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**Appendix 11A**  
**Blackwater Project – Reconnaissance**  
**Terrain and Terrain Stability**  
**Mapping. Rev0.**

**NEW GOLD INC  
BLACKWATER GOLD PROJECT**



**RECONNAISSANCE TERRAIN AND  
TERRAIN STABILITY MAPPING**

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Rev 0  
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## NEW GOLD INC. BLACKWATER GOLD PROJECT

### RECONNAISSANCE TERRAIN AND TERRAIN STABILITY MAPPING VA101-457/4-4

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## EXECUTIVE SUMMARY

New Gold Inc. is in the early stages of developing the Blackwater Gold Project, a large gold-silver deposit located approximately 110 km southwest of Vanderhoof in central British Columbia. The proposed mine comprises an open pit operation with approximately 356 Mt of ore being extracted over the 17 year mine life. The proposed accompanying mine facilities include two NAG Wasterock/Overburden Stockpiles, a Low-Grade Stockpile, two Topsoil Stockpiles, a Tailings Storage Facility (TSF) and a Plant Site. The mine tailings are to be deposited into the TSF from three tailings embankments. The PAG waste rock is to be placed subaqueously in the TSF. Haul roads are to be constructed between the main mine facilities. It is also proposed to construct an approximately 135 km-long transmission line to connect the mine site to the existing transmission line network along Highway 16.

Knight Piésold Ltd. was commissioned by New Gold Inc. to undertake reconnaissance terrain and terrain stability mapping of the project site. The Study Area for the mapping comprises the catchments that are upslope from the mine site and extends eastwards to include a proposed source area for aggregate. The majority of the Study Area lies within the Davidson Creek watershed. Davidson Creek flows north-east from the site towards Tatelkuz Lake. The mapping provides baseline soils and terrain data pertinent to the project Environmental Assessment application. This report presents the findings of the mapping for the mine site. The transmission line alignment terrain mapping is to be undertaken in a separate scope of work.

The terrain mapping indicates the surficial geology at the sites of the proposed mine facilities mainly comprises a blanket of glacial till, ranging from gravelly silt with some cobbles and boulders to silty sandy gravel with some cobbles and boulders. This glacial till is stiff to very stiff or dense and is interpreted to be 'lodgement/basal till'. A different type of till, with a significantly lower relative density, was identified locally in a hand-excavated test pit at the site of the proposed eastern Wasterock/Overburden Stockpile. This soil, which comprised gravelly fine to medium sand with trace to some cobbles and trace silt, is interpreted to be 'ablation till'.

The mapping showed the presence of broad deposits of glaciofluvial soils along the main drainage lines. These soils are interpreted to extend over significant proportions of the footprint areas of the three proposed tailings embankments. The particle size distribution of these soils ranges from fine to coarse sand and fine to coarse gravel with some cobbles and trace silt, to fine to coarse sand with some fine to coarse gravel and some silt. These soils were interpreted to be outwash and 'ice-contact' kame deposits. Glaciofluvial terraces were mapped, locally, in the vicinity of the drainage lines. An area of north-trending sinuous ridges was identified in the east part of the Study Area. These landforms are interpreted to be eskers. They comprise fine to coarse sand and subangular to subrounded fine to coarse gravel with some cobbles and are a possible source of construction aggregate for the project. Glacial lake deposits were mapped locally within the footprint area of the proposed TSF. These soils comprise silts and fine sands.

A surface veneer of colluvium is interpreted to be present on the steepest slopes, in the west part of the Study Area and on the moderately steep, incised slopes, adjacent to the main watercourses.

Organic soils, comprising spongy fibrous peat, were mapped in the footprint areas of the proposed Wasterock/Overburden Stockpiles and Low-Grade Stockpile as well as locally within the footprint



area of the proposed Open Pit and TSF. Fluvial deposits are present in the vicinity of the main water courses. These deposits comprise coarse sandy gravel with cobbles in the vicinity of the channels and finer floodplain deposits of silty sand adjacent to the channels. Fluvial fans have developed, locally, at the confluence of higher and lower-order drainage lines.

Bedrock exposures are, for the most part, limited to the upland south and west parts of the Study Area.

Local areas of gully erosion were identified in the upland area in the southwest part of the Study Area. Local areas of possible seepage erosion were identified in steep slopes in glaciofluvial deposits adjacent to Davidson Creek. Organic soils and silt-rich glacial lake deposits were identified locally at the sites of the proposed mine facilities. These soils are expected to be particularly prone to erosion during the construction phase of the project when the surface vegetation is stripped as part of the embankment foundation preparation. The local presence of such soils with a relatively high susceptibility to surface erosion should be accounted for in the project 'Sediment and Erosion Control Plan'.

Relatively few landslides were identified in the Study Area. The observed landslides are debris slides, rockfalls and two possible relict rock avalanches. Debris slides were observed locally in glaciofluvial deposits in areas of moderately steep to steep incised terrain adjacent to the main watercourses. They were also observed, locally, in areas of gullied terrain.

A terrain stability classification scheme has been established for the Study Area and Terrain Stability Maps developed. The terrain stability mapping indicates the majority of the Study Area to be 'stable', having a 'negligible' to 'low' likelihood of landslides in relation to road construction and timber harvesting. The mapping indicates there to be small, local areas of 'potentially unstable' and 'unstable' terrain. The footprints of the proposed facilities generally avoid areas of 'potentially unstable' and 'unstable' terrain. The exception is the proposed tailings embankment footprints, which include local areas of moderately steep to steep terrain adjacent to Davidson Creek and Creek 505659 that are judged to be 'potentially unstable'. In addition, a local area of 'potentially unstable' terrain was identified in a gully on the north side of Davidson Creek, which lies within footprint area of the proposed Tailings Storage Facility. These areas of 'potentially unstable' terrain will be effectively buttressed by the tailings embankments and the tailings once the mine is operational. Some disturbance, including stripping of vegetation, is anticipated in these areas as part of the construction of the tailings embankments. It is recommended that a work plan be developed during construction in order to address the temporary enhanced likelihood of slope instability and sediment transport in these areas. No areas of 'potentially unstable' terrain were identified along the proposed Main Access Road alignment.

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**APPENDICES**

Appendix A Photos  
Appendix B Findings of Field Truthing

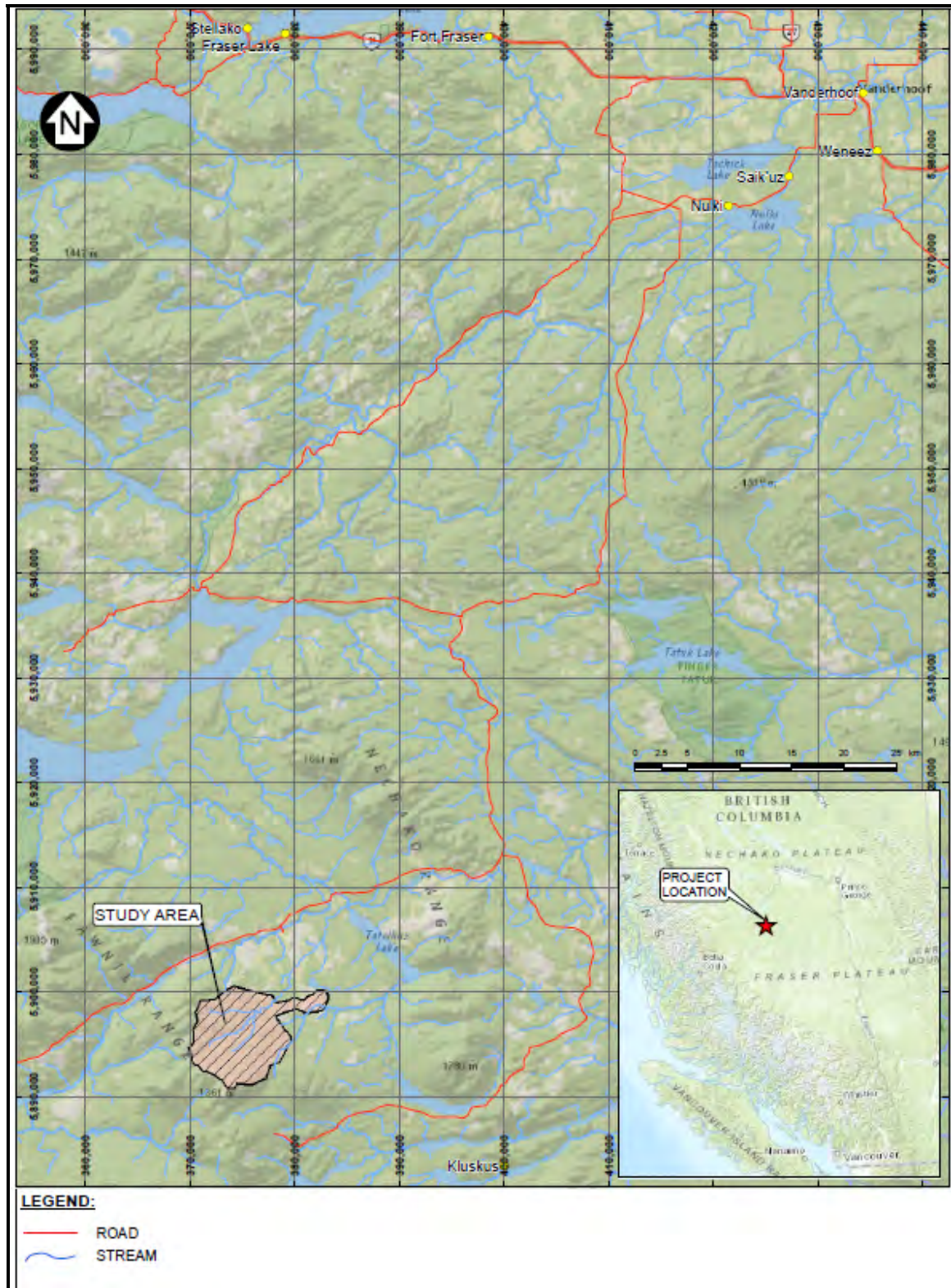
## 1 – INTRODUCTION

The Blackwater Gold Project is a proposed gold-silver mine, located approximately 110 km southwest of Vanderhoof in central British Columbia (Figure 1.1, below; and Drawing G0010).

A Preliminary Economic Assessment (PEA) was completed for the project in September 2012. The proposed mine comprises an open pit operation, with approximately 356 Mt of ore being extracted over the 17 year mine life. The proposed accompanying mine facilities include two NAG Wasterock/Overburden Stockpiles, a Low-Grade Stockpile, two Topsoil Stockpiles, a Tailings Storage Facility (TSF) and a Plant Site. The proposed locations of the facilities are shown on Drawings G0020 and G0021. The mine tailings will be deposited into the TSF from three tailings embankments. The PAG waste rock is to be placed subaqueously in the TSF. Haul roads will be constructed between the main mine facilities. An approximately 135 km-long transmission line will connect the mine site to the existing transmission line network along Highway 16.

Knight Piésold Ltd. (KPL) was commissioned by New Gold Inc. (New Gold) to undertake reconnaissance terrain and terrain stability mapping for the mine site. The Study Area of the mapping comprises the entire area of catchments that are upslope from the mine site, and it extends eastwards to include a proposed source of aggregate. The transmission line alignment terrain mapping is to be undertaken in a separate scope of work.

This report presents the findings of the terrain and terrain stability mapping. The mapping provides baseline soils and terrain data pertinent to the project Environmental Assessment application. The report has been prepared exclusively for New Gold in relation to the Blackwater Gold Project. No third party should rely on the information, conclusions, opinions, or any other matter contained in this report.



