forest Service (USFS).

At this time, the reclamation methodology, such as engineered soil covers, planned for the existing tailings pile final closure is anticipated to be similar for any proposed expansion of the tailings facility.

### Reclamation Projects

KGCMC continued using past interim reclamation measures, such as hydroseeding and erosion control at the tailings facility, to improve and maintain established site controls. In 2001, KGCMC hydroseeded approximately 20 acres, including the lower portions of the south facing slopes at Production Rock Site 23 and also at the tailings site. A growth media (six inches to one foot) of native soils was placed on certain slopes of the tailings pile to promote the hydroseed growth.

KGCMC also continued the use of other sediment control measures such as silt fencing, hay bales, polymer addition, slope armoring and slope contouring throughout the site. KGCMC is committed to the continued use of site controls as the operation has consistently demonstrated the benefits of these interim reclamation programs to reduce impacts during the operational period.

Year 2001 concurrent reclamation projects were important in scope, as some sites were under investigation for closure methodology, cost estimating, technical analysis and performance monitoring, such as the engineered soil cover program at Production Rock Site 23. A main focus of the Year 2001 reclamation work was the information gathering at Site 23, which is recognized within the Waste Disposal Permit as an important feature in determining the effectiveness of the soil cover. Time has been allowed in the permit to gather cover performance information for further analysis, prior to installing the covers en mass. Continued evaluation of the cover performance is planned to justify and improve closure capping technology in 2002. Extensive reviews of the cap performance have also taken place during the KGCMC Stage 2 Tailings Expansion project work with the USFS. It is recognized by KGCMC that the soil covers represent a major part of the site reclamation plan. Therefore, KGCMC has continued to commit resources to develop and monitor the performance of the cover at Site 23 (see Section 3.8).

Physical reclamation projects were limited in 2001, because most of the available sites were under analysis or dependent on the information resulting from the soil cover monitoring. Site E is the largest potential concurrent reclamation site at KGCMC, but is not available until soil cover information progresses and further geotechnical stability analyses of the site are finalized. The costs associated with Site E capping dictates that KGCMC confirm both the cover integrity and geotechnical aspects of this site prior to initiating reclamation of the site.

Site 23 has limited area available for continued cap installation, as the available space on the lower western slope continues to be affected by the ramp development above the area. As the access ramps are raised past this area, KGCMC will have approximately an acre of available final outside slope for cap installation. This project may time out within a year to a year and a half. Site 23 backslope excavation is planned in the Year 2002 to accumulate additional native soils for reclamation capping using engineered soil covers and to establish additional waste disposal capacity at the site. Excavation estimates are between 30,000-40,000cy of backslope material that could be excavated given the potential cover needs at Site 23 and Site E in Year 2003. KGCMC can not over excavate the Site 23 backslope because of highwall safety issues. The planned removals are also dependent on several factors such as production rock availability for Site 23 excavation fill, weather and potential reclamation sites being ready for soil capping. At this time, the concurrent reclamation plan has an extremely flexible schedule and is addressed in the Detail Reclamation Plan Cost Estimates document.

Concurrent reclamation plans for 2002 will be focused on the tailings area and the approved action plan around the tailings area to remove potential ARD materials from the periphery of the active impoundment to reduce effects on the surface drainages in the area. Specifically, the service road along the south side of Pond 6 is recognized as having an ARD potential and will be excavated and removed this 2002 construction season.

## **3.0 Site 23/D**

### **3.1 Introduction**

Kennecott Greens Creek Mining Company (KGCMC) has prepared this report in accordance with the mine's General Plan of Operations (Appendix 11) and Alaska Waste Disposal Permit 9911-BA006. A summary of all operational and monitoring activities performed in 2001 is provided. Refer to GPO Appendix 11 and permit 9911-BA006 for a detailed description of Site 23, Site D and associated monitoring requirements.

KGCMC operated Site 23 (its only active production rock disposal facility) continuously in 2001. See the Site 23 as-built in Appendix 2 for facility layout. Approximately 43,000 tons of production rock were placed at the tailings facility during this report period. The projected remaining capacity at Site 23 is approximately 900,000 tons.

### 3.2 Placement records

Site 23 survey data and truck count haulage information are presented in Table 3.1. Approximately 43,000 tons of production rock were placed at Site 23 in 2001. A tonnage factor of 1.69 tons/yd<sup>3</sup> was used to convert surveyed volume to tonnage. Class 1 production rock comprised just under 60 percent of the total placement at the site. Class 2 and Class 3 production rock comprised just over 10 and 31 percent respectively. The small (approximately 4 percent) difference between truck count totals and calculated totals based on survey data reflects variations in tonnage factors, small differences in load capacities and double handling of materials. The surveyed volume reported in cubic yards has the least uncertainty relative to other quantities reported in Table 3.1. The acid base accounting data presented in Section 3.5 indicate that KGCMC continues to conservatively classify its production rock. Much of the phyllite that is visually classified as Class 3 is actually Class 2 (i.e. it has a NNP between 100 and -100 tons CaCO<sub>3</sub>/1000t).

Table 3.1 Production Rock Placement Data

Date	Production Rock Placed At Site 23				Production Rock Hauled (truck count, tons)					
	Monthly survey (yd <sup>3</sup> )	Cumulative survey (yd <sup>3</sup> )	Monthly calc. (tons)	Cumulative calc. (tons)	Class 1	Class 2	Class 3	Total	To Tailings	Total (sans tails haul)
1/31/01	2,473	372,208	4,186	630,070	4,080	0	327	4,407	0	4,407
2/28/01	1,230	373,438	2,082	632,152	960	0	270	1,230	0	1,230
3/29/01	1,931	375,369	3,269	635,421	4,080	0	327	4,407	1,530	2,877
5/1/01	2,832	378,201	4,794	640,215	600	0	2,691	3,291	495	2,796
5/29/01	1,935	380,136	3,276	643,490	1,589	270	2,396	4,255	570	3,685
6/27/01	748	380,884	1,266	644,757	1,380	0	1,110	2,490	416	2,074
7/31/01	1,137	382,021	1,925	646,681	4,590	390	360	5,340	2,645	2,695
8/28/01	3,616	385,637	6,121	652,802	6,153	2,100	1,838	10,091	1,300	8,791
10/1/01	4,572	390,209	7,739	660,542	6,561	2,124	1,034	9,719	1,184	8,535
10/31/01	2,984	393,193	5,051	665,593	1,350	420	2,820	4,590	493	4,097
11/27/01	1,128	394,321	1,909	667,503	1,440	60	690	2,190	0	2,190
12/27/01	1,000	395,321	1,693	669,195	2,310	120	210	2,640	765	1,875
Totals	25,586	395,321	43,311	669,195	35,093	5,484	14,073	54,650	9,398	45,252
					25,695 Class 1 placement (total minus fraction hauled to tailings)					
Placement percentage by class:					57%	12%	31%			

### 3.3 Stability

#### Compaction Data

Compaction testing of Site 23 is routinely conducted near the end of each month to correspond to the monthly survey confirming placement volume for the month. This allows concurrent survey location of the sample points. KGCMC staff utilizes a Troxler Model 3430 nuclear moisture-density gauge to measure wet density and percent moisture content of placed waste. Nuclear methods are the only viable way to measure placed densities given the size distribution of the waste. The calculated dry densities are compared to a standard Proctor value of 150 PCF which was measured on the minus 1 inch fraction of typical mine waste.

Samples taken from the active placement areas during the report period demonstrate excellent compliance with the goal of achieving greater than 90 percent compaction with respect to a 150 PCF value. Summary statistics for Site 23 compaction data are presented in Table 3.2. Sixteen of the 18 sites tested return values greater than 90 percent compaction. The two sites below 90 percent compaction were recorded in different months in different production rock type zones and probably represent measurement anomalies and not poorly compacted material. One site was noted as not being fully compacted and thus did not represent the final placed density. The second measurement returned a value of 134.2 PCF that represents an 89.5 percent compaction relative to standard Proctor. A second nearby site taken on the same day within the same production rock class returned a value of 137.5 PCF or 92 percent compaction. KGCMC continues to manage the site in a way that minimizes infiltration via placement of thin, compacted lifts at proper drainage grade.

Table 3.2 Summary statistics for 2001 Site 23 compaction testing data

Compaction Variable	Mean	Max	Min	Std. Dev.	n
Measured Dry Density	145	163	130	9.46	18*
Measured moisture (%)	8.6%	15.3%	4.2%	3%	
Rel. Compaction %(w/r to 150 PCF)	97%	109%	87%	6%	

\* n=18 represents the number of individual sites at which multiple replicates are taken.

#### Inspections

Several independent inspections are carried out at Site 23 throughout the year. Operators working at the site carry out daily visual-work place inspections. The Surface Civil Engineer and or Surface Operations Manager carry out weekly visual inspections. The environmental department carries out a monthly checklist inspection. No visible signs of physical instability were observed at Site 23 during this report period. During 2001 the USFS inspected Site 23 approximately 35 times (Site inspection #57-#91) monitoring for Best Management Practices effectiveness and compliance to the General Plan of Operations. No issues of non-compliance or poor operations practices were noted in the inspections. In fact, the USFS inspections typically noted that Site 23 is being developed and operated to required operations and maintenance specifications of GPO Appendix 11.

#### Slope monitoring

Slope monitoring at Site 23/D consisted of GPS monitoring of 14 survey hubs distributed across the sites. See the Site 23 as-built for hub locations. The resolution was sufficient to identify large

potential movement and no such movements were identified. KGCMC intends to improve the slope monitoring hub network in 2002.

Well and piezometer water level data

Well and piezometer water level data are provided in Figures 3.1 to 3.12. The lack of significant pressure in piezometers installed close to the base of Site 23 (piezometers 52-55, Figures 3.1 to 3.4) indicates that the pile is free draining. This is consistent with the construction of a network of finger drains under the pile and a blanket drain at the pile toe. See the Site 23 as-built (Appendix 2) for piezometer and finger drain locations. The lack of pore pressure at the toe indicates that pile stability has been maximized. Water levels from several monitoring locations are shown on Section CC of the as-built. The inferred water table is 30 to 60 feet below the base of the pile up-slope of the active placement area and 5 to 20 feet below the base of Site D and the toe of Site 23, respectively (see also, Figures 3.5 to 3.12). Observations from wells completed in the colluvium below the sites indicate that perched water tables and braided flow paths exist beneath the site (e.g compare Figure 3.6 and 3.7). The silty/clay till that underlies the colluvial unit impedes downward flow and may have an upward hydrologic gradient caused by confining more permeable bedrock below it. MW-23-98-01 (Figure 3.8) is completed in the till unit and indicated a water table near the top of the till, which is approximately 100 feet below the existing topographic surface. Alluvial sands occur between the colluvial unit and the silt/clay till near the toe of Site 23 and under Site D. Data from MW-23-A4 and MW-D-94-D3 (Figures 3.9 and 3.11) indicate that the sands are saturated. A curtain drain installed in between Site D and Site 23 in 1994 collects water that flows at the base of the colluvial unit and the top of the alluvial sands (see as-built and Section CC for locations). This drain helps reduce pore pressures in the foundation of Site D.

