Pebble Project

NORTHERN DYNASTY MINES INC.

DRAFT ENVIRONMENTAL BASELINE STUDIES
2006 STUDY PLANS

CHAPTER 4.
SURFACE HYDROLOGY

JULY 2006

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4. SURFACE HYDROLOGY

The characterization of site hydrology includes both the surface hydrology and the snow-course survey program. HDR Alaska, Inc. will lead the surface hydrology work on the mine site and Bristol Environmental & Engineering Services Corporation will complete the surface hydrology work for the transportation corridor. ABR, Inc. will lead the snow-course survey program.

4.1 Mine Studies

Objectives/Study Area/Methods and Approach

The 2006 surface hydrology program for the mine studies has predominantly the same objectives (Section 4.1.1), study area (Section 4.1.2.1), and methods and approach (Section 4.1.2.2) as stated in the 2005 study plan. Exceptions are described below.

Surface hydrology study tasks for 2006 include:

- Baseline Data Collection
- Baseflow Measurements

Table 4.1-1 provides a general summary of the primary tasks completed from 2004 through 2005 and lists tasks planned for 2006. Table 4.1-2 and Figure 4.1-1 detail the schedule and locations, respectively, for these tasks.

2006 Hydrology Task Summary

Task 1: Baseline Data Collection

Baseline data collection for the 2006 surface hydrology program is primarily designed to increase the period of record and the reliability of the database. Data collection at the 16 continuously gaged stations (Table 4.1-2 and Figure 4.1-1) will continue through 2006 in a manner similar to the past two years.

Data collection at the 16 ungaged stations provides the water quality program with discharge data for mass-flow calculations. Instantaneous discharge measurements are expected to be collected at these stations according to the schedule provided in Table 4.1-2.

A proposed change to the 2006 surface hydrology methodology is the addition of a salt-dilution method that will complement the existing discharge measurement technique (velocity-area method). The field hydrologist will use professional judgment based on site-specific conditions to determine when to apply each of these methods.

Although the current-meter method is often a preferred method of measuring stream discharge, it can be difficult to obtain good velocity readings in small steep streams with turbulent flow. The mine study area also presents additional difficulties in obtaining good discharge measurements at each of the over 30 remote stations. The logistics of measuring very low flows under ice-covered streams in winter and during bank-full conditions during breakup necessitate that alternative methods such as tracer (e.g., salt) dilution be integrated into the program to improve data collection.

Tracer dilution is a standard U.S. Geological Survey method used to measure stream discharge. The basic premise is to introduce a known amount of salt at one point in the stream and measure the concentration wave as it passes a point downstream where it is completely mixed in the flow. Streamflow is calculated from the area under the resulting conductivity curve. The salt dilution method uses common table salt (NaCl) as a tracer to measure discharge without the use of a current meter. Salt is preferred as a tracer over other known tracers because it is non-toxic to aquatic organisms at the concentrations and exposure times associated with the measurements. It is also inexpensive, easily obtained, and convenient to work with. Field measurements will be made with a conductivity meter read by a datalogger. Detailed methodology for the salt-dilution method will be provided in the 2006 field sampling plan.

Task 2: Baseflow Measurements

The objectives of baseflow measurements are to measure critical low-flow surface-water conditions and to better understand the interaction of groundwater and surface water in gaining and losing sections of the study area drainages. To measure baseflow conditions, a series of low-flow streamflow profiles will be completed twice during 2006. These profiles will consist of approximately ten instantaneous discharge measurements along each of the North Fork of Koktuli River, South Fork of Koktuli River, and Upper Talarik Creek for an estimated 30 measurements. The measurements will be collected during the low-flow periods in March or April and following spring runoff (planned for late June or early July).

Measurements will be collected according to the same field methods, including the salt-dilution method, used during the monthly instantaneous discharge measurements.

Snow Surveys and Snow-distribution Mapping

Baseline Studies

Spring snow surveys were conducted in 2006 to provide data for snow-distribution models and ablation-rate calculations in the mine study area. Snow surveys have been performed since 2004 in the mine study area. Most sample locations have remained the same in all years, but adjustments have been made to accommodate changes in the mine development plan. Snow-survey station locations are illustrated in Figure 4.1-2. At each location, snow depth and density are measured using standardized snow survey methods and equipment. Details concerning sampling methods are as presented in Chapter 4, Surface Water Hydrology, in the 2005 study plan.

Table 4.1-3 summarizes activities relating to snow surveys from 2004 through 2006.

