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## **EAGLE GOLD PROJECT**

### **FROZEN MATERIAL MANAGEMENT PLAN**

(INCLUDES ICE-RICH AND NON ICE-RICH PERMAFROST)

*Version 2015-01*

**MARCH 2015**

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# 1 INTRODUCTION

## 1.1 OVERVIEW

StrataGold Corporation (SGC), a directly held, wholly owned subsidiary of Victoria Gold Corp., has proposed to construct, operate, close, and reclaim a gold mine in central Yukon. The Eagle Gold Project (“the Project”) is located 85 km from Mayo, Yukon on existing highway and access roads (Figure 1.1-1). The Project will involve open pit mining at a production rate of approximately 10 million tonnes per year (Mt/y) ore and an average strip ratio (amount of waste: amount of ore) of 1.45:1.0 over approximately 10 years.

Earthworks construction and some operational activities of the Project will result in the excavation and exposure of frozen overburden soils, identified as either permafrost or from within the active zone that freezes seasonally. Frozen soils at the project site consist of:

- fine and/or coarse-grained colluvial/alluvial soils or weathered bedrock with little or no ice content,
- coarse-grained sands and gravels with zones of variable ice content,
- fine-grained soils with relatively thin zones (lenses) and low proportions of “excess ice”, and
- fine-grained silty and clayey soils with relatively thick lenses of highly visible “excess ice”.

The term “excess ice” is used to describe ice that occupies a larger pore space in the soil than water in an unfrozen state. When this ice thaws, the resulting water exceeds the water holding capacity of the soil and excess water will be present. Some of the frozen soil with excess ice, hereafter called “ice rich”, may become unstable upon thawing, particularly if it is fine-grained and excess pore water pressure cannot drain readily. Some of these materials, which could potentially be useful in closure activities (e.g. as cover for reclamation) while thawing and draining, may require temporary containment during construction and operation of the mine. This plan describes the management of frozen materials, and how some of the ice-rich materials will be managed separately from other frozen overburden soils.

## 1.2 SCOPE

This frozen materials management plan includes:

- descriptions of existing site conditions pertinent to materials management;
- protocols for characterizing the nature and extent (lateral and vertical) of frozen materials encountered during construction activities including characterizing the presence and extent of excess ice;
- protocols for determining whether encountered frozen material is thaw stable or thaw unstable;
- estimated quantities of frozen materials to be handled during construction distinguishing between material types and different approaches for their management;
- descriptions of appropriate handling requirements for each frozen material type, including protocols for excavation and removal of thaw unstable material from drainage channels, valley walls, etc...
- design criteria and preliminary engineering for an ice rich overburden storage area;

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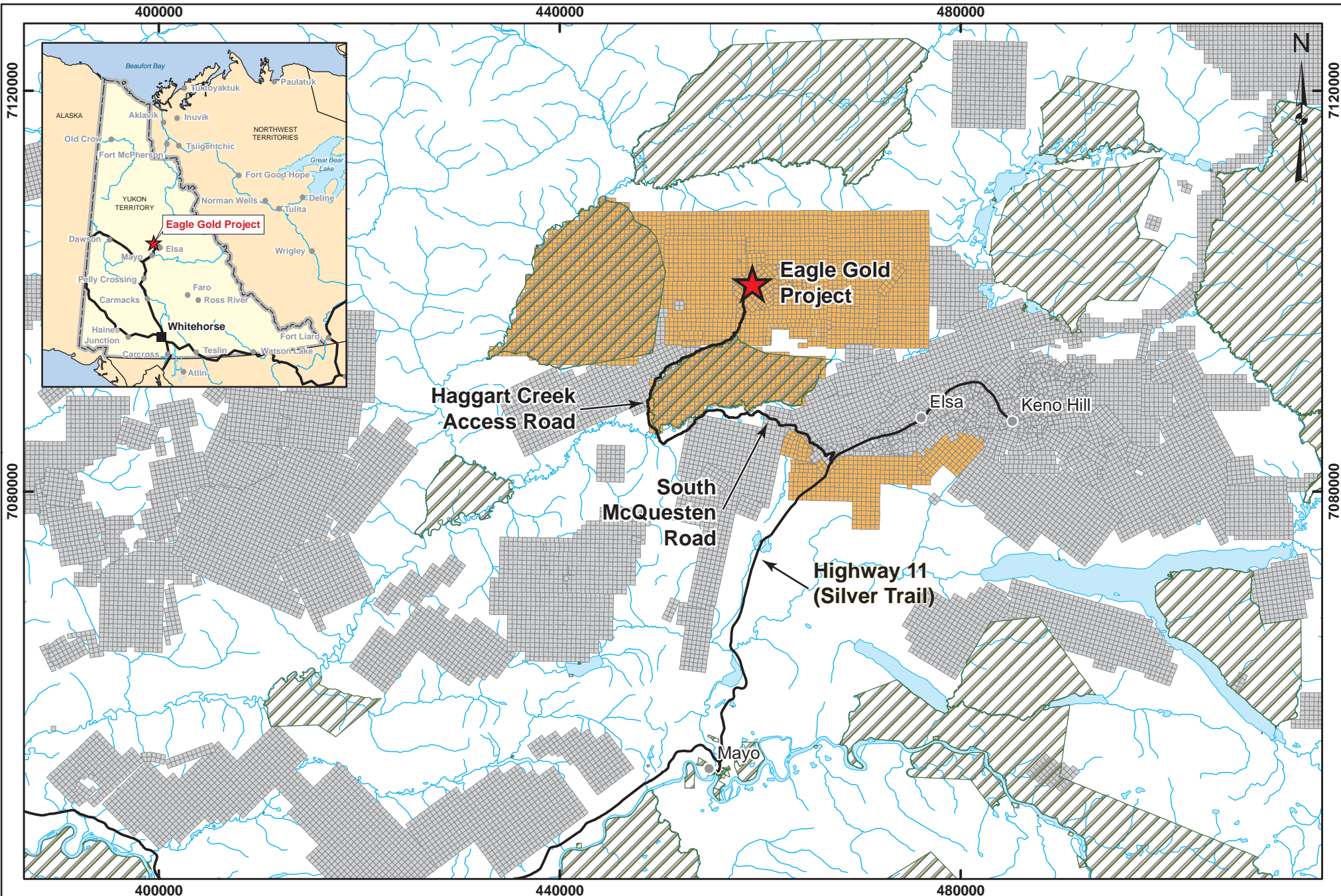
### Frozen Material Management Plan

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- construction quality assurance and quality control planning for the ice rich overburden storage area;
- protocols for recording and reporting on the characterization and management of frozen soils (including thaw stable and unstable materials), and
- monitoring plans for stability and associated water management.

This plan addresses the identification, field practices and overall management of all frozen materials, including permafrost and ice-rich soils as defined herein.



<b>LEGEND</b> Eagle Gold Project Watercourse Nacho Nyak Dun Settlement Land Town StrataGold Claims Waterbody Road Other Claims					PROJECTION: NAD83 Zone 8N	DRAWN BY: SStevens	<b>EAGLE GOLD PROJECT YUKON TERRITORY</b>  <b>Project Location</b>
					DATE: 2013/11/29	FIGURE: 1.1-1	

## **2 SITE DESCRIPTION**

The Dublin Gulch site has been described and characterized extensively in other reports. Surficial geological and permafrost conditions are relevant to this plan and so are summarised herein, for ease of reference.

### **2.1 SURFICIAL GEOLOGY**

The surficial geology of the Dublin Gulch area has been mapped by Bond (1998). Pleistocene and Holocene colluvial deposits are abundant in the Project area and generally consist of diamicton, gravel, shattered bedrock, lenses of sand and silt derived from bedrock, and surficial materials derived by a variety of chemical and physical weathering processes. These deposits overlie weathered to fresh bedrock. Transport of surface material occurs as creep and sheetwash; local shallow mass wasting processes occur on certain slopes in the area.

A till blanket was mapped along the east side of Haggart Creek south of its confluence with Dublin Gulch and into the lower Dublin Gulch valley. Glacial till occurred in patches in specific zones within the Dublin Gulch and Haggart Creek valleys due to the main flow directions of regional Cordilleran ice and the area physiography, and in most cases where present, was disturbed by historical placer mining. Remnants of the till deposits occur along the east Haggart Creek valley wall and south Dublin Gulch valley wall. In these locations the till is generally either a clayey or silty sand matrix with some proportion of larger clasts up to cobble size. Although their distribution has not been mapped, large-boulder (> 1 m) sized erratics have been observed in the Dublin Gulch valley including within some of the placer tailings (i.e., alluvial materials reworked by placer mining) upstream of the confluence with Ann Gulch, but not in the Haggart Creek valley.