Figure 3.1 Pressure Data for Piezometer 52

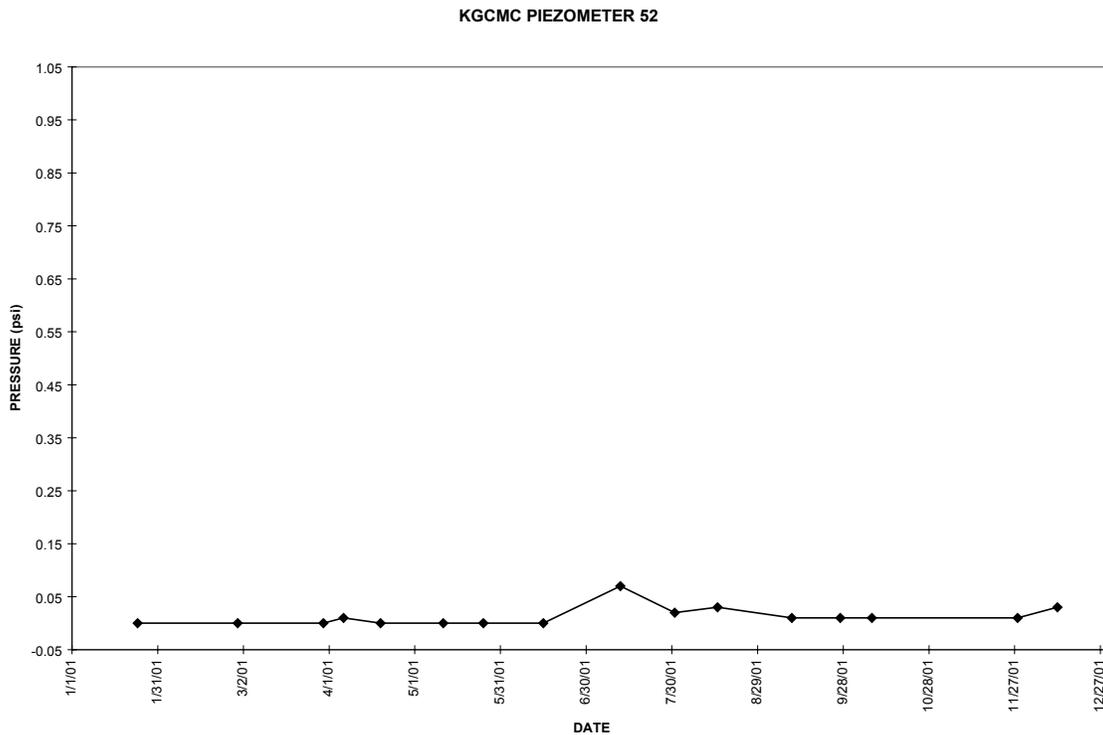


Figure 3.2 Pressure Data for Piezometer 53

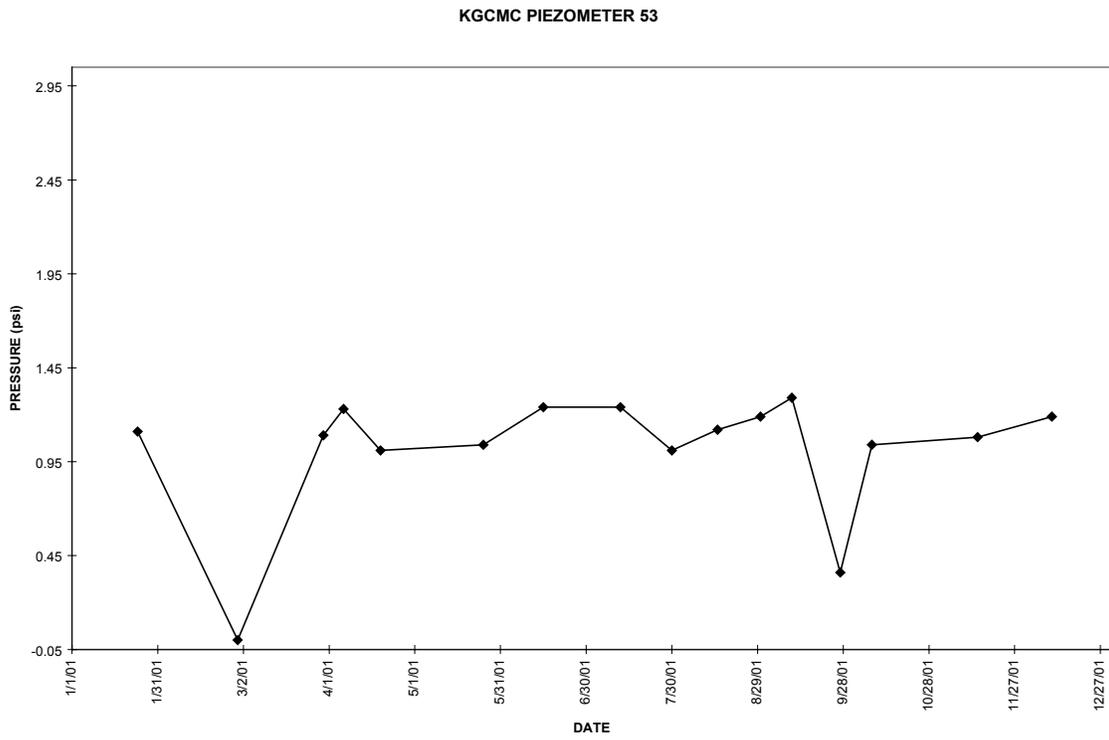


Figure 3.3 Pressure Data for Piezometer 54

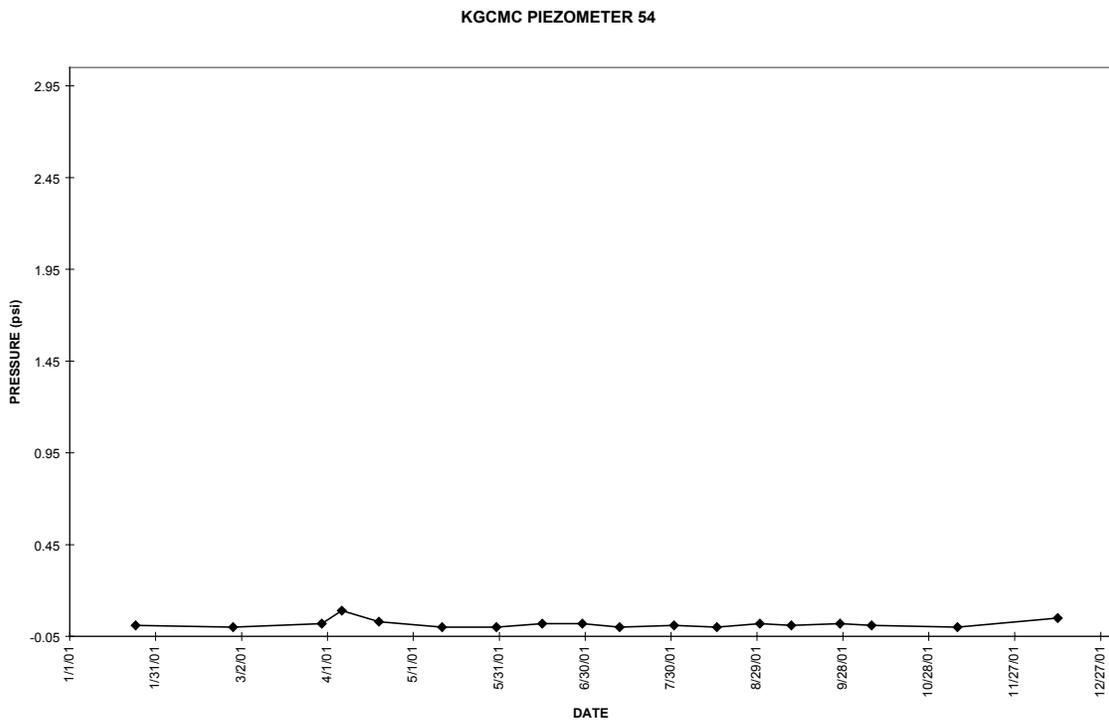


Figure 3.4 Pressure Data for Piezometer 55

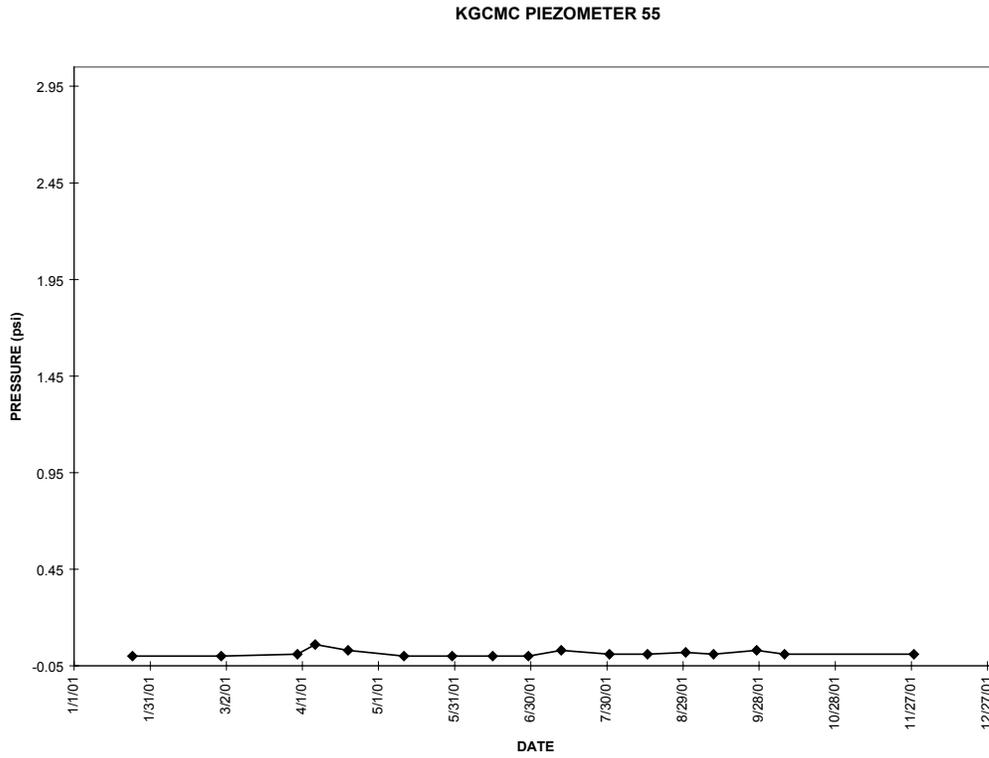


Figure 3.5 Water Level Data for Well MW-23/D-00-03

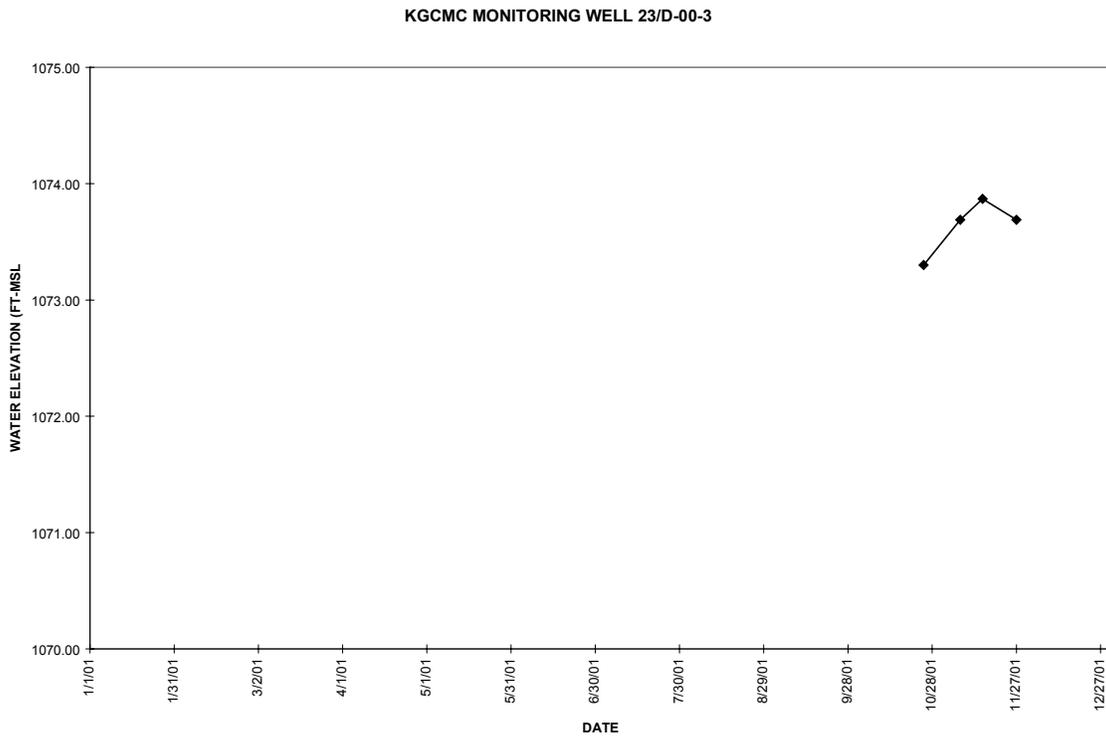


Figure 3.6 Water Level Data for Well MW-23-A2D

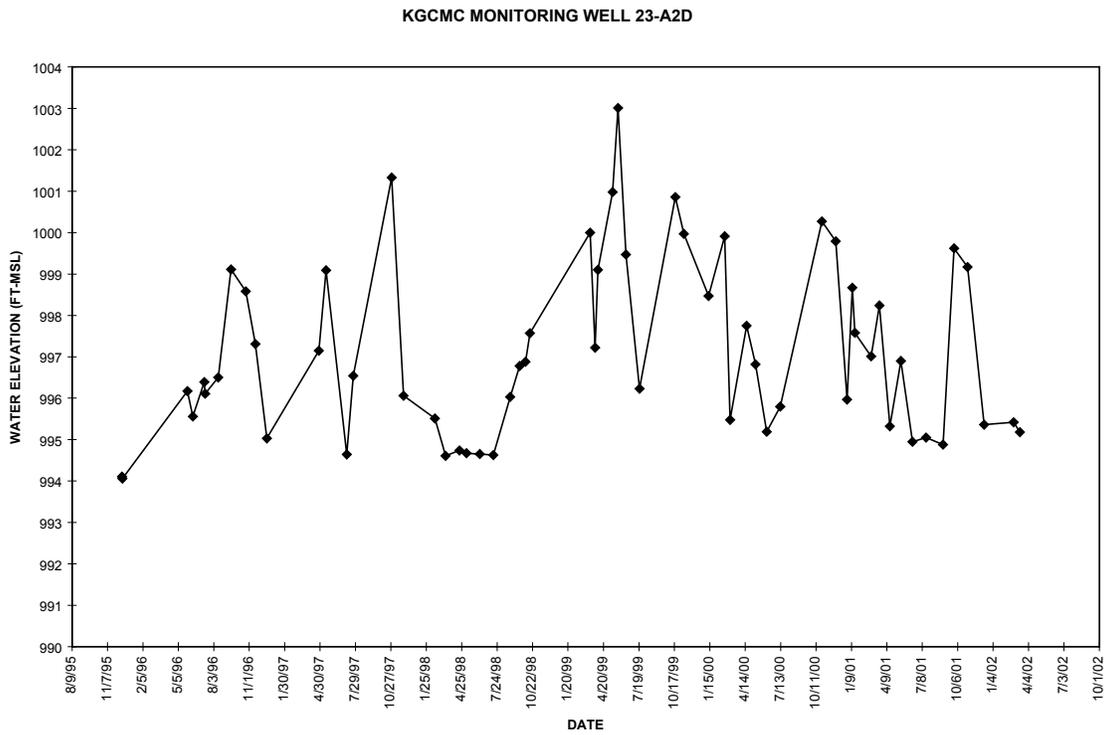


Figure 3.7 Water Level Data for Well MW-23-A2S

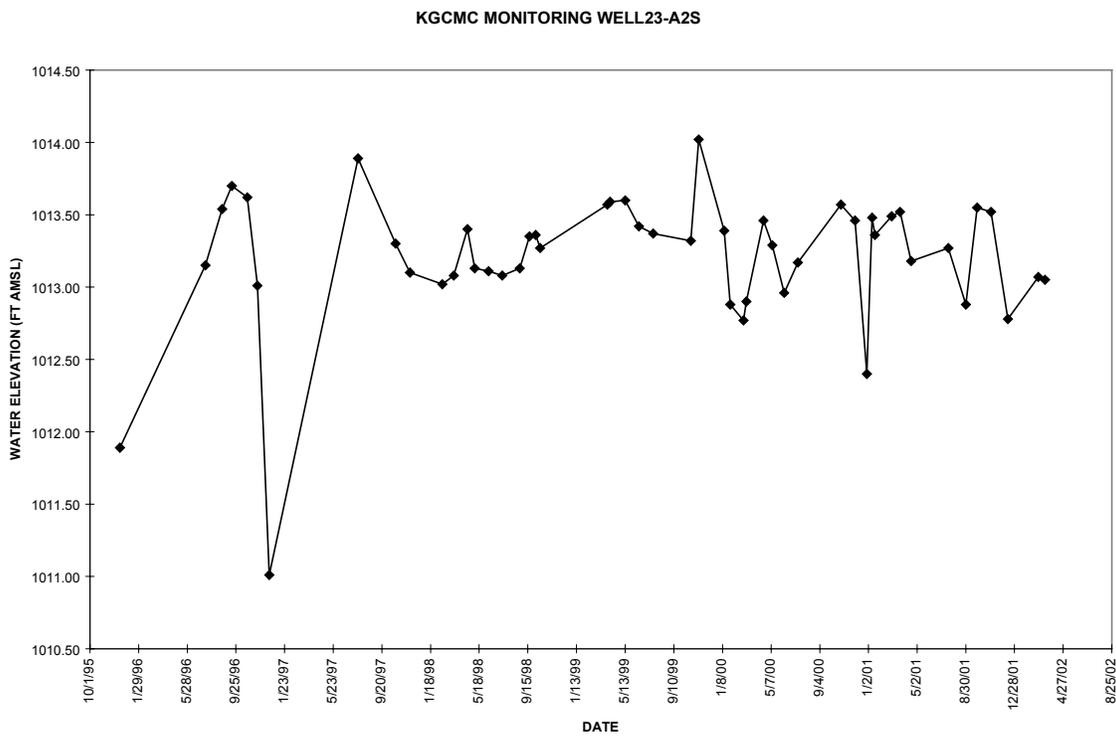


Figure 3.8 Depth to Water Data for Well MW-23-98-01

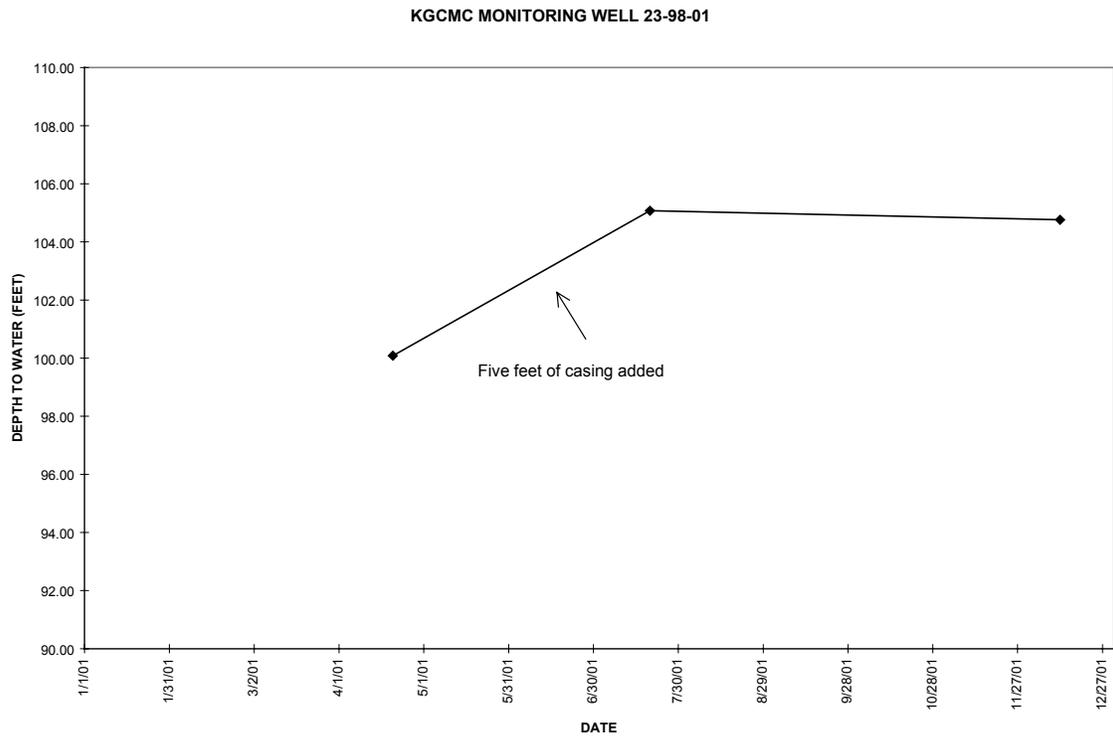


Figure 3.9 Water Level Data for Well MW-23-A4

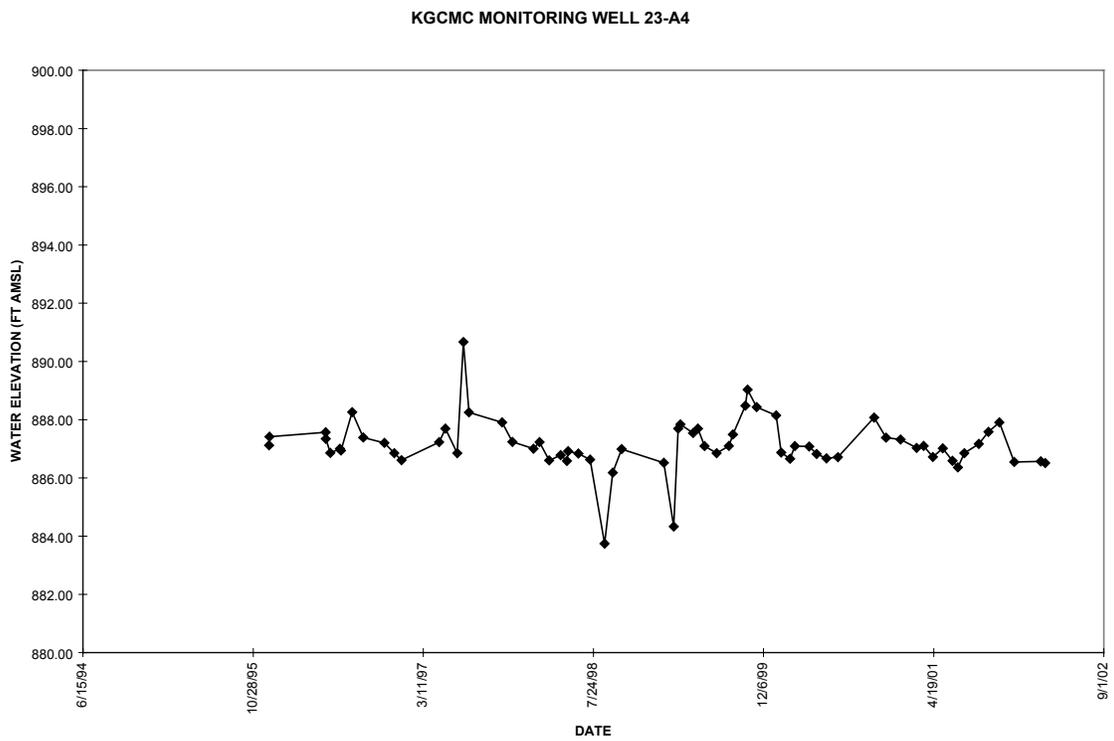


Figure 3.10 Water Level Data for Well MW-23/D-00-01

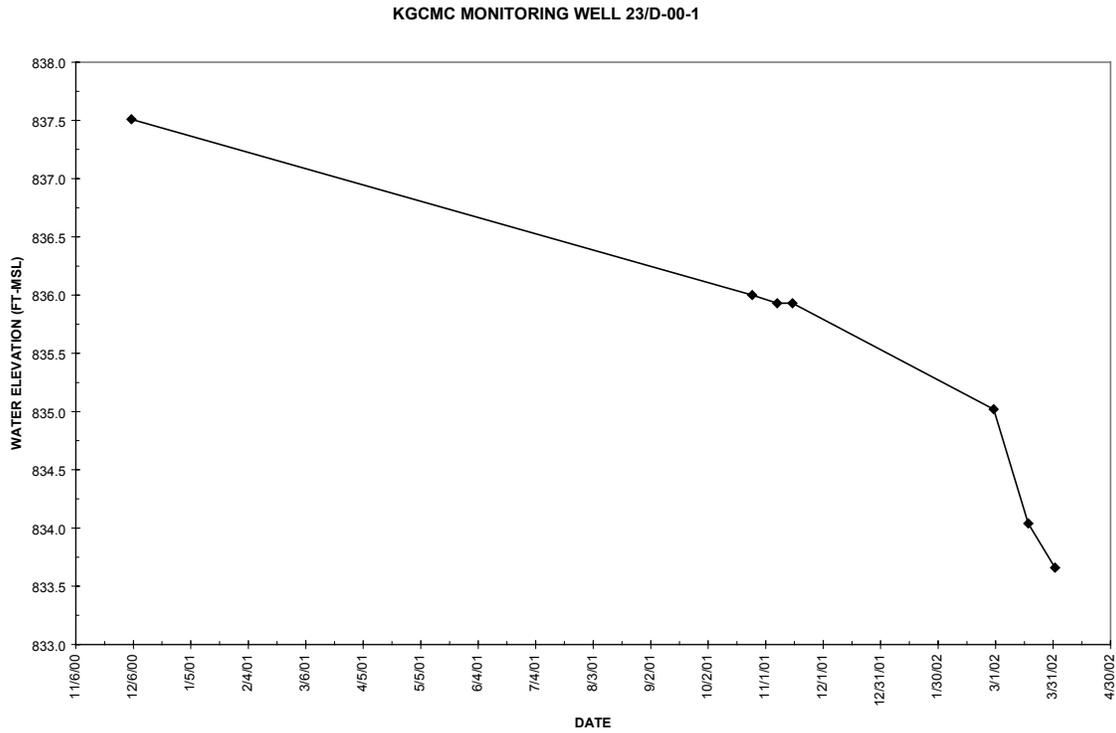


Figure 3.11 Water Level Data for Well MW-D-94-D3

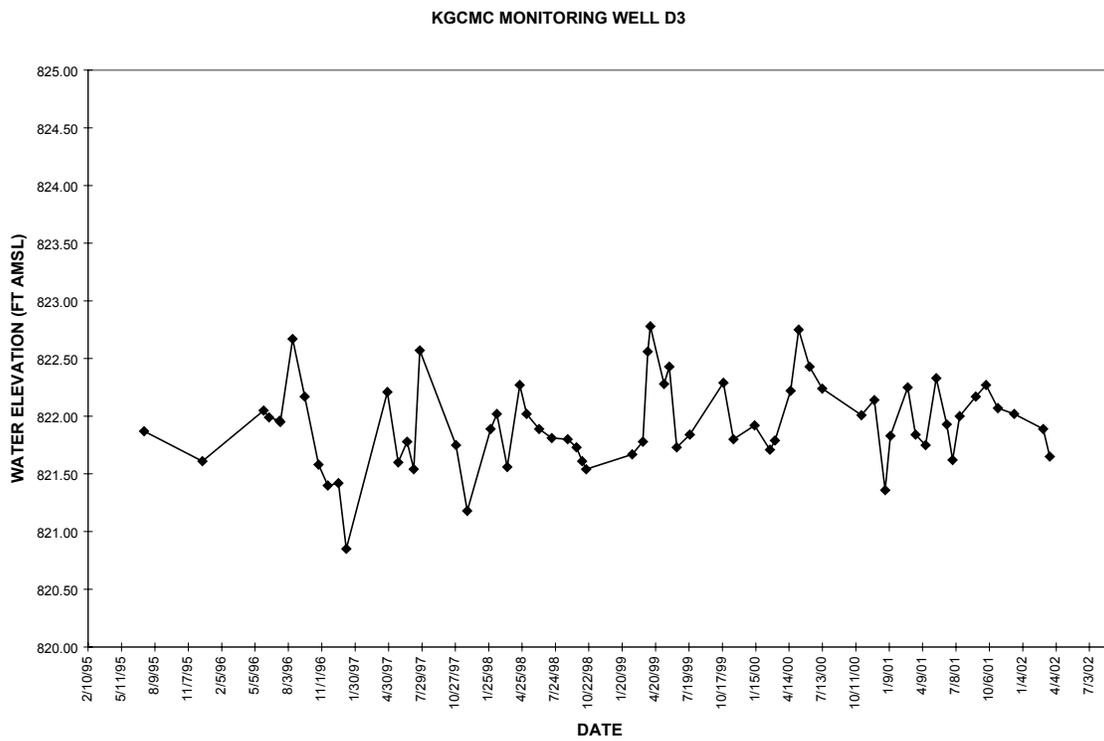
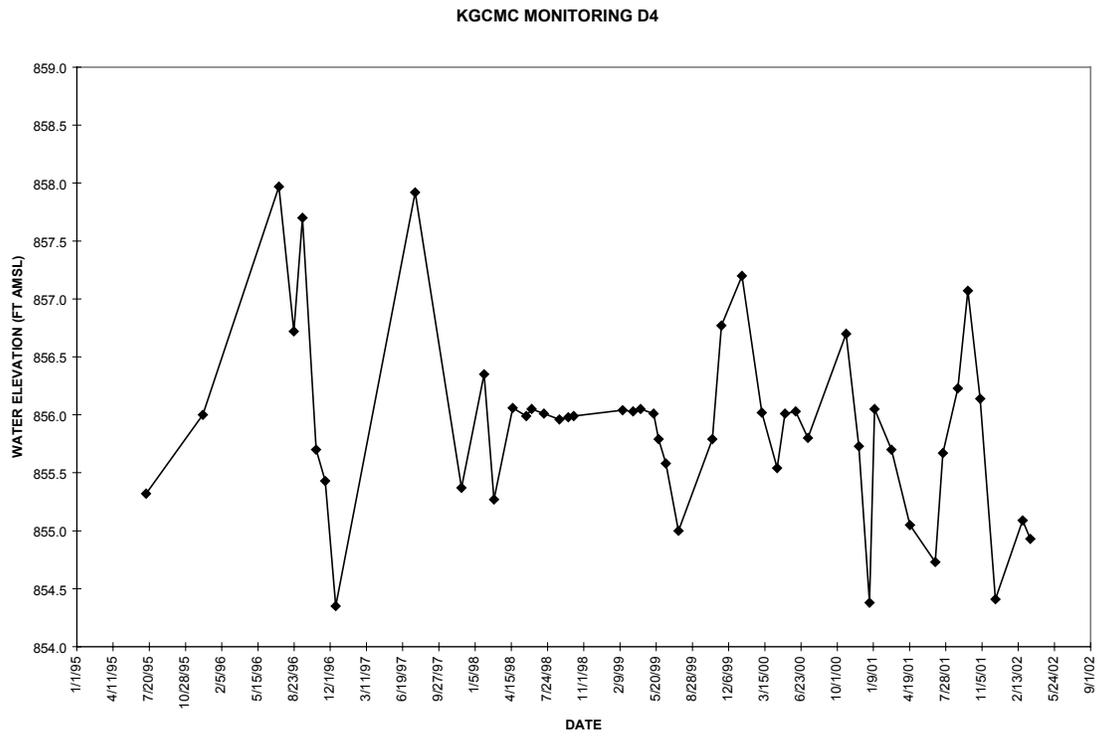


Figure 3.12 Water Level Data for Well MW-D-94-D4



### 3.4 Hydrology

A general description of the hydrogeology of Site 23/D is provided above. Environmental Design Engineering and KGCMC are performing a hydrological and geochemical re-analysis of Site 23/D in 2002. This investigation will provide a more detailed understanding of the existing and future hydrologic and geochemical conditions at the site.

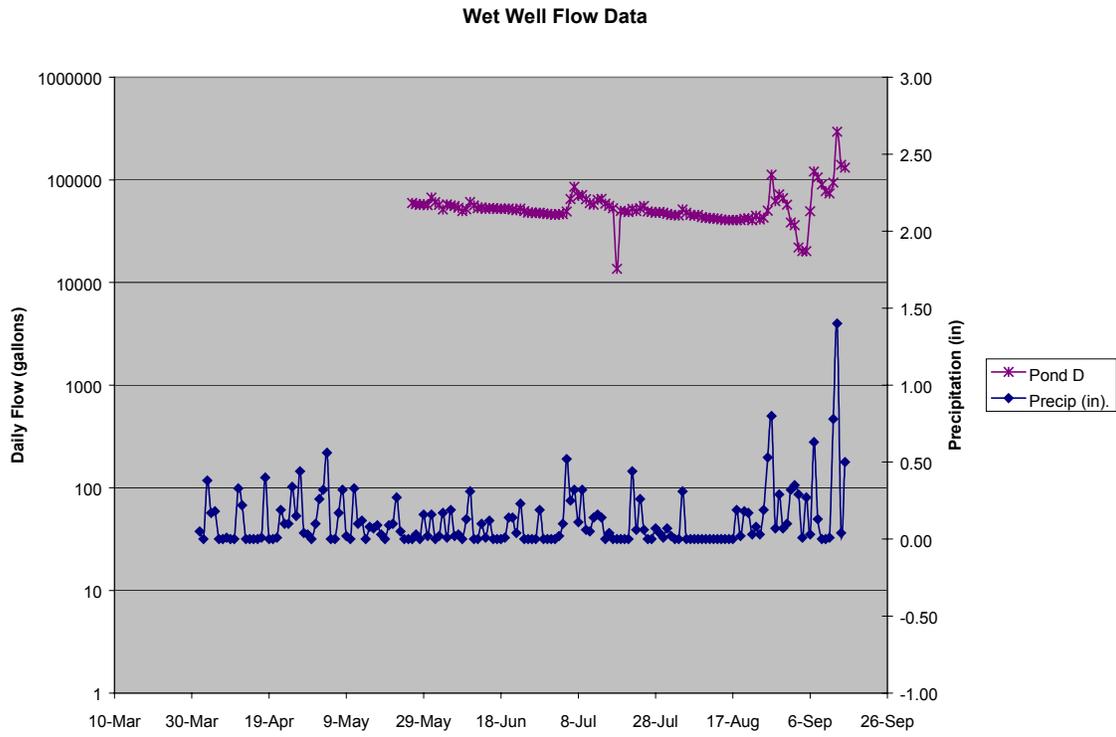
Surface and groundwater are managed using a network of drains, ditches and sediment ponds at both Site D and Site 23. See the Site 23 as-built for locations of these features. Water that is collected in the finger drains beneath Site 23 are routed to Pond 23 along with Site 23 runoff via a lined ditch. Pond 23 also periodically receives stormwater via pipeline from the 920 area. A curtain drain below the toe of Site 23 captures groundwater from the colluvial unit beneath the site and reports to the Pond D wet well via pipelines. Pond D also captures surface water and drainage from seeps near the toe of Site D. Pond D water is returned to the Pond 23 pump station where it is either sent to the mill or down to the Pit 5 water treatment facility.

Monthly temperature and precipitation data are provided in Table 3.3. A total of 73 inches of precipitation fell in 2001. The wettest months were September and October with 14.5 and 10.7 inches of precipitation, respectively. The driest month was June (1.7 in). Flow data for Pond D are shown with precipitation in Figure 3.13.

Table 3.3 Monthly summary of Site 23 climate data

Month	AvgTemp (°C)	Precipitation (inches)
January	1.31	8.56
February	-3.09	4.83
March	-0.89	3.46
April	2.63	3
May	5.26	4.95
June	10.32	1.7
July	11.32	3.95
August	12.74	5.19
September	9.04	14.48
October	3.52	10.74
November	-0.96	6.57
December	-2.35	5.64
2001	4.12	73.07

Figure 3.13 Pond D Flow Data



### 3.5 Water quality

#### Compliance Monitoring

Water sites around the Site 23/D production rock storage area have been monitored for various periods. Sites have been added and deleted over time as rock storage area development required. As with the Tailings area discussion, the multi-agency review team led revision of the Fresh Water Monitoring Program (FWMP - Appendix 1 - General Plan of Operations) received approval from the Forest Service on 27 April 2001. At this date KGCMC was preparing for the 8<sup>th</sup> month (May) of sampling for water year 2001. Sampling on the more comprehensive, prior schedule was thus continued for continuity over the remaining 4 months (June-September) of water year 2001. Monitoring under the revised FWMP schedule and sites began with October 2001 sampling, the first month of water year 2002. The full FWMP Annual Report for water year 2001 is being prepared separately and will be submitted to the Forest Service.

The results of all FWMP sampling at the Site 23/D production rock storage area during calendar year 2001 are summarized below. These sites are monitored each month of the year when a sample can be obtained. Some sample opportunities were lost due to frozen conditions and/or lack of flow. Dissolved analytical results for arsenic, copper, mercury, lead and zinc are presented as representative constituents. Each figure presents data covering the past 5 years of sampling at each site to allow determination of trends. Analytical results below the laboratory instrument detection level are plotted as zero on the figures. All other monitored constituents from these FWMP monitoring wells remain consistent with previous year's results, and far below compliance levels.