**Figure 1.1 Study Site Location Map**

## 2 – BACKGROUND

Terrain mapping is a method to categorize, describe and delineate characteristics and attributes of surficial materials, landforms and geological processes within the natural landscape. Terrain Stability Mapping is a method to delineate areas of stable, potentially unstable and unstable terrain within a particular landscape (MoF, 1999). Both mapping techniques involve sub-dividing the study area into polygons. The '*Guide to Processing a Mine Project under the British Columbia Mines Act*', prepared by the Ministry of Energy, Mines and Petroleum Resources (MEMPR, 2009), states that terrain mapping is to be carried out as part of the mine project application. Mine access roads are affected by different regulations, covered by the *Forest and Range Practices Act of British Columbia*.

Terrain and terrain stability mapping are planning tools, with the latter being a derivative of the former. They are powerful tools in the earliest, hazard-avoidance phase of the terrain hazards assessment process. The findings of the mapping are applicable to the project feasibility study as well as the Environmental Assessment and permitting processes. Terrain and terrain stability maps have additional uses in the planning phase of projects. They can be used to develop 'Erosion Potential Maps' that can aid the development of site-specific 'Sediment and Erosion Control Plans'. In addition, information on the terrain maps, in particular the texture and drainage of the soils, provides information on the pre-mining 'land capability' and is used in reclamation studies.

The management of forestry practices in landslide-prone terrain is covered under the *Forest and Range Practices Act (FRPA)*. Under the FRPA regulations, the licensee 'must ensure that the primary forest activity does not cause a landslide that has a material adverse effect' on a forest value. The *Forest and Range Practices Act* was a significant shift from the hazard prevention strategy of the former *Forest Practices Code* to a risk management strategy. The FRPA regulations are directly applicable to those portions of mine access roads that are outside the permitted mine site. The methods used in the landslide risk management process in the forestry sector, in particular 'Terrain Stability Assessments', are equally applicable to managing the landslide hazards and risks within the permitted mine site.

### 3 – SITE AND PROJECT DESCRIPTION

The Blackwater Gold Project is a proposed gold-silver mine located approximately 110 km southwest of Vanderhoof in central British Columbia (Drawing G0010). The site is located on the Nechako Plateau. The Nechako Plateau is an area of gently undulating highlands dissected by valleys and other low-lying areas. The elevation of the Study Area ranges from approximately 1700 masl on the north-facing slopes of Mount Davidson to 1000 m asl in the valleys. Mount Davidson, the highest peak in the Fawnie Range, is located at the south margin of the mine site. The site area comprises irregular topography with local hill-top plateaus. The site has been glaciated and the mountain tops are typically rounded.

The Study Area comprises all catchments that are upslope from the mine site, and it extends eastwards to include a proposed source of aggregate (Drawings G0020 to G0022).

The majority of the Study Area lies within the Davidson Creek watershed. Davidson Creek flows northeast to its confluence with Chedakuz Creek downstream of Tatelkuz Lake. Creek 505659 is an east-west trending tributary in the upstream reaches of Creek 661 in the southeast part of the Study Area. Creek 661 flows northeast to Tatelkuz Lake. The main watercourses within the Study Area are incised, locally.

Slope Angle Maps of the Study Area were prepared using the *ArcView* Geographic Information System (GIS) software with the '3d-Analyst' extension, and are presented on Drawings G0020 to G0022. The Slope Angle Maps were generated from 5 m LiDAR Survey contours. The slope angle classes correspond with those in the *Terrain Classification System for British Columbia* (Howes and Kenk, 1997). Drawings G0020 to G0022 show that the Study Area predominantly comprises gently sloping terrain. There are moderately steep to steep slopes adjacent to Davidson Creek, 'Creek C' and their tributaries. There are moderately steep to steep, northwest and southeast-facing slopes in the west part of the Study Area. There are some plains (areas with a natural slope angle of less than 5%) within the Study Area. They include low-lying poorly drained areas and plateaus on hill tops.

The majority of the Study Area is located within the moist, very cold, Engelmann Spruce–Subalpine Fir Biogeoclimatic Zone. The east part of the Study Area, including the central portion of the footprint area of the proposed main tailings embankment, lies within the moist, cold Sub-Boreal Spruce Biogeoclimatic Zone. The summit area of Mount Davidson lies within the Boreal Altai Fescue Alpine Biogeoclimatic Zone.

The proposed access route to the site from Highway 16 is along the existing Kluskus and Kluskus-Ootsa Forest Service Roads.

The proposed Open Pit is located on gentle, north-facing slopes in the south part of the Study Area (Photo 1). The 'NAG 4 Stockpile' and the 'Low-Grade Stockpile' will be located northwest of the Open Pit, and the 'NAG 3 Stockpile' will be located in the area to the northeast, all on gently inclined, north-facing slopes. The footprint area of the proposed TSF lies within the upper reaches of the catchment areas of Davidson Creek and Creek 661 (Drawings G0020 to G0021 and Photo 2). The main tailings embankment, referred to as the 'Site D Main Dam', will be located at the eastern end of the facility (Drawing G0021 and Photo 3). The proposed central and western tailings embankments, referred to as the 'Site C Main Dam' and the 'Site C Saddle Dam', respectively, are considerably smaller in size. The terrain within the footprint area of the TSF is generally gently inclined, except

along the incised portions of Davidson Creek and Creek 505659. The latter areas are between the sites of the proposed 'Site C Main Dam' and the 'Site D Main Dam', where there are moderate to moderately steeply inclined slopes adjacent to the drainage lines (Drawings G0020 and G0021). Two possible plant sites are being considered, both located in the area to the north of the proposed Open Pit (Drawing G0020). The northern site, referred to as the 'Option 1' Site, is located on a hill top with gentle slopes. The southern site, referred to as the 'Option 6' Site, is located on gentle north-facing slopes. Two Topsoil Stockpiles are currently proposed, one in the area east of the 'Site D Main Dam' and the other to the north (Drawings G0020 and G0021). The terrain is gently sloping at both sites.



## 4 – DESK TOP STUDY

### 4.1 PUBLISHED GEOLOGICAL MAPPING

The provincial scale bedrock geology map, published by the Geological Survey of Canada, (BCGS, 2005) indicates andesitic lava flows and breccias of the Lower to Middle Eocene Ootsa Lake Group are present in the northeast part of the Study Area, including the footprint area of the proposed TSF. A local area of andesitic lava flows and breccias belonging to the Ootsa Lake Group has been mapped in the upland area at the southwest margin of the Study Area. The mapping indicates the bedrock in the west part of the Study Area also belongs to the Ootsa Lake Formation, but comprises rhyolites and felsic volcanic rocks. The bedrock in the southeast portion of the Study Area, including the footprint of the proposed Open Pit, is rhyolites and felsic volcanic rocks of the Entiako Formation, which belongs to the Middle Jurassic Hazelton Group. A north-east trending fault is mapped along the alignment of Davidson Creek. This fault intersects a north-south trending fault, which extends to the south margin of the Study Area.

The regional 1:50,000-scale surficial geology map for NTS Sheet 93 F/2, published by the Geological Survey Branch of the Ministry of Energy, Mines and Petroleum Resources (Giles and Levson, 1995), indicates that there is an extensive cover of surficial deposits across the Study Area, principally comprising glacial till and glaciofluvial sands and gravels, deposited during the late Wisconsinan Glaciation. A blanket of glacial till covers most of the open slope areas, but there are extensive glaciofluvial deposits in the vicinity of Davidson Creek and Creek 505659.

During the late Wisconsinan Glaciation, ice moved into the Study Area from the Coast Mountains. At the peak of this glaciation, the area was covered by the Cordilleran Ice Sheet to an elevation of at least 2300 m asl. Ice flowed towards the east-northeast over the Study Area and northeast and east onto the Interior Plateau. Massive, compact lodgement tills were deposited at the base of the ice sheet. Ablation tills were also deposited locally as the ice sheet wasted.

Sediments deposited during de-glaciation of the area include glaciofluvial and glaciolacustrine sediments. Glaciofluvial sands and gravels are common in valley bottoms and along the valley flanks, occurring as kames, eskers and terraces. Glaciolacustrine sediments are locally present in valleys and extend up to a maximum elevation of approximately 1070 m asl. The deposits include fine to coarse sand as well as silts and clays. The mapping indicates that the two forks of Davidson Creek are 'minor meltwater channels'. It is noted on the published 1:50,000-scale surficial geology map (Giles and Levson, 1995) that loose sandy gravelly soils occur on top of the glacial till. These deposits were interpreted by Giles et. al. to be glacial debris flow deposits that accumulated as the ice retreated. A series of esker ridges are located approximately 5 km east of the confluence of the tributary channels of Davidson Creek. The ridges trend towards the east-northeast and north. Holocene deposits in the Study Area comprise organic deposits in flat-lying areas, colluvial veneers on steeper slopes and fluvial sediments in the valley bottoms.

The 1:100,000 and 1:250,000 scale surficial geology maps, published by the Geological Survey of Canada (Plouffe, et al., 2004 and Plouffe, et al., 2001, respectively), show a similar distribution of surficial deposits in the Study Area. The glacial till comprises boulder to pebble-sized clasts in a matrix of sand (46% on average), silt (51% on average) and clay (3% on average), according to the descriptive notes provided on the 1:250,000 scale map. The 1:100,000-scale map shows the

approximate locations of kettle holes on the surface of the glaciofluvial deposits. The larger scale mapping also shows an east-west trending meltwater channel in the south part of the proposed footprint area of the TSF coincident with Creek 505659.

#### 4.2 FINDINGS OF SITE INVESTIGATIONS

An extensive geotechnical site investigation was undertaken at the site in 2012. The detailed findings of the site investigation are reported separately (Knight Piésold, 2012). The terrain mapping incorporated the findings of 159 machine-excavated test pits and 20 sonic-drilled boreholes, undertaken as part of the 2012 site investigation. The locations of the test pits and sonic coring boreholes are shown on Drawings G0030 to G0032. The results of Atterberg limits tests, undertaken on soil samples recovered from the geotechnical drillholes and test pits, were utilized in this study.

#### 4.3 FISH HABITAT

A desk top study of potential fish barriers in the Davidson Creek Watershed was undertaken by reviewing the 'Provincial Obstacles to Fish Passage Theme', which compiles data from various government inventories. The published data do not indicate any fish barriers in the portion of the Davidson Creek Catchment between the Study Area and Tatalukuz Lake.

#### 4.4 COMMUNITY WATERSHED SEARCH

The closest community watershed to the Study Area is the Gibbs Community Watershed, situated approximately 140 km to the southwest, according to the Land and Resource Data Warehouse database.

**5 – AIR PHOTO INTERPRETATION**

An Air Photo Interpretation (API) was undertaken using digital stereo pairs. The images were taken in 2010 as part of the LIDAR survey. The stereo pairs were inspected using the *Datam* software package *Summit Lite* with the aid of a 3D screen and 3D glasses. A dual screen set-up was used for the API, with the second screen displaying the 1 m LiDAR contours and the ortho-rectified imagery within the *ArcGis* software package *ArcEditor*. This screen was used to create the terrain polygons.

Historic air photos of the Study Area were borrowed from the University of British Columbia and inspected using a stereoscope. A summary of the historic air photos inspected is presented in Table 5.1, below:

**Table 5.1 - Summary of Historic Air Photos Inspected**

<b>Year</b>	<b>Flight Path</b>	<b>Scale</b>	<b>Photo Numbers</b>	<b>Notes</b>
1947	XR21	N/A	39 - 42	Oblique photos
1953	BC1814	1:36,000	12, 41 - 46, 47 - 51, 70 - 74	
1964	A18594	1:59,000	5 - 9, 6 - 8	
1979	A25179	1:57,000	83, 133, 154, 155	

## 6 – FIELDWORK

Field-truthing was undertaken between July 10 and July 12, 2012 by James Haley P.Eng. of KPL. The field-truthing included examination and description of natural soil and bedrock exposures as well as exposures in cut slopes. In areas where there are no surface exposures, hand-excavated test pits were dug. The weather was dry during the fieldwork. The waypoints (WP) of the field-truthing locations are shown on Drawings G0030 to G0032. Descriptions of the observations at the field-truthing sites are presented in Table B1 in Appendix B.