The Haggart Creek valley in the area of the Project site is filled with a mix of alluvial deposits and placer tailings. At the valley walls, alluvium, where present, grades imperceptibly into colluvium. Bedrock is exposed along the creek bottom or banks in several locations along the length of the placer disturbed area.

### **2.2 PERMAFROST**

The Project is located in a region of widespread discontinuous permafrost (Brown, 1979). On the regional scale, permafrost distribution is typically controlled by mean annual temperature and precipitation, whereas on a local scale it is controlled by vegetation, surface sediments, soil moisture, slope aspect, and snow depth. Within the Project area, frozen ground occurs typically on north- and east-facing slopes at higher elevations, and within poorly drained areas lower in the valleys. Based on site characterization work completed during 2009 to 2012 (BGC 2010, 2011 and 2012a), the distribution and thickness of permafrost is highly variable across the site, sporadic or non-existent in some areas (south-facing slopes) to more prevalent in other areas (north-facing slopes at lower elevations). Within the permafrosted areas, the distribution of excess ice and its lateral and vertical extent is also highly variable. In general, permafrost with zones of excess ice exceeding 1 m in thickness and laterally continuous over 25 m is limited to the lower north-facing slopes within the lower regions of the Eagle Pup and Suttles Gulch valleys, including the interfluvial areas between these valleys.

Frozen ground, when observed, is generally encountered immediately below the organic cover. Ground temperatures have been measured with thermistors installed on site in 1995-1996, and 2009-2012. The

measured ground temperatures showed the frozen ground to be relatively warm when observed, typically between 0°C and -1°C.

## **3 FROZEN MATERIAL MANAGEMENT CONCEPTS**

### **3.1 DEFINITIONS**

Permafrost is defined as- ground (soil or rock and included ice or organic material, if present) that remains at or below 0°C for at least two consecutive years.

Permafrost Distribution is based on estimated geographic continuity in the landscape:

- Continuous permafrost is land where the underlying 80-100% (as defined by the University of the Arctic) of the landscape is underlain by permafrost.
- Discontinuous permafrost is land where the underlying 30-80% (as defined by the University of the Arctic) of the landscape is underlain by permafrost.
- Sporadic permafrost is land where the underlying 0-30% (as defined by the University of the Arctic) of the landscape is underlain by permafrost.

Excess ice - the volume of ice in the soil that exceeds the total pore volume that the soil would have in an unfrozen state.

Frozen material – all frozen soils or rock with or without ice including seasonally frozen (within annual thaw zone or active layer) and perennally frozen material (permafrost)

Ice rich soils – soils comprised of excess ice; while ice rich soils can occur in both seasonally frozen and perennally frozen ground, the management strategies described herein generally apply to ice-rich soils within permafrost

### **3.2 IDENTIFICATION AND CLASSIFICATION**

Table 3.2-1 provides a classification scheme for frozen soils encountered on the Project site. These guidelines were used when reviewing the database of geotechnical borehole and test pit logs to develop the material management strategies as described in Table 3.3-1 and to estimate the expected volumes provided in Table 3.4-1.

These field identification and classification guidelines will be primarily used in the field when preparing for and during excavation activities to classify frozen materials into the five management types. The classifications will be used to guide the field geologist, engineer or technician responsible for monitoring construction activities. It is expected that the specific criteria in Table 3.2-1 and management strategies provided in Table 3.3-1 will be refined in the field during clearing, grubbing and material segregation activities, as needed, based on the visual inspections of cleared and grubbed areas (including the cut banks and upslope areas), with consideration of the duration of exposure, and based on observations of surface water quality monitoring of meltwater ditches and sediment basins, and the results of excavating, transporting and storing materials selected for disposal in the ice rich overburden storage area (IROSA). More detailed description of field activities and responsibilities are outlined in Section 4 (Excavation Management).

**Table 3.2-1: Field Identification and Classification of Frozen Soils**

Material Classification Type	Frozen Material Type Guidelines for Field Classification				
	Soil Properties	USCS Soil Types	Lateral Extent of Ice-bearing soils	% of Ice	Ice-Bearing Lense or Layer Thickness
I	Fine and/or coarse-grained colluvial or alluvial soils, or weathered bedrock	GW, GP, GM, GC, SW, SP, SM, SC, ML, CL, MH and CH	Limited to isolated zones (<5-10% of exposure), not laterally continuous	Little (< 5%) or no ice content	Lenses less than 0.5 m thick and separated by > 1.0 m of non-ice-bearing material
II	Coarse-grained sands and gravels (> 50% retained on No. 200 (0.075 mm) sieve)	GW, GP, GM, GC, SW, SP, SM and SC	Limited to isolated zones (< 20% of exposure), not laterally continuous	zones of variable ice content - up to 10-15% excess ice	Relatively thin lenses < 0.5 m thick
III	Fine-grained soils (> 50% silts and clays)	ML, CL, MH and CH	Limited to isolated zones (<5-10% of exposure), not laterally continuous	low proportions (<5-10%) of "excess ice"	relatively thin (< 0.5 to 1.0 m thick) zones (lenses)
IV	Fine-grained soils (> 50% fines)	ML, CL, MH and CH	Laterally continuous throughout exposure; multiple lenses	Readily visible (> 5-10%) "excess ice"	with relatively thick (> 1 m) lenses
V	Small quantities of ice-rich soils (fine or coarse)	GW, GP, GM, GC, SW, SP, SM, SC, ML, CL, MH and CH	Overall volume is less than 10% of potential fill area	Variable ice content - up to 20% excess ice	Relatively thin zones (lenses) < 1.0 m thick

Note – organic soils (OH, OL and Pt with or without ice) will be excavated and stockpiled for reclamation purposes; reclamation stockpile will be designed to contain some ice-rich material, which will be allowed to thaw and drain (to sediment basins as per the construction water management plan), and then re-graded.

### 3.3 MANAGEMENT STRATEGIES

Frozen ground, where encountered, contains varying amounts of ice, and in some cases can be considered as "excess ice" (as defined above), as described in the detailed records of test pits and cored geotechnical drillholes used to characterize the site by Knight Piésold (1996a and 1996b), Sitka Corp. (1996) and BGC (2010, 2011, 2012a and 2012b). Based on this previous work, it is apparent that frozen ground will be encountered during construction of a number of proposed project facilities, primarily on north-facing slopes. Frozen soils will be identified as one of five material management types using initially previous data, confirmed in the field during clearing, grubbing and general earthworks activities, and then managed as described in Table 3.3-1.

**Table 3.3-1: Management Strategies for Frozen Soils**

<b>Material Classification Type</b>	<b>Frozen Material Type</b>	<b>Strategy</b>	<b>Management Description</b>
I	Fine and/or coarse-grained colluvial/alluvial soils or weathered bedrock with little or no ice content	Used as Fill or Stockpiled for Closure	Used as general fill or if excess to a local fill requirement stored for reclamation.
II	Coarse-grained sands and gravels with zones of variable ice content	Used as Fill	Exposed and readily thawed and drained, and then used as general fill within embankments and platforms.
III	Fine-grained soils with relatively thin zones (lenses) of low proportions of “excess ice”	Stockpiled for closure	Separated and co-disposed with other non-frozen soils within stockpiles to be used for reclamation.
IV	Fine-grained silty and clayey soils with relatively thick lenses of highly visible “excess ice”	To IROSA	Segregated at excavation site based on prior field data/information, and additional observations during excavations. Excavated and hauled to the ice-rich overburden storage area located in the Haggart Creek valley.
V	Small quantities of ice-rich soils (fine or coarse)	Locally stored	Disposed of adjacent to excavation sites where thawing and drainage can be managed locally rather than hauled to the IROSA.

The management strategies described in Table 3.3-1 recognize that the excavation of frozen ground, particularly ice-rich frozen ground, requires additional effort and care beyond that required for typical excavation of unfrozen ground, or for ice-poor frozen ground. Well-bonded, ice-rich material will be difficult to excavate and for planning purposes, is assumed to require some degree of ripping. Consideration will be given to the thaw behavior of this material, and allowances made for adequate drainage and associated erosion and sedimentation control, as well as additional time and effort for the work. The general and specific strategies for managing drainage and sedimentation are described in the Water Management Plan. Exposure of ice-rich material, particularly thick soil horizons, and the associated thaw may result in wet, muddy, soft ground, and poor trafficability, along with local slumping and other nuisance effects. Each of these effects related to exposure of ice-rich material has been considered in the planning, design, and construction of mine site infrastructure. When ice-rich fine-grained soils are excavated and stockpiled, they may become unstable while thawing, and may stand at only very gentle slopes of a few degrees. Water draining from the thawing soil will also be managed, along with any associated sediment load.