The study plan for the 2006 snow surveys includes the following components:

- Continue to refine the distribution map by integrating real-time meteorological data and plant-canopy maps when they become available.
- Perform spring snow surveys (April 15-24, 2006) and snow ablation surveys (May 12-13 and 19-21, 2006) in order to obtain concurrent meteorological and ground truth data (Table 4.1-4).
- Refine the approach to estimating ablation rates through the combination of periodic spring field surveys, analysis of MODIS satellite imagery, and stream discharge measurements (data currently collected by HDR).

- Compile the three years of survey data (2004, 2005, and 2006) to produce a normalized snow distribution map of the mine site.
- Summarize the snow survey information in the environmental baseline document.

Long-term Monitoring

Since snow accumulation has high inter-annual variability, spring field surveys in the mine study area will be continued. In 2004, two snow courses (high and low altitude) were established that were used both as locations within the local (mine study area) distribution survey network and as repeated-measurement sites to compare with measurements from existing National Resource Conservation Service (NRCS) snow survey sites in the Bristol Bay water-resource area. At this time, there is no suitable long-term snowfall-data record applicable to the mine area (such as NRCS snow courses and SNOWTEL sites). The existing sites are too distant to be used as proxy data for determining the maximum probable spring snow amounts. Additional years of monitoring in the mine study area will improve confidence in the relative snow-distribution map and allow for a more accurate prediction of maximum potential spring snow loads.

4.2 Transportation Corridor Studies

Baseline data on surface water hydrology were collected for the transportation corridor in 2004 and 2005 as described in the study plans for those years. A summary of the tasks performed during the surface hydrology study for the transportation corridor is presented in Table 4.2-1. A summary of sampling conducted is presented in Table 4.2-2, and sampling locations are depicted on Figure 4.2-1. No additional data are being collected in 2006, with the following exception.

Roadhouse Creek is fed from small runoff streams that drain the west side of Roadhouse Mountain and empty Iliamna Lake near the Iliamna village townsite. Roadhouse Creek is an anadromous fish stream that meanders through the tundra and has well-vegetated banks.

A continuous-recording stream gage was originally installed in 1973 by the United States Geological Survey (USGS). The gage recorded data for 10 years, until 1983, when the USGS disengaged the station. The Roadhouse Creek gage (USGS No. 15300200) was reinstalled in May 2005 by the USGS to support the baseline surface-hydrology data collection for the Pebble Project transportation-corridor studies. The gage is located at Latitude 59° 45’ 26” NAD 27, Longitude 154° 60’ 59” NAD 27.

At the time of the USGS gage reinstallation, Roadhouse Creek was approximately 21 to 25 feet wide and 1.2 feet deep at the deepest section. A state-owned paved road passes over the creek just south of the gage. Two 10-foot-wide by 42-foot-long culverts are installed in the road’s embankment to allow drainage for the creek.

The Roadhouse Creek gage is currently operated and maintained by the USGS, and satellite data collection from the gage is processed automatically. Peak streamflow, real-time data, and historical data for this gage are available on the USGS website, http://waterdata.usgs.gov/ak/nwis/uv?site_no=15300200.

The baseline data on surface hydrology along the transportation corridor will be presented in the environmental baseline document prior to filing of permit applications.

Table 4.1-1
Surface Water Hydrology Study Summary
Pebble Project Environmental Studies
Study Summary for 2004 - 2006
Consultant: HDR Alaska

Field studies	2004 Study Tasks	2005 Study Tasks	2006 Study Tasks
Surface Hydrology	**Mine Study Area**		
	Baseline Surface-hydrology Data Collection (7 Events)	Baseline Surface-hydrology Data Collection (8 Events)	Baseline Surface-hydrology Data Collection (8 Events)
		Baseflow Measurements (1 Event)	Baseflow Measurements (2 Events)
		Upper Hyporheic Temperature Monitoring	
		Flow-exchange Measurements During Low	
		Aerial Survey of Hydrography for Potential Temporary Road Corridor	

Table 4.1-2
Surface Water Hydrology - Mine Studies
Pebble Project
Sample Site Period-of-Record Index

