PEBBLE GOLD COPPER PROJECT

DRAFT ENVIRONMENTAL BASELINE STUDIES

PROPOSED 2004 STUDY PLAN

Prepared For:

State of Alaska Large Mine Permitting Team
Department of Natural Resources

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Acronyms

AASHTO .....American Association of State and Highway Transportation Officials
ABA ..... Acid Base Accounting
ACHP ..... Advisory Council on Historic Preservation
ACLS ..... Alternative Cleanup Levels
ADEC..... Alaska Department of Environmental Conservation
agl.....above ground level
AHRS ..... Alaska Heritage Resource Survey
APE ..... Area of Potential Effect
ARD/ML ..... Acid Rock Leaching/Metal Leaching
ASCI ..... Alaska Stream Condition Index
BEESC ..... Bristol Environmental & Engineering Services Corporation
CC .....Comprehensive Stations with Continuous Stage Monitoring
CH2M ..... CH2M HILL, Inc.
CIR..... Color Infrared
CWOC ..... Comprehensive Stations without Continuous Stage monitoring
DECD.....Alaska Department of Economic and Community Development
DNR ..... State of Alaska Department of Natural Resources
DO.....Dissolved Oxygen
DOT&PF..... State of Alaska Department of Transportation & Public Facilities
DQOs .....Data Quality Objectives
EC .....Environmental Consequences
EIS .....Environmental Impact Statement
EPA.....Environmental Protection Agency
EBR..... Environmental Baseline Document
FAA ..... Federal Aviation Administration
FHWA..... Federal Highway Administration
FSP.....Field Sampling Plan
GIS .....Geographic Information System
GPS ..... Global Positioning System
HGM .....Hydrogeomorphic
IM..... Initial Monitoring Station
BMR..... Baseline Monitoring Report
mg/L..... milligrams per liter
mm .....millimeters
MRLs ..... Method Reporting Limits
NDM ..... Northern Dynasty Mines Inc.
NEPA .....National Environmental Policy Act
NHPA.....National Historic Preservation Act
NOAA .....National Oceanic & Atmospheric Administration
NPS ..... National Park Service
NRCS .....Natural Resources Conservation Service
NRHP.....National Register of Historic Places
NWI .....National Wetlands Inventory
ORP.....Oxidation Reduction Potential
Pebble Project ..... Pebble Gold Copper Project
PJD.....Preliminary Jurisdictional Determination
PSD .....Prevention of Significant Deterioration
QA.....Quality Assurance

QAPP ..... Quality Assurance Project Plan
QC ..... Quality Control
SHPO ..... State Historic Preservation Officer
SOPs ..... Standard Operating Procedures
SWANCC ..... *Solid Waste Agency of Northern Cook County v. U.S. Army Corp of Engineers*
SWE ..... Snow-Water equivalent
TOC ..... Table of Contents
TPH ..... Total Petroleum Hydrocarbons
USACE ..... United States Army Corp of Engineers
USFWS ..... United States Fish & Wildlife Service
USGS ..... United States Geological Survey
WMP ..... Water Monitoring Plan

1 Introduction

1.1 Purpose

This Draft Environmental Baseline Studies document provides a comprehensive description of the study plan for the Northern Dynasty Mines Inc. (NDM) 2004/2005 Baseline Environmental Program for the Pebble Gold Copper Project (Pebble Project). This study plan is presented for agency and stakeholder review and comment, to ensure the planned program provides a comprehensive and thorough basis for baseline environmental characterization of the Pebble Project.

1.2 Background

The Pebble Project is a proposed open pit mining operation of the gold, copper, molybdenum, and silver deposit located in southwestern Alaska, as shown on Figure 1-1. NDM has commenced extensive study programs to collect the engineering, environmental, and socioeconomic data necessary for a bankable feasibility study and the preparation of applications for state and federal permits.

The design of this project requires the planning and coordination of all aspects of the project from its initial stages through to the final design. In this context, responsibility for environmental stewardship over the project life is a fundamental ingredient to the engineering design and feasibility of the project.

NDM clearly recognizes that a feasible project is one that is both economically viable and environmentally and socially responsible. Therefore, NDM considers that there are three cornerstones to pursuing the development of the Pebble Project:

- Geology and exploration – definition of a mineral deposit that supports an economic mine.
- Engineering – sound, best-practice, and practical engineering that incorporates appropriate environmental and economic standards to give a robust and feasible project design.
- Environmental - diligent characterization of the existing conditions related to environmental and social values of the project area and their incorporation into the project design and operation.

1.3 Goals and Objectives

The primary goal of this study plan is to provide a comprehensive description of NDM's baseline environmental programs for the purpose of agency and stakeholder review. Agency and stakeholder feedback on this study plan is solicited to ensure that it will produce a comprehensive and thorough basis for baseline characterization of the Pebble Project.

This document describes the scope of the study plan for comprehensive characterization of the baseline environmental and social conditions existing in the project area. This characterization is more than a compilation of data documenting baseline conditions though: These baseline

environmental studies are also focused on compiling and analyzing the information that will be incorporated into the sound environmental design of the project, into assessing and managing project impacts, and for the rigorous project review and permitting.

The specific objectives of this document are to:

- Define and describe the study plan for characterization of the baseline conditions.
- Ensure that this study plan will provide a sound technical basis both for project design and permitting, and for ongoing evaluation of environmental effects during mine operation and closure.
- Define the methods and approach for data gathering and analysis for review by others.
- Define the specific objectives of each component of the study plan and the deliverables such that they can be incorporated into the relevant engineering tasks and feasibility analyses.

1.4 Project Description

The Pebble Deposit is a gold-copper porphyry deposit. The geology of the Pebble Deposit and inferred resource evaluated to date is estimated to contain 26.5 million ounces of gold and 16.5 billion pounds of copper with lesser amounts of molybdenum and silver. Resource estimate work to date is based on 20,108 m of drilling in 2002 and 2003 by NDM, combined with 18,353 m in 100 holes by Cominco American Incorporated in the late 1980s and early 1990s. Current assessments of the optimum milling capacity for the Pebble Project range from 90,000 to 200,000 tonnes per day over a mine life ranging from 30 to 60 years.

To date, the geologic and metallurgical data indicate that conventional open pit mining and crush-grind-flotation processing methods can be used to recover the primary ore minerals of gold, copper, molybdenum, and silver. The key mine design considerations and alternatives to be considered include:

- The deposit is a gold-copper porphyry with the primary mineralization occurring as copper iron sulfides with associated gold values.
- The porphyry deposit size, grade, and configuration are consistent with a bulk tonnage open pit operation and would not be economically mineable as an underground mine.
- The primary process for recovering the ore would be to produce a sulfide concentrate(s) from a crushing, grinding, and flotation process.
- The major components of the milling process that require storage would be flotation tailings and associated process water.
- Access for construction, operation, and concentrate shipping would be required.

- Upgrades to existing infrastructure and/or a new port or ship docking facility will be required for concentrate handling and shipping.
- Concentrate(s) produced from the mine must be transported to port/markets.
- The potential for oxidation and metal leaching must be considered for all mine rock components.
- Tailings pond water will be recycled to the process plant.
- The estimated stripping ratio is relatively low, but some permanent mine rock storage must also be considered in the major facilities.

1.5 Approach

There are a wide variety of environmental and cultural values in the project area that require the contributions of experts from a variety of disciplines. There must be coordinated integration of the project's environmental and engineering teams to incorporate environmental design considerations into the project design.

NDM's approach to the integration of the environmental and socioeconomic science and the engineering programs for this study plan, and the steps to achieve the ultimate goals of project feasibility and permitting, is shown schematically in Figure 1-2 Project Activity Flowsheet and Figure 1-3 Integration of Environmental and Engineering Activities. In these figures, three colors are used to indicate the primary responsibility for each team; green indicates the activities that are the primary responsibility of the environmental team, blue indicates those activities that are the primary responsibility of the engineering team, and gold indicates activities that are the responsibility of both teams.

These are schematic figures that represent the approach developed by NDM and its consultants based on experience with other projects. Four elements of these figures are fundamental to NDM's approach to this baseline environmental characterization study plan and the ultimate project permitting needs:

- Acquisition of comprehensive datasets that support evaluation of project alternatives.
- Staged evaluation of options based on engineering and project feasibility considerations; followed by:
  - Incorporation of environmental and socioeconomic considerations into options assessment and project design.
  - Progressive evaluations of environmental and socioeconomic data to allow technical assessment of environmental impacts, compensation, and mitigation.

The baseline programs are designed to characterize the disciplines listed in Table 1-1.

TABLE 1-1
Pebble Project Environmental Baseline Studies Program

Discipline	Consulting Firm
Meteorology	CH2M HILL, Inc.
Noise	TBD
Surface Water Hydrology	Mine - CH2M HILL, Inc. Road/Port - Bristol Environmental & Engineering Services Corporation
Groundwater Hydrogeology	Mine - CH2M HILL, Inc. Road/Port - Bristol Environmental & Engineering Services Corporation
Water Chemistry	Mine - CH2M HILL, Inc. Road/Port - Bristol Environmental & Engineering Services Corporation
Naturally Occurring Constituents in Surface Soil, Sediment, Vegetation, and Fish	Mine - CH2M HILL, Inc. Road/Port - Bristol Environmental & Engineering Services Corporation
Geochemical Characterization and Acid Rock Drainage/Metal Leaching (ARD/ML)	Steffen Robertson and Kirsten (Canada) Inc.
Terrestrial Wildlife and Habitats	ABR, Inc. – Environmental Research & Services
Wetlands	Mine – Three Parameters Plus Road/Port – Three Parameters Plus / HDR Alaska, Inc.
Fish And Aquatic Habitat	Buell & Associates HDR Alaska, Inc. Northern Ecological Services
Marine Habitat	ABR, Inc. – Environmental Research & Services Bristol Environmental & Engineering Services Corporation RWJ Consulting
Subsistence Values	Stephen R. Braund & Associates
Cultural Resources	Stephen R. Braund & Associates
Recreation	TBD
Land Use	TBD
Visual Aesthetics	TBD
Socioeconomics	TBD
Data Management and Geographic Information System (GIS)	Resource Data Inc.

TBD – To be determined

The biophysical and cultural resources are characterized through detailed surveys and mapping, followed by analysis of these data. The site conditions, such as meteorology and hydrology, are defined through site installations and regular monitoring programs. These data are used to develop site models of the existing environment and, as engineering proceeds, of the sites of potentially viable project development alternatives. Clearly, alternatives evaluation and optimization continue as the project engineering develops and as the assessments of the baseline data are available. In this way, environmental considerations are incorporated into the evaluation of options for the various project components and ultimately the identification of the preferred mine development alternative.

This use of baseline data to develop site models, followed by assessment of potential impacts from the predicted conditions for alternative locations/designs, and the iteration with project design is shown in Figure 1-3. This document focuses on the baseline study programs, the majority of which have been or will be initiated in 2004. While the activities related to environmental assessment are not discussed in this document, they are mentioned briefly in the context of the environmental baseline study plan.

1.6 Project Status

1.6.1 Previous Work

The geologic resource definition and engineering studies completed by Cominco provided the basis for the initial NDM scoping level project assessment. The results of this scoping lead NDM to its 2002/2003 drilling program. The analysis of those results, reported early in 2004, has led to the commissioning of a detailed infill drilling program and an engineering feasibility study. NDM also commissioned the environmental baseline studies that are described in this document.

NDM initiated these detailed work programs on the Pebble Project to collect the geological, engineering, environmental, and socioeconomic data needed for the completion in 2005 of both a bankable feasibility study and the applications for permits for construction and operation of an open pit mine. The work builds upon exploration, preliminary design, and environmental studies initiated in the 1990s by Cominco. The locations where data were collected by Cominco are shown in Figure 1-4. The Cominco baseline environmental studies included:

Hydrometeorology

- Miscellaneous stage discharge data for 10 stations (Cominco Data, 1991-1993)
- Additional continuous and hourly stage data for Talarik Creek and South Koktuli River (1991-1993)
- Long-term regional climate stations at Iliamna (46 years) and Port Alsworth (34 years) plus 1993 weather station data for the mine site and Iniskin Bay
- Long-term USGS streamflow stations (Tanalian, Tazimina, and Newhalen Rivers)

Aquatic/Marine Fisheries

- Koktuli River Float Survey reports (1977, 1981, 1982, 1983, 1984, 1986, 1987, 1988)
- Lower Talarik Creek rainbow trout report (1997)
- Baseline Fisheries Investigations reports (1991 & 1993)
- Miscellaneous water quality sampling (1991-1993)
- Williamsport Marine Baseline and EIS report (USACE/Kenai Peninsula Borough, 2001)

Terrestrial/Marine Wildlife Reports

- Caribou Use of Pebble Mine Site (1992, ADF&G)
- Status and Seasonal Movements of Caribou Near Pebble Mine Site (1992-93, van Daele)
- Moose/Caribou Observations (1991, ADF&G)
- Wildlife Reconnaissance Assessment (1990 & 1991, Terra Nord)
- Mulchatna Caribou Management Report (1992-1994, ADF&G)
- Caribou Radio tracking report (1993, Cominco)
- Investigation of Wildlife Use and Harvest at Pebble Mine (1993)
- Bear Den Survey Report (1992)
- Moose Survey Report (1992)
- Caribou Survey reports (1991 & 1992)
- Marine Biota and Habitat Surveys (Williamsport EIS)

1.6.2 Current Status

In addition to initiating these environmental baseline studies, NDM is now in the process of evaluating a range of options for development of the various components of mine site facilities and infrastructure. The initial approach was to define potential options for the individual components that comprise an open pit mine, and then to identify the reasonable combinations of mine, mill, tailings, water, and mine rock storage facilities that represent mine development alternatives, including:

- Deposit location and mining methods
- Mill site locations

- Milling circuit options
- Tailings facility locations
- Mine rock storage locations
- Concentrate handling and shipping options
- Project access and power options

The tailings facility was identified as one of the critical design constraints, having the largest footprint and potentially most demanding water management requirements of the mine facilities. Initial engineering studies showed that some of these tailings management options were critically flawed due to inadequate storage capacity considerations or were impractical from an engineering/construction perspective. These engineering studies identified potential locations for on-land tailings management that would be situated in the vicinity of or adjacent to the ore deposit. A separate mine development alternative examined the potential for deep-water disposal of tailings in Iliamna Lake. Consideration of important environmental constraints related to the main drainage areas in the vicinity of the mine development site is also being given to those mine development options that are considered feasible and practicable from an engineering perspective. Consideration of these initial environmental constraints on possible facility locations resulted in a decision that it will not be appropriate to place tailings in Iliamna Lake, nor to develop on-land tailings management options that eliminate substantial tracts of aquatic resources in the Upper Talarik and North Fork Koktuli drainages.

The integration of these preliminary engineering and environmental studies has resulted in NDM deciding that the preferred mine development alternative will most likely be contained within the general area delineated on Figure 1-5. Figure 1-6 illustrates preliminary options for road access routes and port sites that are currently under consideration by the State of Alaska Department of Transportation and Public Facilities (DOT&PF). As a result of these preliminary findings, the current environmental study programs have been designed to ensure that appropriate baseline data are collected only in those areas that might be affected by proposed development which are predominantly confined to the South Fork of the Koktuli River (with some study effort in the North Fork of the Koktuli), and along the access route corridors.

1.6.3 Project Timeline

The estimated project timeline for the baseline environmental study program is provided in Appendix A. This timeline is integrated with the engineering project schedule, and linked by key tasks/milestones. The schedule for specific activities within each of the technical disciplines is discussed in the following sections of this document.

2 Meteorology

The approaches for collecting meteorological data at the mine site and the port site are generally the same, with the exception that evaporation data will not be collected at the port site. CH2M HILL, Inc., will lead the meteorology on the mine site, road, and port.

2.1 Objectives of Study

The objective of the meteorology baseline study is to collect data needed for engineering design and environmental purposes, including water balance studies, and for the preparation of the air quality construction permit application for the mine and road/port sites. The data will be collected in accordance with Prevention of Significant Deterioration (PSD) permit requirements. Although the road and port facilities may not require a PSD permit, of PSD-level meteorological data will be collected in order to perform the required computer-modeling.

In addition, it is possible that negotiations with concerned agencies (U.S. Environmental Protection Agency [EPA], Alaska Department of Environmental Conservation [ADEC], National Park Service [NPS], and U.S. Fish and Wildlife Service [USFWS]) may result in a requirement to collect background pollutant data. However, an initial year of meteorological data will be needed to determine the location of monitoring equipment for such background data, if such collection is necessary.

2.2 Proposed Study Plan

2.2.1 Study Area/Scope

At present, the scope of this task primarily involves the collection of continuous records of meteorological data at the mine and port sites, including precipitation, temperature, wind speed and direction, solar radiation, and barometric pressure. In addition, evaporation data will be collected at the mine site (see Figure 2-1).

Three meteorological stations will be installed: two at locations in the mine site area and one in the port site area. In the mine site area, one 10-meter meteorological station will be located in the general vicinity of the mill site/ore body primarily to obtain data required for permitting and one 3-meter station will be located in the vicinity of the current preferred option for the primary tailings storage facility to obtain data for site characterization and water management studies. The use of two stations in the mine area will provide information regarding variations within the watershed, which is important from a water balance perspective. A 10-meter station will be located in the general vicinity of the port primarily to obtain data required for permitting.

2.2.2 Methods/Approach

Approved procedures for collecting meteorological data, as well as background pollutant data for permitting purposes, are well documented in EPA guidance documents. A draft work plan will first be developed including the elements suggested in the ADEC Quality Assurance (QA) Plan for meteorological monitoring and the following EPA documents:

- Ambient Monitoring Guidelines for Prevention of Significant Deterioration (EPA-450/4-87-07).
- Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV-Meteorological Measurements (EPA/600/R-94/038d-April 1994).
- Meteorological Monitoring Guidance for Regulatory Modeling Applications (EPA 454/R-99-005, February 2000).

Approval of the mill site/ore body and port site tower locations to obtain data required for permitting is critical. The locations of these meteorological stations will be determined following the review of this document and subsequent discussions by NDM, the ADEC, and the EPA. NDM sees this as a very important step in the data collection program because without agreement on the locations, the data may not be accepted for use in the computer-modeling tasks required for the air quality construction permit application. NDM will proceed once written approval from both agencies is obtained.

Met One Instruments of Grants Pass will manufacture the meteorological instrumentation. All instrumentation will meet or exceed EPA PSD specifications for meteorological data collection. At a minimum, the following meteorological parameters will be measured at all three stations:

- Wind speed (miles per hour)
- Wind direction (degrees)
- Standard deviation of wind direction fluctuations, also called Sigma A (degrees)
- Solar radiation
- Total precipitation
- Air temperature(s) and air temperature difference

2.2.3 Major Activities

The following major activities are planned:

- Construct the monitoring stations (towers, meteorological instrumentation, and electrical power supplies) according to the approved study plan.
- Conduct an initial performance audit after completion of each installation to ensure the sensors are operating within EPA and ADEC guidelines. During installation, train a local field operator to conduct a review of the site in accordance with EPA and ADEC guidelines as described in the standard operating procedures (SOPs) in the approved monitoring plan.
- Operate the meteorological stations and collect data for the duration of the project's life.

- Remotely access the meteorological data daily via modem and perform a review of the data in order to detect problems. The local field operator will conduct routine inspections of the stations' equipment to verify proper operation of the equipment and security of the site. During these inspections, maintenance will be performed on the power supply, proper operation of the instruments will be verified, routine quality control (QC) checks performed, and general conditions of the site observed. Troubleshooting and additional technical support will be provided as needed to achieve maximum data recovery and compile a quality data set.

- Process and validate data on a weekly basis. Weekly processing will ensure problems associated with data collection will be addressed in a timely manner. Data processing, validation, and screening will be performed in accordance with the EPA and ADEC guidance documents and as described for QA in the approved work plan. The data will be processed into hourly average values.

- Summarize the data in quarterly data reports that will include documentation of the QA activities performed during the reporting period. QA activities include calibrations, audits, and data completeness checks.

- Provide the final data report within 45 days of the end of the first 12-month monitoring period.

- For each station, conduct a minimum of three audits over the course of the first 12-month monitoring period in accordance with EPA criteria defined in *Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV, Meteorological Methods*, April 1994 (EPA/600/R-94/038d), and *Meteorological Program Guidance For Regulatory Modeling Applications*, February 2000 (EPA 454/R-99-005). EPA guidance suggests conducting audits within 30 days of station start-up, every 6 months during operation, after significant downtime or major repairs, if the station is relocated, and within 30 days of station shutdown.

2.3 Deliverables

The following deliverables will be prepared during monitoring for meteorological parameters at mine and port sites:

- Station-specific monitoring plans developed through conversations with agency representatives or the engineering design team, as appropriate, describing the monitoring approach and location.

- Quarterly data reports summarizing data collected and associated quality assurance activities (4 total).

- Final data report submitted within 45 days of the end of the first 12-month monitoring periods.

2.4 Schedule

The schedule for collecting meteorological data at the mine and port sites is shown in the overall baseline environmental program schedule in Appendix A. Some key dates for the meteorology program include:

- Quarterly Report – February 1, 2005
- Quarterly Report – May 1, 2005
- Quarterly Report – August 1, 2005
- Quarterly Report – November 1, 2005
- Final Report – December 15, 2005

Baseline air pollutant data, such as particulate matter, will not be collected in the project area this year (2004-2005). What type of monitoring should be done, or whether it should be done, will be determined through discussions with the agencies once basic meteorology of the area has been defined and details of major project component structures and locations have been further refined. It is intended that any necessary air pollutant monitoring will be conducted in the following years (2005-2006), prior to construction.

3 Noise

Specific study plans for five disciplines have not yet been developed: noise, land use, recreation, visual aesthetics, and socioeconomics. These disciplines are less dependent on the 2004 summer season field work which has been the focus of NDM's efforts to date.

NDM is presently working to develop a baseline study program for each of these disciplines, and to employ experienced contractors to conduct such programs. Once these study plans are developed, they will be forwarded to appropriate agencies for review and comment.

4 Surface Water Hydrology

CH2M HILL, Inc. (CH2M), will lead the surface water hydrology work on the mine site, and Bristol Environmental and Engineering Services, Inc. (BEESC) will complete the surface water hydrology work for the road and port.

4.1 Mine Site

4.1.1 Objectives of Study

The characterization of site hydrology includes both the surface water hydrology and the snow course survey program.

Objectives of the baseline surface water hydrology program include:

- Characterization of current site conditions and site resources.
- Collection of surface water baseline data for comparison to future conditions (e.g., construction, operations, and closure).
- Collection of data for design of facilities including water management and water supply structures.
- Data to support aquatic, fish resource, and wetlands habitat assessments.

Surface water hydrology data will be collected to support both environmental baseline characterization studies and engineering design work. This document is focused on the environmental baseline monitoring study plan, but reference is made to the engineering tasks to which these baseline data contribute. In addition, the conceptual flow models of the baseline conditions that were developed as part of the preliminary site engineering are used to define appropriate monitoring station locations and boundaries. The close links between the baseline programs and the engineering programs are shown in Figure 1-3, as discussed earlier in this document.

Baseline studies will provide physical flow data information for surface water systems in the vicinity of the proposed locations for the mine site, mill site, tailings disposal facilities, and water management facility. The surface water baseline program will be conducted as an integrated program with the groundwater studies (see Chapter 5). The surface water and groundwater baseline systems will be documented in order to identify any hydrologic interactions between the systems and changes throughout the year. Surface water quality (see Chapter 6) and flow data will be linked to provide estimates of baseline surface water load from the mineralized area to downgradient surface water systems. This information is key to understanding current conditions and will provide a baseline for the evaluation of future potential impacts during operation and closure. Details of the groundwater hydrology monitoring are addressed in Chapter 5, while water chemistry is discussed in Chapter 6.

Key issues for the surface water baseline studies at the mine site include:

- Documenting the existing surface water baseline conditions to understand the annual hydrographs and the interaction between the surface and groundwater systems and how this interaction changes throughout the year.

- Providing physical information on the surface water flow systems as input to water balance and loading models.

The snow course survey is designed to complement concurrent surface water hydrology studies by characterizing the distribution, snow-water equivalent (SWE), and ablation rates of late-season (pre-breakup) snow across the landscape of the mine region. This information on winter precipitation and the contribution to surface water in the area will be critical for the design of tailings storage areas and water management plans for the mine. Specific objectives of this study include:

- Mapping of late-season snow distribution using data from field surveys, terrain characteristics, and MODIS satellite imagery.

- Mapping of snowpack ablation rates from field survey data, terrain characteristics, and climate data.

- Paired field measurements of snow depths and densities at meteorological stations to compare with automated precipitation gauge measures.

- Evaluation records from proximal snow survey sites administered by the Natural Resources Conservation Service (NRCS) and Federal Aviation Administration (FAA) as appropriate proxies for historical snowpack data.

4.1.2 Proposed Study Plan

4.1.2.1 Study Area/Scope

The project area, including the ore body and potential mine and mill sites, tailings and mine rock storage facilities and associated infrastructure, is drained by the North Fork and South Fork of the Koktuli River, Upper Talarik Creek, and tributaries of these water bodies. The Kaskanak Creek watershed is located to the southwest of the project area and will also be monitored to identify potential interbasin transfers from the South Fork of the Koktuli River.

4.1.2.2 Methods/Approach

Surface Water Hydrology

The general approach includes establishing surface water monitoring stations at 28 locations in the project area and monitoring the stations to characterize the surface water hydrology of the area. The locations of the surface water monitoring stations are shown in Figure 4-1. These stations were selected with consideration of a number of hydrologic criteria including:

- Surface water bodies that have the potential to be impacted by project activities.

- Locations both upstream and downstream of potential locations of mine facilities.
- Major watercourses that may be crossed or affected.
- Streams of hydrologic importance (e.g., stations to provide data on groundwater and surface water interactions.
- Stations that coincide with historic (Cominco) monitoring stations and the information obtained from those studies and related literature.
- Water bodies in areas of potential water supply.

Additionally, the selection and development of station locations was a coordinated process involving the engineering design team and the environmental baseline studies team including water chemistry, fisheries and aquatic resources, and sediment and trace elements studies. The conceptual level understanding of surface and groundwater regimes and the preliminary project alternatives for facilities, were used to help define the surface water monitoring program.

Monitoring at these stations will include point discharge measurements at selected frequency at all stations, continuous stage monitoring at select stations, and water quality monitoring at all stations as described in Chapters 6 and 7. Point discharge measurements will be obtained with channel transects and flow velocity meters, as is standard U.S. Geological Survey (USGS) practice. USGS personnel will be engaged to provide assistance with gauging site selection and to install and operate three stations on the largest water courses in the project area. Continuous stage monitoring will be conducted with datalogger/pressure transducer installations.

Snow Course Surveys

Field snow surveys will be conducted in the three major drainage basins in and around the proposed mine site. This study is designed to complement concurrent surface water hydrology studies by characterizing the distribution, SWE, and ablation rates of late-season (pre-breakup) snow across the landscape of the mine region. This information on winter precipitation and the contribution to surface water in the area will be critical for the design of tailings storage areas and water management plans for the mine.

The approach to mapping spring snow distribution will rely on a combination of detailed field surveys and a terrain model that incorporates the predominate variables that influence snow accumulation (elevation, aspect, slope, and vegetation canopy). To determine the spring snow distribution across the study site, snow depths and density will be measured along 12 to 15 slope/aspect transects and at 2 permanent snow courses (Figure 4-2). Sampling along the slope/aspect transects will extend from ridge tops to valley bottoms with snow depths and densities measured at 100-foot elevation intervals. At each measurement location, SWE will be calculated from three measures of snow depth and snow density. Percent snow cover will be visually estimated at each measurement site. Slope and aspect will also be determined at each site for use in the snow distribution model. Slope/aspect transects will range from 0.6 to 1.9 miles and will cover the predominant elevation spans and aspect present in the major drainage basins in the study area. Three of the slope/aspect transects will include (begin or end)

meteorological station locations. At each meteorological station, snow depth and density will be measured at five locations situated on a 10-foot radius around the station.

