KENNECOTT GREENS CREEK MINING COMPANY

GENERAL PLAN OF OPERATIONS

APPENDIX 1

FRESH WATER MONITORING PROGRAM

Revision Dates:
September 16, 1995
October 10, 1996
April 14, 1997
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%R	Percent Recovery
AGO	Attorney Generals Office
ANICLA	Alaska National Interest Land Conservation Act
ASTM	American Society for Testing and Materials
AWP	Annual Work Plan
AWQS	Alaska Water Quality Standards
BMP	Best Management Practice
CFR	Code of Federal Regulations
CH	Clean Hands
COC	Constituent of Concern
CV	Casing Volume
CWA	Clean Water Act
DEC	Department of Environmental Conservation
DFG	Department of Fish and Game
DH	Dirty Hands
DI	Deionized Water
DNR	Department of Natural Resources
DQO	Data Quality Objective
DW	Depth to Water
EA	Environmental Assessment
EPA	Environmental Protection Agency
FB	Field Blanks
FEIS	Final Environmental Impact Statement
FWMP	Fresh Water Monitoring Program
GPO	General Plan of Operations
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
IDL	Instrument Detection Limit

KGCMC	Kennecott Greens Creek Mining Company
LCS	Laboratory Control Sample
MAG	Management Information Goal
MB	Method Blank
MDL	Method Detection Limit
MIG	Monitoring Information Goal
ML	Minimum Level
MOM	Monitoring Operations Manual
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RIG	Regulatory Information Goals
ROD	Record of Decision
RPD	Relative Percent Difference
SIG	Statistical Information Goal
SOP	Statement of Procedures
SOW	Statement of Work
TD	Total Depth
TSS	Total Suspended Solids
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service

1. OVERVIEW

The Kennecott Greens Creek Mining Company (KGCMC) Fresh Water Monitoring Program (FWMP) documents the necessary methods and procedures for sample collection, laboratory analysis, data management, and information utilization necessary to ensure that the monitoring requirements defined in the mine's Federal Environmental Impact Statement (FEIS), Record Of Decision (ROD), and Environmental Assessments (EA) are fulfilled. This manual provides the Quality Assurance Project Plan (QAPP) for fresh water quality monitoring at the Greens Creek Mine, Admiralty Island, Alaska. Both surface water and ground water monitoring are included. Marine water, sediment, and bioassay monitoring are addressed in the General Plan of Operations (GPO), Appendix 2, National Pollutant Discharge Elimination System (NPDES) Marine Water and Sediment Sampling Programs. Copies are available from KGCMC.

This manual is to be reviewed and updated as needed to ensure best use of resources, appropriate quality of data, and use of the results in management decisions. Prior to 1995, fresh water monitoring at the Greens Creek Mine was conducted under two documents; the Greens Creek Fresh Water Monitoring Operations Manual (MOM), 12/9/88; and the draft GPO, Appendix 1, 6/1/92. In 1995 these documents were revised and combined into a single document.

The purpose of the 1995 revision was to update the information goals for monitoring, and the standard procedures for sample collection, laboratory analysis, data handling, data analysis, and information utilization. Information goals are specific quantitative and qualitative statements describing the information expectations of the monitoring program. Information utilization is defined as how the information derived from data analysis is reported and applied to management decisions.

This 2000 revision of the FWMP is a result of a Greens Creek sponsored interagency regulatory review of the Greens Creek Mine. The Project Team consisted of representatives from KGCMC and several State and Federal regulatory agencies, including the State of Alaska Department of Natural Resources (DNR), Environmental Protection Agency (EPA), United States Forest Service (USFS), United States Fish and Wildlife Service (USFWS), State of Alaska Department of Fish and Game (DFG), State Attorney Generals Office (AGO) and State of Alaska Department of Environmental Conservation (DEC). The purpose of the review was to allow the State and Federal agencies having jurisdiction over the mine to ascertain overall compliance with existing authorizations and environmental laws and to implement corrective action, if needed; amend existing authorizations or plans, if necessary; and process any new authorizations necessary to provide for confidence in regulatory compliance and environmental effectiveness of the Greens Creek programs. This revision incorporates changes requested and approved by the participating regulatory agencies and KGCMC. Included in a separate document are Project Team comments, and a response to those comments by the third party contractor (Shepherd Miller, Inc.) who prepared this

document at the request of the Project Team.

1.1. Regulatory Monitoring Directives

Ensure that monitoring requirements in the National Environmental Policy Act (NEPA) documents that relate to KGCMC are met. 40 CFR § 1505.3 states that agencies may provide for monitoring to assure their decisions are carried out.

Ensure that Alaska Water Quality Standards (AWQS) are met. The State of Alaska, Department of Environmental Conservation has promulgated water quality standards to protect all uses of a water body. Monitoring at Greens Creek has particular relevance to the protection of aquatic organisms against chronic toxicity.

Ensure the intent of the Clean Water Act (CWA) is met. While this plan does not address discharges authorized by the mine's NPDES permit under the CWA, some procedures described in this plan are similar to those described in 40 CFR § 136. This CFR referenced document describes guidelines that were established for test procedures for the analysis of pollutants discharged under Section 402 (NPDES) and Section 401 (State Certification) of the CWA.

1.2. Actions To Meet Monitoring Directives

Implement the revised FWMP.

Conduct annual reviews of information goals, analytical data, statistical analyses, and sampling frequencies to ensure that information utilization needs are met.

Apply the information derived from data analysis and interpretation to management decisions.

1.3. FWMP Guidance Documents

FWMP guidance documents include several NEPA documents containing monitoring expectations, as well as guidance that describes regulatory standards, data collection, analysis and interpretation. These documents include:

- Final Environmental Impact Statement (FEIS), January 1983, pg. 2-53 through 2-56.
- U.S. Forest Service Record of Decision (ROD), 1983.
- Environmental Assessment (EA) for Proposed Changes to the GPO for the Development and Operation of the Greens Creek Mine, March 1988, pg. 2-1 through 2-3, 2-6, 2-7,and 2-10.

- Environmental Assessment Decision Notice and Finding of No Significant Impact, 1988.
- EA for Additional Waste Rock Disposal Capacity at the Greens Creek Mine, Admiralty National Monument, Alaska, Decision Notice and Finding of No Significant Impact, 1992.
- Alaska Water Quality Standards (18 AAC 70), and excerpts From the Alaska Water Quality Standards Workbook.
- Regulations implementing the Clean Water Act (Federal Water Pollution Control Act of 1965 and subsequent amendments) requirements are found in 40 CFR § 100 to 149.
- USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, EPA, 1994.
- A Framework for Development of Data Analysis Protocols for Ground Water Quality Monitoring, Nadine C. Adkins, June 1993.
- Design of Water Quality Monitoring Systems, Ward, Loftis, and Mcbride, 1990.
- Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska, EPA, May 1991.

1.4. Involved Parties Implementing The FWMP

Kennecott Greens Creek Mining Company (KGCMC)
P.O. Box 32199
Juneau, AK 99803
(907) 789-8113

United States Forest Service (USFS)
8461 Old Dairy Road
Juneau, AK 99801
(907) 586-8790

2. INFORMATION GOALS

This monitoring program is designed to meet defined information goals. The goals were derived after reviewing the mine's history, relevant regulatory documents and permits, and discussions between KGCMC and the regulatory agencies. The goals provide the basis for deciding what will be monitored, where, when, and how. They also guide how the resulting data will be analyzed and reported. The following are the information goals for this program.

2.1. Regulatory Information Goals (RIGs)

RIGs define the type of monitoring information needed. RIGs are distilled from permits and regulations pertaining to the site. RIGS will ensure that:

a) surface and ground water resources and their related beneficial uses are protected and maintained (CWA, AWQS, EA 1988);

b) human health and the environment are protected (CWA, AWQS);

c) water quality criteria are met (AWQS);

d) NEPA required monitoring is accomplished; and

e) Admiralty National Monument water quality values are protected (NEPA, Alaska National Interest Land Conservation Act "ANILCA").

2.2. Management Information Goals (MAGs)

MAGs are developed from the water quality management functions of KGCMC and the regulatory agencies. MAGs also define the type of monitoring information needed. MAGs will:

a) ensure the specific methods and procedures stated in this FWMP are implemented;

b) evaluate the effectiveness of the FWMP annually, using the information collected through monitoring;

c) collect data for designing specific reclamation needs and additional resource protection requirements, if needed (EA 1988, EA 1992);

d) ensure monitoring plans are generated (NEPA, FEIS 1983, EA 1988, EA 1992);

e) validate the assumptions and predictions of the 1988 and 1992 EAs;

f) ensure Admiralty National Monument water quality values are adequately maintained (NEPA, EA 1988, ANILCA); and

g) ensure the economic efficiency of this FWMP.

2.3. Monitoring Information Goals (MIGs)

MIGs are site specific qualitative statements based on the RIGs and MAGs which describe the information expectations of the monitoring program. Sites are selected and MIGs are developed based on their ability to generate the data needed to address one or more RIGs/MAGs. MIGs applicable to a given site are listed in the individual monitoring site summaries referenced in Section 4.1 and found in Attachment A of this document.

2.4. Statistical Information Goals (SIGs)

SIGs are specific statements describing the data analyses to be performed to provide information in support of the MIGs. SIGs applicable to a given site are listed in the individual monitoring site summaries referenced in section 4.1 and found in Attachment A of this document. A description of the specific data analyses are found in Section 10.6.2.f.

2.5 Definitions

A list of definitions of key technical words used in this FWMP follows.

a) Anomaly: A deviation from what is considered the norm.

b) Artifact: A product of artificial character due to extraneous influence.

c) Below: Underneath.

d) Down gradient: Downhill.

e) Instrument detection limit (IDL): The smallest signal above background noise that an instrument can detect.

f) Method detection limit (MDL): The minimum concentration of a substance that can be identified, measured and reported with 99 percent confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

g) Minimum level (ML): The lowest level at which the entire analytical system gives a recognizable signal and acceptable calibration point. The minimum level can be calculated using the formula ML=3.18 x MDL, rounded up to the same number of significant digits as the AWQS for that analyte.

h) Outlier: Measurements that are extremely large or small relative to the rest of the data and, therefore, are suspected of misrepresenting the population from which they were collected. Refer to Section 10.6.2 (f)(2) for a description of how outliers are determined.

i) Production rock: Mined rock that is not processed in a mill, but placed in a specified disposal area. Used interchangeably with waste rock.

j) Qualified data: Data that have been reviewed by an independent party and determined to be restricted as to the nature of its use.

k) Up gradient: Uphill.

l) Waste rock: Mined rock that is not processed in a mill, but placed in a specified disposal area. Same as production rock.

m) Water Year: October through September. For example, water year 2001 is October 1, 2000-September 30, 2001.

3. DATA QUALITY OBJECTIVES (DQOs)

DQOs are quantitative and qualitative objectives for the quality of the data used to determine whether the RIGs and MAGs have been met. DQOs define the quality of services requested from the laboratory, and are used in the quality assurance (QA) review by comparing the quality control (QC) data against the DQOs to qualify the data as fully usable, estimated, or rejected as unusable. A lab experienced in the analysis of biological tissues shall be chosen to analyze collected fish tissue.

3.1. Qualitative DQOs

Qualitative DQOs are established for representativeness and comparability.

Representativeness is a determination of how well the sample represents environmental conditions. It is addressed by monitoring site selection and sample collection and handling protocols. Requirements for blank analyses and QA review of blank data verify that samples have not been contaminated in the sampling or analytical processes.

Comparability is a determination of how well data from different sources compare to each other. It is addressed by ensuring appropriate method detection limits are achieved, and QC measures and QA data reviews are performed to verify that the data are of known and acceptable quality.

3.2. Quantitative DQOs

Quantitative DQOs are established for method detection limits (MDLs), minimum levels (MLs), precision, accuracy, and completeness.

MLs are established for each analyte at 90% of the AWQS with one exception: the ML for chromium will be the same as for chromium VI. Waters monitored under this plan are protected for all uses, and the most protective standard is applicable (18 AAC 70.020(1)). Of particular concern for these waters is protection for the growth and propagation of freshwater fish, shellfish, other aquatic life, and wildlife (18 AAC 70.020 (1) (C)). For those analytes having a hardness dependant AWQS, the hardness value used to calculate the standard for determining the ML was based on the 25th percentile of the measured hardness at surface water and groundwater sampling sites over the previous 5 years. Surface water and groundwater hardness values were summarized independently for the 25th percentile determination. Table 3.1 shows the MLs for each analyte evaluated by this plan.

MDLs are calculated based on the ML using certain information developed by EPA (EPA 821-B-95-002, April, 1995). For the purposes of this plan, the MDL=ML÷3.18, rounded up to the same number of significant digits as the AWQS for that analyte. Table 3.1 shows the MDLs for each analyte evaluated by this plan.

Precision is a measure of the ability to replicate an analysis and is expressed as the relative percent difference (RPD). The RPD criterion for water samples is ±20% and is only applicable when the analyte concentration is more than 5 times the IDL, and as long as the native amount is not greater than 4 times the spiked amount. The RPD criterion for biological samples is ±35% due to the greater degree of variability in samples.

Accuracy is a measure of how close the analytical result is to the true concentration of the analyte, and is expressed as percent recovery (%R). The Matrix Spike/Matrix Spike Duplicate (MS/MSD) criteria are 75-125 %R for all metals. The criteria are only applicable for MS/MSD analyses as long as the native amount is not greater than 4 times the spiked amount. The accuracy limits for the Laboratory Control Sample (LCS) are method dependent, e.g. 90-110 %R for Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).

Completeness is a measure of how many planned analyses for all analytes actually resulted in usable data, defined as all data that is not rejected, and is expressed in percent (%). The completeness criterion is 95% for a water year, which is October 1st through September 30th.

Table 3-1 lists the AWQS and the quantitative DQOs for each analyte. The laboratory may achieve lower MDLs than specified but not higher.