## 7 – MAPPING

Terrain and terrain stability maps were prepared for the Study Area at a scale of 1:15,000 following the provincial guidelines (MoF, 1999). The terrain maps were prepared in accordance with the Terrain Classification System for British Columbia, as detailed by Howes and Kenk (1997). The mapping incorporated field truthing to Terrain Survey Intensity Level 'D' (MoF, 1999). Forty-eight of the total 299 polygons (approximately 17%) were field-truthed. The maps were developed from the API and the slope angle maps, supplemented by the field observations. The terrain units were identified based upon the morphology, the presence and nature of soil or rock exposures, and vegetation associations.

Landslides mapped in the API are shown on Drawings G0030 to G0032. The years of the air photos on which the landslides were first identified are highlighted on the drawings. 'Recent' landslides that may have occurred during or shortly before the period of the air photo record (i.e. within approximately the last 50 to 100 years) are distinguished from older 'relict' landslides. Some of the 'recent' landslides identified in the API are post-logging landslides, which occurred either along old FSR's (denoted by an 'R') or within clearcuts (denoted by a 'C'). Descriptions of the main landslides are included in Table B1 in Appendix B.

Terrain stability refers to the likelihood of a landslide initiating in a terrain polygon following road construction activities and timber harvesting. Terrain stability class criteria were developed for the Study Area.

Three terrain stability classes were used:

- *Stable* (S) – Identified as terrain with a 'negligible' to 'low' likelihood of landslide initiation following road construction and timber harvesting
- *Potentially unstable* (P) – Expected to contain areas with a 'moderate' likelihood of landslide initiation following road construction and timber harvesting, and
- *Unstable* (U) – Expected to contain areas where there is a 'high' likelihood of landslide initiation following road construction and timber harvesting.

A 'moderate' likelihood of landslide occurrence is representative of an approximately 10% to 30% annual probability along a 1 km-long section of road alignment, assuming side-cast construction practices. A 'high' likelihood translates to an annual probability in excess of 30%.

## 8 – FINDINGS

### 8.1 TERRAIN MAPPING

The Terrain Maps are presented as Drawings G0030 to G0032. The legend for the terrain maps is included on Drawing G0010. The findings of the mapping are presented in the following sections.

#### 8.1.1 Surficial Geology

The interpreted surficial geology in the Study Area is shown on Drawings G0030 to G0032. The main surficial unit at the sites of the proposed mine facilities and along the proposed haul road alignments is a blanket of till (Mb). The till is stiff to very stiff or dense and is interpreted to be 'lodgement/basal till', as shown below in Figure 8.1 and in Photo 6.



**Figure 8.1 Exposure of Very Stiff Lodgement Till at the Site of the proposed Open Pit (WP 57)**

A different type of glacial till was identified in a poorly drained swale setting at the site of the proposed 'NAG 3 Overburden Stockpile' (Polygon 199) based on field truthing at location WP 51. The relatively coarse soil at WP 51 is interpreted to be till due to the sub-angular nature of some of the gravel, combined with the subdued nature of the terrain. The deposit has a significantly lower density than most of the till observed in the field and was interpreted to be ablation till. A very coarse glacial till was found in Polygons 266, 269 and 283 in the upland southern portion of the Study Area.

Streamlined landforms consisting of till were identified locally in hill-top settings (Mbz1). These features were interpreted to be drumlins. Drumlins are present at Polygon 63 at the 'Option 1' Plant Site and at Polygon 62 in the south part of the footprint of the proposed 'Site D Main Dam'.

Extensive deposits of glaciofluvial soils were mapped adjacent to Davidson Creek and Creek 505659. These soils are interpreted to extend over much of the footprint areas of the three proposed tailings embankments. Sonic drilling, undertaken in the footprint area of the proposed 'Site D Main Dam', indicates the glaciofluvial deposits include layers of glacial till. The valleys of Davidson Creek and Creek 505659 are glacial meltwater channels. Some of the glaciofluvial soils mapped in these valleys are characterised by hummocky topography and are interpreted to be 'ice-contact' kame deposits (FG<sub>h</sub>). Glaciofluvial terraces (FG<sub>t</sub>) are also present in these valleys. An area of north-trending sinuous ridges was identified in the east part of the Study Area (Drawing G0032 and Photo 7). These landforms are interpreted to be eskers, comprising ice-contact glaciofluvial deposits (FG<sub>r</sub>). The interpreted distribution of these landforms is broadly consistent with that shown on the published 1:100,000-scale surficial geology map (Section 4.1).

Glacial lake deposits (L) were mapped locally in the area west of the proposed 'Site D Main Dam' and within the footprint area of the proposed TMF (Polygons 245 and 246). Glacial lake deposits were also identified locally in Polygons 180 and 1095 at the sides of Davidson Creek, in the area between the proposed 'Site C Main Dam' and 'Site C Saddle Dam'.

A surface veneer of colluvium (C<sub>v</sub>) is present on the steeper terrain, in particular in the west part of the Study Area and on the moderately steep, incised slopes adjacent to Davidson Creek and Creek 505659. Rockfall talus (aC-R<sub>b</sub>) has accumulated at the toes of steep rock slopes in the west part of the Study Area. Photo 8 shows a southeast-facing talus slope in Polygon 74 and Photo 9 a north-facing talus slope in Polygon 291.

Organic soils have accumulated from the decomposition of organic material in poorly-drained settings, including swales, depressions and upland settings with shallow bedrock. Organic soils (eOp) were mapped in the footprint areas of the proposed 'NAG 4 Stockpile', 'Low Grade Stockpile' and 'NAG 3 Overburden Stockpile', as shown below in Figure 8.2, on Photo 10, and Drawing G0030.



**Figure 8.2 Organic Soils in the Footprint Area of the proposed NAG 4 Stockpile**

The organic soils are interpreted to extend over approximately 5 to 10% of the total footprint areas of these proposed stockpiles. The largest area of organic soils is approximately 800 m long (Drawing G0030 and Photo 10). The footprint area of the proposed NAG 4 Stockpile lies partly in this area of organic soils. Organic soils were also mapped locally within the footprint areas of the proposed Open Pit and TSF. A gently sloping apron of organic soil (eO<sub>v</sub>) was mapped locally at the margins of the floodplains along the incised portions of Davidson Creek and Creek 505659 (e.g. Polygons 209 and 190). The gently sloping apron of organic soil at Polygon 209 is shown on Photo 11. The downstream toe of the proposed 'Site D Main Dam' is located in this area (Drawing G0031). Photo 12 shows upland areas of organic soils in Polygon 270, in the southwest part of the Study Area.

Fluvial deposits are present in the vicinity of the main water courses. The deposits comprise active channel deposits (F-I) along the drainage lines and overbank deposits (F<sub>p</sub>) in the adjacent floodplains (Photo 13). Fluvial fans (F<sub>f</sub>) have developed locally at the confluence of higher and lower-order drainage lines.

Bedrock (R and D) exposures are, for the most part, limited to the upland south and west parts of the Study Area.

#### 8.1.2 Geological and Geomorphological Model

Terrain mapping facilitated the development of a geological and geomorphological model for the Study Area. The surficial geology and landforms in the Study Area are predominantly the product of the late Wisconsinan (Fraser) Glaciation. The Fraser Glaciation left an extensive cover of till and glaciofluvial sands and gravels within the Study Area. The rounded mountain tops provide evidence



that the area was completely covered with ice at the maximum of the Fraser Glaciation. Bedrock outcrops are generally limited to the mountain tops and steep slopes in the south and west parts of the Study Area. The local presence of streamlined drumlins in the Study Area provides evidence that ice flowed generally towards the northeast at the maximum of the Fraser Glaciation.

Till was deposited principally at the base of the ice sheet as a compact lodgement till. Ablation till was deposited locally, by down wasting of debris-covered ice at the end of the Fraser Glaciation. The ablation till developed in topographically confined settings, such as the site of the proposed 'NAG 3 Overburden Stockpile'. Kettle holes with small lakes formed from the melting of stranded blocks of ice.

Terrain mapping highlighted the extensive presence of ice-contact glaciofluvial soils, deposited by glacial meltwater streams. These deposits occur mainly in the vicinity of the valleys and are interpreted to be mainly outwash kame deposits. Small lakes in the mapped areas of kame deposits result in classic 'kame and kettle' topography. A network of north-trending sinuous ridges was identified in the east part of the Study Area. These landforms are interpreted to be eskers comprising ice-contact glaciofluvial deposits. Glacial lakes developed locally on the valley floors as the ice retreated. Fine sediments, comprising silts and fine sands, accumulated in the lakes. It is possible that coarser beach deposits, comprising sands and gravels, accumulated on the margins of the lakes, although the presence of such deposits was not confirmed by the field-truthing. The kame deposits were incised by meltwater channels as the ice sheet retreated, leaving glaciofluvial terraces adjacent to the watercourses.

Colluvium has accumulated locally on the steeper slopes within the Study Area as a result of soil creep and landslides.

Organic soils have developed from the decomposition of organic material in poorly drained settings, including swales, depressions and upland settings with a shallow bedrock surface. Organic soils also accumulated on gentle slopes at the margins of the floodplains of Davidson Creek and Creek 505659. The creeks in the Study Area are actively depositing coarse alluvium within their channels and finer overbank deposits on their floodplains.

### 8.1.3 Characterization of Geological Materials

Lodgement till, the predominant surficial soil at the Study Site, ranges from stiff to very stiff gravelly silt with some cobbles and boulders to dense silty sandy gravel with some cobbles and boulders. The lodgement till was found to be generally finer grained on the north side of Davidson Creek than on the south side. Ablation till was interpreted to be present at WP 51, at the site of the proposed 'NAG 3 Overburden Stockpile'. The soil encountered in a hand-excavated test pit at this location was found to have a significantly lower relative density than the lodgement till and comprised gravelly fine to medium sand with trace to some cobbles and trace silt.

The particle size distribution of the kame deposits (FGh) ranges from sandy, angular to subrounded, fine to coarse gravel with some cobbles and trace silt, to fine to coarse sand with some fine to coarse gravel and some silt. The esker deposits (FGr), in the east part of the Study Area, were field-truthed at WP 62. The material there comprises fine to coarse sand and subangular to subrounded fine to coarse gravel with some subrounded cobbles.

Glacial lake soils (L), comprising compact sandy silt, were encountered at WP 22 during field-truthing. A firm, laminated silt is described in the logs for Test Pits TP 12-027 and TP 12-028, undertaken in the 2012 site investigation. This soil is also interpreted to be a glacial lake deposit.

The open slope colluvium (C) encountered during field-truthing comprises fine to medium sand with some angular to subangular fine to coarse gravel and trace silt at WP 16 and gravelly fine to medium sand with some silt and trace to some subangular cobbles at WP 56. At WP 35, a thin veneer of colluvium, comprising silty fine to medium sand with some gravel and some cobbles was found to overlie alluvium. The talus slopes (aC-Rb), in the west part of the Study Area, comprise angular cobble and boulder-sized blocks.

Organic soils (O) found during field-truthing generally comprise brown to dark grey spongy fibrous peat. Fluvial deposits comprise both channel deposits (F-I) and floodplain deposits (Fp). The channel deposits range from gravelly fine to medium sand with trace silt (WP 11) to gravelly cobbles with some fine to coarse sand (WP 53). The floodplain deposits comprise fine to medium sands with trace to some silt (WP 1 and WP 54), as well as sandy silt with some subangular to subrounded fine to coarse gravel and some plant remains (WP 35).