Effective management of ice-rich material excavated during construction will be supported through prior planning, and will consider: the volume of material excavated, the spatial (lateral and vertical) distribution of material excavated, the schedule for material excavation, locations of sources of ice-rich material, potential locations of temporary or permanent storage facilities, design and operation of storage facilities, potential re-use of suitable thawed and drained materials, and closure of permanent storage facilities.

The excavated ice-rich materials will be derived from several different lithological units, including till, colluvium, alluvium and weathered rock. These materials vary in thickness, lateral distribution, texture, grain size distribution and natural moisture content (or ice content). Difficulties in handling thawing ice-rich materials will vary depending primarily on grain size, ice content and the thickness of the ice-rich unit. Coarser soils, like sand and gravel, will tend to drain more quickly and more freely on thawing, and will thus be less difficult to handle than finer soils. Thick zones of fine-grained ice-rich soils (referred to here as problematic) tend to drain more slowly, retain excess pore pressures, and have lower strength for longer periods than isolated thinner lenses of fine-grained materials, or coarser soils in general. It will be advantageous to segregate problematic ice-rich materials from less or non-problematic ice-rich and other frozen materials during construction on the basis of thickness, lateral extent and grain size. Decisions on potential segregation will be made during site development activities when it becomes more evident whether the materials can be meaningfully separated. The expected proportion of problematic fine-grained ice-rich material has been estimated together with the proportion of other frozen/non-frozen material where other material management practices can be used (i.e., identifying soils that can be readily stockpiled with other closure soils).

### 3.4 MATERIALS QUANTITIES

BGC (2012c) estimated the quantity of ice-rich soils that may be encountered during the construction of Project facilities. This preliminary estimate did not segregate the ice-rich soils for management strategy. Further, the estimate was derived using the General Arrangement (GA) assumed for the Feasibility Study. Based on additional field reconnaissance and the revised facility footprints of the updated GA, and a detailed assessment of test pit logs, photos and borehole records the estimate was further refined and segregated based on thickness, lateral extent and grain size of the ice-rich soil horizon/lense into material management strategy types described in Table 3.3-1. This strategy distinguishes between potentially ice-rich fine grained soils which must be fully contained (referred to here as problematic or Type IV soils in Table 3.3-1), other frozen materials that may either be directly utilized for engineered fill (Type II) or which may be directly co-disposed with soils designated for closure stockpiling (Type III). The estimated quantity of problematic ice-rich soils expected to be hauled and stored within the IROSA is approximately 195,000 m<sup>3</sup> (plus 15% for swell and 15% for contingency). Approximately 80% of this material is expected to be generated in the first year of construction.

Based on the earthworks materials take-off estimates, a total of approximately 1.7 million cubic meters of excess cut, including topsoil, ice-rich (Types I, II and III) and non-ice-rich overburden soils will be stored in the various designated soil stockpiles. This is expected to satisfy the overall requirement for closure covers, which is currently estimated at approximately 1.6 million cubic meters. Further, all locally stored Type V ice-rich material will be put in stockpiles that will utilize silt fencing or other best practices to prevent the uncontrolled conveyance of sediment laden runoff or melt water from entering water courses. Table 3.4-1 summarizes the sub-division of estimated quantities of potentially ice-rich soils into the various material management categories.

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Frozen Material Management Plan

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**Table 3.4-1: Functional Area Ice-rich Material Volume Estimates by Classification Type**

Functional Area	Ice-rich Total	Type I or II Used as fill	Type I or III -disposed closure use	Type IV IROSA	Type V Locally stored	Year
HLF	96	0	72	24	0	1
DGDC	111	28	28	56	0	1
Dublin south pond	60	30	15	15	0	1
Dublin north pond	0	0	0	0	0	1
Temporary crusher	113	28	28	56	0	1
ADR	6	0	3	0	3	2
Truckshop	35	9	9	9	9	2
Main crusher site	14	3	7	0	3	2
Eagle Pup – rock drain, pond	104	26	52	26	0	2
Platinum - rock drain, pond	9	2	5	2	0	2
Site access roads	65	16	33	0	16	2
Pit and truckshop haul roads	24	6	12	0	6	2
Camp expansion	0	0	0	0	0	2
Overland conveyor	0	0	0	0	0	2
Pads explosives storage	0	0	0	0	0	2
Magazine storage pad	0	0	0	0	0	2
Pad landfill	0	0	0	0	0	2
Laydown area	15	0	7	7		2
<b>Total</b>	<b>651</b>	<b>148</b>	<b>271</b>	<b>195</b>	<b>37</b>	<b>1</b>
<i>Year 1 Construction Total</i>	<i>380</i>	<i>86</i>	<i>144</i>	<i>150</i>	<i>0</i>	
<i>Year 2 Construction Total</i>	<i>271</i>	<i>62</i>	<i>127</i>	<i>45</i>	<i>37</i>	
<b>Add 15% for swell and 15% for Contingency</b>						
<b>Total</b>	<b>846</b>	<b>351</b>	<b>193</b>	<b>254</b>	<b>48</b>	

Note – all values in 1,000 m<sup>3</sup>

## 4 EXCAVATION MANAGEMENT

### 4.1 FIELD GUIDELINES FOR SUPERVISING EXCAVATIONS

There is an extensive set of background subsurface geotechnical data for the Dublin Gulch area collected over the past five years, which is in addition to that collected by prior operators during the 1990's. This data was collected and logged by engineering professionals using professional judgment and standard engineering field classification practices. The subsurface data sets were collected for site-specific areas identified for excavation and construction activities.

Following best management practices for construction activities (i.e., using professional geotechnical field staff experienced in identifying soils and rocks in permafrost terrain and construction operators and managers experienced in permafrost field conditions), and adaptive management practices for incorporating site-specific field information collected during the construction process are key factors for the successful execution of this Plan. One of the primary objectives for those supervising excavation will be to segregate frozen materials into the five types as described in the Table 3.2-1.

The purpose of the classification structure presented in Table 3.2-1 is to provide a set of field guidelines to support standard best practices for supervising excavation activities where materials will be classified and sorted for particular uses (e.g., structural fill, road base, top soil, potential reclamation cover material, etc.). A typical sequence for a particular construction area will include:










- 1) detailed review of construction plans for cutting/filling in a specific area,
- 2) detailed review of the existing data from air photos, test pits and borings,
- 3) field assessment of the site-specific terrain to undergo construction including reconnaissance across the terrain to be excavated, along existing road cuts, and to the locations of previous test pits,
- 4) conducting additional site investigations, if needed, in specific areas,
- 5) implementing erosion and sediment control measures as stipulated in the Water Management Plan,
- 6) initiating excavation and material haulage as dictated by cut and fill balances specified in facility designs, while classifying and segregating materials for specific uses or storage,
- 7) implementing adaptive management practices based on the observed feasibility and/or continuing need of executing the classification guidelines, and
- 8) modifying the classification system, as needed, to achieve the most efficient, cost effective way and environmentally sound method to manage the excavations and material management at the site; this would include achieving lower environmental impact due to minimizing construction vehicle usage, requiring minimal material movement, and maintaining more local material sources that would be available for future reclamation purposes.

In general, the field supervisor (a geologist, engineer or technician) will record and document their observations prior to and during all excavation activities using standard practices. These would include general descriptions of soil and bedrock type, stratigraphy (lateral and vertical extent) of units exposed or as determined by interpolating between boreholes and test pits, soil properties (USCS Soil Type), lateral and vertical extents of

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ice-bearing soils, including the percentage of ice of each unit or sub-unit as necessary. Representative samples will be collected from borehole cores, test pits or excavation faces for grain size analyses conducted in the field. In addition, approximate ice volumes or percentages, using a 5 cm diameter core or bulk sample of an approximate volume, will be estimated (following the classification system shown in Figure 4.1-1).

**Figure 4.1-1: Classification for Description of Frozen Ground**

<b>ICE NOT VISIBLE</b>			
GROUP SYMBOL	SUBGROUP		
	SYMBOLS	DESCRIPTION	
N	Nf	Poorly bonded or friable	
	Nbn	No excess ice, well bonded	
	Nbe	Excess ice, well bonded	
<b>VISIBLE ICE LESS THAN 2.5cm THICK</b>			
V	Vx	Individual ice crystals or inclusions	
	Vc	Ice coatings on particles	
	Vr	Random or irregularly oriented ice formations	
	Vs	Stratified or distinctly oriented ice formations	
<b>VISIBLE ICE GREATER THAN 2.5cm THICK</b>			
ICE	ICE + soil type	Ice with soil inclusions	
	ICE	Ice without soil inclusions	

(Modified from Guide to Field Description of Permafrost for Engineering Purposes, NRC. Technical Memorandum 79)

NOTE 1) Dual symbols are used to indicate borderline or mixed ice classifications  
 2) Visual estimates of ice content as indicated on borehole logs are  $\pm 5\%$

LEGEND  or   
 Soil Ice

The objective will be to provide estimates of the bulk ice content across an area, including volumetric estimates for the stable and thaw unstable zones (i.e., as classified into the types identified in Table 3.2-1).

