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NORTHERN DYNASTY MINES INC.
PEBBLE PROJECT

TAILINGS IMPOUNDMENT A
INITIAL APPLICATION REPORT
(REF. NO. VA101-176/16-13)

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EXECUTIVE SUMMARY

The Pebble Project is a proposed copper-gold-molybdenum mine, processing facility and associated Tailings Storage Facility (TSF) located latitude 59°53’54” and longitude 155°17’44” in the Bristol Bay region of southwest Alaska, approximately 238 miles southwest of Anchorage and 17 miles northwest of the Village of Iliamna. It is situated within Iliamna D6 and D7 topographic maps in Townships 3 to 5 South, Ranges 34 to 37 West in the Seward Meridian. Northern Dynasty Mines Inc., the project owner, is developing the project, and has engaged Knight Piésold Ltd. to design the TSF, which includes the staged construction of confining dams.

The procedures for applications to construct a dam are outlined in Chapter 5 of the Guidelines for Cooperation with the Alaska Dam Safety Program, dated June 2005, (the “Guidelines”) published by the Dam Safety and Construction Unit, Water Resources Section, Division of Mining, Land and Water Resources of the Alaska Department of Natural Resources. This report constitutes the Initial Application Package for submission under the Alaska Dam Safety Program as the first step towards receipt by Northern Dynasty Mines Inc. of a Certificate of Approval to Construct a Dam.

The proposed impoundment will incorporate three embankment structures in the South Fork Koktuli River situated near the headwaters as follows:

- A north embankment that will be progressively raised in a series of staged expansions to an ultimate height of 700 feet,
- A southeast and southwest embankment that will be constructed in stages to an ultimate height of 710 feet and 740 feet, respectively.

Knight Piésold Ltd. has carried out a Hazard Potential Classification of the dams, based on the classifications set out in the Guidelines. The resulting preliminary classification for each of the dams is Class II (Significant). However, Northern Dynasty Mines Inc. is planning to incorporate more stringent design criteria for flood and earthquake events consistent with a Class I (High) classification.

This report provides a project description; an assessment of the site characteristics with respect to hydrometeorology, seismicity and geology; an overview of comprehensive siting studies carried out to date; a description of the preliminary design basis and design methods that are used in the design of the impoundment and confining dams; and an overview of the design quality assurance and design quality control procedures.

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SECTION 1.0 - INTRODUCTION

1.1 PROJECT DESCRIPTION

The Pebble Project property incorporates a copper-gold-molybdenum mineral deposit centered at latitude 59°53'54" and longitude 155°17'44" in the Bristol Bay region of southwest Alaska, approximately 238 miles southwest of Anchorage and 17 miles northwest of the Village of Iliamna. It is situated within Iliamna D6 and D7 topographic maps in Townships 3 to 5 South, Ranges 34 to 37 West in the Seward Meridian. The location of the Pebble Project within the State of Alaska is shown on Figure 1.1. The mineral deposit is situated on a drainage divide, with the Upper Talarik Creek draining to the east and south, and North Fork and South Fork Koktuli River draining to the west and southwest, respectively.

Northern Dynasty Mines Inc. (NDM) is currently planning a mine development to extract and process the mineralized resource, and has retained the specialist consulting engineering firm Knight Piésold Ltd. (KPL) to develop the designs for the tailings impoundment facilities that will be required for the proposed Pebble Mine. Mr Ken Brouwer, PE (Alaska 10963) is the Knight Piésold Project Director and is the Engineer of Record for the design of the tailings impoundments.

The design basis for the TSF at Site A will allow for secure storage of approximately 2 billion tons of tailings solids discharged into an engineered containment impoundment. The tailings impoundment would be expanded in stages during on-going operations of the proposed mine development.

The design of the TSF at Site A includes a north, southwest and southeast embankment constructed along the headwaters of the South Fork Koktuli River. This tailings storage impoundment location is referred to as the Site A Tailings Storage Facility (Site A TSF) and is the subject of this application.

