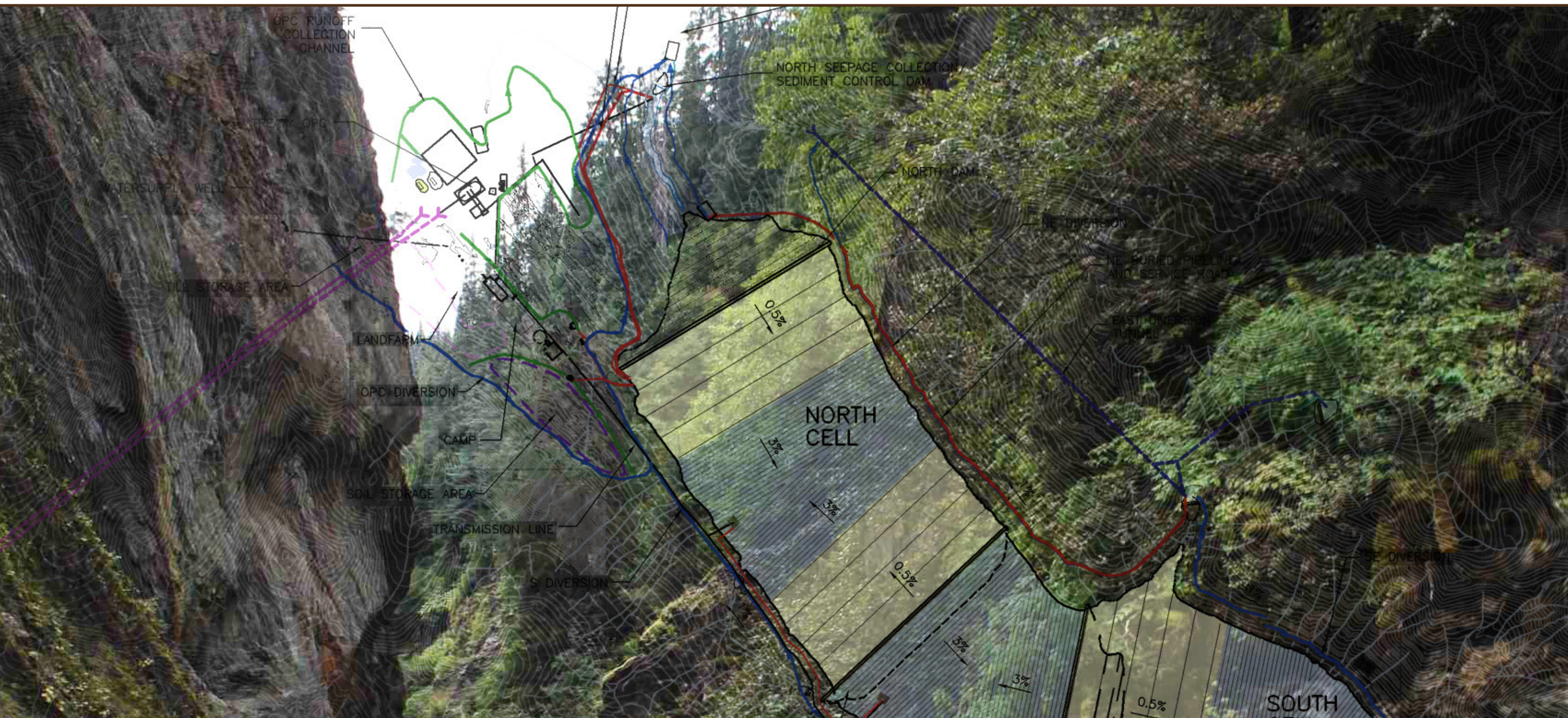
REPORT - MEETING No. 2
INDEPENDENT GEOTECHNICAL REVIEW BOARD (IGRB)
November 2017