The responsibility of the field supervisor also includes monitoring the following areas: any headwall retreat of the cutslope, re-vegetation, channeling and rilling of slope face, type/nature of any failures (slump, drip, crumble or block fail), and rates of sediment accumulation in ditches and sediment basins. The field supervisor, in conjunction with the construction foreman, will attempt to minimize the duration of the disturbance and confirm that slope stabilization and re-vegetation measures based on observed field conditions are implemented as soon as practicable or institute adaptive management measures (e.g., change cutslope angles, add sediment basins, etc.).

## 4.2 EXCAVATION METHODS

Generally, drilling and blasting of frozen materials will not be required. Where site-specific conditions indicate that the best management practice for ice-rich material will be excavation and removal to the IROSA a shovel, equipped with a ripper tooth, as necessary, will be employed with transport of any excavated material to the IROSA via a haul truck. Based on-site experience in building exploration roads and excavating trenches and test pits, thinner pocket lenses of poorly to moderately bonded coarse-grained ice-rich material can be excavated with a shovel; thicker layers of well-bonded fine-grained ice-rich material will require ripping with a shovel tooth.

## 4.3 SEDIMENT AND EROSION CONTROL

Sediment and erosion control measures will be implemented and maintained to ensure that excavations do not result in discharge of sediment-laden water to the receiving environment without adequate controls. Sediment mobilizations and erosion will be minimized by using the following measures.

- Limiting the extent of land disturbances to the practical minimum.
- Reducing water velocities across the ground using soil bioengineering, surface roughening, sediment logs, and recontouring.
- Reseeding disturbed land and constructing drainage controls to improve stability.
- Constructing sediment control devices, such as collection and diversion ditches, sediment traps, in-channel energy dissipaters, and sediment basins.
- Installing rock riprap, channel lining, sediment filters, or other suitable measures in ditches on steep gradients as required.
- Restricting access to re-vegetated and stabilized areas.
- Directing all sediment-laden runoff to the appropriate sediment control measure.
- Constructing appropriate temporary best management practices (e.g., silt fences, hay bales) downslope of disturbed sites where more permanent sediment control measures are not appropriate or in combination with permanent measures.

A description of these measures, their construction considerations, and follow up monitoring are provided in the Operations Water Management Plan (OWMP) and must be followed for all excavations.

## 4.4 SPECIFIC CONSIDERATIONS FOR THE DUBLIN GULCH DIVERSION CHANNEL

### 4.4.1 Management Approach

The management of frozen ground during construction and the effects of that construction are approached on a site-wide basis, as described herein, and by related plans (for example, the Water Management Plan and the Environmental Monitoring, Surveillance and Adaptive Management Plan). Due to its long linear character and the varied ground conditions that are crossed, the Dublin Gulch Diversion Channel (DGDC) has some specific considerations that are described below.

Permafrost encountered in excavations for the DGDC will be managed to avoid potential deformation of the completed channel that could result from the thawing of permafrost. Most of the DGDC construction will occur in cut, such that the south and north banks may expose permafrost, some of which may contain excess ice.

As the DGDC is a long linear structure, excavation and construction of the facility will be managed and conducted in four separate sections for more efficient management of equipment traffic, runoff, erosion and sedimentation processes, excavation quantities (including general frozen and problematic soils), and material supplies for construction. The four sections are divided based on physiographic breaks and topography so that runoff, seepage and meltwater can be directed via gravity to specific sediment basins located at the downstream extents of each reach. Each sediment basin will discharge to a ditch that will ultimately convey water to the Lower Dublin North Pond. Intermediate sediment basins may be considered based on the volume of runoff/seepage/meltwater expected and/or observed. The four sections include:

- Reach I (18+20 to 23+81), which extends from the DGDC inlet to Eagle Pup,
- Reach II (11+80 to 18+20), which extends from Eagle Pup to Suttles Gulch
- Reach III (3+75 to 11+80), which extends from Suttles Gulch to the main access road crossing through the culvert battery, and
- Reach IV (0+00 to 3+75), which extends from the culvert battery to Haggart Creek.

Based on geotechnical investigations of the proposed DGDC (BGC 2010, 2011 and 2012), only Reach II is expected to contain permafrost or permafrost with excess ice. All cuts will be managed according to the planned mitigation measures described in Section 4.2.1 of the OWMP and the best management practices as described in Section 4.2.2 of the OWMP.

### 4.4.2 Excavation Procedures

With respect to excavations in permafrost, and while keeping in mind criteria for cut slope gradients, the vertical face of the top of the cutslope, could be steepened so that natural stabilization using in-situ vegetation can take place. In this case, it is preferable to allow the vegetative mat to drape over the top edge to shade the interface between the slope and the original ground, so this part of the area should not be stripped. Also, in many cases, larger trees on the edge should be hand cut, to minimize the collapse of the tree onto the exposed slope face so that the organic mat is not torn and more permafrost is exposed. On flatter cut slopes, a windrow of vegetative mat could be stripped and conserved for later machine spreading onto the stripped area. If frozen gravels

(coarser materials in general) are exposed in the cutslope, the slope can be re-graded and stabilized to allow natural re-vegetation processes to reclaim the cut.

In a few locations proposed for the construction of the DGDC, the excavated channel bed may also expose permafrost with excess ice. In these cases, the channel bottom will be over-excavated, as needed, to a depth where the thickness of channel backfill (coarse sand and gravels) will provide sufficient insulation to minimize any effect from the potential thawing of permafrost.

#### **4.4.3 Cutslope Criteria**

Field investigations in support of geotechnical recommendations for design of Project infrastructure were undertaken in 2009, 2010, 2011 and 2012. Based on the observed subsurface conditions for the Project site and generally accepted engineering practices, recommended slope geometry was developed for permanent cut slopes and engineered fill slopes for various Project components.

The recommended slope geometry developed for the permanent cut slopes required for the construction of the DGDC indicated that a steepest cut slope angle of 2.5H:1V in overburden and 2H:1V in till should be used for the design. The geotechnical recommendations also suggested that engineered fill slopes constructed of structural fill or rock fill should be at angles of 2H:1V or flatter. The geotechnical recommendations were considered for the design of the DGDC and a maximum cut slope angle of 2.5H:1V and a maximum fill slope angle of 3H:1V have been applied.

## 5 STORAGE MANAGEMENT

### 5.1 GENERAL FROZEN MATERIALS

#### 5.1.1 Design Assumptions

This section describes the management strategies for material types I, II, III and V. Management strategy for Type IV (problematic) soils is described in Section 5.2.

The soil stockpile areas will be managed in the same manner as all other construction areas by means of interception and diversion of runoff around and away from the disturbance areas. Stockpile areas will be set out so that sediment from erosion is trapped and contained locally in swales and depressions, making use of more competent soils to form containment berms. The drainage management of the stockpile areas will be integral with general construction water management measures across the site and is described in more detail in the Construction Water Management Plan.

#### 5.1.2 Management Approach

The Mined Rock and Overburden Piles Investigation and Design Manual Interim Guidelines (Design Manual) provides the general criteria that will be used for each soils stockpile constructed on site (Piteau 1991). Relatively small quantities of ice rich fine-grained soils can be feasibly and practicably co-disposed with larger quantities of overburden soils in gently sloping areas. If required, toe berms will be constructed to provide containment against flowsliding in an uncontrolled manner.

Frozen soils that do not exhibit flow sliding potential (Types I or III) will be co-disposed with overburden soils set aside for closure. The stability of closure soil stockpiles is addressed separately, but it is assumed that the geotechnical properties of any frozen co-disposed soils will exhibit similar stability to the closure materials sourced from other non-frozen areas. Alternatively, closure materials could be placed in zones that ensure the stability and containment of the frozen soils (upon thawing).

Frozen soils found to be suitable for use as general fill (Type II), that meet criteria for engineered compacted fills, when thawed and drained, will be used accordingly. Their properties will be similar to other cut materials judged suitable for fill or storage in stockpiles where there is an excess above the required fill volume. This material could also ultimately be used for closure.