Table 3-1 Analyte Data Quality Objectives

ANALYTE	AWQS[1]	MDL[3]	ML[4]	Precision[5,7]	Accuracy[6,7]	Completeness
Total Alkalinity, mg/l	20	1.0	18	± 20 RPD	75-125 %R	95%
Hardness, mg/l	None	1.0	None	± 15 RPD	75-125 %R	95%
Conductivity, umhos/cm	None	10	None	± 15 RPD	75-125 %R	95%
pH, s.u.	6.5-8.5			± 0.2 s.u.	± 0.1 s.u.	95%
Arsenic, T, µg/l	50	14	45	± 20 RPD	75-125 %R	95%
Barium, T, µg/l	1000	283	900	± 20 RPD	75-125 %R	95%
Cadmium, TR, µg/l	0.52 / 0.38	0.15 / 0.11	0.47 / 0.34	± 20 RPD	75-125 %R	95%
Chromium, T, µg/l	100	3.1	9.9	± 20 RPD	75-125 %R	95%
Chromium VI, TR, µg/l	11	3.1	9.9	± 20 RPD	75-125 %R	95%
Copper, TR, µg/l	5.1 / 3.6	1.4 / 1.0	4.6 / 3.2	± 20 RPD	75-125 %R	95%
Lead, TR, µg/l	0.90 / 0.54	0.25 /0.15	0.81 / 0.49	± 20 RPD	75-125 %R	95%
Mercury, TR, µg/l	0.012	0.0003	0.011	± 20 RPD	75-125 %R	95%
Nickel, TR, µg/l	44.9 / 33.3	12.7 / 9.4	40.4 / 30.0	± 20 RPD	75-125 %R	95%
Selenium, TR, µg/l	5	1.42	4.5	± 20 RPD	75-125 %R	95%
Silver, TR, µg/l	0.73 /0.37[2]	0.21 / 0.10	0.66 / 0.33	± 20 RPD	75-125 %R	95%
Sulfate, mg/l	250	70.7	225	± 20 RPD	75-125 %R	95%
Zinc, TR, µg/l	45.6 / 32.7	12.9 / 9.3	41.0 / 29.4	± 20 RPD	75-125 %R	95%

T = measured and reported as total, TR = measured and reported as total recoverable

1. If AWQS is hardness dependent, two numbers are listed for the purposes of calculating the ML and MDL. First number listed is based on a hardness value of 37 to represent the 25th percentile of surface water hardness values, the second number listed is based on a hardness value of 25 to represent the 25th percentile of groundwater hardness values. AWQS is for chronic conditions unless otherwise noted. The actual hardness dependent AWQS for that constituent will depend on the actual hardness of the sample, not on the number that appears in this table.
2. AWQS is a 24 hour average (acute).
3. MDL=ML÷3.18, rounded up to the same number of significant digits as the AWQS for that analyte. If AWQS for this constituent is hardness dependent, two numbers are listed. First number listed is for surface water sites, the second is for groundwater sites.
4. ML based on AWQS x 0.9. If AWQS for this constituent is hardness dependent, two numbers are listed. First number listed is for surface water sites, the second is for groundwater sites.
5. The precision DQO is only applicable when the analyte concentration is more than 5 times the IDL.
6. Listed accuracy is for MS/MSD only. The accuracy DQO for the LCS QC sample is method dependent.
7. The precision and accuracy DQOs for MS/MSD analyses are only applicable as long as the native amount is not greater than 4 times the spiked amount.

4. MONITORING SITES

KGCMC has designated freshwater monitoring sites with numbers 1-99. These sites include those utilized in the FWMP, the NPDES program, the stormwater program, and inactive sites. Once a site is established it is never changed and remains a site even if it becomes inactive. If a site is obliterated by construction or moved, the original site number becomes inactive and the new monitoring location is given a new site number.

Monitoring can be discontinued and a site becomes inactive for a variety of reasons. These include if the site is no longer needed to meet current RIGs and MAGs, is destroyed due to construction or natural phenomenon, was discontinued at some time in the past prior to the 1995 FWMP revision, or deemed no longer necessary by the regulatory agencies and KGCMC.

4.1. Individual Monitoring Site Summaries

Attachment A contains detailed information for all active and inactive monitoring sites. It is organized by individual monitoring site numbers for ease in information retrieval. Each monitoring site has the following information headings. When information on a monitoring site is missing or the information is presumptive, it is so labeled.

a) Site Number, Site Name, Site Status (Active or Inactive)

b) RIGs and/or MAGs Supported By Monitoring At This Site

c) Monitoring Information Goals (MIGs)

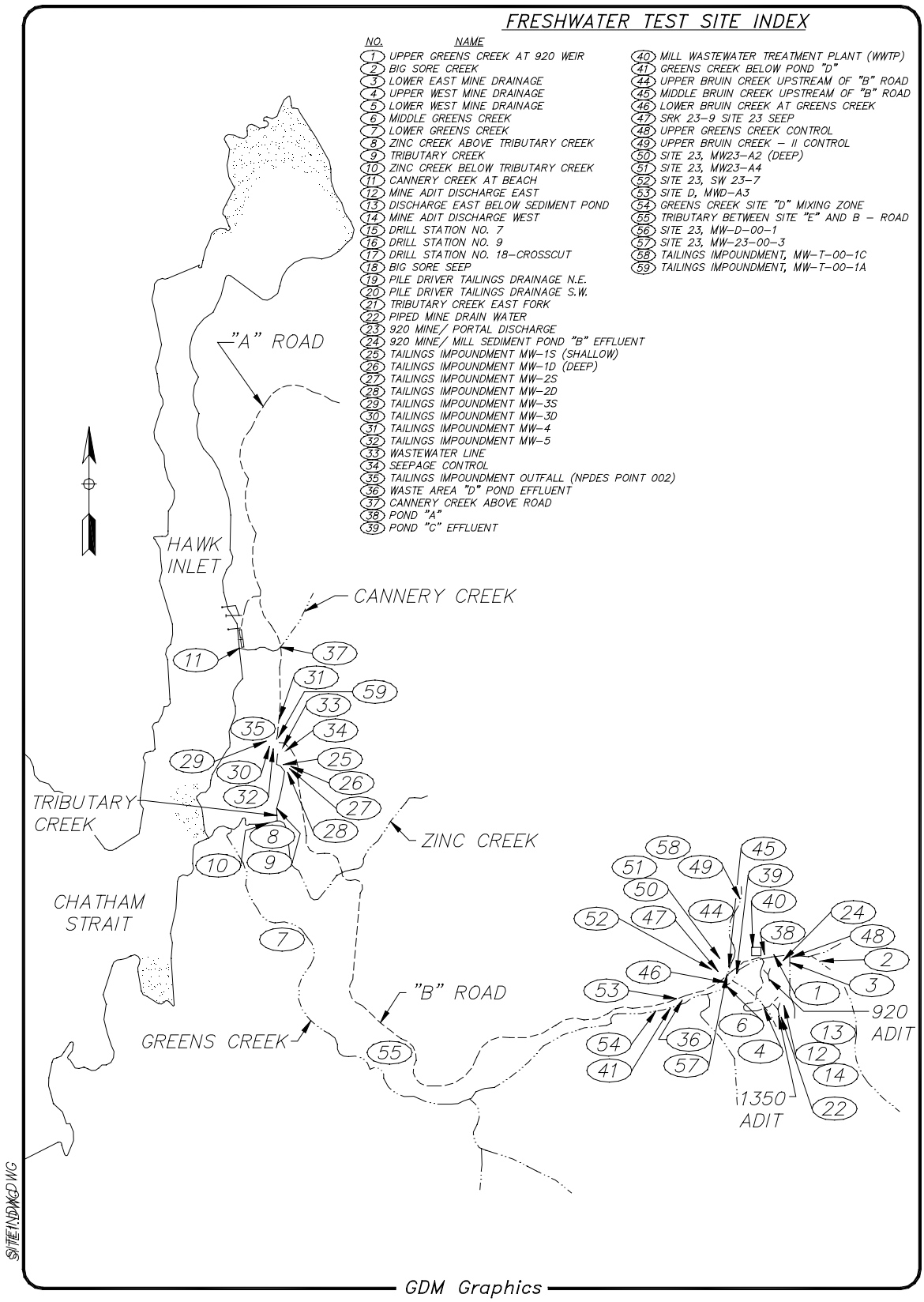
d) Statistical Information Goals (SIGs)

e) Analyte and Frequency Justification

f) Monitoring Site History

g) Site (#) Map - Note that no maps other than the overview map in section 4.2. are provided for historical sites 2, 3, 5, 12, 14-21, and 23 as the specific locations are unknown. No maps or descriptions are provided for sites 41, 42, 43, and 47 as they were never part of the FWMP.

4.2. Monitoring Site Location Map



4.3. Monitoring Site Description Table

Table 4-1 below lists the monitoring sites, contains a brief description, lists the Authority and Source. "Authority" lists that entity which has control authority over the monitoring site, and "Source" lists the first known documentation of the site. If the site is an active FWMP site, the USFS is listed as the “Authority”. For inactive sites, KGCMC is listed as the “Authority”. Active sites are listed in bold typeface.

Table 4-1 Monitoring Site Descriptions

S#	Site Name	Description	Authority	Source
1	Greens Creek - Upper	Site was originally above the confluence with Big Sore Creek, and was moved to the 920 USGS Weir.	KGCMC	FEIS
2	Big Sore Creek - Lower	Site is just above the confluence with Greens Creek	KGCMC	FEIS
3	East Mine Drainage - Lower	Small drainage to the East from the 1350 adit, site is just above the confluence with Greens Creek	KGCMC	FEIS
4	West Mine Drainage - Upper	Small drainage to the West from the 1350 adit, site is below adit area.	KGCMC	FEIS
5	West Mine Drainage - Lower	Same drainage as site 4, site is just above the confluence with Greens Creek.	KGCMC	FEIS
6	**Greens Creek - Middle**	Site is just above the confluence with Bruin Creek.	USFS	FEIS
7	Greens Creek - Lower	Site is well downstream of all mine activity, one mile from the mouth of the creek.	KGCMC	FEIS
8	Zinc Creek - Upper	Control site, above the confluence with Tributary Creek.	KGCMC	FEIS
9	**Tributary Creek - Lower**	Site is just above the confluence with Zinc Creek.	USFS	FEIS
10	Zinc Creek - Lower	Site is just below the confluence with Tributary Creek.	KGCMC	FEIS
11	Cannery Creek - Lower	Site is close to the beach downstream from the drinking water intake.	KGCMC	FEIS
12	Mine Adit Discharge - East	The 1350 adit discharged west, then east, then was piped to the 920. Site no longer exists.	KGCMC	FEIS
13	**East Mine Drainage - Upper**	Small drainage to the East from the 1350 adit, site is below the sediment pond in the adit area.	USFS	FEIS
14	Mine Adit Discharge - West	The 1350 adit discharged west, then east, then was piped to the 920. Site no longer exists.	KGCMC	FEIS
15	Drill Station No. 7	This site was used during ore-body exploration. Site no longer exists.	KGCMC	FEIS
16	Drill Station No. 9	This site was used during ore-body exploration. Site no longer exists.	KGCMC	FEIS
17	Drill Station No. 18	This site may have been used during ore-body exploration. Site no longer exists.	KGCMC	FEIS
18	Big Sore Seep	Site was on an active seep at Big Sore.	KGCMC	FEIS
19	Piledriver Tailings Drainage NE	Site was at a possible tailings disposal area, so baseline data were collected.	KGCMC	FEIS
20	Piledriver Tailings Drainage SW	Site was at a possible tailings disposal area, so baseline data were collected.	KGCMC	FEIS
21	Tributary Creek - East Fork	Site was in the muskeg at or near the present tailings impoundment prior to construction.	KGCMC	FEIS
22	Mine Adit Discharge - Piped East	The 1350 adit discharged west, then east, then was piped to the 920. Site no longer exists.	KGCMC	MOM
23	Mine Portal Discharge	The 920 portal discharge was piped into the mill waste treatment system. Site no longer exists.	KGCMC	MOM

Table 4-1 (con't.)

S#	Site Name	Description	Authority	Source
24	Pond "B" Overflow	Site was the outfall of this mine/mill sediment pond. The pond was removed in 1996. Site no longer exists.	KGCMC	MOM
25	Monitoring Well MW-1S	Site is a shallow well in muskeg area closest to and below the tailings impoundment.	KGCMC	MOM
26	Monitoring Well MW-1D	Site is a deep well in muskeg area closest to and below the tailings impoundment.	KGCMC	MOM
27	**Monitoring Well MW-2S**	Site is a shallow well in the muskeg area, down gradient from Site 25. Same aquifer as Site 25.	USFS	MOM
28	**Monitoring Well MW-2D**	Site is a deep well in the muskeg area, down gradient from Site 26. Same aquifer as Site 26.	USFS	MOM
29	**Monitoring Well MW-3S**	Site is a shallow well in the muskeg area, near the NPDES outfall shack. This is a different aquifer from 25 and 27.	USFS	MOM
30	**Monitoring Well MW-3D**	Site is a deep well in the muskeg area, near the NPDES outfall shack. This is a different aquifer from 26 and 28.	USFS	MOM
31	Monitoring Well MW-4	Site is a shallow well located in the tailings expansion area, within the tailings impoundment.	KGCMC	MOM
32	Monitoring Well MW-5	Site is a shallow well near the NPDES outfall shack. This is a different aquifer from 25 and 27, same aquifer as 29.	KGCMC	MOM
33	Waste Water Line	Site is the waste water line coming from mine/mill just before the tailings impoundment.	KGCMC	MOM
34	**Seepage Control**	Site is in a pond between Pond "6" and a seepage control structure.	USFS	MOM
35	NPDES Outfall 002	Site is an NPDES permitted outfall for the mine/mill/tailings wastewater discharge, SW of the tailings impoundment.	EPA / ADEC	NPDES
36	Pond "D" Overflow	Site is the outfall of this Waste Rock Area "D" sediment pond. Now a NPDES Storm Water site.	EPA / ADEC	MOM
37	Cannery Creek - Upper	Site is above the B road and the Hawk Inlet facilities' drinking water intake.	KGCMC	MOM
38	Pond "A" Overflow	Site is the outfall of this mine/mill sediment pond. This discharge was piped into the mill waste treatment system	KGCMC	MOM
39	Pond "C" Overflow	Site is the outfall of this Waste Rock Area "C" sediment pond. Now a NPDES Storm Water site.	EPA / ADEC	MOM
40	Waste Water Treatment Plant	Site is the mine/mill waste water treatment plant effluent which is discharged under the NPDES permit.	KGCMC	MOM
41	Greens Creek - Lower	Site is below Pond "D". Exact historical location unknown.	KGCMC	Unknown
42	Company Site	Unknown	KGCMC	Unknown
43	Company Site	Unknown	KGCMC	Unknown
44	Bruin Creek - Upper	Originally a control site. Site abandoned because it was not far enough upstream for a good control site.	KGCMC	Unknown
45	Bruin Creek - Middle	Baseline site prior to rock placement at Waste Rock Area "23".	KGCMC	Unknown
46	**Bruin Creek - Lower**	Site is at the lower end of Bruin Creek just before the confluence with Greens Creek.	USFS	Unknown
47	Seep - Waste Rock Area 23	Monitored prior to area development, covered during Waste Rock Area "23" construction. Site no longer exists	KGCMC	Unknown
48	**Greens Creek - Upper**	Control site on Greens Creek above all mine influences, replaced Site 1. Site is also used for biological monitoring	USFS	FEIS
49	**Bruin Creek - Upper**	Control site on Bruin Creek above Waste Rock Area "23" influences. Replaced Site 44.	USFS	FWMP
50	Monitoring Well MW-A2D	Control site well upgradient of Waste Rock Area "23".	KGCMC	FWMP
51	Monitoring Well MW-A4	Site is a monitoring well located near the middle of Waste Rock Area "23".	KGCMC	FWMP

Table 4-1 (con't.)

S#	Site Name	Description	Authority	Source
52	Pond "23" Overflow	Site is the outfall of this Waste Rock Area "23" sediment pond. Now a NPDES Storm Water site	EPA / ADEC	FWMP
53	Monitoring Well MW-D3	Site is a monitoring well located near the middle of Waste Rock Area "D".	KGCMC	FWMP
54	**Greens Creek - Lower**	Site is below Pond "D" and all mine/mill influences. Replaced Sites 7 and 41. Site is also used for biological monitoring	USFS	FWMP
55	Waste Rock Area "E" Drainage	Drainage between Waste Rock Area "E" and the B road. Site is now a NPDES Storm Water site.	EPA / ADEC	FWMP
56	**Monitoring Well MW-D-00-1**	Site is a monitoring well located down gradient of Waste Rock Area 23 and D	USFS	FWMP
57	**Monitoring Well MW-23-00-3**	Site is a reference monitoring well located upgradient of Waste Rock Area 23	USFS	FWMP
58	**Monitoring Well MW-T-00-1C**	Site is a shallow monitoring well located upgradient of the Tailings Pile	USFS	FWMP
59	**Monitoring Well MW-T-00-1A**	Site is a deep monitoring well located upgradient of the Tailings Pile	USFS	FWMP

4.4. Monitoring Site Status Table

Table 4-2 displays which monitoring sites are or have been active. An "A" indicates sampling occurred even though it may be only one sample. The year shown represents a calendar year for years 1978-1996. Beginning with 1997, the year represents a water year (i.e., water year 2001 includes data from October 1, 2000 to September 30, 2001), which is the basis of the annual reporting period.