The two permanent snow courses will be established to provided data suitable for comparison with existing NRCS snow course sites, and to provide precise inter- and intra-annual comparison of SWE. One snow course will be located at 2,000 feet on a ridge near Groundhog Mountain, and the other at 1,100 feet on a hill in the headwaters of Upper Talarik Creek. Each snow course will comprise a 1- to 2-mile circuit around a small ridge or knob with 10 to 16 stations located to cover all slope aspects. Additional spring field surveys, in conjunction with calibrated MODIS snow data, will be used to estimate snowpack ablation and provide runoff estimates.

4.1.2.3 Major Activities

Activity 1: Surface Water Field Studies.

Identify Sampling Station Locations. The exact number of stations installed will depend on the ongoing evolution of the mine development plan, but it is anticipated that 28 stations will be operated, the majority of which will be on the north and south forks of the Koktuli River. One will be placed in Kaskanak Creek. Proposed locations of surface water monitoring stations are shown on Figure 4-1. Final station locations must be selected in the field based on suitability for making discharge measurements and establishing stage-discharge relationships.

Three types of surface water monitoring stations were identified:

- Comprehensive stations with continuous stage monitoring (CC)
- Comprehensive stations without continuous stage monitoring (CWOC)
- Initial monitoring station (IM)

Comprehensive stations (with or without continuous stage monitoring) were selected with the intent that they would likely become baseline monitoring stations. The designation of baseline stations will be based on which alternatives are selected for the project and on the information developed during the monitoring program. Initial monitoring stations were generally selected for specific short-term monitoring purposes (e.g., geochemical signature), with the intent that they likely would not be continued as part of the regular monitoring program.

Conduct Surface Water Field Studies. The field program will focus on characterizing the hydrology of the surface water systems in the vicinity of the proposed sites of the mill, mine rock and tailings disposal facilities, as well areas upstream and downstream of the project area. This will be achieved by the following:

- Collecting data on surface water hydrology. For all monitoring events, creek stage and discharge will be measured. Point discharge will be measured with a wading rod and current meter when feasible. At times when high flow precludes wading the creek, flow estimation techniques will be used.
- A continuous measurement device (e.g., pressure transducer and data logger) will be installed at designated locations in the major drainages (Upper Talarik Creek, the south and north

forks of the Koktuli River, and Kaskanak Creek) to provide site-specific continuous stage data. This will help characterize baseline flow regimes and develop rainfall/runoff relationships.

- Each monitoring station with continuous stage measurement will be installed after breakup by establishing survey control, installing a staff gage, and then surveying channel geometry. Surface water quality sampling also will be accomplished when measuring surface water hydrology parameters.

- Nine surface water field monitoring events are planned, including breakup (late April), monthly summer monitoring (May through October), and two winter events (January and March).

Activity 2: Snow Course Surveys

Field surveys of snow distribution and snow ablation rates began in mid-April 2004 with continuing surveys in May 2004. The major activities of the snow survey include:

- Terrain analysis derived from existing DEM data to identify representative areas of slope, aspect, and elevation in order to develop a balanced field sampling plan.

- Field sampling in the spring of 2004 and 2005 (12 to 15 transects) to directly measure snow depths and SWE along slope transects and snow courses shortly before breakup (circa 1 April).

- Periodic spring sampling in April and May to directly measure snowpack ablation and correlate landscape changes with MODIS snow data imagery.

- Field measures of snow depth and SWE at meteorological stations to verify automated precipitation gauge data.

- Classification of terrain model using field measures of snow depth and SWE to derive snow distribution and ablation rate maps of the mine study area for 2004 and 2005.

- Evaluation of MODIS snow data products to monitor and calculate spring snow ablation rates.

- Comparison of snow course measurements with data from NRCS and FAA sites to identify long-term data sets that can be used to estimate the probable range of spring snowpack SWE.

Activity 3: Evaluation and Processing of Field Data

Surface water hydrology evaluations will include:

- Develop stage-discharge relationship for each surface water monitoring station.

- Develop annual hydrographs for each station with continuous monitoring equipment.

4.1.3 Deliverables

- Contribution on surface water hydrology to Baseline Surface Water and Groundwater Monitoring Report (BMR), including surface water monitoring activities, details on surface water monitoring station installation, monitoring results, and data interpretations.
- A GIS-compatible raster grid with an expected resolution of 10 to 20 feet (depending on the horizontal resolution of the final elevation DEM) representing snow depth, SWE, and spring ablation rates for each year of the study (currently 2004 and 2005).
- An Access-compatible database of field data and site photos collected during the snow survey suitable for integration into the overall data management system for the mine.

Other data products produced to support this study include:

- Delineation of watersheds in the study area using NASA Shuttle Topography DEM data.
- Calculation of slope, aspect, and equivalent latitude grids of the mine project area.
- Oblique aerial photography of the mine project area in mid April, early May and mid-May to assist delineation of large snowbeds.
- Additional data sets that will be produced to support other aspects of the project will be used to enhance maps of snow distribution. These data include:
  - High resolution elevation surveys
  - Habitat mapping (vegetation canopy classifications)
  - Daily precipitation records (on-site meteorological stations)

4.1.4 Schedule

The schedule for the surface water hydrology program is included in the overall environmental baseline study schedule, Appendix A. Some of the key dates for the snow survey tasks are:

- April 2004 - Snow distribution surveys
- May 2004 - Snow ablation surveys
- September 2004 - Acquisition and calibration of MODIS imagery
- April 2005 - Snow distribution surveys
- May 2005 - Snow ablation surveys
- June 2005 - Submit report on 2004 and 2005 field surveys

4.2 Road/Port

4.2.1 Objectives of Study

The objectives of the baseline surface hydrology studies along the road corridor, and at the port site area, are to:

- Identify and describe the existing surface water conditions at the road crossings, along the preferred road corridor identified by DOT&PF.
- Identify and describe the processes that control the hydrologic balance within the project watersheds.
- Provide baseline information in order to evaluate the potential impacts the proposed road will have on the upstream and downstream environment.

4.2.2 Proposed Study Plan

The proposed work plan uses guidelines established by DOT&PF, the Federal Highway Administration (FWHA), and the American Association of State and Highway Transportation Officials (AASHTO).

4.2.2.1 Study Area/Scope

The study area includes all watersheds located between the mine site and the preferred port site that are intersected by the preferred road corridor, as shown on Figure 4-3. The preferred road corridor, as identified by DOT&PF, may have up to 18 larger streams that will require study in order to properly evaluate them for Title 41 (AS § 41.14.870) permits.

4.2.2.2 Methods/Approach

The baseline data collection effort will include preliminary data compilation and documentation of existing conditions using available information and data collected in the field. The field data will document those stream reaches that lie within a 1-mile-wide corridor.

All data collection and the analysis of these data will conform to the established procedures of both DOT&PF and FWHA. The data will be collected to ensure that there is sufficient information within the road corridor to allow the designers to choose a specific road alignment.

4.2.2.3 Major Tasks/Activities

The major tasks for this study are data compilation and the documentation of existing conditions. The work will consist primarily of researching existing information, as well as preliminary field data collection in those stream reaches that would be crossed by the preferred alternative road corridor. It expected that this study will aid DOT&PF in the selection of the final road alignment.

Research sources include:

- Agencies: DOT&PF, ADEC, Alaska Department of Community and Economic Development (DCED), USGS, U.S. Army Corps of Engineers (USACE), FAA, and others as necessary.
- Local residents.
- Aerial photography and other remote sensing data inspection and analysis.

Field work will consist of:

- Surface water (discharge) measurements on approximately 17 selected rivers and streams that require a Title 41 permit for proposed crossings, see Figure 4-3.

A Basin Characteristics file will be created for each stream that the preferred road corridor will cross. The data will be stored within a GIS.

Information to be collected for each basin includes:

- Corridor station number
- Stream name
- Latitude and longitude
- Location map (USGS quadrangle map designation)
- Drainage area (square miles)
- Mean channel slope (feet per mile)
- Channel length (miles)
- Surface water area of lakes and ponds (square miles)
- Total storage area (square miles)
- Precipitation (inches mean annual) data provided by National Weather Service
- Mean basin elevation (feet above sea level)
- Forested area (square miles)
- Glaciers (square miles)
- Mean January temperature (degrees Fahrenheit) data provided by National Weather Service
- Digital photos of the stream reach that the corridor crosses including shots looking up and downstream of the corridor

- Title 41 classification
- All existing surface hydrological measurements and flood records data provided by the USGS, Water Resources Branch
- Stream classification (stable, transitional, or unstable, and sinuous, straight braided, alluvial, or incised) within the corridor reach
- Geomorphologic data (description sediment scour and deposition trends, stability of form over time, bed and bank material identification)
- Estimates of expected maximum and minimum flows
- Flow measurements collected during field programs
- Base images:
  - Aerial photography copies of 2003 Aerial Photography taken by others
  - "U2" false color infrared photography provided by NDM
  - USGS topographic maps

4.2.3 Deliverables

Deliverable products will include:

- Basin Characteristics File for each stream crossed by the preferred corridor.
- Estimation of flow conditions for all Title 41 streams and tributaries.
- Field notes, calculations, and interim progress reports.
- Impact analysis report in support of the Environmental Impact Statement (EIS).
- Hydrologic and hydraulic summary for all crossings, in accordance with DOT&PF, Alaska Highway Drainage Manual, Appendix B.

4.2.4 Schedule

Phase I research and initial data compilation began in May 2004. Phase I field work will be carried out from July to September 2004, upon receipt of preferred road corridor from DOT&PF. Final deliverables will be produced in April 2005.

5 Groundwater Hydrogeology

CH2M will lead the groundwater hydrogeology work on the mine site, and BEESC will complete the groundwater hydrogeology work for the road and port.

5.1 Mine Site

5.1.1 Objectives of Study

The objectives of the groundwater hydrogeology study are as follows:

- To characterize the existing groundwater flow regime within the project area and define how the local regime interacts with the regional groundwater system. This will necessarily include evaluation of the interaction between ground water and surface water and the presence of cross-basin transfer of ground water, both of which appear to occur within the study area. The study will need to include an assessment of both seasonal and long-term changes in the system.

- To characterize the baseline groundwater conditions to identify the potential changes to the groundwater regime that may result from construction, operation and closure of the mine. These may potentially include changes in groundwater recharge and discharge quantities, as well as spatial and temporal distributions, changes in recharge water chemistry and groundwater geochemical setting, and the transport and fate of constituents that may enter the groundwater system.

- To use the above baseline data and analyses of these data to develop the baseline water flow and water chemistry models that will be used to evaluate alternatives, and to identify potential mitigative measures.

- To identify and assess alternative groundwater supply sources.

- To support aquatic, fish resource, and wetlands habitat assessments.

To achieve these objectives, the baseline study program comprises comprehensive collection of data, including surface and subsurface geology, hydrogeologic parameters such as piezometric levels and hydraulic conductivities, location of groundwater recharge and discharge sites, and existing groundwater quality within areas of mineralized and barren rock as well as within the alluvial aquifers. Collection of background groundwater data is important and will ensure that naturally occurring variations over all the seasons are documented.

5.1.2 Proposed Study Plan

5.1.2.1 Study Area/Scope

The Pebble Mine site is located in the headwater areas of Koktuli River and Upper Talarik Creek. The main stems of the creek and river primarily flow within flood plain channels eroded

into widespread glacial deposits. The valley glacial infill is bounded by bedrock mantled with glacial deposits. Pre-mining groundwater levels, flow, and chemistry (discussed in Chapter 8) will be defined within major bedrock units and within the overburden. This will allow a detailed assessment of the potential impacts during mining operations and after closure.

The study area will encompass all local and regional ground water which has the potential to become affected by the proposed project, or which has the potential to affect the surface water system. The specific extent of the groundwater study area will be determined based on the initial data collected and preliminary project design.

The open pit is proposed along the margins of the valley infill deposits, so that certain sectors of the pit wall may be excavated into saturated overburden. Mining is expected to require dewatering of the sands and gravels and some additional dewatering of bedrock. During dewatering, local groundwater levels will likely be changed within the overburden. The baseline groundwater program is intended to quantify the pre-mining conditions in the vicinity of the proposed pit.

Alternatives are under consideration for the location of the mill, tailings storage facilities, and other components. At this time, therefore, groundwater characterization is required at two tailings facilities to assist in alternatives assessment. The groundwater regime and the related environmental considerations with respect to downstream water supply and aquatic (fisheries and wetlands) resources, will be important factors for optimizing the location and design of the mill and related mine rock and tailings storage facilities. As planning proceeds, sampling sites no longer required for mine design or long-term monitoring may be dropped from the regular monitoring schedule. Other baseline data required to assess the tailings areas include geologic descriptions, piezometric levels and flow directions, and hydraulic conductivity distributions.

The underlying groundwater system will be an important consideration for the operational and post-closure water balance of the tailings area. Baseline groundwater conditions will be carefully assessed to allow evaluation of the effect of the tailing facility on the local water tables, groundwater underflow, surface water baseflow, and local and downgradient surface and groundwater quality. Consideration will be given to size, capacity for tailings to store water, conductivity of tailings, and hydrogeologic characteristics of the foundation material.

The detailed assessment of the groundwater system will include collection of adequate data to develop groundwater models appropriate to evaluate potential changes in local and regional water tables, and the groundwater interaction with local streams, wetlands, and lakes.

5.1.2.2 Methods/Approach to the Groundwater Study

The general approach used for the groundwater study will be as follows:

- Collation and interpretation of existing data
- Detailed determination of monitoring locations and well completion details
- Installation, testing, and sampling of baseline monitoring wells
- Installation, testing, and sampling of supplementary groundwater monitoring sites
- Hydraulic testing of the key units

- Investigation of the hydrogeology in the area of the deposit
- Investigation of the hydrogeology in each potential tailings area

Information collected in the baseline groundwater program will also be used in the project engineering studies. However, as this study plan is focused on the baseline characterization program, the emphasis of the following discussion is on the environmental baseline characterization tasks, rather than the engineering studies that will utilize the baseline data and analyses.

5.1.2.3 Major Activities

Activity 1: Data Review

This activity includes a review of previous baseline studies, geologic reports, and data. These reports and databases are available from Cominco, NDM, USGS, ADF&G, USFWS, the State of Alaska Department of Natural Resources (DNR), and the National Oceanic and Atmospheric Administration (NOAA). The review will include an evaluation of basin and sub-basin drainage areas, channel lengths, annual precipitation, relief, typical flow regimes, and stream characteristics. This geologic, meteorologic, and hydrologic information will be used to prepare a preliminary conceptual model of the project area and to optimize the layout of baseline monitoring wells and piezometer networks.

Activity 2: Determination of Monitoring Requirements

The number and location of investigations and monitoring is dependent on both the groundwater regime and the proposed locations of mine facilities. The priorities for monitoring sites are: 1) site-wide characterization, 2) detailed characterization of the area around the ore body, and 3) detailed characterization of the tailings and mine rock storage areas. An additional consideration for selection of baseline monitoring locations will be ongoing sampling after the baseline period. It is expected that some of the sites will be monitored for many years during the planning, development, and operational phases of the project.

A primary objective will be to install monitoring wells as early as possible in the field program cycle. Locations of some wells may be modified as new data become available and the overall understanding of the system develops. The proposed monitoring installations based on the current proposed mine development alternatives are shown in Figure 5-1 and described in Table 5-1. Specific locations of the groundwater monitoring installations will be adjusted as appropriate, and as the overall mine development plan evolves.

Activity 3: Field Program

The field program consists of multiple components, including monitoring well installation, groundwater sampling, seep and spring sampling, stream seepage evaluation, and piezometer installation and hydraulic testing. The following paragraphs describe each of these components in more detail.

TABLE 5-1
Summary of Draft Groundwater Drilling Locations (also shown on Figure 5-1)

	Well No.	Area	Location	Nominal Depths* (feet)
Baseline Monitoring Wells				
	MW-1	Tailings	west dam	30, 100, 200
	MW-2	Tailings	south dam	"
	MW-3	Tailings	east dam	"
	MW-4	Pit area	east side	"
	MW-5	Pit area	north side	"
	MW-6	Tailings	north	"
	MW-7	Tailings	southwest	"
Supplementary Monitoring Wells				
	MW-8	Tailings	between J and Upper Talarik	50, 150
Regional Piezometers				
	P-1	Pit	south	50, 200
	P-2	Pit	south	"
	P-3	Pit	west	"
	P-4	Pit	west	"
	P-5	Pit	east	"
	P-6	Pit	east	"
	P-7	Tailings	south	150
	P-8	Tailings	south	"
	P-9	Tailings	south	"
	P-10	Tailings	south	"
	P-11	Tailings	east	"
	P-12	Tailings	north	"
	P-13	Tailings	north	"
	P-14	Tailings	north	"
	P-15	Tailings	south	"
Pumping Test Sites				
	PW-1	Pit	east (overburden)	4 x (30, 100, 200)
	PW-2	Tailings	middle	2 x (30, 100, 200)

* Actual depths will depend on depth to bedrock and depths to permeable horizons.

Background Monitoring Well Installation. Based on an initial review of project information, 8 baseline monitoring wells, 15 regional piezometers, and 2 pumping tests are planned around the mine site (see Figure 5-1). Locations will be adjusted and finalized once the mine plan is advanced. Expected depths of the wells range from 30 to 200 feet. These wells will be used primarily to help characterize groundwater geochemistry at the proposed open pit, tailings impoundment locations, mill site, and stockpile locations so that adequate background data are available for the permitting process and sufficient information is available for the design to proceed.

Monitoring wells will be installed in the field with a helicopter supported field program. Qualified drillers and hydrogeologists will be responsible for locating, designing, installing, and sampling the wells, so that the necessary quality is maintained. Geology and drilling data will be used to make decisions in the field regarding exact well designs. The shallow wells will likely be installed with an ODEX heli-portable rig as this drilling technique eliminates the problems associated with the addition of drilling mud and minimizes potential site disturbance. A heli-portable rotary drill rig may be utilized to install deeper piezometers. These piezometers will be constructed of either 1-inch or 2-inch diameter PVC casing depending whether NQ, HQ, or PQ rod or rotary casing is used in drilling.

Each monitoring well will be developed, response tested, and completed with a dedicated submersible sampling pump. Dedicated pumps will eliminate problems that can result from cross-contamination of wells.

Supplementary Groundwater Sampling Sites. In addition to the baseline monitoring sites, supplementary groundwater levels and chemistry data may be collected from:

- Mineral exploration and geotechnical holes as they are drilled
- Piezometers installed in mineral exploration and geotechnical holes

Additional piezometers and monitoring wells will be installed as necessary to address key engineering aspects of the program

Stream Seepage Investigation. Because surface water-groundwater interaction is a significant concern in this project, a survey will be conducted to determine which portions of the streams are "losing" (flow to the ground) and which are "gaining" (flow from the ground). This survey will include installation of seepage meters and mini-piezometers. The seepage meters will measure the seepage directly and will be installed once to test the feasibility of using seepage meters in this terrain. The mini-piezometers will be used to measure vertical head differences between the stream stage and the underlying materials. The mini piezometer measurements will be collected nine times during the course of the baseline study and will be timed to coincide with groundwater sampling. As such, the stream seepage evaluation will allow interpretation of high flow periods during spring runoff and fall storms, and low flow periods during the summer and winter. Samples of the stream and groundwater seepage will be collected when the seepage meter installation is attempted. A total of 16 stream seepage stations are planned; specific locations will be determined in the field.

Piezometer Installation and Hydraulic Testing. Piezometers will be installed in the proposed pit and tailings areas for the purpose of hydraulic testing and for defining regional gradients.

These piezometers will be installed in exploration or geotechnical drill holes where possible and will be constructed of 1-inch or 2-inch diameter PVC casing, depending on drill rod size. Slug testing and injection testing in the completed piezometers will provide information from the completion zone. Some supplementary piezometers may also be installed in holes drilled with the ODEX drilling method.

Pumping tests will be conducted in alluvium that will likely be exposed in the pit walls and in areas of significant alluvium at the proposed tailings storage facilities. Each test site will include a pumping well and multiple piezometers for monitoring water levels. Two piezometer nests (3 holes each) are proposed at the main tailings site and one in the pit area (see Table 5-1). The data from these *in situ* tests will help define baseline conditions, and will be used to evaluate dewatering requirements, and predict post-mining groundwater conditions.

The pumping test at each site will start with a step test to determine the most appropriate pumping rate for a constant rate test. The constant rate test will last about 24 hours. The flow rate of the pumping well will be recorded regularly. The water levels in the pumping well and observation wells will be recorded frequently either with transducers or with manual sounding tapes. Barometric pressure will be monitored during the test so that the necessary corrections can be applied to the water level measurements. The recovery of water levels will also be recorded after the pump is turned off.

Groundwater Sampling. Four sampling programs will be conducted for baseline monitoring wells (see Table 5-1). Sampling events have been timed to coincide with high groundwater levels in the spring and early fall, and low groundwater levels in summer and winter and to be coincident with the surface water chemistry sampling programs. Water levels will be measured in monitoring wells and piezometers nine times during the year, concurrent with surface water sampling (see Section 4.1).

Activity 4: Modeling of Groundwater Flow and Surface Water / Groundwater Interaction

The detailed objectives and scope of modeling for the groundwater system will be progressively refined as the project evolves. Initially, a conceptual model will be developed with field data in a simple form to help define the most important hydrogeologic issues at the site and to help guide the field program. The model will be progressively refined as field data become available and the overall mine plan is developed.

More detailed analyses will likely be required for the tailings facility and for the open pit:

- **Tailings Storage Facility**. A groundwater model of the proposed tailings impoundment areas will be developed in conjunction with tailings storage facility engineering. The model would be used to estimate leakage rates and evaluate changes in groundwater levels expected from operation and closure of the tailings storage facility, and quantify potential downgradient flow and chemistry changes to the surface water and groundwater regime. Special emphasis can be placed on evaluating changes to surface water-groundwater interaction because of the significance of this interaction on the groundwater study. Pre-mining, operational and post-closure conditions will be simulated to allow comparison of pre-mining baseline conditions with the predicted operational and post-closure conditions.

- **Pit Area.** Seepage modeling of the pit area will be done in conjunction with the project engineering, to fulfill several functions, including the following: 1) help design the operational dewatering system for the pit, 2) allow design of the system to minimize downgradient impacts, and 3) assess operational and post closure pit water management requirements.

Activity 5: Ongoing Monitoring

Surface water and groundwater monitoring will continue beyond the project baseline period. Therefore, the monitoring program will be evaluated after the first year to identify any needed changes to monitoring frequency, locations, or parameters, or any potential data gaps for the detailed design studies.

5.1.3 Deliverables

- A Water Monitoring Plan (WMP) summarizing the geologic and hydrologic conditions in and around the project area, description of the conceptual model of the hydrogeologic conditions for the site, location and rationale for selection of groundwater monitoring installations, the monitoring parameters, related analytical methods, and SOPs used in field data collection.

- Quality Assurance Project Plan (QAPP) that outlines QA/QC data validation.

- The groundwater characterization component of the BMR will be developed after the field effort including:
  - Description of groundwater monitoring site and activities.
  - Monitoring results and interpretations including QA/QC data validation.
  - Details of all site installations and sampling results.
  - Analysis and interpretation of the hydrogeologic conditions at the site.

5.1.4 Schedule

The groundwater schedule for the baseline groundwater program is included in the overall environmental baseline study schedule, Appendix A.

5.2 Road/Port Site

5.2.1 Objectives of Study

The objective of the study is to establish baseline conditions for groundwater flow, and evaluate potential impacts to groundwater hydrogeology for the EIS.

5.2.2 Proposed Study Plan

It is not anticipated that ground water will be impacted by the development of the road. At this time, hydrogeologic work along proposed road routes will be restricted to aerial photo interpretation and field observations made during the course of other surveys. If areas of substantial groundwater recharge are noted, and these sites have the potential to be impacted by the road, further work will be carried out on an as-needed basis.

Structures to be built at the port site may also require analysis of potential groundwater impacts. The need for more detailed investigations will be evaluated once a preferred port site is selected.

6 Water Chemistry

CH2M will lead the water chemistry work on the mine site, and BEESC will complete the water chemistry work for the road and port.

6.1 Mine Site

6.1.1 Objectives of Study

Water chemistry baseline studies will include collection and analysis of surface water, groundwater, and water from seeps. The main objectives of this study are to:

- Collect baseline data to provide defensible documentation of the naturally-occurring levels and variability of trace elements in surface water and groundwater.
- Evaluate sources that could be used for mine make-up water.
- Provide the database for the site water chemistry and site loading models for project design and environmental impact assessment.
- Develop the baseline for the evaluation of potential environmental impacts during construction, operation, and closure.

These studies will provide the data on the surface water and groundwater systems to link with the physical flow data to provide estimates of baseline surface water and groundwater load from the mineralized area to down gradient groundwater and surface water systems.

The water chemistry results will be used in the evaluation of the site geochemistry described in Chapter 8. This information is key to understanding current conditions and will provide a baseline for the evaluation of future potential environmental impacts during operation and closure. The baseline water chemistry data are also important for determining if site-specific water chemistry standards are required for water bodies in the project area.

6.1.2 Proposed Study Plan

6.1.2.1 Study Area/Scope

The project area, including the deposit area and potential mine, mill, and tailings disposal facilities, is drained by the north fork and south fork of the Koktuli River, Upper Talarik Creek, and tributaries of these water bodies. The Kaskanak Creek watershed is located to the southwest of the project area and will also be monitored to identify potential interbasin transfer from the south fork of the Koktuli River.

6.1.2.2 Methods/Approach

Water chemistry monitoring will be conducted for surface water, ground water, and seeps. Surface water stations will be selected to characterize the surface water system for geochemical

parameters, establish baseline water chemistry, provide data for fisheries studies, document water chemistry in water bodies in areas of water supply, and to document water chemistry in potential receiving waters.

To meet the project objectives, the following activities will be conducted:

- Sampling and analysis of naturally occurring constituents in surface water from each waterway to characterize the signature of natural conditions.
- Characterization of the natural statistical variance of the naturally occurring element concentrations in each system.
- Characterization of surface water and groundwater baseline systems throughout the year under a range of hydrologic conditions to understand the seasonal changes throughout the year.
- Surface water chemistry sampling under different hydrologic conditions will document variability of water chemistry with flow.

This information is key to understanding current conditions and will provide a baseline for the evaluation of future potential impacts during construction, operation, and closure.

NDM has appointed an Analytical QA/QC Manager responsible for quality management for all laboratory programs. This is to ensure both consistency among the various programs within the baseline study, and that data quality objectives (DQOs) are met for the program.

The Pebble Gold Copper Project environmental baseline studies sample collection and handling protocols are outlined in the Project Quality Assurance Plan (QAPP).

6.1.2.3 Major Activities

Major activities will include:

- Water chemistry data from previous studies in the project area will be compiled and reviewed to evaluate the suitability of the existing data for planning purposes and to determine if it can be used to supplement the data to be collected under the current program.
- Field studies will include collection of water chemistry data for surface water, ground water, and seeps and the collection of sediment quality data.
- Data will be reviewed as part of the analytical QA/QC program and incorporated into the project database as discussed in Chapter 19.
- Evaluation of the water and sediment quality data will then be conducted.

The field studies and data evaluation are discussed in additional detail in the following sections.