#### 5.1.3 Soil Stockpiles

##### 5.1.3.1 Soil Stockpile Design

Soil salvage is the removal of soil after vegetation has been cleared and transport of soil by haul trucks to designated long-term storage sites. This includes selected frozen soils (Types I and III) that are not judged to be so wet, ice-rich or fine grained that their presence will cause instability in the stockpiles. Selection of the stockpile locations has taken into account:

- Volume of soil that must be stored,

- Topography (in some instances site preparation to level the area, or to stabilize it in areas of permafrost will need to be completed),
- Avoidance of natural drainages, and
- Travel distances.

Soil stockpiles will be created at several locations at the site. Advantage can be taken of access and haul road embankments to contain weaker materials, and to provide localized sedimentation ponds.

Careful zoning of the stockpiles will facilitate retrieval of selected materials required for closure, and also can result in improved stability by utilizing better drained stronger materials to contain weaker ones.

Also, stripped soils ultimately needed for closure will be stored as close as practical to sites where they will be required, taking advantage of local swales and depressions. All stripped soils, whether frozen or not, and whether ice rich or not, are regarded as very valuable for closure, and will be carefully placed for ease of retrieval.

Soil stockpile storage volumes are based on stockpile heights between 8 to 10 m and slopes of about 2H:1V. The precise slope angle will be determined on the basis of geotechnical evaluation of both specific foundation conditions as encountered, and the actual materials requiring storage.

Best management practices and mitigation measures the stockpiling of soils will include the following:

- Soil will be stockpiled in suitable locations where it will not be moved or subject to further disturbance to minimize admixing and physical deterioration;
- Stockpile locations will be a sufficient distance away from operations to protect soils from contamination from risk of spills or metal and non-metal deposition;
- Protective ditches will be constructed around stockpiles to prevent any spill reaching stockpiles and prevent any erosion from stockpiles from escaping offsite;
- Erosion will be managed by limiting the height and slope of stockpiles. Where possible, slopes will be approximately 2:1 and heights will not exceed 10 m;
- Stockpiles will be oriented to reduce wind erosion as much as practical, and stockpiles will not be stored at heights of land to reduce wind exposure;
- Where appropriate, erosion control measures will be implemented;
- Vegetation slash that is not cleared from the site will be incorporated into soil stockpiles;
- Soil stockpile locations and soil types will be identified by signage to prevent removal of material from the site and minimize mixing of soil types; and
- Vegetation will promptly be established on stockpiles, where appropriate, to reduce exposure of bare soil to wind and water erosion forces and control the establishment of invasive plants.

All locally stored Type V frozen material will be added to locally placed stockpiles that will incorporate silt fencing and/or other best practices to prevent the uncontrolled conveyance of sediment laden runoff or melt water from entering watercourses.

### **5.1.3.2 Foundation Conditions**

As noted above, geotechnical evaluation of specific sites, and of materials being stockpiled will require ongoing assessment and field direction. As Type I, II III and V materials thaw and drain, their stability will improve. Similarly, weak wet foundation conditions, if encountered, will require site-specific direction by the geotechnical engineer to ensure that materials are placed in ways that buttress against flow-sliding rather than trigger it.

These stockpiles are not creating permanent structures and the main objectives are to avoid mass sliding during their temporary placement (i.e., during operations), and facilitate ultimate retrieval of valuable soil media. Foundation preparation may be required for adjacent road embankments and this effort should be coordinated with any measures that provide buttressing containment for stockpiled material that requires toe support.

### **5.1.3.3 Transport and Disposal**

All excess cut soils for use at closure will be transported by truck from the excavation sites to the appropriate closest storage/stockpile areas. Detailed layouts of the road access into these areas will be determined by the field geotechnical engineer, making allowance for foundation conditions, and making best use of more competent materials to buttress wetter and weaker ones. As noted above, the disposal layout will seek to ensure mass stability rather than trigger flow sliding.

### **5.1.3.4 Construction Quality Assurance and Quality Control**

Construction of soil stockpiles will be carefully directed, documented and monitored. Corrective action to stabilize localized flow-sliding will be taken by constructing toe berms and/or improving drainage. Upon completion, each stockpile will be characterized geometrically and geotechnically, based on field records, so that closure planning can be optimized.

## **5.1.4 Monitoring and Surveillance**

The role of the supervising geotechnical engineer in monitoring actual soil conditions and stockpile behavior during construction is important. Ongoing intermittent inspection will be carried out as part of site-wide monitoring of the performance of all civil works. Guided by construction records of actual material conditions and zoning within and beneath the stockpiles, more or less importance will be assigned to the ongoing inspection of stockpiles during the mine life.

As noted earlier, the composition of the soil stockpiles will be documented so that as part of adaptive management the design of the closure capping system can be advanced to best utilize the actual properties and quantities of available material.

## **5.2 PROBLEMATIC ICE-RICH MATERIALS**

### **5.2.1 Management Approach**

This section describes the management strategy for material Type IV, problematic ice-rich soils. Fine-grained silty and clayey soils with relatively thick lenses of highly visible “excess ice” are problematic due to their inherent low stability upon thawing, which in some cases may take a few years. Thus, the management approach for these soils is to segregate at the excavation site and then haul to the IROSA located in the Haggart Creek valley. This section describes the design concept, design criteria and construction issues associated with the storage facility.

## 5.2.2 Design Concept

### 5.2.2.1 Siting and Alignment Selection

Site selection for the IROSA was completed in three stages, BGC (April 2013). Twenty-one potential disposal areas were identified around the general project area, and ranked according to storage efficiency. Nine of the highest ranked alternatives were selected for further comparison, and rated according to criteria for resource conflicts, environmental considerations, social considerations, construction and design considerations, and closure and post-closure considerations. A sensitivity analysis identified two superior options in the existing depressions in placer tailings along Haggart Creek, and the area of Suttles Gulch above the diversion channel.

The Haggart Creek site (Figure 5.2-1) was selected as the preferred alternative, with Suttles Gulch (Figure 5.2-2) identified as a contingency, to be developed later for use if the quantities of ice-rich material generated in construction become significantly greater than expected and cannot be accommodated in the IROSA area.

The proposed IROSA is approximately 660 m long by 50 to 150 m wide and has been previously developed for placer mining. It lies along the east valley wall within the Haggart Creek Valley and is comprised of several large mounded tailings piles that separate four large depressions from Haggart Creek, which flows from north to south. The design considered tying five berms into the existing mounded tailings and till side-slopes to create four separate storage cells. The berms will be constructed using readily available coarse tailings material and a filter material on the upstream slope in order to promote draining of excess pore water while containing the fine-grained ice-rich overburden. The combined estimated storage capacity of the storage cells amounts to approximately 255,000 m<sup>3</sup>.

### 5.2.2.2 Site Investigation

Following site selection, a geotechnical investigation was completed by NELPCo (2013) within the perimeter of the proposed IROSA to gather geotechnical information on subsurface conditions to support the design process. The geotechnical investigation consisted of:

- Review of all available historical data for the area of interest;
- A field reconnaissance of the IROSA;
- Drilling of seven boreholes (strategically located in ideal locations for the storage area berms) using hollow stem augers to depths varying from 8 to 18 m to allow for the collection of Standard Penetration Tests and soil samples at 1.5 m intervals;
- Installation of three monitoring wells (one nested) and two standpipe piezometers for monitoring piezometric pressures and completing hydraulic conductivity testing; and
- Index soil testing.

The site area consists of four depressions situated between till cliffs cut into the eastern valley wall and mounded sand and gravel tailings produced by historical placer mining activities. The tailings are sparsely to non-vegetated, with higher densities of brush occurring within low lying areas. An overgrown road that traverses east and uphill from the till cliffs connects with tailings at the southern end of the storage area. A portion of the road includes a ditch that diverts mountainside surface runoff away from the placer tailings area.

Surface water run off drains into the depressions and has formed four small ponds. Runoff entering the ponds has historically originated from upslope road-side ditching along Haggart Creek Road (directed across the road via culverts during September 2013), freshet overflow from a historic diversion built by placer miners (likely early 1990's) from Platinum Gulch and primarily freshet run-off from the eastern slope. Drainage within the depressions is north to south to the southernmost pond, where it exfiltrates to subsurface soils. These ponds are leaky-confined by fine-grained sediments and are perched above the local groundwater table. At the time of the drilling and site work, there was no active outlet from the confined valley.

The soils encountered beneath the tailings included disturbed alluvial and fluvial sands and gravels overlying silt till and weathered bedrock. The in-situ subsurface soil densities varied from very loose to compact sands, compact clay, and very dense to hard till and weathered bedrock. No permafrost was encountered during the geotechnical investigation.