Review of Water Dam, Water Management and Tailings Storage Systems, KSM Project

British Columbia, Canada



SEABRIDGE GOLD
KSM PROJECT

REPORT – MEETING NO. 2, INDEPENDENT GEOTECHNICAL REVIEW BOARD

REVIEW OF WATER DAM, WATER MANAGEMENT AND TAILINGS STORAGE SYSTEMS, KSM PROJECT

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Acronyms and Abbreviations

3-D	Three-dimensional
ACRD	Asphalt Core Rock-fill Dam
ARD	Acid Rock Drainage
BAT	Best Available Technologies
BC	British Columbia
BGC	BGC Engineering Consultants
BCWQG	British Columbia Water Quality Goals
CDA	Canadian Dam Association
CIL	Carbon-In-Leach
CL	Clay
El.	Elevation
EA	Environmental Assessment
FMEA	Failure Modes and Effects Analysis
FOS	Factor of safety
FS	Feasibility Study
Gs	Specific gravity
HPGR	High Pressure Grinding
HDPE	High Density Polyethylene
HDS	High Density Sludge
Board or Board	Independent Geotechnical Review Board
KCB	Klohn Crippen Berger
KSM	Kerr-Sulphurets-Mitchell
Mine Site	Proposed mine pits area
ML	Silt
NAG	Non-acid generating
NSCD	North Seepage Collection Dam
OPC	Ore Processing Centre

PAG	Potential acid generation
PFS	Pre-Feasibility Study
PGA	Peak Ground Acceleration
PMF	Probable Maximum Flood
RSF	Rock Storage Facility
SCD	Seepage Collection Dam
SG/P	Seabridge Gold Inc. and KSM Partner
SPT	Standard Penetration Test
SSCD	South Seepage Collection Dam
SSD	Saddle Seepage Collection Dam
TMF	Tailings Management Facility
WAD	Weak acid dissociable
WSD	Water Storage Dam
WSF	Water Storage Facility (this includes the WSD and the SCD)

Units of Measurement

Bt	billion tonnes
km	kilometre
kPa	kilo pascals
l/s	litres per second
m	metre
M	million
M^2	cubic metres
t/m^3	tonnes per cubic metre
tpd	tonnes per day

1. Introduction

The second meeting of the KSM Independent Geotechnical Review Board (Board) was convened by Seabridge Gold Inc. and future KSM Partner (SG/FP) and was held from June 6th to June 10th, 2016. The Board is comprised of Dr. Andrew Robertson (Chairman), Mr Anthony Rattue (Vice Chairman), Mr. Terry Eldridge, Dr. Gabriel Fernandez, Dr. Ian Hutchinson, Mr. Jim Obermeyer, Dr. Leslie Smith, and Dr. Jean-Pierre Tournier. All eight members of the Board were in attendance. The meeting included a visit to the Project Site in northern British Columbia and follow-up meetings at the Klohn Crippen Berger (KCB) offices in Vancouver.

The purpose of this meeting was primarily to carry out a comprehensive site visit, using helicopters for access, to visually inspect the locations of the key project components to the extent possible given the nature of the terrain. An examination of some of the rock cores was also undertaken. In addition, the Board received responses to the recommendations formulated at the first meeting (Meeting No. 1), was acquainted with updates for the Pre-Feasibility Study (PFS), and was given the opportunity to partake in several discussions on issues arising from the above.

The Board was advised of the results of the studies aimed at ensuring that the Best Available Technology (BAT) and Best Available Practices (BAP) are being applied for the Tailing Management on the KSM project. Discussions were held on the study and the presentations being prepared to disseminate this information to the regulatory agencies and the public.

As for Meeting No. 1, the Board's review was carried out at "Discussion Level".

In this report, the Board provides: observations made during the site visit; comments on the responses provided to previous recommendations; presents the outcomes of the discussions; and gives recommendations for future work. *The recommendations are given in the body of the report in italics and in <u>underlined italics</u> to indicate matters the Board considers are more important. Further, Board's recommendations are also identified as to which of the following phases of work these apply to:*

- **Category 1:** This recommendation applies to the PFS and should be addressed before that phase of work can be considered complete;
- **Category 2:** These are recommendations the Board suggests are best addressed during the period before the next phase of engineering is performed, which is Feasibility Study (FS). These recommendations are typically for longer lead time activities such as specific studies, field data collection, or project controls.
- **Category 3:** These are recommendations the Board recommends be addressed during performance of the FS.

As a general project description was provided in the report of the Meeting No. 1, this will not be repeated and the reader is referred to that document for companion information.

The agenda for the site visit and meetings between June 6 and June 10 is presented in Attachment 1.

A list of attendees at the various sessions is given in Attachment 2.