Highly weathered bedrock (D), interpreted to be volcanic breccia, was encountered at WP 21 and WP 23. The material consists of very dense, angular to subangular, fine to coarse gravel with some fine to medium sand and trace silt. Very weak to medium-strong, moderately to highly weathered bedrock, interpreted to be andesite, was found at WP 59.

## 8.2 SOIL DRAINAGE

The areas of lodgement till are poorly to imperfectly drained. The area of ablation till is imperfectly to moderately well drained and is inferred to have a water table that is closer to ground surface. The glaciofluvial sands and gravels are well drained and the colluvium moderately well drained. The fluvial deposits are moderately well drained in the vicinity of the active channels and poorly drained on the floodplains. The organic soils are poorly drained and the water table is at or very close to ground surface. Areas of bedrock exposure are expected to be generally poorly drained.

## 8.3 LANDSLIDES AND EROSION

Relatively few landslides were identified in the Study Area. The landslides that were observed include debris slides, rockfalls and two possible relict rock avalanches, all of which occur in areas of natural terrain. 'Recent' debris slides were identified in Polygons 69 and 129, in the southwest part of the Study Area (Drawing G0030). The landslide in Polygon 69 occurred in an area of steep terrain. The 'recent' debris slide in Polygon 129 occurred in an area of gullied terrain. A possible 'relict' debris slide was identified at WP 32 (Drawing G0030). The natural slope angle at this site was measured to be approximately 60%. An area of hummocky terrain was identified on a 60% slope at WP 17. This area is interpreted to be a possible 'relict' slump. A thin veneer of colluvium overlies fluvial soils at WP 35. This site is situated at the toe of an area of incised terrain and is interpreted to have been subject to previous landsliding.

The talus slopes identified in the west part of the Study Area accumulated from previous rockfalls. Two possible relict rock avalanches were identified on the northwest-facing slopes in the west part of the Study Area (Drawing G0030 and Photo 14).

The terrain mapping did not reveal any widespread areas of sheet or gully erosion within the Study Area. Local areas of minor gully erosion were identified in Polygons 129 and 130 in the southwest part of the Study Area (Photo 15). A surface veneer of cobbles with some gravel was observed on moderately steep slopes adjacent to Davidson Creek at WP 5, in the vicinity of the site of the proposed 'Site D Main Tailings Dam' (Photo 16). This very coarse surficial soil is interpreted to be a lag deposit resulting from seepage erosion of the underlying glaciofluvial terrace deposit.

## 8.4 TERRAIN STABILITY

### 8.4.1 Classification Scheme

A Terrain Stability Classification Scheme was developed for the Study Area using the terrain attributes, in particular, the surficial geology, the natural slope angle and the morphology (Table 8.1):

**Table 8.1 - Terrain Stability Classes**

<b>Terrain Stability Class</b>	<b>Landslide Likelihood Upon Construction</b>	<b>Terrain Attributes</b>
Stable	Negligible to Low	Plains of fluvial or glaciofluvial deposits (F <sub>p</sub> and FG <sub>p</sub> ), Glacial Lake Deposits (L) and Organic Swamps (O <sub>p</sub> or O <sub>v</sub> )
		Gentle to moderately steep (5 to 60%), hill slopes, comprising glaciofluvial sands and gravels (FG), without 'recent' landslides
		Gentle to moderately steep (5% to 60%), hill slopes, comprising glacial till (M) or colluvium (C), without 'recent' landslides
		Gentle to moderately steep (5% to 60%), hill slopes, comprising weathered bedrock (D or R), without 'recent' landslides
Potentially Unstable	Moderate	Moderately steep (> 50%) gullied terrain (g) without 'recent' landslides
		Moderately steep to steep (> 60%), hill slopes comprising glaciofluvial sands and gravels (FG), without 'recent' landslides'
		Moderately steep to steep (> 60%), hill slopes comprising glacial till (M) or colluvium (C), without 'recent' landslides
		Moderately steep to steep (> 60%), hill slopes comprising weathered bedrock (D or R), without 'recent' landslides
Unstable	High	Steep (> 70%) gullied terrain (g)
		Sites of 'recent' landslides

Observations of the terrain attributes at the landslide sites were used to establish terrain stability class criteria for 'unstable' and 'potentially unstable' terrain. The Terrain Stability Classification Scheme applies principally to the likelihood of landslide initiation along roads assuming conventional side-cast construction practice. It can also be applied to landslide susceptibility in areas of natural terrain, once stripped of vegetation.

The moderately steep and steep areas of gullied terrain are assumed to be susceptible to landsliding because of concentrations of both surface and sub-surface water. A lower-bound natural slope angle of 50% for 'potentially unstable' terrain was assigned to the areas of gullied terrain. A lower-bound natural slope angle of 60% for 'potentially unstable' terrain was assigned elsewhere. Glacial lake deposits can be prone to landsliding, but these soils only occur in areas of gently sloping terrain at the Study Site. Consideration was given to the possibility that cohesive till at the site might have a relatively high plasticity and a shear strength that is sensitive to changes in moisture content. Atterberg Limits tests were undertaken on samples of till at the mine site as part of the 2012 site investigation program. The test results are generally indicative of silts of low plasticity. It was concluded from these results that the shear strength is unlikely to be significantly affected by changes in the natural moisture content and that a lower-bound slope angle of 60% is appropriate for delineating areas of 'potentially unstable' terrain in areas of till. Areas of exposed bedrock are expected to be the least prone to landsliding.

The 'unstable' areas in relation to road construction and timber harvesting are sites of 'recent' landslides as well as steep (>70%) gully-side slopes.

#### 8.4.2 Terrain Stability Mapping

Terrain Stability Maps have been developed for the Study Area and are presented as Drawings G0040 to G0042. The terrain stability mapping indicates the majority of the Study Area is 'stable', having a 'negligible' to 'low' likelihood of landslides in relation to road construction and timber harvesting. The mapping indicates there are small, local areas of 'potentially unstable' and 'unstable' terrain. The footprints of the proposed facilities are generally outside the identified areas of 'potentially unstable' and 'unstable' terrain, with the exception of the proposed tailings embankment footprints. These footprints include local areas of moderately steep to steep terrain adjacent to Davidson Creek and Creek 505659 that were mapped as 'potentially unstable' terrain. In addition, a local area of 'potentially unstable' terrain was identified in a gully on the north side of Davidson Creek, which lies within footprint area of the proposed TSF. No areas of 'potentially unstable' terrain were identified along the proposed Main Access Road alignment.

#### 8.5 OTHER HAZARDS

The location and altitude of the Study Area render it potentially susceptible to snow avalanche hazards during the winter. The mapping did not highlight the presence of any clearly discernible snow avalanche paths in treed areas. Snow avalanches generally occur on terrain with slope angles of approximately 27 to 40 degrees. There is a possibility of relatively small avalanches occurring in the local steeper areas of terrain after removal of mature vegetation. However, the areas of proposed development are generally outside such areas, and where development is proposed in such areas, the lengths of the moderately steep and steep slopes are relatively short. The risk of snow avalanches is therefore judged to be relatively low.

## 9 – DISCUSSION AND RECOMMENDATIONS

### 9.1 RELIABILITY AND LIMITATIONS OF STUDY

Reconnaissance terrain and terrain stability mapping has been undertaken for the catchment areas of the proposed Blackwater Gold Project. Approximately 17% of the polygons were field-checked, corresponding to 'Terrain Survey Intensity Level D'. The availability of 1 m contour base mapping for the Study Area facilitated the delineation of certain features of significance to the mapping, e.g. the lateral margins of kame deposits and areas of gullied terrain. Factors limiting the accuracy of the mapping are the forest cover and the limited presence of soil exposures away from the roads and tracks. The availability of LiDAR-derived topographic contours facilitated determination of accurate slope angles, which helped in the terrain stability mapping.

The hand-excavated test pits, undertaken as part of the field-truthing, were typically taken to depths of approximately 0.5 m. The relatively shallow depth of the soil sampling meant that limited information could be obtained on the thickness of the soil units. Extensive supplementary information on the nature and thickness of the glacial soils at the site was obtained from boreholes and test pits, undertaken in the 2012 geotechnical site investigation.

### 9.2 FURTHER STUDY

The terrain mapping indicated that till is the dominant surficial material at the Study Site. The till is very stiff or very dense and is interpreted to be lodgement till. An ablation till is present locally in a topographically-confined setting at the site of the proposed NAG 3 Overburden Stockpile. The ablation till has a higher permeability than the lodgement till and its presence has possible implications for groundwater flow, leaching and seepage. The NAG 4 Stockpile and the Low Grade Stockpile will be located in a similar topographic setting and it is possible that ablation till may also be present in those areas. It is recommended that further site investigation be undertaken to investigate the presence, extent, depth and nature of ablation till at the proposed sites of these three stockpiles.

The terrain mapping identified organic soils at the sites of the proposed NAG 3 Overburden Stockpile, NAG 4 Stockpile and Low Grade Stockpile. It is recommended that further site investigation be undertaken to determine the depths of the organic soils in these areas.

It is recommended that the Study Area be extended to include a corridor along the full extent of the proposed Main Access Road alignment.

The terrain mapping could be refined further with the aid of a 'Bare Earth Digital Elevation Model' that would show the land surface without the vegetation cover. A 'Bare Earth Digital Elevation Model' could prove particularly valuable for delineating the glacial landforms within the Study Site.

### 9.3 SEDIMENT AND EROSION CONTROL

The terrain mapping did not identify any existing widespread areas of sheet or gully erosion within the Study Area. Organic soils and silt-rich glacial lake deposits were identified locally at the sites of the proposed facilities. These soils are expected to be particularly prone to erosion during the construction phase of the project when the surface vegetation is stripped as part of the embankment

foundation preparation. The local presence of such soils with a relatively high susceptibility to surface erosion should be accounted for in the project 'Sediment and Erosion Control Plan'.

#### 9.4 TERRAIN STABILITY CONSIDERATIONS

The terrain stability mapping indicates that the footprint areas of the proposed facilities are generally 'stable' terrain with a 'negligible' to 'low' likelihood of landslides. The footprint of the proposed TSF does, however, include local areas of 'potentially unstable' terrain. These areas of 'potentially unstable' terrain will be effectively buttressed by the tailings embankments and the tailings once the mine is operational. Some disturbance, including stripping of vegetation, is anticipated in these areas as part of the construction of the tailings embankments. It is recommended that a work plan be developed during construction in order to address the enhanced likelihood of slope instability and sediment transport in these areas at that time.

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**11 – CERTIFICATION**

This report was prepared, reviewed and approved by the undersigned.