Groundwater was encountered in all but one borehole (MW03 – see Figure 5.2-1). Below the perched ponds, ground water was encountered at roughly the same elevation as Haggart Creek. Recovery tests were completed in a thick gravelly, silty sand aquifer encountered in borehole MW02 (located in the approximate center of the investigation area). The estimated hydraulic conductivity was  $9.76 \times 10^{-6}$  m/s.

Bedrock in the area has been characterized as zones of quartzite and granodiorite. The drill equipment used for this geotechnical investigation was able to drill into weathered bedrock, but unable to penetrate into competent bedrock. A rough comparison using topographic maps and borehole locations indicates that bedrock is highest at MW03 and decreases gradually to the south and dips towards the east.

### **5.2.2.3 Containment Filter Berm Concept**

The design concept comprises five berms that will form four storage cells within the IROSA (Figure 5.2-1). The crests of the berms will vary from five to eight metres in height with an upstream and downstream slope of 2H:1V. The berms will tie into the contours of the mounded tailings piles at elevations ranging from 750 to 758 m. Table 5.2-1 lists the estimated storage capacities and the required volumes of coarse aggregate and filter material for each berm. The Haggart Creek IROSA will be capable of storing approximately 255,000 m<sup>3</sup> of problematic ice-rich material (i.e., Type IV), assuming an approximate 2% (50H:1V) gradient for the storage surface, with a berm fill quantity of 28,000 m<sup>3</sup>. The storage volume could be increased substantially (~25% to 35%) if the ice-rich material can be stacked behind the berms at slightly steeper grades (e.g., 15H:1V), or even more if the tailings mounds along the western side of the IROSA were re-configured and re-shaped into a single berm connecting the four storage cells.

**Table 5.2-1: Estimated Storage Capacity and Volume of Berm Material**

Storage Area	Overburden (m <sup>3</sup> )	
1	37,000	
2	73,000	
3	45,000	
4	100,000	
<b>Total</b>	<b>255,000</b>	
Berm	Coarse Material (m <sup>3</sup> )	Fine Material (m <sup>3</sup> )
A	4,700	420
B	11,000	1,125
C	5,400	850
D	2,600	375
E	1,400	295
<b>Total</b>	<b>25,100</b>	<b>3,065</b>

Note: estimated volumes assume 6 m wide crest widths

The filter berms will consist of two parts, a coarse aggregate and a finer filter zone. The bulk of the berms will be constructed with coarse aggregate (25 to 200 mm diameter material with little to no fine-grained gravel) to facilitate proper drainage and avoid the build-up of pore water pressure in the berm.

The containment berm and the storage area's foundation are relatively permeable, and are expected to promote drainage of the thawing stored materials. Silt and clay found at the base of the berms will be relocated to promote increased infiltration of excess pore water into the subsurface and to the ground water table. A 2m wide granular filter, comprised of well graded sand and gravel, will be placed on the storage side of each berm to prevent migration of fines through the berm.

### 5.2.3 Design Criteria

As described NELPCo (2013) the IROSA will be designed, constructed and operated in accordance with the Design Manual prepared for the British Columbia Mine Waste Rock Pile Research Committee (Piteau, 1991). As noted in section 3.2, approximately 195,000 m<sup>3</sup> (up to 255,000 m<sup>3</sup> assuming 15% swell and 15% for contingency) of ice-rich fine grained soils may require containment at the IROSA. These materials may be generated at rates of about 4,000 m<sup>3</sup> per day under the worst conditions, although it is not practical to predict the rate accurately. It is possible, that approximately 75% to 80% of the total can be expected to be generated in the first year of construction.

#### 5.2.3.1 Materials Properties

The foundation for the berms is composed of a variety of materials ranging from loose to compact sand, and clay tailings all underlain by weathered bedrock. Material properties including  $N_{(60)}$  values, angle of internal friction, and bulk unit weight are provided in Table 5.3-1. At this time, the overall ice content of the overburden material to be placed within the storage area cannot be known; therefore, a high ice content has been assumed giving low strength parameters.

**Table 5.3-2: Material Properties**

		<b>N(60)</b>	<b>Angle of Internal Friction</b>	<b>Bulk Unit Weight (kN/m<sup>3</sup>)</b>	<b>Cohesion (kPa)</b>
Foundation and Overburden	Very Loose Sand	<5	25	18.1	0
	Loose Sand	5 to 10	30	18.1	0
	Compact Sand	10 to 20	36	18.1	0
	Clay Tailings	13	30	20	0
	Weathered Bedrock	>50	45	23	0
	Overburden	-	2	15.7	0
Berm Material	Coarse Aggregate	-	36	17.1	0
	Filter Material	-	36	22.5	0

### 5.2.3.2 Stability Assessment

Following the Design Manual (1991), the selected ground motion parameters were based on an exceedence probability of 10% in 50 years, which corresponds with a return period of 475 years, and a Peak Ground Acceleration (PGA) of 0.14g.

The berm designs were analyzed by NELPCo (2013) assuming 1.3 factors of safety for the static condition and 1.0 factor of safety for the pseudostatic condition. These values were chosen based on the Design Manual guidelines, and from presented ranges of values using past experience, the existing site conditions, and material properties determined through site investigation and laboratory testing.

The storage area berms were evaluated assuming that fine-grained tailings were scraped off to expose the berm foundation and enhance the effective draining of excess pore water pressure created by thawing ice-rich overburden. Existing groundwater level readings taken during the geotechnical investigation were used in determining pore water conditions for the stability analyses.

The overburden materials to be placed within the dump are considered to be ice-rich (Type IV). As the overburden thaws this material could experience excess pore water pressure. For design purposes, a phreatic surface was assumed to be at the surface of the overburden material, extending to the inner side of the filter material where it decreases to the existing groundwater table below the base of the berm but into the foundation material. Analyses also considered the potential of higher groundwater table rising to within the foundation material to the base of the berm, although this scenario is considered unlikely.

Three failure modes were considered in the stability analysis: shallow seated, deep seated, and pseudostatic failures. NELPCo found that shallow failures were the most probable failures on the downstream and upstream faces. These failures are not considered to be critical to the stability of the design provided the slumps are repaired promptly. NELPCo considered the deep seated failures to be of greater concern, therefore, a deep seated critical slip surface that would have a larger impact on the stability of the berm was analysed.

Stability was checked for both empty and full capacity cells. Stability analyses were completed for each berm. All berms met or exceeded the minimum factor of safety recommended by the Design Manual.

### 5.2.3.3 Water Management

Controlling surface water run-off and groundwater is key in maintaining overall function of the IROSA. Build-up of pore water pressures within the berm could negatively impact the stability of the storage area. Ensuring that major surface water run-off sources are diverted from entering each storage cell, and that groundwater does not buildup at and along the berm is critical to the overall stability of the storage area. To ensure that melt water adequately drains through the storage berm and into the subsurface, the fine-grained silty tailings should be scraped off the berm foundation, and coarse grained aggregate should be used for berm construction. Surface water run off should be actively managed, if necessary, to minimize the amount of standing water collecting within the storage area.

The historical diversion of Platinum Gulch freshet overflow should be decommissioned to prevent the freshet flows from Platinum Gulch entering the IROSA. Further, the existing interceptor ditch located upslope of the IROSA should be cleared and extended to the north, as much as feasible to divert non-contact runoff to the south and away from the facility. The west and east side diversion ditches on either side of the IROSA, will be built prior to loading of ice-rich material into the IROSA

Once the ice-rich material has been placed in storage to final grade, surface erosion and sediment control will be required within the containment area. A roadside interceptor ditch draining to a small sediment control pond may be required downslope of the storage facility for collection of any water that might seep from the lowermost containment berm. Pond outflow meeting discharge criteria would be directed towards Haggart Creek; if criteria are not met, pond water would be pumped back to within the IROSA where it can later exfiltrate to groundwater. Details of interceptor ditches and sediment control measures are discussed in the Construction Water Management Plan.

Wherever freeboard for containment of surface runoff does not exist at any point around the perimeter of a filled cell of the IROSA, suitable erosion control measures including (but not limited to) silt fencing will be established such that sediment laden runoff from the cell is intercepted prior to flowing from the cell

The IROSA including containment berm toes have been sited to avoid encroaching into the Haggart Creek floodplain, and are well back from the required 30 m offset of facilities (Figure 5.2-1).