A selection of photographs taken during the visit and serving to illustrate items in the report can be found in Attachment 3.

2. Information Provided

Information provided to the Board, prior to the site visit and meetings, included three draft technical addendum reports on the following topics:

- Mine Water Management;
- Rock Storage Facility (RSF); and
- Tailings Management Facility (TMF).

Presentations given to the Board during the site visit and meetings included:

- KSM Water Quality Objectives & Methodology: TMF Ponds & Water Storage Dam (WSD);
- Regional vs Local Precipitation Data;
- Design Changes to the Tailings Management Facility;
- Design Changes to the Mine Area Water Management (WSF, Mine, Climate, Pumping);
- Geohazard Mitigation Options; and
- KSM Best Available Technology (BAT) Study.

Other information provided to the Board included:

- Process and Tailings Management Area Wide Water Model Report, dated May 2016;
- Draft Mine Site Water Model Report, dated April 2016;
- Site Visit Maps and Figures;
- Copies of weekly minutes from November 19, 2015 through June 1, 2016 prepared by Tetra Tech;
- Ground Response and Seismic Stability Assessment (Appendix VII to 2012 Engineering Design Update of Tailing Management Facility);
- KSM Water Storage Dam - Value Engineering Study Report, December 17, 2012;
- Table of comparative advantages and disadvantages of ACRD and RCC Dam; and
- Draft “Best Available Technology (BAT) Study for Tailing Management at the KSM Project”.

3. Matters Arising from Previous Report

Presentations were made to the Board of the responses to the recommendations included in Board Report of Meeting No. 1 (Report 1).

These responses were provided in a variety of formats:

- Direct responses included in draft addendum reports that form the appendices for the Pre-Feasibility Update Report prepared by KCB;
- Presentations and discussions that were included in the agenda and discussion topics of meeting No. 2; and
- Listed as planned studies or actions to be performed during future Project evaluations and designs leading to the FS Design Report.

The Board considers SG/FP and/or KCB to have been responsive to all recommendations required for completion of the PFS Update. While there would be benefit from more complete adoption of the Board's recommendations, these are scheduled for action in future study programs. The Board recognizes the constraints imposed by site conditions and the stage of project, and is of the opinion that the studies and the designs have been advanced adequately for pre-feasibility reporting. As a result, there are no Category 1 recommendations in this Board Report.

SG/FP also posed to the Board the following questions that relate directly to the prior Board recommendations contained in the Report No. 1:

a) Water Storage Dam

   Based on discussions at this meeting regarding Board Report #1 action item #19: *"The dam, at its base, will close a deep and narrow canyon, the Board recommends considering the inclusion of a concrete plug, in this canyon part of the valley, on which the asphalt core can be based. The plug would incorporate the recommended gallery"*, KCB requested that the Board provide a description of the concept that is recommended to be examined during future design stages. As discussed in Section 5.3.1 this is a Category 3 recommendation.

b) Tailing Management Facility

   Regarding Action Item #57: *"In the opinion of the Board, this (liner) strategy needs additional development and the Board recommends consideration of an underdrain system beneath the liner to control uplift pressures on the geosynthetic liner. It will be necessary to estimate the volumetric flow and water quality in the discharge from an underdrain system, to determine how best to manage this water"*. The question posed to the Board was whether the concepts presented for the underdrainage system beneath the Carbon-in-Leach (CIL) tailings facility liner are adequate for the pre-feasibility level design, provided that adequate underdrain capacity is included and the drain is extended to the South Pond. As discussed further in Section 5.7.1 this includes both Category 2 and Category 3 more detailed recommendations.

c) General

   The question posed was whether the pre-feasibility designs including the draft addendum reports adequately provide a basis for the PFS Update. With the results of the updated pre-feasibility study (referred to as the PFS Update) presented to the Board during these June 2016 meetings, the Board is of the opinion that investigations, designs and analyses now meet the definition of pre-feasibility.

d) Other Board Action Items

The Board was also asked to comment on whether the activities documented in the 2016 PFS Weekly Meeting Minutes, copies of which were provided to the Board, and the provision of the KSM Project SharePoint site data room, address the contractor and project team coordination as covered in the following Board recommendations #1 and #2.