Period of Record by Discipline

Sample Location	Year[1]	Hydrology[2]												Water Quality											
	Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
KC100A	2004					I	I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q							
KR100A	2004				I		I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005			I			I	I	I	I	I					Q			Q	Q	Q	Q	Q		
	2006	I		I		I								Q		Q		Q							
NK100A (USGS)	2004						I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
NK100B (Orig. Location)	2004				I												Q	Q							
	2005																								
	2006																								
NK100B	2004								I	I	I										Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
NK100C	2004				I	I		I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
NK119A	2004				I		I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
NK119B	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I								Q		Q		Q							
SK100A	2004				I		I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
SK100B (USGS)	2004				I		I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
SK100B1	2004																								
	2005									I	I	C	C									Q	Q		
	2006	C	C	C	C	C	C	C	C	C	C	C	C	Q		Q		Q	Q	Q	Q	Q	Q		
SK100B2	2004																								
	2005					I	I	I	I	I	I								Q	Q	Q	Q	Q		
	2006	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
SK100C	2004						I	I	C	C	C						Q	Q	Q	Q			Q		
	2005	I		I		C	C	C	C	C	C			Q				Q	Q	Q		Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
SK100D	2004						I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
SK100F	2004					I	I	I	C	C	C							Q	Q	Q	Q	Q	Q		
	2005	I		I		C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q							
SK100G	2004				I	I	I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q							
SK119A	2004				I	I	I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
SK124A	2004																								
	2005	I		I		C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
SK131A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I								Q		Q		Q							
SK133A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005			I		I	I	I	I	I	I							Q	Q	Q	Q	Q	Q		
	2006	I		I		I								Q		Q		Q							
SK134A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I								Q		Q		Q							
SK136A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I								Q		Q		Q							
SK136B	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I								Q		Q		Q							
UT100A	2004					I			I	I	I						Q	Q			Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q		Q		
	2006	I		I		I								Q		Q		Q							
UT100B (USGS)	2004					I	I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
UT100C	2004				I	I											Q	Q							
	2005																								
	2006																								
UT100D	2004				I	I	I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
UT100E	2004				I	I	I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
UT119A	2004				I	I	I	I	C	C	C						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I	C	C	C	C	C	C	C			Q		Q		Q	Q	Q	Q	Q	Q		
UT119B	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
UT135A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I								Q		Q		Q							
UT138A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I								Q		Q		Q							
UT141A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005			I		I	I	I	I	I	I					Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
UT146A	2004				I	I	I	I	I	I	I						Q	Q	Q	Q	Q	Q	Q		
	2005	I		I		I	I	I	I	I	I			Q		Q		Q	Q	Q	Q	Q	Q		
	2006	I		I		I								Q		Q		Q							
Black Lake	2004																								
	2005																								
	2006																								
Big Wiggly	2004																								
	2005																								
	2006																								
Frying Pan Lake	2004																								
	2005																								
	2006																		Q						
Chiquita Lake	2004																								
	2005																								
	2006																								
Lake No. 2	2004																								
	2005																								
	2006																								
Mud Lake (Near Lily Lake)	2004																								
	2005																								
	2006																								
Seeps	2004																	X				X			
	2005																			X			X		
	2006														X			X		X	X		X		