Sample Site Selection

The selection of the sampling sites for water chemistry was done in conjunction with the site surface water hydrology sample site selection (Chapter 4), groundwater site selection (Chapter 5), and aquatic studies (Chapter 11) as shown on Figures 4-1, 5-1, and 11-1. A preliminary definition of alternative sites for the mine site, milling facilities, and associated waste management facilities was provided by the engineering team for consideration in sample site selection. This was used to locate stations that would be useful both for baseline characterization and, in the appropriate areas, to be maintained for operations and closure monitoring.

Field Studies

Surface Water Chemistry. The surface water chemistry sampling is designed to quantify the water chemistry throughout the year and under a range of different hydrologic conditions at key surface water locations. The surface water chemistry sampling is designed to occur during breakup and six times in the summer when there is the greatest potential variation in water chemistry. As hydrologic conditions change (i.e., flows vary due to breakup and storm events), there is greater potential for varying water chemistry. During the winter, flows will gradually decrease as winter progresses and sampling is planned three times during this period. Late winter surface water sampling is important because this represents minimum flows, which are most representative of base flow due to groundwater discharge. This results in nine planned surface water monitoring events for the 12-month period from April to March.

Samples will be collected at 35 surface water monitoring stations shown in Figure 4-1. Flow and depth integrated water chemistry samples will be collected with a DH-48 sampler when possible. Appropriate QA/QC procedures will be used and QA/QC samples will be collected.

Surface water will be tested in the field for select parameters and samples sent to the selected independent external laboratory for chemical analysis. The primary laboratory is SGS Environmental Services in Anchorage, Alaska, and the QA laboratory is Columbia Analytical Services, Inc., in Kelso, Washington. Some additional laboratories may also be used for specialized tests. Field screening parameters include dissolved oxygen (DO), conductivity, pH, temperature, turbidity, and oxidation reduction potential (ORP).

Metals analyses will be conducted on total (unfiltered) and dissolved (filtered) samples. Samples will be filtered in the field or will be iced and filtered within 12 hours of collection. Hexavalent chromium will only be analyzed if total chromium exceeds 11 ug/L (aquatic life criteria for fresh water). The laboratory analysis will be conducted under the laboratory QA/QC program. Chemical data received from the analytical laboratory will be validated by the Analytical QA/QC Manager. Samples from select monitoring stations for two sampling events will be analyzed for organic constituents. These constituents will include pesticides, volatile compounds, and semi-volatile compounds.

Laboratory analysis of surface water samples will be conducted for the parameters in Table 6-1. This table presents methods, method reporting limits (MRLs), and precision and accuracy criteria for each parameter.

TABLE 6-1
Surface Water and Groundwater Analytes for Laboratory Determination

Analyte	Method	Method Reporting Limit, ug/L
Aluminum, total and dissolved	E200.8	25
Antimony, total and dissolved	E200.8	0.2
Arsenic, total and dissolved	E200.8	0.5
Barium, total and dissolved	E200.8	0.3
Beryllium, total and dissolved	E200.8	0.4
Bismuth	E200.8	5
Boron	E200.7	10
Cadmium, total and dissolved	E200.8	0.1
Calcium, total and dissolved	200.7	50
Chromium, total and dissolved	E200.8	0.2
Cobalt, total and dissolved	E200.8	0.1
Copper, total and dissolved	E200.8	0.2
Iron, total and dissolved	E200.7/200.8	20
Lead, total and dissolved	E200.8	0.2
Magnesium, total and dissolved	E200.7/200.8	20
Manganese, total and dissolved	E200.8	1
Mercury, total and dissolved	E1631	0.001
Molybdenum, total and dissolved	E200.8	1
Nickel, total and dissolved	E200.8	0.2
Potassium, total and dissolved	E200.7/200.8	50
Selenium, total and dissolved	E200.8	1
Silver, total and dissolved	E200.8	0.2
Sodium, total and dissolved	E200.7/200.8	100
Thallium, total and dissolved	E200.8	0.05
Tin, total and dissolved	E200.8	1
Vanadium, total and dissolved	E200.8	0.4
Zinc, total and dissolved	E200.8	1.5
pH	E150.1	NA
Conductivity	E120.1	1 (μS/cm)
Alkalinity	SM20 2320B	10 (mg/L)

TABLE 6-1
Surface Water and Groundwater Analytes for Laboratory Determination

Analyte	Method	Method Reporting Limit, ug/L
Acidity	E305.1	NA
Ammonia	E350.2	0.1 (mg/L)
Chloride	E300.0	0.1 (mg/L)
Cyanide-total	SM20 4500	5
Cyanide-WAD	SM20 4500	5
Fluoride	E300.0	0.1 (mg/L)
Nitrate + Nitrite	E300.0	0.1 (mg/L)
Phosphorus-total	E365.2	0.1 (mg/L)
Sulfate	E300.0	0.1 (mg/L)
Silicon	E200.7	500
TDS	E160.1	10 (mg/L)
TSS	E160.2	0.5 (mg/L)
Thoicyanate	Lab SOP	1 (mg/L)

E – Methods for Chemical Analysis of Inorganic Substances in Environmental Samples, EPA/600/R-93-100, August 1993 and Methods for the Determination of metals in Environmental samples, EPA/600/4-91-010, June 1991.

SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition.

Groundwater Chemistry. The groundwater chemistry sampling goal is to quantify the water chemistry under seasonal hydrologic conditions at key locations in the project area. Sampling will be conducted four times during the year. This is planned for August, October, March, and May, representing summer, early winter, late winter, and after breakup in early summer.

Samples will be collected at monitoring wells presented in Figure 5-1. The selection of the locations of these wells is discussed in Chapter 5. Groundwater samples from the wells will be obtained using dedicated sampling pumps.

Groundwater chemistry sampling will be conducted concurrently with the groundwater monitoring described in the Groundwater Hydrology chapter. Sample and data handling procedures will be the same as surface water with the exception that groundwater samples for dissolved metals will be filtered immediately after collection in the field because of potential to oxidize reduced groundwater prior to filtration.

The baseline groundwater samples will be collected from 22 monitoring wells, as detailed in Table 5-1 in Chapter 5. The field parameters pH, specific electrical conductance (EC), temperature, and DO will be measured each time groundwater samples are collected (Table 6-2).

TABLE 6-2
Parameters for Field Determination

Parameter	Method (range)	Units	Detection Limit	Sensitivity	Precision	Accuracy
Depth to water	Electric sounder (0 to 100)	feet	NA	0.001	± 0.01	± 0.02
pH	pH meter	pH units	NA	0.1	± 0.2	± 0.2
Electrical conductivity	Conductivity meter	μS/cm	10	10	± 10 %	± 10 %
Temperature	Thermometer	^{o}C	NA	0.5	± 0.5	± 0.5
	(-5 to 50)					
Dissolved Oxygen (DO)	DO meter					

In addition, about 15 non-baseline samples will be collected from supplementary monitoring wells, flowing drillholes, and selected piezometers to help delineate the groundwater regime. These samples are in addition to the baseline data.

Another 18 samples from springs and seeps, and 16 samples from stream seepage stations will be collected in a single sampling event.

All samples will be analyzed for a wide range of cations and anions. The parameters have been selected to fulfill two purposes:

- Provide baseline values for possible contaminants.
- Provide general information on groundwater quality that can help with natural attenuation assessments and the site-wide water balance.

The analytical method and MRL for each parameter is summarized in Table 6-1.

In addition to the water chemistry sampling at the intervals specified above, field staff will measure water levels and field chemistry parameters in the monitoring wells on the same schedule as the surface water monitoring program.

Seep Chemistry. The objective of conducting seep sampling programs is to document the water chemistry of water discharging from seeps or springs in the vicinity of the deposit. This type of sampling is useful for ephemeral flows, low flows, or seeps that are specific to a certain area of the site but will not remain in operation. These data are typically useful for interpretation of apparently anomalous (elevated) values in areas of mineralization and for calibration of the mine rock testing results. A seep survey will be conduced in May and September to identify seeps and measure water chemistry and flow. Water chemistry data will be used to establish geochemical signatures of the seeps. Sample and data handling procedures and sample analysis will be the same as for groundwater.

Laboratory Analysis and Quality Management

The Analytical QA/QC Manager's role is to ensure consultant work plans, field procedures, laboratory analyses, and deliverables meet technical and quality requirements stipulated by regulatory agencies and NDM. The primary objective is to ensure analytical data quality is consistent among consultants, meets specified DQOs, including MRLs, and is legally defensible. This role will include regular, well-defined QA/QC review of program plans and design, program execution, agency coordination and compliance and program deliverables. At a minimum, tasks will include:

- Evaluation of laboratory QA/QC programs
- QA/QC review of sampling and analysis plans
- Design and execution of double blind studies
- On-site QA/QC evaluation of field sampling activities
- Analytical data review/validation
- Quality Assurance Reports
- Corrective Action

The QA/QC program is described in detail in the project-specific QAPP to be submitted under separate cover.

Data Evaluation

Data presentation and evaluation will include preparing tabulated water chemistry data and summary statistics of water chemistry data; plots of key parameters and a comparison of results to water chemistry criteria; spatial distribution of key parameters; and flow and quality relationships where appropriate. These data will also be used as input data for the site baseline water balance and water chemistry (loading) models.

6.1.3 Deliverables

Two documents will be prepared:

- The WMP as described for the surface water hydrology work in Chapter 4 is in production. This document covers both hydrology and water chemistry. The WMP presents the location and rationale for selection monitoring stations and the monitoring parameters, related analytical methods, and SOPs used in field data collection.

- The BMR will present both hydrology and water chemistry monitoring results. It will include tabulated water chemistry data and the data evaluation presented in the previous section.

6.1.4 Schedule

The environmental baseline studies schedule is presented in Appendix A.

6.2 Groundwater Quality - Road/Port

6.2.1 Objectives of Study

The objective of the groundwater quality studies is to define the chemical characteristics of project area ground water used for drinking water. Establishment of this baseline and regular, ongoing monitoring will give local residents confidence that their health is being considered and protected. At the port site, where ore concentrates will be temporarily stored and handled, there is potential for environmental impact to groundwater. The objective at the port site is to establish background concentrations of trace elements in groundwater.

6.2.2 Proposed Work Plan

6.2.2.1 Study Area/Scope

The study area will include the proposed road corridor in the region located between the Newhalen River and Cook Inlet, including the area surrounding the port site. More specifically, groundwater samples will be collected from existing water supply wells in Iliamna, Newhalen, Nondalton, Pedro Bay, and Williamsport, and possibly at other existing groundwater well locations along the road corridor, if any exist. Initial research indicates there is a database of previously collected public data that can be used. Documentation of local water supply quality will determine whether there is any pre-existing problem. Upon selection of the port site, a program involving installation of groundwater monitoring wells may be required. This aspect of the program will be evaluated after the port site is chosen.

6.2.2.2 Methods/Approach

One drinking water well from each village will be selected for groundwater sampling. Wells will be identified from ADEC public water supply records, village records, and contact with local individuals. Public water supply records will be reviewed for information on the well installation, water quality, and analyte concentration trends. The location of the well, depth, and depth to water will be recorded. Water samples will be submitted to the project laboratory for the analyses listed in Table 6-1. Sample collection will be coordinated with existing plans. Groundwater will be tested for the same laboratory parameters and field parameters as surface water (Tables 6-1 and 6-2). QA/QC protocols will follow procedures outlined in Section 6-1 and the QAPP.

6.2.2.3 Major Activities

Major activities include:

- Research, compile, document, and review existing groundwater data for the area.
- Inventory drinking water supply wells in each community.
- Select one well from each community as an indicator well.
- Collect quarterly groundwater samples from each well.
- Prepare reports.

6.2.3 Deliverables

Quarterly reports will be prepared listing groundwater results in a tabular format. A final report will be prepared comparing all quarterly data, and will include a discussion of results, trends, and variations. Impact analysis in support of the EIS will be made.

6.2.4 Schedule

Samples will be collected every year on a quarterly basis in July, October, January, and April. The first sampling effort will be conducted in July 2004.

6.3 Surface Water Quality - Road/Port

6.3.1 Objectives of Study

The objective of the surface water quality studies is to define the chemical characteristics of surface waters that could be potentially impacted by the future road and port facility. The baseline data will be used to monitor potential impacts associated with:

- Road construction.
- Transportation of concentrate along the road, and handling at the port site.

The information generated in this baseline study will be used in the creation of the EIS.

6.3.2 Proposed Work Plan

6.3.2.1 Study Area/Scope

The study area will include the chosen road corridor in the region located between the Newhalen River and Cook Inlet, including the area surrounding the port site as shown in Figure 4-3.

6.3.2.2 Methods/Approach

For surface water, samples will be collected from 16 stream crossing locations on a monthly basis (as shown on Figure 7-3). Streams near villages and anadromous streams will be targeted in particular for regular sampling. Sample locations will be determined in coordination with locations chosen for fish studies.

Adjustments to sample locations, sample frequency, and analytes tested will be made after review of initial results and agency consultation. Surface water will be tested for the laboratory parameters and field parameters presented in Tables 6-1 and 6-2. QA/QC protocols will follow procedures outlined in Section 6.1 and the QAPP.

6.3.2.3 Major Activities

Major activities are as follows:

- Research, compile, document and review existing surface water data for the area.

- Collect monthly surface water samples from each established surface water sampling location.
- Report results.

6.3.3 Deliverables

Monthly reports will be prepared listing surface water results in a tabular format. An annual report will be prepared comparing all monthly data, and will include analysis and discussion of results, trends, observed impacts, and impact analysis in support of the project EIS.

6.3.4 Schedule

Samples will be collected monthly, with the first sampling effort to be conducted in July 2004. A report will be delivered in June 2005 in anticipation of an EIS submittal in 2005.

7 Naturally Occurring Constituents in Surface Soil, Sediment, Vegetation, and Fish

CH2M will lead the naturally occurring constituents work on the mine site, and BEESC will complete the naturally occurring constituents work for the road and port.

7.1 Mine Site

The following provides the study plan for the baseline characterization of parameters of interest in surface soil, sediment, vegetation, and fish at the mine site. Naturally occurring constituents include trace elements, anions, and petroleum hydrocarbons. For the mine site, field work will occur in the summer and fall 2004, and spring 2005, concurrently with the road and port site studies if possible.

7.1.1 Objectives of Study

The objective of this study is to collect baseline data to provide defensible documentation of the natural levels of trace elements, anions, and petroleum hydrocarbons in environmental media, prior to mining operations. Surface soil samples will be analyzed by gas chromatography to establish their naturally occurring biogenic fingerprint associated with petroleum hydrocarbon analysis. Media to be studied include surface soils, stream and lake sediment, vegetation, and fish.

This information is key to understanding current conditions and will provide a baseline for the evaluation of future potential environmental impacts to these media during operation and closure, and also to support long-term site monitoring objectives.

7.1.2 Proposed Study Plan

7.1.2.1 Study Area/Scope

Based on the Bureau of Land Management (BLM) cadastral survey system of range/township/ section, the proposed mine, mill, and storage facilities encompass an area that is 16 survey sections long by 10 sections wide, which is 160 square miles. The study area for parameters of interest for the mine site is shown on Figure 7-1. As noted in the study objectives, baseline characterization of trace elements will be completed for four media: surface soils, sediments, vegetation, and fish.

The trace elements team will accomplish the following scope of work:

- Adequately characterize naturally occurring constituents (e.g., trace elements) in:
  - Surface soil media
  - Vegetation that are used as forage by wildlife or food by humans
  - Surface sediment found beneath tundra lakes, ponds, and streams

  - Fish tissue

- Document statistical variance of the natural trace element concentrations in each of the above media.

- Collect sufficient data to support long-term site monitoring objectives.

Soil samples collected at a 1.5-foot depth will also be analyzed for total organic carbon (TOC) and total petroleum hydrocarbons (TPH) screen by gas chromatograph. This biogenic "fingerprinting" will provide information for use in calculating more realistic alternative cleanup levels (ACLs) that can be applied as part of petroleum spill contingency cleanup plans.

7.1.2.2 Methods and Approach

As described in earlier chapters, mine operations will include open pit mining, and construction of earthen impoundment dams and tailing piles, gravel roads, and pads. These are features that will cut across landforms common to the study area. These specific landforms have characteristic types of surface soils, sediment, and vegetation common to the site and the region.

Therefore, the approach to adequately characterize surface soils, sediment, and vegetation media is based on first identifying landforms in the mine site study area, identifying sample types from each environmental medium common to these landforms, and then ensuring sufficient samples from each of the media are collected to be statistically valid. Ideally, to be spatially representative and statistically equivalent to a 99 percentile confidence level, 21 samples will be collected for each of the 10 sample types. The sampling strategy described here meets, and in one instance, exceeds the required sample numbers.

Fish will be sampled from streams and lakes. Samples will consist of individual fish as a whole and of organs separately.

Sample Types

Surface Soil, Tundra Lake and Pond Sediments, and Vegetation. A valid sampling strategy must include a sufficient distribution of data points (sample locations) to create a statistically representative and technically valid data set. Therefore, a systematic random sampling program was developed and employed to establish sampling locations to ensure a more accurate representation of study area conditions. Landforms and their estimated physiographic distribution and correlative sample types by media are presented in Table 7-1.

This systematic random sampling program is based on the BLM township/ range/section cadastral survey system. This allows for sampling locations to be re-established in the field via global positioning system (GPS). A grid using the existing cadastral survey sections as grid cells was laid out over the study site resulting in 160 grid cells (Figure 7-2). Table 7-1 shows the number of samples to be collected. Starting in the southwest corner, each section "cell" was assigned a temporary sequential number, and a random number generator was utilized to select 50 (section) cells. Each selected section cell was then inspected to identify landform types. Grid cell locations and results of the landform inspection are summarized by USGS section number in Figure 7-2.

TABLE 7-1
Sample Numbers for Surface Soil, Vegetation, and Sediment Sample Type

Sample Types	Ground Moraines	Outwash Plains	Talus Slopes	Stream Channel & Flood Plains	Tundra Lakes & Ponds	Totals
Estimated Physiographic Distribution						
	37%	16%	24%	17%	6%	100%
Media: Surface Soil and Sample Numbers						
1. Organic-rich silts (OL)	10	5	6	0	0	21
2. Fine sands with silts and clay (ML and CL)	10	5	6	0	0	21
3. Poorly graded gravel with sands and silts (GP and GM)	10	5	6	0	0	21
4. Glacial till (GM and GC)	10	5	6	0	0	21
Media: Vegetation and Sample Numbers						
5. High brush shrubs including species such as willow, American green elder and blueberry	10	5	6	0	0	21
6. High brush sedges, grasses such as lichen, bluejoint, horsetail, fireweed	10	5	6	0	0	21
7. Alpine tundra shrubs, such as dwarf arctic birch, crowberry	10	5	6	0	0	21
8. Alpine sedges	10	5	6	0	0	21
Media: Sediments and Sample Numbers						
9. Stream[a]	0	0	0	57	0	57
10. Lake and Ponds	0	0	0	0	21	21
					Total	**246**

[a]Stream sediment sampling locations and frequency is based on surface water quality sampling (Chapter 8) and will occur at 19 surface water stations 2 times during 2004 and once in 2005.

TABLE 7-2
Stream Sediment Sampling Locations

Stream	Identification Number for Monitoring Sites (Figure 4-1)
South Fork Koktuli River	SK100G, SK131A, SK100F, SK100C, SK119A, SK100B
North Fork Koktuli River	NK100C, NK119A, NK100A
Main Stem Koktuli River	KR100A
Kaskanak Creek	KC100A
Upper Talarik Creek	UT100E, UT146A, UT141A, UT100D, UT138A, UT119A, UT100B, UT100A

Up to three sample locations will be sampled in each cell to ensure sufficient representative sample types are collected for each landform and media.

Stream Sediments and Fish. The sampling strategy for stream sediments and fish will follow a slightly different format given that these matrices are closely related to water quality. Stream sediment samples will be collected at the same time and location as water quality samples.

Fish samples will be collected in two ways. Whole body samples and organ samples will be collected and analyzed separately, depending on the sample location and purpose.

Sampling Methods

The sampling method for each matrix is presented below. Appropriate field QA/QC samples will be collected and analyzed.

Surface Soil Sampling. About 90 percent of surface soil samples will be collected to a depth of 0.5 feet by using hand tools, such as stainless steel or disposable polyethylene shovels and trowels. The remaining 10 percent of surface soil samples will be collected at a depth of 1.5 feet, and will be submitted for additional analysis relative to ACLs for petroleum spills. If an organic mat occurs at the surface, the mat will be removed before the soil sample is collected. Sampling will follow state and federal guidelines for analytical requirements. The laboratory will sieve the soil sample and conduct analysis on the less than 2 mm fraction. Sampling for surface soil will occur once, in August 2004, concurrent with sampling for the road and port areas if possible. Wherever possible, surface soil and vegetation samples will be collected from the same location.

Sediment sampling. Lake and tundra pond sediment samples will be collected from the top 0.5 feet of sediment by using lexan tubes, ponar dredge, eckman dredge, or hand troweling (depending on field conditions). The tundra pond and lake sediment sampling will be coordinated between the trace elements program and aquatic biological program. Sampling for tundra lake/pond sediments will occur once, in August 2004, concurrent with sampling for the road and port areas if possible.

The frequency of stream sediment sampling is different than lake/pond sediment sampling due to the dynamic changes expected from variation in stream flow. Stream sediment sampling will be carried out in close coordination with groundwater baseline hydrology and surface water quality work (Chapters 4 and 6). Specifically, stream sediment samples will be collected concurrent with surface water samples at 19 surface water monitoring stations (Table 7-2). The location of the surface water monitoring stations that will also be used for stream sediment sampling are presented in Section 4.1, Figure 4-1.

The concentration of trace elements in stream sediments is expected to be less dynamic than water chemistry variability; hence, sediment sampling will occur less frequently than for surface water quality sampling. Stream sediment sampling will occur two times in 2004 and once in 2005 to encompass the greatest variation in hydrologic conditions (i.e., flows vary due to breakup and storm events). The 2004 sampling events will occur in July and September to represent summer and autumn flows. The May 2005 sampling event will occur during spring breakup. The laboratory will sieve the sediment sample and conduct analysis on the less than 2 mm fraction.

Vegetation Sampling. The settling of dust on vegetation and plant uptake of trace elements are pathways of interest in the vegetation trace element characterization program. To consider dust on

plant surfaces, vegetation sampling will occur a minimum of four days after rain. Non-woody material will be collected from the plants by using clippers and placed into sealed plastic bags to ensure edible portions of the plant species are analyzed (i.e., leaves and browsable twigs and shoots). Each sample will be a composite within a taxonomic group (genus or species) from at least three plants listed in Table 7-1. Selection of these particular species will be based on overall dominance, bio-uptake potential, use as wildlife forage, and/or subsistence use, including traditional medicines. Sampling for vegetation will occur once, in August 2004, concurrent with sampling for the road and port areas if possible. The vegetation samples will be collected from the same areas as the surface soil samples.

Fish Sampling. Fish will be sampled for trace element analysis in two manners. Individual whole fish will be analyzed and two tissues within fish will be analyzed separately.

One or more key fish species will be selected for each drainage and/or monitoring site and sampled for tissue trace element concentrations. Fish will be sampled from 17 sampling locations on streams and two lakes. Juvenile salmonids, primarily coho salmon and/or rainbow trout, will be selected as key species when present. For juvenile fish collected from streams, whole body samples will be used and 15 fish from each key species will be collected for individual analysis to provide an adequate measure of variability. This results in 255 whole body fish samples for analysis.

In addition to juvenile salmonids, fish tissue sampling will include samples of northern pike because of its position as an apex predator, as well as Arctic grayling and/or whitefish because of their use in subsistence and sport fisheries. In the case of adult fish (northern pike, grayling, whitefish) that might be consumed by people, whole body samples will not be practical because of the size of the fish and the potential for false signals from tissues not normally consumed. Therefore specific tissues will be removed for analysis. It is suggested that liver and skeletal muscle tissue be used. Northern pike and other adult fish will be captured either by angling or gill nets. The whole fish will be frozen and shipped to the laboratory where the selected tissues will be removed and analyzed for trace elements. Grayling and whitefish will be captured using gill nets. For sampling resident fish in lakes, 10 fish of each species will be collected from each of two lakes and two organs will be analyzed (liver and muscle tissue). This results in 120 separate samples for trace element analysis.

Fish for tissue analysis will be collected in conjunction with the standard trap sampling, if practical. If necessary, another fish capture method may be used for the tissue sample. Individual sample fish will be placed directly into acid washed jars with minimal handling by gloved personnel, frozen at the earliest opportunity, and transported to an analytical lab using normal chain-of-custody procedures. Fish tissue sampling will occur once per year in the fall and will likely only be required at a subsample of monitoring sites.

Chemical Analysis

The matrices sampled at the mine site will be analyzed for parameters identified in Table 7-3. Appropriate laboratory QA/QC sampling will be conducted, and data will be validated by the NDM chemist. MRLs will be sufficiently low enough to detect risk-based concentrations of these constituents in the media of concern.

TABLE 7-3
Mine Site Surface Soils, Sediments, and Vegetation Sample Analysis

Analyte	Method
Surface Soils, Sediments, and Vegetation	
Hg	SW7471 (CVAA)
Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mo, Mn, Ni, K, Se, Ag, Na, Tl, Sn, V, Zn	SW 6010/6020 (ICP/ICP-MS)
Total Cyanide	E335.2
Chloride	E300.0
Fluoride	SM4500-FC
Sulfate	E300.0
Ammonia as N	E350.3
Surface Soils Only	
Total Organic Carbon	ASTM D4129-82M
Total Petroleum Hydrocarbons (biogenic "fingerprinting)	Gas Chromatography
Fish	
Sb, As, Cd, Cu, Pb, Ni, Se, Ag	SW6020 (ICPMS)
Hg	SW7471 (CVAA)

ASTM – American Society for Testing and Materials
E – Methods for Chemical Analysis of Inorganic Substances in Environmental Samples, EPA/600/R-93-100, August 1993 and Methods for the Determination of metals in Environmental samples, EPA/600/4-91-010, June 1991.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition.
SW – U.S. EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Third edition, September 1986.

7.1.2.3 Major Activities

Pre-field Planning: Prepare a Work Plan and Oversight

To ensure clear direction for field sampling and adequate QA, a work plan will be prepared containing a field sampling plan (FSP) and QAPP to be followed in the field. The trace element baseline characterization work plan developed by others for the road and port study areas will be reviewed, to ensure consistency across the sampling program.

Conduct Field Studies

Before soil and vegetation sampling begins, general sample locations in sections selected from the random grid system will be translated into longitude/latitude coordinates and transferred to an on-board, helicopter navigational GPS. This GPS data will be recorded in a format compatible with the existing GIS.

The field team will use the helicopter to locate each section, where up to three sample locations will be staked, flagged, and marked. Field teams will begin sample collection after about 20 sample locations have been laid out, with surveying ongoing.

Sample locations for stream and lake sediment and fish tissue will also be recorded by GPS.

Prepare Summary Report

A summary report will be prepared upon receipt of validated analytical laboratory results and will include:

- Data summary tables
- Sampling location figures
- Summary statistics for each landform and medium
- Statistical comparison of the differences between landforms
- Field photographs of sample locations
- Vegetation type descriptions, maps, and representative photographs
- Basic soil descriptions

7.1.3 Deliverables

The following project deliverables will be prepared during the trace elements studies to be conducted for the mine site.

- Technical memorandum on the study work plans for the road and port, providing recommendations on how to make the entire trace element baseline study consistent from mine to road to port while being statistically representative of conditions.
- Draft and final mine study area work plan.
- Draft and final summary report for mine site study.
- Technical memorandum describing senior review of draft summary reports for the road study area and the port study area.