Prepared:

*J. Haley* FEB. 14, 2013  
James Haley, P. Eng.  
Senior Geotechnical Engineer



Reviewed:

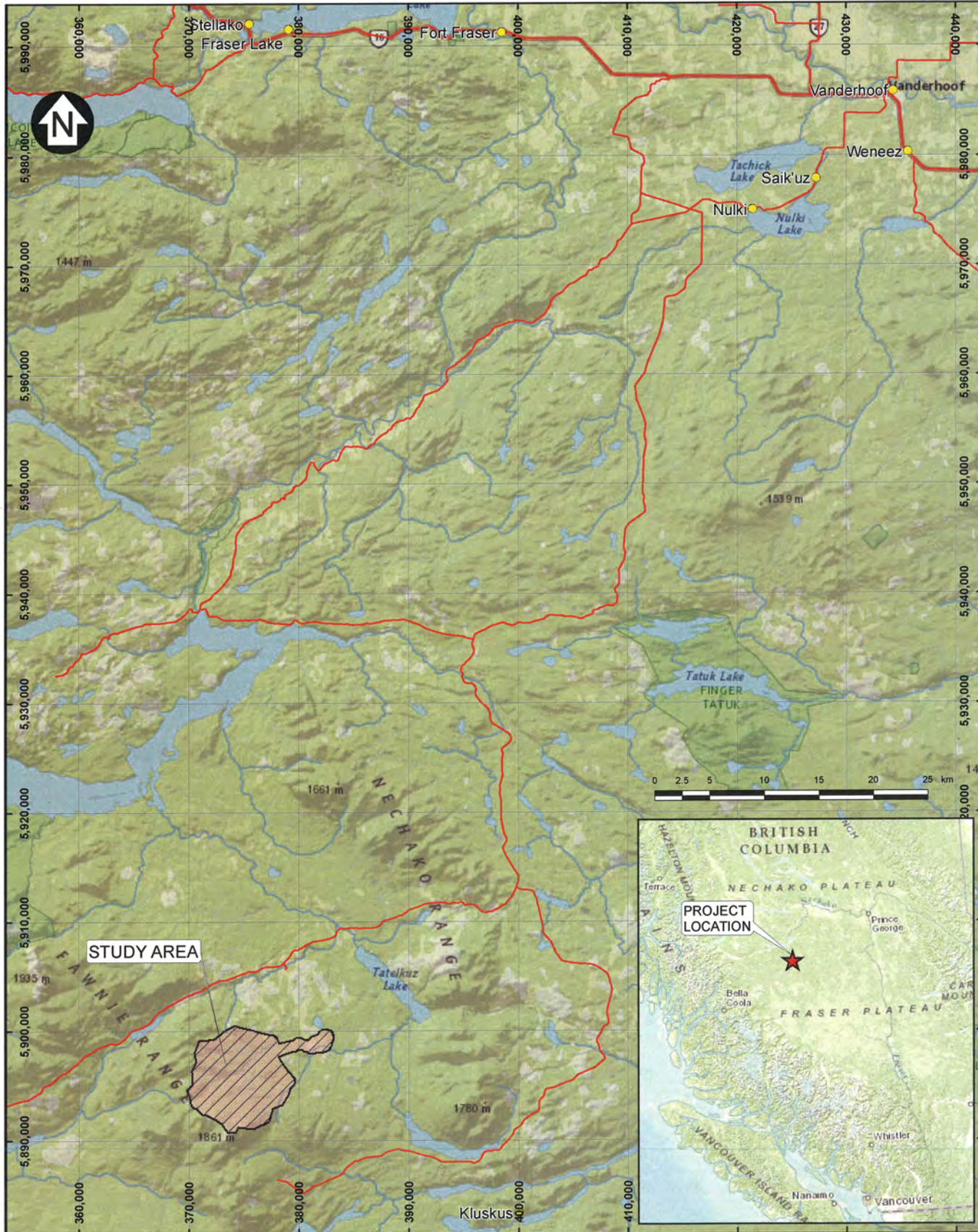
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Approved:

*K. Brouwer*  
Ken Brouwer, P.Eng.  
President

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**TERRAIN UNIT MAP LEGEND**

**TEXTURE**

- a blocks (>256 mm; angular)
- b boulders (>256 mm; round)
- c clay (<0.002 mm)
- d angular and rounded particles; >2 mm
- e fibric organics
- g gravel (rounded particles, >2mm)
- h humic organics
- k cobbles (64-256 mm, rounded)
- m mud (silt and /or clay)
- p pebbles (2-64 mm, rounded)
- r rubble (2-256 mm, angular)
- s sand (0.63-2 mm)
- u mesic organics
- x 2 to 256 mm, angular
- z silt (0.002-0.63 mm)

**SURFICIAL MATERIALS**

- A anthropogenic material
- C colluvium
- D weathered bedrock
- E aolian sediments
- F fluvial sediments
- FG glaciofluvial sediments
- I ice
- L lacustrine sediments
- LG glacial lake sediments
- M morainal material (glacial till)
- O organic materials
- R bedrock
- U undifferentiated materials
- V volcanic sediments

**SURFACE EXPRESSION**

- a moderate slope(s) (27-49%)
- b blanket
- c cone
- cl cliff
- d depression
- e plateau (no upslope catchment)
- f fan
- g gully slope
- h hummocky topography
- j gentle slope(s) (6-26%)
- k moderately steep slope(s) (50-70%)
- l lobe
- m rolling topography
- p plain (0-5%)
- r ridge topography
- s steep slope(s) (>70%)
- t terraced
- u undulating topography
- v veneer
- w mantle of variable thickness
- x thin veneer
- y1 topographically confined hill slope
- y2 topographically confined plain
- z1 hill top (rounded)
- z2 hill top (sharp)

**GEOMORPHOLOGICAL PROCESSES**

- A snow avalanches
- B braided channel
- E glacial meltwater channels
- F slow mass movement
- G glacial processes
- H kettled
- I irregularly sinuous channel
- J anastomosing channel
- L abundant seepage
- M meandering channel
- N nivation
- O decomposition of plant remains
- R rapid mass movement
- S solifluction
- U sheet erosion
- V gully erosion
- W weathering
- X permafrost processes
- Z general periglacial processes

**GEOMORPHOLOGICAL PROCESSES: SUBCLASSES AND SUBTYPES**

- F" slow mass movement, initiation zone
- Fc soil creep
- Fe slow earthflow(s)
- Fg rock creep
- Fk tension cracks
- Fr slow rockslide(s)
- Fs slow debris slide(s)
- R" rapid mass movement, initiation zone
- Rb rockfall(s)
- Rd debris flow(s)
- Rr rapid rockslide(s)
- Rs rapid debris slide(s)
- Rt debris torrent(s)

**LEGEND:**  
 ROAD  
 STREAM

**NOTES:**  
 1. BASE MAP: (C) MICROSOFT BING MAPS. INSET (C) ESRI ARCGIS ONLINE MAPPING.  
 2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.  
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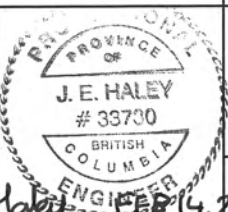
**TERRAIN SYMBOLS**

- components on either side of the symbol are of approximately equal proportion
- / the component in front of the symbol is more extensive than the one that follows
- // the component in front of the symbol is considerably more extensive than the one that follows
- the component in front of the symbol overlays the one that follows

DRG. NO.	DESCRIPTION
	REFERENCE DRAWINGS

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0	14FEB13	ISSUED WITH REPORT	JEH	CC	JH	EB

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**BLACKWATER GOLD PROJECT**

<b>PROJECT LOCATION MAP AND TERRAIN MAP LEGEND</b>	
PIA NO. <b>VA101-457/4</b>	DRAWING NO. <b>G0010</b>
REVISION <b>0</b>	

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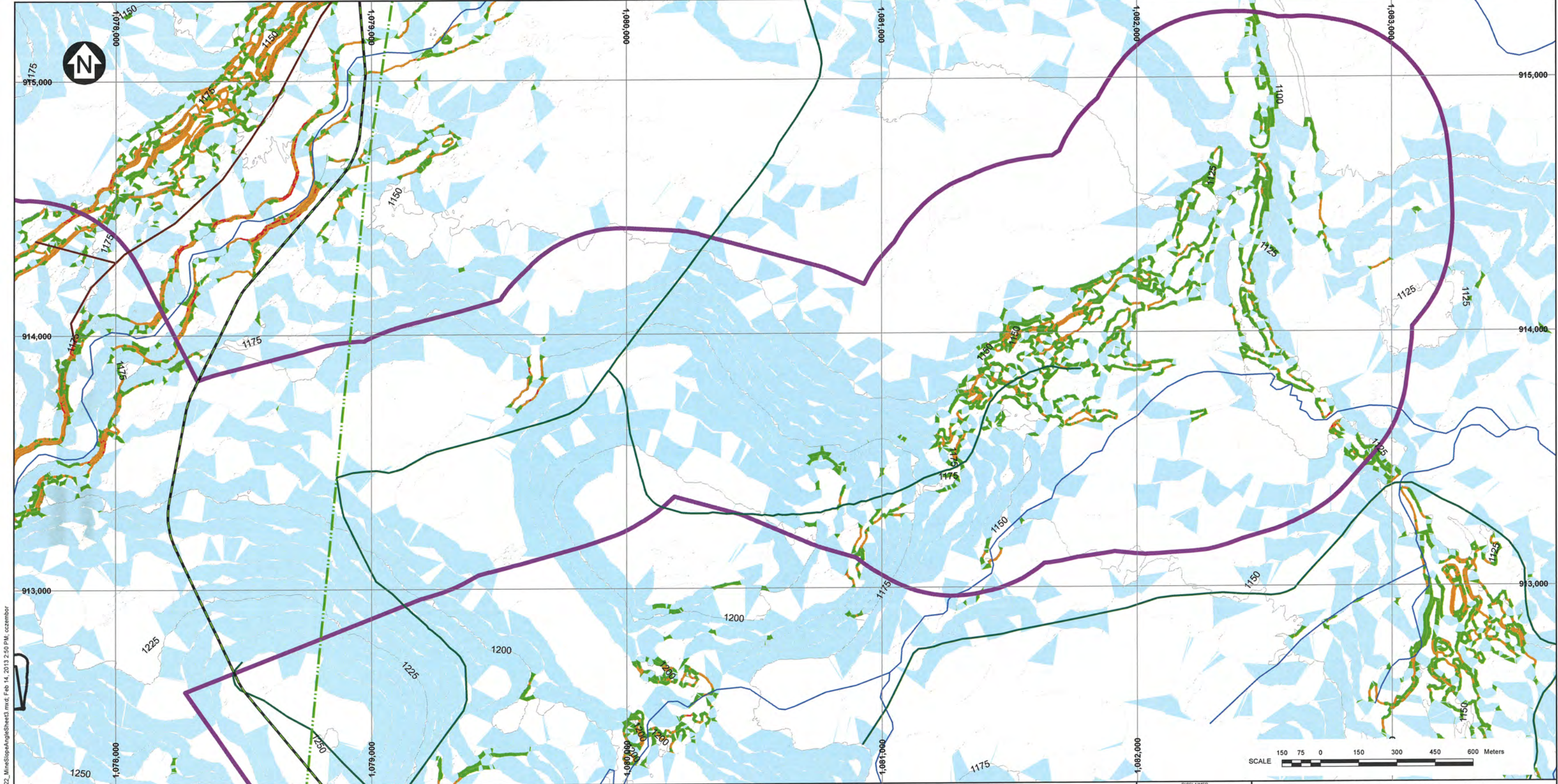












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**LEGEND:**  
**GENERAL**  
 - EXISTING FOREST SERVICE ROAD  
 - EXISTING ROAD / TRAIL  
 - CONTOUR (25 M)  
 - CONTOUR (5 M)  
 - RIVER/CREEK  
 - KP STUDY AREA

**SLOPE ANGLE**  
 0 - 5% (PLAIN: 0 - 3 DEGREES)  
 6 - 26% (GENTLE: 4 - 15 DEGREES)  
 27 - 49% (MODERATE: 16 - 26 DEGREES)  
 50 - 70% (MODERATELY STEEP: 27 - 35 DEGREES)  
 >70% (STEEP: >35 DEGREES)

**PROPOSED FACILITIES**  
 - MAIN ACCESS ROAD  
 - PROPOSED TRANSMISSION LINE  
 - HAUL ROAD  
 - MINE FACILITIES

**NOTES:**  
 1. COORDINATE GRID IS IN METRES.  
 COORDINATE SYSTEM: NAD 1983 BC ENVIRONMENT ALBERS.  
 2. THE CONTOUR INTERVAL IS 5 METRES; SOURCE: EAGLE MAPPING.  
 3. THIS MAP IS PRODUCED AT A NOMINAL SCALE OF 1:15,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.  
 4. FACILITIES BASED ON 4JUN12 VERSION OF THE GENERAL ARRANGEMENT.