Sample Location	Year[1]	Fisheries												Macroinvertebrates												Sediment											
	Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
KC100A	2004								W										D		D											F		F			
	2005								W																						F	F					
	2006																																				
KR100A	2004																		D		D											F					
	2005																																				
	2006																																				
NK100A (USGS)	2004								W										D		D											F		F			
	2005								W										S												F	F					
	2006																														F						
NK100B (Orig. Location)	2004								W										D		D																
	2005								W																												
	2006																																				
NK100B	2004																																				
	2005																														F	F		F			
	2006																														F						
NK100C	2004								W										D		D											F		F			
	2005								W										S												F	F		F			
	2006																														F						
NK119A	2004								W										D		D																
	2005								W																												
	2006																																				
NK119B	2004																															F		F			
	2005																														F	F					
	2006																																				
SK100A	2004								W										D		D										F						
	2005								W																						F	F					
	2006																														F						
SK100B (USGS)	2004								W										D		D											F		F			
	2005								W										S												F	F					
	2006																														F						
SK100B1	2004																																				
	2005																																				
	2006																																				
SK100B2	2004																																				
	2005																																				
	2006																																				
SK100C	2004								W										D		D											F		F			
	2005								W																						F	F					
	2006																														F						
SK100D	2004																																	F			
	2005																																				
	2006																																				
SK100F	2004								W										D		D											F		F			
	2005								W																						F						
	2006																																				
SK100G	2004								W										D		D											F	F	F			
	2005								W																						F	F					
	2006																																				
SK119A	2004								W										D		D											F		F			
	2005								W																						F						
	2006																														F						
SK124A	2004																																				
	2005																																				
	2006																																				
SK131A	2004																															F		F			
	2005																																				
	2006																																				
SK133A	2004																																				
	2005																																				
	2006																																				
SK134A	2004																																				
	2005																																				
	2006																																				
SK136A	2004																																				
	2005																																				
	2006																																				
SK136B	2004																																				
	2005																																				
	2006																																				
UT100A	2004																																	F			
	2005																																				
	2006																														F						
UT100B (USGS)	2004								W										D		D											F	F	F			
	2005								W										S												F	F		F			
	2006																														F						
UT100C	2004								W										D		D										F						
	2005								W																												
	2006																																				
UT100D	2004								W										D		D											F		F			
	2005								W										S												F	F		F			
	2006																														F						
UT100E	2004								W										D		D											F		F			
	2005								W																						F						
	2006																														F						
UT119A	2004								W																							F		F			
	2005								W																						F						
	2006																														F						
UT119B	2004																																				
	2005																															F					
	2006																																				
UT135A	2004																																				
	2005																																				
	2006																																				
UT138A	2004								W										D		D											F		F			
	2005								W										S																		
	2006																																				
UT141A	2004																															F		F			
	2005																																F				
	2006																														F						
UT146A	2004																															F		F			
	2005																																				
	2006																																				
Black Lake	2004																																				
	2005								T																								F				
	2006								T												P																
Big Wiggly	2004								T												M																
	2005								T										M													F					
	2006																				P																
Frying Pan Lake	2004								T												M																
	2005								T										M													F					
	2006																				P																
Chiquita Lake	2004																																				
	2005																																	F			
	2006																				P																
Lake No. 2	2004																																				
	2005								T																								F				
	2006								T																												
Mud Lake (Near Lily Lake)	2004																																				
	2005																																	F			
	2006																																				
Seeps	2004																																				
	2005																															7			5		
	2006																																				

KEY:

- **C** Continuous-stage/discharge hydrometric data collected in streams (gaged stations with dataloggers).
- **D** Macroinvertebrate sites were sampled with drift nets AND ASCI methods; periphyton was collected with RBP and diatoms were assessed.
- **F** Sediment samples collected. Seep sediment samples show number of seeps sampled in 2005. Sediment symbol not shown on associated map.
- **I** Instantaneous stream discharge measurements taken each month coincident with water quality (ungaged stations without dataloggers).
- **M** Macroinvertebrate samples from lakes were collected with a modified ASCI approach.
- **P** Plankton tows .
- **Q** Surface-water-quality samples collected for field and laboratory analyses.
- **S** Macroinvertebrate sites were sampled with Surber Sampler AND ASCI methods; periphyton was collected with DNR methods and chlorophyll a was assessed.
- **T** Fish-tissue sample consisted of discrete muscle and liver samples from adult northern pike.
- **W** Fish-tissue sample consisted of discrete whole body juvenile fish .
- **X** Seep measurements/samples collected as described in notes.

NOTES:

1. Work for 2006 is shown as planned, but not yet completed.
2. At stations where continuous hydrometric data is collected, continuous hydrographs will be estimated throughout winter months using standard hydrometric methods. Stream gages are reinstalled each spring as early as breakup conditions allow.

Table 4.1-3
Snow Surveys Study Summary
Pebble Project Environmental Studies
Study Summary for 2004 - 2006
Consultant: ABR, Inc.

Discipline	2004 Data Collected or Tasks	2005 Data Collected or Tasks	2006 Tasks to be Completed
Snow Surveys		**Mine Studies Area**	
	Information Gathering / Literature Search	Information Gathering / Literature Search & Review	Information Gathering / Literature Search & Review
	Scope, Schedule, Field Sampling Plan	Scope, Schedule, Field Sampling Plan	Scope, Schedule, Field Sampling Plan
	2004 Study Plan	2005 Study Plan	2006 Study Plan Summary
	Snow Distribution Surveys (April)	Snow Distribution Surveys (April)	Snow Distribution Surveys (April)
	Snow Ablation Surveys (May)	Snow Ablation Surveys (May)	Snow Ablation Surveys (May)
	Data Entry and Analysis	Data Entry and Analysis	Data Entry and Analysis
	Communication and Data Management	Communication and Data Management	Communication and Data Management
	Coordination with NDM, Agency Meetings	Coordination with NDM, Agency Meetings, and Monthly Reporting	Coordination with NDM, Agency Meetings, and Monthly Reporting
		2004 Progress Report	Preliminary Environmental Baseline Document