Table 4-2 Active Site Chart

S#	Baseline				Construction							Operation																					
	Calendar Year																			Water Year													
	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11
1	A	A	A	A	A	A								A	A	A	A	A																
2	A	A	A	A	A																													
3	A	A	A	A																														
4	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A																
5	A	A	A	A																														
6	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A										
7	A			A								A	A	A	A	A	A	A															
8				A	A	A	A	A	A	A	A	A	A	A	A	A																		
9				A	A	A	A	A	A	A	A	A	A	A	A	A								A										
10				A	A	A	A	A	A	A	A	A	A	A	A	A																		
11				A									A	A	A	A	A	A																
12																																		
13				A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A										
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24										A	A	A	A	A	A	A	A	A	A	A														
25											A	A	A	A	A	A	A	A	A	A	A	A	A											
26											A	A	A	A	A	A	A	A	A	A	A	A	A											
27											A	A	A	A	A	A	A	A	A	A	A	A	A	A										
28											A	A	A	A	A	A	A	A	A	A	A	A	A	A										
29											A	A	A	A	A	A	A	A	A	A	A	A	A	A										
30											A	A	A	A	A	A	A	A	A	A	A	A	A	A										
31											A	A	A	A	A	A	A	A	A	A	A	A	A											
32											A	A	A	A	A	A	A	A	A	A	A	A	A											
33											A	A	A	A	A	A	A	A																
34											A	A	A	A	A	A	A	A	A	A	A	A	A	A										
35												A	A	A	A	A	A	A																
36													A	A	A	A	A	A	A	A														
37														A	A	A																		
38														A	A	A																		
39														A	A	A	A	A																
40														A																				
41															A	A																		
42																																		
43																																		
44																A	A	A																
45																A	A	A																
46																A	A	A	A	A	A	A	A	A										
47																A	A																	
48																		A	A	A	A	A	A	A										

Table 4-2 (con't.)

S#	Baseline				Construction							Operation																					
	Calendar Year																			Water Year														
	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11
49																		A	A	A	A	A	A	A										
50																		A	A	A	A	A	A											
51																		A	A	A	A	A	A											
52																		A	A	A														
53																		A	A	A	A	A	A											
54																		A	A	A	A	A	A	A										
55																		A	A	A														
56																								A										
57																								A										
58																								A										
59																								A										

5. MONITORING SCHEDULE

5.1. Site Selection

Monitoring site selection is determined based upon an annual review of the RIGs and MAGs, the MIGs necessary to meet those information needs, and an analysis and interpretation of previous data.

5.2. Frequency Selection

Monitoring frequency is determined based upon results of previous data analysis, planned future uses of data, and changes in mine operations. Frequency will be sufficient to detect any seasonal trends. For new monitoring sites, quarterly or monthly sampling will be sustained until sufficient samples are taken to conduct statistical trend analyses. Unexpected events that necessitate changes in RIGs or MAGs which result in changes to MIGs to meet either KGCMC or USFS informational needs, may also effect monitoring frequency.

5.3. Analyte Selection

The suite of analytes to be monitored at a given site in a given month is determined based upon an annual review of the RIGs and MAGs, the MIGs necessary to meet those information needs, and the results of previous data analysis. The analyte suites currently in the monitoring schedule include suites for water chemistry and biological monitoring. The sampling suites are as follows:

Table 5-1 Analyte Suites

Suite P (surface water only)		
Conductivity	Dissolved Arsenic	Dissolved Mercury
pH, Temperature & Hardness	Dissolved Cadmium	Dissolved Zinc
Sulfate	Dissolved Copper	
Total Alkalinity	Dissolved Lead	

Suite Q (groundwater and surface water twice a year)		
Conductivity	Dissolved Barium	Dissolved Mercury
pH, Temperature & Hardness	Dissolved Cadmium	Dissolved Nickel
Sulfate	Dissolved Chromium	Dissolved Selenium
Total Alkalinity	Dissolved Copper	Dissolved Silver
Dissolved Arsenic	Dissolved Lead	Dissolved Zinc

Suite R

Juvenile fish will be sampled to determine relative abundance and distribution and a subsample from each sample site will be analyzed for whole body concentrations of total Cadmium, Copper, Lead, Selenium, Silver and Zinc. Metals are to be reported as total per dried weight of tissue. The laboratory shall also report the percent moisture of the samples so that wet weight values can be calculated. Water temperature will be measured. Periphyton samples will be collected for estimates of biomass, as Chlorophyll-a, b, and c. Water samples will be collected for Standardized Laboratory Toxicity Testing (e.g. Microtox, or other suitable test). Aquatic invertebrate samples will be collected to determine abundance and community structure. Refer to Table 6-1 for specific sampling requirements.

If a dissolved chromium value greater than 11 ug/l is detected, then chromium VI will be analyzed. As the required holding time of chromium VI is 24 hours, a new sample will need to be taken, and analyzed for total recoverable and dissolved chromium VI.

If a water quality sample of a dissolved metal exceeds the ML, the site will be immediately re-sampled for the metal of concern and analyzed for the total/total recoverable fraction (as identified in Table 3-1), the dissolved fraction, and total suspended solids (TSS). Three subsequent monthly samples will be taken at the site and analyzed for total/total recoverable fraction, dissolved fraction and TSS regardless of the monitoring schedule shown in Table 5-1. If the total/total recoverable result exceeds the AWQS, procedures described in Section 10.4 will be followed. If these three subsequent samples continue to show the dissolved fraction remains greater than the ML, these samples will be continued for an additional three months.

5.4. Current Monitoring Schedule

The current monitoring schedule for a given water year, running from October 1st through September 30th, is shown in the Table 5-1. The schedule documents the sites to be sampled each month and the suite of analytes to be analyzed for at each site each month.

Table 5-2 Water Year Monitoring Schedule

Site	Site Name	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
6	Greens Creek - Middle	P	P	Q	P	Q	P	P	P	P	P, R	P	P
9	Tributary Creek-Lower										R		
13	East Mine Drainage - Upper	Q	Q					Q	Q	Q	Q	Q	Q
27	Monitoring Well MW-1S								Q				Q
28	Monitoring Well MW-1D								Q				Q
29	Monitoring Well MW-3S								Q				Q
32	Monitoring Well MW-5								Q				Q
34	Seepage Control								Q				Q
46	Bruin Creek - Lower	P	P	Q	P	Q	P	P	P	P	P	P	P
48	Greens Creek - Upper	P	P	Q	P	Q	P	P	P	P	P,R	P	P
49	Bruin Creek - Upper	P	P	Q	P	Q	P	P	P	P	P	P	P
54	Greens Creek - Lower	P	P	Q	P	Q	P	P	P	P	P,R	P	P
56	Monitoring Well MW-D-00-1	Q	Q					Q	Q	Q	Q	Q	Q
57	Monitoring Well MW-23-00-3	Q	Q					Q	Q	Q	Q	Q	Q
58	Monitoring Well MW-T-00-1C								Q				Q
59	Monitoring Well MW-T-00-1A								Q				Q

6. SAMPLE COLLECTION

In accordance with the current monitoring schedule in Section 5.4, water samples are collected using protocols designed to minimize bias from systematic and/or erratic contamination introduced during sample collection. This section of the FWMP describes sampling procedures that can be used to collect water quality and biological samples.

Water quality protocols are performance based and were developed from prior KGCMC sampling protocols incorporating selected procedures from EPA and U.S. Geological Survey methods. These protocols are applicable to the analytes being monitored, and the MDLs and MLs required to ensure appropriate comparisons to AWQS. While these water quality sampling protocols are not required to be used, they are recommended. If other water quality sampling protocols are used, they should be based on proven methodologies such that the required MDLs and MLs can be achieved without experiencing false positive constituent levels due to introduced contamination.

Biological monitoring sampling protocols are also provided in this section. These protocols are based on EPA Rapid Bioassessment Protocols (EPA 841-B-99-002; 1999), and on the methodology for sampling juvenile fish outlined in the Tongass National Forest Monitoring Guidebook (June 30, 1999).

6.1. Quality Control (QC)

Water quality QC samples include but are not limited to field blanks (FBs). FBs are collected to evaluate the level of sample contamination through the course of collection, processing, preservation, and transportation.

a) One FB will be collected each month for ten or less sampled sites. For each subsequent ten or less sampled sites in a month an additional FB will be collected.

b) Prior to sampling each month the site(s) at which QC samples will be collected are selected. The FBs will be sequentially taken from each site.

c) The laboratory performing the analyses will provide deionized (DI) water for use in collecting FBs.

d) Additional types of blanks may be collected to determine possible sources of anomalous values that may be due to sample contamination.

e) Each water year the date and site number for all QC samples collected will be logged on a quality control sample log. An example of the log currently being utilized is found in Attachment B.

6.2. Personnel

All personnel collecting samples will be thoroughly trained in protocols currently used for collection of water quality and biomonitoring samples. All sampling will be done by teams of at least two trained people regardless of the type of monitoring site or weather conditions. Two people provide additional safety and overall efficiency while collecting samples in the field.

6.3. Containers And Equipment

a) A container and equipment checklist is found in Attachment B. This checklist identifies all sample containers, equipment, and ancillary supplies needed for routine water quality and biological sample collection.

b) Sample containers are supplied by the laboratory conducting the analyses or by a company specializing in sample containers. All sampling equipment and sample containers must be suitable, non-metallic material, such as fluoropolymer (FEP, PTFE), conventional or linear polyethylene, polycarbonate, or polypropylene, and free from any material that may contain metals. Fluoropolymer or glass bottles should only be used for mercury samples.

c) Sample bottles will be pre-cleaned and pre-labeled at the laboratory prior to shipment to KGCMC. They will be stored in a dry, dust free environment to avoid contamination on the outside of the bottles that could be inadvertently transferred to the sample during collection.

d) Each bottle for trace metal analyses is placed within its own set of double ziplock bags. Each bottle for the measurement of physical analytes is placed within a single ziplock bag. The individually bagged bottles for each site are placed together into a large clear plastic bag designated for that site. All site bags are placed into a cooler lined with an additional clear plastic bag. New bags are used for each bottle set. Identical handling is to be followed for biological tissue samples.

e) If a pre-cleaned bottle becomes uncapped during shipment or storage it will be returned to the laboratory and not used.

f) Extra containers may be taken to the field for unscheduled QC samples, lost samples, or if there is container breakage or contamination.

g) Only clear or white plastics will be used for containers or bags used to hold sample bottles or to place samples in. This is to eliminate metals cross contamination derived from colored plastics.

h) Only disposable non-powdered latex gloves will be used during sample collection. Clean gloves will be kept in a sealed container prior to use. Used gloves will be placed in a garbage bag for disposal.

6.4. General Procedures

The following procedures apply regardless of the type of site being sampled. Contamination will be minimized by paying strict attention to the work being done, awareness of potential contaminant sources, and minimizing atmospheric dust and debris from roads, vehicles, sampling locations, and the general environment.

a) Assemble all requisite supplies (Attachment B) for the samples scheduled to be collected that day, place them in the vehicle, and drive to the sample location(s) parking a safe distance away when the sample site is near a roadway to minimize contamination by airborne particulate.

b) Open the storage cooler and remove the appropriate site bag (section 6.3.d.) containing the sample bottles and any QC sample bottle(s) scheduled for that site. Gather all ancillary supplies in a heavy clear plastic bag.

c) Walk to the sampling location and set up to take samples designating one member of the sampling team as "clean hands" (CH) and the second member as “dirty hands" (DH). CH may touch only the innermost ziplock bag and the sample bottle and cap. DH is responsible for all other activities that do not involve direct contact with the innermost ziplock bag or the sample bottle and cap. DH should not touch metal surfaces or extremely sediment-laden objects.

d) At each site each member involved in collecting samples will put on a new set of clean gloves. At any time if CH gets dirty by touching anything but the innermost ziplock bag or the sample bottle and cap, the contaminated gloves will be removed and a new pair of clean gloves put on.

e) DH removes the bagged sample bottle from the site bag and opens the outer ziplock bag. CH opens the inner ziplock bag (if applicable) and removes the sample bottle pushing the inner bag down. DH reseals the outer bag.

6.5. Surface Water Sample Collection Procedures

Samples are collected facing upstream and/or upwind to minimize the potential for contamination. If conditions exist to entirely submerge the sample bottle without disturbing sediments the procedure in section 6.5.1. is utilized. When the sample bottle cannot be entirely submerged without disturbing sediments the procedure in section 6.5.2 will be utilized.

6.5.1. For each sample bottle to be filled when conditions exist to entirely submerge the sample bottle without disturbing bottom sediments:

6.5.1.1. CH completely submerges the bottle, unscrews the cap moving it off to one side with the inside of cap facing upstream allowing flushing of cap interior, and allows the bottle to partially fill.

6.5.1.2. While the bottle is still submerged CH screws the cap back on the bottle and then removes it from the water.

6.5.1.3. CH shakes the bottle several times and then empties the rinsate downstream and away from the site.

6.5.1.4. After two more rinsings, CH submerges the bottle entirely and allows the bottle to completely fill with sample leaving as little air space as possible.

6.5.1.5. While the bottle is still submerged CH replaces the cap on the bottle and secures as tight as possible before removing it from the water.

6.5.1.6. DH opens the outer ziplock bag. CH puts the bottle into the inner bag (if applicable) and reseals it. If needed CH may become DH at this point and DH reseals the outer bag. DH replaces the bagged, sample filled bottle back into the clear heavy plastic site bag.

6.5.2. For each sample bottle to be filled where the bottle cannot be entirely submerged without disturbing bottom sediments:

6.5.2.1. The sampling team examines the site for sands and silts trying to avoid areas of high fine concentrations and to avoid stagnant or very slow moving water to eliminate surface micro-layer contamination.

6.5.2.2. CH removes the cap from the sample bottle holding it in one hand, while submerging the bottle as much as possible without disturbing bottom sediments and allowing it to partially fill.

6.5.2.3. CH screws the cap back on the bottle, shakes it several times, and then empties the rinsate downstream and away from the site.

6.5.2.4. After two more rinsings if they can be obtained without disturbing sediments, CH allows the bottle to fill as completely as possible with sample leaving as little air space as possible and secures the cap as tight as possible.

6.5.2.5. DH opens the outer ziplock bag. CH puts the bottle into the inner bag (if applicable) and reseals it. If needed CH may be come DH at this point and DH reseals the outer bag.

6.5.2.6. DH replaces the bagged, sample filled bottle back into the clear heavy plastic site bag.

6.6. Ground Water Sample Collection Procedures

The procedures in Section 6.6.1 are used to generate the site specific Well Data Sheets found in Attachment B. Certain wells that are required to be purged prior to sampling will follow the purging protocols described in Section 6.6.2. After purging a given well the appropriate procedures in section 6.7.3 will be utilized for sample collection.

6.6.1. The procedures below are used to generate the site specific information for the Well Data Sheets found in Attachment B. They are included here for use when new wells are added to the FWMP, or when updating the existing Well Data Sheets. These sheets contain the necessary data referenced in the purging procedures found in section 6.6.2.