#1: ""The various firms engaged for the design of these specific structures collect and evaluate the required information to develop their PFS level designs. Some of the data collected by any given firm can be very valuable to reinforce and support the design efforts carried out by another firm. The Board emphasizes the need for appropriate, timely and extensive dissemination of this information, which might require SG/FP coordination."

and

#2: "There is a need for more integration of activities by the various consulting groups that have been involved with the project. Time frames may have varied in the past but completion of Pre-feasibility, Feasibility, and Detailed Design phases will require enhanced coordination. Traditional methods at PFS and FS levels include weekly progress reports, meetings, and collaboration websites. There is benefit in scheduling additional discussion time at each meeting for each consultant to bring up concerns/un scoped items and any coordination related issues. It would be helpful for SG/FP to have an online data room."

As discussed in Section 5.2 these are Category 2 recommendations.

These four questions are further addressed in Section 5 of this report.

4. Site Visit

4.1 SITE TOUR

During the afternoon of June 6, a general site tour was carried out, by helicopter, with all Board members moving as a group. Time permitted two stops during this site introduction; the first on the ridge forming the western side of the Tailing Management Facility (TMF), at a location approximately aligned with the centre of the North Cell (Photos 1, 2). This stop provided a general view of the TMF basin in the upper reaches of the South Teigen and North Treaty Creeks, provided a good sense of the scale of the proposed tailings management facilities, and a view towards the locations of the dam axes and the East Catchment Valley (seen in the middle of Photo 1). The second stop was in the Mitchell Valley, near the toe of Mitchell glacier. This stop provided the opportunity to view the geology and structure exposed on the valley walls, the geometry of the Mitchell Glacier and the outflow of water from its toe (Photo 3), the geometry of Mitchell Valley in the vicinity of the proposed Mitchell Pit and the upper reach of the Rock Storage Facility (RSF) (Photo 4) and a number of surface flows impacted by naturally-occurring ARD (Photo 5).

During the transit between these two sites by helicopter, the Board was also able to view from the air the lower Mitchell Valley where the Water Storage Dam (WSD) will be located, McTagg Valley where waste rock is also to be placed as part of the RSF, the alignment of the Mitchell Treaty Tunnel, East Catchment Valley (and the slope movements on the valley wall), the alluvial fan that has formed where East Catchment Valley enters the Teigen Creek Valley, and Treaty Creek Valley (where it is proposed that a diffuser will be constructed to discharge water from the North and South Cells of the TMF when flow volumes in Treaty Creek permit a release).

On the morning of June 7, the Board split into two groups, with one group first visiting the site of the proposed WSD and the other group the TMF. The site tour was repeated in the afternoon, with the destinations reversed.

With respect to the sites visited in Mitchell Valley, helicopter landings were made at several sites:

- Stop one was at the axis of the proposed WSD, viewed from the left abutment. The group walked along the bench above Mitchell Creek, but sight lines were limited to view the valley floor or rock outcrops below the bench. (Note-the TMF group did not make this stop).
- Stop two was at the confluence of McTagg Creek and Mitchell Creek to observe the natural water conditions (Photo 6), and to view exposures of till, and sand and gravel (Photo 7) that could be used to construct certain elements of the RSF. Note that the primary sources of alluvial materials for the project are to be found in the Ted Morris valley.
- Stop three was at the axis of the proposed Seepage Collection Dam, viewed from the bench forming the left abutment. An outcrop was visible on the left abutment (Photo 8).

With respect to the sites visited in the Treaty-Teigen valleys of the TMF and Process plant areas, helicopter landings were made as follows:

- Stop one was at the location of the ore concentrator plant, located on the plateau above the North Dam (Photo 9).
- Stop two was in the East Catchment Valley, to view slope movements and the location of the proposed East Catchment Valley Diversion Tunnel. Photo 10 shows the lower section of the

mass movement zone, while Photo 11 shows where the mass movement had, in an earlier event, moved across the valley bottom and dammed the creek. Photo 12 shows a view of the alluvial fan that has accumulated at the confluence of the East Catchment Valley and the Teigen Valley.

- The TMF group made additional stops to view select core from the TMF drilling program and the Treaty Creek diffuser location (Photo 13).

On the morning of June 8, both groups had the opportunity to examine core from two boreholes located in the vicinity of the WSD (KC10-33 and KC12-55 on the left and right abutments of the WSD, respectively) and from one borehole at the Seepage Recovery Dam (KC10-32).