Table 4.1-4
Pebble Project
Sample Site Period-of-Record Index, Snow-Course Surveys
Consultant: ABR

Transect	Stations	Year	Distribution	Ablation
1	13	2004	×	×
		2005	×	×
		2006	×	×
2	10	2004	×	×
		2005	×	×
		2006	×	×
3	5	2004	×	
		2005		
		2006		
4	7	2004	×	
		2005		
		2006		
5	7	2004	×	
		2005		
		2006	×	
6	9	2004	×	
		2005	×	
		2006	×	
8	8	2004	×	
		2005	×	
		2006	×	
9	7	2004	×	
		2005		
		2006		
10	5	2004	×	
		2005		
		2006		
11	7	2004	×	
		2005	×	
		2006	×	
12	8	2004	×	
		2005	×	
		2006	×	
13	6	2004	×	
		2005		
		2006		
14	9	2004	×	
		2005	×	
		2006	×	
20	10	2004		
		2005	×	
		2006	×	
21	8	2004		
		2005	×	
		2006	×	
22	8	2004		
		2005	×	
		2006	×	
23	8	2004		
		2005	×	
		2006	×	
24	7	2004		
		2005	×	
		2006	×	
25	9	2004		
		2005	×	
		2006	×	
26	7	2004		
		2005	×	
		2006	×	
27	7	2004		
		2005	×	×
		2006	×	×

Table 4.2-1
Pebble Project Environmental Studies
Study Summary for Surface Hydrology, Transportation Corridor, 2004 - 2006
Consultant: BEESC

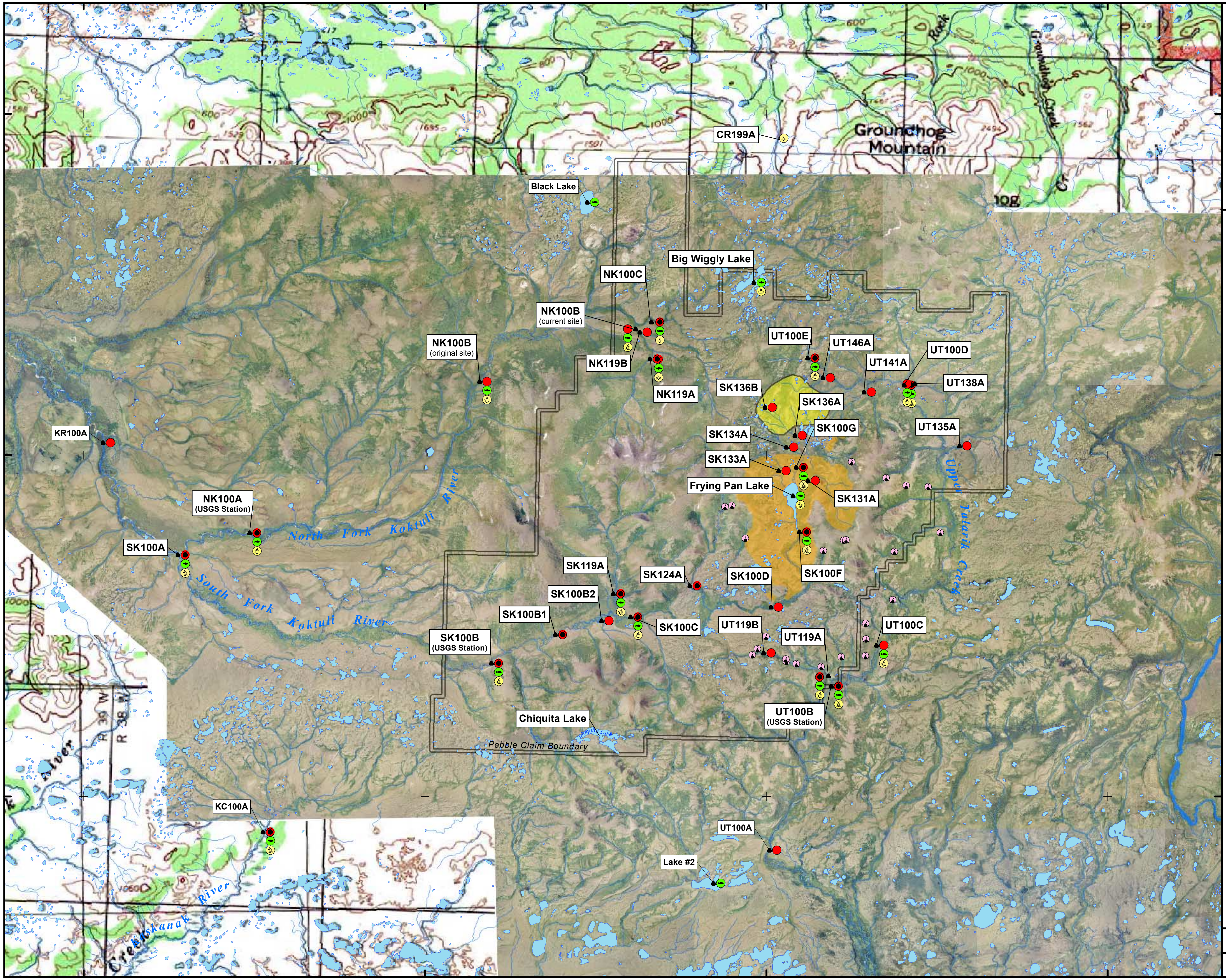
Discipline	2004 Data Collected or Tasks	2005 Data Collected or Tasks	2006 Tasks to be Completed
Surface Hydrology		**Transportation Corridor**	
	Information Gathering	Information Gathering	Data Compilation and Analysis
	Preparation of Scope, Schedule, Field Sampling Plan	Preparation of Scope, Schedule, Field Sampling Plan	Prepare preliminary environmental baseline document
	Field Flow Measurements	Field Flow Measurements	
	Communication and Data Management	Coordination with NDM	
	Coordination with NDM	Coordination with local communities for observers	
	Coordination with local communities for observers	Data Compilation and Analysis	
	Preparation of Presentation	Preparation of 2004 Progress Report	
	Report Writing		