## 5.2.4 Facility Construction

### 5.2.4.1 Construction Sequence

Development of the IROSA will consist of the following main tasks:

- Borrow development from placer tailings in the immediate area, including selection and processing of engineering materials for the coarse aggregate berms and the upstream filter zones;
- Foundation preparation, including leveling and relocating of existing organics, fine-grained materials or other unsuitable materials within the footprint of the berm foundation, and excavation of key trenches, as necessary;
- Fill placement and compaction in lifts up to 1.5 m thick, including coincident placement of berm and upstream filter materials;
- Initial survey of completed berm for baseline deformation monitoring.

While each of these activities can be completed throughout most of the year, berm fill placement and compaction will be completed during post-freshet and prior to freeze-up to minimize difficulties with watering and compaction. Details of foundation preparation and embankment construction are described in NELPCo (2013).

#### **5.2.4.2 Transport and Disposal**

Ice-rich materials will be hauled to and placed in the IROSA by dump truck. Ice-rich materials will not be placed in any of the cells of the IROSA until the confining berm for that cell has been constructed.

Materials will be hauled immediately on excavation to minimize the time for thawing during handling, transport and placement, and should be placed so as to thaw as much as possible to reduce swell and facilitate conditioning for future reclamation. The stored materials may become soft on thawing. This phenomenon will be more pronounced during summer and early fall when air temperatures are highest. Lifts of waste will be graded gently, as feasible and practical depending on trafficability of the materials, toward the working edge to promote drainage away from the stacked waste into temporary in-storage water collection areas within each cell.

#### **5.2.4.3 IROSA Volume Management and Contingency Storage**

SGC will conduct frequent (daily when adding material to a facility) monitoring which will include periodic estimates of stockpile volumes. Standard construction management BMPs for maintaining a daily inventory (or" counting") of truckloads, which will be complemented by periodic (i.e., monthly when facility is active) surveying of storage facilities to check the volume and rate of filling of each storage facility will also be followed.

Further, the volume build-up in the IROSA will be closely monitored. Although not finalized at this point, a likely threshold volumes would be when 85% of the initial (195,000 m<sup>3</sup>) and contingency volumes (255,000 m<sup>3</sup>) are reached, at which time additional design capacity would be developed based on predicted additional volume requirements associated with future construction activities. As stated above, the Haggart Creek IROSA was selected because of the potential to continue to build additional capacity, up to 1,000,000 m<sup>3</sup>, as needed. It will be highly unlikely, however, that the storage requirements would approach this volume. SGC is willing to provide additional detailed design for the IROSA if it becomes necessary to expand the storage volume 10 days prior to any expansion being constructed.

Prior to the providing the additional design, a revised estimate of the remaining Type IV and other types of ice rich material still to be excavated and deemed to require engineered storage will be provided. If the revised estimate indicates that there is insufficient storage for expected ice-rich material then additional capacity at the Haggart Creek IROSA will be designed. This additional storage volume will consider a 15% contingency plus an additional 15% for swell. The current plan calls for additional (or contingency) storage by increasing the capacity at the Haggart Creek IROSA by incrementally increasing berm heights, which would ultimately join some or all of the storage cells until the maximum capacity of the area is reached. Based on preliminary estimates (BGC 2013), this area could contain up to 1,000,000 m<sup>3</sup>.

#### **5.2.4.4 Construction Quality Assurance and Quality Control**

A construction quality assurance plan will be developed to ensure that the parameters used during the design process are achieved. Elements to consider include:

- Monitoring of fill material particle size distribution and placement;
- Preparation of construction record drawings

The site development contractor will prepare a construction quality control plan, and SGC will implement independent quality assurance inspection and testing, to be developed in detailed design, and to include, at a minimum, the following components:

- Inspection and approval of foundation subgrades;
- Inspection, testing and approval of selected berm and upstream filter materials;
- Regular survey control during fill placement and grading;
- Daily inspections and photographic records of construction activities;
- Photographs of the construction process at each stage of construction;
- Oversight of installation of any required deformation monitoring targets;
- Initial baseline survey for deformation monitoring; and
- Preparation of construction record drawings as a record of initial construction signed and sealed by a professional engineer registered in the Yukon.
- a detailed design report submitted to the Board at least 10 days prior to construction of any additional storage capacity to be utilized.

### **5.2.5 Monitoring and Surveillance**

The overall performance of the IROSA will be dependent on the physical stability of the berms. For a Class II dump, the guidelines specify visual monitoring with basic instrumentation. Visual inspections will be completed regularly to check for signs of instability including tension cracking, surficial sloughing, bulging, or seepage zones along the downstream face of the berms.

A monitoring program will be designed, and implemented, and will include the following:

- Regular visual inspection of the berms (crest and toe) looking for any signs of instability (cracking or differential settlement) or erosion;
- Regular visual inspection of the berm toes for any signs of seepage containing fine grained materials;
- Installation of settlement pins for deformation monitoring after construction and initial survey of completed berms for baseline deformation monitoring; and
- Monitoring of settlement pins.

The results of the visual monitoring will provide insight into the physical performance of the filter berms over the course of operations. In the event of instability, or poor performance (e.g. slumping of the crest, bulging of toe areas, erosion), deformation monitoring of specific areas or remedial construction may be required.

Prior to construction, water levels in the existing piezometers/wells will be read a sufficient number of times to establish baseline ground water table conditions. Once construction begins, instrumentation will be monitored regularly to inform the construction process until the berm construction is completed.

Visual inspections of the berms will be routinely conducted by technical personnel at the mine. More detailed visual inspections will be conducted on a monthly basis by the mine's geotechnical engineer or a competent

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person who has appropriate geotechnical experience and is familiar with the technical aspects of the containment berms design, construction, and monitoring.

Data from visual inspections and any more detailed deformation monitoring, if required, will be collected and interpreted in an annual data report, with a detailed assessment and recommendations for monitoring and remediation.

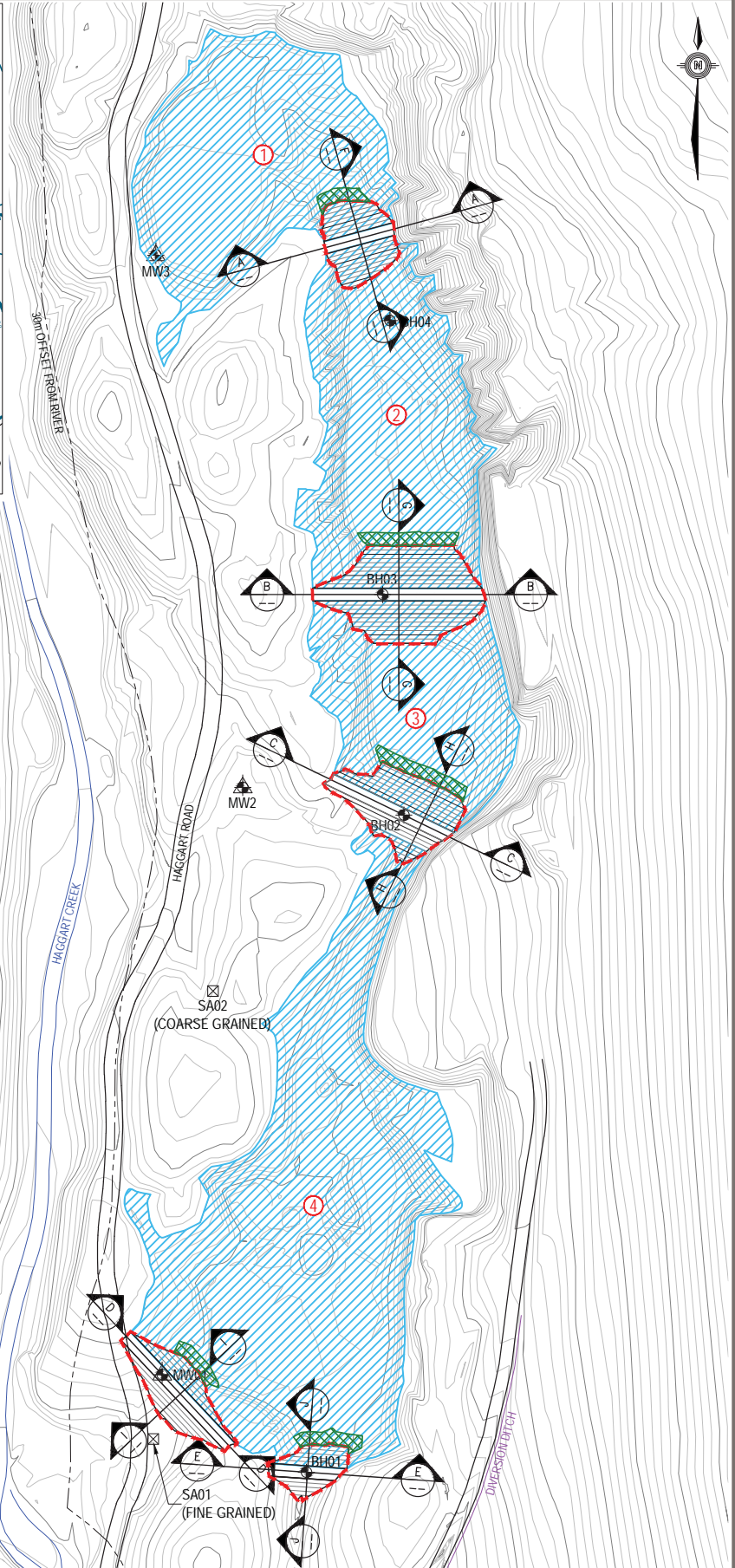
The IROSA will be monitored periodically as warranted by weather and use of the facility. Visual monitoring will include inspection for tension cracking, sloughing, bulging, or seepages flows at the toe of the berm. Groundwater levels will be monitored by piezometers installed prior to construction and use of the IORSA. Survey points will be established on the crests of each berm which will be surveyed on a semi-annual basis to monitor settlement or lateral movement. The frequency of monitoring will increase if significant movement is identified.