1.2 SCOPE OF REPORT

This report has been prepared as part of the Initial Application Package for the proposed Site A TSF in accordance with the *Guidelines for Cooperation with the Alaska Dam Safety Program, June 2005* and based on the comments received from Mr Charles F. Cobb; State Dam Safety Engineer on August 21, 2006.

This Initial Application Package is submitted in support of NDM water right application for the Pebble Project as requested by the Water Resources Section, Division of Mining Land and

Water, Alaska Department of Natural Resources. This application package is intended to support the NDM water right application for South Fork Koktuli River.

This Initial Application Package is the first step in the application process for the Alaska Dam Safety Program and is intended to establish agreement on important information early in the project planning. The Application Form is included in this report as Appendix A.

SECTION 2.0 - HAZARD POTENTIAL CLASSIFICATION

The Hazard Potential Classification (HPC) is the basis for evaluating the level of attention that is required for a dam throughout its lifetime as defined by Alaska Dam Safety Program (ADSP). The Hazard Classification and Jurisdictional Review form (Version 7, 3/2005) has been completed for each of the dam sites by Mr Ken Brouwer, P.E. and these are included in Appendix B.

The proposed hazard classification has been carried out on the basis of KPL site investigations, tailings impoundment siting studies, preliminary analyses and the initial discussions with the Dam Safety and Construction Unit of Alaska Department of Natural Resources (ADNR) on August 21, 2006.

The proposed classification for each of the dams at the Site A TSF is Class II (significant). However, NDM has determined that further precautions may be appropriate for hydrologic and seismic design parameters consistent with the more conservative Class I (high) hazard potential standards. Therefore, the design of the tailings impoundment dam structures has been based on extreme hydrologic and seismic events that will be further discussed in the following sections.

SECTION 3.0 - SITE CHARACTERISTICS

3.1 METEOROLOGY AND HYDROLOGY

Detailed baseline studies have been implemented and the third year of site specific data is currently being compiled by a number of specialist consulting groups that have been retained by NDM. Processing of data and updating of hydrometerologic values for the project are ongoing. A number of data reports and various compilations are presently available, including the Knight Piésold (KP) report "Pebble Hydrometeorology" (Report No. 101-176/7-4, September 15, 2005) some of the findings from relevant studies are summarized below.

The mean annual precipitation (MAP) for the project site is estimated to be between 35 inches and 40 inches. A range of values is provided to reflect the uncertainty in deriving the MAP value, which is determined on the basis of extrapolating long-term regional records at Iliamna to the site, according to KP's current understanding of factors that influence climatic conditions in the region. Which value should be used for a particular modeling application depends on the purpose of the modeling, as determined by the engineer. Mean monthly precipitation values are highest in August and lowest in April, with variations from year to year represented by coefficients of variation ranging from approximately 0.5 to 1.0. Two climate stations are currently operating on the site, as shown on Figure 3.1, with the intent of using the collected data to refine the current estimated values.

Mean annual runoff is estimated to be equivalent to MAP, based on the concept that any increase in precipitation with elevation is largely offset by runoff losses to evapotranspiration and deep groundwater. Runoff patterns in the region differ substantially from precipitation patterns due to the effects of snow accumulation and melt. Peak runoff periods are in the spring due to snowmelt and in the fall due to rain and rain combined with the melt of immature snowpacks, while the lowest flow period occurs during the coldest winter months.

Return period peak flow estimates have not yet been determined for the site. However, it is the intent to generate such values for specific design purposes, as required, on the basis of the limited relevant historical regional peak flow data, peak flow equations for the region developed by the USGS, peak flow data currently being collected at sixteen gauging stations in the Pebble Project mine site area, snowpack data currently being collected on site, and historical regional extreme precipitation data. The locations of the site gauging stations, three of which are operated by the USGS, are shown on Figure 3.1.

The probable maximum flood (PMF) has been selected as the inflow design flood (IDF) for the tailings impoundment embankments at Pebble. The PMF is the flow resulting from the most severe combination of probable maximum precipitation (PMP) and basin hydrological conditions. The PMP is the precipitation that results from the worst possible meteorological conditions.