Table 4.2-2
Surface Water Hydrology, Transportation Corridor
Pebble Project
Sample Site Period-of-Record Index

Sample Location	Year	Period Of Record By Discipline																																	
		Surface Hydrology												Surface Water Quality												Groundwater Quality											
	Month	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
NHRIV	2004																			Q	Q	Q	Q														
	2005														Q	Q		Q	Q	Q	Q	Q	Q														
	2006																																				
GS20	2004							I	I	I	I									Q	Q	Q	Q														
	2005		I	I											Q	Q				Q	Q	Q	Q														
	2006																																				
GS20A	2004							I	I	I	I									Q	Q	Q	Q														
	2005		I	I											Q	Q																					
	2006																																				
GS18A	2004							I		I	I									Q	Q	Q	Q														
	2005		I	I											Q	Q																					
	2006																																				
GS17A	2004							I	I	I	I									Q	Q	Q	Q														
	2005		I	I		I	I	I	I	I	I				Q	Q		Q	Q	Q	Q	Q	Q														
	2006																																				
GS14A	2004							I	I	I	I									Q	Q	Q	Q														
	2005		I	I											Q	Q																					
	2006																																				
GS14B	2004							I	I	I	I									Q	Q	Q	Q														
	2005		I			I	I	I	I	I	I				Q	Q		Q	Q	Q	Q	Q	Q														
	2006																																				
GS12A	2004							I	I	I	I									Q	Q	Q	Q														
	2005		I	I											Q	Q																					
	2006																																				
GS11A	2004							I	I	I	I									Q	Q	Q	Q														
	2005		I	I		I	I	I	I	I	I				Q	Q		Q	Q	Q	Q	Q	Q														
	2006																																				
GS8A	2004							I	I	I	I									Q	Q	Q	Q														
	2005		I	I		I	I	I	I		I				Q	Q		Q	Q	Q	Q	Q	Q														
	2006																																				
GS7A	2004										I												Q														
	2005																																				
	2006																																				
GS6A	2004							I	I	I	I									Q	Q	Q	Q														
	2005		I	I											Q	Q																					
	2006																																				
GS4A	2004							I	I	I	I									Q	Q	Q	Q														
	2005		I			I	I	I	I		I				Q	Q		Q	Q	Q	Q	Q	Q														
	2006																																				
GS4B	2004									I	I											Q	Q														
	2005														Q	Q																					
	2006																																				
GS3A	2004								I	I											Q	Q	Q														
	2005		I												Q	Q		Q	Q	Q	Q	Q	Q														
	2006																																				
GS23	2004							I	I	I	I									Q	Q	Q	Q														
	2005																																				
	2006																																				
GS22	2004							I	I	I	I																										
	2005																			Q	Q	Q	Q														
	2006																																				
GS21	2004								I	I	I											Q	Q														
	2005		I	I		I	I	I	I	I	I				Q	Q		Q	Q	Q	Q	Q	Q														
	2006																																				
PSC	2004																																				
	2005																			Q																	
	2006																																				
PSD	2004																																				
	2005																			Q																	
	2006																																				
NEWH2	2004																															Q			Q		
	2005																										Q					Q			Q		
	2006																																				
NONDA	2004																															Q				Q	
	2005																										Q					Q			Q		
	2006																																				
ILIWI	2004																															Q			Q		
	2005																										Q					Q			Q		
	2006																																				
PEDRO	2004																															Q			Q		
	2005																											Q				Q			Q		
	2006																																				