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**SLOPE ANGLE MAP**  
**SHEET 3 OF 3**

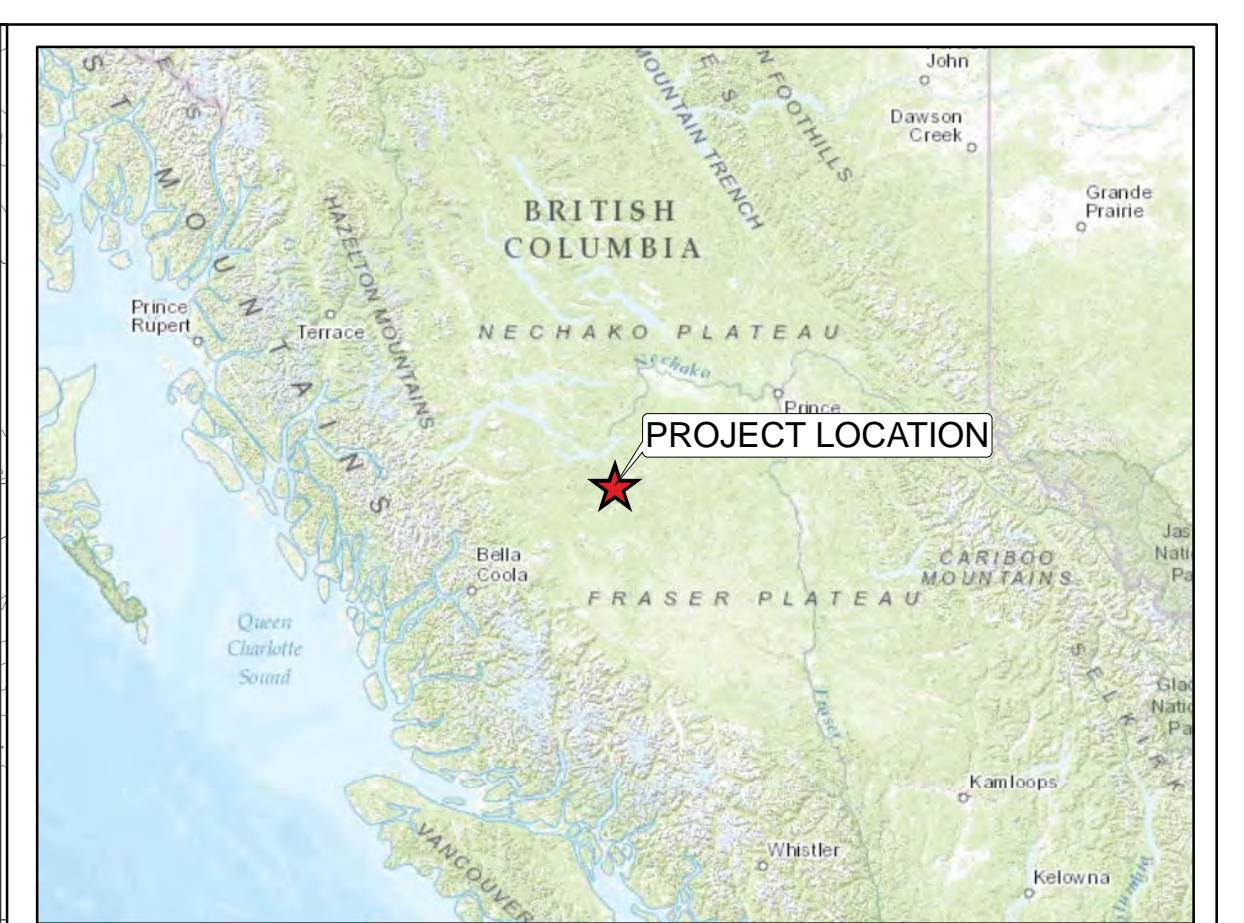
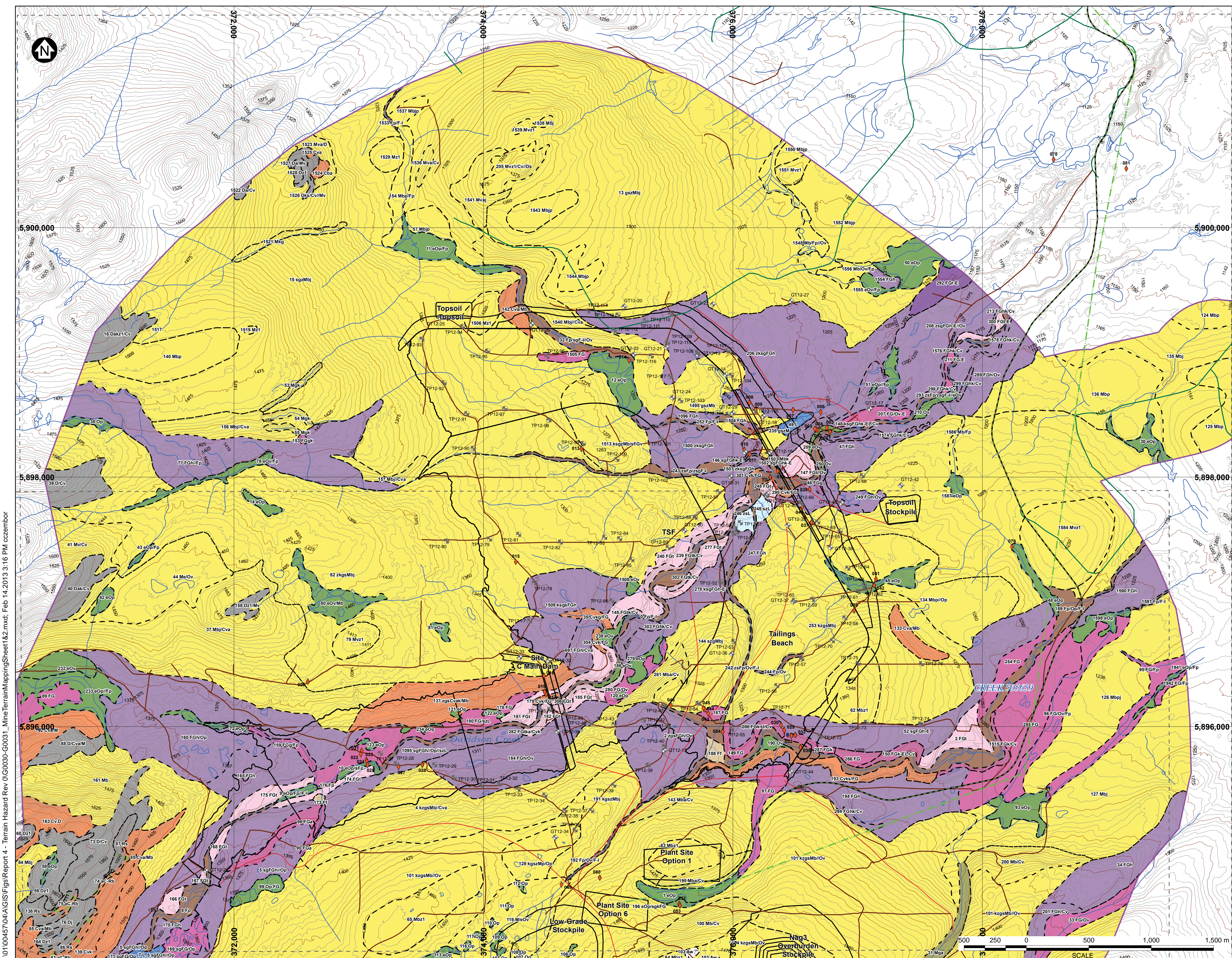
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 BRITISH COLUMBIA  
 ENGINEER  
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	REFERENCE DRAWINGS							0	14FEB13	ISSUED WITH REPORT	KK	CC	JH	ZB	VA101-457/4	G0022	0
	REVISIONS									REVISIONS							









**LEGEND**

**GENERAL**

- TP12-02 TEST PIT
- GT12-30 SONIC DRILLHOLE
- Field Truthing Location
- EXISTING FOREST SERVICE ROAD
- EXISTING ROAD
- EXISTING TRAIL
- CONTOUR (25 M)
- CONTOUR (5 M)
- RIVER/CREEK
- LAKE
- STUDY AREA

**PROPOSED FACILITIES**

- TRANSMISSION LINE
- MAIN ACCESS ROAD
- HAUL ROAD
- MINE FACILITIES

**TERRAIN FEATURES AND HAZARDS**

- TERRAIN UNIT
- CLIFF
- ROCK FALL PATH
- RECENT DEBRIS SLIDE
- RELICT DEBRIS SLIDE
- RELICT ROCK AVALANCHE

**SURFICIAL GEOLOGY**

- A ANTHROPOGENIC MATERIAL
- Fp ALLUVIUM
- F FLUVIAL FAN
- O ORGANIC SWAMP
- C COLLUVIUM
- L GLACIAL LAKE DEPOSIT
- Fgl GLACIOFLUVIAL SANDS AND GRAVELS (TERRACE)
- Fgh GLACIOFLUVIAL SANDS AND GRAVELS (KAME DEPOSIT)
- Fgr GLACIOFLUVIAL SANDS AND GRAVELS (ESKER)
- Fg GLACIOFLUVIAL SANDS AND GRAVELS (UNDIFFERENTIATED)
- M GLACIAL TILL (ABLATION TILL)
- Y GLACIAL TILL (LODGEEMENT TILL)
- D, R WEATHERED BEDROCK

- NOTES:**
- COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 UTM ZONE 10N.
  - THE CONTOUR INTERVAL IS 5 METRES; SOURCE: EAGLE MAPPING.
  - THIS MAP IS PRODUCED AT A NOMINAL SCALE OF 1:15,000 FOR 24x36 ("D" SIZE) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
  - REFER TO DRAWING G0010 FOR TERRAIN UNIT LEGEND.
  - TERRAIN MAPPING UNDERTAKEN TO TERRAIN SURVEY INTENSITY LEVEL D.
  - 'RECENT' LANDSLIDES ARE THOSE OBSERVED IN THE AIR PHOTO RECORD OR IN SITE RECONNAISSANCE AS BEING DEVOID OF VEGETATION, BEING ONLY PARTLY RE-VEGETATED OR BEING RE-VEGETATED WITH PIONEER SPECIES E.G. ALDER.
  - 'RELICT' LANDSLIDES PRE-DATE THE AIR PHOTO RECORD.
  - 1953 - YEAR OF AIR PHOTO IN WHICH THE LANDSLIDE WAS FIRST OBSERVED.
  - FACILITIES BASED ON 4JUN12 VERSION OF THE GENERAL ARRANGEMENT. MINE ACCESS ROAD ALIGNMENT DATED 09JAN13