6.6.1.1. Measure the well's total depth (TD) with a weighted well tape and record the TD in feet on the Well Data Sheet.

6.6.1.2. Measure the well's depth to water (DW) with an electronic well tape and record the DW in feet on the Well Data Sheet.

6.6.1.3. Calculate the well's casing volume of water (CV) using the following formula, and record the CV in gallons on the Well Data Sheet:

CV = A(TD-DW); A = inside area of well casing=3.14/4*(d)^2;. d = well inside diameter in feet

6.6.1.4. Pump three CVs from the well or until it has gone dry, whichever occurs first. Measure the time required for recovery of the well's original DW and record this information on the Well Data Sheet.

6.6.1.5. Determine the length of time required, if any, for the well to sufficiently recover after purging to enable collection of a sample. Record this information on the Well Data Sheet.

6.6.2. Non-artesian wells are purged prior to sampling following the procedures below. Refer to the site's specific Well Data Sheet found in Attachment B for the requisite information on any given well scheduled to be purged and sampled.

6.6.2.1. Pump water from all but artesian wells at the well’s established recharge rate until the pH, conductivity and temperature equilibrate.

6.6.2.2. Artesian/flowing wells are not pumped. The purged water is collected in the bucket by placing it under the well head spigot.

6.6.2.3. Empty the bucket at least 15 ft. from the well head to avoid potential contamination of the sample.

6.6.2.4. After purging the well wait the required amount of time, if any, for the well to sufficiently recover to enable collection of a sample using the procedures defined in section 6.6.3.

6.6.3. Well samples are collected following the procedures below. They were developed to accommodate the use of either hand or electric pumps.

6.6.3.1. After the pH, conductivity and temperature equilibrate, DH pumps the well while holding the discharge tubing upright, flushing at least one and a half to two tubing volumes. This allows water to bubble up and rinse the end of the tubing.

6.6.3.2. For electric pumping, DH connects a new length of tubing to the well's discharge tubing and to the pump.

6.6.3.3. For manual pumping, DH steadies the end of the tubing in one hand and begins pumping it with the other trying to minimize sediment disturbance in the bottom of the well. For electric pumping, DH turns the pump on. Both team members are careful not to touch the end of the tubing or to let it touch anything.

6.6.3.4. CH removes the cap from the sample bottle holding it in one hand while holding the bottle under the end of the tubing and allowing it to partially fill.

6.6.3.5. CH screws the cap back on the bottle, shakes it several times, and then empties the rinsate into the purge bucket.

6.6.3.6. After two more rinsings CH allows the bottle to completely fill with sample leaving as little air space as possible, and secures the cap as tight as possible. DH replaces the tubing into the well casing

6.6.3.7. DH opens the outer ziplock bag. CH puts the bottle into the inner bag (if applicable) and reseals it. If needed CH may be come DH at this point and DH reseals the outer bag.

6.6.3.8. DH replaces the bagged, sample filled bottle back into the clear heavy plastic site bag.

6.7. Biological Monitoring

The role of biological monitoring is to ensure the continued use of Greens Creek and its tributaries by fish and other aquatic species, and to document the continued health of all levels of the biological community: primary productivity, invertebrate communities, and fish. Biomonitoring also will detect early changes to the aquatic community that may result from changes in water chemistry, either through surface or groundwater inputs to the system.

Results from biomonitoring usually are compared to baseline conditions, or if baseline data are unavailable, to a reference site that is unaffected by the mine. There were few baseline studies conducted before development of the Greens Creek mine using current state-of-the-art protocols. The existing biomonitoring program is designed to compare present conditions to future conditions, with consideration given to any previous monitoring. All biological monitoring should follow standard protocols acceptable to USEPA, ADEC, and other appropriate agencies. This document serves as the quality assurance plan for biological monitoring.

6.7.1. Elements of the Biological Monitoring Program

The biological monitoring program for the Greens Creek mine addresses the following factors:

1. Distribution and abundance of juvenile fish;
2. Whole body concentrations of Cd, Cu, Pb, Se, Ag, and Zn in juvenile fish;
3. Periphyton biomass, estimated by chlorophyll concentrations;
4. Abundance and community structure of Benthic invertebrate populations;
5. Standardized laboratory toxicity testing.

6.7.2. Summary for Biological Monitoring

Baseline Site:	Site #6 Middle Greens Creek
Routine Monitoring:	Site #48 Upper Greens Creek
	Site #54 Greens Creek below Pond D
	Site #9 Tributary Creek

The table below summarizes the sites to be sampled, factors sampled at each site, and sampling frequency.

Table 6-1 Summary of Biomonitoring Sites

Site Name	Monitoring Objective	Compare to:	Frequency	Factors	Time to Sample
Middle Greens Creek (Site #6)	Baseline		Sample on 5 year schedule, unless indication of WQ exceedence	FA, FM, P, MI, TOX	mid-late July
Upper Greens Creek (Site #48)	Routine, control		Annually for 5 years, then review	FA, FM, P, MI, TOX	mid-late July
Greens Creek below Pond D (Site #54)	Routine, treatment	Control	Annually for 5 years, then review	FA, FM, P, MI, TOX	mid-late July
Tributary Creek (Site #9)	Baseline	Change over time	Annually for 5 years, then review	FA, FM, P, MI, TOX	mid-late July

KEY:
WQ water quality
FA fish abundance and distribution
FM fish metals content
P periphyton biomass
MI macroinvertebrate abundance, community
TOX micro-toxicity tests

6.7.3. Description of Sample Locations

Upper Greens Creek: FWMP Site #48
This site was located as an upstream, control site for comparison to “treatment” sites in those stream reaches adjacent to and downstream from the KGCMC facilities. This site lies approximately ½ mile upstream of the weir which blocks access to anadromous fish. Therefore, the only salmonid species at this site are the resident Dolly Varden.

Middle Greens Creek: FWMP Site #6 (upstream of Bruin Creek confluence):
The site has a long FWMP history with continuous monitoring since 1978. It is situated to detect potential effects on Greens Creek from activities in the KGCMC Mine/Mill/Shop area. This site is near the upper limit of anadromous fish access due to the weir positioned some ½ mile upstream. Anadromous access to this stream reach was created by KGCMC in 1989 by installing a fish pass in a waterfall area about 3 miles downstream. Both Dolly Varden and Silver (Coho) Salmon have been previously documented in this reach. Where possible, data from this site will be compared to that developed from Site #48. Trend information for the site will also be developed to detect changes over time.

Greens Creek Below D-Pond : FWMP Site #54
This site is located to detect potential effects on Greens Creek from activities in the KGCMC Production Rock Storage Areas 23 and D. It is situated about ¼ mile downstream of Site #6, about ¾ mile downstream of the weir, and near the upper limit of anadromous fish. Anadromous access to this stream reach was created by KGCMC in 1989 by installing a fish pass in a waterfall area some 3 miles downstream. Both Dolly Varden and Silver (Coho) Salmon have been previously documented in this reach. Where possible, data from this site will be compared to that developed from Site #48, and Site #6 when data are available. Trend information for the site will also be developed to detect changes over time.

Tributary Creek : FWMP Site #9
This site was previously monitored under the FWMP from 1981 through 1993. It is being reactivated in 2001 for the inclusion of biomonitoring. It was, and is situated so as to detect potential effects on Tributary Creek from activities in the KGCMC dry tailings placement facilities one-mile further upstream on Tributary Creek. This is the closest free-flowing stream reach suitable for biomonitoring to the tailings placement facilities. As these placement facilities were situated on the hydrographic divide, there is no comparable upstream site. This site is available to Pink (Humpie), Chum (Dog), and Silver (Coho) Salmon, as well as Dolly Varden char. Data from this site will be analyzed for trends showing changes over time.

6.8. Periphyton Biomass

6.8.1. Introduction and Rationale

Many fish species are highly migratory and their presence or absence does not adequately describe the health of a specific reach of stream. Periphyton, or attached algae, is sensitive to changes in water quality. Their abundance confirms that productivity is occurring at specific locations within a water body. Sampling is relatively easy with simple equipment. Laboratory analysis requires extraction of chlorophyll pigments and measurement of chlorophyll concentrations on a fluorometer or

spectrophotometer. Measurements on a spectrophotometer require a centrifuge. Laboratory analysis is relatively easy and follows established protocol.

The protocol for collecting and analyzing stream periphyton, stated below, is derived from Freshwater Biological Sampling Manual 1997, Resources Inventory Committee, Government of British Columbia, Alaska Department of Fish and Game (1998), and Barbour et al (1997).

6.8.2. Methods for Field Collection of Samples

Periphyton sampling should be done in summer during periods of stable flow. The system should be allowed to recover, for up to three weeks, after a heavy scouring event. Upstream ('control') and downstream sampling reaches should be matched as closely as possible in regards to flow regime, substrate composition, depth, and habitat type (i.e. riffle, run, pool). Matching riffle habitat with cobble substrate and current velocities of 10-50 cm/sec will be identified and sampled.

Ten rocks are collected from the stream benthos in each study reach. A 5-cm x 5-cm square of high-density foam is placed on the rock. Using a small toothbrush, all material around the foam square is removed and rinsed away with clean water. The foam is removed from the rock and the rock is brushed with a clean toothbrush and rinsed onto a 0.45 *u*m glass fiber filter, attached to a hand vacuum pump. After extracting as much water as possible, approximately 1 ml saturated $MgCO_3$ is added to the filter to prevent acidification and conversion of chlorophyll to phaeophytin. The dry filter is wrapped in a large filter (to absorb any additional water), labeled, placed in a sealable plastic bag, and packed over silicon gel desiccant. Filters are frozen in a lightproof container with desiccant.

6.8.2.1. Laboratory Analysis

Filters are cut into small pieces and placed in a centrifuge tube with 10 ml of 90% buffered acetone. Filters may be ground with a tissue grinder, using a measured amount of additional 10 ml of 90% buffered acetone, if required. Extraction tubes are placed in a metal rack, covered with aluminum foil and held in a dark refrigerator for 24 hrs. After extraction, samples are read on a split beam Spectrophotometer and a Fluorometer (e.g. Turner Model 10, 1996). Trichromatic equations (according to Standard Methods, APHA 1992) are used to convert spectrophotometric optical densities to total chlorophyll-a, b, or c. The Turner Fluorometer is calibrated with primary and secondary chlorophyll-a standards, according to Standard Methods (APHA 1992). A calibration curve is developed with chlorophyll-a standards using a spectrophotometer. New calibration curves are developed every year.

6.8.2.2. Quality Control of Field Sampling

Samples will be placed in pre-labeled bags, placed over fresh silica gel desiccant, and frozen. Samples will be kept frozen during transport to the laboratory and until chlorophyll-a extraction is done.

6.8.2.3. Quality Control for Chlorophyll-a Determinations

Fresh chlorophyll-a standards will be used to calibrate the Fluorometer for each annual sampling event. Samples containing sufficient chlorophyll-a will be read on both the Fluorometer and the Spectrophotometer to check calibration curves. Samples with chlorophyll-a concentrations below the calibration point will be reported as "non-detectable."

6.9. Benthic Macroinvertebrates

6.9.1. Introduction and Rationale

The primary objective of sampling benthic macroinvertebrates in the biomonitoring program is to collect sufficiently quantitative samples to characterize structure and abundance of benthic macroinvertebrate communities exposed to measured water quality conditions. Macroinvertebrate species abundance and diversity is a useful measure of stream health. An earlier investigation of macroinvertebrates in Greens Creek conducted in 1997 by Elaine Major found significant benthic communities. Stream sampling should be done on an annual basis and should be conducted in mid to late July. Macroinvertebrate community assessment should follow the techniques described in Major and Barbour, 1999. Standard Operating Procedures for the Alaska Stream Condition Index: A Modification of the U.S. EPA Rapid Bioassessment Protocols.

6.9.2. Methods

Surveys should be conducted in similar habitats at all routine biomonitoring sites, (refer to Table 6-1*)*. Baseline population data will be collected from Middle Greens Creek (above confluence of Bruin Creek) in a stream section above Monitoring Site 6.

Methods for collecting aquatic invertebrates follow the protocol of the Rapid Bioassessment Techniques, modified for Alaska (Barbour et al 1997 and Major and Barbour, 1999). A D-frame dip net is used. Substrate disturbance is done through kicking or jabbing the substrate 20 times in all major habitat types in a 100-meter reach stream. If fish surveys are to be conducted in the same reaches, benthic surveys should be conducted after nets are placed for the fish surveys (described in Section 6.10).

A 100-meter reach representative of the stream characteristics should be selected. Whenever possible, the area should be at least 100 m upstream from any road or bridge crossing. There should be no major tributaries discharging to the stream in the sampling area.

Different types of habitat are sampled in rough proportion to their representation of the surface area of the total habitat in the reach. Begin at the downstream end of the reach and proceed upstream. A total of 20 jabs or kicks are taken over the reach length using the D-frame dip net. Movement is upstream or laterally after each sample to an undisturbed spot in the reach. For each kick, the net frame is placed on the bottom, and the cobble, gravel, and debris is systematically jabbed or kicked a linear distance of 0.5 m for approximately 30 seconds or until thoroughly disturbed.

Contents of the net should be carefully washed down to the bottom of the net before transfer to sample containers. It may also be necessary to pick some organisms out of the net using forceps. All organisms collected from the 20 jabs or kicks are composited into a single sample. Preserve sample in 95 percent ethanol to cover the sample. Multiple containers may be necessary and all containers should be properly labeled.

Sorting samples for identification does not require any field sorting, except to remove large debris after rinsing and inspecting for organisms. Complete all data sheets for benthos and physical characterization/water quality (Major and Barbour 1999). Methods for subsampling and invertebrate identification and forms for recording data are provided in Major and Barbour (1999).

6.9.2.1. Quality Control of Invertebrate Samples

Twenty percent of each sample lot will be used as a replicate to estimate sampling precision.

6.10. Abundance of Rearing Fish

6.10.1. Introduction and Rationale

Annual population estimates for juvenile salmonids will be made in short sections of stream at three routine biomonitoring sites, refer to Table 6-1. Baseline population data will be collected from Middle Greens Creek (above confluence of Bruin Creek) in a stream section above Monitoring Site 6. Future fish sampling will be done at this station if results from routine surface, groundwater or bio-monitoring sites indicate potential metals contamination from mill-mine or waste rock storage facilities.
The purpose of juvenile fish monitoring is to determine potential trends in populations of Dolly Varden and coho salmon in stream segments down gradient from mine facilities in the Greens Creek and Tributary Creek drainages. The sampling protocol outline below was derived from the Tongass National Forest Monitoring Guidebook (June 30, 1999).

6.10.2. Methods

The monitoring crew will be required to obtain a fish-sampling permit from the Alaska Department of Fish and Game. Juvenile fish population estimates will be made in 100-meter long sections located at specified Tributary Creek and Greens Creek FWMP monitoring sites. These streams have fair to good fish rearing habitat and moderate to high populations of Dolly Varden and juvenile coho salmon (where no migration barriers exist). Population trends will be measured by annual population estimates from within permanently marked sections of stream. Sampling will take place during July in conjunction with periphyton and macro invertebrate monitoring at the same sites. Fish will be active and stream flows should be relatively low during this period allowing for easy sampling. Dolly Varden and coho salmon spawning activity in these sites is not expected to begin until fall. Monitoring should not be attempted during high flows following large storms. These streams normally return to normal summer flows within two days following a significant rainfall event.