One common thread among the data Figures, very little data apparent in 1997 and early 1998, represents an artifact of laboratory analyses and the data plotting procedure noted above. Through this period laboratory instrument capabilities and new techniques provided lower detection levels. The previously undetectable constituent levels in the monitored waters became documentable, leaving the graphs appearing to show no metals data present over the first year and a half of the five-year graphed period. In fact those historic constituent levels occurred just below the laboratory instrument detection levels giving laboratory results of "non-detectable". For clarity they were therefore plotted as zero on the figures as noted above. Once the constituent levels were reached by the ever-more-sensitive laboratory instruments/techniques, it became possible to document those actual data levels.

The FWMP monitors two streams in the vicinity of the Site 23/D production rock storage area, Bruin Creek and Greens Creek. Bruin Creek runs along the eastern side of the rock storage area and feeds into Greens Creek immediately upgradient of the toe of Site 23/D. The two monitoring sites on Bruin Creek (upper site 46 & lower site 49) provide upstream and downstream monitoring locations.

Greens Creek flows east to west through this area. It lies to the south of Site 23/D, flowing along the toe of this rock storage area. Also, upstream of the Site 23/D production rock storage area Greens Creek lies just to the south of the KGCMC surface facilities which include the mill and associated operations. The portal (entrance) to the Greens Creek mine penetrates the mountain on the southern side of the creek. A bridge spans Greens Creek providing the mine access to and from the associated surface facilities. The three monitoring sites on Greens Creek are upstream of all KGCMC facilities (Site 48), upstream of Bruin Creek (Site 6), and downstream of the Site 23/D facilities (Site 54).

As with the tailings facility, monitoring around the Site 23/D production rock storage area continues to show no evidence of contamination from the facility at the monitored compliance points. The water quality sampling results, combined with the biomonitoring results demonstrate that KGCMC activities are not impacting the environment of Greens Creek.

Bruin Creek

Arsenic results at the Bruin Creek sites show fluctuations over a very tight range from 0.1 to 0.27 ug/l (Figure 3.14). In general the upstream (Site 46) produces slightly higher arsenic levels than the downstream (Site 49). Both Bruin Creek sites' analytical results remain far below the Alaska Water Quality Standard FWMP target arsenic level of 50 ug/l.

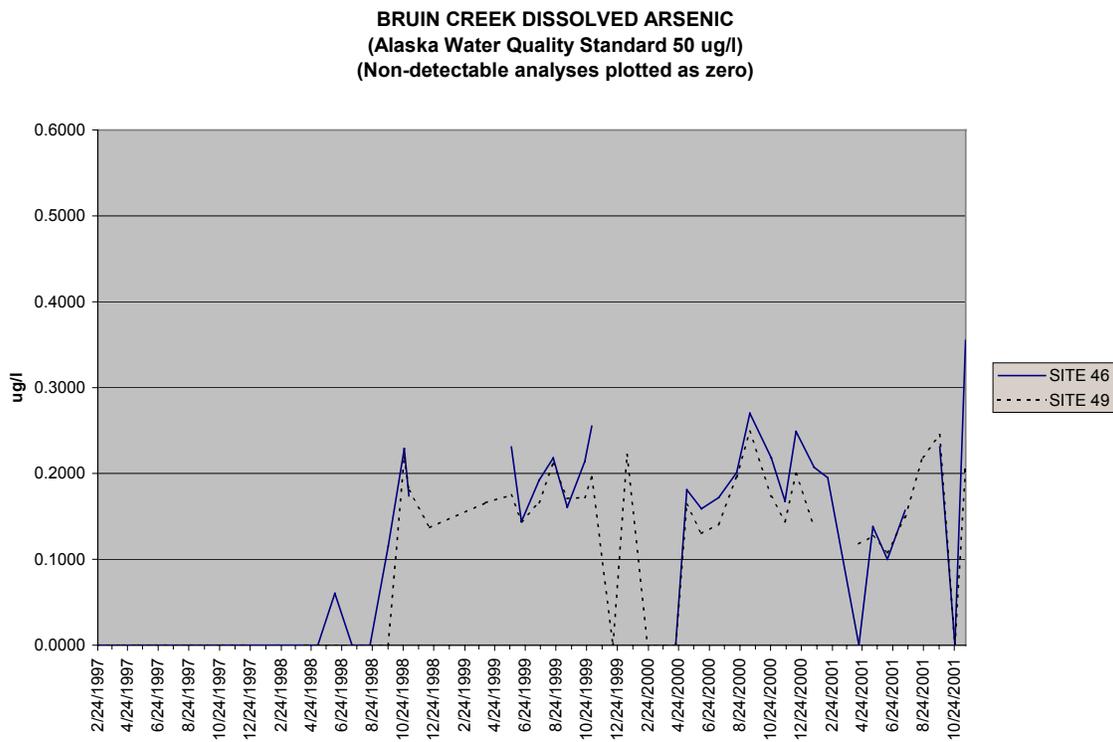


Figure 3.14 FWMP Sites 46 and 49 Arsenic Data

Copper analytical results at the Bruin Creek sites appear much like those for arsenic. Both sites generally fluctuate in a fairly tight range, from 0.24 to 0.44 ug/l (Figure 3.15), with the upstream (Site 46) generally producing slightly higher copper levels than the downstream (Site 49). Both Bruin Creek sites' analytical results remain far below the Alaska Water Quality Standard FWMP copper target level of 5.1 ug/l.

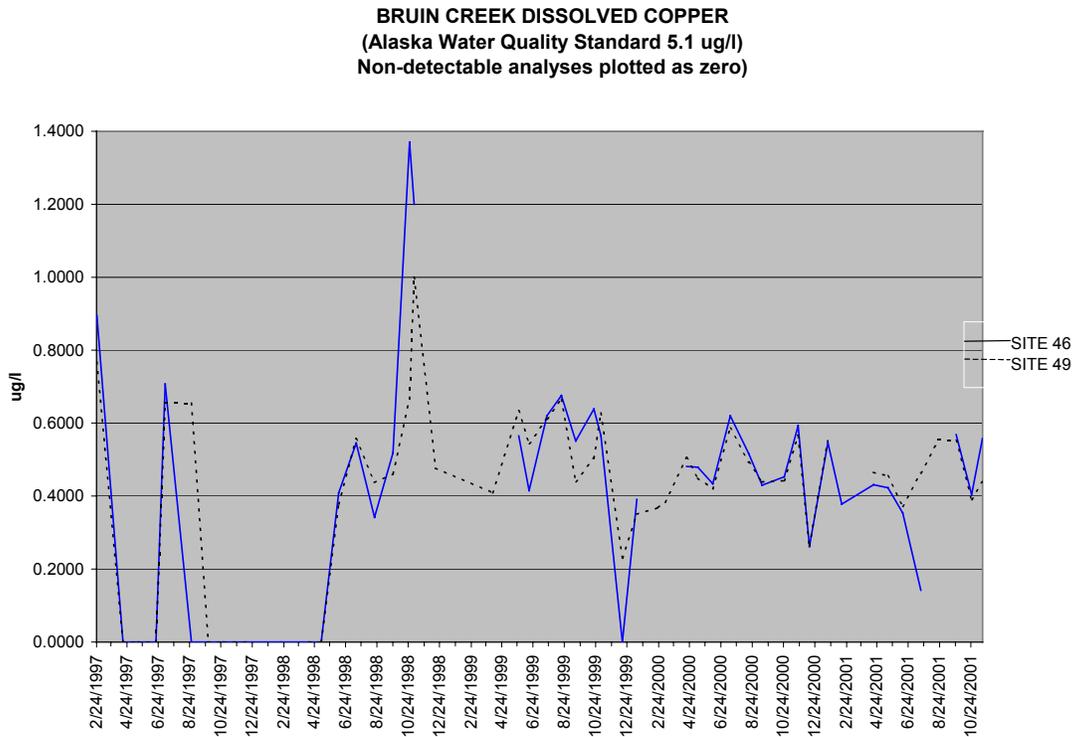


Figure 3.15 FWMP Sites 46 and 49 Copper Data

Mercury results at the Bruin Creek sites follow the same pattern as the above arsenic and copper results. Fluctuations generally find the mercury level between 0.001 and 0.003 ug/l (Figure 3.16), again with the upstream (Site 46) generally producing slightly higher mercury levels than the downstream (Site 49). A spike in both sites' analytical results in April 2000 was still well below the Alaska Water Quality Standard FWMP mercury target level of 0.012 ug/l. These results then dropped right back into the normal range with the following analyses, and have remained in this low range since. Both Bruin Creek sites' analytical results remain far below the Alaska Water Quality Standard FWMP mercury target level of 0.012 ug/l.

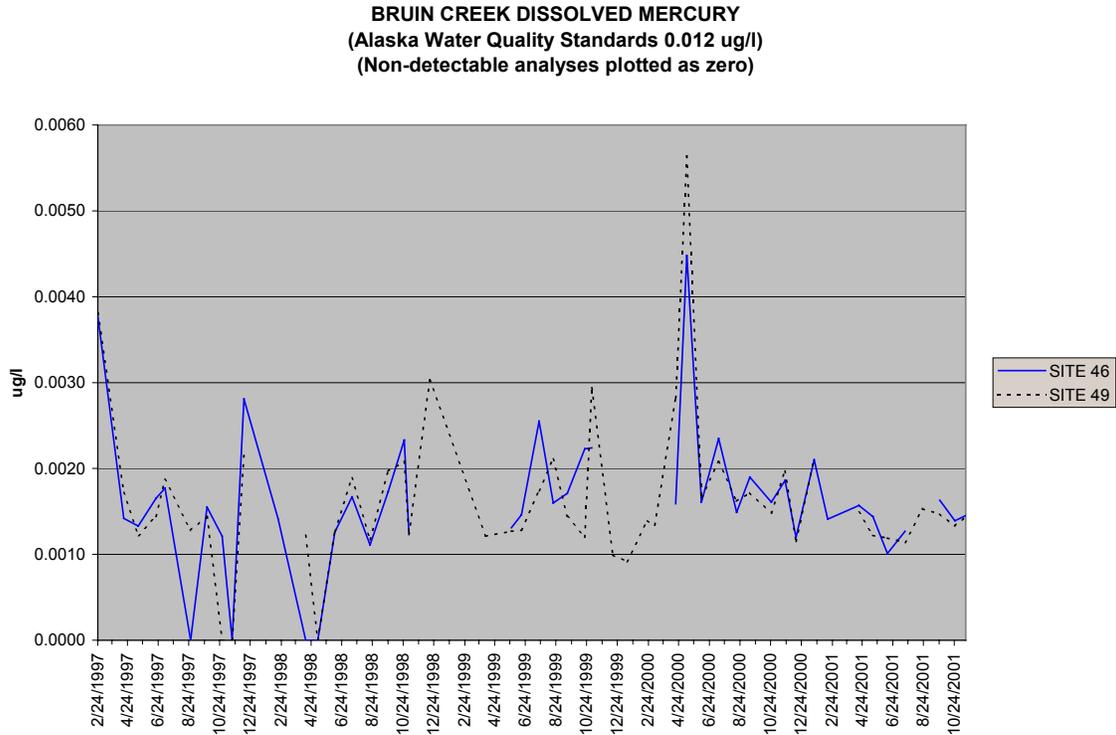


Figure 3.16 FWMP Sites 46 and 49 Mercury Data

Lead results at the Bruin Creek sites follow the same pattern as the above arsenic, copper, and mercury results. Both sites generally fluctuate in a very low, fairly tight range, generally below 0.2 ug/l (Figure 3.17). However, in a difference from the other constituents at the Bruin Creek sites, for lead the downstream (Site 49) generally produces slightly higher lead levels than the upstream (Site 46). Both Bruin Creek sites' analytical results remain far below the Alaska Water Quality Standard FWMP lead target level of 0.9 ug/l.