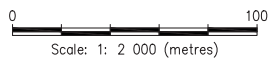
STORAGE AREA VOLUMES	
STORAGE AREA	OVERBURDEN (m³)
1	37000
2	73000
3	45000
4	100000
<b>TOTAL</b>	<b>255000</b>

BERM MATERIAL VOLUMES		
BERM	COARSE MATERIAL (m³)	FINE MATERIAL (m³)
A	4700	450
B	11000	1150
C	5400	850
D	2600	400
E	1400	300
<b>TOTAL</b>	<b>25100</b>	<b>3150</b>

FINE GRAINED MATERIAL VOLUME ESTIMATES	
BERM	MATERIAL (m³)
A	150
B	280
C	280
D	160
E	200
<b>TOTAL</b>	<b>1070</b>



- LEGEND:
- ☒ - BORROW SOURCE SAMPLE LOCATION
  - ⊕ - BOREHOLE LOCATION
  - ▲ - MONITORING WELL LOCATION
  - - - - PROPOSED CONTAINMENT BERM FOOTPRINT
  - ① - CONTAINMENT AREA
  - ▨ - ESTIMATED MATERIAL TAKE OFF LOCATION
  - - - - EXISTING DIVERSION DITCH ALIGNMENT



CLIENT

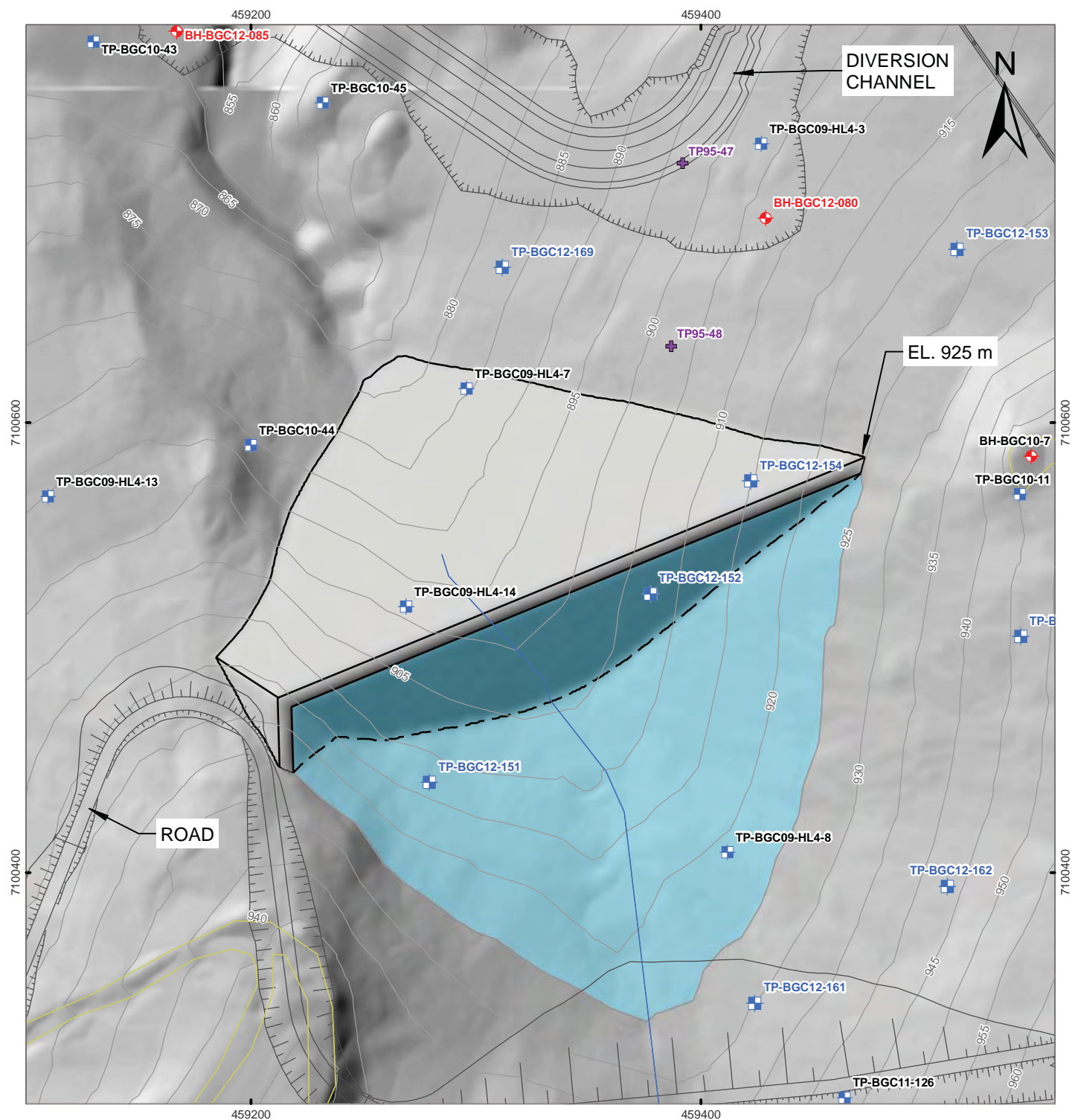
2013 GEOTECHNICAL INVESTIGATION  
VICTORIA GOLD ICE RICH OVERBURDEN STORAGE AREA

SITE PLAN SHOWING  
PROPOSED CONTAINMENT BERM LOCATIONS

PROJECT NO. W14103150-02	DWN CB	CKD KAE	REV 0
OFFICE EBA-WHSE	DATE November 28, 2013		

Figure 5.2-1

BGC: X:\Projects\0792\_Victoria Gold\008\Workspaces\20130108\_REPORT\_Ice\_Rich\_Materials\_Management\_Plan\fig\_5\_1-2\_Suttles\_Gulch\_Option\_Location\_FINAL.mxd



### LEGEND

- PROPOSED INFRASTRUCTURE LAYOUT
- EXISTING ROAD
- STREAM
- BGC BOREHOLE
- BGC TEST PIT
- BOREHOLE BY OTHERS
- TESTPIT BY OTHERS
- CONTAINMENT BERM
- POTENTIAL STORED ICE-RICH MATERIALS
- 5 m CONTOUR

PRELIMINARY DESIGN.  
FOR INFORMATION ONLY.  
SUBJECT TO CHANGE.  
NOT FOR CONSTRUCTION.

### NOTES

- Proposed infrastructure layout received from Wardrop March 28, 2012.

## EAGLE GOLD PROJECT YUKON TERRITORY

Suttles Gulch Ice-Rich  
Overburden Storage Area

PROJECTION UTM Zone 8	DATUM NAD83
Scale: 1:2,500	

FILE NO. 0792008-03-10	DWN LL	CKD DW	APVD PQ	REV 0
PROJECT Eagle Gold	OFFICE	DATE April 2013		

CLIENT

BGC ENGINEERING INC  
AN APPLIED EARTH SCIENCES COMPANY  
BGC

PROFESSIONAL SEAL  
STATUS  
FINAL

Figure 5.2-2

## **6 REPORTING**

An annual report will be prepared that will summarize management activities and field results from the excavation, construction, transport, stockpiling, disposal and monitoring of frozen materials. Records of monitoring shall include summaries of data generated as a result of the monitoring activities described herein, including analysis and interpretation by a qualified individual or firm and a discussion of any variances from baseline conditions, from the previous years' data, or from expected performance, or variances from expected conditions such as the volume of ice rich material.

## **7 REFERENCES**

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