A three-pass removal method is recommended using ¼ in mesh minnow traps baited with salmon eggs. This procedure has been developed and tested by the Forestry Sciences Laboratory, Juneau for streams in Southeast Alaska. Previously collected data indicate confidence intervals around point estimates are relatively tight (see Bryant 1999). The study channels had bankfull widths ranging from approximately 15 to 25 feet and gradients from approximately 1 to 4 percent, which represent equivalent habitat conditions found in the Tributary and Greens Creek Freshwater Monitoring sites. It is recommended that a minimum of 25 traps be used. In the Greens Creek monitoring sites, up to 40 traps may be required to saturate rearing habitat within the 100m sample section. Traps should be placed throughout the sample section focusing on pools, undercut backs, bank alcoves, and under root-wads or logjams. Natural obstructions, like shallow riffles or small waterfalls over log steps, should be used as upper and lower section boundaries to minimize fish movement into the sample section during a sampling event. Where possible, these natural obstructions should be relatively permanent features. In any case, the ends of the selected study reaches should be permanently marked for future relocation. Metal tags nailed to trees are recommended as permanent markers.

Minnow traps should be set for approximately 1.5 hours at which time all captured fish will be transferred to buckets. It is suggested the buckets have holes drilled in the sides and be placed in the stream for water exchange to keep the fish aerated. The traps should be rebaited and reset for another 1.5 hour period. While the second set is fishing, fish captured during the first set should be processed. This can be repeated for three cycles. Data collected for each set should include the number of fish captured by species and their fork lengths. The recommended bait is fresh, or fresh frozen salmon eggs. Eggs have to be treated with betadyne to prevent inadvertent transmission of disease.

A subset of the fish population sample will be retained for whole body analysis for metals accumulation. (See Section 6.11) Fish not retained for metals bioassay should be returned to the stream immediately after sampling is completed. Fish should be re-distributed to preferred habitats throughout the sample reach.

6.11. Metals Concentrations in Whole Body Juvenile Fish

6.11.1. Introduction and Rationale

The rational behind sampling is to document the health of the fish population and the bioaccumulation of metals of concern. The response time for juvenile fish to accumulate metals is rapid; for example, ADFG has documented metals accumulation in juvenile Dolly Varden within two months of dispersing from their overwintering grounds to mineralized and unmineralized tributaries. Should changes occur at the Greens Creek mine that result in higher concentrations of metals in the creek, tissue sampling of non-anadromous juvenile fish would identify bioaccumulation.

6.11.2. Methods

Individual juvenile fish will be caught in baited minnow traps as described under Section 6.10.2. When possible, six individual fish will be retained from each Routine Sample Site; fish should be at least 80 mm (ideally >100 mm), and not yet migrated to the ocean. After collection, fish will be measured to fork length, then individually packed in clean (EPA Series 300, Protocol C) sample jars and frozen. If clean sample jars are not available fish will be double wrapped in clean, locking plastic storage bags (1 liter size). All fish will be submitted to a private analytical laboratory, where they will be digested, dried, and analyzed for those analytes listed in Table 5-1 (Suite R).

6.11.3. Quality Control for Collecting Fish Samples

Each fish will be immediately placed in a clean plastic bag after being caught. Fish will be labeled with time and location of collection and frozen as soon as possible. Fish will be kept frozen during transport to the analytical laboratory. Chain of custody forms will be prepared for each sample catalogue. Samples will be numbered following the convention used by ADF&G:

Date/Stream Code/Species Code/Age Code/Sample Number/

An example fish label would read:

071201GR54DVJ01

Where 070201 represents July 2, 2001; GR54 represents Greens Creek, Site 54; DV represents Dolly Varden; J represents juvenile; and 01 represents sample replicate #1.

6.11.4. Quality Control / Quality Assurance of Laboratory Analysis

The analytic laboratory will provide quality assurance/quality control information for each analyte, including matrix spikes, standard reference materials, laboratory calibration data, sample blanks, and sample duplicates.

6.12. Toxicity Testing

6.12.1. Introduction and Rationale

Toxicity tests measure the combined toxic effects of all constituents in any particular sample. They measure toxicity of multiple components that may not be able to be measured using analytical techniques since some substances can be toxic in amounts that are below detection limits of some analytical methods. This is especially true when multiple toxic components are synergistically causing toxicity and each component is below detection limits. A commonly available test is the Microtox test, which uses the luminescent bacteria *Vibrio fischeri*. When grown under optimum conditions, the bacteria produce light as a by-product of their cellular respiration. Bacterial bioluminescence is directly related to cell respiration, and any inhibition of cellular activity results in a decreased rate of respiration and a corresponding decrease in the rate of luminescence.

6.12.2. Methods

The Microtox test requires approximately 100 ml of sample water per test replicate. Water samples should be collected at the same time other biomonitoring sampling is done, refrigerated, then shipped to an analytical laboratory with facilities for standardized laboratory toxicity testing. Analysis should be done within two weeks of sample collection.

6.12.3. Laboratory Methods, Including Laboratory QC

Microtox samples are analyzed with the Microtox analyzer, by Azure Laboratories Inc. The auto-analyzer/incubator is attached to a computer that tracks the elapsed time for each sequential test: 15 minutes, 30 minutes, and 60 minutes. At the end of each test period, the amount of light generated by the bacteria in each test cuvette is measured, recorded by computer, and the percent effect is calculated. At the end of the 60-minute sample period, the sample results are automatically printed. Results show light depletion and percent effect.

Quality assurance for this test is provided by duplicate tests and duplicate control samples.

6.13. Sample Filtration And Preservation

The filtration procedure described below is used for dissolved analyses of metals, except mercury, when environmental conditions allow. If weather or safety conditions do not permit filtration in the field at the time of sample collection, filtration should occur as soon as possible after sample collection in a dust-free, safe environment prior to sending the samples to the laboratory. Because of the risk of contamination, it is recommended that samples for mercury be shipped unfiltered by overnight courier and filtered when received at the laboratory.

Each laboratory will preserve the samples following the guidelines contained in 40 CFR Part 136.

Filtration cartridges and tubing shall be manufactured out of suitable materials as listed in Section 6.3.

6.13.1. Set up the filtration system inside the site bag, using the shortest piece of pump tubing as is practicable. Place the peristaltic pump immediately outside of the site bag and poke a small hole in the site bag for passage of the tubing. Also, attach a short length of tubing to the outlet of the capsule filter.

6.13.2. CH removes the water sample from the inner storage bag using the technique described in Sections 6.5 through 6.6 and places the sample inside the site bag. CH also places two clean empty sample bottles, a bottle containing reagent water, and a bottle for waste in the site bag.

6.13.3. When a blank is collected, CH removes the lid of the reagent water bottle and places the end of the pump tubing in the bottle.

6.13.4. When a blank is collected, DH starts the pump and passes approximately 200 mL of reagent water through the tubing and filter into the waste bottle. CH then moves the outlet tubing to a clean bottle and collects the remaining reagent water as a blank. DH stops the pump.

6.13.5. CH removes the lid of the sample bottle and places the intake end of the tubing in the bottle.

6.13.6. DH starts the pump and passes approximately 50 mL through the tubing and filter into the remaining clean sample bottle and then stops the pump. CH uses the filtrate to rinse the bottle, discards the waste sample, and returns the outlet tube to the sample bottle.

6.13.7. DH starts the pump and the remaining sample is processed through the filter and collected in the sample bottle.

6.13.8. CH replaces the lid on the bottle, returns the bottle to the inside bag, and zips the bag. CH then places the zipped bag into the outer bag held by DH.

6.13.9. DH zips the outer bag, and places the double-bagged sample bottle into a clean, ice-filled cooler for immediate shipment to the laboratory.

6.14. QC Sample Collection Procedures

The procedures listed below are used for the collection of all QC samples including duplicates and field blanks.

6.14.1. To collect duplicates the same procedures as those used to collect the sample at the site where the duplicate is to be collected are followed.

6.14.2. To obtain FBs the following procedures are used at both surface and ground water sites where field blanks are scheduled for collection.

6.14.2.1. DH removes the bagged bottle of DI water from the site bag and opens the outer ziplock bag pulling it down but not off. CH opens the inner ziplock bag (if applicable) and removes the cap from the bottle of DI water, pushing the inner bag down slightly.

6.14.2.2. DH sets the still bagged but open bottle down where it won't get knocked over while the site's sample(s) are collected.

6.14.2.3. After the routine sample(s) are collected at the site DH removes the bagged FB bottle from the site bag and opens the outer ziplock bag. CH opens the inner ziplock bag (if applicable) and removes the FB bottle, pushing the inner bag down. DH reseals outer bag.

6.14.2.4. CH removes the FB bottle cap and holds it, while DH retrieves the open bottle of DI water picking it up by touching only the outer bag. DH pours the DI water into the FB bottle being held by CH.

6.14.2.5. CH secures the cap as tight as possible while DH reseals the outer bag of the empty DI water bottle, puts it back in the site bag, and retrieves the bag(s) for the FB bottle.

6.14.2.6. DH opens the outer ziplock bag for the FB bottle. CH puts the bottle into the inner bag (if applicable) and reseals it. If needed CH may become DH at this point and DH reseals the outer bag. DH replaces the bagged, FB filled bottle back into the clear heavy plastic site bag.

6.14.3. To collect duplicate biological tissue samples the following procedures are to be used.

6.14.3.1. The duplicate samples will be collected at one location at each site, where there is sufficient periphyton, benthic macroinvertebrate and/or fish tissue biomass necessary for analysis. Sufficient tissue sample weight for analysis needs to be greater than or equal to 10 g. on a fresh weight basis (i.e. equivalent to at least a 1 g dry weight sample).

6.14.3.2. Tissue samples will be collected and then split into a primary and duplicate sample, making sure each are homogeneous in both species representation and species biomass.

7. SAMPLE PACKAGING AND SHIPPING

All FWMP samples are collected by KGCMC personnel, packaged, and transported off Admiralty Island for laboratory analyses. This section describes the steps necessary to properly document the sample shipment, package the samples for shipment, and to arrange for and coordinate shipment of the samples from the mine site to the laboratory.

7.1. Documentation

A sample inventory sheet(s), or chain of custody form, and a bill of lading are the documents involved with each sample shipment. An example sample inventory sheet is found in Attachment B. A copy of each is kept by sampling personnel to properly document the sample shipment and to aid in recovery of lost shipments, etc. Documentation will be filed at the KGCMC mine site.

7.1.1. Routine sample shipments will use a sample inventory sheet and seals on the sample shipping container(s), rather than a formal chain of custody procedure. The laboratory will indicate in their report if the seals were intact or broken when the samples were received.

7.1.1.1. Chain of custody is recommended only for samples that are to be introduced into court as evidence. Errors made in filling out chain of custody forms invalidate evidence. Samples must be locked up or in the visual presence of the sample custodian at all times. An unbroken chain of custodian signatures must be maintained (with the exception of common carriers).

7.1.1.2. If shipping samples with formal chain of custody procedures, a chain of custody form is used with frangible seals for the containers that readily indicate tampering. The lab must be instructed to maintain full chain of custody on the sample and the results at all times.

7.1.2. A sample inventory sheet is prepared listing the number descriptor for each site sampled, the date and time each sample was collected, the suite of analytes each sample is to be analyzed for, and the samplers' initials. Site descriptor, date, and time collected define a unique sample.

7.1.2.1. FBs are designated as "Field Blank - site XXX" in the site description on the sample inventory sheet.

7.1.2.2. Blind duplicates taken at the discretion of KGCMC are designated as "Blind Dup" on the sample inventory sheet.

7.1.3. A bill of lading is completed for the shipping carrier to be used. KGCMC has accounts with Alaska Airlines Gold Streak Service, DHL, Federal Express, and United Parcel Service. The carrier used is based on their ability to deliver samples to the laboratory's location, and the carrier's flight schedule. The account number is put on the bill of lading.

7.1.4. The samples and documentation are inspected and reviewed for accuracy, completeness, and legibility. The reviewer by initialing the sample inventory sheet (or chain of custody form) documents the review as complete. The items to be reviewed are as follows:

7.1.4.1. The monitoring schedule is referenced to ensure all sample bottles including the QC samples are present.

7.1.4.2. The preprinted sample bottle labels and the sample inventory sheet (or chain of custody) are reviewed to ensure the labels are legible and they match the sample inventory sheet.

7.1.4.3. The bill of lading is reviewed to ensure the correct delivery address.

7.2. Sample Packaging

Packaging the samples is facilitated by the laboratory shipping empty bottle sets in the coolers that will be used for shipping the samples back to the laboratory. Coolers protect the sample containers, and provide the necessary environmental conditions (cleanliness, temperature, etc.) during transport. Blue Ice or frozen water in appropriate containers is used to maintain a temperature of 4°C within the coolers during sample shipment to the laboratory, and it is KGCMC's responsibility to freeze Blue Ice or water-filled containers prior to use.

7.2.1. In a clean place without removing them from their ziplock bag(s) ensure each sample bottle lid is tight, the bottle is properly labeled, and the cooler is clean to help minimize any contamination.

7.2.2. Ensure each sample bottle for metals analyses is within a set of double ziplock bags, each sample bottle for the measurement of physical analytes is within a single ziplock bag, and both are within the large clear heavy plastic bag designated for each site.

7.2.3. Place all site bags into the cooler lined with an additional clear plastic bag. Set the bottles snugly in the cooler using clean packing material as necessary to prevent the sample bottles from moving within the cooler during transportation.

7.2.4. Place sufficient previously frozen Blue Ice or water filled bottles in the cooler with the samples to maintain the cooler temperature at 4°C during transportation.

7.2.5. Copy the sample inventory sheet (or chain of custody form), seal the original in a ziplock plastic bag, and place the bag within the cooler. Retain the copy for KGCMC's files.

7.2.6. Place KGCMC security strapping tape around the cooler as necessary to ensure the lid does not open during transportation. Tape should be applied over the cooler lid lock mechanism if present. The person packing the samples must sign their name across the tape seal.

7.3. Sample Shipping

Shipment of samples is coordinated between sampling personnel, laboratory personnel, and the transportation carrier(s) to be used. Samples are shipped expeditiously to the laboratory, and should arrive in less than 2 days from the sample collection date.

7.3.1. Sample shipments are not scheduled when it would result in expected delivery on late Friday afternoons, weekends, or holidays. Samples must be unpacked, logged, filtered (mercury samples only), and preserved immediately upon receipt at the laboratory.

7.3.2. Shipments are scheduled in consideration of the ability to get samples to town in time to meet the carrier's flight schedule. The carrier's schedule is checked beforehand for changes due to holidays or other reasons which could result in delayed delivery.

7.3.3. The sample cooler(s) is brought to the drop-off point or common carrier in town and a copy of the bill of lading is returned to the mine for filing.

7.3.4. A copy of the bill of lading is faxed to the Laboratory or they are called with the air bill number confirming to them the expected shipment and delivery time.

8. SAMPLE ANALYSES

Independent laboratories will be used for water sample analyses. A written statement of work (SOW) defining contractual requirements, DQOs, and data deliverables for the FWMP will be prepared and sent to any laboratory selected to conduct water quality analyses. Laboratories will also be periodically audited (Section 12.4).

8.1. Historical Summary Of Laboratories And Detection Limits

Laboratories used to analyze water quality monitoring samples varied over the years, resulting in changes to analytical methods and detection limits. The following table lists the laboratories used.

Table 8-1 Laboratories Used for Analysis

Dates	Laboratory	Location
78-89	Laucks Testing Laboratories, Inc.	Seattle, WA
90-93	Inter-Mountain Laboratories, Inc.	Sheridan, WY
94-9/96	Montgomery Laboratories	Juneau, AK
10/96-present	Battelle Marine Sciences Laboratory	Sequim, WA

8.1.1. The following table lists the MDLs for metals monitored in the FWMP. Other analytes were historically analyzed, but are not included herein.