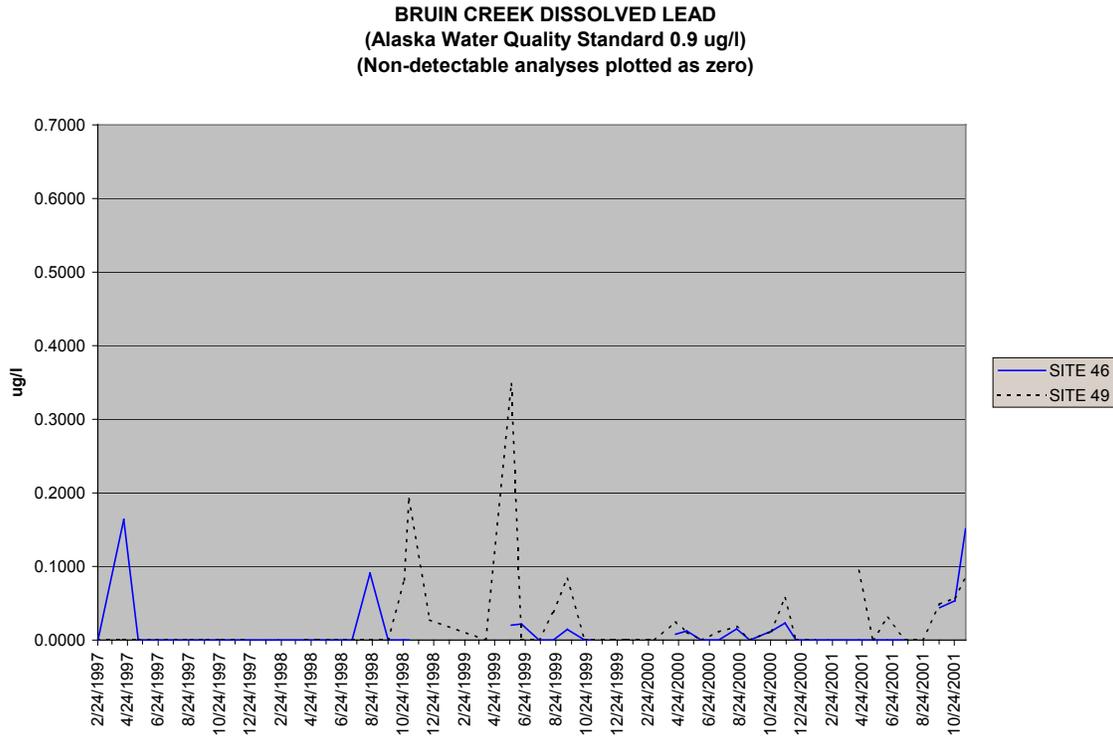


Figure 3.17 FWMP Sites 46 and 49 Lead Data

Zinc results at both Bruin Creek sites have remained low and stable. Over the past three years these results have shown the two sites to “trade” back and forth with the highest/lowest analytical zinc level generally between 2 and 4 ug/l (Figure 3.18). Both Bruin Creek sites’ analytical results remain far below the Alaska Water Quality Standard FWMP zinc target level of 45.6 ug/l.

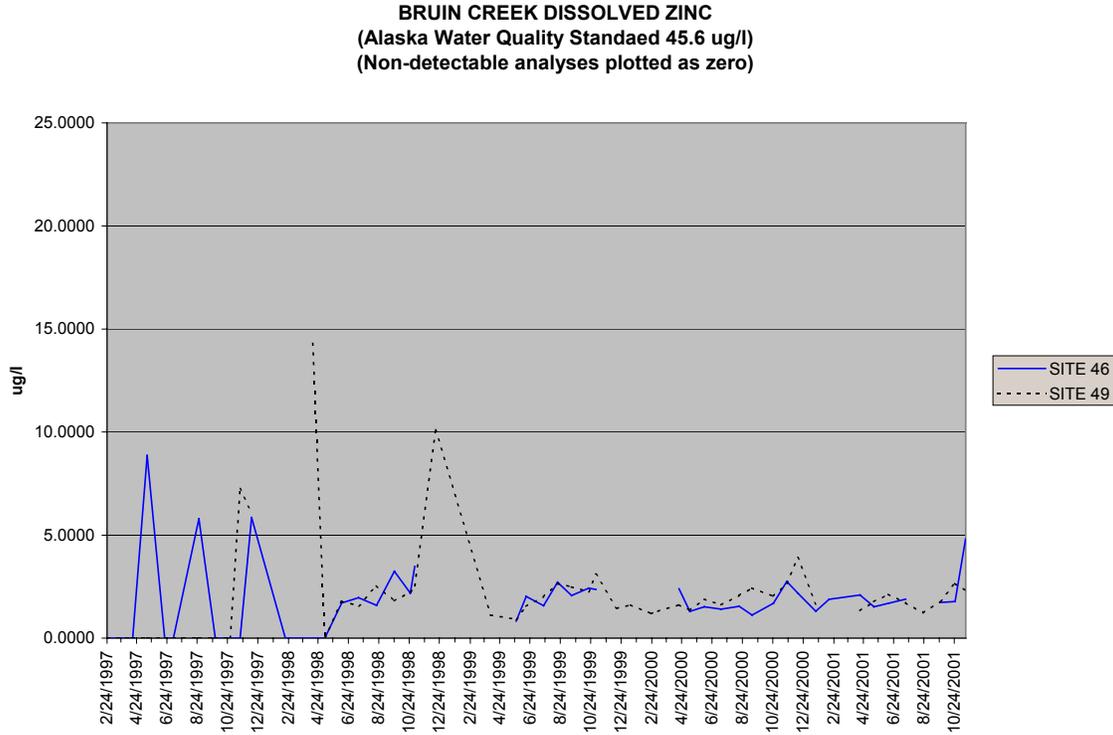


Figure 3.18 FWMP Sites 46 and 49 Zinc Data

Greens Creek

Arsenic analytical result levels from the three Greens Creek sites over three years have remained quite stable. Similar to the Bruin Creek monitoring results, the Greens Creek results generally fluctuate between 0.1 and 0.3 ug/l (Figure 3.19). An unexplained spike of 60 ug/l at the upgradient Site 48 was recorded in the September 2001 sample. Other than this unusual, and unaccounted for spike from the site above the KGCMC facilities, all three Greens Creek sites continue to produce analytical results far below the Alaska Water Quality Standard FWMP arsenic target level of 50 ug/l.

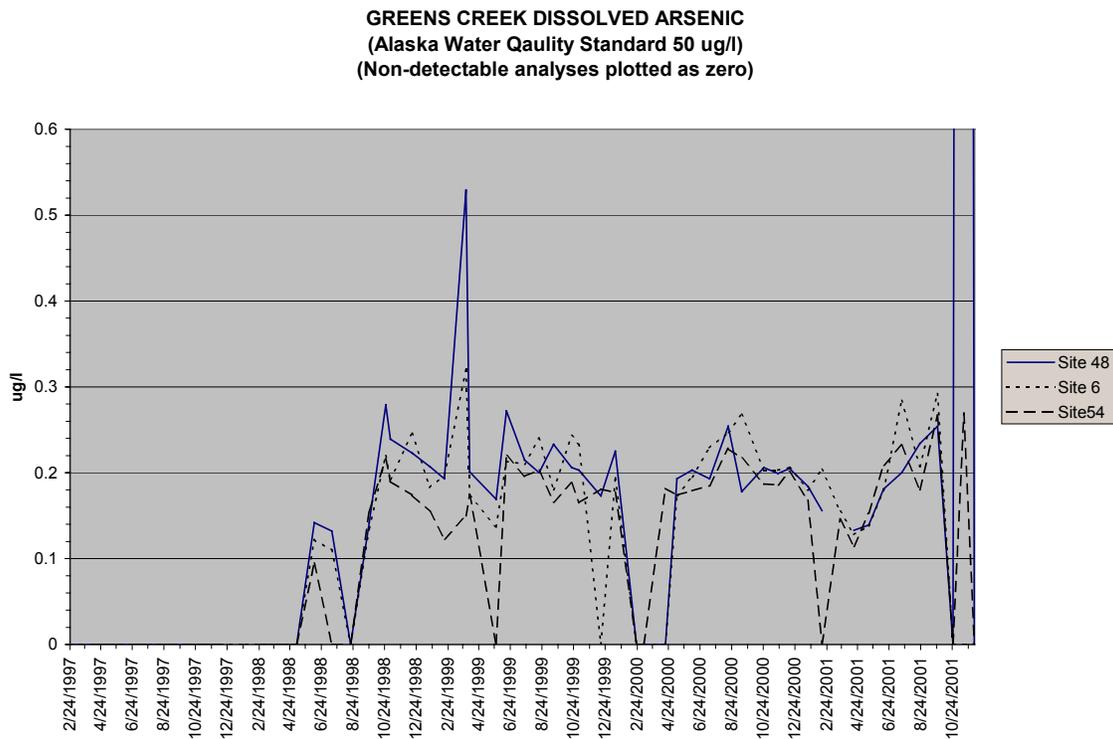


Figure 3.19 FWMP Sites 48, 6 and 54 Arsenic Data

Copper results for the three Greens Creek sites has been similar to the arsenic analytical results. All three Greens Creek sites tend to fluctuate together in a range between 0.2 and 0.6 ug/l (Figure 3.20). Similar to the arsenic analytical results, the upstream Site 48 analysis showed an anomalous spike of 4.27 in the November 2001 sample. The December analytical result dropped right back down to a “normal” 0.265. All three Greens Creek sites continue to produce analytical results far below the Alaska Water Quality Standard FWMP copper target level of 5.1 ug/l.

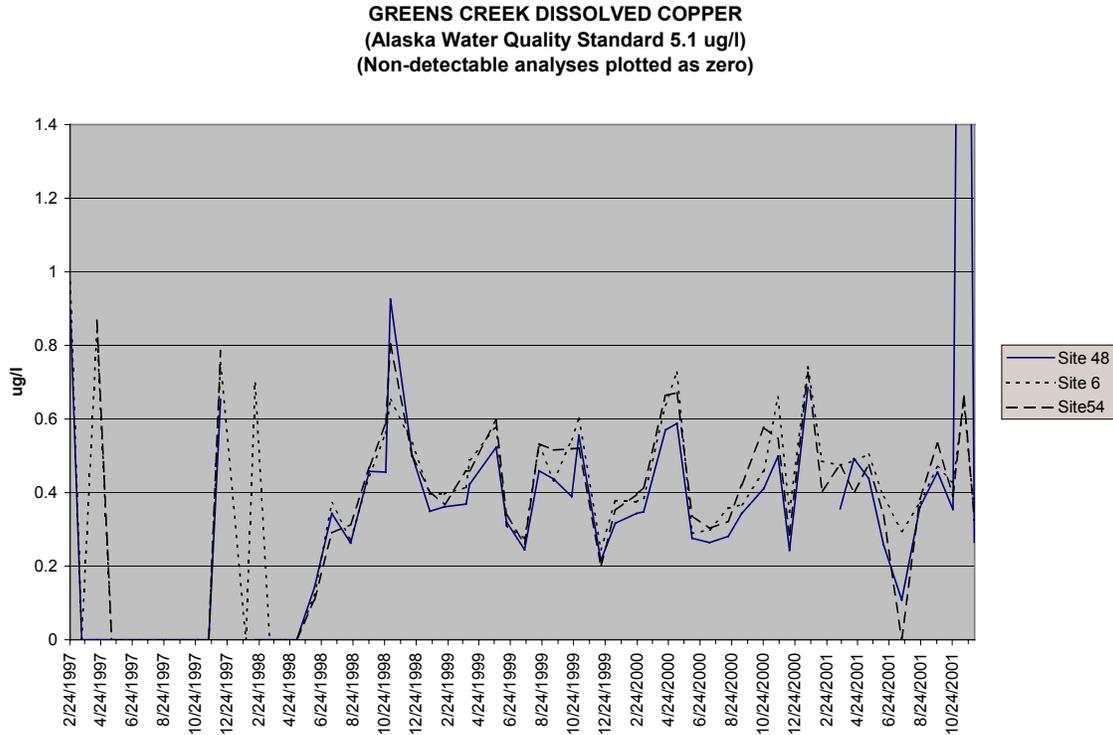


Figure 3.20 FWMP Sites 48, 6 and 54 Copper Data

Mercury results for the Greens Creek sites with fluctuations usually close to 0.001 ug/l (Figure 3.21), show generally slightly lower analytical levels than the Bruin Creek sites. Each of the three Greens Creek sites have shown the highest as well as the lowest analytical level of mercury, interchangeably over the past five years. Other than an anomalous spike way back in early 1997, all three Greens Creek sites continue to produce analytical results far below the Alaska Water Quality Standard FWMP mercury target level of 0.012 ug/l.

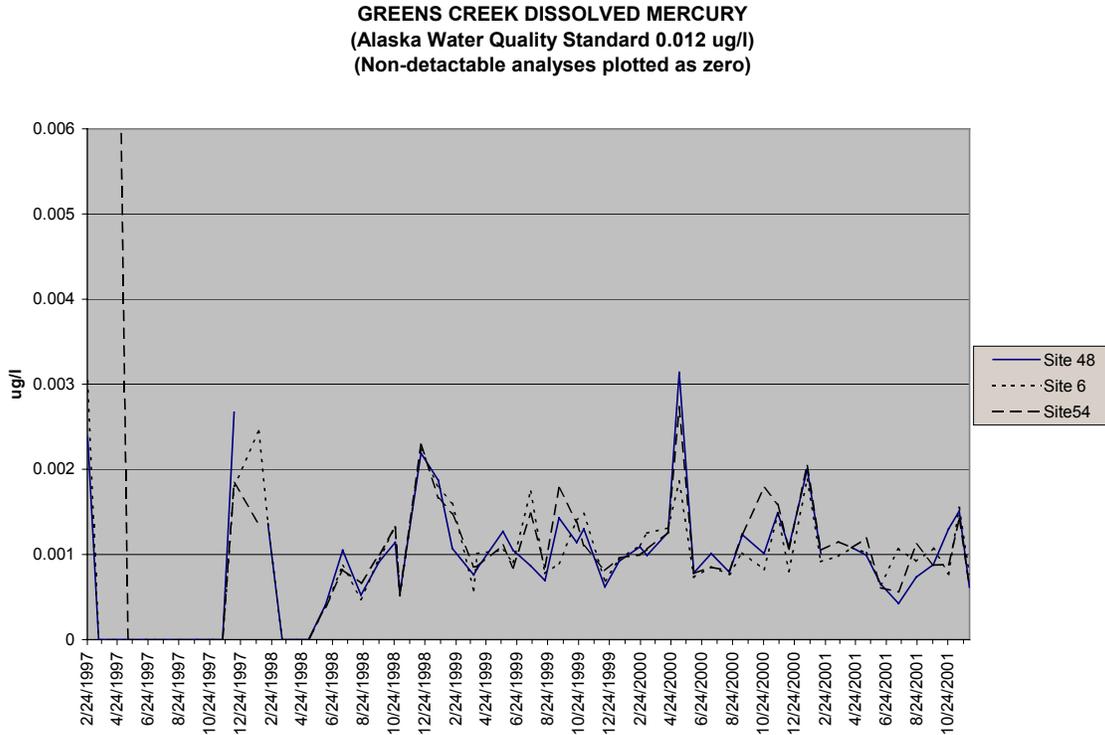


Figure 3.21 FWMP Sites 48, 6 and 54 Mercury Data

Lead results for the three Greens Creek sites, while low (Figure 3.22), have generally shown analytical levels higher than the Bruin Creek results. Additionally, the upstream Site 48 generally records the lowest lead level. Sites 6 and 54 fluctuate back and forth between highest and lowest results. September 2001 saw a spike in lead results at both of the downstream sites which was followed immediately by their return to levels below 0.1 ug/l the next month. Then in November 2001 the upstream Site 48 spiked to 0.663 ug/l while the two downstream site analytical results remained relatively low at less than 0.2 ug/l. December found all three Greens Creek sites analytical results to be undetectable for lead. All three Greens Creek sites continue to produce analytical results well below the Alaska Water Quality Standard FWMP lead target level of 0.9 ug/l.

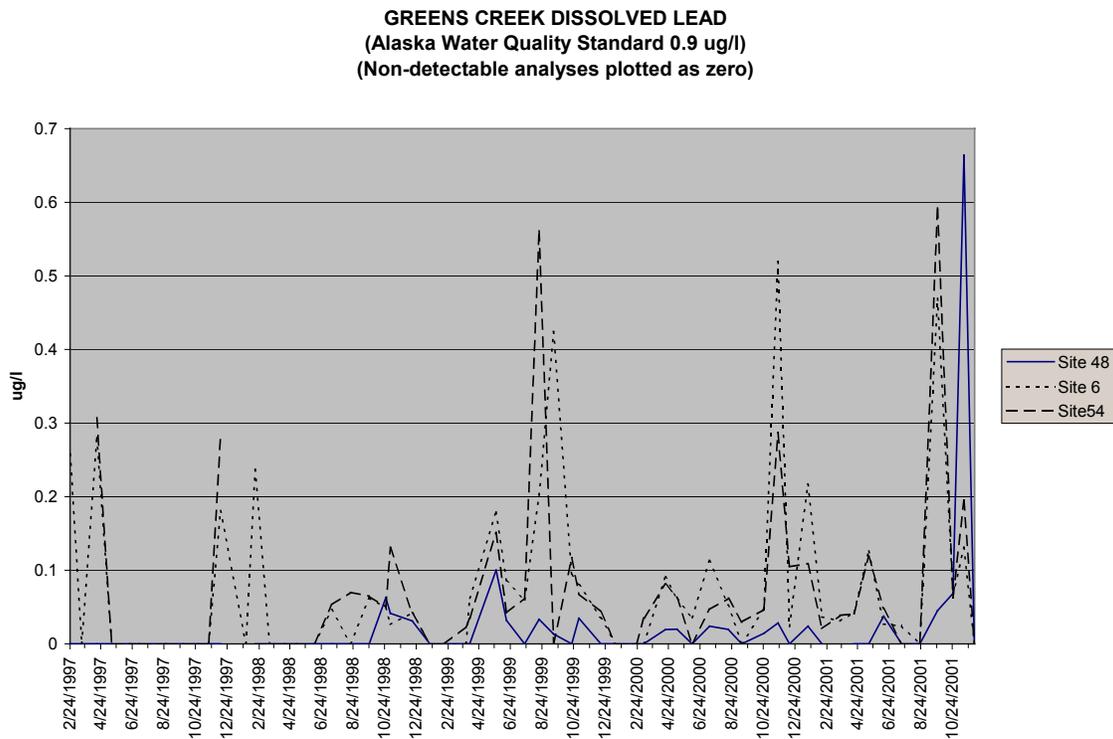


Figure 3.22 FWMP Sites 48, 6 and 54 Lead Data

Zinc results have shown more variability from the Greens Creek sites than the other constituents (Figure 3.23) or the Bruin Creek zinc analytical results. As with the lead results for the Greens Creek sites, zinc analytical results generally show the upstream Site 48 to produce the lowest zinc levels. However, the November 2001 results show an anomalous spike to 37.8 ug/l for that site's results. As with the Greens Creek site's mercury and lead results, zinc results for the two downstream sites fluctuate back and forth between highest and lowest analytical levels. All three Greens Creek sites continue to produce analytical results well below the Alaska Water Quality Standard FWMP zinc target level of 45.6. All three Greens Creek sites continue to produce analytical results well below the Alaska Water Quality Standard FWMP lead target level of 0.012 ug/l.