7.1.4 Schedule

The schedule for collecting sediment, soil, vegetation, and fish samples in the mine site area is provided in Appendix A.

7.2 Road/Port Site

7.2.1 Objectives of Study

The objective of these studies is to characterize the baseline concentrations of naturally occurring constituents in surface soil, vegetation, fish, and stream and lake sediments within the road corridor and at the proposed port facility. In addition to characterizing area soil, vegetation, fish, and sediment types and chemical characteristics, baseline data will be used to evaluate the potential ecological effects of fugitive dust from the road and port facility, once constructed and in use. Trace elements are often detected in sediments at higher concentrations than the overlying surface water and often relate much closer to fish tissue data than water quality results.

7.2.2 Proposed Study Plan

7.2.2.1 Study Area/Scope

Two predominant soil types have been identified in the literature for the study area. From the mine site to the east side of Pile Bay, unconsolidated materials consist of outwash plains, terraces, and moraines. The soil is reported to predominately comprise well-drained gravelly material with interbedded coarse volcanic ash. Poorly drained, fibrous peat locally caps the sequence. From Pile Bay to Iniskin Bay, exposed bedrock predominates. The unconsolidated material is talus and locally derived glacial till in mountain foot-slopes and moraine hills. Soils consist of shallow silt-loam over gravelly loam or sandy loam with local, poorly drained, fibrous peat cover (Selkregg, 1976). The soil sampling effort will collect samples that are both representative of the predominant soil types encountered and will establish spatial distribution of trace elements along the road corridor and at the port.

Two predominant vegetation types have been identified from literature in the study area: high brush and upland spruce – hardwood forest. The west side of the study area, west of the Chekok River is reported to be a caribou winter range and the area east of the Chekok River is reported to have moose present year-round. Grizzly and brown bear are reported to be present along the streams where fish are present (Selkregg, 1976). Vegetation sampling is intended to define the types present and baseline trace element concentrations, particularly in and on vegetation that may be a food source for upland mammals, birds, or humans. In addition, vegetation used traditionally for medicinal purposes will be sampled.

The study area will include the preferred road corridor, when it has been identified by DOT&PF, between the mine site and Cook Inlet and will also include the area surrounding the proposed port site as shown in Figure 7-3. The corridor will be one mile in width along the defined alignment.

Sampling is intended to adequately characterize trace element concentrations in soils, vegetation, fish, and sediments along the road corridor and at the port site for current baseline conditions for the EIS and for evaluation of potential future ecological risks associated with dust migration.

7.2.2.2 Methods/Approach

Sampling activities are intended to characterize the entire length of the road corridor, and to be representative of the soil, vegetation, and sediments present along the route and at the port site. At the approximate sample collection area, the sample location will be selected to be representative to the most common soil and vegetation in the area. Location of each sample site will be determined using GPS and specified consistent with the project coordinate system.

Soil Samples

Soil samples will be collected during a single sampling event, planned for August 2004. Soil samples will be collected at regular intervals along the road corridor; one sample for every 4 miles, for a total of 19 sample locations (Figure 7-3). Six samples will be taken at the preferred port location once it has been identified by DOT&PF. Samples will be collected to characterize predominant soil types. Soil samples will be collected from the upper 0.5 feet below the soil surface following the same procedures used for the sample collection in the mine site.

The soil samples will be submitted to the project laboratory for the analyses listed in Table 7-4. At each sample location, the soil type and approximate amount of organic materials will be documented. If an organic mat is present, it will be removed before the soil is sampled.

TABLE 7-4
Road/Port Surface Soils, Sediments, and Vegetation Sample Analysis

Analyte	Method
Surface Soils, Sediments, and Vegetation	
Hg	SW7471 (CVAA)
Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mo, Mn, Ni, K, Se, Ag, Na, Tl, Sn, V, Zn	SW 6010/6020 (ICP/ICP-MS)
Total Cyanide	E335.2
Chloride	E300.0
Fluoride	SM4500-FC
Sulfate	E300.0
Ammonia as N	E350.3
Surface Soils Only	
Total Organic Carbon	ASTM D4129-82M
Total Petroleum Hydrocarbons (biogenic “fingerprinting)	Gas Chromatography

ASTM – American Society for Testing and Materials
E – Methods for Chemical Analysis of Inorganic Substances in Environmental Samples, EPA/600/R-93-100, August 1993 and Methods for the Determination of metals in Environmental samples, EPA/600/4-91-010, June 1991.
SM – Standard Methods for the Examination of Water and Wastewater, 20th Edition.
SW – U.S. EPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Third edition, September 1986.

Vegetation Samples

Vegetation sampling will occur during a single sampling event, planned for August 2004, to be performed concurrent with the soil sampling. Vegetation samples will be collected at regular intervals along the road corridor; one sample for every 4 miles, for a total of 19 sample locations (Figure 7-3). Six samples will be taken at the preferred port location once it has been identified by DOT&PF. Vegetation samples will be collected from the same location as soil samples.

At each sample site, a sample area encompassing a 10-foot radius from the soil sample location will be designated. Within each sample area, all vegetation species present will be documented. Up to four species will be sampled at each location, and may include moss, lichen, grass, shrub, or berry producing plants depending on type and density present. Vegetation samples will be collected following the same procedures as used for sample collection at the mine site.

The vegetation samples will be submitted to the project laboratory for the analyses listed in Table 7-4.

Sediment Samples

Stream sediment samples will be collected on three occasions, concurrent with surface water sampling events. Sample collection is planned for July and September 2004, and May 2005. Stream sediments will be collected at 16 locations (Figure 7-3). These locations will correspond to surface water sample collection sites as discussed in Section 6.3.

Five tundra ponds along the road corridor will be sampled to provide baseline characteristics of these sediments (Figure 7-3).

Sediment samples will be collected following the same procedures as used for the mine sampling.

7.2.2.3 Major Activities

Major activities are as follows:

- Data Review - Research, compile, document, and review existing data including past soil and vegetation studies, aerial photography, topographic maps, and other documents to determine target sample areas. Conditions at these locations will be visually verified in the field prior to establishing the sample point.
- Collect samples from the road corridor and port facility as described for each media above.
- Analyze field and laboratory data.
- Report results.

7.2.3 Deliverables

Following completion of the soil, sediment, and vegetation sampling effort, a report will be prepared. The report will include a listing of soil and vegetation types observed, vegetation density and other significant field observations, and analytical results in a tabular format. The report will include a discussion of results, trends, and an impact analysis in support of the project permitting.

Characterization of sediment data will be included in the surface water characterization report to be completed as described in Section 6.3. The report will list analytical results in a tabular format, and will include a discussion of results, trends, and an impact analysis in support of the project permitting.

7.2.4 Schedule

Key events for the trace element sampling program include:

- Sediment sampling - July and September 2004, and May 2005.
- Soil and vegetation sampling - August 2004.
- Preliminary soil and vegetation sampling report - October 2004.
- Preliminary sediment sampling report - May 2005 (with surface water quality report).

The environmental baseline studies project schedule is included in Appendix A.

8 Geochemical Characterization and ARD/ML

The geochemical characterization and acid rock drainage/metal leaching (ARD/ML) component of the study plan addresses the geochemical characterization of tailings and the mine rock facilities for the mine site. The term mine rock includes waste rock, waste rock to be used for construction, the walls and floor of the open pit and the stockpiles. There is no mine rock characterization study for the road or port. Steffen Robertson and Kirsten (Canada) Inc. (SRK) will lead the geochemical and ARD/ML work for the mine site.

8.1 Objectives of Study

This study program is designed to characterize the materials that will be produced from the mining and milling process with respect to geochemistry and, particularly, water chemistry. The data produced from the geochemical testing program will be used for prediction of tailings and mine rock water chemistry, and for the evaluation of alternative mine waste deposition plans for operation and closure. Thus, the overall objective of the geochemical characterization program is to provide data for assessment of environmental impact and for the design and mitigation measures to minimize potential for adverse environmental impact from mine rock (or mine waste) management facilities. It is well recognized in the mining industry that designing for sound environmental management can significantly reduce the potential for adverse environmental impacts and long-term environmental liabilities.

This overall objective will be accomplished through the sequences of activities summarized in Figures 8-1 and 8-2, and discussed in more detail in the following sections. The specific tasks to accomplish the overall objectives are to:

- Define the conceptual project description and project alternatives with respect to waste management, in order to design a representative sampling and testing program.
- Determine the amount and types of mine rock and ore that can be anticipated over the mine life based on the ultimate resource (potential pit limits).
- Develop a sampling program for existing drill core and for 2004 drilling program for mine rock, and similarly for tailings from the metallurgical testing program.
- Characterize the geochemistry and potential variability of the tailings solids and tailings water chemistry.
- Characterize the geochemistry and potential variability of the mine rock from the open pit through laboratory testing.
- Quantify the potential rate and extent of the geochemical reactions controlling drainage water chemistry for mine rock and tailings.

- Apply quantitative mathematical modeling techniques to these data to predict water chemistry from waste rock, open pit, and tailings facilities both during operation and at closure.

- Develop, and evaluate with respect to water chemistry and environmental impact, alternative waste/water management options for the waste rock and tailings facilities and for the open pit.

8.2 Proposed Work Plan

8.2.1 Study Area/Scope

The assessment of project geology for environmental geochemistry and mine waste management is focused on the Pebble deposit geology, with a lesser emphasis on the regional setting and geology. The sampling and characterization test work will be completed in detail for the mineable reserve that is defined as the basis for the feasibility study. This is currently defined as a resource of 1.5 billion tonnes. However, the sampling program also encompasses the total extent of the Pebble deposit, that is, including potential areas that may be included as part of the deposit as the exploration continues or as the mine develops. This potential is currently defined as 2.2 billion tonnes.

The environmental geochemical characterization program includes:

- Waste rock (including construction rock)
- Ore stockpiles
- Process tailings
- Open pit walls and floor rock
- Surficial materials in the vicinity of tailings and mine rock storage areas

This chapter of the baseline study program describes activities that are in part a baseline environmental program and in part an engineering program. The environmental aspects are emphasized in this study plan, namely the sampling and testing for the characterization of the mine rock and tailings. This characterization is then combined with the engineering design, and the mine plan and the site water balance are developed within the project engineering scope of work in order to predict the water chemistry throughout the site.

A critical element linking the two is the preparation of the conceptual site surface and groundwater flow model and the site water balance. The baseline data collected herein are used to calculate the conceptual site surface/groundwater flow model and the site baseline water balance. This balance is then used to develop the chemistry loading balance for operations and closure. The interaction of these components is shown in Figure 8-1 and Figure 8-2.

8.2.1.1 Mine Rock

The exploration work to date has been used to define a preliminary geologic model for the deposit, which provides the basis for the 2004 infill drilling program. Similarly, this geologic

model will be used as the basis for specific sample selection for mine rock for the preliminary design open pit limits. In addition to the detailed sampling for this design pit, the geologic model and resource estimation has been used to define the drilling and sampling required to characterize the mine rock for the potential ultimate open pit limits.

The actual pit limits, and therefore the amount/types of mine rock and tailings, will depend on the detailed exploration drilling program and feasibility analyses currently in progress. It is recognized that as drilling and resource modeling proceed, the defined reserve (i.e., the economic pit limits) may be less than the deposit size considered herein.

While it is recognized to be potentially conservative, it is considered to be reasonable to sample and test the maximum potential range of geologic materials, and therefore mine waste geochemistry, that may be encountered from the open pit over the ultimate mine life. Within this larger database, the study limits used for the water chemistry prediction and environmental impact assessments can be defined to address either the defined maximum mine plan and resource, or various interim pit development stages.

8.2.1.2 Tailings

The tailings geochemical characterization program will be done in parallel with the metallurgical program. Thus, as various alternatives for the milling process and ore types are evaluated in the metallurgical laboratory, samples of tailings solids and process water will be characterized with respect to environmental geochemistry. As a consequence, the scope of the tailings characterization program also may include a variety of tailings that are not representative of the final process flowsheet. However, as for the mine rock, this more comprehensive geochemical characterization program provides an additional benefit for project design, allowing environmental considerations to be included in selection of the preferred alternatives for both mine rock and tailings disposal.

8.2.2 Methods and Approach

The approach to the geochemical characterization programs is based on best practice industry methods for mine rock characterization comprising the following sequence of major activities:

- Definition of project description and geologic model to identify range of geologic units for sampling.
- Representative sampling of pre-2004 and 2004 drill core and metallurgical tailings samples.
- Staged geochemical testing comprising static and kinetic testing.
- Calculation of oxidation, neutralization, and metal production for each sample/material type in kinetic testing.
- Modeling of water chemistry for each of mine facilities (i.e., mine waste storage pile, tailings pond, tailings dams, open pit walls) using loading calculations and geochemical equilibrium modeling where appropriate.

- Incorporation of water chemistry predictions for each of the mine facilities into the overall site water balance and loading balance.

- Preparation of design, monitoring and mitigation plans, and environmental impact assessment.

This methodology is summarized in Figure 8-1 for tailings characterization and in Figure 8-2 for mine rock characterization. The central portion of each flowsheet shows the activities that are part of the mine rock geochemical characterization program. The other tasks, shown on the sides and in black, are those for which the input of other project team disciplines is required. The following section discusses the approach to each of the sampling, testing, and water quality prediction activities.

8.2.3 Major Activities

8.2.3.1 Activity 1: Sample Selection and Collection

Selection of representative samples for both mine and tailings is the most critical component of a technically sound and practical geochemical characterization program. Samples will be selected for testing mine rock and tailings of ore to quantitatively characterize the deposit in terms of the variables that can affect geochemistry:

- Geologic controls and resulting variations in geology/lithology/mineralogy and metal content

- Spatial distribution in deposit (aerial extent and depth)

- In situ weathering, oxidation, or mineral enrichment as a result of geologic processes

- Open pit design parameters including reserve estimate, total tonnages by rock type, strip ratio, pit wall geology

- Production schedule

- Processing alternatives

- Deposition alternatives

Site baseline sampling and testing also includes native soils and rock from the areas of tailings and mine rock storage to assess potential for attenuation of seepage from these facilities. These will be collected from the geotechnical test pit sampling program.

The geologic characterization and sampling program will be done in two main phases:

- Initial definition of geology and mine plan for design of 2004 sampling and testing program, based on the current geologic model.

- Evaluation as drilling and mine planning proceed over the 2004 exploration program to ensure complete representative of geology, mineralogy, and spatial distribution.

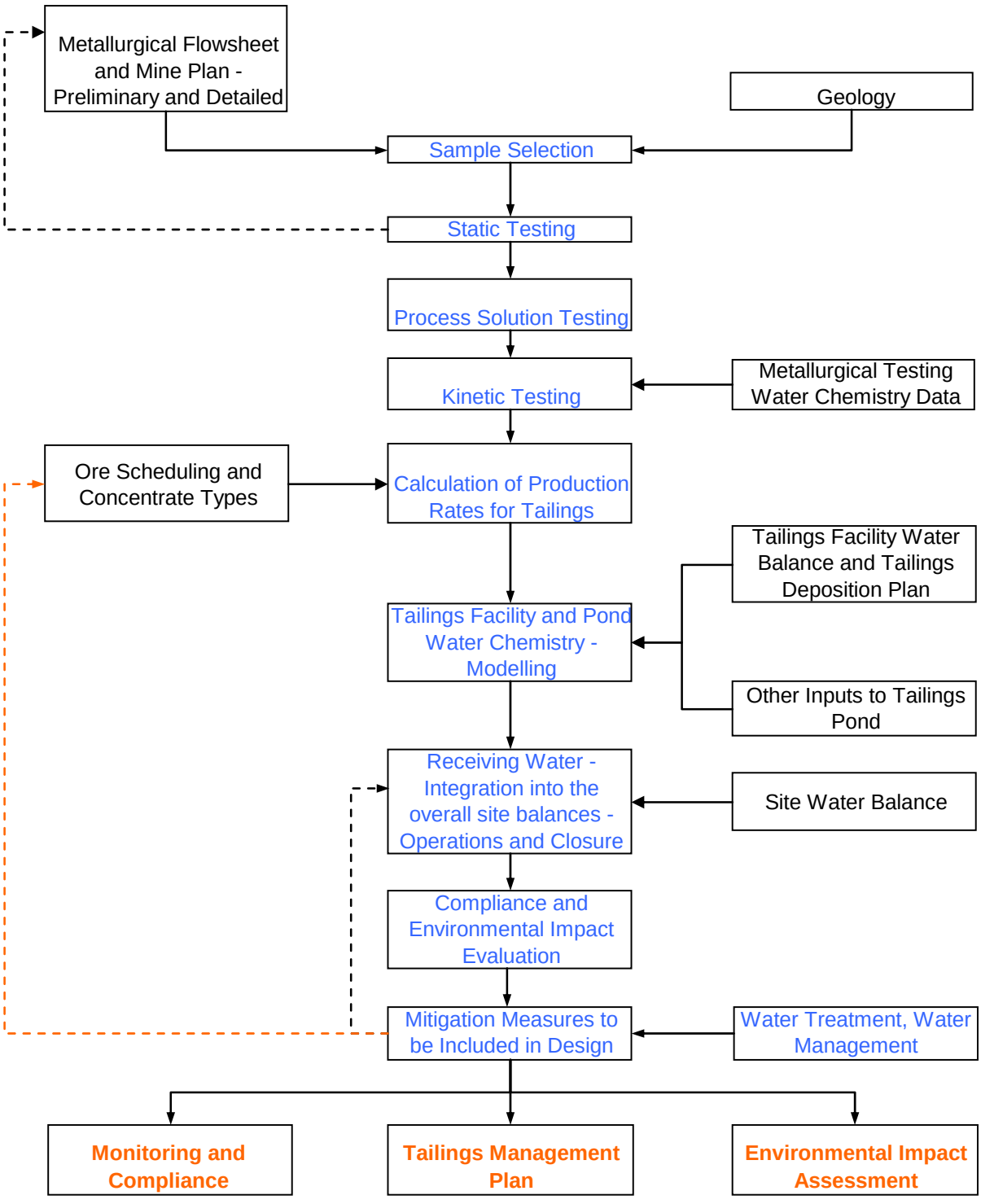


Figure 8-1: Characterization Program Flowsheet – Tailings

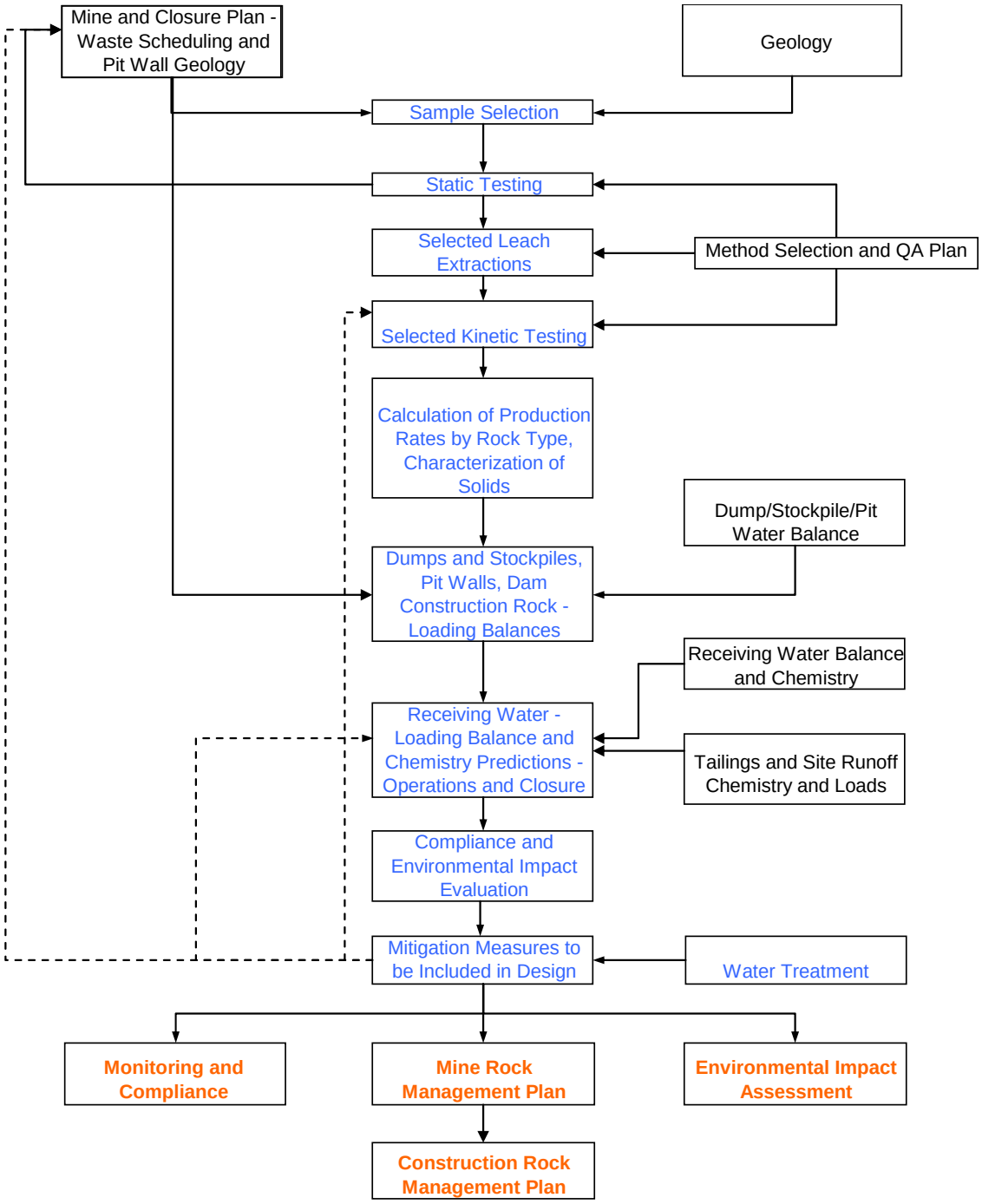


Figure 8-2: Characterization Program Flowsheet - Mine Rock

Based on the current geologic model, and the existing analytical information (for approximately 16,000 samples) from previous exploration programs, it is anticipated that up to 1,000 mine rock samples will be collected. These samples will be collected from both existing and fresh core. Of these, approximately 500 will be tested in the initial static testing program. It is anticipated at this time that a total of 25 kinetic tests will be conducted on waste rock samples. Testing of both older and fresh samples of comparable geology can provide valuable information on the weathering characteristics of the different rock types, and an empirical basis for calibration of water chemistry predictions for mine rock and pit walls.

Further samples will be selected for analysis as required to resolve any uncertainties or gaps in sampling to fulfill the criteria for representative sampling listed in the preceding section. Addressing the potential variability in the geology/geochemistry of the deposit as described earlier is the key to a representative sampling program. It is for this reason a large number of samples are collected and tested in a staged approach to ensure that there are no information gaps. It is not sufficient or appropriate to select the number of samples simply proportional to the amount of rock that each represents. Table 8-1 summarizes the approximate number and type of samples that will be collected from existing core and from the 2004 drilling program. Figure 8-3 shows the existing drillholes, and the holes from which samples will be collected for environmental geochemistry characterization. However, the sample selection represents the range of deposit characteristics listed above including spatial distribution and geology. It should also be noted all exploration geologic samples are logged in the field with respect to geology and alteration, and are assayed. These data are also available to this geochemical characterization program as will be the resultant geologic models.

Tailings samples will be collected from each stage of metallurgical testing (including batch testing and locked cycle testing) and each ore sample/composite, for both static and kinetic testing. It is anticipated that up to 12 kinetic tests will be conducted on tailings samples, depending on the disposal alternatives to be tested and the number of feed/tailings streams that are maintained throughout the metallurgical testing program. In addition, process water samples from within the milling process and of the final tailings solutions will be collected for detailed environmental analyses.

Sample selection and collection comprises the following activities:

Information Review

- Existing drill core and samples from previous drilling programs, existing geologic database and model information.
- Project description with respect to waste rock quantities, mine waste piles/stockpile sizes, construction rock requirements, pit wall geology, and mineralogy.
- Geostatistical analyses of drillhole data with respect to environmental parameters.
- Metallurgical program and geology with respect to tailings testing.
- Regulatory requirements and guidelines.

- 2004 planned drilling program including exploration, geotechnical metallurgical, and geoenvironmental holes for mine rock and pit walls.
- Definition of Deposit Geology and Mine Plan.
- Review of geologic database, core logging, availability of core and samples.
- Definition of additional drilling requirements.
- Identification of key parameters for geochemical testing and for baseline environmental monitoring.
- Incorporation of environmental geochemistry parameters and rock management criteria into geologic database (initial for sampling, revised for final design and operational management).
- Evaluation of surrogates and analyses for rock management (initial for sampling, revised for final design and operational management).
- Characterization of mine rock geology and distribution.
- Definition of pit wall geology for pit lake geochemistry.

Sample Collection

- Site visit to review available core, developing a specific understanding of the site geology as related to environmental geochemistry, and initiate sample collection.
- Tailings sampling including sample selection from batch metallurgical testing, and sample selection from detailed/design metallurgical testing. Samples provided by metallurgical testing laboratory.
- Mine rock sampling including sample selection and collection from existing core, pulps and rejects, and sample collection from 2004 drilling program. Samples collected by site geologists, using rigorous, agreed protocols consistent with geological sampling.

8.2.3.2 Activity 2: Geochemical Testing

Static and kinetic testing programs are designed to provide a complete and detailed characterization of the range of mine rock geology and mineralogy in the deposit. In addition, the test programs provide information for design and closure planning including assessment of mine waste management options (e.g., use of rock for construction, potential for co-disposal with tailings), pit wall geochemistry over time, and stockpile management. Thus, the kinetic testing program may be changed as results of the static tests are available. This is required to ensure that all key variables that will determine the geochemistry of the sample, and thus the required mine rock management measures, are addressed in the testing.

A detailed geochemical testing plan, complete with specific methods, number of samples, and laboratory procedures will be prepared for review for each of the static and kinetic phases of testing shown in the project schedule. The methods used for geochemical characterization of both mine rock and tailings will be consistent with international industry standards and protocols. There are additional procedures, or modifications to procedures, that provide important information for assessment of water chemistry and water management programs. The approach and principles described in the *EPA and Hardrock Mining, A Source Book for Industry in the Northwest and Alaska* document provides the basis for the testing program. The test procedures will follow ASTM, EPA, or MEND documented procedures.

The major activities in the mine rock testing program comprise:

Mine Rock Static Testing

- Phase 1 – Immediate testing of a small suite of samples to provide initial data for input into subsequent test work design.
- Phase 2 – Major phase of testing for input to mine rock characterization.
- Testing procedures include solids analysis by ICP and AA, acid base accounting (ABA) using standard and modified procedures, short-term leach extraction or contact testing.

Mine Rock Kinetic Testing

- Phase 1 – Initiation of a small number of tests to provide initial kinetic information.
- Phase 2 – Test program to address specific mine design questions and water quality prediction needs.

Testing procedures include humidity cells (ASTM), humidity columns for waste rock and, as required saturated columns or sequential kinetic tests for evaluation of disposal options such as underwater or co-disposal of mine rock and tailings.

The tailings characterization program is determined by the range of options evaluated in the metallurgical testing. Priorities for this program are to sample and test a representative range of tailings samples, including both solids chemistry and tailings (process) water chemistry within the tailings pond and for the tailings to be used for dam construction.