Upon departing from the site, the Board made a helicopter stop on the ridge above the Kerr deposit. This stop allowed a view across to the location of the Sulphurets Pit and the quartz monzonite unit that caps the ore deposit, and which could be used as a quarry site for non-acid-generating (NAG) construction rock for the WSD (Photo 14).

4.2 OBSERVATIONS FROM TOUR

4.2.1 Axis of the WSD

The area in the vicinity of the dam axis was overflown several times at different altitudes to view the shape and morphology of the canyon walls. A landing on the left dam abutment permitted observation of rock exposures in a limited area of the lower right abutment. Steep rock slopes were observed in the lower 40 m of the valley walls. However, while the right slope extends upwards at a relatively steep and uniform inclination, the left abutment has several, wide terraces at different elevations. The terraces are draped with moraine and/or colluvial materials. The rock mass exposures on the right abutment indicate the presence of, steeply inclined, dark shale and siltstone beds of variable thickness, striking obliquely to the river valley and dipping downstream. No evidence of springs or seeps was seen. Rock exposures on the left abutment could not be viewed from the ground.

4.2.2 Confluence of the McTagg and Mitchell Valleys

The area visited at the confluence of the two creeks is above the WSD operating level but below the flood level. Inspection of the valley floor deposits revealed the presence of sand and gravel layers, as well as cobbles and very large boulders, indicative of high peak flows. The distinct color of water in the McTagg (clear) and Mitchell (brownish) creeks can also be observed in the photograph (Photo 7).

The Board recommends further exploration of the alluvial deposits at the foundations of the submerged toe of the RSF to assess their potential for liquefaction. The deposits may be exploited to obtain construction materials for certain elements of the RSF. (Category 3 recommendation)

4.2.3 Seepage Collection Dam

The axis of the Seepage Collection Dam is located near the confluence of the Mitchell and Sulphurets valley, at the farthest practical location downstream of the WSD whilst avoiding a right bank tributary creek that is a potential source of avalanches and debris flows. Rock exposures on both dam abutments were observed from a helicopter landing on the left valley wall. Downstream, steeply inclined, relatively thin, dark siltstone and shale beds with occasional, interbedded calcite seams, striking across the valley were observed on the left abutment wall. Two sets of joints were observed within the rock mass. One set consists of vertical fractures striking parallel to the valley walls, while the second set included relatively flat, tight joints with a slight dip towards the valley. The rock mass exposed in an avalanche scar in the right abutment was similar to that observed on the left wall, except for the presence of a distinct joint set dipping moderately towards the valley. Past block sliding along this joint surface was evident. Considerable surface flow with no evidence of infiltration was observed in the avalanche area.

4.2.4 Mitchell Valley

Two prominent geological features which have a significant impact on the rock mass quality and groundwater flow were observed during the Mitchell valley inspection: the near-horizontal thrust fault parallel to the valley walls; and the vertical Brucejack shear fault, with hydrothermally altered material, striking across the valley upstream of the current location of the toe of the glacier. Competent rock could be observed on the valley walls downstream of the Brucejack Fault, especially beneath the thrust fault in the portal area of the proposed Mitchell tunnels. Springs and seeps were observed on both valley walls downstream (to the west of) of the Brucejack Fault. Impacted groundwater seeps were observed at the toe of the south slope emerging from the altered material below the Mitchell Thrust Fault. Glacial outflow emerging at the toe was significant and includes melt water and acidic flows mixing beneath the glacier.

4.2.5 Tailings Management Facility

The size and shape of the TMF valley, the top elevation of the TMF dams, as well as vegetation on the flanks of the valley were observed at the introductory stop above the basin drainage divide between the Treaty and Teigen Creek valleys (Photos 1 and 2). The vegetation indicates the past occurrence of avalanches on the east slope extending down into the TMF area, while the high elevation of the tree line on the west slope indicates a low probability of avalanche phenomena within the TMF area.

The creek flow in the North Cell area decreased gradually from the lower elevations towards the basin divide, and in the alluvial fan at the confluence with the East Catchment Valley creek flow was not observed by the Board. This phenomenon results from runoff infiltration in the alluvial and colluvial deposits at the upper end of the valley, which gradually emerge along the descending valley bottom towards the Teigen drainage.