**DISCLAIMER**

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*J. Haley* FEB 14, 2013

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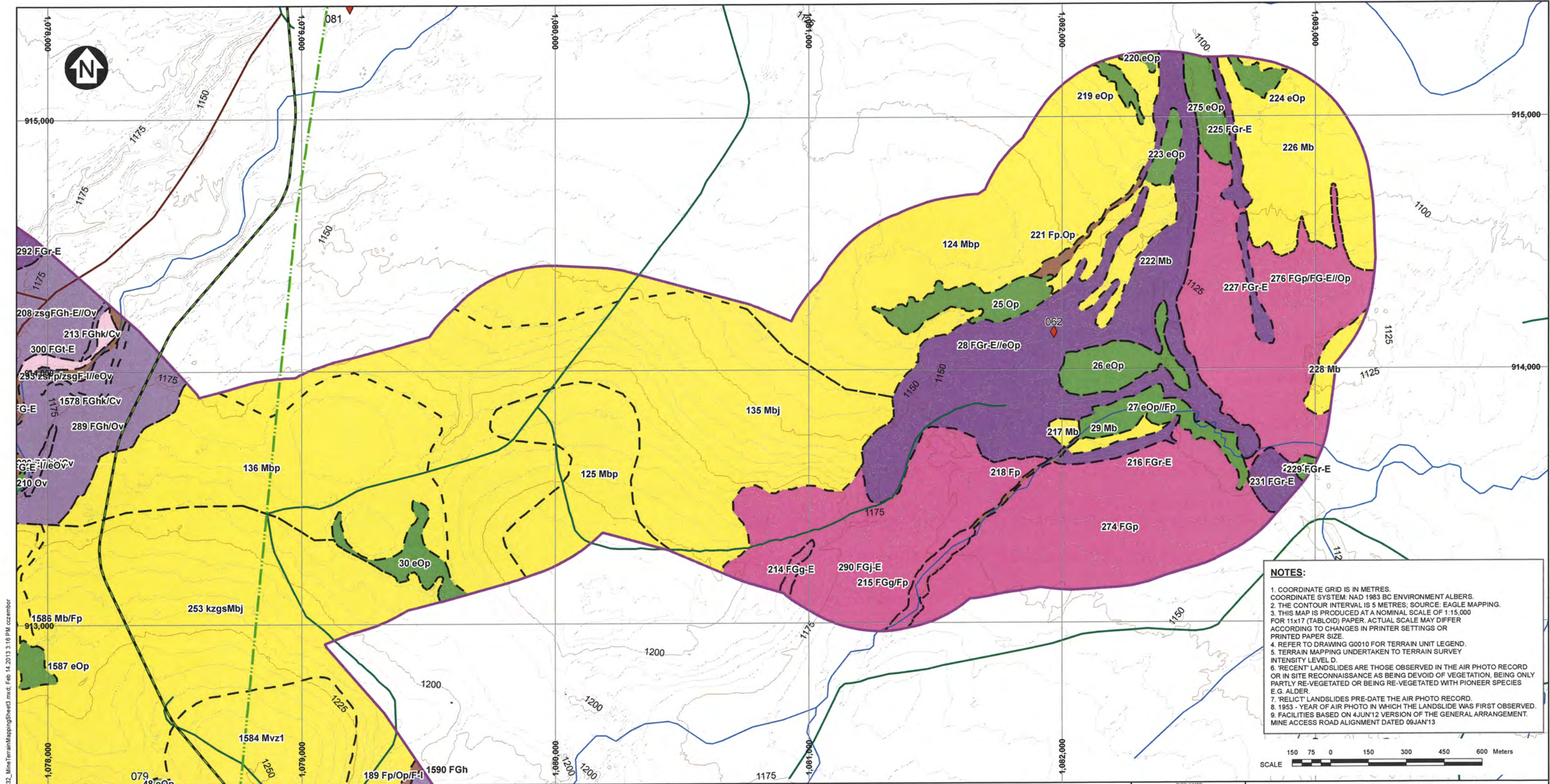
**TERRAIN MAP SHEET 2 OF 3**

DRG. NO.	DESCRIPTION	REV	DATE	DESIGN	DRAWN	CHKD	APPD	REV	DATE	DESCRIPTION	DESIGN	DRAWN	CHKD	APPD	REV	DATE	DESCRIPTION	
	REFERENCE DRAWINGS																	
				REVISIONS							REVISIONS							

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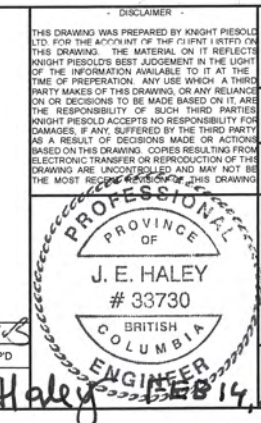


**NOTES:**

1. COORDINATE GRID IS IN METRES.
2. COORDINATE SYSTEM: NAD 1983 BC ENVIRONMENT ALBERS.
3. THE CONTOUR INTERVAL IS 5 METRES; SOURCE: EAGLE MAPPING.
4. THIS MAP IS PRODUCED AT A NOMINAL SCALE OF 1:15,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
5. REFER TO DRAWING G0010 FOR TERRAIN UNIT LEGEND.
6. TERRAIN MAPPING UNDERTAKEN TO TERRAIN SURVEY INTENSITY LEVEL D.
7. "RECENT" LANDSLIDES ARE THOSE OBSERVED IN THE AIR PHOTO RECORD OR IN SITE RECONNAISSANCE AS BEING DEVOID OF VEGETATION, BEING ONLY PARTLY RE-VEGETATED OR BEING RE-VEGETATED WITH PIONEER SPECIES E.G. ALDER.
8. "RELICT" LANDSLIDES PRE-DATE THE AIR PHOTO RECORD.
9. 1953 - YEAR OF AIR PHOTO IN WHICH THE LANDSLIDE WAS FIRST OBSERVED.
10. FACILITIES BASED ON 4JUN'12 VERSION OF THE GENERAL ARRANGEMENT. MINE ACCESS ROAD ALIGNMENT DATED 09JAN'13



- LEGEND:**
- GENERAL**
- TEST PIT
  - SONIC DRILLHOLE
  - FIELD TRUTHING LOCATION
  - EXISTING FOREST SERVICE ROAD
  - EXISTING ROAD
  - EXISTING TRAIL
  - CONTOUR (25 M)
  - CONTOUR (5 M)
  - RIVER/CREEK
  - LAKE
  - KP STUDY AREA
  - PROPOSED FACILITIES
  - TRANSMISSION LINE
  - MAIN ACCESS ROAD
- SURFICIAL GEOLOGY**
- ANTHROPOGENIC MATERIAL
  - ALLUVIUM
  - FLUVIAL FAN
  - ORGANIC SWAMP
  - COLLUVIUM
  - GLACIAL LAKE DEPOSIT
  - FGI GLACIOFLUVIAL SANDS AND GRAVELS (TERRACE)
  - FGH GLACIOFLUVIAL SANDS AND GRAVELS (KAME DEPOSIT)
  - FGK GLACIOFLUVIAL SANDS AND GRAVELS (ESKER)
  - FG GLACIOFLUVIAL SANDS AND GRAVELS (UNDIFFERENTIATED)
  - M GLACIAL TILL (ABLATION TILL)
  - M GLACIAL TILL (LODGEEMENT TILL)
  - D.R WEATHERED BEDROCK
- TERRAIN FEATURES AND HAZARDS**
- TERRAIN UNIT
  - CLIFF
  - ROCK FALL PATH
  - RECENT DEBRIS SLIDE
  - RELICT DEBRIS SLIDE
  - RELICT ROCK AVALANCHE



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**TERRAIN MAP SHEET 3 OF 3**

DRG. NO.	DESCRIPTION	REV	DATE	DESIGN	DRAWN	CHK'D	APP'D	REV	DATE	DESCRIPTION	DESIGN	DRAWN	CHK'D	APP'D	PIA NO.	DRAWING NO.	REVISION
	REFERENCE DRAWINGS														VA101-457/4	G0032	0

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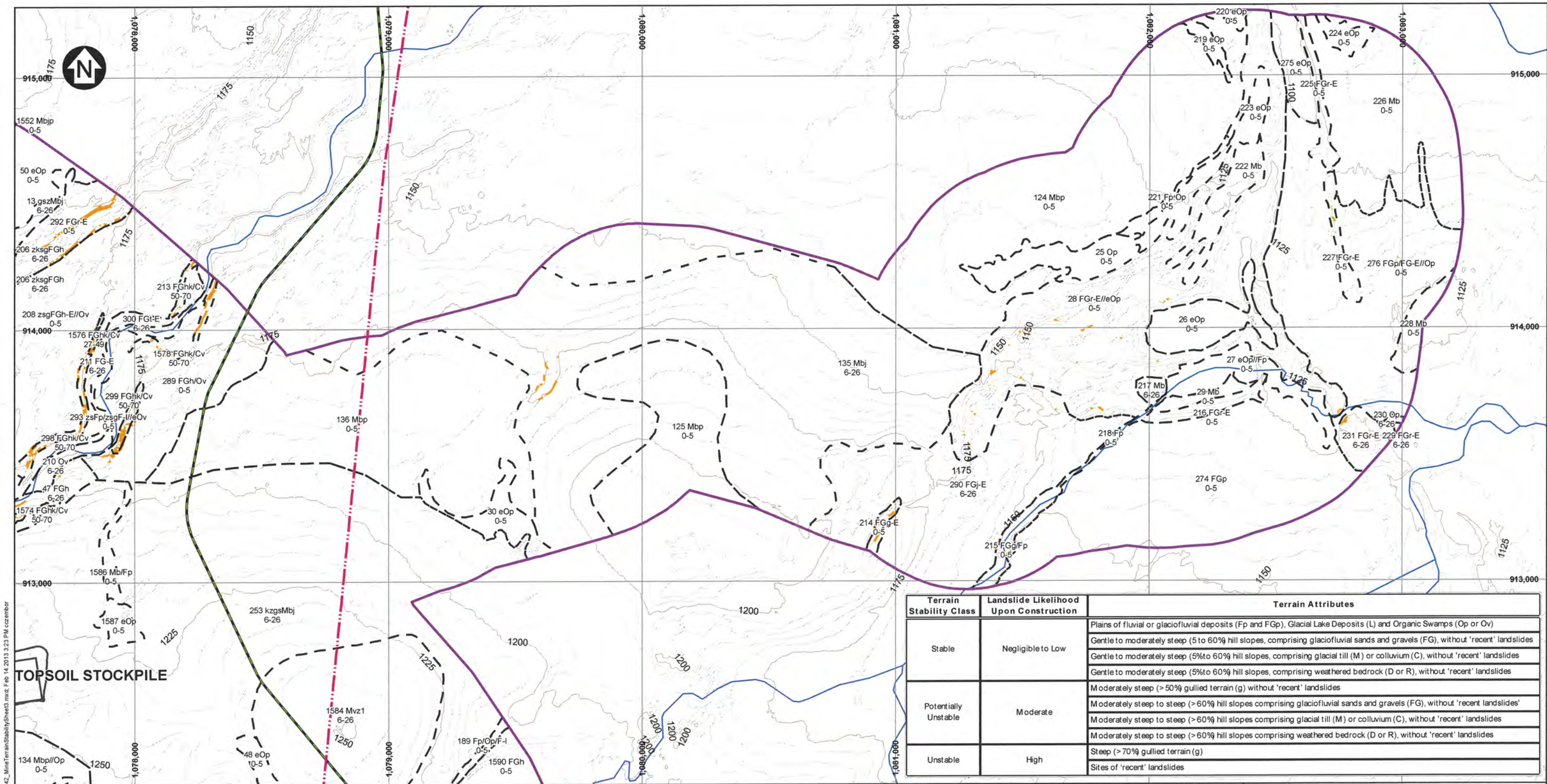












Terrain Stability Class	Landslide Likelihood Upon Construction	Terrain Attributes
Stable	Negligible to Low	Plains of fluvial or glaciofluvial deposits (Fp and FGp), Glacial Lake Deposits (L) and Organic Swamps (Op or Ov)
		Gentle to moderately steep (5 to 60%) hill slopes, comprising glaciofluvial sands and gravels (FG), without 'recent' landslides
		Gentle to moderately steep (5% to 60%) hill slopes, comprising glacial till (M) or colluvium (C), without 'recent' landslides
Potentially Unstable	Moderate	Gentle to moderately steep (5% to 60%) hill slopes, comprising weathered bedrock (D or R), without 'recent' landslides
		Moderately steep (> 50%) gullied terrain (g) without 'recent' landslides
		Moderately steep to steep (> 60%) hill slopes comprising glaciofluvial sands and gravels (FG), without 'recent' landslides
Unstable	High	Moderately steep to steep (> 60%) hill slopes comprising glacial till (M) or colluvium (C), without 'recent' landslides
		Moderately steep to steep (> 60%) hill slopes comprising weathered bedrock (D or R), without 'recent' landslides
		Steep (> 70%) gullied terrain (g)
		Sites of 'recent' landslides