The same staged approach will be used for tailings characterization, with the exception that samples will be selected from the batch metallurgical testing on a large variety of ore types, composites, or processing methods. This will be followed by a second phase of testing on the products of the locked cycle tests that are anticipated to be conducted on a fewer number of ore samples that are considered by metallurgists and mine planning/geology to be representative of the deposit. The results of this approach will provide the data to assess alternatives for tailings deposition (number and type of facilities), tailings water management constraints, requirements for water treatment, and construction rock.

The major activities in the tailings testing program comprise:

Tailings Static Testing

- Testing of tailings samples from scoping testing of various process alternatives and metallurgical composites.
- Ongoing testing of tailings products from flowsheet design testing.

Tailings Kinetic Testing

- Testing of tailings samples from scoping testing.
- Testing of tailings products from flowsheet as testing is completed and modifications if required to address tailings management options.

Static and kinetic test results will be used to define the geochemical units that determine drainage water chemistry. These geochemical units may be the same as the lithologic definitions, or may also include factors such as alteration, metal content, location in pit, etc. From these definitions of the distinct geochemical units, the block model and pit designs will be used to quantify the amount of each unit in the pit walls and waste rock.

Data from the static and kinetic testing programs will be reviewed on a regular basis for quality management, and to evaluate the geochemical behavior of the materials.

Bench scale testing of aquifer materials from the Pebble site will be conducted. This will allow an estimate of the natural attenuation properties of these materials along potential groundwater flow paths downgradient from key facilities such as the tailings impoundment, mine rock storage areas, and the open pit. The results of this testing will be incorporated in the fate and transport model developed for the site.

8.2.3.3 Activity 3: Water Chemistry Prediction

The prediction of water chemistry will comprise three steps:

- Prediction of drainage water chemistry by rock type and then, using this, for each of the mine rock piles, tailings facility(ies) including the beaches, dams and the saturated tailings mass, and open pit walls.
- Geochemical modeling using commercially available or publicly available software.
- Incorporation of the predicted drainage water chemistry for each mine facility into the overall site water balance and loading balance.

For the open pit, water chemistry predictions will be made for various pit limits, periodically throughout operation and to the ultimate pit limits. Drainage water chemistry predictions will be made for waste rock to assess disposal requirements. Tailings pond water chemistry will depend on both the geochemical characteristics identified in the kinetic testing, and the process water characteristics identified in the metallurgical and static testing. Once the water chemistry

modeling predictions for each of the mine components are completed, these predictions will be incorporated into an overall site water and loading balance to assess the potential impacts on water chemistry from alternative facility designs.

The water chemistry modeling will use standard spreadsheets for calculations of loading, combined with geochemical modeling packages to address geochemical controls on water chemistry. The laboratory testing protocols will be selected to allow calibration and quantitative extrapolation of laboratory data to field conditions, based on both theoretical and empirical factors. Specific site calibration factors will be developed, where possible, from planned testing on existing older core samples as compared to comparable "fresh" core samples.

Protection of water quality both within the mine site and in the downstream receiving environment is a key consideration for project design. An initial assessment of water chemistry will be done in the fall of 2004, using the static and kinetic testing data. As the project design is refined and the geologic model is revised to include the 2004 exploration drilling, the specific quantities of ore/waste rock/pit wall rock can be defined and input to the water chemistry prediction models.

8.2.3.4 Activity 4: Design and Mitigation Alternatives

The water chemistry predictions will be done in two stages to allow incorporation of water chemistry into the assessment of project design alternatives as the project proceeds. This is, of course, an iterative process – estimates are made of potential water chemistry for various milling/design alternatives, and then the alternatives are refined to optimize water chemistry where possible.

A key component of the mine rock testing program is the development of this geochemical sampling and testing program in close conjunction with the exploration geology and resource modeling. This allows the development of a mine rock management program in the same way as the ore is modeled and scheduled for production. These activities are initiated from the start of the sampling program (as discussed earlier) and finalized with the results of the geochemical testing and water chemistry modeling – to enable the facilities to be designed to minimize the potential for oxidation and metal leaching as part of design. The specific additional activities that are required to link the geochemical testing programs with the mine design and environmental management include:

- Definition of Material Quantities and Alterative Mine Rock and Tailings Designs
- Development of Waste Rock (Tailings) Management Criteria
- Integration with Water Management and Tailings Deposition Plan

8.2.3.5 Activity 5: Evaluate Environmental Effects

The results of the water chemistry modeling will be used as the basis to evaluate potential environmental effects as a result of project development. These evaluations will be done in conjunction with the results of the environmental baseline study programs that characterize the existing environment. This evaluation includes not only water chemistry but also the related

uses of the water in the project area. This task is an iterative task, as shown in Figures 8-1 and 8-2, so that the project design can benefit from the information on environmental geochemistry.

8.3 Deliverables

The main deliverables from these activities comprises:

- Phase 1 Geochemical sampling and testing plan including numbers of samples and descriptions, test methods and laboratory procedures, quality management program specific to the geochemical testing procedures, and data handling protocols for the detailed static program and the proposed kinetic program.

- Phase 2 Geochemical sampling and testing plan, as above, for additional static testing and for the final kinetic testing program (based on results of phase 1).

- Draft geochemical testing data report(s) containing data, and data analyses. This report will contain all of the data from the static and kinetic testing interim progress reports and provide analysis of the data set to the report date.

- Draft geochemical mine rock characterization report containing interpretations of testing data, geochemical/geological characterizations, and water chemistry predictions for each component.

- Excel files for water chemistry prediction and loading balances for each mine component, and site loading balance.

- Environmental assessment of predicted water chemistry, potential mitigation measures, with respect to compliance objectives.

- Criteria for environmental management including:

    - Mine rock management program for construction and operations.

    - Operation and closure with respect to tailings solids/water chemistry.

    - Definition of tailings geochemical characteristics for dam construction.

    - Parameters to incorporate into geologic database and, where possible, block modeling for environmental geochemistry.

    - Potential surrogate parameters for mine rock management criteria and program for operations.

    - Final geochemical mine rock characterization report containing above draft reports and predictions, suitable for use in environmental impact assessment and permitting documentation.

As the project proceeds, interim technical memos will be produced at key project stages for discussion with the project team, consistent with the approach shown in Figure 8-1 and Figure 8-2.

8.4 Schedule

The timeline for the geochemical characterization program is included in the overall environmental baseline study schedule, Appendix A. It is essential that the mine rock characterization program is integrated into the project design and alternatives selection. Some of the key considerations in the logical progression of tasks include:

- The mine rock testing program will begin with static testing on samples of existing drill core, as soon as samples are available. If static testing shows that there are sufficient representative samples, some kinetic testing may also be initiated on these samples. Testing will begin in July 2004. The rest of the testing program will start as samples are available from the exploration program.

- The tailings testing program will be done in sequence with the metallurgical testing program, as soon as samples are available. If static testing shows that there are sufficient representative samples, some kinetic testing may also be initiated on these samples. Testing began in May 2004, and the rest of the testing program will start as samples are available from the metallurgical program.

- The open pit water chemistry prediction will use much of the same geochemical data as the waste rock and stockpile water chemistry predictions. This task will be done in conjunction with the waste rock modeling. As above, the schedule for predictions will depend on the receipt of design information for the mine plan and geologic descriptions of the pit walls.

- The kinetic testing will be reviewed as it is available (i.e., each cycle of kinetic testing) to ensure data quality and to understand the geochemical characteristics of the different rock units bring tested. A preliminary geochemical/loading model will be developed within the first three to six months of testing. These model results will be integrated with the tailings deposition, water balance, and tailings dam construction programs. The model will be finalized to reflect the design project parameters and metallurgical flowsheet design.

9 Terrestrial Wildlife and Habitats

ABR, Inc. – Environmental Research & Services (ABR) will complete the terrestrial wildlife and habitats work for the mine site, road, and port.

9.1 Mine Site

9.1.1 Objectives

This study program is designed to characterize the species, abundance, distribution, and habitats of terrestrial wildlife in the project's mine site area. The objectives are to describe the baseline conditions prior to mine development, and to provide input to the evaluation of preferred mine development options to minimize or prevent adverse impact on terrestrial wildlife and habitats. For the five major species components of this study program, the specific objectives are as follows.

9.1.1.1 Mammals

- This study element is designed to collect baseline data to supplement existing information from previously published and unpublished work in the region and to compile and analyze telemetry data previously collected by management agencies for use in impact analyses. Field survey data will provide site-specific information on these species to supplement the information gained from the literature review, thereby augmenting and strengthening the baseline data available for the project EIS.

9.1.1.2 Raptors

- The objectives of the raptor surveys are to determine the distribution and abundance of nesting raptors in the proposed mine area and to assess potential impacts on raptors from mine construction and operation. Special emphasis will be placed on protected or sensitive species, such as Bald and Golden eagles (Bald and Golden Eagle Protection Act), Peregrine Falcons (delisted Endangered Species), and Northern Goshawk. The major objectives are:

- Identify and map raptor nest sites and delineate important cliff-nesting raptor habitats in the region of the proposed mine.

- Compile a comprehensive list of raptor species nesting in, and utilizing, the region of the proposed mine.

- Develop strategies to avoid and minimize impacts to raptors in the area.

9.1.1.3 Waterfowl

- The objective of this study program is to determine the distribution, status, and relative abundance of waterbirds that might be impacted by activities in the mine site area. Emphasis

will be placed on waterfowl and waterbirds of special concern, including both species of swans, Harlequin ducks, and loons.

9.1.1.4 Breeding Birds

- To assess landbirds and shorebirds that cannot be surveyed from the air. These breeding bird surveys are designed to:
- Determine which landbird and shorebird species breed in the area of the mine site.
- How common these species are.
- Which habitats they use during the breeding season.

9.1.1.5 Habitat Mapping

- The classification and mapping of wildlife habitats in the Pebble Mine vicinity will be used to assess the potential impacts of mine construction and operation on the habitats of breeding birds (including raptors) and mammals.

9.1.2 Proposed Study Plan - Mammals

9.1.2.1 Study Area/Scope

Aerial surveys for large mammals, analysis of existing telemetry data, analysis of ADF&G harvest data, and a local mammal sightings log will be the primary methods used in this study. The aerial survey area will encompass the mine site and tailings/mine rock disposal sites, plus an additional buffer distance of up to 3 miles around those sites.

The principal mammal species of interest with regard to the Pebble Project is caribou – it is the most abundant large mammal in the region and one that is vitally important both for subsistence use and sport hunting. The mine and access route options are located within the annual range of the Mulchatna Herd, the second largest herd in the state. One of the hallmarks of the Mulchatna Herd has been the unusual and substantial variation it has shown in range use within the last 15 years. In previous years, the mine area was thought to host a small number of resident caribou and to provide locally important calving habitat and occasionally winter range. In the years since then, the herd also has used the area during the post-calving aggregation period and the rut. Field information regarding use of the mine area by caribou will be obtained for the following seasons: late winter/spring, calving, post-calving aggregation (early summer), fall migration/rut, and early winter.

Other large mammal species are important residents of the mine area as well, and will be included in our surveys. Brown bears are abundant in southwestern Alaska and black bears also occur in the project region. Winter concentrations of moose have been noted previously (as described in the ADF&G Habitat Management Guides) in the Upper Talarik Creek drainage. These species will be included in our surveys along with others encountered incidentally (e.g., furbearers).

9.1.2.2 Methods and Approach

Several lines of inquiry are being pursued in this study:

- Field surveys, emphasizing aerial survey by fixed-wing airplane and, to a lesser extent, by helicopter.
- Analysis of regional telemetry data.
- Analysis of regional harvest data.
- Solicitation of mammal sightings in the project area by other personnel working on the baseline studies program.

9.1.2.3 Major Activities

Aerial Surveys

The primary method used to survey large mammal species in the mine area will be systematic aerial surveys of strip transects (spaced at 1-mile intervals on USGS section lines; Figure 9-1) in a fixed-wing airplane (Cessna 206 or similar). The size of the survey area was chosen to encompass the mine site and the potential tailings and mine rock disposal alternatives, plus an additional buffer distance of up to 3 miles around those sites to approximate the area within which maternal caribou with calves potentially might be displaced due to mine activities (applying research findings from northern Alaska oilfields and mines). The primary species of interest is caribou, but all species of large mammals will be recorded and mapped opportunistically whenever encountered on each survey. Two additional surveys will focus primarily on other species (bears in late July/early August and moose in late November), but will record caribou at the same time.

All surveys will use two observers, each viewing an 875-yard-wide transect strip, and data will be recorded by a third person, preferably a local resident (e.g., from a subsistence council or panel). Complete sampling coverage of the survey area will be obtained. The airplane will be flown at an airspeed of 85–90 knots and an altitude of 500 ft above ground level (agl) (occasionally higher as dictated by terrain) for all surveys. All mammal locations will be recorded using a GPS receiver for portrayal on GIS map figures and basic data will be noted (number; sex/age, when possible; activity; direction of movement).

In addition to the six seasonal fixed-wing surveys, at least one additional survey will be conducted by helicopter specifically to search for and examine bear dens in the mine area and to look for seasonal concentrations of bears along anadromous fish streams in the mine area. The helicopter survey will be scheduled within a day after the fixed-wing survey in late July/early August. Locations of suspected bear dens will be solicited from other project personnel for examination during this survey.

Telemetry Data Analysis

An important element of the mammal study will be analysis of existing telemetry data for caribou, bears, and moose obtained previously in the project region by state and federal resource

agencies. These data constitute an extremely important base of information for use in the environmental baseline report (and thus eventually in the project EIS). The intent is to work cooperatively with ADF&G and USFWS to perform these types of project-specific analyses, using fixed kernels and other methods of GIS analysis to summarize and depict seasonal distribution patterns of various species in relation to project facilities. Successful application of these methods will depend on cooperation with agency biologists to identify and obtain permission to work with existing data sets. We are fully aware of potential sensitivities regarding access to such data. If required, memoranda of understanding will be established regarding which data are to be used and for what purpose, as well as how they are to be analyzed and presented. The need for such data and agreements on how to handle and analyze them will be an important topic for agency scoping meetings and follow-up meetings with agency biologists.

Harvest Data Analysis

We will request harvest data from ADF&G on mammal species in the project region to provide background on human use of mammal species. Furbearer harvest data also provide important background information on the distribution and abundance of these species, which can be difficult to enumerate using field methods, in the project area. This effort will be coordinated with the subsistence task for the project to further document harvest levels and locations in the project area.

Wildlife Observation Logs

To take advantage of and solicit input from other contractors working on the project, wildlife observation log sheets will be posted prominently in common locations at camps for workers to record miscellaneous sightings of wildlife encountered anywhere in the project area. This approach, which greatly expands the number of potential observers, was used successfully at the Pogo Mine in interior Alaska and produced useful information for the environmental baseline report and EIS by taking advantage of the presence of other observers when survey biologists were not present. The effectiveness of this system can be increased by having wildlife survey crews give informal talks while at the work camp to explain the research program to other workers. Observation log sheets will be distributed in electronic form to other contractors to solicit their input as well.

9.1.3 Proposed Study Plan - Raptors

9.1.3.1 Study Area/Scope

The study area in 2004 will include all suitable woodland and cliff habitat available for nesting raptors at the mine site and all the original waste rock disposal alternative sites (Figure 9-2). Suitable habitat within one mile of the outer boundaries of these areas also will be surveyed. Large, suitable habitat features (such as large cliffs or drainages) greater than one mile from the outer boundaries also will be surveyed when adjacent to the boundaries.

Several raptor species have been included in pre-development baseline studies because of their legal or conservation status. Bald Eagles and Golden Eagles are emphasized because they are afforded special protection under the Bald and Golden Eagle Protection Act. The American

Peregrine Falcon subspecies, whose range may include the Lake Clark–Iliamna region, was delisted as an endangered species in 1999. It is included in our baseline studies, along with other cliff-nesting raptors, because of continued agency interest in their populations and sensitivity to disturbance. All cliff nesting raptors (including the coastal subspecies of Peregrine Falcon) will be identified during the cliff-nesting surveys for Golden Eagles. Other tree-nesting species (e.g., Northern Goshawk) may be identified during pre-leaf out surveys for Bald Eagles.

The Northern Goshawk is a State of Alaska Species of Special Concern in southeast Alaska. Although nests of Northern Goshawks may be discovered during surveys for Bald Eagles, more intensive coverage of woodland nest sites is often necessary to locate nests of this species. An aerial survey will be conducted to search for Northern Goshawks within approximately ½ mile of the proposed transportation corridor between the mine and Newhalen River. However, because nests in coniferous woodlands are difficult to detect from aircraft, this survey will provide a conservative estimate of sites. Play-back recordings (of goshawk calls) in such a large area are cost-prohibitive and premature. These would be considered only to determine Northern Goshawk territories after a final road alignment is selected (playback surveys could help locate specific nest sites and allow for avoidance of nests).

9.1.3.2 Methods and Approach

This work will be accomplished through a combination of:

- Aerial surveys in the mine area.
- Literature and agency file review to collect information on raptors in the region and other known nest sites.

9.1.3.3 Major Activities

Two aerial surveys of suitable nesting habitats will be conducted by helicopter in the mine area to identify large raptors nesting in the area:

- Suitable nesting habitats include cliffs for Peregrine Falcons, Gyrfalcons, and Golden Eagles, and trees for Bald Eagles and other woodland raptors, including Osprey, Northern Goshawks, *Buteo* hawks, and Great-horned Owls.
- Surveys will be conducted during the arrival and early nesting (incubation) stages for these species (late April–late May). The first survey will before deciduous tree leaf-out (late April-early May) and will be used to identify the nests of tree-nesting species, particularly the Northern Goshawk and Bald Eagle. The second survey will occur at least two weeks later and will be used to identify cliff-nesting raptors, particularly Gyrfalcons, Peregrine Falcons, and Golden Eagles.
- Low level (~150 ft agl) helicopter survey of suitable forest stands, cliffs, banks, and islets: two observers seated on the same side of the aircraft will scrutinize woodlands and cliffs for nesting raptor use (stick nests, ledges, aggressive or perched birds). Multiple passes of some habitats may be necessary (cliffs). SOPs include flying shorelines of the ocean, lakes, streams, and areas of substantial relief.

- SOPs for goshawks, bald eagles, and other tree-nesting raptors will include flying to good woodland stands, along creeks, on hillsides, and along lake edges. All islets and islands will also be searched. Flight will include appropriate angle to look into stick nests.

- SOPs for cliff-nesting species habitat searches include angling toward the cliff or bank area at least 0.50 miles from the site and slowly approaching the cliff area. Search for all whitewash, stick nests, perched and flying birds, and areas of orange-crustose lichen. When a nest or suggestions of nesting occur (aggressive pair), observers will get a location and take a digital picture of the site. Sites will be enumerated chronologically as they are found.

- All observations of raptors will be recorded on USGS topographic maps (scale 1:63,360) or aerial photos. Locations also will be recorded using an onboard GPS receiver.

- Information recorded at each site will include species present, physical characteristics of the nest site, brief habitat description, occupied status, and numbers of birds observed.

9.1.4 Proposed Study Plan - Waterfowl

9.1.4.1 Study Area/Scope

The study area will include all suitable wetland habitats available for migrating, staging, nesting, and brood-rearing waterbirds at the mine site and all the original waste rock disposal alternative sites (Figure 9-3). Suitable habitat within one mile of the outer boundaries of the mine site will also be surveyed.

Important waterbird species in the area include Tundra Swans and possibly Trumpeter Swans, and a diverse assemblage of diving ducks. River deltas in the area (proposed port sites, Iliamna Lake) may serve as migration stopovers in spring before region-wide breakup. The Alaska Peninsula and the Lake Iliamna region are important migration routes for many bird species moving to and from breeding areas in western and northern Alaska and eastern Asia.

Harlequin Ducks are likely to breed in the study area and winter on nearshore waters in the Kamishak Bay region. The Harlequin Duck was formerly listed as a species of concern by USFWS (Category 2 candidate species). Although its current conservation status is unclear, it has received recent attention by resource agencies, particularly because it has been identified as a species not fully recovered from the *Exxon Valdez* Oil Spill.

9.1.4.2 Methods and Approach

These objectives will be carried out by:

- Conducting aerial surveys of all water bodies to determine the distribution and abundance of waterfowl and waterbirds during spring and fall migration, nesting, and brood-rearing.

- Describing species composition and the selected use of lakes, rivers, and wetland areas in the mine site area.

- A literature and agency file review to collect information on waterfowl in the region.

A combination of fixed-wing, helicopter, and ground surveys will be used to determine the composition of breeding waterbirds in the area, and to identify areas of high use during nesting and migration/staging in the mine region.

9.1.4.3 Major Activities

During each survey, the field team will count and map the distribution and abundance of waterbirds seen on lakes, rivers, and wetland areas.

- For migration and staging surveys, low-level, fixed-wing aerial surveys will be flown every 8–10 days during spring (4 surveys, 20 April–25 May) and fall (4 surveys, 10 September–20 October), along a pre-selected route covering upland lakes in the mine area. Lakes will be grouped as survey units based on relative closeness and other topographic features. One or two observers (depending which aircraft [Cessna 206 or Piper Cub] proves the better survey platform) will gather information on habitat conditions, flock size, and species composition. The survey will be flown lake-to-lake and the route will be tracked using a GPS.

- For the breeding pair survey, a fixed-wing aircraft will be flown in early June similar to the annual breeding pair surveys flown near Bristol Bay by the USFWS. A series of transects will be flown guided by GPS in the most dense lake areas in the Upper Talarik Creek and Koktuli River basins. Data gathered will include species, estimated numbers, and observation type (e.g., male, pair, flock). In addition, a helicopter will be used to detect pre-breeding pairs of Harlequin Ducks along streams in the mine area. Observations will be recorded on topographic maps and with an onboard GPS receiver. Surveys will occur in concert with cliff-nesting raptor surveys in late May/early June.

- The brood-rearing survey will be undertaken in mid-July. A helicopter will be used to visit a sample of lakes in the mine area. Observations will be made from the helicopter, but at larger lakes, the helicopter may drop off two observers who will then circumnavigate the lake on foot and count broods. Data collected will include species, numbers, brood-size, and age.

9.1.5 Proposed Work Plan – Breeding Birds

9.1.5.1 Study Area/Scope

The study area in 2004 will encompass all proposed facilities expected to be developed at the mine site, including the mine site itself, internal mine roads, mill sites, and waste rock sites. Surveys will be focused on the use of habitats in and around the areas proposed for development (see Figure 9-4).

Information is limited on the bird species that nest in the area of the proposed Pebble Mine, but several species of passerines that are considered conservation priority species for Alaska are likely to occur. These include Northern Shrike, Gray-cheeked Thrush, Varied Thrush, Blackpoll Warbler, Golden-crowned Sparrow, and possibly others. Breeding information also is sparse for shorebirds, but likely species that are of conservation concern would include Wandering Tattler, and perhaps Hudsonian Godwit and Short-billed Dowitcher. It will be important in the permitting process to establish baseline breeding data for the Pebble Mine.

9.1.5.2 Methods and Approach

Breeding landbirds and shorebirds in the mine area will be surveyed in June 2004, using a combination of point counts to locate singing or calling birds and circular study plots to locate cryptic ground-nesting shorebirds. Wildlife habitats for each observation will be recorded in the field to determine the habitat associations of breeding birds in the area.

Habitats to be sampled will be determined from existing land-cover data for Lake Clark National Park (which covers a portion of the mine site), from 1970s–1980s color infrared aerial photography, and from 1990s true color aerial photography for the area. (The 2004 aerial photography for the mine will not be available until late 2004.)

Point counts (used to detect singing male passerine birds defending territories) will be conducted to record all species seen or heard within standard 10-minute intervals at each sample point location. All observations will be categorized in estimated distance categories to allow density calculations. These point-count data will yield the number of species and individual birds found in each habitat type at each point-count location. These data will be presented as densities, if the data are sufficient to allow density estimates. Otherwise, the data will be presented as birds per point. The locations of all nests discovered opportunistically will be recorded with a GPS receiver; dedicated nest searching is not planned. The field team will conduct point counts at several locations in each major habitat type at the mine site to quantify the natural variability in bird species and numbers occurring in each habitat type. At this time, it is unclear how many habitat types occur at the mine but 80 point counts has been assumed at this time. Point counts will be focused in those areas likely to be developed (the mine site itself and the waste management area most likely to be used).

Circular study plots will be used in open habitats where cryptic ground-nesting shorebirds may occur. Plots of 157 acres (1476-ft radius) will be used, where two observers will record all species seen or heard as the observers, working simultaneously, walk the area in concentric circles around the plot center. These circular plot data will yield species present and densities of birds. No specific attempt will be made to locate nests of any species as this requires a much more substantial effort. As in the point-count sampling, however, all nests found coincidentally will have positions recorded using GPS.

9.1.5.3 Major Activities

Major activities for this work will include:

- Identifying the species occurrence and abundance of breeding landbirds and shorebirds in the mine area.

- Determining the habitat associations of landbirds and shorebirds in the study area.

9.1.6 Proposed Study Plan – Habitat Mapping

9.1.6.1 Study Area/Scope

The habitat mapping and evaluation area will be a contiguous area including the mine site, the potential mill site(s), three potential tailings storage areas, and a buffer area around all these sites

(Figure 9-4). The total area to be mapped will be ~60,300 acres. The actual area to be mapped may change as project plans develop further and study areas will be refined as necessary to accommodate any changes.

9.1.6.2 Methods and Approach

These objectives will be met by:

- Classifying, mapping, and quantifying the area covered by various habitat types.
- Identifying the importance of these habitats to wildlife species (using survey data specific to the mine, see above).
- Quantitatively assessing the area of each mapped wildlife habitat that could potentially be affected by mine construction using GIS.

Wildlife habitats will be classified and mapped by stereoscopic interpretation of true-color aerial photography. In addition, photo interpretation will be augmented, as required, with NASA high-altitude color infrared (CIR) photography, primarily to verify scrub habitats and partially vegetated areas, both of which may be common in the project area. Habitat boundaries will be mapped digitally on-screen with ArcGIS software, using orthophotos and/or orthophoto mosaics for the area. Each map polygon will be coded with a vegetation (land cover) type, a surface form type, and a provisional wildlife habitat type. Wildlife habitats then will be formally derived by combining land cover types and surface form types using wildlife habitat classification systems developed by ABR biologists for similar forest and tundra regions in Alaska. These mapping classification systems have been effectively used in mountainous and lowland terrain similar to that of the Pebble Mine project area, at Fort Richardson in southcentral Alaska.

All wildlife habitat mapping will be supported by ground reference data for the area. To collect ground reference data, field surveys will be conducted in the project area in August 2004. The goal of these surveys is to verify vegetation and surface form information for several sample sites representing each photo-signature (up to 5 sites per photo-signature), and to examine, on the ground, those photo-signatures that are difficult to interpret. Sites will be accessed by helicopter and on foot, and located by navigating to pre-determined GPS locations. At a minimum, each site visited, the dominant plant species will be assessed visually and vegetation and surface form types recorded. Any wildlife observations, including wildlife sign, will be recorded at each site. Documentary photos will be taken at each survey location.

To determine impacts to wildlife habitats, the high-value habitat(s) will be determined for a number of species in the mine region (including mammals, raptors, waterfowl, landbirds, and shorebirds, as noted above). Using data from the 2004 wildlife surveys in the mine region, and from a review of the literature, the most important habitats for these species will be determined. Following this, project facility outlines will be overlain (in GIS) on the wildlife habitat map of the mine region. Finally area figures will be calculated for the high-value habitats of mammals, raptors, waterfowl, landbirds, and shorebirds that will be affected by mine construction. In the impact assessment for wildlife habitats, existing land-cover data for Lake Clark National Park and Preserve will be used. These public-domain data are coarse-scale (30-m pixels) and the land-cover classes are general, but the data do cover a broad region surrounding and including

the mine site. In addition to evaluating impacts on a local scale at the mine site, these Lake Clark land-cover data will be used to evaluate the impacts to wildlife habitats in a broader, landscape-scale context.