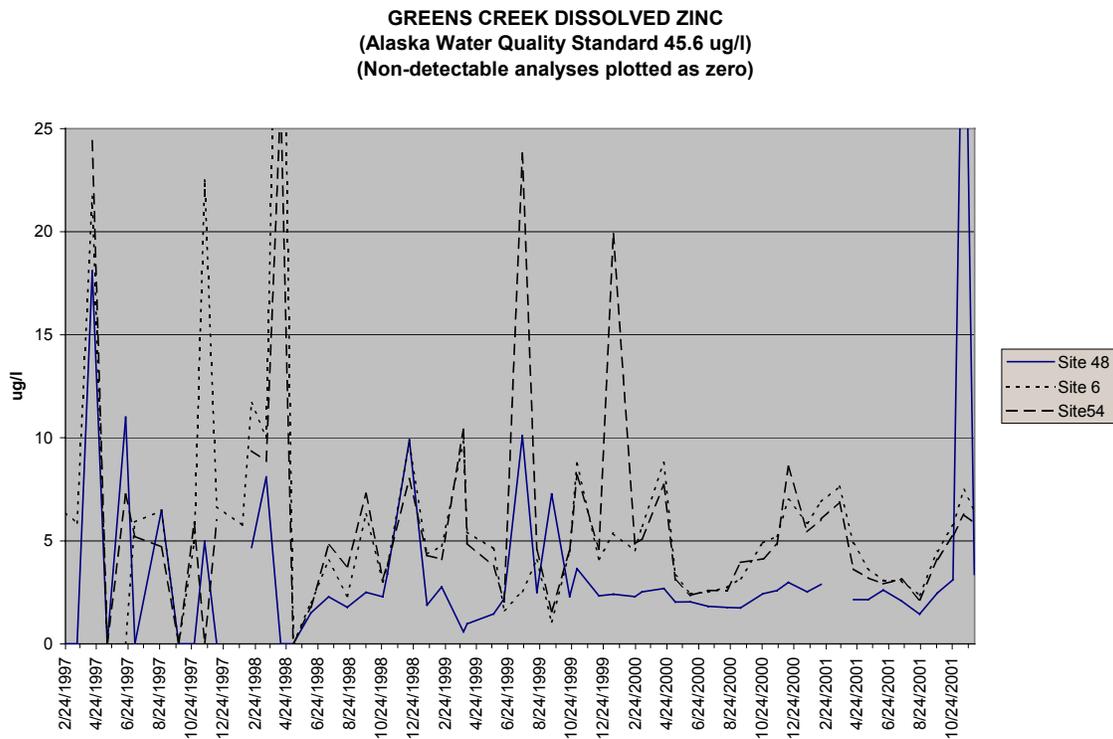


Figure 3.23 FWMP Sites 48, 6 and 54 Zinc Data

### Internal Monitoring

On 31 May 2001 Kennecott Greens Creek Mining Company (KGCMC) submitted an Internal Monitoring Plan to the Alaska Department of Environmental Quality – Solid Waste Management Program. This submittal satisfied Section 2.8.3.1 of the KGCMC Waste Disposal Permit Number 9911-BA006.

As described in permit Section 2.8.3.1, the internal plan addressed monitoring at both the surface tailings facility, and the surface production rock storage areas covered by the permit. The Internal Monitoring Plan describes monitoring within the pile areas, in contrast to the compliance monitoring (under the Fresh Water Monitoring Plan) at peripheral facility boundary sites. As such, data generated by the Internal Monitoring Plan effort are "... not for compliance purposes..." as noted in the above referenced permit Section 2.8.3.1.

Operationally for KGCMC, the production rock Site 23 and the adjacent production rock Site D are treated as a single entity, primarily due to their conterminous positions making isolation from one another unpractical. Consequently, they are referred to as Site 23/D in this report.

On 19 July 2001 KGCMC submitted historic water quality and quantity data collected from the Site 23/D area, and the associated pond/pump station. This submittal satisfied Section 4.1.2.1 of the KGCMC Solid Waste Permit Number 9911-BA006. This data submittal included data from Pond D, as well as the four outlets from the Curtain Drain installed along the common boundary of the two areas (Site 23 & Site D).

The results of KGCMC's Site 23/D internal site monitoring plan (outlined in KGCMC letter to ADEC 31 May 2001) are summarized in Figures 3.24 to 3.32. Sample collection from the Site 23 finger drains is dependent upon their flow. KGCMC tries to collect a sample from each drain each month flow is observed. Flow from several of these finger drains is very irregular, in response to infiltration and groundwater fluctuations due to precipitation. An in-depth re-evaluation of the geochemistry and hydrology of Site 23 and Site D is currently being performed by Environmental Design Engineering (EDE) and KGCMC in accordance with Waste Disposal Permit Section 4.1.1. The observations made under the internal monitoring plan are an initial phase and will help define the scope of the study.

Waters represented by the internal monitoring sites are captured, routed to the mill or tailings facility and treated prior to discharge to the ocean floor under KGCMC's National Pollutant Discharge Elimination System Permit (AK 004320-6).

Figure 3.24 shows the pH of waters collected from Site 23 Finger Drains 2 through 8, monitoring wells MW-23-A2D, MW-23-A4, MW-D3 and Pond D (see as-built in Appendix 2 for locations). Values of pH were between 6 and 8.5 for all internal monitoring site samples in 2001. The lower pH values (generally pH 6 to 7) were recorded in MW-23-A4 and MW-D3, both of which are completed in alluvial sands beneath Site 23 and Site D, respectively. MW-23-A2D, which screens colluvium above Site 23 typically has the highest pH (generally pH 7.5 to 8). The Site 23 finger drains fluctuate at values between those of the monitoring wells. Albeit chaotic, Figure 3.24 suggests that waters from different foundation units have different pH values and that Site 23 and Site D contact waters and the materials with which they are in contact exhibit sufficient buffering capacity to prevent acidification of site drainage in the near term.

**GREENS CREEK SITE 23/D INTERNAL MONITORING SITES - FIELD pH**  
 (Non-detectable analyses plotted as zero)

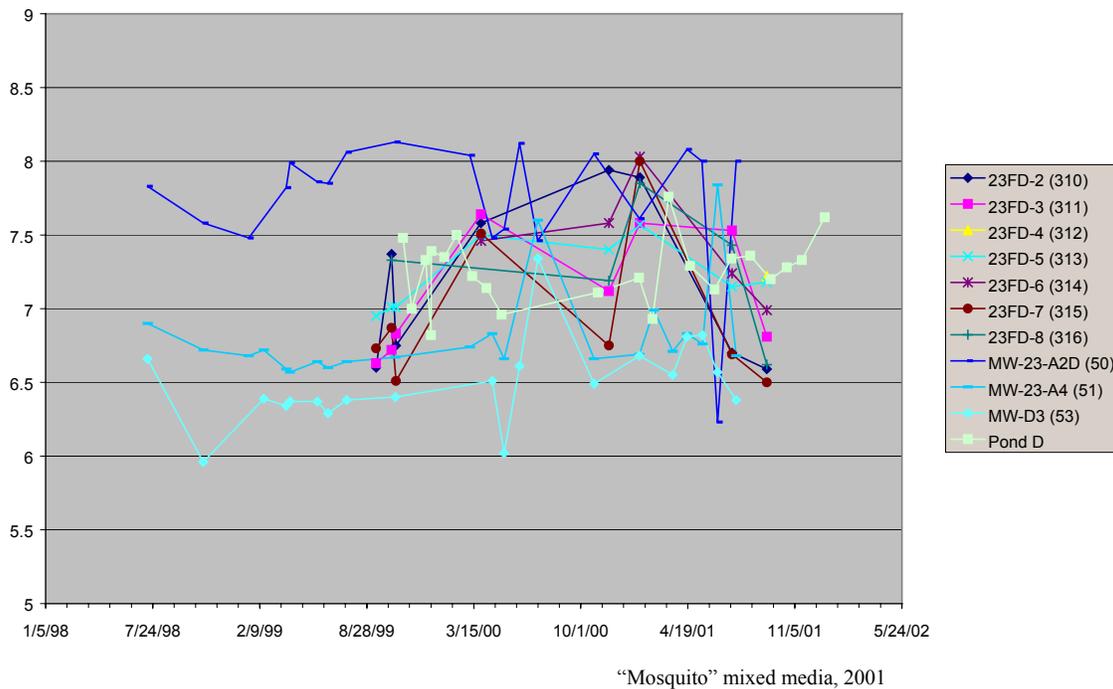


Figure 3.24 Site 23/D Internal Monitoring Plan Sites – pH Data

The conductivity results from internal monitoring site waters are presented in Figure 3.25. 2001 conductivity measurements range up to 5000 uS/cm. MW-23-A2D and MW-D3 have the lowest conductivity. MW-D3 is completed in alluvial sands below the fill placed at Site D. The finger drains with the highest flow (e.g. FD-5, which directly drains an excavated spring) have the lowest conductivity. This reflects a larger contribution from groundwater relative to site contact water than in the other finger drains. The significant decrease in conductivity in FD-7 that occurred in 2000 is probably the result of incorporation of groundwater collected in the upper portion of the drain above the active placement area. The presence of contact water in the alluvial sand below Site 23 (as seen in MW-23-A4) is not surprising given the permeable nature of the colluvium that lies immediately beneath the site. A clay till layer underlies the colluvium and alluvial sands beneath the site. The clay till acts as a barrier to downward flow, however it is well below the base of both piles.

The fact that MW-D3 does not show signs of a contribution from contact water suggests that an upward hydrologic gradient may exist beneath Site D. Finger Drain FD-2 has the highest conductivity but consistently low flow, suggesting no significant influence from groundwater. This drain may also be influenced by runoff that infiltrates along the access ramp to the site. The higher conductivity of the site contact waters reflects a larger dissolved load caused by weathering of the production rock. As with tailings, pyrite oxidation and carbonate dissolution contribute dissolved ions such as sulfate, bicarbonate, calcium and magnesium to the contact waters, increasing their conductivity. Sulfate concentrations for the finger drains are plotted in Figure 3.26 and match closely the values of conductivity.

**GREENS CREEK SITE 23/D INTERNAL MONITORING SITES - FIELD CONDUCTIVITY**  
 (Non-detectable analyses plotted as zero)

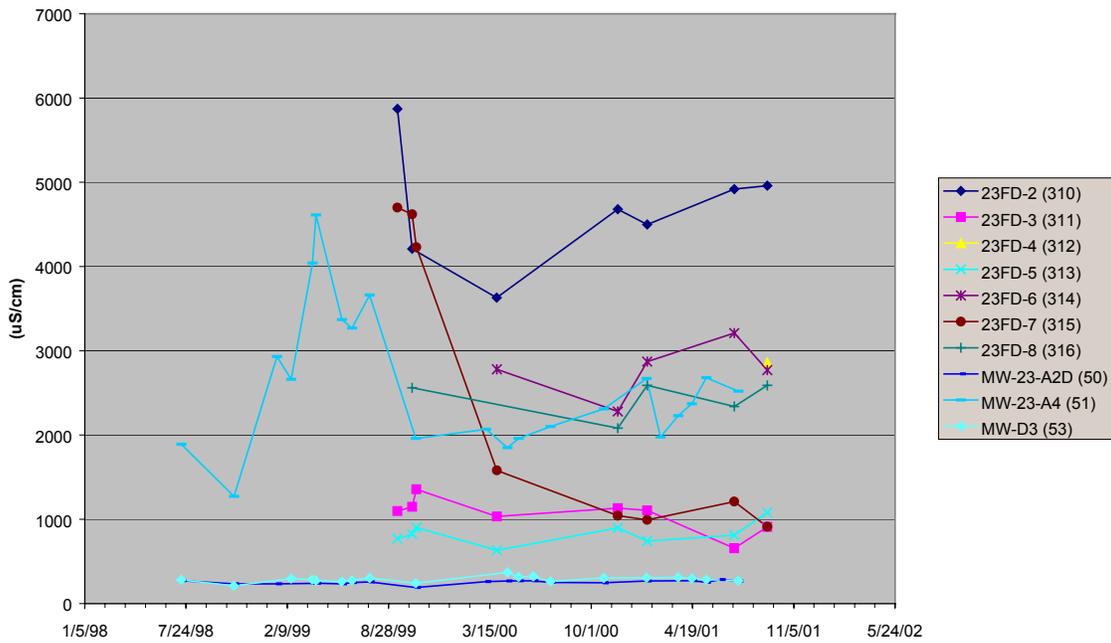


Figure 3.25 Site 23/D Internal Monitoring Plan Sites – Conductivity Data

**GREENS CREEK SITE 23/D INTERNAL MONITORING SITES - SULFATE**  
 (Non-detectable analyses plotted as zero)

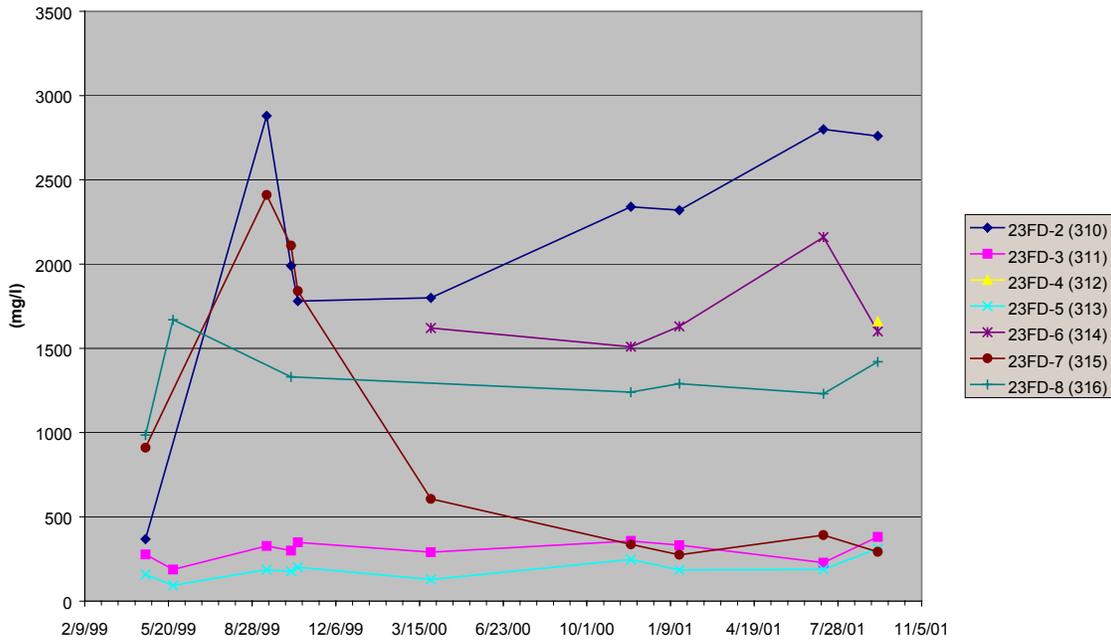


Figure 3.26 Site 23/D Internal Monitoring Plan Sites – Sulfate Data

Arsenic data are presented in Figure 3.27 and are generally quite low (less than three ppb in 2001). The downward trend for Arsenic in FD-2 is opposite that of sulfate and other metals for this finger drain. The decrease does not appear to be related to pH changes and may reflect changes in redox conditions or relative contributions from source waters.

Figure 3.28 shows the concentration of zinc in the 11 internal monitoring sites. Zinc levels appear to be controlled by seasonal conditions. The changes in zinc concentrations mimic those for conductivity and sulfate. Although FD-2 shows an increasing trend for zinc and other metals, zinc concentrations in the range of 20 to 40 mg/l are consistent with kinetic weathering test performed on samples of argillite and serpentinite (Vos 1993). The zinc concentrations recorded for Pond D are generally below 0.7 mg/l and reflect contributions from several source waters. Pond D receives water from Site D surface runoff, seeps on the slope and at the toe of the site and the effluent from the curtain drain that KGCMC installed between Site D and Site 23.

The concentrations of lead and copper (Figures 3.29 and 3.30) are considerably lower than that of zinc in the Site 23/D internal monitoring sites. Both of these metals show the same general trends as zinc with the exception of one anomalous lead result in a sample from FD-2 in 1999. The nickel concentrations presented in Figure 3.31 support the observation that the drainage from FD-2 is different than that of other drainages. It is possible that the material that supplies water to this drain has a greater proportion of serpentinite, which was shown to produce higher zinc and nickel concentrations than other rock types such as argillite and phyllite (Vos 1993). KGCMC will continue to investigate the potential causes for the unique composition of the water from FD-2.