KEY:

I	Instantaneous stream discharge measurements taken each month coincident with water quality (ungaged stations without dataloggers).
Q	Water quality samples collected for field and laboratory analyses.



Pebble Project

NORTHERN DYNASTY MINES INC.

Figure 4.1-1
Hydrology, Surface Water, and Aquatic Resources Study Area (2004-2006 Mine Studies)

DRAFT

Legend

- Mine Development Concept Plan
- Ore Body
- Claim Boundary
- Sampling Location

Type of Sample Site

- Hydrology & Water Quality sample site with data logger
- Hydrology & Water Quality sample site without data logger
- Fish tissue sample site
- Macroinvertebrate & Periphyton sample site
- Seep water quality sample site

N

Miles: 0 2 4 6 8

Kilometers: 0 2.5 5 7.5 10

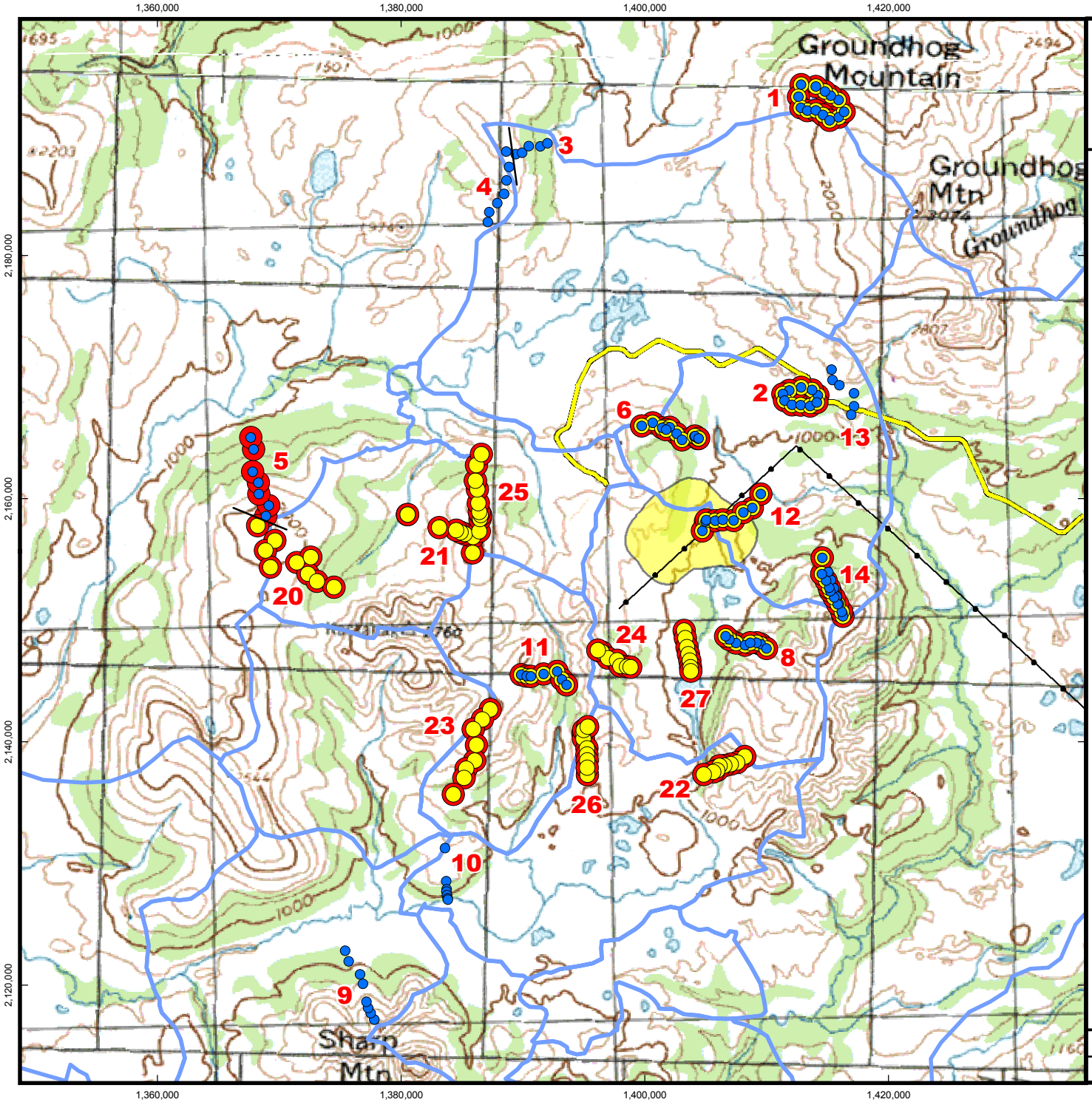
Scale 1:167,981

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: Figure 4.1-1.mxd	Date: June 02, 2006
Version: 2	Author: HDR-CEB, DW

Z:\200847 Northern Dynasty Minerals\All Disciplines\GIS\RD\Source\HDR\All Disciplines\DELIVERABLES\2006 Study Plan\V_2 All\Disc\MXD\2006studyplan_fig4 1-1v2

ASP 5 NAD 83



Pebble Project

NORTHERN DYNASTY MINES INC.

Figure 4.1-2.
2004, 2005 and 2006
Snow Survey Station Locations
in the Mine Study Area

DRAFT

Snow Survey Station Locations

- 2004 Snow Survey Location
- 2005 Snow Survey Location
- 2006 Snow Survey Location
- Local Watershed
- 2005 Pit Outline
- Proposed Road Alignment