4.2.6 East Catchment Valley

Inspection of the East Catchment Valley indicated the presence of an unstable zone of hummocky terrain, indicative of intermittent displacements, on the North wall about 2.5 km upstream of the confluence with Teigen Valley (Photos 10, 11). Evidence of past slope toe displacements which plugged the lower section of the valley, and were subsequently eroded by the creek flow, could be observed by the colluvial debris on the lower elevations of the opposite valley wall. The volume of the displaced mass appears to be relatively modest and the steep inclination of the valley floor would result in relatively small water impoundment upstream of the slide. An artesian flowing borehole casing situated in the unstable mass indicates that uplift pressures could be the slide triggering mechanism.

4.2.7 Kerr Pit

The site visit to the Kerr Pit area provided a vantage point to observe the rock mass along the North flank of Sulphurets Creek where the Mitchell drainage tunnel would be excavated (Photo 14). A massive, competent rock was observed along the stable, steep, ~300 m to 400 m high slopes, and no springs or signs of significant permeability were observed.

4.2.8 Core Inspection

Vertical borehole KC10-33 drilled on the left WSD abutment at an elevation of ~620 m encountered about 33 m of weathered rock overlying calcareous siltstone with numerous calcite specks, as well as dark siltstones with interbedded calcite layers and seams. Acid testing indicated the calcite to be susceptible to dissolution. Oxidation stains, indicative of water flow, were observed along fractures and bedding at several depths, above the river bed (El. ~560 m) and in deeper zones about 40 m to 60 m below creek level (El. ~510m). Zones of greater hydraulic conductivity, where the pump flow rate was insufficient to obtain the required Lugeon testing pressures, were reported in the lower 1/3 of the borehole. No evidence of dissolution was observed in the inspected core except for isolated, localized, small calcite specks.

Borehole KC12-55 was drilled on the right WSD abutment with a 45 degree inclination to the upstream, at El. ~670 m. The core indicated the presence of tight, dark siltstone and shale bedding, some of them soft and susceptible to slaking with changes in moisture content. A tight interface, with no evidence of dissolution between the graphitic shale and the calcareous siltstone upstream was intersected at a depth of ~15 m above the river bed. No evidence of rock dissolution was observed below the interface, although interbedded calcite seams react to acid. Packer test results confirmed the low permeability of the rock mass at this boring location.

Vertical Boring KC10-32 drilled on the left abutment of the Seepage Collection Dam at El. ~660 m encountered tight, interbedded, black shale and siltstone with occasional, thin calcite seams. No evidence of water flow (oxidation stains) were observed in the inspected core.

5. Review Commentary

5.1 GENERAL

5.1.1 Design Criteria

It is appreciated that the volume of information pertaining to a project of this scope, and the number of study reports, is substantial. Several firms have and are participating in the work. The design bases are presented in several documents.

In order to more readily assess the analyses and designs presented, particularly for coherence, the Board *requests that a document which consolidates the Design Criteria for the major structures of the project be prepared. This document should include:*

- *Operating requirements;*
- *Permit restrictions, including those arising from commitments or conditions related to the Environmental Assessment (EA);*
- *Corporate commitments to governments and to First Nations; and*
- *Long-term performance considerations allowing for access, instrumentation and maintenance.*

The above referenced document could also include the engineering design criteria, even if these have been provided elsewhere in the interests of ensuring that all parties are working from a common base. Sources of the criteria and any appropriate discussion on the selection would facilitate the consistent application. In the interest of providing a concise document, design parameters such as material properties, need not be included. (Category 2 recommendation)

5.1.2 Refined Hydrology Design Parameters

Design parameters used by the Design Team such as the 50-year, 100-year and 200-year storm and flood events for the sizing of diversion ditches and tunnels, the 100-year dry year and 200-year wet year for evaluation of water quality in receiving waters have to date been developed from several years of on-site precipitation and streamflow gauging, the nearby longer period Eskay Creek station, as well as use of Global Climatic Models (GCMs). While these analyses provide suitable design parameters for the PFS, more comprehensive analyses incorporating long-term records in the wider region surrounding the sites are required to confirm and potentially refine the current design parameters. In general terms, the longer-term (20 to 30 plus years) meteorological and runoff data from regional stations provide more accurate statistical distributions which may then be extrapolated to the various areas of the site using the information obtained from the on-site station, some of which have now been monitored for 8 years.