9.1.6.3 Major Activities

The major activities for this work will include:

- Field surveys to collect ground reference data to aid in identifying photo signatures.
- Digital mapping of wildlife habitats.
- An evaluation of wildlife use of the mapped habitats.

9.1.7 Deliverables

The primary deliverable will be a technical report that covers terrestrial wildlife and terrestrial wildlife habitats in the mine area. Each component (mammals, raptors, etc.) will constitute a separate chapter in the technical report. The bulleted list for each species component below identifies the specific information that will be presented in the chapter for that component.

9.1.7.1 Mammals

- Literature review of published and unpublished information and data on mammal species, populations, movements, and habitat use in the mine area.
- Description of survey methods, data collection techniques, and data analyses.
- GIS-based map graphics displaying the locations of all mammals observed during aerial surveys of the mine area, as well as incidental observations collected by project personnel working on other tasks.
- GIS-based map graphics presenting the results of project-specific analyses of existing agency telemetry data for the seasonal distribution of caribou and, if available, other large mammals, as agreed to under a memorandum of understanding with the agencies.
- Data tables presenting baseline data and analytical results.
- Discussion of potential impacts of mine area on mammals.
- Suggestions for potential measures to mitigate project impacts on mammals.

The draft report will be completed by May 31, 2005.

9.1.7.2 Raptors

- Literature review of published and unpublished information and data on raptor species and habitat use in the mine area.

- Text summarizing methods, study areas, and results of these surveys, as well as discussion comparing relative distribution and abundance and species recorded in 2004 with historical or regional summaries.

- Maps depicting the location of cliff-nesting and arboreal nesting raptors, particularly Bald and Golden eagles, Peregrine Falcons, Gyrfalcons, Rough-legged Hawks, and osprey.

- Maps characterizing potential nesting habitat for these same species.

- Discussion of potential impacts on raptors in the mine area.

- Suggestions for potential measures to mitigate project impacts on raptors.

9.1.7.3 Waterfowl

- Literature review of published and unpublished information and data on waterfowl species and habitat use in the mine area.

- Text summarizing methods, study areas, and results of all surveys, as well as discussion comparing the relative distribution and abundance, distribution and species richness in 2004 with other similar regions.

- Characterization of species abundance, richness and distribution of waterbirds in the mine area during spring and fall migration, nesting, and brood-rearing.

- Tables comparing the relative density of breeding waterfowl in the mine area with USFWS strata for other regions.

- GIS figures showing distribution and species composition of waterfowl and waterbirds during spring and fall migration, nesting, and brood-rearing.

- Discussion of potential impacts of mine site and road/port development on waterbirds in the mine area.

- Suggestions for potential measures to mitigate project impacts on waterbirds.

9.1.7.4 Breeding Birds

- Literature review of published and unpublished information and data on breeding landbird and shorebird species and habitat use in the mine area.

- Characterization of the relative abundance and distribution of landbirds and shorebirds within the mine area using point count methodology.

- Tables and figures depicting breeding bird distribution and species abundance within specific habitat types.

- GIS figures showing locations of breeding birds and their nest sites (if available) in the mine area.
- Discussion of potential impacts on landbirds in the mine area.
- Suggestions for potential measures to mitigate project impacts on landbirds and shorebirds.

9.1.7.5 Habitat Mapping

- A report including wildlife habitat maps at a scale appropriate to the final mine development area selected by NDM.
- An evaluation of the use of each habitat type by wildlife based on 2004 field survey data and a literature review.
- Summary tables and maps illustrating the total area of wildlife habitats to be affected by construction in the mine area, as well as the individual wildlife habitat types affected.

9.1.8 Schedule

The timeline for the terrestrial wildlife and habitat assessment work is included in the overall environmental baseline study schedule, Appendix A.

9.1.8.1 Schedule - Mammals

- Mid-April 2004: Aerial surveys for caribou (late winter/spring migration) and bears (den emergence).
- Mid-May 2004: Aerial surveys for caribou and moose (calving).
- Late June–early July 2004: Aerial surveys for caribou (post-calving aggregation).
- Late July–early August 2004: Aerial surveys for bears (fish spawning stream use and den checks).
- Mid-October 2004: Aerial surveys for caribou (rut/fall migration).
- Late November 2004: Aerial surveys for caribou and moose (early winter).
- May 2005: Draft report submitted.

9.1.8.2 Schedule - Raptors

- April 2004: Aerial survey for tree-nesting species (pre-leaf out).
- May 2004: Aerial survey for cliff-nesting species.
- May 2005: Draft report submitted.

9.1.8.3 Schedule - Waterfowl

- April–May 2004: Aerial survey for spring migration use areas.
- May–June 2004: Aerial survey for breeding pair distribution.
- July 2004: Aerial survey for Brood-rearing groups.
- September–October 2004: Aerial survey for fall migration use areas.
- May 2005: Draft report submitted.

9.1.8.4 Schedule – Breeding Birds

- June 2004: Field surveys for breeding landbirds and shorebirds.
- May 2005: Draft report submitted.

9.1.8.5 Schedule – Habitat Mapping

- August 2004: Field surveys for wildlife habitat data.
- November 2004–April 2005: Digital mapping of wildlife habitats and analysis.
- May 2005: Draft report submitted.

9.2 Road/Port

9.2.1 Mammals

The objectives, methods, schedules, and deliverables for the mammal surveys and studies to be conducted in the region of the road and port site for the Pebble Project are identical to those described for the Mine Site (Section 9.1.1.1). The survey area will encompass the proposed road and port site options. The timing of surveys will be identical and the same aircraft, flight crew, and procedures will be used as in the mine area transect surveys. Instead of systematically spaced transects, however, the flight line will follow a GPS track of the access route, with observations recorded in 875-yard-wide strips on each side of the airplane and a survey altitude of 500 feet agl. The helicopter survey for bears in late July or early August will extend a half-mile upstream and downstream of all fish-spawning streams crossed by the proposed road route.

9.2.2 Raptors

The objectives, methods, schedules, and deliverables for the raptor surveys to be conducted in the region of the road and port site options for the Pebble Project are identical to those described for the Mine Site (Section 9.1.1.2). The only difference is the study area in this case will be a corridor of at least one mile on either side of the centerline of proposed road alignment and the proposed port sites.

9.2.3 Waterfowl

The objectives, methods, schedules, and deliverables for the waterfowl surveys to be conducted in the region of the road and port site options for the Pebble Project are identical to those described for the Mine Site (Section 9.1.1.3). The only difference is the study area in this case will be a corridor of at least one mile on either side of the centerline of proposed road alignment and the proposed port sites, and during spring and fall migration, outlets of rivers flowing into Iliamna Lake will be surveyed for staging waterbirds.

9.2.4 Breeding Birds

No field surveys for landbirds and shorebirds will be conducted along the proposed road or port site options. Instead of field surveys, bird occurrence and habitat use information from areas studied near the road corridor (primarily in Lake Clark National Park and Preserve) will be analyzed.

9.2.5 Habitat Mapping

The objectives, methods, schedules, and deliverables for the habitat mapping to be conducted in the region of the road and port site options for the Pebble Project are identical to those described for the Mine Site (Section 9.1.1.5). The study area in this case, however, will be a 1,312-foot-wide corridor centered on the proposed road alignment, as well as in areas to be affected by port site development. The total area to be mapped will be approximately 18,700 acres.

9.2.6 Deliverables

The primary deliverable will be a technical report that covers terrestrial wildlife and terrestrial wildlife habitats in the region of the road corridor and port site options. Each species component (mammals, raptors, etc.) will constitute a separate chapter in the technical report.

The deliverables for mammals, raptors, waterfowl, breeding birds, and habitat mapping will be the same as described in Section 9.1.7 for these species components, except they will address the areas surveyed for the road corridor and port options.

9.2.7 Schedule

The schedule for the terrestrial wildlife and habitat assessment work for the road corridor and port options is included in the overall environmental baseline study timeline, Appendix A. For mammals, raptors, waterfowl, breeding birds, and habitat mapping the schedule will be the same as shown in Section 9.1.8.

10 Wetlands

The objectives, process, and deliverables for the mine site, road, and port options are the same except where noted below. Work on the mine site and the road and port sites meet the stated objectives of the wetlands work program. Three Parameters Plus (3PP) will lead the wetlands work on the mine site while providing oversight of the wetlands work at the road and port, and HDR Alaska, Inc. (HDR) will complete wetlands work for the road and port.

10.1 Objectives of Study

The main objective of the wetlands study is to collect baseline data necessary to prepare and submit legally defensible Preliminary Jurisdictional Determination (PJD) reports to the USACE Regulatory Branch. These documents, one for the mine and one for the road/port sites, will be prepared and submitted to the USACE when project plans and options have been adequately defined and evaluated.

10.2 Proposed Study Plan

10.2.1 Study Area/Scope

Existing data for both the mine and road project areas will be compiled in the project GIS for approximately 750,000 acres between the Iniskin Bay port sites and the upper Koktuli Watershed. Chapter 19 (Data Management and GIS) provides additional information on this effort. Work specifically underway to support the wetlands program includes digital presentation of the following:

- Existing National Wetland Inventory (NWI) mapping.
- EROS land cover mapping and vegetation/land cover types associated with the Bristol Bay Land Management Plan.
- Vegetation mapping/cover classes found on the Lake Clark National Park web site.
- Ortho mosaic coverage of the 1978 NASA color infra-red photography.
- True color ortho photography and associated contour data (2 – 10’ depending on the complexity of the terrain) for the mine area.
- Watershed boundaries as previously determined by the Bristol Bay Native Corporation.
- Exploratory Soil Survey Data and other data sources related to soil types and parent materials.

In addition to the GIS layers, crews may complete preliminary mapping directly onto true color aerial photo contact prints, where such prints are available prior to the 2004 field season. Satellite images may also be utilized where true color photography does not currently exist.

New true color aerial photography and ortho-photography will be utilized by field crews as soon as it is available. When the DOT&PF completes its aerial survey of the preferred road corridor and provides the ortho-photography and topographic mapping to the NDM team, this will also be incorporated into the NDM GIS database. However, this is not expected to occur until the 2004 field season is nearly complete.

The 2004 field verification area for the mine site will focus work on:

- Preliminary tailings disposal sites and associated water management structures (e.g., diversion ditches)
- Preliminary mill site locations
- The ore body
- Mine rock storage areas
- Possible access routes for roads within the mine area
- Possible access alternative routes between the mine site and the existing road between Iliamna and Nondalton

Figure 10-1 shows the field evaluation area the wetlands teams will evaluate during the 2004 field season. However, minor modifications to this area may be made as the season progresses. The exact area will be determined after the initial options analysis is complete and the practicability of the various tailings options has been determined. The anticipated sampling area includes approximately 72,000 acres.

After the initial options analysis is complete and the least damaging practicable options have been identified (spring 2005), the mine wetlands team will next map substantial portions of the remaining watersheds associated with the proposed facilities. The extent of the watershed mapping will be determined after more information regarding the sub-basins and basins of the drainages to be affected has been compiled. This work, along with the evaluation of any potential mitigation options identified during the 2004 field season, will occur during the 2005 field season.

The 2004 field verification area for the road and port sites will focus work on (in priority order):

- An approximately 3,300-foot-wide corridor centered on the preferred road alignment option selected by the DOT&PF from the mine to the Cook Inlet preferred port site (above approximately mean high water) and adjacent proposed development area.
- Any suitable construction sites associated with the preferred port site, as determined by DOT&PF.
- Any material sites or other facilities that are identified by DOT&PF or NDM between Iniskin Bay and the existing road between Iliamna and Nondalton.

- Other areas specified by NDM or DOT&PF, including a potential electrical transmission line corridor.

Depending on the number and size of sites or corridors added under the last three bullets above, field verification may extend into the 2005 field season.

10.2.2 Methods/Approach

As part of this effort, the wetlands team will:

- Determine the extent of existing soil/vegetation disturbance in the project area in order to ascertain if there are any outstanding compliance issues that need resolution (in order to expedite future permit application processing).

- Determine the extent and types of jurisdictional wetlands found in the project area.

- Describe the predominant vegetation types found in the project area, and determine the normal prevalence of hydrophytic vegetation species in each. Vegetation types will also be correlated with the terrestrial wildlife study habitat types, and where appropriate, fisheries habitat data.

- Describe the predominant soil types found in the project area and their hydric characteristics/status. Contribute data to soil salvage and suitability studies.

- Determine the predominant hydrogeomorphic (HGM) class of wetlands identified in the project area, and describe the primary functions associated with each.

- Apply a quantitative method for determining the functions of wetlands identified in the study area. This methodology will be determined by the USACE with input from the EPA, and will likely be based off of each wetland's hydrogeomorphic (HGM) classification.

- Develop strategies to avoid and minimize impacts to wetlands associated with potential project facilities.

- With input from other study team members, develop a draft compensatory mitigation plan based on guidance found in Special Public Notice 03-07; Alaska District Compensatory Mitigation Guidelines.

10.2.3 Major Activities

The project approach to mapping wetlands and vegetation for the Pebble Project area is relatively simple, involving several major steps:

- Collection/review of existing data sources, including construction of a GIS to analyze, track, and evaluate a variety of data sources, and to prepare high quality map products.

- Preliminary mapping of wetlands and water bodies, or prospective sampling locations, on aerial photographs (where available) or in the GIS.

- Identification within the GIS and on field maps or photos of representative sites for sampling in the field, focusing on complex wetland/upland boundary areas, areas with questionable boundary locations, and areas where multiple sample points can be easily accessed.

- Field verification of preliminary mapping and sampling of representative sites using criteria and indicators found in the *1987 Corps of Engineers Wetland Delineation Manual* and subsequent regulatory guidance related to wetland determinations.

- Collection of data sufficient to conduct a wetland function assessment according to the method selected by the USACE.

- Photographs of any incidental observations of important habitat features, streams, cultural resources, new or existing disturbances, etc.

- Entry of data from jurisdictional wetland determinations and wetland functional assessments into a web based/accessible relational database. This will allow the data to be analyzed and evaluated much faster, with more built-in quality control measures/options. These data will be integrated into the overall data management system for the mine, and will provide baseline data on conditions within the project area over the life of the project.

- Field review with regulatory and resource management agency staff prior to starting the final mapping process. The purposes of this review will be to familiarize agency reviewers with the project area, discuss our mapping process in more detail, and discuss how problem areas, if encountered, will be addressed during the final mapping process.

- Final mapping of wetlands and water-bodies on digital true color ortho rectified photography within the GIS. Final mapping is expected to include designation of mosaics of wetland types (with respect to HGM classes and vegetation types) and wetlands and uplands. Cowardin classification will not be provided unless specifically requested by the regulatory agencies.

- Polygon coding with respect to potential regulatory exemption per *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers* (SWANCC) will be based on connectivity of each polygon to a navigable water body (or tributary thereof) in an NDM or USGS GIS stream coverage, or to wetlands that abut such waters as shown in the NDM produced wetland coverage.

- Analysis of wetland functional data and creation of a “rating” layer in the GIS.

- Documentation to support the Pebble Project Environmental Baseline Document (EBD) and eventually the project PJDs.

Throughout the project, the wetland scientists will provide input to the evaluation of mine, road, and port alternatives, primarily from a wetland conservation and regulation perspective. These discussions, and follow-up memoranda, will include recommendations on avoidance and minimization measures, including measures to avoid adverse effects on wetlands perceived as having higher functional capacity than others, based on the results of the functional assessment

and professional judgment. The memoranda may also include professional opinions regarding tradeoffs among resource impacts that will play into developing the least environmentally damaging practicable alternative.

Definition of appropriate compensatory mitigation measures will occur throughout 2004 and 2005 and until project permitting is complete. The amount and type of compensatory mitigation will be defined by the USACE and other decision-making agencies, with technical input and proposals by the NDM team. Determining the type and quantity of compensation will employ information on acreage, types, and locations of wetlands impacted; the types of impacts; the wetlands' functional ratings; and the compensation opportunities available. Opportunities will be defined through observation in the field, discussions with regulatory and resource agencies, contacts with Native groups and local governments, the EIS scoping and public involvement processes, and contacts with conservation groups. Means of compensation may include restoration or clean-up of human-disturbed areas, enhancement of natural areas to increase their functional capacity, development or dissemination of knowledge to aid in ecosystem management, and preservation of important natural areas.

10.3 Deliverables

Deliverables common to the mine and road/port options include:

- ArcView Polygon shape file with the following attributes for each polygon. Disturbed (yes or no), jurisdictional wetland status (i.e., wetland, water body, or non-wetland), vegetation type, HGM classification (wetlands only), functional assessment rating (wetland polygons only), any potential for exemption from jurisdiction under guidance related to the SWANCC court decision (yes or no).

- ArcView Arc (Line) shape file which delineates streams too small to be mapped as polygons, and drainages that likely carry surface water flow at least some time during the year.

- ArcView point file that contains the locations of all field sample/photo points. This file will be linked to the digital photos taken at each site, such that the GIS user can view the photos by clicking on the button where they were taken. The attribute file for each point will include a variety of information collected at each sample point.

- Field photographs of each sample/evaluation point; and any nests, dens, stream crossings, rare plant observations, or cultural resource observations encountered during the extensive field evaluations.

Deliverables anticipated only for the mine site (spring of 2005) also include:

- Routine on-site jurisdictional wetland determination forms (up to 750).

- Numerical results from quantitative functional assessments (number unknown).

- Vegetation type descriptions, maps, and representative photographs suitable for inclusion into the Pebble Project EBD.

- Basic soil descriptions (not including engineering/soil testing data) and representative photographs suitable for inclusion into the EBD. Contributions to soil salvage/suitability mapping as requested from NDM.

- Jurisdictional wetland descriptions, maps, and representative photographs suitable for inclusion into the EBD.

- Integrated resource specialist input, including two professional wetland scientists, into the review of options, feasibility of construction, economic practicability, impacts, and the selection of least damaging environmental alternatives.

- Integrated resource specialist input, including two professional wetland scientists, into the selection of potential mitigation options, drafting of a compensatory mitigation plan outline/format.

Deliverables anticipated only for the road/port site(s) during the spring of 2005 also include:

- Routine on-site jurisdictional wetland determination forms (up to 320) and associated photographs.

- Numerical results from quantitative functional assessments (number unknown).

- A PJD or wetlands assessment report in a format consistent with DOT&PF guidelines or expectations. This will include a description of vegetation types and their hydrophytic vegetation status, including representative photographs; brief descriptions of major soil types and their hydric status, including representative photographs; maps showing wetland/upland and wetland type boundaries, with wetland polygons labeled by vegetation type and HGM type, and showing field verification sites; and a description of wetland functions according to wetland type (based on the output of the functional assessment).

- Upon request, resource specialist input into the review of road/port options, discussion and comparison of impacts, recommendation of wetland impact avoidance and minimization measures, and the selection of least environmentally damaging options.

- Upon request, resource specialist input into the selection of potential mitigation options, drafting of a compensatory mitigation plan in sufficient detail regarding the road impacts when known, and long-term support in design, implementation, and monitoring of such.

10.4 Schedule

The environmental baseline studies schedule is included in Appendix A.

11 Fish and Aquatic Habitat

Buell & Associates is providing oversight of the fish and aquatic habitat studies, with work being completed for the mine site, road, and port by HDR and Northern Ecological Services (NES).

11.1 Mine Site

11.1.1 Objectives of Study

The primary objectives for the 2004 aquatic resources studies are to:

- Characterize the distribution and relative abundance of aquatic resources within the project area in sufficient detail to provide information required for impact assessment, mitigation planning and project permitting.

- Acquire pre-development baseline data for post-development monitoring.

11.1.2 Proposed Study Plan

11.1.2.1 Study Area/Scope

The overall study area will include the general project vicinity consisting of a 10-mile radius around the ore body. Specific study programs, as described below, will extend beyond this boundary to include the full length of the north and south forks of the Koktuli River, portions of the main stem Koktuli River and Upper Talarik Creek.

Investigations will be conducted throughout the project area to thoroughly document the distribution and abundance of fish, aquatic invertebrates, and aquatic habitats. The level of detail required for these investigations will depend on proximity to proposed direct impact areas. In those parts of the study area that are not expected to have direct project effects, qualitative and semi-quantitative studies will be undertaken. More detailed investigations will be undertaken in direct impact areas. All studies will build on information from earlier studies completed in the early 1990s (Buell, 1991, 1993). The stream notation system developed by Buell (1991), consistent with the ADF&G Anadromous Fish Stream Catalogue numbering system, will be used to ensure consistency.

11.1.2.2 Methods/Approach

The methods used for this study follow the following protocols and procedures:

- Standard Operating Procedures for the Alaska Stream Condition Index - Alaska Department of Environmental Conservation (2001 – 5th Edition).

- Aquatic Habitat Management Handbook – developed by the U.S. Forest Service (USDA 2001).

- Methods for determining abundance/density of fish – Hankin and Reeves (1981).

- Stratified Population Analysis System – Arnason (1996).

- U.S. Environmental Protection Agency Bioassessment Protocols (Barbour et al., (1999).

The basis of the methodology for characterization of fish and aquatic habitat is the development of standardized monitoring sites which are common to this program, and to the monitoring programs for hydrology (Chapter 4), water chemistry (Chapter 6) and sediment chemistry (Chapter 7). The monitoring stations described in the preceding sections were developed in conjunction with the aquatic and fish monitoring plan.

Streams and lakes within the project area will be mapped for habitat classification and sampled for fish distribution and relative abundance. Spawning surveys will be conducted within the immediate project area, in headwaters of the streams feeding the project area and in certain reaches of Upper Talarik Creek, the South Fork Koktuli River, the North Fork Koktuli River and the main stem Koktuli River downstream of the immediate project area.

11.1.2.3 Major Activities

Review of Existing Information

Existing information relative to mine area drainages will be reviewed. The review of the mine vicinity information will include all aspects of aquatic resources within the Upper Talarik and Koktuli drainages. This will include portions of drainages downstream from potential development areas so that the fish and aquatic resources in the mine area can be seen in a watershed context. Information sources will include scientific literature, gray literature, resource agency files, interviews with agency personnel, earlier baseline and reconnaissance work conducted by Cominco, and interviews with local sport fishing guides. An annotated bibliography will be compiled.

Development of Standardized Monitoring Sites

A series of monitoring sites will be established within the three primary drainages in the potential mine project area to document measurable baseline conditions and to provide a means of comparing stream conditions and aquatic biological resources from year-to-year. Standard monitoring procedures for a variety of physical and biological parameters will be established which can be repeated over time at each station and provide reliable quantitative comparisons between sampling events.

Site Selection. Monitoring sites will be selected to provide a clear picture of conditions and to provide a basis for detecting potential changes within these drainages. Monitoring at standard locations will lead to a determination of homogeneity and/or heterogeneity of the project area and will establish intra-annual variation. The intent will be to select sites that are suitable for sampling each of the five principal monitoring parameters: water quantity (Chapter 4) and quality (Section 6), fish, periphyton, macroinvertebrates, and sediment (Chapter 7). (See Table 11-1, Aquatic Monitoring Site Matrix). The sampling sites are shown on Figure 11-1. In general, sites will be distributed so that some are upstream of mineralized areas and/or zones of potential man-made influences (reference sites), some are within impact zones, and some are downstream from the project area.

TABLE 11-1
Aquatics Monitoring Site Matrix (includes road information)

June Monitoring Event	August Monitoring Event
Macroinvertebrates and Periphyton Study	Macroinvertebrates and Periphyton Study
Stream Monitoring	**Stream Monitoring**
15 Stream monitoring reaches, 100m each, 2 duplicates.	15 Stream monitoring reaches, 100m each, 2 duplicates.
Macroinvertebrate Rapid Bioassessment Protocol samples.	Macroinvertebrate Rapid Bioassessment Protocol samples.
Macroinvertebrate drift net sampling.	Macroinvertebrate drift net sampling.
Periphyton Rapid Bioassessment Protocol samples.	Periphyton Rapid Bioassessment Protocol samples.
Ambient water quality measurements (DO, temp, pH, Conductivity).	Ambient water quality measurements (DO, temp, pH, Conductivity).
Lake Monitoring	**Lake Monitoring**
2 Lake monitoring stations.	2 Lake monitoring stations.
Macroinvertebrate Rapid Bioassessment Protocol samples.	Macroinvertebrate Rapid Bioassessment Protocol samples.
Periphyton Rapid Bioassessment Protocol samples.	Periphyton Rapid Bioassessment Protocol samples.
Ambient water quality measurements (DO, temp, pH, Conductivity).	Ambient water quality measurements (DO, temp, pH, Conductivity).
	Road Site Monitoring
	5 Stream monitoring reaches, 100m each, 1 duplicate.
	Macroinvertebrate Rapid Bioassessment Protocol samples.
	Macroinvertebrate drift net sampling.
	Periphyton Rapid Bioassessment Protocol samples.
	Ambient water quality measurements (DO, temp, pH, Conductivity).
	Road right-of-way Monitoring
	5 Monitoring sites – Intertidal and stream inputs, 1 duplicate.
	Macroinvertebrate Rapid Bioassessment Protocol samples in freshwater streams.
	Periphyton Rapid Bioassessment Protocol samples in freshwater streams.
	Collection of 1 or more species for metals analysis in intertidal habitat.
	Ambient water quality measurements (DO, temp, pH, Conductivity).

Other factors that will influence site selection include the presence of special habitats or special physical conditions, such as presence of groundwater input or mineralization areas. Practical considerations, such as availability of helicopter landing areas, will necessarily influence the final selection of sites. Site selection will be a collaborative process and will require input from NDM, its consultants, and regulatory agencies. It is intended that some or all of these

monitoring site locations would continue to be used for operations and for post-closure monitoring.

For planning purposes (subject to revision), we are proposing the use of five stream monitoring sites within each of the three major drainages, plus at least two lake/pond monitoring sites. It may not be necessary to measure all parameters at all sites or during all time periods.

Stream Monitoring Procedures. The following measurements and or sampling procedures will occur at each of the stream monitoring sites (unless otherwise noted):

- Initial Site Description – During the first sample session, stream morphology and aquatic habitats will be described within a 200 m reach surrounding the site center.

- Initial Census of Fish Resources – Fish presence at the monitoring site will be established by sampling within a 200 m reach using a variety of sampling techniques.

- Standardized, Repeatable Fish Sampling - Standard fish sampling will target juvenile salmonids, if present, and will follow standard protocols listed in Section 11.1.2.2. Captured fish will be identified, counted, measured, and released. Catch per unit effort will be calculated for each sample event. In the event that sites are selected in areas where key fish species do not respond to the standard protocols, then alternative means of capture will be used (electroshocker or seine nets or gill nets). Effort will be standardized in a manner that is appropriate for the technique and sample site. Standard fish sampling will be conducted once per year in the fall at each monitoring site.

- Macroinvertebrate sampling - Macroinvertebrate samples will be collected according to the Alaska Stream Condition Index (ASCI) protocols (Major and Barbour, 1997). The ASCI method (a modification of EPA's Rapid Bioassessment Protocols) includes habitat evaluations, macroinvertebrate collection and processing techniques, and taxa identification procedures. These bioassessment methods sample primarily organisms living on stream substrates using D-frame kick nets employed over a 100 m stream reach. Experience at other sites in Alaska, indicates that such sampling may miss organisms present in the water column (drift); consequently, drift net samples will also be collected at each sampling station. At each site, a composite sample will be collected from 5 drift nets set across the stream within the sample reach. The nets will be allowed to collect organisms for at least 1 hour. Stream velocity will be measured at the time of sampling at each net mouth to allow calculation of the number of drifting organisms per volume of water filtered. In order to stay within the established protocols, drift net samples will be analyzed separately. Additionally, separate analysis will allow a comparison of the efficacy of the two techniques. Macroinvertebrate sampling will occur two times per year (early June and mid-August) for the first two years following the establishment of the monitoring stations. Sampling frequency will be reviewed at the end of this period to determine the timing of future sampling.