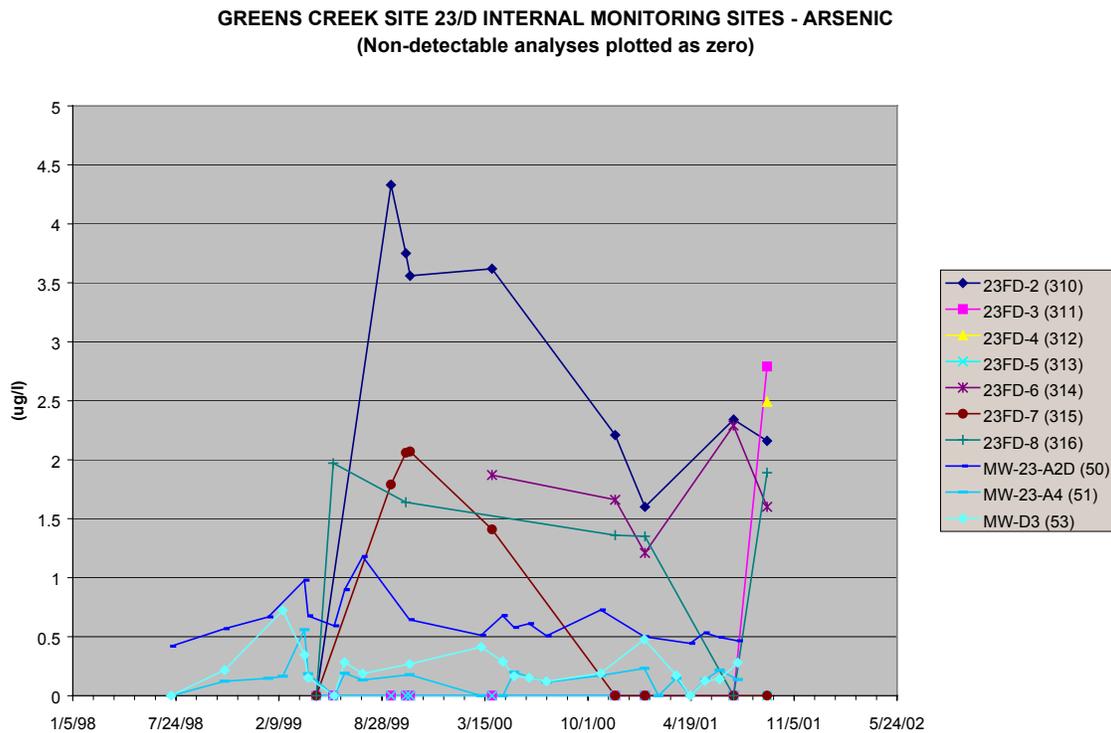


Figure 3.27 Site 23/D Internal Monitoring Plan Sites – Arsenic Data

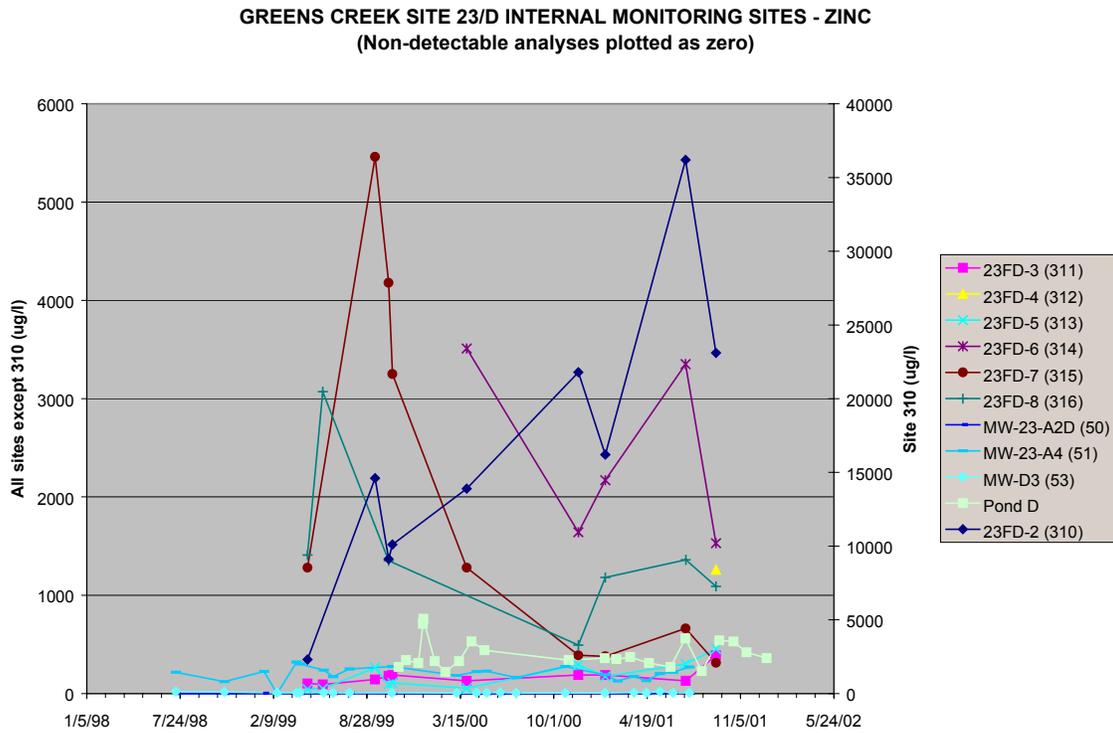


Figure 3.28 Site 23/D Internal Monitoring Plan Sites – Zinc Data

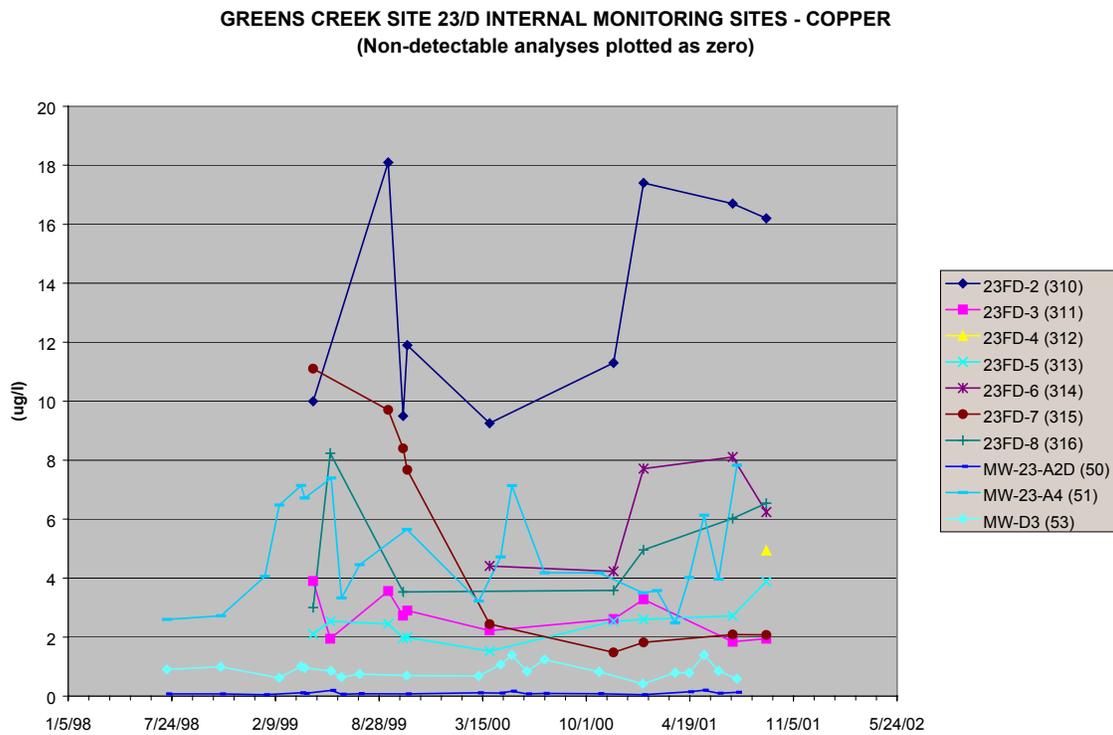


Figure 3.29 Site 23/D Internal Monitoring Plan Sites – Copper Data

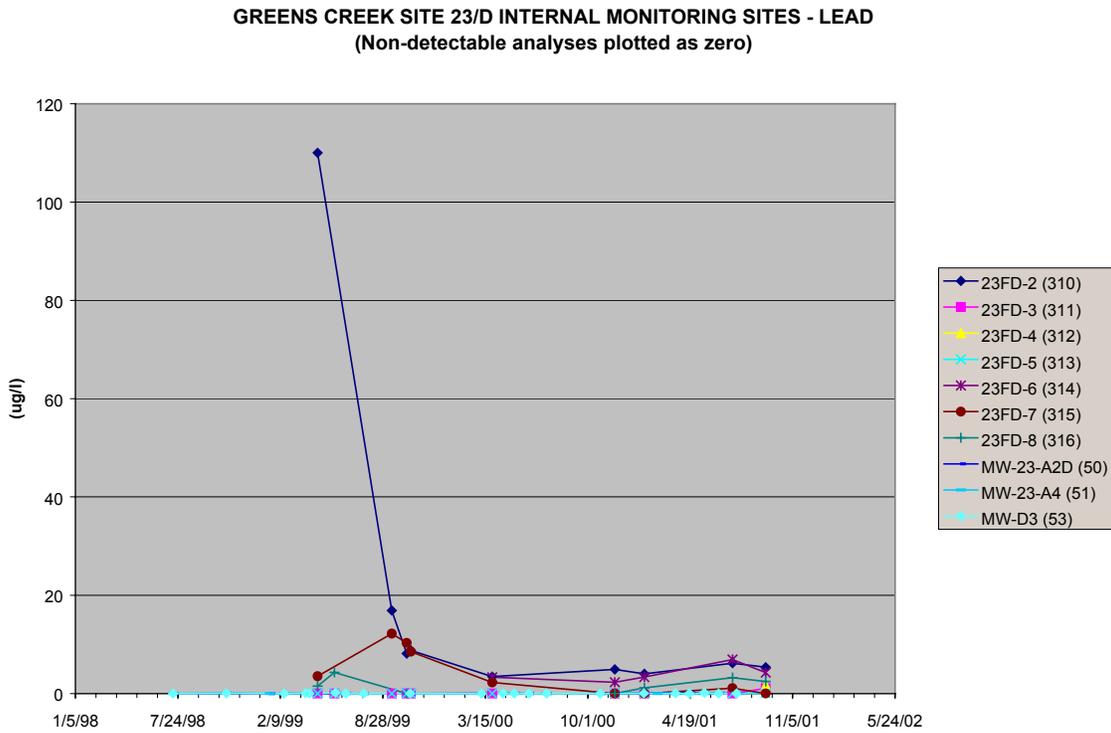


Figure 3.30 Site 23/D Internal Monitoring Plan Sites – Lead Data

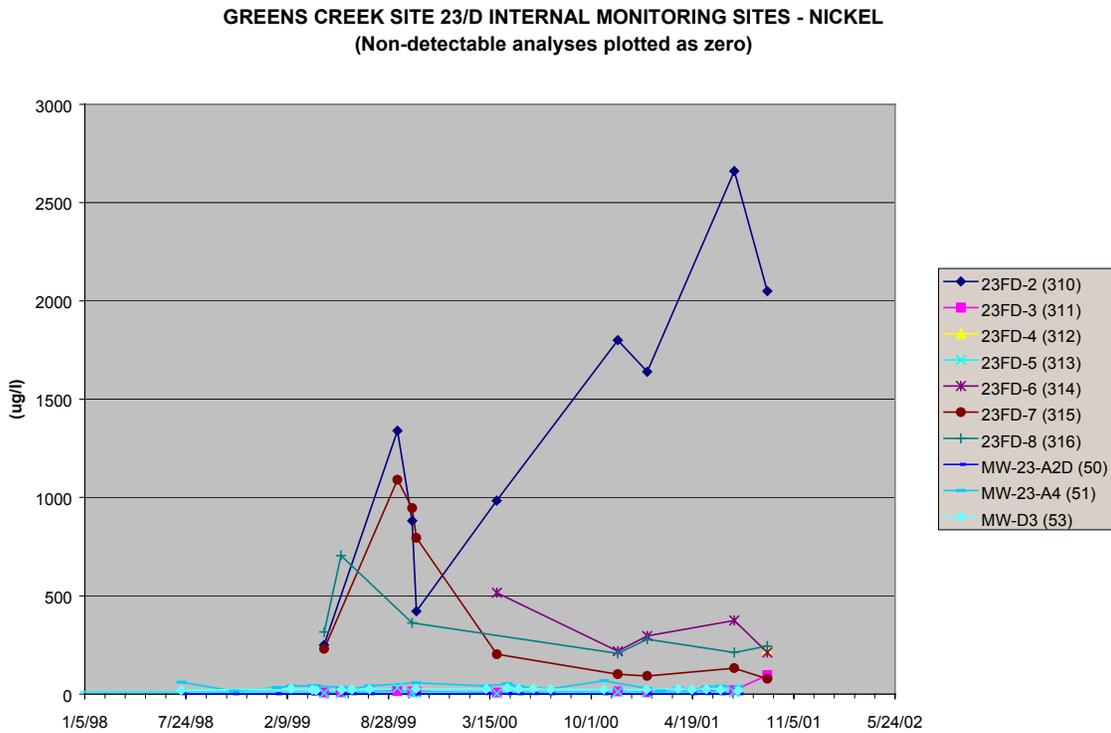


Figure 3.31 Site 23/D Internal Monitoring Plan Sites – Nickel Data

**GREENS CREEK SITE 23/D INTERNAL MONITORING SITES - FLOW**

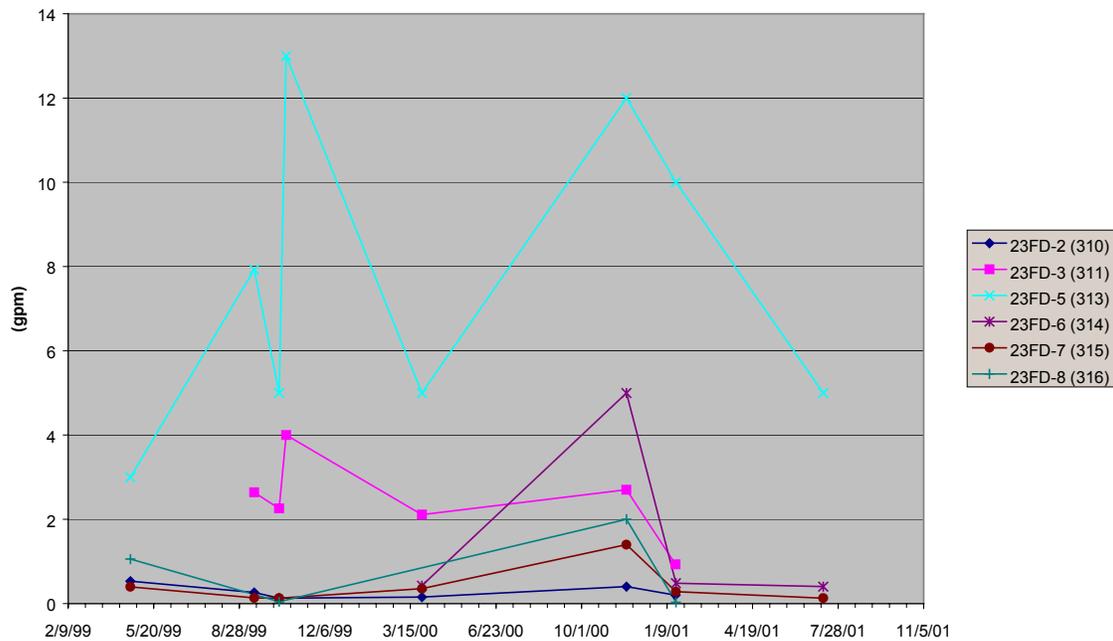


Figure 3.32 Site 23/D Internal Monitoring Plan Sites – Flow Data

Acid Base Accounting Data

Acid base accounting (ABA) results from 55 underground composites are presented in Table 3.4. Class 1 samples had an average neutralization potential (NP) of 493 tonsCaCO<sub>3</sub>/1000t, which is equivalent to almost 50% carbonate. The Class 1 samples had an average acid potential (AP) of 101 tonsCaCO<sub>3</sub>/1000t, which produced an average net neutralization potential (NNP) of 392 tonsCaCO<sub>3</sub>/1000t. Class 1 production rock does not have the potential to generate acid rock drainage, however the potential for metal mobility (primarily zinc) exists. KGCMC recognizes this characteristic of Class 1 production rock and handles the material accordingly by placing it in controlled facilities such as Site 23 and the tailings area.

Class 2 production rock samples had a relatively high NP value (307 tonsCaCO<sub>3</sub>/1000t) and an AP of 150 tonsCaCO<sub>3</sub>/1000t. The resulting NNP for the Class 2 samples was 156, which actually falls in the Class 1 classification bracket (NNP greater than 100 tonsCaCO<sub>3</sub>/1000t). This supports the observation that KGCMC takes a conservative approach to classifying its production rock. Class 3 samples had an average NP, AP, and NNP of 112, 246 and -134 tonsCaCO<sub>3</sub>/1000t, respectively. These data indicate that the Class 3 materials have the potential to generate acid rock drainage. Class 3 production rock that is brought to Site 23 is placed toward the center of the pile so that it is as far from the outer surface of the pile as possible (see Site 23 as-built cross sections for designated placement zones). This reduces the potential for oxidation during pile construction and after closure when a composite soil cover will further minimize oxygen availability. Class 4 samples produced an NNP of -307 tonsCaCO<sub>3</sub>/1000t, which is just below the cutoff for Class 3 material (-300 tonsCaCO<sub>3</sub>/1000t). All Class 4 material was retained underground.

Table 3.4 Acid Base Accounting and Assay Data Summary for Production Rock Samples

Class #	NP	AP	NNP	Fe(%)	Pb(%)	Zn(%)
1	493	101	392	2.73	0.18	0.23
2	307	150	156	4.08	0.13	0.13
3	112	246	-134	6.71	0.51	0.83
4	163	470	-307	12.63	0.26	0.91

units ABA units tons CaCO<sub>3</sub>/1000t

NP determined by standard Sobek method

AP determined from iron assay (converted to pyrite equivalent)

### Biomonitoring

Biomonitoring at Greens Creek was restarted following a program added to the revised FWMP in 2001 as noted earlier. Program design was based upon preliminary sampling conducted in 2000. Five different aspects make up this phase of monitoring at Greens Creek; periphyton biomass, benthic macroinvertebrate community structure and abundance, juvenile fish populations, juvenile fish whole-body metals loading, and laboratory micro-toxicity testing. This range of monitoring techniques is designed to detect early changes to the aquatic community that may result from changes in water chemistry, either through surface or ground water inputs to the monitored systems.

Streams draining areas of Greens Creek activities are monitored for indications of effects from those mining, milling and associated activities under the biomonitoring program. The biomonitoring efforts are coordinated with the ongoing FWMP water quality monitoring at Greens Creek. Sampling is conducted at established FWMP surface water monitoring sites. Water samples for FWMP quality analyses are collected concurrently with the biomonitoring samples.

The Tributary Creek biomonitoring site (Site 9) lies downstream from the Southern Tailings area wells discussed above, downgradient of the muskeg in which they are situated. As the tailings facility sets atop the hydrologic divide at the head of Tributary creek, there is no upstream biomonitoring site for the tailings facility. Three monitoring sites comprise the Greens Creek biomonitoring effort. One site lies upstream of the Greens Creek facilities (Site 48). A second site (Site 6) lies between the mine/mill activities and the production rock Site 23/D. The third Greens Creek biomonitoring site (Site 54) lies downstream from the Site 23/D production rock storage area.

For presentation optimization, results from the Site 23/D and Tailings biomonitoring are presented together. Tributary Creek's lower elevation and gradient, as well as proximity to the ocean clearly influences the site differences seen in the following material.

### Periphyton

Periphyton biomass is estimated by chlorophyll concentrations. The three Greens Creek sites clearly show a different signature than the Tributary Creek site (Figure 3.33). Chlorophyll-a clearly dominates all four sites with levels of 0.16 to 16.6 mg/m<sup>2</sup> at Site 9, with 0.3 to 5.4 mg/m<sup>2</sup> at Site 48, and 0.37 to 5.4 mg/m<sup>2</sup> at Site 6, and 1.4 to 4.9 mg/m<sup>2</sup> at Site 54. There are few filamentous green or blue-green bacteria at these stream monitoring sites. Chlorophyll-b is at or

below the laboratory detection level in most-to-all samples at all four sites. Chlorophyll-c at Sites 48 and 54 was found below 0.7 and 0.5 mg/m<sup>2</sup> respectively in all samples. Chlorophyll-c at Site 6 ranged from 0.16 to 1.9 mg/m<sup>2</sup>, comparable to Site 9 where Chlorophyll-c concentrations were found at less than 2 mg/m<sup>2</sup>.

GREENS CREEK 2001 BIOMONITORING  
Periphyton biomass, expressed as concentration of chlorophyll-a, all sites

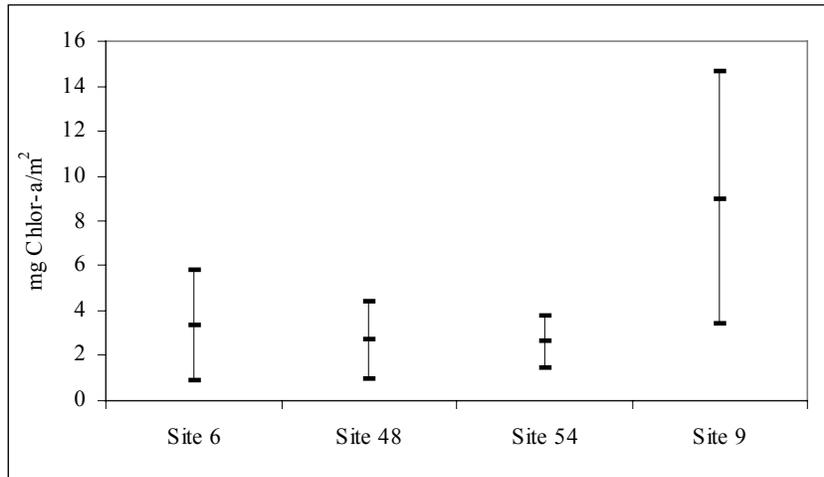


Figure 3.33 Greens Creek Biomonitoring – Periphyton Biomass

### Benthic Macroinvertebrates

Benthic macro-invertebrate densities and number of Taxa identified appear in Figure 3.34. Densities 2 to 3 times greater were found in the Greens Creek sites than those found in Tributary Creek. The 2001 sampling confirmed 20 to 29 macroinvertebrate Taxa at each of the four sites. The three Greens Creek sites were dominated by Ephemeroptera and Plecoptera, while the Tributary Creek site was dominated by Ephemeroptera, Plecoptera, and Trichoptera. Ostracoda were also found common in both streams. Ephemeroptera and Ostracoda are both Taxa known to be sensitive to many pollutants. The high proportion of these Taxa, combined with the high taxonomic richness at all four sampled sites indicates a diverse and complex macroinvertebrate community that is not stressed.