The PMF will be evaluated using a mathematical model to convert PMP and snowmelt into basin runoff. The HEC-HMS computer program will most likely be the model used for this analysis. HEC-HMS is a flood hydrograph package developed by the Hydrological Engineering Center of the U.S. Army Corps of Engineers. This updated model was previously called HEC-1 and is recognized as one of the leading computer models for computing runoff hydrographs from precipitation data. Inputs into the HEC-HMS model include precipitation, precipitation distribution and various physical characteristics of the watershed.

There are three model input parameters that are site specific to each basin that will be considered: the time of concentration, the basin area, and the baseflow. The time of concentration reflects how quickly a basin responds to precipitation. This parameter essentially determines the maximum slope of the hydrograph curve, and therefore the time before peak flow is observed at the basin outlet.

The snowmelt contribution to the PMF will be determined using the U.S. Army Corps of Engineer publication, Engineering and Design – Runoff from Snowmelt (1998).

Several environmental factors influence snowmelt and its potential contribution to the PMF. These factors are the snowpack depth at the time of the PMP storm event, the temperature during the storm event, the wind speed during the storm event and the precipitation depth for the duration of the storm event. Available site specific baseline data and published guidelines will be used to determine these parameters.

3.2 SEISMICITY

3.2.1 Regional Seismicity

Alaska is the most seismically active state in the United States and in 1964 experienced the second largest earthquake ever recorded worldwide. Both crustal earthquakes in the continental North American Plate and subduction earthquakes affect the Alaska region. Historically, the level of seismic activity is highest along the south coast, where earthquakes are generated by the Pacific Plate subducting under the North American plate. This seismic source region, known as the Alaska-Aleutian megathrust, has been responsible for several of the largest earthquakes recorded, including the 1964 Prince William Sound magnitude 9.2 (M9.2) earthquake. There is potential for a future large subduction earthquake (M9.2+) along the southern coast of Alaska, and this seismic source zone is located approximately 125 miles from the project site.

Several major active faults in Alaska have generated large crustal earthquakes within the last century. A magnitude 7.9 earthquake occurred along part of the Denali fault in 2002, approximately 44 miles south of Fairbanks. The western portion of the Denali Fault trends in a northeast-southwest direction, approximately 125 miles north of the project site. Approximately 19 miles northeast of the project site is the western end of the northeast-southwest trending Castle Mountain Fault, which terminates approximately at the northwest end of Lake Clark. A magnitude 7.0 earthquake associated with this fault occurred in 1933. The Denali and Castle Mountain faults are capable of generating large earthquakes with magnitudes in the range of M7.5 to M8.0.

3.2.2 Seismic Hazard Analyses

The seismic hazard for the Pebble project has been examined using both probabilistic and deterministic methods of analysis.

Maximum bedrock accelerations have been determined based on the published USGS probabilistic seismic hazard model for Alaska. This was developed by the USGS to produce their latest seismic hazard maps for Alaska. Maximum horizontal acceleration values have been determined for return periods ranging from 100 years to 5000 years. The results have been summarized in Table 3.1**,** in terms of earthquake return period, probability of exceedance and maximum acceleration. The calculated probabilities of exceedance assume a design operating life of 20 years. For a return period of 475 years the corresponding maximum acceleration is 0.14g, implying a moderate seismic hazard.

A deterministic analysis has been carried out by considering known seismic sources and fault systems in the region and applying a maximum earthquake magnitude to each potential source. The resulting deterministic acceleration at the study site for each source is considered to be the maximum credible acceleration that can occur, on the basis of available geologic and tectonic information. The maximum accelerations were calculated using the mean plus one standard deviation values with appropriate ground motion attenuation relationships. The ground motion attenuation relationships used are applicable to western North American earthquakes, and are consistent with those used by the USGS. As indicated by the review of regional seismicity summarized above, the three most prominent seismic sources in the region of southwestern Alaska are the Denali Fault, Castle Mountain Fault and the Alaska-Aleutian megathrust. The results of the deterministic analysis are presented in Table 3.2, including the potential maximum magnitude for each of these seismic sources, the estimated minimum epicentral distance and the calculated maximum acceleration at the project site. Based on these results a Maximum Credible Earthquake (MCE) of M7.8 causing a maximum bedrock acceleration of 0.3g has selected for the Pebble project site.