- Proposed Transmission Line

Miles
0 1 2 3
Kilometers
0 1 2 3 4 5
N

Scale 1:140,000

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: Snow_Survey_StudyPlan06_06-170-1.mxd	Date: June 9, 2006
Version: 1	Author: ABR-AZC

DRAFT

1,400,000 1,450,000 1,500,000 1,550,000 1,600,000 1,650,000 1,700,000 1,750,000

2,250,000 2,200,000 2,150,000 2,100,000 2,050,000 2,000,000

LAKE CLARK A-7 LAKE CLARK A-6 LAKE CLARK A-5 LAKE CLARK A-4 LAKE CLARK A-3 LAKE CLARK A-2

ILIAMNA D-7 ILIAMNA D-6 ILIAMNA D-5 ILIAMNA D-4 ILIAMNA D-3 ILIAMNA D-2 ILIAMNA

ILIAMNA C-7 ILIAMNA C-6 ILIAMNA C-5 ILIAMNA C-4 ILIAMNA C-3 ILIAMNA C-2 ILIAMNA C-1

ILIAMNA B-7 ILIAMNA B-6 ILIAMNA B-5 ILIAMNA B-4 ILIAMNA B-3 ILIAMNA B-2

NONDALTON
ILIAMNA
NEWHALEN
KAKHONAK
PEDRO BAY

GS-20a GS-18a GS-17a GS-14a GS-14b GS-11a GS-12a GS-8a GS-7a GS-6a GS-4a GS-4b GS-3a GS-20 GS-23 GS-22 GS-21

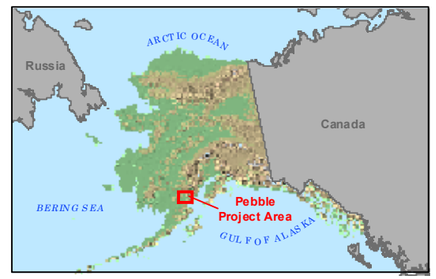
Pebble Project

NORTHERN DYNASTY MINES INC.

Figure 4.2-1
Surface Water Hydrology
Transportation Corridor
2004 and 2005 Sampling Locations

Legend

- Surface Hydrology Stations Sampled in 2004 and 2005
- Surface Hydrology Stations Sampled only in 2005
- Towns
- Proposed Transportation Corridor



0 4 8 12 16 Miles

0 4 8 12 16 Kilometers

N

Scale 1:363,852

Alaska State Plane Zone 5 (units feet)
1983 North American Datum

File: 2006StyPlan_1_V04.mxd	Date: June 7, 2006
Version: 4	Author: BEESC-ME