**LEGEND:**

**GENERAL**

- CONTOUR (5 M)
- CONTOUR (25 M)
- RIVER/CREEK
- LAKE
- STUDY AREA
- MAP INDEX
- TERRAIN UNIT

**PROPOSED FACILITIES**

- TRANSMISSION LINE
- MAIN ACCESS ROAD

**STABILITY CLASS**  
(IN RELATION TO ROAD CONSTRUCTION AND TIMBER HARVESTING)

- POTENTIALLY UNSTABLE
- UNSTABLE

**TERRAIN UNIT CLASSIFICATION**

UNIQUE POLYGON IDENTIFIER

TERRAIN UNIT

19 Cgs-Av >70

PREDOMINANT RANGE OF SLOPE ANGLES IN POLYGON

**NOTES:**

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PROFESSIONAL  
PROVINCE OF  
J. E. HALEY  
# 33730  
BRITISH COLUMBIA  
ENGINEER

**Knicht Piesold CONSULTING**

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**TERRAIN STABILITY MAP SHEET 3 OF 3**

DRG. NO. 014FEB'13 ISSUED WITH REPORT JEH CC JEH RJS

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DESIGN DRAWN CHKD APPD

PIA NO. VA101-457/4

DRAWING NO. G0042

REVISION 0

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**APPENDIX A**

**PHOTOS**

(Pages A-1 to A-11)



**PHOTO 1 – Site of proposed Open Pit in the background and Organic Soils at Site of the proposed Nag 3 Overburden Stockpile in the foreground**



**PHOTO 2 – Site of Proposed Site D Main Tailings Dam (view to the northeast)**



**PHOTO 3 Proposed North Abutment of Site D Main Tailings Dam (view to the south)**

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**PHOTO 4 – Site of Proposed Site C Main Dam (View to the northwest)**



**PHOTO 5 – Site of Proposed Site C Main Dam (view to the north)**

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**PHOTO 6 – Very Stiff Lodgement Till at the Site of the proposed Open Pit (WP 57)**



**PHOTO 7 – Esker Ridge (WP 62)**

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**PHOTO 8 – Southeast-facing Talus Slope in Polygon 74 (view to the north)**



**PHOTO 9– North-facing Talus Slope in Polygon 291**

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**PHOTO 10 – Organic Soils in the footprint area of the proposed NAG 4 Stockpile (WP 60)**



**PHOTO 11 – Gently Sloping Apron of Organic Soil (WP 3)**





**PHOTO 12 – Upland Organic Swamps in Polygon 270, in the Southwest part of the Study Area**

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**PHOTO 13 – Fluvial Plain at WP 1, adjacent to Davidson Creek**





**PHOTO 14 – Relict Rock Avalanche in Polygon 24, in the west part of the Study Area**



**PHOTO 15 – Area of minor Gully Erosion in Polygon 129, in the southwest part of the Study Area**

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**PHOTO 16 – Interpreted Lag Deposit resulting from Seepage Erosion (WP 5)**

**APPENDIX B**  
**FINDINGS OF FIELD TRUTHING**  
(Page B-1)

**TABLE B1**  
**NEW GOLD INC.**  
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**FINDINGS OF FIELD TRUTHING**

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Field Truthing Location	Description
WP 1	Test Pit - Brown grey fine to medium sand, trace silt (Fluvial Plain). Fluvial plain extends to the north for approximately 20 m. There is an approximately 5 m wide active channel approximately 5 m to the south
WP 2	Test Pit - Brown dark grey spongy fibrous Peat. Deposit is approximately 20 m-wide
WP 3	Test Pit - Brown dark grey spongy fibrous Peat.
WP 4	Break of Slope (toe of 55% slope)
WP 5	Test Pit - Grey brown sandy angular to subrounded fine to coarse Gravel, trace subrounded cobbles; sand is fine to coarse (Fluvioglacial sands and gravels)
WP 6	Test Pit - Grey orange brown fine to coarse Sand and subangular to subrounded fine to coarse Gravel, trace cobbles
WP 7	Sump excavation - as WP 6
WP 8	Road Cut Slope - brown grey fine to medium Sand and subangular to subrounded fine to coarse Gravel, trace silt, trace cobbles and boulders. Boulder-sized pocket of brown grey sandy silt, some gravel, trace cobbles
WP 9	Break of Slope (contact between Fluvioglacial sands and gravels and Glacial Till)
WP 10	Test Pit - Grey orange brown gravelly fine to medium Sand, trace to some cobbles; gravel is subrounded to subangular and fine to coarse (Fluvioglacial sands and gravels)
WP 11	Flat area: Test Pit - orange brown gravelly fine to medium Sand, trace silt; gravel is subrounded to subangular and fine to coarse (Old Fluvial Channel)
WP 12	Test Pit - Grey brown subrounded to subangular fine to coarse Gravel, some fine to coarse sand, trace silt (Old Fluvial Channel)
WP 13	Test Pit - Very stiff grey gravelly Silt, some fine to medium sand, trace subrounded cobbles; gravel is subangular to subrounded and fine to coarse (Glacial Till)
WP 14	Organic Swamp: Test Pit - brown fibrous spongy Peat
WP 15	Test Pit - Grey brown fine to medium Sand, some angular to subrounded gravel, trace to some silt, trace subangular to subrounded cobbles (Glacial Till)
WP 16	Test Pit - Grey orange brown fine to medium Sand, some angular to subangular fine to coarse gravel, trace silt (Colluvium)
WP 17	60% Slope from here down to the creek. Ground surface is hummocky - possible relict slumping. Trees generally show vertical growth and are approximately 20 to 30 years-old.
WP 19	Test Pit - Orange brown fine to coarse Sand and subangular to subrounded fine to coarse Gravel, trace silt (Fluvial Terrace?)
WP 20	Test Pit - Dense greyish orange brown gravelly fine to coarse Sand, trace silt, trace cobbles and boulders; gravel is angular to subrounded and fine to coarse (Glacial Till)
WP 21	Road Cut - 0 to 0.5 m: Very dense angular to subangular fine to coarse Gravel, some fine to medium sand, trace silt (highly weathered Volcanic Breccia). Below 0.5m: Very weak friable moderately to highly weathered Volcanic Breccia
WP 22	Test Pit - Compact grey brown sandy Silt (Glacial Lake Deposit)
WP 23	Very dense red brown angular to subangular fine to coarse Gravel, some fine to medium sand, trace silt (Highly weathered Volcanic Breccia)
WP 24	Break of Slope (edge of Fluvial Plain)
WP 25	Test Pit - Grey brown fibrous Peat; becoming grey fine to coarse sand at 0.4 m depth (Fluvial Plain)
WP 27	Test Pit - 0 to 0.1 m: Soft to firm grey Silt, trace sand, some plant remains (Glacial Lake Deposit). Below 0.1 m: grey orange brown fine to coarse Sand and subrounded to subangular fine to coarse Gravel, trace subrounded cobbles (Glaciofluvial Sands and Gravels)
WP 28	Test Pit - Compact grey brown fine to medium Sand, some silt, some subangular to subrounded fine to coarse gravel, trace cobbles and boulders (Glacial Till)
WP 29	Test Pit - Grey brown fine to medium Sand, trace silt (Fluvial Terrace?)
WP 30	Crest of 60% slope
WP 32	Possible relict debris slide at crest of escarpment, spoon shaped (approximately 15 m long x 10 m wide x 1.5 m deep); trees in source zone are approximately 20 to 30 years old. Natural slope = 60%
WP 33	End of terrace
WP 35	Test Pit - 0 to 0.2 m: Grey silty fine to medium Sand, some gravel, some cobbles (colluvium); below 0.2 m: Soft grey sandy Silt, some subangular to subrounded fine to coarse gravel, some plant remains (Fluvial Plain)
WP 36	Outcrop of weathered bedrock, comprising andesite? Extends for approximately 30 m to the north (down slope) and then go back into Glacial Till
WP 37	Test Pit - Dense grey brown fine to medium Sand, some subrounded to subangular fine to coarse gravel, trace to some subrounded cobbles, trace silt (Glacial Till)
WP 38	3 m - high Scarp: Grey brown gravelly fine to coarse Sand, trace subrounded cobbles; gravel is subangular to subrounded and fine to coarse (Glaciofluvial Sands and Gravels)
WP 40	Contact between Glacial Till and Glaciofluvial Sands and Gravels
WP 41 to WP 42	Organic Swamp: Test Pit -Dark grey fibrous Peat
WP 43	Grey brown fine to coarse Sand and subangular to subrounded fine to coarse Gravel, some subrounded cobbles (Glaciofluvial Sands and Gravels)
WP 44	Boundary between Glacial Till and Glaciofluvial Sands and Gravels
WP 45	Test Pit - Grey brown fine to medium Sand , some subrounded to subangular fine to coarse gravel, trace to some silt, trace cobbles (Glacial Till)
WP 46	Glacial Till
WP 47	Organic Swamp: Test Pit - brown black fibrous spongy Peat
WP 49	Organic Swamp: Test Pit - 0 to 0.2 m: Brown dark grey fibrous spongy Peat; below 0.2 m: cobbles recoverd (old fluvial channel?)
WP 50	Cut Slope - Very dense grey brown silty, gravelly fine to medium Sand, trace cobbles; gravel is subangular to subrounded and fine to coarse (Glacial Till)
WP 51	Test Pit - Grey orange brown gravelly fine to medium Sand, trace cobbles, trace silt; gravel is subrounded to subangular and fine to coarse (Glacial Till - Ablation Till)
WP 52	Test Pit - Firm dark grey fibrous Peat
WP 53	Test Pit - Grey gravelly Cobbles, some fine to coarse sand (Old Fluvial Channel?)
WP 54	Test Pit - Loose grey orange brown fine to medium Sand, some silt (Fluvial Plain)
WP 55	Test Pit - 0 to 0.2 m: Subangular Cobbles, some gravel, some fibrous peat; below 0.2 m: gravelly subangular cobbles, some medium to coarse sand, trace silt; gravel is angular to subangular and fine to coarse (highly weathered bedrock?)
WP 56	Cut Slope - Grey brown gravelly fine to medium Sand, some silt, trace to some subangular cobbles; gravel is subangular to subrounded and fine to coarse (Colluvium?)
WP 57	Cut Slope - Very stiff brown grey sandy Silt, some subangular to subrounded fine to coarse gravel, some subangular to subrounded cobbles, trace subrounded boulders (Glacial Till)
WP 58	Test Pit - Grey orange brown gravelly fine to medium Sand, some subangular to subrounded cobbles, trace boulders, trace silt; gravel is subangular to subrounded and fine to coarse (Glacial Till)
WP 59	0 to 0.5 m: Grey brown gravelly fine to medium Sand, some subrounded cobbles, trace silt; gravel is subangular to subrounded and fine to coarse (Glacial Till); Below 0.5 m: Very weak to medium strong brown dark grey moderately to highly weatherd Andesite
WP 60	Organic Swamp: Test Pit - Brown fibrous spongy Peat
WP 61	Organic Swamp: Test Pit - Grey brown fibrous spongy Peat
WP 62	Grey brown fine to coarse Sand and subangular to subrounded fine to coarse Gravel, some subrounded cobbles (Glaciofluvial Sands and Gravels -Esker)
WP 65	Cut Slope - Grey brown gravelly fine to medium Sand, some silt, trace cobbles and boulders; gravel is subangular to subrounded and fine to coarse (Glacial Till)

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REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D