3.2.3 Design Earthquakes

Consistent with current design philosophy for geotechnical structures such as dams, two levels of design earthquake have been considered: the Operating Basis Earthquake (OBE) for normal operations; and the Maximum Design Earthquake (MDE) for extreme conditions (ICOLD, 1995).

Appropriate OBE and MDE events for the facilities are determined based on a hazard classification of the facility, with consideration of the consequences of failure. The hazard classification was carried out using the criteria provided by the document “Guidelines for Cooperation with the Alaska Dam Safety Program” (2005). Classification of the facilities is carried out by considering the potential consequences of failure, including loss of life, economic loss and environmental damage. The hazard classification has been assessed as at least Class II (Significant). The OBE and MDE are selected based on the dam hazard classification and an appropriate earthquake return period, as defined by the “Guidelines for Cooperation with the Alaska Dam Safety Program” (2005).

For a Class II hazard classification, the OBE is selected from a range of return periods from 70 to 200 years, depending on the operating life of the facility, the frequency of regional earthquakes and the difficulty of quickly assessing the site for repairs. The impoundment would be expected to remain functional during and after the OBE and any resulting damage should be easily repairable in a limited period of time.

The MDE is typically selected from a range of return periods from 1,000 to 2,500 years for a Class II hazard classification. However, the MDE for the Pebble tailings storage facilities embankments have been conservatively based on a Class I hazard classification making it equivalent to the MCE, which has a bedrock acceleration of 0.30 g corresponding to a magnitude M7.8 earthquake, occurring along the nearby Castle Mountain Fault system. The MCE is considered to be the seismic event with the highest possible maximum ground acceleration at the project site. A M9.2+ megathrust earthquake does not impose the highest maximum ground acceleration at the Pebble site (predicted maximum acceleration of 0.17 g), but the event is also considered in seismic design analyses due to the very long duration of ground shaking associated with earthquakes of this magnitude.

The tailings storage facility embankments will be designed to meet or exceed the Alaska Dam Safety requirements to ensure the embankment will remain stable without release of tailings or process water for all loading cases, including the MDE and the M9.2+ megathrust event.

3.3 GEOLOGIC AND GEOTECHNICAL CONDITIONS

General

The geotechnical investigations completed at the site through the end of 2005 include testpits and boreholes. These are illustrated on Figure 3.2 and Figure 3.3, respectively. The field and laboratory investigation programs are summarized in the following reports:

- KP 2005 Geotechnical Investigation Data Report VA101-00176/8-6 Draft in Progress
- KP 2004 Geotechnical Investigation Data Report VA101-00176/8-3
- KP 2005 Open Pit Geotechnical Investigations VA101-00176/8-5
- KP 2004 Open Pit Geotechnical Investigations VA101-00176/8-2
- WMC Draft 2004 Progress Report – Hydrogeology.

NDM is currently continuing to collect geologic and geotechnical information at the Pebble project site. This updated geologic, geotechnical and hydrogeologic information will continue to be compiled and integrated into on-going project planning and design. The following sections provide a general overview of the bedrock and overburden geology of the Pebble project site and at the proposed tailings impoundment site.

Bedrock Geology

The Pebble property lies within the northern circum-Pacific orogenic belt, a part of Alaska structurally controlled by the complex tectonic characteristics of an active continental margin. The structural grain in this area is defined by northeasterly trending faults related to translational motion along the Lake Clark structure that marks a lithotectonic boundary between the Peninsular terrane in the east and the Kahiltna terrane in the west. The Pebble deposit is situated immediately west of this boundary.

The Peninsular terrane consists of Permian limestone, Upper Triassic limestone, chert, tuff and agglomerate, together with Early to Middle Jurassic volcanic and intrusive rocks and Middle Jurassic to Cretaceous clastic rocks. The bedded rocks of the Peninsular terrane are bounded on the east side by an intrusive complex which is dominantly comprised of quartz diorite, and has been dated as Middle to Upper Jurassic in age.