Table 8-2 Historic Method Detection Limits for Metals

Analyte	Dates	MDL, (µg/L)
Arsenic	78-5/98	5
	6/98-8/00	0.05
	10/00-present	see Table 3-1
Cadmium	78-95	2
	95-5/98	0.066
	6/98-10/00	0.03
	10/00-present	see Table 3-1
Chromium	78-88	2
(total species)	89	5
	89-92	20
	92-95	50
	95-5/98	12
	6/98-10/00	0.1
	10/00-present	see Table 3-1
Copper	78-89	2
	90-92	10
	93-95	20
	95-5/98	0.65
	6/98-10/00	0.05
	10/00-present	see Table 3-1
Lead	78-90	10
	91-92	20
	92-95	2
	95-5/98	0.13
	6/98-10/00	0.02
	10/00-present	See Table 3-1

Analyte	Dates	MDL, (µg/L)
Mercury	78-95	1
	95-5/98	0.012
	6/98-10/00	0.00005
	10/00-present	See Table 3-1
Selenium	78-88	10
	88-95	5
	95-5/98	2
	6/98-10/00	0.8
	10/00-present	see Table 3-1
Silver	78-81	2
	81-88	0.1
	88-89	2
	89-92	10
	93-95	50
	95-5/98	0.012
	6/98-10/00	0.008
	10/00-present	See Table 3-1
Zinc	78-88	2
	89-92	10
	93-95	20
	95-5/98	4.7
	6/98-10/00	0.1
	10/00-present	See Table 3-1

8.2. Laboratory Selection Criteria

This section provides guidance for selecting laboratories that can provide data meeting the DQOs specified in Section 3. Experienced environmental professionals will evaluate potential laboratories for the following elements:

8.2.1. The laboratory must have a QAPP designed to ensure data are scientifically valid and defensible, and of known and acceptable precision and accuracy. It should contain the following items or refer to SOPs and methods published elsewhere.

8.2.1.1. Procedures for sample container preparation, biological sample preparation, QC, shipping, and record keeping.

8.2.1.2. Sample handling procedures that specify maintaining sample integrity from receipt to disposal and chain of custody procedures.

8.2.1.3. Instrument or equipment calibration procedures and preventative maintenance procedures with schedules and record keeping requirements specified.

8.2.1.4. Analytical procedures and the MDLs, IDLs, reporting limits (if used), and precision and accuracy control limits that the laboratory routinely achieves for each analyte.

8.2.1.5. Specific procedures for determining MDLs, IDLs, reporting limits (if used), and precision and accuracy control limits for each analyte.

8.2.1.6. Procedures for internal QC checks and audits, and procedures for corrective action when QC limits are exceeded which include frequency, record keeping, and reporting practices.

8.2.1.7. Data reduction, validation, and reporting procedures including those for electronic and hardcopy record keeping.

8.2.1.8. Laboratory organization charts, responsibilities, staffing levels, and education and/or experience requirements for supervisory and key technical staff.

8.2.1.9. Facility description, data flow diagrams, and major analytical equipment list(s).

8.2.1.10. Past experience with analysis of biological tissues.

8.2.2. The laboratory must provide evidence of competency in conducting the analytical methods, which may be established by one or more of the following for the analytes specified in the FWMP.

8.2.2.1. Certification by the EPA or State Drinking Water Program.

8.2.2.2. Acceptable annual performance in the EPA Water Supply and/or Water Pollution Performance Evaluation Programs.

8.2.2.3. Certification by a national third party certification organization.

8.2.2.4. Participation in the EPA Contract Laboratory Program for Low Level Water Sample Analyses.

8.2.3. The laboratory must be able to provide data that meets the DQOs. This is determined by reviewing the MDLs and the precision and accuracy control limits provided in their QAPP. Laboratories may be able to achieve lower MDLs than what is routinely provided and inquiry should be made before discounting a laboratory's potential participation.

8.2.4. The laboratory must provide qualified staff to conduct the specified analyses. This can be determined by reviewing the qualifications of supervisory and key technical staff in the laboratory's QAPP.

8.2.5. The laboratory must have the equipment required to perform the needed analyses. This can be determined by reviewing the major analytical equipment list in the QAPP.

8.2.6. The laboratory must be physically located where transportation can be arranged to ensure holding times are met. This must also be verified if branch labs in other locations are used for some of the analyses.

8.2.7. The laboratory must have sufficient analytical capacity to analyze samples within holding times and return data within the specified time.

8.3. Selected Laboratory Documentation

The following documentation for laboratories selected to conduct FWMP water sample analyses will be kept on file at the mine site.

8.3.1. Copies of method competency certifications.

8.3.2. A copy of the laboratory QAPP including analytical methods, MDLs, reporting limits (if used), precision and accuracy control limits, staff qualifications, facility description, and equipment lists described above.

8.4. SOW For Analyses

A written SOW shall be provided to the selected laboratory(s) giving direction on the analytical work to be furnished which includes the following.

8.4.1. The anticipated number of samples including QC samples, the analytes to be monitored, and the DQOs that must be met will be stated.

8.4.2. The laboratory shall notify KGCMC immediately if any sample is lost due to a lab accident. This prompt notification allows KGCMC the option of re-sampling to replace the sample or taking additional samples to confirm the unusual result.

8.4.3. Water quality sample analyses shall be performed within holding times and using the approved methods listed in 40 CFR § 136, Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act.

8.4.4. The laboratory shall be responsible for biological sample preparation. This includes final cleaning of benthic macroinvertebrate samples of debris before analysis, and rinsing periphyton samples with DI water before analysis.

8.4.5. The laboratory shall provide their latest comprehensive MDL study, done in accordance with 40 CFR § 136 Appendix B, to the third party conducting the QA review (Section 9) and will provide updates as they are done.

8.4.6. Field Blank (FB) samples shall be analyzed for the same suite of analytes as the sample collected at the site where the FB was collected.

8.4.7. For every sample group a method blank (MB) shall be analyzed for each analyte scheduled for analysis in that sample group.

8.4.8. For every sample group a laboratory control standard (LCS) shall be analyzed that is traceable to different source standards than the ones used for calibrations. The LCS will have a concentration for each required metal at its MDL level or, for those analytes whose MDL is outside the range of the calibration curve, at a concentration appropriate to the curve. A duplicate analysis of this LCS will also be performed.

8.4.9. For every sample group matrix spike/matrix spike duplicate (MS/MSD) analyses shall be performed for all the metals scheduled for that group.

8.4.9.1. The laboratory will select the site on which MS/MSD analyses are performed and rotate it monthly to ensure all sites are included. In the laboratory the sample from the selected site will be split into thirds and two of them spiked accordingly. At least one fraction will be spiked and the laboratory will select that fraction. The spiking level should result in concentrations at or above the AWQS for each metal.

8.4.9.2. The laboratory shall keep the complete set of raw data for the samples including sample preparation logs and instrument calibration information in easily accessible files for a period of at least 6 months.

8.4.9.3. The laboratory shall notify KGCMC immediately upon any change in certification status, personnel, equipment, or any other aspect of laboratory operations that may adversely impact the integrity of the samples or the attainment of DQOs for the analytical results.

8.5. SOW For Data Deliverables

The written SOW provided to the selected laboratory(s) shall give direction on the data deliverables to be provided in a report to KGCMC, on laboratory letterhead, within 45 days of sample receipt, with the following information:

8.5.1. Document the date samples were received by the laboratory, whether or not the shipping container was received with the seal intact, and if all samples listed on the sample inventory sheet were present.

8.5.2. Document whether or not inductively coupled plasma (ICP) was used and if raw data were generated before inter-element and background corrections were applied.

8.5.3. Document any problems, QC criteria exceedances, holding time exceedances, and observations affecting sample integrity and provide a detailed description.

8.5.4. Provide a statement of authenticity and certification of the data with the date the report was generated and dated signature of the lab manager.

8.5.5. Document the results of all sample analyses, including blind duplicates submitted at KGCMC's discretion, with KGCMC sample numbers and their corresponding laboratory number(s), date received, analyses performed (analyte and dissolved, total, or total recoverable fraction), analytical result, IDL, MDL, ML, and unit of measurement for each analyte.

8.5.6. Document the results of the MB and FB analyses for each analyte.

8.5.7. Document the results of the LCS analyses including the calculated %R for each analyte, and the RPD of the LCS results for each analyte.

8.5.8. Document the results of the MS/MSD analyses including the calculated %R for each analyte, and the RPD of the MS and MSD results for each analyte.

8.5.9. Document all analyses not meeting holding times, MDLs, or the precision and accuracy control limits by flagging them in the analytical report and provide definitions for the flags.

8.5.10. Provide a compatible computer disk with the analytical results in a file format compatible with Microsoft Access, to reduce errors and labor required for data entry in the KGCMC database.

9. QA REVIEW

Data used for decision making are to be of known and acceptable quality. All data are reviewed by a qualified QA reviewer to determine if the DQOs have been met. A qualified QA reviewer has no bias about the data quality and can evaluate the possible impacts to data comparability introduced by the use of multiple labs in the analysis of samples. As a result of the QA review, data may be qualified as estimated or rejected for failure to meet the DQOs.

The data deliverables from the laboratory(s) specified in section 8.5. provide the documents for an adequate review. Requesting all the raw data from the laboratory may make for a more thorough review. The same review is made of each laboratory's submittal when multiple laboratories are used.

9.1. General

9.1.1. KGCMC has the responsibility to arrange for and ensure that all laboratory data are reviewed for QA by a qualified QA reviewer.

9.1.2. KGCMC shall provide the QA reviewer a copy of the data deliverables from the laboratory(s) and direct them to document the results of their review in a report to KGCMC within 20 working days of receipt.

9.1.3. The QA review of the data must be performed before inclusion of the data in KGCMC's monthly report to the USFS.

9.2. QA Review Content

The report(s) from the laboratory(s) is reviewed to ensure all information required in section 8.5 is present, and to make the following determinations:

9.2.1. Determine if the blank data meet the representativeness DQO. Negligible contamination in the analytical process indicates that the analyses are representative of the environment.

9.2.2. Determine if the IDLs are at least as low as the MDLs for each analyte, and if the comparability DQO has been met.

9.2.3. Determine if the RPD and %R for each analyte in the LCS analyses meet precision and accuracy DQOs.

9.2.4. Determine if the RPD and %R for each analyte in the MS/MSD analyses meet precision and accuracy DQOs, as long as the native amount is not 4 times the spiked amount.

9.2.5. Field sample results will be qualified based upon field blanks and laboratory QC results. Determine if there are data which should be qualified as estimated or rejected due to failure to meet the DQOs specified in Section 3, or for failure to be analyzed within holding times.

9.2.6. Calculate the percentage of planned analyses that resulted in useable data, and determine if the DQO for completeness specified in Section 3 has been met.

9.2.7. Contact the laboratory if there are data missing or unusual results for any additional information or clarification needed by writing, fax, or e-mail with a courtesy copy to KGCMC.

9.2.8. If more than 5% of the data do not meet DQOs conduct a QA review following the current edition of Functional Guidelines for Evaluating Inorganic Analyses, to assess data usability and the laboratory's ability to produce data of the needed quality. The raw data including standardizations and QC may be requested from the laboratory.

9.3. QA Review Documentation

The QA review of the laboratory's analytical report(s) will be documented in a report to KGCMC signed by a qualified QA reviewer that contains the following information:

9.3.1. Include a table of KGCMC sample numbers with their corresponding laboratory number(s) and the date sampled.

9.3.2. Identify any missing documentation and state why it is missing if known.

9.3.3. Discuss sample representativeness issues (blank contamination, analytical fraction) relative to the DQO for representativeness.

9.3.4. Discuss sample comparability issues (methods, MDLs, MLs, analytical fraction) relative to the DQO for comparability.

9.3.5. Discuss analytical precision (RPDs) and accuracy (%Rs) issues relative to the precision and accuracy DQOs.

9.3.6. List data requiring qualification along with the rationale for qualification. This is to include data values between the ML and the MDL.

9.3.7. Discuss any limitations on data usability as a result of the QA review.

9.3.8. Discuss data completeness issues relative to the completeness DQO.

9.3.9. Include copies of any laboratory correspondence necessary in the course of the QA review and list any references.

10. REPORTING

Data specification and collection provide the foundation of a monitoring system. Review, evaluation, and reporting the data is the next essential step. Information users base decisions on the monitoring results and contents of reports.

10.1. Purpose Of Reports

Documentation and communication of information resulting from data evaluation is the purpose of reports.

10.1.1. Defined, periodic, KGCMC reports document the following:

a) The monitoring activities.

b) The information gained in the monitoring process.

c) The results of information evaluation.

10.1.2. Reports communicate information that is used as follows.

a) To provide the basis for management decisions.

b) To provide the basis for determining if the RIGs, MAGs, and MIGs are being met.

c) To provide the basis for assessing the effectiveness and efficiency of the FWMP.

10.2. Responsibility For Reports

KGCMC is responsible for the preparation and distribution of the reports specified in this section.

10.3. Distribution of Reports

The reports specified in this section are to be distributed in electronic format to the KGCMC General Manager, the USFS Admiralty National Monument Ranger, and ADEC. Other interested parties may request copies of these reports. The USFS and ADEC may have standardized requirements for the submittal of electronic data. KGCMC will submit the data in the format required by these respective agencies.

10.4. Reports of Exception

The purpose of a report of exception is to communicate changes or unanticipated problems and resulting actions. Exceptions are very short-term temporary conditions not requiring a FWMP modification. An example is the taking of additional samples for a short period of time to verify an unusual result. The report also documents the event for the historical record.