- Periphyton Sampling – Periphyton (benthic algae) will be sampled as an additional indicator of physical, chemical and biological processes. Sampling methods will conform to the EPA Bioassessment Protocols (Barbour et al., 1999). To streamline periphyton sampling methods with macroinvertebrate methods, each stream reach will be assessed for microhabitats (i.e., rocky, silty, woody, bedrock, macrophytes) and 20 periphyton samples will be collected in proportion to these habitats. The samples will be collected by scraping or brushing all the periphyton from a standardized area of cobble or gravel. The material from all 20 samples will be combined to form a single composite sample for the station. Relative abundance of algal taxa and other taxa metrics will be analyzed per the protocols. Periphyton sampling will occur two times per year in conjunction with the macroinvertebrate sampling.

- Sediment Sampling – as discussed in Chapter 7.

- Fish Tissue Sampling – See Chapter 7.

- Hydrological sampling and water quality – as discussed in Chapter 4 and Chapter 6.

Lake Monitoring Procedures. Standard sampling at lake monitoring sites will be similar to the stream sites except that macroinvertebrate sampling will not be conducted.

Reconnaissance Investigation of Greater Project Area

Stream Habitat Classification and Mapping. Basic habitat mapping will be conducted based on aerial photography, supplemented by additional low level videography and ground-truthing. Clear water and sparse overhanging vegetation suggests that aerial habitat analysis is especially feasible in the Pebble Project area. In areas where aerial photography does not provide enough detail, stream channels will be recorded from a low flying helicopter using digital video equipment. The images will be played back and processed on a computer and a map of stream habitats developed from the combined photographic and video images. Conventional aerial photos will be used to provide distance and location references. Selected ground-truthing will aid in interpretation. The end product will be stream maps portraying stream width, depth, substrate type, pool locations, bank cover, etc. Parameters such as pool area and density will be calculated from the maps. Other features noted during the various study programs, such as spring locations, barriers, beaver ponds, and unusual geomorphologic features will be added to the habitat maps as necessary. Channel types will be described using the system described in USDA (2001). It is proposed to provide these basic habitat maps for the full length of the Upper Talarik Creek, South Fork Koktuli River, and North Fork Koktuli River, as well as headwaters tributaries and lakes.

Fish Sampling. Sample sites will be selected based on aerial reconnaissance and any evolving need for additional information. Sites will include unstudied areas, as well as areas that were surveyed in earlier studies to compare current fish use with past use in order to confirm preliminary baseline studies and fill in areas not previously sampled. Emphasis will be placed on establishing the distribution limits of anadromous fish and other important resource species. A variety of methods will be used to sample fish depending on the nature of the habitat. Available methods will include backpack electroshocker, minnow traps, seines, and angling. Variable mesh gill nets may be selectively used in ponds and lakes. Essentially, fish presence and

qualitative abundance will be examined using whatever technique works at a particular location. Aquatic habitat sampling kits have been developed for other projects that are readily transportable by helicopter. All fish captured will be identified, measured, and released at the point of capture. Sample locations will be marked using GPS coordinates.

Investigation of Potential Direct Impact Areas

Stream Habitat Classification and Mapping. Streams within the proposed mine area and immediate vicinity will receive the greatest attention, including all streams and ponds flowing south into Frying Pan Lake (headwaters of the South Fork Koktuli River) and selected tributaries of Upper Talarik Creek. These areas will be surveyed on foot using stream habitat survey methods adapted from the *Aquatic Habitat Management Handbook* developed by the U.S. Forest Service (USDA, 2001). This method establishes standard quantitative methods for aquatic ecologists conducting fish and aquatic stream habitat surveys in coastal Alaska. Method protocols are described in detail in the above handbook with level of detail (tier level) depending on the specific need. A modified Tier II survey is proposed for the above area which includes measurement and/or description of stream length, macrohabitat distribution, macrohabitat surface area, channel type, presence of bank cover, and presence of woody debris. Cross sectional geometry and flow will be measured at selected locations along each stream reach.

Habitat analysis and mapping of water bodies within proposed tailings disposal areas will emphasize the aerial imaging approach described above for the greater study area. Ground truthing of mapped areas will be conducted to assure precision and accuracy. Habitat description nomenclature for streams will follow that of the Forest Service methodology described above. Surface area and shoreline length will be calculated for lakes and ponds. Depth profiles will be determined for selected lakes including Frying Pan Lake and larger lakes in the North Fork Koktuli Basin.

Fish Sampling. Within stream habitats, abundance or density of fish will be estimated within a subsample of habitat units following the method of Hankin and Reeves (1981) where appropriate. In this method, a subsample of habitat units (pools, riffles, runs, etc.) is selected and fish number and density per unit surface area are estimated within each unit. Average density for each unit type is calculated and overall fish abundance within the water body is estimated by extrapolating over the full length. Where the Hankin and Reeves method is not appropriate (e.g. homogeneous habitat type without recurring units), stream habitats will be described in detail. Fish density estimation methods in streams will include snorkeling, electroshocker total counts, electroshocker removal method, minnow trap removal method and, where needed, seines and or gill nets. The method to be used in any given habitat unit will be selected based on the characteristics of the site. In some small streams with uniform habitat distribution, it may be more appropriate to estimate fish abundance within representative reaches rather than by habitat unit.

In selected lake and pond habitats, numbers of key fish species will be estimated using mark and recapture techniques. Angling and/or trap nets will be used to capture (and recapture) northern pike and/or Arctic grayling. All captured fish greater than an established minimum length will be tagged using individually numbered T-bar anchor tags. Standard methods will be utilized to calculate population numbers and test method assumptions. The Stratified Population Analysis System (SPAS) software (Arnason, 1996) will be used to help analyze mark and recapture data.

Spawning Surveys

A ground survey will be conducted within the headwaters of the South Fork Koktuli drainage (streams flowing into Frying Pan lake) to locate Arctic grayling spawning areas. The survey will be conducted during the immediate post-breakup period and will rely on visual observations. Survey crews will begin at the downstream end (Frying Pan Lake Inlet) and work upstream, noting any signs of adult grayling presence within potential stream spawning areas. Angling will be used where appropriate to catch grayling and determine reproductive condition.

Aerial surveys for adult salmon will be conducted from a helicopter at several times during the spawning season in order to determine distribution and number of spawners. Timing of spawning for the various salmon species (chinook, sockeye, and coho) will be obtained from local sources during the initial information review so that surveys can be conducted at optimal times for each species and drainage. Multiple surveys for each species may be conducted so that observation of the spawning peak can be assured. For planning purposes, it is assumed that a minimum of four sets of salmon surveys will be conducted – late July, mid-August, early September, and early October. Additional aerial surveys for rainbow trout may be conducted in the spring if flow and water clarity conditions permit. During each survey, the full length of the Upper Talarik Creek, South Fork Koktuli, North Fork Koktuli, and main stem Koktuli Rivers will be surveyed.

Salmon and trout will be counted by species and GPS waypoints will be entered at each spawning location. Live and dead fish will be counted separately. Spawning distribution maps will be prepared by overlaying GPS coordinates on digitized maps of the project area. The surveys will result in estimates of peak abundance rather than actual escapement. Escapement estimates will be derived using constants which relate peak abundance to escapement for each species as determined by the ADF&G for the southwestern Alaska region.

Analysis of Reduced Flow Implications

Potential reduction of flow within project area drainages as a result of various project activities may suggest the need for specific study programs to analyze these effects. The effort required for such “instream flow” studies is highly variable depending on the needs of each project. For the Pebble Project, the instream flow study will utilize the modified wetted perimeter method.

11.1.3 Deliverables

The principal deliverable from the studies related to fish and aquatic resources studies will be presented in a final report expected in early 2005. This report will include:

- Mapping of baseline fish, fish habitat values, and aquatic resources for the inner and outer mine areas.
- Estimates of fish population abundance and distribution.
- Results of site sampling (fish, aquatic invertebrates, etc.).
- An annotated bibliography of background information about the project site.

11.1.4 Schedule

The timeline of fish and aquatic mine site studies is included in the overall schedule in Appendix A. Some study elements, such as winter fish habitat distribution will begin as early as early April, followed by monitoring site selection in mid to late May. The principal ground effort for the mine area field study program will be conducted during the summer, from June through August. Aerial salmon surveys will be conducted as needed in June, July, August and September. Data analysis will occur in late 2004 with draft study reports completed by January 31, 2005.

11.2 Road/Port Site

11.2.1 Objectives of Study

The principal objective of the road/port study program will be to identify fresh water fish resources and aquatic habitat values within the proposed road corridors with the intent of providing enough information so that road crossings of streams or other water bodies can be adequately designed and permitted.

11.2.2 Proposed Study Plan

11.2.2.1 Study Area/Scope

The study area will include the preferred access corridor identified by DOT&PF and will emphasize stream crossing areas. However, if appropriate for stream characterization, portions of drainages outside the corridor will also be included.

11.2.2.2 Methods/Approach

The methods for characterization of the aquatic habitat along the road corridor are similar to those described for the greater project area, Chapter 11.1.2.2.

11.2.2.3 Major Activities

Review of Existing Information

Existing information relative to corridor drainages will be reviewed. Information sources will include scientific literature, gray literature, resource agency files, interviews with agency personnel, and interviews with local sport fishing guides. An annotated bibliography will be compiled.

Corridor Stream Crossing Investigations

A preliminary list of known, probable, and potential fish streams will be prepared based on corridor alignment, map and aerial photo interpretation, interviews of ADF&G personnel and local residents and review of existing literature. GPS coordinates will be determined for each crossing and will provide the primary means of locating streams. It is expected that some field investigation will be required to locate some of the streams. Actual coordinates will be determined in the field and will provide documentation of stream location. The study will

emphasize data collection at smaller streams where culvert crossings are most likely. Larger streams with well known resources and planned bridge crossings will receive less effort.

A biological team will access each stream near the corridor crossing location. Since road routes will likely not be surveyed in the field and will likely be subject to field design change, the access points will necessarily only be an approximation of crossing location. The team will collect a standard suite of physical data and descriptive information at each stream crossing with the effort concentrated within a stream reach extending for 100 m on either side of the likely corridor crossing location. The data will include basic water quality information (pH, dissolved oxygen, conductivity, temperature, and turbidity), average and maximum depth, average width, water velocity, estimated flow, cover characteristics, bank characteristics, riparian vegetation (type and condition), substrate composition, habitat distribution, channel type and potential migration barriers. Photographs will accompany all physical descriptions.

The study area will be sampled for fish using a variety of methods depending on the physical and biological characteristics of the stream. Methods will include backpack electroshocker, beach seine, angling, and baited minnow-type traps. If local conditions dictated minnow traps be set overnight as opposed to two or three hours, the use of traps may be limited to special circumstances where repeat access is practical. The amount of effort to be expended in sampling at each stream will be determined by the judgment of the team leader following general guidelines established in advance. The intent will be to adequately characterize fish use within the sampling area. Within small, wadeable streams, the entire 200 m reach will be sampled with the electroshocker, if practicable. All fish captured will be identified to species, measured, and released alive near the point of capture.

A field estimation of habitat value to various species and life history stages will be determined based on fish presence and physical characteristics. The team will provide comments relative to special conditions, needs for mitigation, etc. Data will be recorded either on standard field data sheets or digital data loggers.

Five stream sites along the proposed road and a small number of streams (fewer than 5) in the proposed port location will be selected for macroinvertebrate and periphyton sampling. These sites will be sampled in accordance with the protocols described in the Section 11.1.2.2, shown on Figure 11-2, and listed in Table 11-1.

General Description of Stream Habitat Sensitivity

Information from the corridor crossing studies described above will be combined with other information sources to develop an overall description of habitat sensitivity within specific water bodies crossed by the corridor. Other sources of information will include aerial reconnaissance of each drainage (at the time of the crossing studies), aerial photo interpretation, existing information from initial literature review, and local knowledge of the stream. The distance to upstream and downstream migration barriers will receive special emphasis because of its relevance to both stream sensitivity and road routing. The final product for each stream will include a presentation of probable habitat values and sensitive time periods.

11.2.3 Deliverables

The principal deliverable for road corridor studies will be a draft technical report to be completed in early 2005. Interim summary reports of activities and preliminary results will be submitted monthly beginning in May 2004.

11.2.4 Schedule

The timeline for fish and aquatic road and port activities is summarized in Appendix A. Review of existing information will begin immediately. Corridor field studies (all aspects) will begin in July and will continue until all streams have been completed. The intent will be to complete all streams by late August. The mid- to late summer time period generally coincides with the maximum distribution of resident fish species into feeding habitats.

Information synthesis and data analysis will occur in late 2004, following the field season. A draft technical report of corridor studies will be completed by January 31, 2005.

12 Marine

This section is relevant only to the road/port facilities of the Pebble Gold Copper Project. The marine work plan for the 2004 field season includes detailed marine bird studies and reconnaissance level surveys of marine fauna, flora, and their habitat. If required, additional marine study plan components will be identified and planned at a later date. ABR will complete the marine bird survey work for the port, and BEESC/RWJ Consulting will complete the marine reconnaissance level work.

12.1 Marine Birds – Port

12.1.1 Objectives

The objective of this study plan is the characterization of the seasonal distribution and abundance of marine-oriented birds in the potential port area(s), particularly those that could be affected by the construction of the port facility and the passage of ships through the area. Special emphasis will be placed on endangered species, such as Steller's Eiders, and on species that have been nominated for listing under the Endangered Species Act, such as Kittlitz's Murrelets.

12.1.2 Proposed Study Plan

12.1.2.1 Study Area/Scope

The study area will include the proposed port areas and nearby open coastline, weather permitting (Figure 12-1). At this time, until the preferred port site option is selected, the survey will include:

- The shoreline of Iniskin Bay
- The shoreline of Iliamna Bay
- The shoreline of the nearby outer coastline (east to Oil Bay and south to Ursus Head)
- Islands and islets near the mouth of Iniskin Bay (the Mushroom Islets and Scott, Vert, Iniskin, and Pomeroy islands)
- Islands and islets near the mouth of Iliamna Bay (White Gull Island, Turtle Reef, Black Reef)
- Deeper water in the centers of Iliamna and Iniskin bays and in the open bight to the southeast of them

The taxonomic scope of the surveys will include all marine-oriented birds that have a marine orientation during at least one stage of the annual cycle. This group includes:

- Waterfowl (geese, swans, and ducks)
- Loons
- Grebes

- Tubenoses (fulmars and storm-petrels)
- Cormorants
- Herons
- Raptors
- Cranes
- Shorebirds
- Larids (jaegers, gulls, and terns)
- Alcids
- Kingfishers
- Corvids

12.1.2.2 Methods and Approach

Three boat-based surveys for marine-oriented birds will be conducted in Iniskin and Iliamna bays and nearby areas: early summer 2004 (June), fall 2004 (November), and late winter/early spring 2005 (March). During each survey, the distribution and abundance of marine-oriented birds seen on nearshore surveys will be plotted, as will the general locations of marine-oriented birds seen on offshore surveys. Each segment will be surveyed at least one time/cruise, weather permitting; if time permits, replicate samples will be taken.

Nearshore and offshore survey methods are standardized sampling techniques used by the USFWS and other researchers. Specifically, to conduct nearshore surveys, we will:

- Sample from a skiff (e.g., Achilles raft).
- Follow the shoreline ~100 m from shore
- Identify, count, and map locations of all marine-oriented birds seen in the nearshore zone (within 200 m from shore) or on the shoreline or near-shore areas (within 100 m from the coastline; primarily for raptors and corvids) or flying over these areas (Figure 12-1); however, flying birds will not be mapped.
- Describe locations (habitats) and activities (e.g., resting, feeding) of each bird sighting.
- Record environmental characteristics associated with each nearshore survey segment.
- Use GIS measurements to determine the area sampled in each nearshore segment.
- Use the GIS information to convert counts to estimates of birds/km^2 of area surveyed in each segment.
- Digitize locations of all except flying birds.

To conduct offshore surveys, we will:

- Sample a series of strip-transect segments in the offshore zone (central portion) of each bay and in the open bight.

- Follow a fixed trackline (Figure 12-1).
- Record ship speed, time, and beginning and ending coordinates for each segment.
- Count all marine-oriented birds seen within 150 m on either side of the boat.
- Describe locations (habitats) and activities (e.g., resting, feeding) of each bird sighting.
- Record environmental characteristics associated with each offshore survey segment.
- Use GIS measurements to determine the area sampled in each offshore segment.
- Use the GIS information to convert counts to estimates of birds/km^2 of area surveyed in each segment.
- Use waypoints in each sampling transect to map approximate locations of each sighting.

12.1.2.3 Major Activities

Major activities will include counting and determining the distribution of marine birds in the study area at various times of the year. Locations of birds on the water or shoreline will be mapped.

The major activities in this program are to:

- Survey the distribution and abundance of marine-oriented birds in the potential port areas with standardized boat-based surveys during three seasons (summer, fall, late winter/early spring).
- Describe the seasonal species-composition of the marine-oriented bird community.
- Determine and describe the use of the potential port areas by Steller's Eiders and Kittlitz's Murrelets so that, if either species occurs there, strategies can be developed to minimize impacts.

12.1.3 Deliverables

Deliverables include:

- GIS file that lists locations of all nearshore survey segments and offshore survey segments.
- GIS file that lists locations of all mapped bird sightings from nearshore surveys.
- Database files that list all data recorded during nearshore surveys and offshore surveys respectively, including segment numbers, times of sampling, species seen, numbers, sexes and ages, locations, activities, and associated environmental data.

- Detailed report on marine-oriented birds that will describe the study area, activities, and the results of each of the surveys, and will include any relevant background information available on marine-oriented birds in this area.

12.1.4 Schedule

- June 2004: Summer survey for summering birds and nesting seabirds, especially Steller's Eiders and Kittlitz's Murrelets.

- November 2004: Fall survey for overwintering birds, especially Steller's Eiders and Kittlitz's Murrelets.

- March 2005: Late winter/early spring survey for overwintering birds, especially Steller's Eiders and Kittlitz's Murrelets.

- May 2005: Draft report submitted.

12.2 Marine Reconnaissance – Port

12.2.1 Objectives of Study

The objective of this work is to characterize the marine fauna, flora, and related habitat conditions in the potential port area(s) that could be potentially affected by a port and related shipping activities.

12.2.2 Proposed Study Plan

12.2.2.1 Study Area/Scope

The study area will include the proposed port area(s) and nearby coastlines, and will include a consideration of intertidal, infaunal, and epifaunal communities, marine and anadromous fish, and marine mammals.

12.2.2.2 Methods/Approach

A thorough review of the existing marine environment information base will be completed, including the following:

- *Navigation Channel Feasibility Report and Environmental Assessment* – Williamsport (USACE, Alaska District, 1995).

- *A Survey of Selected Cook Inlet Intertidal Habitats* (Pentec Environmental Inc./Cook Inlet Regional Citizens Advisory Council, 1996).

- *Outer Continental Shelf Environmental Assessment Program* (U.S. Department of Commerce, [NOAA/NOS/OOMA] and U.S. Department of the Interior, [MMS], 1986).

- In addition, additional field studies will be conducted using standard marine biological survey techniques as outlined below.

12.2.2.3 Major Activities

- Field effort in marine study area in July through September 2004. Conduct sediment, water (surface and bottom), and marine invertebrate sampling at the preferred port site; more extensive sediment sampling would be conducted at the preferred port site. Use Van Dorn water bottle for collecting bottom water samples. Use Van Veen grab sampler to collect sediments for grain size analyses, trace metals concentration, and other levels of contaminants, and to assess benthic community structure in infauna and epifauna species assemblages. Side scan sonar mapping will be considered for use in the field to stratify sediment infauna and epifauna sampling by habitat type (e.g., sand, silt, or cobble); use of bathymetry data will also allow stratifying by water depth.

- Conduct opportunistic sampling of fishes for trace metals concentrations and species identification.

- Locate and make qualitative counts. Conduct general marine mammal observations. Endangered or threatened species that are encountered will also be a priority for observations.

- Document field reconnaissance findings and summarize physical and biological data. Compare and contrast to existing literature and other available information.

- Agency and team interaction:

  - Interface with project team to further define work scope – ensure minimum EIS requirements.

  - Provide support to the project team for interaction with agencies and public, particularly the EIS scoping process.

  - Participate in team meetings with NDM and its other consultants.

  - Provide environmental input into project design options.

  - Make, or assist with, permit applications.

12.2.3 Deliverables

Deliverables include:

- GIS file locations of all survey segments and sample locations.

- Database files that list all data recorded during all surveys of marine fauna, flora, and related habitat.

- Report characterizing marine fauna, flora, and related habitat in the study area with special emphasis on any rare, endangered or particularly sensitive habitats or species that may be potentially affected by marine port/shipping activities.

12.2.4 Schedule

- June to July 2004: literature reviews and analysis of existing marine environmental information.

- July to October 2004: conduct marine field studies.

- May to July 2005: follow-up field studies as required.

13 Subsistence

The objectives, methods/approach, and deliverables for the mine site, road, and port options are the same throughout this discussion. Stephen R. Braund & Associates (SRB&A) will lead the subsistence work on the mine site, road, and port.

13.1 Objectives of Study

The objectives of the subsistence study are to characterize the baseline conditions and current usage of the land for subsistence living, to provide the data required to assess the potential effects of the Pebble Gold Copper Project near Iliamna, Alaska, and its related road/port infrastructure, and to provide the necessary information for project permitting. The following specific objectives form the basis of the major activities include in this portion of the study plan:

- Characterize the existing subsistence activities in the project area, and contributing areas.
- Provide environmental input into the analysis of project design options (e.g., waste storage, road/port, etc.) and their potential effects on subsistence uses.
- Compile data to assess the project's environmental effects on subsistence activities related to the facilities and activities associated with construction, operation, and closure stages.
- Identify alternative design or impact mitigation measures.
- Recommend ongoing monitoring studies needed to ensure compliance with all state and federal permitting requirements.
- Perform the appropriate quantity and quality of studies/analyses necessary to expeditiously achieve all state and federal project permitting requirements.

13.2 Proposed Study Plan

13.2.1 Study Area/Scope

The study area includes those communities whose residents utilize the mine site or road right of way and port areas for the harvest of subsistence resources or who harvest resources that migrate through or utilize this area. At the broadest scale, this would include all of the communities in the Lake Clark and Iliamna Lake areas, communities down river from the mine in the Koktuli-Mulchatna-Nushagak river drainages, communities down river from the mine in the Kvichak River drainage, and communities on the Kenai Peninsula that may use the Iniskin and/or Iliamna bay areas.

Based on a preliminary review of the project (e.g., the potential location of the mine, roads, and port site), there is a potential for the Pebble Project to affect multiple communities' subsistence activities. In an effort to distinguish among the communities and their potential likelihood of

experiencing effects from the project, and thus focus the baseline studies, several groups or tiers of potentially affected communities were developed (see Figure 13-1 and Table 13-1). This classification also takes into consideration current and proposed research to be conducted by the ADF&G Division of Subsistence, and thus the following typology is not simply a potential effects classification.

The communities in **Tier One** (Nondalton, Port Alsworth, Iliamna, Newhalen, and Pedro Bay) have subsistence use areas most likely to overlap with the proposed project. Furthermore, ADF&G Division of Subsistence, in association with the National Park Service, is planning to conduct household surveys in Nondalton and Port Alsworth. This work plan proposes that the ADF&G Division of Subsistence conduct a similar study in Iliamna, Newhalen, and Pedro Bay (discussed in more detail below). Tier One communities would participate in both the ADF&G Division of Subsistence household survey and the NDM team subsistence/traditional knowledge interviews (described below).

Tier Two communities (Kokhanok, Igiugig, Levelock, Ekwok, New Stuyahok, and Koliganek) are further removed from the proposed project. However, some of these communities (e.g., Kokhanok and Igiugig) are known to make use of the area north of Iliamna Lake in the vicinity of the proposed mine for subsistence activities. The subsistence range of the other communities in this group is not definitively known, and it is proposed that the ADF&G Division of Subsistence household survey is not conducted in these six communities, but that NDM conducts subsistence interviews to determine the contemporary extent of subsistence uses and any possible overlap with the proposed mine.

TABLE 13-1
Subsistence - Potentially Affected Communities

Tier 1:		**Tier 3:**	
1	Iliamna	-	Ninilchik
2	Newhalen	-	Homer
3	Nondalton	-	Seldovia
4	Pedro Bay	-	Chinitna Bay
5	Port Alsworth		
		Tier 4:	
Tier 2:		12	Dillingham
6	Kokhonak		
7	Igiugig	**Tier 4:**	
8	Koliganek	13	Portage Creek
9	New Stuyahok	14	Naknek
10	Ekwok	15	South Naknek
11	Levelock	16	King Salmon
	Pile Bay - camp with caretaker		

Tier Three communities (Ninilchik, Seldovia, Homer, and residents of the west side of Cook Inlet in the vicinity of Chinitna Bay) may or may not use the proposed port areas. However, there is evidence of historic linkages to this area. Telephone interviews are proposed with selected residents in these areas as an exploratory method to gain information on the extent of subsistence uses, if any, related to any contemporary uses in the vicinity of the proposed port. A preliminary list of names for telephone interviews has been developed.

Tier Four Communities (Dillingham and Portage Creek; Naknek, South Naknek, and King Salmon) are down river from the Pebble Gold Copper Mine and thus may be affected. However, there are several factors to consider as reasons for not undertaking field research in these communities at this time. Foremost, all of these communities are a considerable distance from the mine, and residents likely do not travel as far as the mine area during their customary subsistence activities. Dillingham is more a small town than a village and as such would require a separate sampling plan and a significant research effort. Dillingham's 2000 population was 2,466 persons in 888 households. King Salmon, Naknek, and South Naknek subsistence use areas are generally south of Lake Iliamna. Pile Bay is primarily a camp with caretaker, and hence it is not included as a subsistence/traditional knowledge interview community.

13.2.2 Methods/Approach

Consistent with this purpose and with the assistance of the ADF&G Division of Subsistence, literature and field studies for the collection, analysis, and documentation of a comprehensive database to characterize baseline conditions in the project area, consistent with state/federal agency expectations will be conducted. The environmental baseline studies will be performed in a manner that makes them readily useful for a future EIS preparation.

As the primary goal of the subsistence work plan is to document subsistence uses to provide sufficient and relevant information to assess the potential effects of the Pebble Gold Copper Project and its related road/port infrastructure on subsistence uses, it is important to understand how environmental effects will be determined under the National Environmental Policy Act (NEPA). The four primary elements of the NEPA impact assessment are direct effects, indirect effects, cumulative effects and mitigation. The approach of this work plan is to gather and analyze subsistence information that will be readily usable in a NEPA environmental consequences analysis.

Direct effects “are caused by the action and occur at the same time and place” (40 CFR 1508.8). Thus, a fundamental data need is spatial subsistence information (e.g., a description of where residents hunt, harvest, fish, and gather subsistence resources) in relation to the proposed development. Existing maps of subsistence use areas date from the early 1980s (e.g., maps in ADF&G Habitat Management Guide from 1982 and 1983). Subsistence/traditional knowledge interviews will be completed in the Tier One and Two communities to identify contemporary (last 10 years) subsistence use areas that may be affected by the Pebble Project. In addition, a method to distinguish subsistence areas used more intensely than other areas will developed and implemented.