The Kahiltna terrane consists of Late Triassic and younger basalt, andesite, tuff, chert, shale and limestone that may correlate with the Lower Peninsular terrane. The southern Kahiltna terrane was intruded by Cretaceous to Tertiary plutons, including the Later Cretaceous Kaskanak Batholith and coeval, proximal stocks, dikes, sills and irregular bodies associated with the Pebble deposit, which is made of granodiorite, quartz monzonite or quartz diorite. They are partly covered by Tertiary and Quaternary volcanic and sedimentary rocks.

Overburden Geology

The Pebble property falls into the Nushagak-Big River Hill physiographic division (Detterman and Reed, 1973). This is an area of low rolling hills separated by wide shallow valleys. Most of the area is an upland surface that stands 650 feet to 1,000 feet above the lowlands around Iliamna Lake. The project is located in a heavily glaciated area. The normally consolidated glacial debris has been extensively reworked and transported a short distance downstream from the source areas.

Four major glacial advances from the Alaska Range, to the northeast, formed most of the deposits in this area. The soil deposits consist mainly of till (ground moraine, terminal moraine and ablation), outwash plains, modified moraine (terraces) and glacio-fluvial sediments. Other soil deposits that occur less extensively in the region include swamp, landslide and solifluction deposits.

The underlying soil stratigraphy is very complex and heterogeneous both vertically and horizontally, due to the multiple stages of glaciation that have modified the area.

The river basins were generally formed as a result of numerous glaciations and is predominantly composed of ablation till and outwash moraine, with localized fluvial and swamp deposits. The till has been eroded and re-deposited in both fluvial and lacustrine environments along ancient and existing drainage courses. Given the multiple glaciations, there are areas where more recent till has been deposited over glaciofluvial and glaciolacustrine deposits of more ancient periods.

Site A is underlain by two predominant soil sequences. The valley sides and the upland area to the south of Frying Pan Lake are underlain by a complex sequence of coarse-grained moraine and outwash deposits. The central portion of the valley was once covered by a larger glacial lake, which the current shallow lake is a remnant of.

According to the Permafrost Map of Alaska (Ferrians, 1965), the Pebble site lies within a zone of sporadic permafrost. Permafrost in this region is most likely a relic from previous periods of glaciation. Permafrost was not observed during the 2004/2005/2006 site investigations.

TABLE 3.1

NORTHERN DYNASTY MINES INC.
PEBBLE PROJECT
Tailings Impoundment A - Initial Application Report
PRELIMINARY SUMMARY OF PROBABILISTIC SEISMIC RISK

M:\1\01\00176\16\A\Report\Report 13_dam application - Site A\Rev 0\Tables\[Table 3.1 and 3.2 - Design Scope.xls]Table 3.1

Print: Sep 8, 06
Rev: Aug 16, 06

Return Period (Years)	Probability of Exceedance[1] (%)	Maximum Acceleration[2] A (g)
108	16.9	0.08
224	8.5	0.10
475	4.1	0.14
975	2.0	0.18
2475	0.8	0.24
4975	0.4	0.30

Notes:
1) Probability of Exceedance calculated for a design life of 20 years.

$$q = 1 - \exp(-L/T)$$

where, q = probability of exceedance
L = design life in years
T = return period in years

2) Maximum Accelerations are for values on bedrock/firm ground.

TABLE 3.2

NORTHERN DYNASTY MINES INC.
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Tailings Impoundment A - Initial Application Report
PRELIMINARY SUMMARY OF DETERMINISTIC SEISMIC HAZARD ANALYSIS

Print: Sep 8, 06

M:\1\01\00176\16\A\Report\Report 13_dam application - Site A\Rev 0\Tables\[Table 3.1 and 3.2 - Design Scope.xls]Table 3.2 Rev: Aug 16, 06

A Earthquake Source	Maximum Magnitude (Mw)	Epicentral Distance (miles)	Maximum Acceleration[1] (g)
Castle Moutain Fault	7.8	18	0.30
Denali Fault - Central	8.0	125	0.08
Mega-Thrust Subduction Event	9.2	125	0.17

Notes:

1) Maximum Accelerations are for values on bedrock/firm ground.