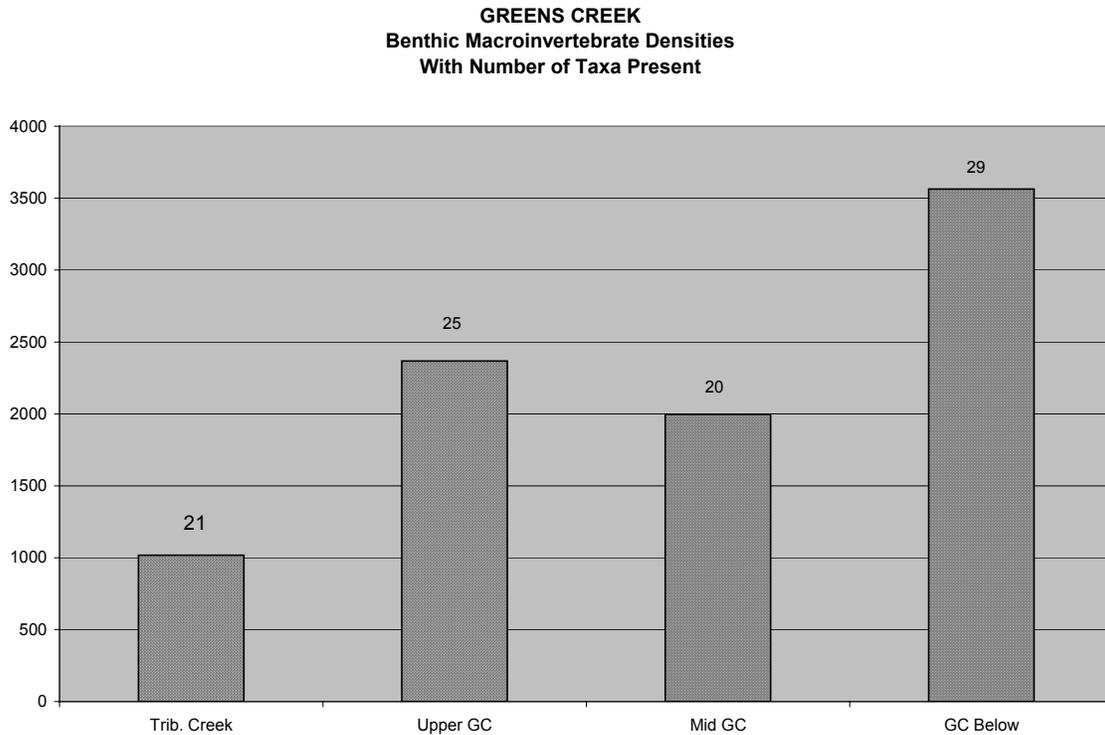


Figure 3.34 Greens Creek Biomonitoring – Benthic Macroinvertebrate Densities

### Juvenile Fish

The Greens Creek sites supported predominately Dolly Varden while Coho salmon parr were also heavily present in Tributary Creek (Figure 3.35). The Tributary Creek densities of both species were considerably higher than regional averages for the stream types. Dolly Varden densities at all three Greens Creek sites were also greater than regional averages for that stream type.

Previous studies had led to expectations of higher Coho numbers in the two lower Greens Creek Sites (6 & 54). The AF&G speculated that the reduced numbers found in the 2001 sampling may have been the result of low Fall flow restrictions on spawning adults, or a small Coho run in 2000. A fish pass structure previously installed by KGCMC has opened access to this stretch of Greens Creek for anadromous fish. However, anadromous fish passage to the upstream site (48) remains impeded by a weir. Therefore, intra-site comparison of the Dolly Varden provides a more meaningful, dependable juvenile fish assessment for the Greens Creek sites.

**GREENS CREEK BIOMONITORING  
 Dolly Varden Population and Density Estimates**

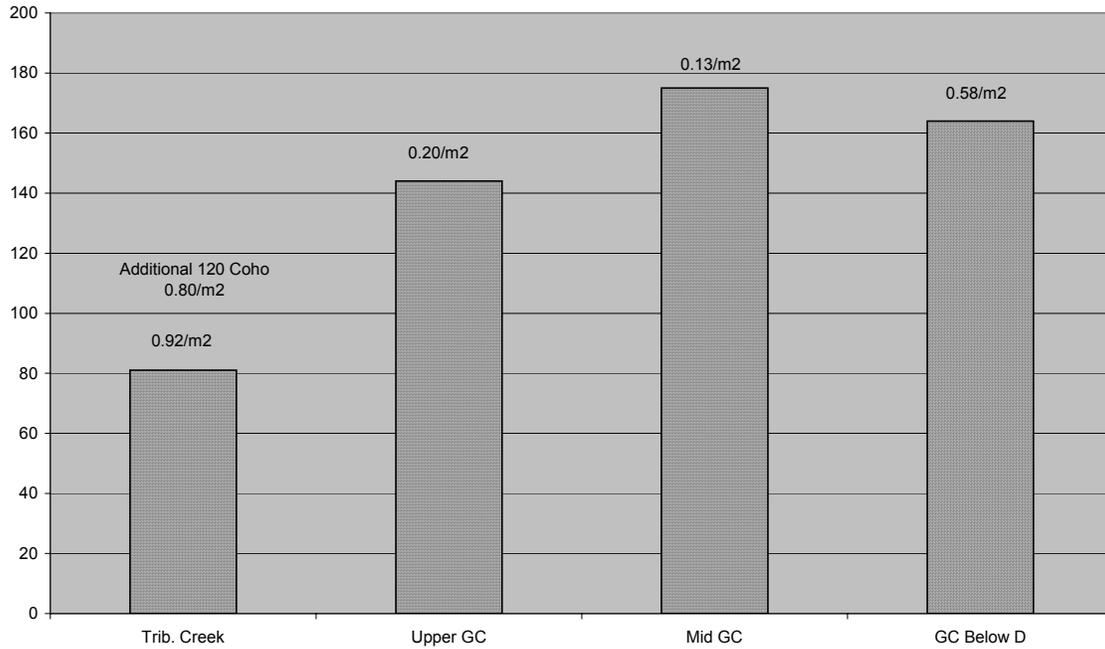


Figure 3.35 Greens Creek Biomonitoring – Dolly Varden Population and Density Estimates

Juvenile Fish Tissue Metals

Analytical results for zinc, the most prevalent metal in the KGCMC ore, fish tissue concentrations have been presented in the Figure 3.36. The three Greens Creek Sites' fish tissue show a slightly higher zinc body burden than the Tributary Creek samples. Zinc tissue concentrations are very similar between the three Greens Creek sites. The metal-rich region, which surrounds the mine, may easily explain the higher zinc concentrations in the Greens Creek samples.

**GREENS CREEK 2001 BIOMONITORING  
 Concentration of Zinc in Juvenile Dolly Varden**

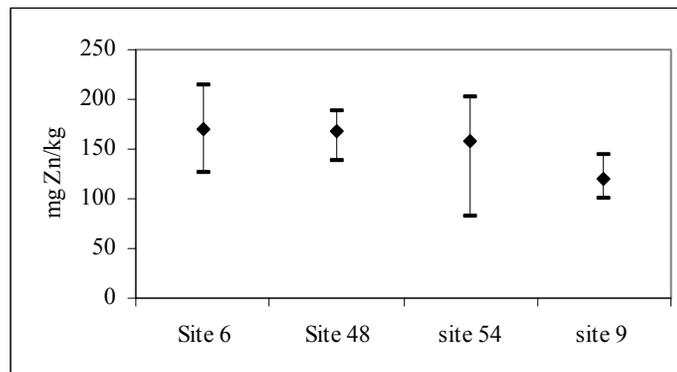


Figure 3.36 Greens Creek Biomonitoring – Zinc Concentrations in Juvenile Dolly Varden

Silver results, conversely to the zinc results in Tributary Creek samples, show a higher body burden of silver than the Greens Creek fish tissues (Figure 3.37). As with the zinc results, silver tissue concentrations are very similar between the three Greens Creek sites. No equally obvious answer for the difference in the silver analyses between the two streams is available.

GREENS CREEK 2001 BIOMONITORING  
Concentration of Silver In Juvenile Dolly Varden

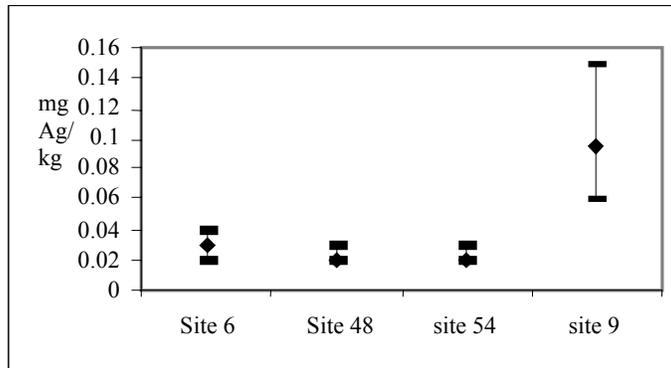


Figure 3.37 Greens Creek Biomonitoring – Silver Concentrations in Juvenile Dolly Varden

Cadmium analyses showed the highest concentrations at Site 48, the upstream site (Figure 3.38), with nearly comparable levels from the Tributary Creek Site 9. The lower two Greens Creek sites produced comparable concentrations of cadmium, yet lower than the Site 48 levels.

GREENS CREEK 2001 BIOMONITORING  
Concentration of Cadmium in Juvenile Dolly Varden

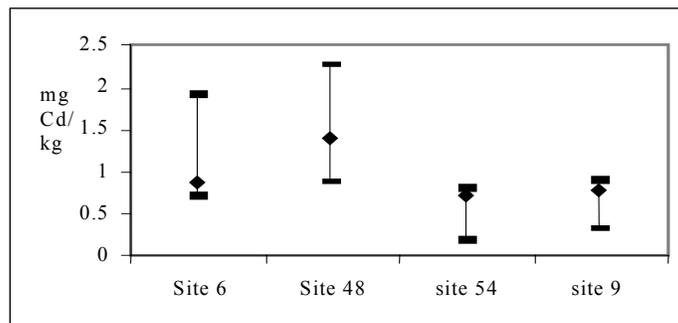


Figure 3.38 Greens Creek Biomonitoring – Cadmium Concentrations in Juvenile Dolly Varden

Copper and Selenium concentrations were similar between the four biomonitoring sites (Figures 3.39 and 3.40). The middle Greens Creek Site 6 copper sample results showed a little bit more variability than the other Greens Creek or Tributary Creek site's results.

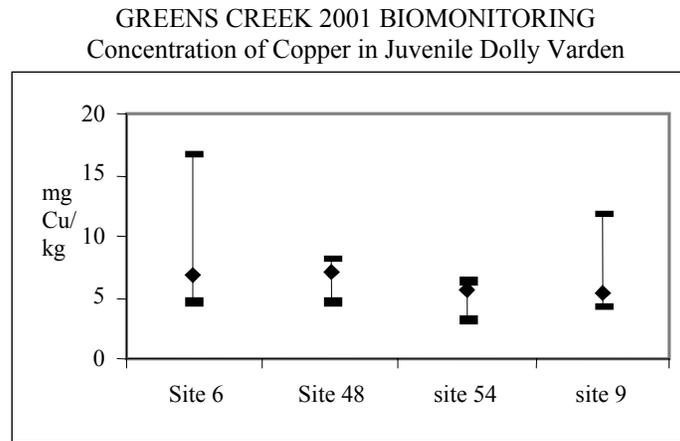


Figure 3.39 Greens Creek Biomonitoring – Copper Concentrations in Juvenile Dolly Varden

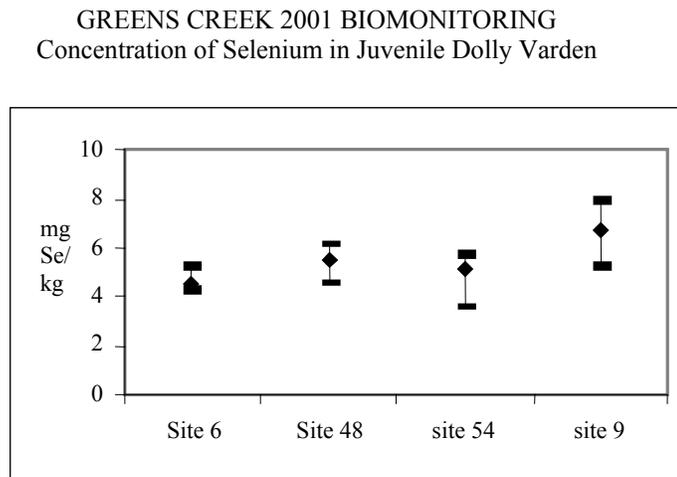


Figure 3.40 Greens Creek Biomonitoring – Selenium Concentrations in Juvenile Dolly Varden

Lead tissue concentrations averaged highest for the middle Greens Creek Site 6 sample results, while the other Greens Creek sites (48 & 54) produced the lowest levels (Figure 3.41). Two fish tissue lead concentrations from the Tributary Creek Site 9 were inordinately high, skewing that site's lead variability results.

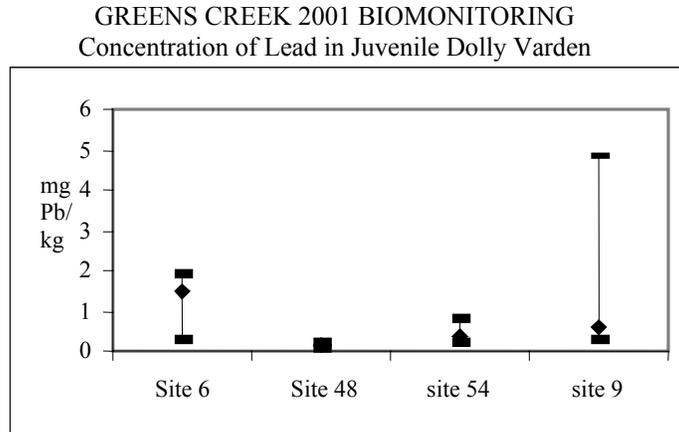


Figure 3.41 Greens Creek Biomonitoring – Lead Concentrations in Juvenile Dolly Varden

#### Toxicity Testing

Microtox toxicity testing of water from all four biomonitoring sites produced the same results. None of the tests at any of the four biomonitoring sites detected acute (one-hour) or chronic (24-hour) toxicity, with growth of the *Vibrio fischeri* bacteria similar to the control for all dilutions tested at each site up to and including undiluted sample water. Because there were no toxic responses, for each site the calculated IC-20 value is >100%. The “IC-20” means the estimated toxicant concentration that would cause a 20 percent reduction in a non-lethal biological measurement of the test organisms. In these microtox tests of KGCMC samples, toxicity was measured by the effect on the growth or cell respiration, and therefore luminescence of the *Vibrio fischeri* bacteria.

### **3.6 General site management**

The construction method used at Site 23 (bottom-up construction) limits the site's complexity. All placement activity in 2001 occurred between the 960 and 990 levels of the pile. Designated placement zones are marked on the active lift of the site and production rock is placed according to class. Class 2 and Class 3 materials are placed five and ten feet, respectively, from the outer edges of the pile. Class 1 can be placed anywhere in the pile but is most often used to provide the thickness required to maintain the five-foot zone between the outer surface and the Class 1,2 placement zone. See Section 3.7 for photographs of designated placement zones.

In 2001 KGCMC began to raise the west portion of the pile where the access ramp reaches the active placement surface. This will facilitate construction of a switchback in the access ramp, which is needed to continue ramp development on the outside surface of the pile.

A small amount of Site 23 backslope material was hauled to the tailings facility for use as erosion protection on the outer slopes of the pile. Otherwise, no changes to the slope above Site 23 were made in 2001.

Routine inspection of Site 23 revealed no problems associated with management of the site.

For a full discussion of the Internal Monitoring Plan submitted by KGCMC to ADEC in May 2001, see Section 3.5 text above.

### 3.7 Site as-built

An as-built for Site 23/D is presented in Appendix 2. The as-built shows the year-end topography, water management features, monitoring device locations, and other significant features of the site. The as-built also includes cross sections that show the following information:

- existing topographic surface
- prepared ground upon which the pile was constructed
- original unprepared ground
- water levels
- designated placement zones for the three production rock classes

Figure 3.42 Aerial Photograph of Site 23/D



This photograph shows Site 23 (foreground) and Site D (separated from Site 23 by the B Road). The composite soil cover plot (green) is visible on the lower slope of Site 23. Pond 23 and Pond D are visible on the southwest (right) perimeters of their respective sites. Reclamation materials have been removed from the slope above Site 23 (below tree line, foreground).

Figure 3.43 Photograph of Site 23 Composite Soil Cover Plot



The photograph shows the recently seeded composite soil cover placed on the lower slope of Site 23. A portion of the lower capillary break is visible below the seeded growth layer. The B Road and lined ditch that brings surface waters to Pond 23 are visible in the foreground.

Figure 3.44 Photograph of Site 23 Designated Placement Zones



The photograph shows the designated placement zones (Class 1, left; Class 2, center; Class 3, right). Marks from the grid roller are visible on the recently spread and compacted production rock surface. The view is looking east.

Figure 3.45 Photograph of Site 23 Foundation Preparation



This photograph shows construction of base of the pile. Native rock and sediments are removed from the back slope and stockpiled for use in future reclamation projects. Finger drains (not visible) are extended over the prepared surface and a five-foot thickness of Class 1 production rock are placed prior to placement of other classes.

Figure 3.46 Photograph of Site 23 Backslope and Designated Placement Zones



The three designated placement zones are visible in the lower half of the photograph. Class 3 in the foreground, Class 2 at center and Class 1 at base of backslope. Safety berms are left between the placement zones. Excavated material from the backslope (upper half of photo) will be used for site reclamation. Monitoring well MW-23-98-01 is visible in the foreground (right). The view is oriented north.

### **3.8 Reclamation**

KGCMC has monitored the performance of a one-acre composite soil cover plot on Site 23 since September 2000 (see Site 23 as-built in Appendix 2 for plot location). The results of the monitoring indicate that the design objectives of the cover system are being attained. Key performance aspects of the cover system include:

- The monitoring indicates that the primary objective of maintaining at least 85% saturation in the compacted barrier layer of the cover has been met. This is significant because maintaining water saturation in the barrier layer minimizes oxygen transport into the underlying production rock.
- Of the 82 inches of precipitation that fell since the lysimeter collection system was installed, approximately 11 inches of percolation into the lysimeter has been recorded. The cover system allowed approximately 13 percent of the incident precipitation into the lysimeter. As the cover system vegetation matures, transpiration is expected to decrease the amount of infiltration through the cover system.
- The temperature in the barrier layer has remained above 32°F throughout the monitoring period, which implies that the barrier layer is not susceptible to freezing during the winter.
- Data capture from the 14 monitoring instruments has been 100% and all components of the field monitoring system are functioning properly.

#### Reclamation Plan

The KGCMC Reclamation Plan, as well as its implementation is discussed above in Section 2.8 Tailings of this report. Please refer to that discussion for aspects relevant to Site 23/D area reclamation.

## **4.0 References**

Environmental Design Engineering (EDE), 2002a Kennecott Greens Creek Mining Company Stage II Tailings Expansion Hydrologic Analysis, February 5, 2002.