There will be two groups for the subsistence/traditional knowledge interviews: 1) retired hunters/elders who historically utilized the study area, and 2) hunters who currently (last 10 years) go to the study area. These subsistence interviews will not be a formal survey using a questionnaire based on a probability sample; rather, a community liaison, working with the community, city and/or tribal governments, will select key knowledgeable persons to be interviewed.

The ADF&G Division of Subsistence will provide the results from systematic household surveys conducted in five communities updating baseline information about subsistence hunting, fishing, and gathering that is compatible with information collected in previous rounds of ADF&G household interviews. During the household surveys, ADF&G will gather information on the

location of hunting and harvests of moose and caribou in 2004 in the five Tier One communities (Nondalton, Port Alsworth, Iliamna, Newhalen, and Pedro Bay).

Indirect effects "are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable." For subsistence activities, this includes such things as harvest effort, costs, and travel distance, sharing of subsistence resources, transfer of traditional knowledge, the integrity of culturally significant places, and other culturally significant activities. The research design will include subsistence harvest amounts, harvest locations, harvest use areas, distribution and sharing of resources, and traditional knowledge.

The NEPA process is generally based on the best available information. However, using the best available data for communities in the proposed mine/road/port area would likely not reflect current subsistence uses in the study area. For communities closest to the proposed development, ADF&G, Division of Subsistence has subsistence harvest information for the communities of Nondalton (1973, 1980, 1981, 1983), Newhalen (1983 and 1991), Iliamna (1983 and 1991), Kokhanok (1983 and 1992), Port Alsworth (1983), and Pedro Bay (1982 and 1996 [unpublished]). Most of this information is dated and there is a need for updated baseline information. The residents of these communities rely on subsistence hunting, fishing, and gathering for nutrition and to support their way of life. They utilize a variety of resources, including salmon and other fish; large land mammals (caribou, moose, bears, sheep); small game and furbearers; birds; and wild plants.

The ADF&G Division of Subsistence has ongoing subsistence and traditional knowledge studies in the Lake Clark/Iliamna Lake region. This research will be incorporated into the subsistence/traditional knowledge baseline.

In addition, the ADF&G Division of Subsistence has a cooperative agreement with the National Park Service to conduct systematic household surveys about subsistence hunting, fishing, and gathering in Nondalton and Port Alsworth. The Division, in collaboration with NDM's team and the study communities, will conduct a similar study in Newhalen, Iliamna, and Pedro Bay for the NDM project. The ADF&G Division of Subsistence team will use identical data collection methods, and research in all five communities will occur according to an integrated schedule. In association with these systematic household surveys, ADF&G personnel will train local research assistants in each community to administer the household survey. The goal will be to interview a representative of each year-round household in both communities. Participation will be voluntary and all individual and household level responses will be confidential. ADF&G Division of Subsistence will provide the study findings for all five communities to the NDM project team to incorporate into the NDM subsistence baseline report.

The success, timing, and length of time in the field for the subsistence and traditional knowledge interviews is dependent on the availability and willingness of local residents to participate in the interviews. We assume there will be no participation difficulties. The subsistence/traditional knowledge field trip will be planned during non-intense subsistence/commercial harvest periods to facilitate higher participation by local residents.

13.2.3 Major Tasks/Activities

Major tasks/activities to document subsistence uses and assess impacts associated with the Pebble Project area include:

- Planning Meetings/Work Plan. This task includes preliminary project meetings, review of project description, communication with NDM for additional project information and clarification, preliminary formulation of research designs, preparation of work plans for subsistence and cultural resources, review proposed work plan with NDM, and revise work plan. (This activity applies to both subsistence and cultural resources.)

- Review of published and unpublished literature. A literature review of existing sources of subsistence and traditional knowledge relevant to the study area will be conducted and will identify and review the scope of any ongoing subsistence or traditional knowledge programs in the study area. These preliminary data will also be used as part of the engineering alternatives assessment.

- Review and compilation of existing harvest data and subsistence use areas by community.

- Identify data gaps.

- Prepare preliminary field protocol.

- Contact and coordinate with appropriate community organizations (e.g., traditional council) for selecting interviewees, suitable space to conduct the subsistence/traditional knowledge interviews, honoraria amounts, and translation (if necessary). A protocol respectful to each community will be followed which incorporates sensitivity to community schedules, expectations, and desires. Community participation and identification with the project is critical for a success.

- Conduct subsistence/traditional knowledge interviews will occur in Tier One and Tier Two communities. These interviews will include at least one visit to each community by two persons.

- Subsistence/traditional knowledge field work will occur during a time period that does not interfere with harvests/commercial fishing. Community interviews are conditioned upon council approval and community schedules.

- Edit and quality control field data, process field data.

- Prepare a draft environmental baseline, prepare a draft impact analysis, identify appropriate impact mitigation measures, and identify monitoring studies.

- During this process, the project team will coordinate with ADF&G to avoid any duplication and to ensure the highest quality report is prepared.

13.3 Deliverables

- Preliminary subsistence information (e.g., hunting and/or harvest information) as necessary to inform mine, road and port location.
- Environmental baseline that incorporates traditional knowledge and maps of subsistence use areas for key resources.
- Subsistence impact analysis.

13.4 Schedule

The subsistence survey work is included in the environmental baseline studies schedule in Appendix A.

14 Cultural Resources

The objectives, methods/approach, and deliverables for the mine site, road, and port options are the same except where noted below. SRB&A will lead cultural resources work on the mine site, road, and port.

14.1 Objectives of Study

The objective of the cultural resources component of this project is to locate, identify, delineate, inventory, and assess the eligibility of archaeological, historical, ethnographic, and other cultural use areas for inclusion on the National Register of Historic Places (NRHP) and the Alaska Heritage Resource Survey (AHRS).

14.2 Proposed Study Plan

14.2.1 Study Area/Scope

The study area will include the general vicinity of the two proposed project segments and will follow the definition of area of potential effect (APE) as defined in 36 CFR Part 800 (Sec. 800.16(d)). An APE is defined as the "geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist."

The mine site will include the proposed open pit, mill site, mine rock piles and tailings impoundment(s), and associated site infrastructure, and the right of way for the road from the mine to the Newhalen River.

For the road/port segment of the study, road right of way from the Newhalen River crossing to the proposed port facility and the area around the port facility for at least a quarter mile will comprise the second study area when the location of those components are more clearly delineated by the applicant.

14.2.2 Methods/Approach

Cultural resources may include historic structures and landscapes, prehistoric and historic archaeological sites, and traditional and religious use areas. Once located in the field and identified, the extent of these resources will be determined and delineated where practicable. When sections of the project area or road/port are complete, any discovered sites will be inventoried and recorded. The sites will be documented and assessed as to their eligibility for the AHRS and the NRHP.

The project approach to identifying and assessing impacts on cultural resources for the Pebble Project Area will rely on methods outlined in:

- Section 106 of the National Historic Preservation Act (NHPA) (16 USC 470).

- The implementing regulations of the Advisory Council on Historic Preservation (36 CFR 800).
- The Alaska Historic Preservation Act (41.35.240).
- The Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation (as amended and annotated) (48 FR 44716).

Other relevant legislation that applies to cultural resources includes, but is not limited to:

- The Antiquities Act of 1906 (16 USC 431 et seq.).
- The Archaeological Resources Protection Act of 1979 (ARPA) (16 USC470 et seq.).
- The Native American Graves Protection and Repatriation Act (NAGPRA) (25 USC 3001-3013).

14.2.3 Major Tasks/Activities

Major tasks/activities for identifying cultural resources and assessing potential impacts on cultural resources for the Pebble Project Area include:

- A review of published and unpublished literature and the Alaska Heritage Resource Survey files maintained by the DNR, Office of History and Archaeology.
- Consultation with interested state and federal agencies, Native organizations, and other parties.
- Field survey and testing.
- Evaluation of data and proposed facilities to assess potential adverse impacts and alternative mitigative strategies.

These tasks are described below.

14.2.3.1 Task 1. Literature Review

Historic, ethnographic, and archaeological accounts of the region will be reviewed to document prehistoric, historic, and recent cultural uses of the mine site and road/port areas. Historic and ethnographic accounts should give indications of land use through time in the project areas and may include locations and descriptions of potentially important historic and prehistoric cultural sites and landscapes. Consultation of the AHRS database, and review of the archaeological literature on file at the Office of History and Archaeology should provide specific information on previous archaeological research in the area. Aerial and satellite photographs will be used to determine the location of any visible surface features such as structures, caribou drive lines, corrals, and house and cache pits.

These data will be critically reviewed and compiled into an historic and ethnographic narrative describing the human presence in the project areas and an inventory of archaeological, ethnographic, and historical sites in the area of the proposed project. This preliminary compilation will be used to define the field research strategies. It will also be used in the engineering alternatives analysis, to minimize potential impacts to cultural resources by guiding the applicant's routing and location of proposed project areas. This preliminary report will also be the basis for the final environmental baseline and Section 106 report, which will include the results of the field survey and site nomination forms for cultural resources in the project area that are determined to be eligible for listing on the National Register.

14.2.3.2 Task 2. Initiate Consultation

Before conducting field research, consultation on behalf of the project proponent will be initiated with relevant state, federal, and tribal entities. The State Historic Preservation Officer (SHPO) issues field archaeology permits and manages the database of known cultural resource sites for the State of Alaska and is the first contact for many federal cultural resource issues depending on a variety of potential factors, including land ownership, funding, surface and subsurface estate, and trust relationships with Tribal entities.

14.2.3.3 Task 3. Field Work Mine Project Area

The mountain valley that contains the proposed Pebble Project open pit and associated facilities will be the first area surveyed in the summer of 2004. Intensive survey coverage for this area will be completed, including a systematic pedestrian survey utilizing multiple surveyors walking transects, thus covering most of the area, and frequent, subsurface testing. The project team will examine the terrain for irregularities and vegetation changes that would indicate the presence of buried cultural remains. Surface features such as depressions that may represent a former house pit, or berms that may indicate the presence of a former habitation wall, all provide surface indications of potential archaeological resources. Field crews will examine elevated terrain, stream crossings and areas close to the fresh water sources more carefully than areas with less archaeological potential, such as boggy and low-lying areas. Erosional and other subsurface exposures will be examined for the presence of archaeological materials.

Following the identification/selection of the specific route for the road connecting the proposed mine site to the Newhalen River crossing, the NDM field crew will survey the right of way for that subcomponent. A pedestrian transect survey will be completed from the mine site along the right of way, examining the right of way itself and the peripheral area outside the right of way for potential cultural resources. Subsurface testing will also be performed along the proposed right of way and at proposed gravel source locations.

14.2.3.4 Task 4. Assessment of Information

Following field work and processing of field and published data, the project's environmental effects on cultural resources during construction, operation, and closure stages at the mine site, road, and port site will be assessed and documented. Subsequently, consultation with SHPO and the Advisory Council on Historic Preservation (ACHP) will be done as necessary to address issues of site management and preservation where possible as well as mitigation strategies should preservation not be feasible. Recommendations will be made for any ongoing monitoring

studies needed to ensure compliance with all state and federal permitting requirements following this consultation.

The task is somewhat iterative with Task 1 and Task 3, as a preliminary assessment of cultural resources will be required for the engineering alternatives assessment for siting of facilities.

14.2.3.5 Task 5. Road and Port

Following selection of the proposed road right of way from the Newhalen River crossing to the port site on Cook Inlet, a pedestrian survey will be performed for the road right of way. This right of way would include the road footprint, the centerline, and the periphery of the corridor. Field crews will excavate test pits at widely spaced intervals along the right of way. It has been assumed that the preferred road corridor will not go through the Lake Clark Park and Preserve.

The port site, when selected, will likely require intensive pedestrian survey and numerous test pits, as locations along Cook Inlet are the highest probability areas for all project sections for cultural deposits and historic resources.

14.3 Deliverables

- Initiation of consultation letter with SHPO/Agencies/Tribes (mine site only for 2004 field season).
- Internal Cultural Resources Preliminary Report: Literature Review and Recommendations providing input regarding known cultural resources based on AHRS review (mine site and road/port).
- Environmental Baseline (mine site only; road and port if locations known).
- Impact Analysis following identification/locations of components and field surveys (mine site only; general discussion for road and port if locations known).
- Section 106 Final Report (includes Literature Review, Field Survey, and Consultation Results and Determinations of Eligibility if cultural resources are identified in the study area/areas of potential effect) (mine site only).
- Consultation follow-up letters.

14.4 Schedule

Field work will commence in June of 2004 in the area of the open pit and then move to the tailings impoundment(s) and associated storage facilities as the location information becomes available. Field surveys will be initiated as other component locations are identified, staked, surveyed, or otherwise delineated. The components east of the Newhalen River could be completed by the end of August if the location information is available by July 15, 2004. If the road to Cook Inlet develops, the proposed route survey will be conducted as possible between the time of route finalization through the end of possible field operations. In the event that a large number of prehistoric and historic sites or structures are found, more field time will be required to delineate and document under state and federal laws.

15 Recreation

Specific study plans for five disciplines have not yet been developed: noise, land use, recreation, visual aesthetics, and socioeconomics. These disciplines are less dependent on the 2004 summer season field work which has been the focus of NDM's efforts to date.

NDM is presently working to develop a baseline study program for each of these disciplines, and to employ experienced contractors to conduct such programs. Once these study plans are developed, they will be forwarded to appropriate agencies for review and comment.

16 Land Use

Specific study plans for five disciplines have not yet been developed: noise, land use, recreation, visual aesthetics, and socioeconomics. These disciplines are less dependent on the 2004 summer season field work which has been the focus of NDM's efforts to date.

NDM is presently working to develop a baseline study program for each of these disciplines, and to employ experienced contractors to conduct such programs. Once these study plans are developed, they will be forwarded to appropriate agencies for review and comment.

17 Visual Aesthetics

Specific study plans for five disciplines have not yet been developed: noise, land use, recreation, visual aesthetics, and socioeconomics. These disciplines are less dependent on the 2004 summer season field work which has been the focus of NDM's efforts to date.

NDM is presently working to develop a baseline study program for each of these disciplines, and to employ experienced contractors to conduct such programs. Once these study plans are developed, they will be forwarded to appropriate agencies for review and comment.

18 Socioeconomics

Specific study plans for five disciplines have not yet been developed: noise, land use, recreation, visual aesthetics, and socioeconomics. These disciplines are less dependent on the 2004 summer season field work which has been the focus of NDM's efforts to date.

NDM is presently working to develop a baseline study program for each of these disciplines, and to employ experienced contractors to conduct such programs. Once these study plans are developed, they will be forwarded to appropriate agencies for review and comment.

19 Data Management and GIS

Resource Data Inc. (RDI) is providing GIS and data management services to support the Pebble project. The GIS and scientific data generated as part of the permitting process is a valuable asset to NDM. In the short term, NDM will need to make the data available to the environmental baseline project team. In the long term, the data will support the EIS, and ultimately monitoring throughout the life of the Pebble Mine. A sound data management plan will ensure that the data is accurate, timely, and integrated into a multidisciplinary database.

Proactively managing the data will ensure that it is accurate and available when needed. The project strategy for data management is completely automated. The plan is to provide data sources with clear requirements for data deliverables, and to provide the tools for the data sources to verify compliance prior to delivery.

The Data Management and GIS scope of work is divided into two sections:

- Section 19.1 - GIS
- Section 19.2 - Website and Data Management

The *GIS* section covers managing all the mapping data collected during the baseline studies, creating and loading base map and Pebble-specific data, providing GIS support for the wetlands study, and providing cartographic services to support the entire project.

The *Website and Data Management* section includes building a central data repository for the project, providing web-based tools to enter and report on project data, and tools to upload data into the project database. The website and database will be designed to provide long-term storage and access to baseline data throughout the mine life.

19.1 GIS

19.1.1 Objectives

The objectives of the GIS activities described in this document are to:

- Develop standards for spatial data including datum, projection, and accuracy
- Compile base map data
- Compile 2004 study data
- Distribute data to all investigators

19.1.2 Proposed Study Plan

The scope of services includes developing GIS standards, building a GIS to support permitting, and providing GIS support to all team members.

Activity 1: GIS Management: Standards will developed for the Pebble GIS. The standards will be documented and distributed to the project team. The standards will include projection information, acceptable formats, documentation requirements, and revision naming schema. Standards development will be followed by development of a GIS data repository. The repository will be developed using ArcSDE / Oracle geodatabase. Map templates and ESRI layer files will be developed to assure that all maps have a consistent appearance. Finally, the exchange of spatial data will be facilitated between team members. Some data will be exchanged via the FTP site while other data will be distributed on CDs or portable hard drives.

Activity 2: Compile Base map Data: Create the GIS base map layers for the Pebble Project area. These layers consist of features that make up a typical USGS quadrangle map including rivers, lakes, contours, infrastructure, place names, townships, sections, range lines, etc.

Activity 3: Load Pebble Data: Load NDM's Pebble Data to the GIS. This includes claim block data, drill hole and geotechnical location data, proposed facilities and road alignment, and existing baseline study data.

Activity 4: Environmental Data: Existing environmental datasets obtained from government agencies will be loaded or digitized. Datasets include:

- ADF&G anadromous fish stream catalog
- USFWS raptor nest data
- NMFS critical habitat data for fish, marine mammals, and stellar sea lions
- ADF&G fish and game habitat

Activity 5: Data Acquisition for Wetlands Team: GIS data will be provided to support the Wetland Delineation. These datasets are in addition to those loaded under previous activities and include:

- NWI data
- Natural Resource Conservation Service (NRCS) data
- Bristol Bay Land Cover Map Data from USGS/EROS
- USACE Permit Layer

Activity 6: Ongoing support for Wetlands Team: Support will be provided throughout the wetland delineation process. The following activities will be required to complete this activity:

- Create wetland layer files.
- Produce field maps and photo reports.
- Scrub wetlands data (close polygons, remove slivers, etc.).

- Process photos and photo locations.
- Provide analysis of wetland mapping such as summary tables showing acres disturbed, by vegetation type and HGM classification.
- Environmental baseline report plotting
- Support alternative impact analysis.

Activity 7: Cartographic Services: Maps will be provided for use in meetings with agencies. Maps will also be provided for the final documents.

19.1.3 Approach

An NDM GIS environment will be established. Digital and hardcopy data will be acquired and loaded into the GIS for distribution to the project team. For the most part, ArcInfo will be used to create coverages, which will be output as shape (SHP) files. This is the most expedient method to process data, and SHP files are the preferred format for the environmental team. Most of the data that will be loaded into the GIS is available in digital format. Data available in hardcopy only will be digitized. Distribution will be accomplished by transferring media such as CDs and portable hard disk drives. Smaller files will be published on the project website for download.

The SHP files will also be used to load the ArcSDE / Oracle database. This database will support the website GIS discussed in next section of this document.

19.1.4 Deliverables

Activity	Deliverable Description
2: Compile Base map Data	GIS base map dataset
3: Load Pebble Data	GIS with project specific data loaded
4: Environmental Data	FEMA data

19.2 Website and Data Management

A project website will be developed with functionality that has been proven effective in facilitating project communications, document sharing, and data acquisition and management. Data quality and availability, that arms all participants with the tools necessary for success, will be assured through an automated data acquisition strategy.

19.2.1 Objectives

The objectives of the website and data management activities described in this document are to:

- Establish standards for data format, content, and transfer.

- Support 2004 field operations through the development of web-based software for data entry, document management, project management (calendar, logistics tools, etc.), and mapping.
- Support data analysis and reporting.
- Manage documents.

19.2.2 Proposed Study Plan

A wide range of activities are necessary to set-up and then support the website and data management system. These activities include:

- *Activity 1: Framework*: Involves the design and implementation of the core framework for the web site. This would involve all web site design activities that take place before any coding occurs. It also encompasses the implementation details of this design.
- *Activity 2: Data Access/Storage*: The Data Storage component involves the creation of a single database to house all required application information. The Data Access component involves the creation and implementation of an "access layer" that all system components will use to connect to and manipulate the database in a consistent, secure manner.
- *Activity 3: Field Input Forms:* Web-based field input forms will serve as the field crews' input mechanism into the system's central database. Any input form necessary for the capturing of data will be reconstructed from its paper form into a digital representation.
- *Activity 4: Document Repository:* The document repository will serve as a central location for the storage of all documents in the system. This repository will be held in the project database and will be accessed and updated via a FTP site and through a comprehensive web-based search/retrieval mechanism.
- *Activity 5: Project Applications:* Project applications are any applications that have been predefined to be project wide and accessible by all project members
- *Activity 6: Data Acquisition and Management:* Data acquisition and management includes the design and creation of all necessary components for acquiring data from the project team and managing the data in a centralized database.
- *Activity 7: Administration:* Site administration will involve the creation of an application control structure allowing administrative users access to configurable site elements, such as user management screens and database connection strings.
- *Activity 8: Migrations:* The migration plan will involve a comprehensive strategy for scheduling rollouts and testing.
- *Activity 9: Website GIS:* The GIS portion of the website is assumed to be an ArcIMS designed site capable of showing all portions of the site and the connecting road system. It will also perform analysis based on spatial selections.

19.2.3 Approach

The project website and data management system will be developed concurrently. Website development will begin by establishing the technology framework including servers, software, and standards for coding. Once the framework is in place, high priority applications to support field operations will be developed. These applications include a project calendar, logistics form, contact list, and document repository. Of equally high priority is the sample-tracking application. This application requires development of the data access / storage system. The first four applications will be developed first, followed by the sample tracking application.

Web forms will be provided to support data entry in the field. The water-sampling forms are of highest priority. Additional forms may be created to support other sample types.

Data that cannot be entered from the field will need to be delivered to the data management team for incorporation into the project database. Proactively managing the data will ensure that it is accurate and available when needed. Data sources will be provided with clear requirements for data deliverables, and software will be provided to verify compliance prior to delivery. Using this strategy, data will be ready to load when transferred to the database team. Further, we will use the website will be used to facilitate transmittals and to load data when it is detected by the system. The goal is to eliminate, or at the least minimize, manual data management activities.

Finally, GIS capabilities will be built into the website to provide support for spatial query and analysis from any known user with Internet access.

19.2.4 Deliverables

Activity	Deliverable Description
3: Field Input Forms	Sample Labels / Chain of Custody Water Sampling Forms Other Forms (TBD)
4: Document Repository	FTP Site Search Retrieval Mechanism
5: Project Applications	Project Calendar Contact List Logistics Form
6: Data Acquisition & Mgmt	Data Source Identification Analytical Methods Identification Publish Code Lists Publish Data Reporting Formats Deliverable Compliance Software Data Delivery Process Data Source Training
7: Administration	User Management Screens
9: Website GIS	Web-based GIS

19.2.5 Schedule

Key GIS and data management activities and estimated timelines include:

GIS Management – March 2004 – June 2005

- Compile Base Map Data – April 2004 – July 2004
- Load Pebble Data – May 2004 – December 2004
- Environmental Data – March 2004 – August 2004
- Data Acquisition and Support for Wetlands Team – March 2004 – May 2005
- Cartographic Services – June 2004 – June 2005

Data Management and Project Web Site – May 2004 – February 2005

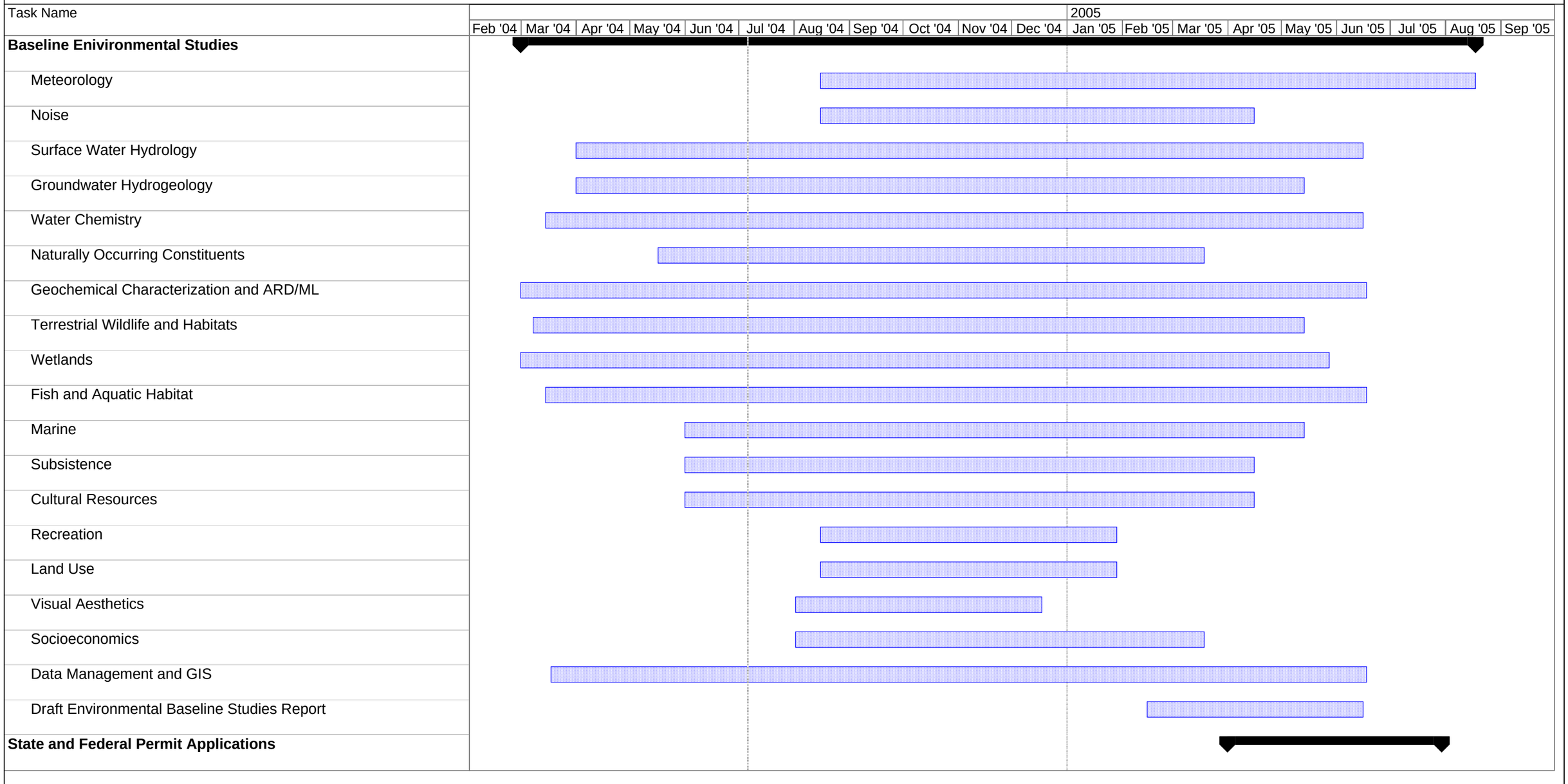
- Framework – May 2004 – June 2004
- Data Access and Storage – June 2004
- Field Input Forms – May 2004 – July 2004
- Document Repository – July 2004 – November 2004
- Project Applications – May 2004 – June 2004
- Data Acquisition and Management – May 2004 – February 2005
- Site Administration – October 2004 – December 2004
- Migration Plan – May 2004 – June 2004
- Website GIS – September 2004 – November 2004

FIGURES

APPENDIX A

PEBBLE GOLD COPPER PROJECT
ENVIRONMENTAL BASELINE STUDIES
PROPOSED SCHEDULE

NORTHERN DYNASTY MINES INC.
PEBBLE GOLD COPPER PROJECT
DRAFT ENVIRONMENTAL BASELINE STUDIES SCHEDULE



Project: DRAFT Schedule
Date: Tue 7/6/04

Task | Split | Progress | Milestone | Summary