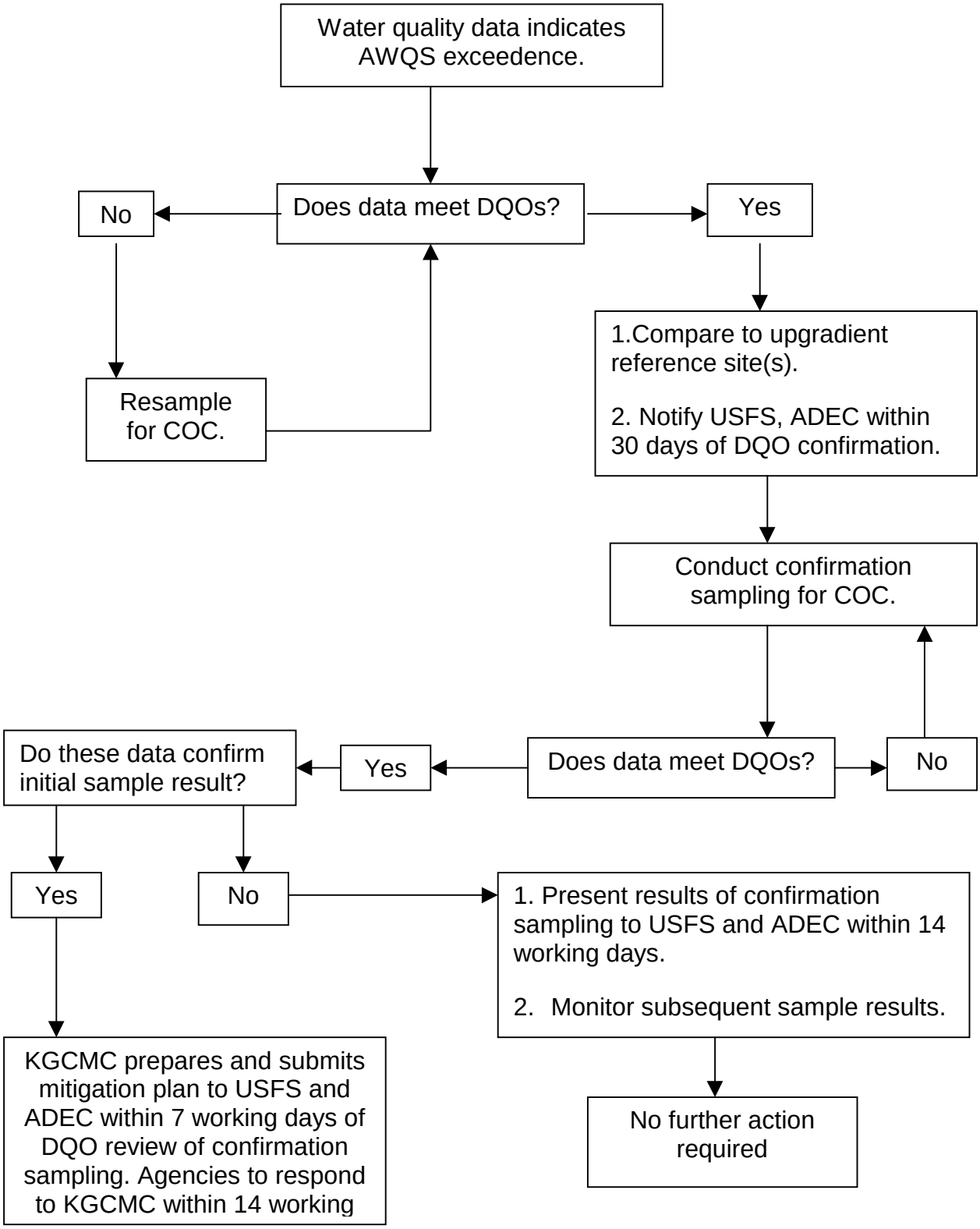
The content of a report of exception varies depending on the exception. The information provided should be clear and fully explained.

Reports of exception are made as needed and may be either an emergency or not an emergency. Emergencies are events with actual or potential significant resource damage. A report for an emergency such as a chemical spill affecting fresh water is distributed as soon as possible.

Events that are unanticipated and unscheduled but do not appear to cause or have the potential of causing significant resource damage are not time critical. They may be reported along with the next scheduled report.

Should KGCMC suspect that an AWQS has been exceeded at a FWMP sampling site, the protocol outlined in Figure 10-1 will be followed. KGCMC will first determine if an actual exceedence has occurred. If KGCMC determines an exceedence occurred, they will identify and explain the cause of the exceedence in a written notice to the USFS and ADEC within 30 days of identifying the exceedence. This notice shall also contain a plan to mitigate the cause of the exceedence. If KGCMC believes the exceedence is caused by factors outside the influence of mining activities, the mitigation plan will address that fact by referencing upgradient background sites and/or other means of verification. USFS and ADEC shall respond to KGCMC regarding the contents of this plan within 14 working days of receiving the notice. The agencies response shall consist of either approval of the mitigation plan, or recommendations for changes to the plan that will help alleviate potential impacts to the designated uses of the receiving waters.

Figure 10-1 AWQS Exceedence Determination Protocol



10.5. Monthly Reports

The purpose of the monthly reports is to provide information which the USFS and KGCMC use to determine if MIGs related to monthly monitoring requirements for each site are met.

The content of the monthly reports covers activities during a calendar month and includes the following items:

a) A cover letter from KGCMC containing the following information.

   (1) A statement indicating whether all of the scheduled samples for the month were collected and if not an explanation why.

   (2) Identification of any data anomalies resulting in rejected data from either the QA reviewer or the KGCMC outlier analyses including an explanation why.

   (3) Identification and explanation for any data exceeding the AWQS listed in Section 3.2.

   (4) Identification of any unanticipated changes in sampling or analytical processes including an explanation why.

   (5) Discussion of any QC problems resulting in qualified data by the QA reviewer including possible causes and any steps being taken to resolve them.

b) Copies of KGCMC's year-to-date FWMP monitoring schedule and FWMP QC sample log.

c) A copy of the laboratory analytical report specified in Section 8.5.

d) A copy of the QA review report specified in Section 9.3.

e) An electronic copy of the laboratory data with qualifiers from the QA reviewer.

f) Any reports of exception that don’t need immediate transmittal.

10.5.1. KGCMC's monthly reports shall be submitted (postmarked) to the USFS within 90 working days (weekends and Federal holidays excluded) of the date the laboratory received the last samples for the month.

10.6. Annual Reports

10.6.1. The purpose of the annual reports is to provide information which the USFS and KGCMC use to determine the following:

a) If the RIGs, MAGs, and MIGs for each site have been met and whether any changes are warranted.

b) If any changes to the monitoring schedule are needed.

c) If any other changes to the FWMP are needed including any aspects of monitoring, evaluation, or reporting.

d) If any changes in best management practices (BMPs) are needed.

10.6.2. The content of the annual reports covers activities during a water year, October 1st to September 30th, and includes the following items:

a) A table of contents.

b) A list of interventions (procedural changes, natural phenomena and mine operation changes) that could possibly affect data during the water year and any effects detected from visual data analyses.

c) A list of any negotiated mid-year FWMP or mine BMP modifications that were made including changes to the monitoring schedule and the problems including AWQS exceedences they address.

d) A list of company and agency personnel who were involved in the FWMP during the water year and their function or job title.

e) A list of proposed program modifications including proposed revisions to the monitoring schedule, and discussion/rationale for proposed changes based on data analysis.

f) The results of data analyses required by the SIGs section of the individual monitoring site summaries (referenced in Section 4.1 and found in Attachment A.) including the following:

   (1) An interpretive report of the conclusions drawn from the data analyses including comparisons to previous years' data, baseline data, and background data.

(2) A clarification of what data were used in the analyses and identifying any data which was not included such as data that was qualified as rejected by the QA reviewer or confirmed as an outlier based on the outlier analyses and re-sampling performed by KGCMC.

The evaluation and handling of potential outliers will be performed using the guidance found in the EPA document “Guidance for Data Quality Assessment”, EPA/600/R-96/084. Section 4.4 of the EPA document provides guidance on identifying potential outliers, choosing the proper statistical test, evaluating the results and documenting the process.

The first step is to review the data to determine whether any of the points may be potential outliers. Graphical representations are the most common method. Once potential outliers are found, the data must undergo a statistical test designed to detect outliers. The statistical test chosen must be applicable to the distribution type of the data set and the number of potential outliers in the data set.

At this point, the results of the statistical outlier test must be evaluated fully to determine whether the potential outliers are a true outlier or simply an extreme value that may be part of the data set’s distribution. No data points should ever be excluded solely based upon statistical testing. Any potential outliers identified by proper statistical testing must be verified. The verification of outliers must include scientific support that the data point is truly an outlier. If further checking does not suggest the point is an outlier, the results of the statistical test cannot be used to label the point as an outlier. If the support is found the data point may be identified as an outlier.

The data analysis performed on the data set to which the outlier belongs must be performed once with the outlier included and again with the outlier excluded. The results are then to be reviewed to determine the impact on the data analysis with regards to the contribution of the outlier data points.

The final step for outlier designation is documentation. The rationale for the choice of the outlier test must be given, along with the results. Then, the supporting scientific facts must be given to demonstrate the outlier is not just a statistical anomaly, but was in fact a true outlier. Finally, the impact the outlier data point had on the statistical processing of the data must be given.

(3) A list of qualified data from the monthly QA review reports.

(4) A chronological list by site of all data collected during the water year that exceeds AWQS.

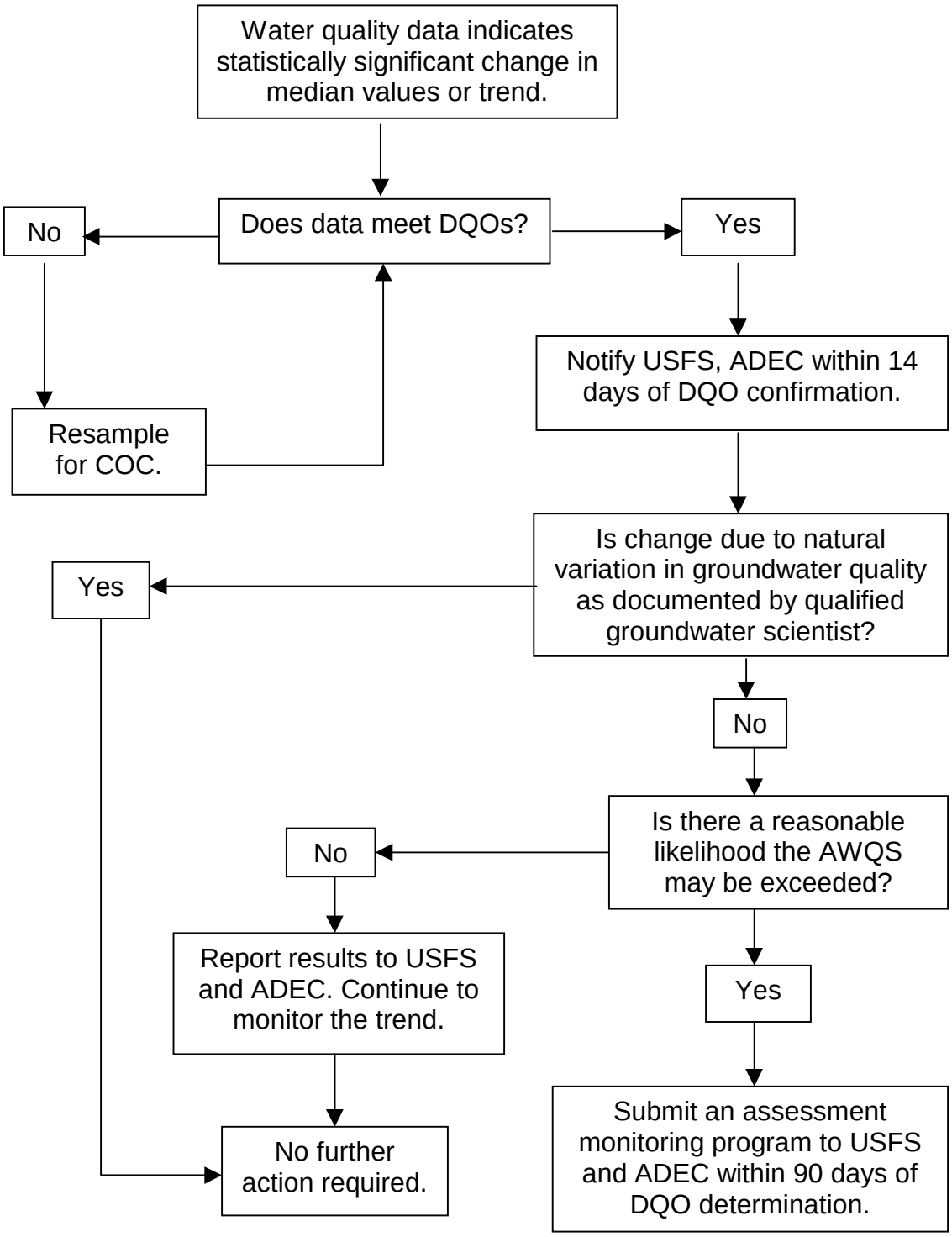
(5) A comparison of medians will be made as specified by the SIG's. Data outliers shall not be used in the data set used for median comparisons. Values between the MDL and ML will be used. A notation will be included in the report that states which values used in the median comparison fall between the MDL and ML. Data values below the MDL shall be assigned a value of zero for the purposes of median comparisons. A description of applicable median comparisons follows.

Analytical results must be statistically compared to determine whether concentration changes have occurred in a geographic situation or over time. Since nearly all data is not from a normally distributed population, it is necessary to compare the medians between the data sets. Although the initial step involves difference testing of the medians, several additional steps are taken to fully evaluate the meaning of that difference testing.

The first step is analysis of variance based upon the ranked data. Ranking must be used due to the nonparametric distributions. The results of the analysis of variance are evaluated to estimate what level of significance is attached to the difference testing of the means. The significance level is then compared to the project objectives to ascertain whether the two data sets differ. This significance level must receive equal attention as did the result of the difference testing.

Multiple comparisons testing is then performed so that the indications given in the earlier median testing and significance testing are confirmed. If the multiple comparisons testing does not support the conclusions of the earlier testing, then further examination is needed to rule out the possibility that false indications were given. If the multiple comparisons testing confirm the other testing, then there is a greater confidence the original results are indicative of site conditions. The multiple comparison methods chosen must be sufficiently robust as to either confirm or countermand the simpler one-on-one testing. If a median comparison indicates that a statistically significant change in concentration has occurred at a FWMP sampling site, KGCMC will notify the USFS and ADEC within 14 days of DQO confirmation following the protocol shown in Figure 10-2. KGCMC will determine the cause of the change, and whether the AWQS for the constituent of concern may be exceeded as a result of the changing conditions. If KGCMC determines that the change is not the result of natural variation in groundwater, they will establish an assessment monitoring program within 90 days of DQO confirmation.

Figure 10-2 Protocol for Statistically Significant Change or Trend



(6) X-Y graphs of the analytes specified and a trend analysis if indicated by visual inspection of the graphs. The scale shall be appropriate to conduct visual trend analyses, i.e., each scale will be as confined as possible based on each data range. AWQS criteria will be displayed on the graphs. Data outliers shall not be displayed on the x-y graphs. Data qualified by the QA contractor shall be labeled as such on the x-y graphs. Data values below the MDL shall be assigned a value of zero for the purposes of the x-y graphs.

Any indeterminate trend (may or may not be a trend) shall be verified using a statistical trend analysis. Data outliers shall not be used in the statistical trend analysis. Data values below the MDL shall be assigned a value of zero for the purposes of the trend analysis. Trend analyses must be performed on the data sets such that the appropriate level of confidence is achieved. This level is based upon the traditional false positive / false negative rate (related to α) that can be tolerated. Also, the statistical test chosen must be powerful enough to conclude whether a trend is present or not. In other words, the test cannot be so weak that no conclusion is reached, even on data where clear trends are evident.

Also, the test must be selected and the test parameters chosen such that the distribution of the data is either properly matched or is non-parametric. If the data are tested and proven to be normally distributed, then normal statistical tests shall be utilized. If the data distributions cannot be matched, then non-parametric testing is needed.

Once these two issues are resolved, the statistical test must be able to handle a seasonality component. The first step in the process is to choose a proper technique to determine whether the data have a seasonality component. If they do, the trend test must have a seasonality parameter to adjust for this component in the data. Further, the data set must contain enough data within the periodicity of the season to allow for this testing. This means that a seasonality component cannot be identified unless there are frequent enough data points within each season to allow for this conclusion to be reached. An example, would be that a seasonal component of about 6 months (one wet and one dry season per calendar year) can not be tested if the data were only obtained quarterly or semi-annually, unless independent proof of the seasonal component can be provided.

If a trend evaluation indicates that a statistically significant upward trend in concentration has occurred at a FWMP sampling site, KGCMC will notify the USFS and ADEC within 14 days of DQO confirmation, following the protocol shown in Figure 10-2. KGCMC will determine the cause of the trend, and whether the AWQS for the constituent of concern may be exceeded as a result of the changing conditions. If KGCMC determines that the trend is not the result of natural variation in groundwater, and there is a reasonable likelihood the AWQS may be exceeded, they will establish an assessment monitoring program within 90 days of DQO confirmation.