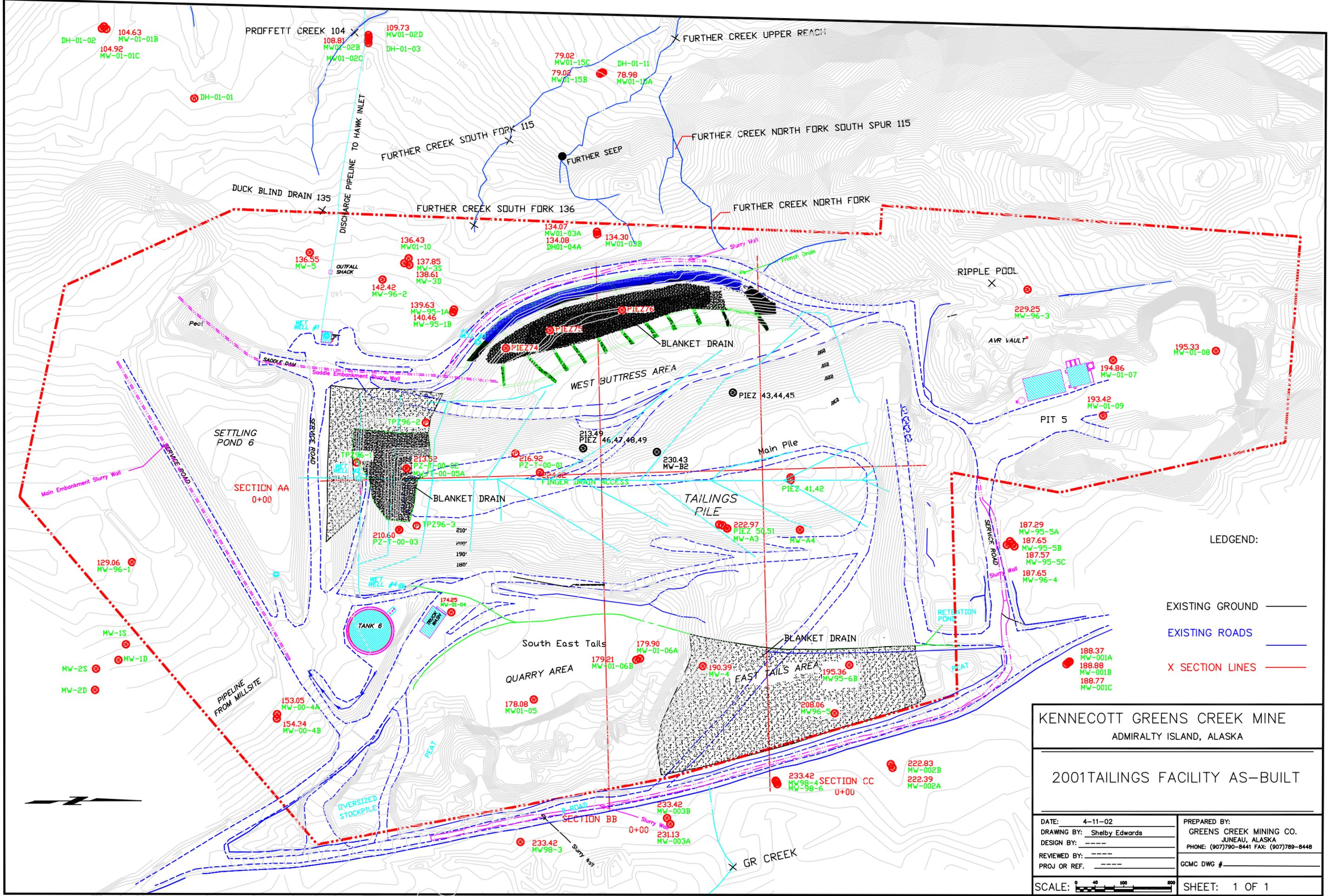
Environmental Design Engineering (EDE), 2002b Kennecott Greens Creek Mining Company Stage II Tailings Expansion Geochemistry Report, February 5, 2002.

Kennecott Greens Creek Mining Company (KGCMC), 2002 Update of Information and Action Plan on Seeps West of the Current Tailings Disposal Facility, January 2002.

Vos, R.J., 1993, Weathering Characteristics of Waste Rock From Admiralty Island Deposit (23 Month Report, B.C. Research Inc., July 1993.

## **APPENDIX 1**

### Tailings Facility 2001 As-built and Cross Sections



- LEDGEND:
- EXISTING GROUND ———
  - EXISTING ROADS ———
  - X SECTION LINES ———

KENNECOTT GREENS CREEK MINE  
ADMIRALTY ISLAND, ALASKA

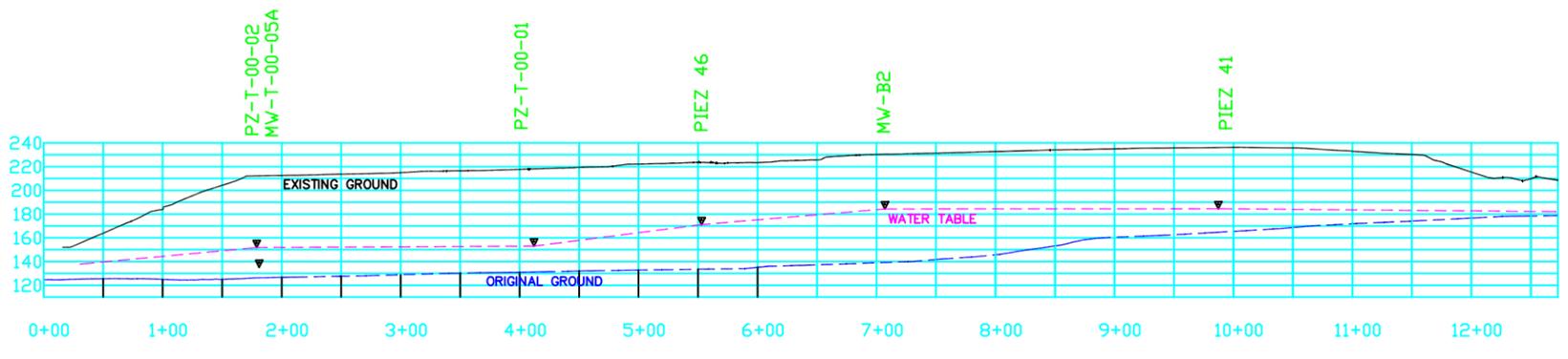
2001TAILINGS FACILITY AS-BUILT

DATE: 4-11-02  
DRAWING BY: Shelby Edwards  
DESIGN BY: -----  
REVIEWED BY: -----  
PROJ OR REF. -----

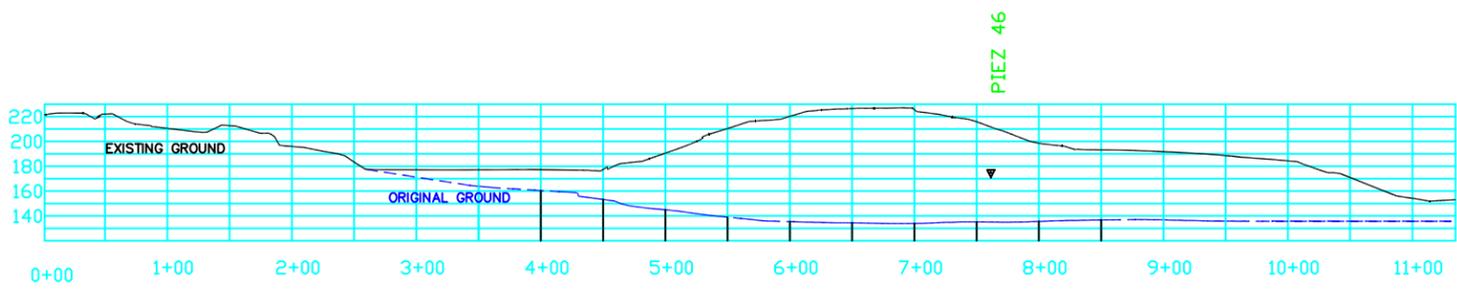
PREPARED BY:  
GREENS CREEK MINING CO.  
JUNEAU, ALASKA  
PHONE: (907)790-8441 FAX: (907)789-8448  
GCMC DWG # -----

SCALE: 0 40 80 160 320

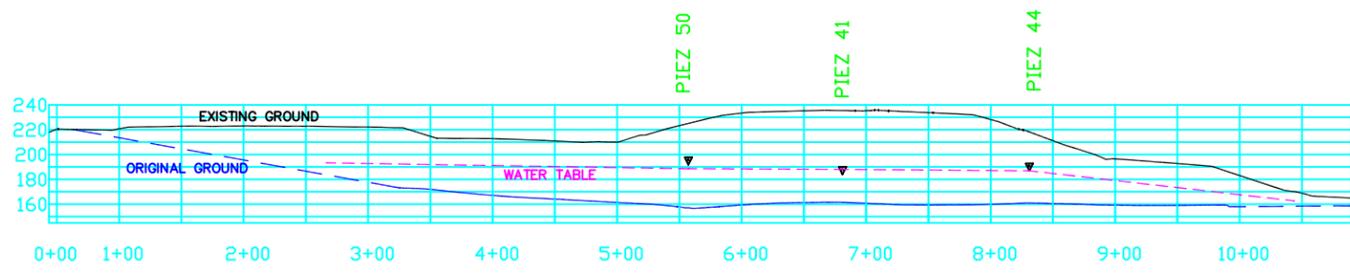
SHEET: 1 OF 1



DATUM ELEV  
AA



DATUM ELEV  
BB



DATUM ELEV  
CC

EXISTING GROUND \_\_\_\_\_

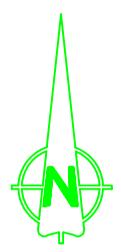
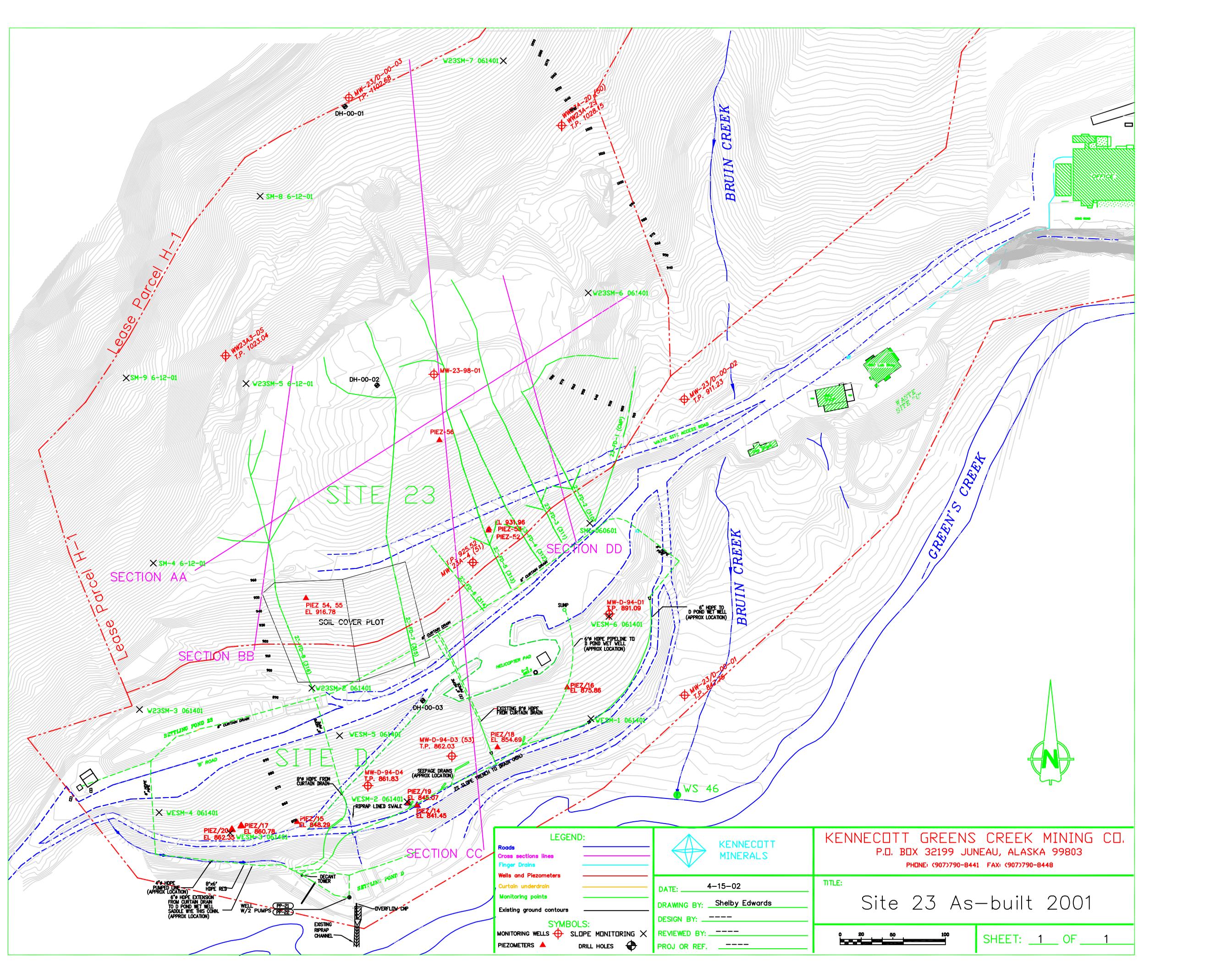
ORIGINAL GROUND - - - - -

WATER TABLE - - - - -

KENNECOTT GREENS CREEK MINE ADMIRALTY ISLAND, ALASKA	
2001 TAILINGS FACILITY AS-BUILT CROSS SECTIONS	
DATE: 4-11-02	PREPARED BY: GREENS CREEK MINING CO. JUNEAU, ALASKA PHONE: (907)790-8441 FAX: (907)789-8448
DRAWING BY: Shelby Edwards	GCMC DWG # _____
DESIGN BY: _____	
REVIEWED BY: _____	
PROJ OR REF. _____	
SCALE: _____ IN FEET	SHEET: _____

## **APPENDIX 2**

Site 23/D 2001 As-built and Cross Sections

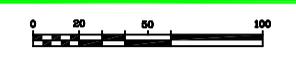


LEGEND:	
Roads	
Cross sections lines	
Finger Drains	
Wells and Piezometers	
Curtain underdrain	
Monitoring points	
Existing ground contours	
SYMBOLS:	
MONITORING WELLS	
PIEZOMETERS	
SLOPE MONITORING	
DRILL HOLES	

	KENNECOTT MINERALS
	DATE: 4-15-02
	DRAWING BY: Shelby Edwards
	DESIGN BY: ---
	REVIEWED BY: ---
PROJ OR REF. ---	

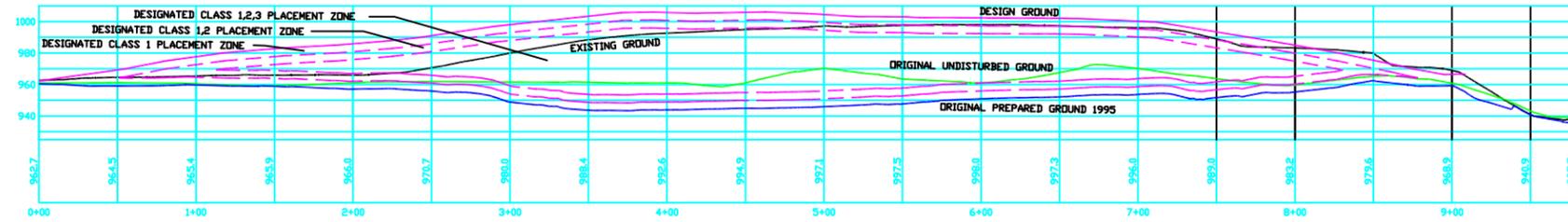
KENNECOTT GREENS CREEK MINING CO.  
 P.O. BOX 32199 JUNEAU, ALASKA 99803  
 PHONE: (907)790-8441 FAX: (907)790-8448

TITLE:  
 Site 23 As-built 2001

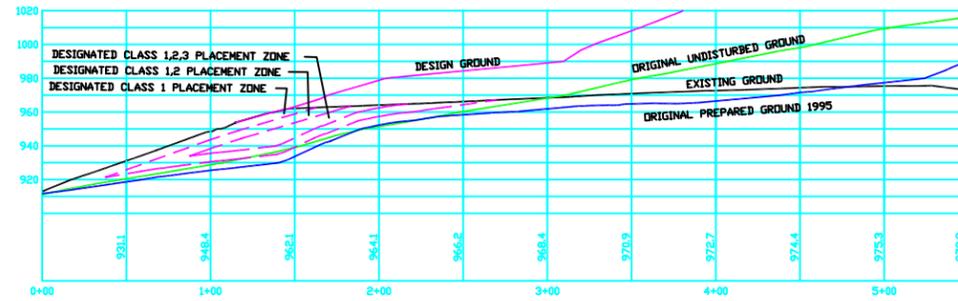


SHEET: 1 OF 1

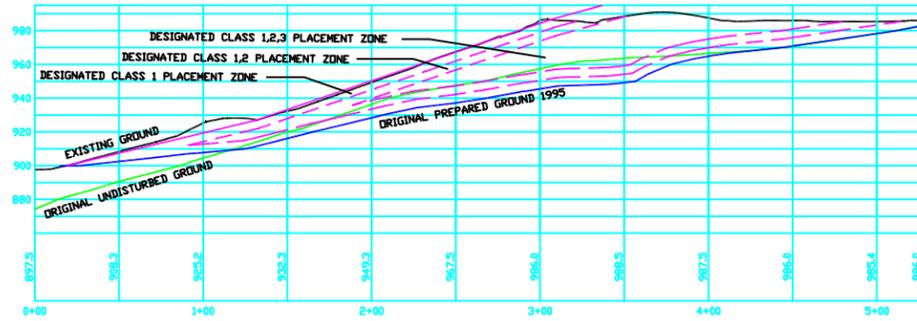
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SECTION AA



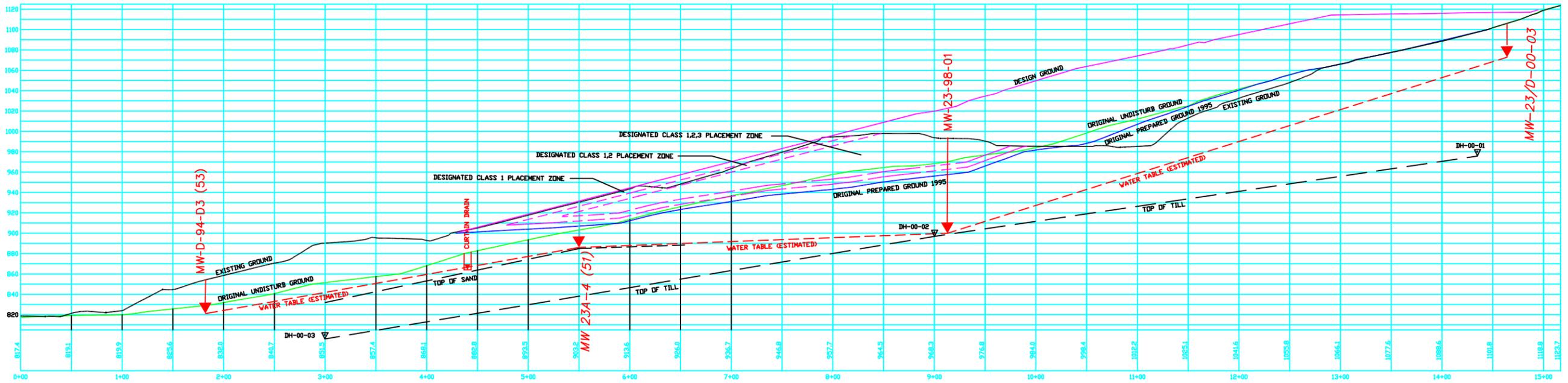
DATUM ELEV  
SECTION BB



DATUM ELEV  
SECTION DD



DATUM ELEV  
SECTION CC



**LEGEND:**

- ORIGINAL PREPARED GROUND 1995
- DESIGN GROUND
- PLACEMENT ZONES
- WATER TABLE (ESTIMATED)
- TILL AND SAND LAYER
- ORIGINAL UNDISTURBED GROUND
- EXISTING GROUND

**SYMBOLS:**

- WELL DATA ▼
- DRILL HOLE DATA ▽

**KENNECOTT MINERALS**

DATE: 4-15-02

DRAWING BY: Shelby Edwards

DESIGN BY: ----

REVIEWED BY: ----

PROJ OR REF: ----

**KENNECOTT GREENS CREEK MINING CO.**  
P.O. BOX 32199 JUNEAU, ALASKA 99803  
PHONE: (907)790-8441 FAX: (907)790-8448

TITLE:  
Site 23 Cross Sections 2001

SHEET: 1 OF 1