(7) Relevant field observations by the biological tissue sampling crew will be provided as a qualitative assessment of stream health.

10.6.3. Biomonitoring Reporting

10.6.3.1. Periphyton Biomass

Periphyton samples will be analyzed on either a fluorometer or a spectrophotometer. All samples with sufficient chlorophyll to measure on a spectrophotometer and not exceeding the limits of a fluorometer will be measured on both instruments. Chlorophylls a, b, and c will be calculated from samples measured on the spectrophotometer.

Periphyton biomass will be reported as mg chlorophyll / m2 of stream substrate. Comparisons will be made among the different sample sites and between different sampling years using appropriate statistical methods. Data will be presented graphically, and the data values will be contained in appendices to biomonitoring reports.

10.6.3.2. Benthic Macroinvertebrates

Data compilation and analyses for benthics samples should follow the protocol of the Alaska Stream Condition Index (Major and Barbour 1999), as described below and with modifications. An example data sheet (from ADF&G 1998) is included (Attachement B).

List of Metrics:

<u>Abundance Measures</u>

Total invertebrates counted per subsample

Total aquatic invertebrates per subsample

Total terrestrial invertebrates per subsample

Estimated total aquatic invertebrates per sample

Estimated total terrestrial invertebrates per sample

% sample terrestrial

% sample aquatic

Taxonomic Richness Measures

Total aquatic taxa

Average taxa/sample

No. of Ephemeroptera taxa

No. of Plecoptera taxa

No. of Trichoptera taxa

Community Measures (estimate of total sample)

Est. number Ephemeroptera

Est. number Plecoptera

Est. number Diptera

Percent Ephemeroptera

Percent Plecoptera

Percent Diptera

Richness Measures

Composition Measures

% EPT

% Chironomidae

% Dominant Taxon

The metrics are calculated from the data collected and recorded on the laboratory bench sheet after the laboratory identification and analysis (see example sheets in Attachment B from Weber Scannell and Andersen 2000).

10.6.3.3. Abundance of Rearing Fish

Analysis of fish population estimates should include graphical display of fish abundance trends at all bio-monitoring sites, and a statistical comparison of means (or medians) between control and treatment sites.

Data analysis should include graphical displays of annual fish population trends by species for each bio-monitoring site. Graphs displaying species /length distribution by year should also be provided.

Potential change in juvenile fish abundance between the Greens Creek control and treatment bio-sites will be analyzed using box-plots and t tests (or equivalent statistical methods). Data should be normalized using an appropriate transformation (e.g. natural log or square root). Results of this analysis should be compared with similar statistics for water quality, metals content, periphyton biomass, macroinvertebrate indices and toxicity collected at these monitoring sites for the same time periods. This information will be used to evaluate and document potential cause-effect relations between changes in water quality, and aquatic biota abundance, distribution and community structure.

10.6.3.4. Metals Concentrations in Rearing Fish

The median, maximum, and minimum concentrations of each metal will be reported for each sampling site. Comparisons will be made among sampling sites. Metals concentrations also will be compared to metals concentrations in whole body juvenile fish of similar species from other regions of Alaska (e.g. Weber Scannell et al., 1995, 1998, 2000b; Snyder-Conn et al. 1992, 1993) and to the concentrations reported in national studies (e.g. Lowe et al. 1985, Schmitt and Brunbaugh 1990).

10.6.3.5. Toxicity Testing

Results of the toxicity testing will be used to calculate IC-25 and IC-50 (or appropriate metrics for individual tests. Comparisons will be made among sites or over time, as listed in Table 6-1. Laboratory data recording sheets and quality assurance analysis will be provided in report appendices.

10.6.4. KGCMC's annual report for a water year shall be submitted (postmarked) to the USFS and DEC by March 1st of the following year. Before performing the data analyses and generating the report KGCMC shall contact the USFS to discuss any special needs for information that may have come up during the year as a result of the following:

a) Changes in regulations.

b) Changes in mine operations.

Changes in monitoring sites.

11. DATA MANAGEMENT

This section documents information storage, access, and archive practices for both hardcopy and electronic information.

11.1. Reports

11.1.1. Access to records is controlled by the remoteness of the location and the limited access to mine premises.

11.1.2. All incoming original hardcopy laboratory reports and associated QA review reports are filed chronologically at the mine.

11.1.3. Hardcopies of KGCMC's monthly reports, annual reports, and reports of exception are filed chronologically at the mine.

11.1.4. Original hardcopies never leave the premises. They are photocopied as needed for distribution and satisfying information requests.

11.1.5. Hardcopy reports not already sequentially numbered are numbered before disassembly for copying to ensure they can be reassembled in correct order and copy completeness can be easily verified.

11.1.6. Hardcopy reports may be archived 6 years after the date of creation. They may be moved to a less accessible location provided the previous five years of hardcopy are kept readily accessible.

11.1.7. Electronic copies of report documents are kept for a minimum of 6 months on a hard disk or diskette at the mine.

11.1.8. Electronic backup copies of report documents are kept for a minimum of 6 months on a second diskette, tape, or hard drive stored in a separate building at the mine.

11.2. Electronic Data

11.2.1. A relational database containing all the FWMP data is maintained by KGCMC at the mine. Copies or partial copies of the database may be distributed to others as needed to facilitate data analysis.

11.2.2. Data security is maintained by limiting access rights to the database files through network login IDs and passwords. Passwords are changed as needed.

11.2.3. Laboratory data are electronically imported or manually entered into the KGCMC database. Associated qualifiers are manually entered after the QA review report is finalized and received by KGCMC.

11.2.4. Personnel will be trained in reading the data sheets, electronic data transfer, and using the database before data entry is performed.

11.2.5. All data (100%) entered into the database manually, and a sample (5%) of the data imported into the database electronically, are verified against the hardcopy before the data are used for analysis.

11.2.6. A complete backup of the database is performed at least weekly and stored in a separate building on site. A log of backups is kept to aid in recovery from hardware or software failure and stored with the backups.

11.2.7. Data produced before January 1989 may be archived to maintain processing speed and reduce the size of the backups.

11.2.8. If data is archived it must be reloaded before database upgrades or enhancements are made to ensure it remains accessible and compatible. After the changes are completed it may be archived again.

11.2.9. Changes to the database structure or utilities may be needed as a result of changes to the FWMP, data analysis protocols, or other reasons. A log of database changes, enhancements, problems, and fixes is kept to aid in troubleshooting.

12. PROGRAM AUDITS

Program audits provide an evaluation of the efficiency and effectiveness of the QA functions of the FWMP. This feedback loop provides the information needed for continuous improvement of the FWMP. The audit procedures below evaluate how well the information goals and DQO's are being met.

12.1. Responsibilities

KGCMC has the primary responsibility for ensuring that the data are of known and acceptable quality and the FWMP has been implemented as designed and thus has primary audit responsibility.

The USFS and ADEC have regulatory oversight responsibility and may perform independent audits on a random and/or as needed basis. Other agencies may also perform audits.

12.2. Data Acquisition Audits

A review of the data collection system will evaluate whether or not the QC procedures in the FWMP are being followed and if documentation of these activities is sufficient to establish the quality of the information collected. Findings may be used to make improvements to the FWMP or to initiate corrective action by KGCMC for lapses in execution or documentation.

12.2.1. KGCMC will perform one audit per year as scheduled in the company's Annual Work Plan (AWP) and may perform additional audits as needed.

12.2.2. The laboratory and QA review reports for a randomly selected month in conjunction with the FWMP and the current monitoring schedule are reviewed for the following determinations:

a) The accuracy of the site maps and access information identifying any changes that need to be incorporated in the FWMP.

b) The completeness of the laboratory data versus what was planned in the monitoring schedule and if the correct analytical fractions were analyzed.

c) Whether or not analyses were performed within holding times.

d) Whether or not a QA review of the data was performed and the amount of data qualified as estimated or rejected.

e) The reviewer prepares a report of the items reviewed and the findings, with recommendations for improvement if needed. Copies will be provided to the USFS and KGCMC and kept on file at the mine site.

12.3. Data Management Audits

A review of data management evaluates whether or not the procedures for data management in the FWMP are being followed and if data integrity is being maintained. If lapses in data management are found corrective action will be taken by KGCMC and documentation kept on file at the mine site.

12.3.1. KGCMC will perform one scheduled audit per year but may perform additional audits as needed.

12.3.2. The data management specifications of the FWMP are reviewed for the following determinations:

a) Whether all reports were received within the specified time and copies forwarded as required.

b) Whether hardcopy and electronic data are stored such that unauthorized access is minimized.

c) Whether or not laboratory data have been QA reviewed and qualified if necessary, which is documented with a report.

d) Whether laboratory report and QA review report originals are in the files where expected.

e) Whether the laboratory data with appropriate qualifiers have been accurately entered into the database.

f) Whether regularly scheduled backups for the database are being performed and stored in a separate building.

g) Whether statistical analysis of the data is being appropriately performed and reports are found in the files where expected.

h) Whether the FWMP has been reviewed and updated as needed.

i) Whether previous copies of updated versions of the FWMP are retained and found in the files where expected.

12.3.3. The reviewer prepares a report of the items reviewed and the findings, with recommendations for improvement if needed. Copies will be provided to the USFS and KGCMC and kept on file at the mine site.

12.4. Laboratory Audits

A review of the laboratory's facility, equipment, personnel, organization, and management will evaluate the data reliability the laboratory is capable of producing. The laboratory as a system is verified against the documentation provided in their QA manual, their MDLs, and the SOW defining the services to be provided to KGCMC. A complete and thorough audit may be done through contractual services. KGCMC may choose to accept the results of a third party audit done for other purposes, such as drinking water certification or national accreditation programs such as A2LA, instead of performing their own audit.

12.4.1. Laboratory audits should be performed at least every two years.

12.4.2. Guidelines for laboratory audits are available from the USEPA or ASTM Standard Practice E548. The basic elements are summarized below.

a) Organization:
   Well Organized
   Duties/Responsibilities Clearly Defined
   Supervision/Inspection/Audit/Self Appraisal Program

b) Staff:
   Technical Competence
   Qualifications Documented
   Training/Maintenance/Upgrading of Competence
   Sufficient Supervision
   Adequate Number of Staff

c) Equipment:
   Adequate in Kind and Quality
   Maintained

d) Calibration/Reference Standards

e) Test Methods/Standard Operating Procedures

f) Environment/Facilities:
   Space
   Physical/Chemical Control
   Housekeeping

g) Samples:
   Handling
   Storage
   Integrity/Chain of Custody

h) Analytical Reports and Record Keeping

i) QA program with specified QC activities

12.4.3. A copy of the letter of certification or accreditation may be used as the documentation of an audit. Otherwise, the auditor will prepare a report listing the items reviewed and the conclusions of the review with any recommendations. Copies will be provided to the USFS and KGCMC and kept on file at the mine site.

13. FWMP MODIFICATIONS AND DOCUMENT REVISIONS

Changes to this FWMP are expected. As new priorities arise or priorities change the FWMP must be adjusted to meet those needs. Changes requiring a FWMP modification are listed in section 13.1. and are made and documented through the process described in section 13.2. Revisions to this document are made and documented through the process described in section 13.3. Changes to the laboratory(s) used for FWMP sample analyses are made and documented through the process described in section 13.4.

13.1. Required FWMP Modifications

Any changes impacting the uses of historical data or the FWMP information goals are required to go through the FWMP modification process in section 13.2. Anticipated FWMP modifications are listed below:

a) Any change in relevant water quality criteria requires a FWMP modification. If no change is made in the FWMP when relevant criteria have changed, a statement of rationale is required to explain the unchanged status.

b) Any change to the RIGs, MAGs, MIGs, or SIGs requires a FWMP modification.

c) Analytes are selected to collect data needed to meet FWMP information goals. If information goals change it may also be necessary to change the analytes being monitored which requires a FWMP modification.

d) Monitoring site locations may need to be changed if information goals change or there are topographic or stream morphology changes, construction activities, landslides, access safety issues, or changes in management practices. Addition of new sites or inactivation of existing sites requires a FWMP modification.

e) Monitoring frequency is selected to provide data to meet FWMP information goals. Frequency may change if the information goals change. Changes in data analysis protocols may require a change in monitoring frequency. Changes in monitoring frequency require a FWMP modification.

f) Any changes to the monitoring schedule require a FWMP modification.

g) Any change in the analytical methods used for sample analyses including any change in sample preparation or fraction analyzed requires a FWMP modification.

h) Raising MDLs above what's listed in the DQOs (section 3.2.5.) requires a FWMP modification.

i) Any change in the required data analysis or statistical processing specified in the individual monitoring site summaries (section 4.1. and Attachment A) requires a FWMP modification.

j) Any change in the required content or frequency of specified reports requires a FWMP modification.

13.2. FWMP Modification Process

KGCMC or the USFS may request and propose a FWMP modification to the other party at any time on an as needed basis.

13.2.1. The process starts prior to any change with a letter of request to the other party containing a written proposal with the following information:

a) A description of the proposed modification.

b) The expected impacts to the current FWMP and to the use of historical data.

c) A proposed time schedule for implementation of the modification.

13.2.2. The party receiving the request will respond within 21 working days of receipt with either a proposed meeting date, a request for additional information, a counter proposal, or a bilateral agreement to the change. If a response is not given within this time period, the proposal modification shall be automatically approved.

13.2.3. Any proposal requires agreement of both parties before implementation, excepting that circumstance described in Section 13.2.2. Meetings may be scheduled as needed for discussion or agreement may be reached through written or verbal correspondence.

13.2.4. Copies of all correspondence regarding FWMP modifications are kept on file at the mine. The actual date (vs. planned date) that modifications went into effect must be documented in the next annual report.

13.3. Document Revision Process

Revisions to this document to reflect an agreed to FWMP modification, correct errors or omissions, clarify language, or reflect current practice, are made and documented by KGCMC through the process described below.

a) Revisions to this document or its appendices are indicated by changing the revision number in the header located on each page in the upper right hand corner. The revision number affects each section. The header date serves as a publishing date for the current revision.

b) If there are only a few changes to the document or the changes occur only in the appendices, only the affected section(s) needs to be printed. If the revisions result in the insertion of additional pages, the table of contents will be regenerated and the whole document will be reprinted, if necessary to avoid pagination problems.

c) KGCMC will submit draft copies of all revised pages to the USFS and ADEC for their review and comments. Once finalized, KGCMC will provide the USFS and ADEC a complete copy of the current revision.

d) Updated pages replace pages of the preceding version. The removed pages are kept on file at the mine site for reference as needed.

13.4. Changing Laboratories Used

Section 8.2. provides laboratory selection criteria and any laboratory used will meet these criteria. If a change in laboratories is needed the following process will be followed:

a) KGCMC will provide the USFS with the following documentation at least 30 days in advance of the date the laboratory is scheduled to receive FWMP samples for analyses.

   (1) A letter stating that laboratories will be changed and the proposed date for changing to the new laboratory(s).

   (2) Documentation of how the new laboratory(s) meets each criterion listed in section 8.2.

   (3) A copy of the new laboratory's QAPP.

   (4) A copy of KGCMC's SOW to the new laboratory containing the information in sections 8.4. and 8.5.

b) The USFS will respond within 2 weeks of receipt if there are any questions or clarifications needed pertaining to the laboratory's qualifications.

c) Clarifications will be made before changes are implemented.

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