It is important for the FS design to broaden the meteorological and runoff data base and refine the design parameters by conducting a regional hydrologic evaluation incorporating precipitation and stream flow monitoring data from a larger area surrounding the mine site. Typically the steps in such an analysis include:

- *Selection of long term meteorological and runoff stations;*
- *Single station frequency analyses for the parameters of interest (such as precipitation of durations ranging from hours to a year, annual maximum flood peaks, etc; and*
- *Regional analyses to determine frequency curves applicable to the various areas at the mine site area, such as the mine site, the TMF area, etc. (Category 2 recommendation)*

5.2 RESPONSES TO SG/FP QUESTIONS

a) *Water Storage Dam*

The request for additional description of the foundation plug in the gorge and the location of the grouting gallery is covered in section 5.3.1 below.

b) *Tailings Management Facility*

With regard to the enquiry as to the adequacy of the drain system beneath the CIL pond liner, this item is discussed in detail in section 5.7.1. Changes are suggested by the Board for some geometrical aspects of the liner and control of the drain discharge elevation but the current concept will meet pre-feasibility level design requirements.

c) *General*

By definition, pre-feasibility design levels for a project are sufficient to conclude that technical and operational performance of structures are anticipated to meet project objectives and criteria but, this level of design and analysis is not required to demonstrate all aspects of technical and operational feasibility. Designs are developed to a stage sufficient to allow development of cost estimates that are accurate to within the tolerance required to make decisions to proceed to Feasibility Design levels. Future project development will be directed to advancing investigation, designs and analyses to Feasibility stage.

The investigations, designs and analyses performed by KSM Project Team (including Consultants) and presented to the Board in March 2015, have been updated in what is referred to as the PFS Update. The Board is of the opinion that investigations, designs and analyses now meet the above definition of pre-feasibility. Some investigations/designs are more advanced than others and elsewhere in Section 5 the Board provides observations and recommendations for further development and optimization of designs.

d) *Coordination and Data Dissemination*

The Board was advised of the methods and procedures by which the KSM Project is disseminating data, and making data archives available to all involved, and also of weekly coordination meetings. The Board has questioned consultants to the KSM Project team regarding their access as well as support with obtaining available data. The data dissemination is greatly improved but weekly coordination meetings tend to focus on progress and budget rather than on an exchange of technical data and understanding. The Board encourages SG/FP to continue to optimize this exchange. (Category 2 recommendation).

5.3 WATER STORAGE FACILITY

5.3.1 Location and Design of the Water Storage Dam

No additional geological information on the foundation of the WSD has been obtained since the previous report. Thus, as already stated in the Board Report No. 1, "considering the topographic constraints and current knowledge of geological conditions, the location of the dam is appropriate but some adjustment may be made after more detailed investigations." The Board notes that moving the axis about 20 m downstream would limit the overburden excavation though consideration has to be given to the rock quality and topography as and when more detailed information becomes available at later design stages.

The Board suggested, in Report No. 1, that foundation grouting as well as initial placement and compaction of the asphalt core within the confined area of the gorge at the base of the WSD would be facilitated if a starter concrete plug was constructed in this area. (Category 3 recommendation). Clarification of this recommendation was requested and was provided during the meetings and is summarized as follows.

Two aspects have to be taken into consideration:

a) *Grouting of the foundation is intensive, could take considerable time and, due to special conditions (geology and water chemistry), will probably necessitate long term monitoring, maintenance, and remedial grouting. Thus, the provision of a grouting gallery is appropriate and will also remove grouting from the critical path.* (Category 3 recommendation).

b) *The asphaltic core has to be constructed on a concrete slab or plinth that must be provided both at the bottom and on the sides of the narrow gorge. The alternative of filling the gorge with concrete to a certain elevation may be simpler. Some remodelling of the abutments by excavation will be needed, in particular to eliminate overhangs. The inclusion of such a concrete plug in the base of the gorge should be part of an optimisation to minimise the remodelling excavation volumes and permit the use of the paving machine more quickly.* (Category 3 recommendation).

Considering these two needs, the grouting gallery may be constructed within the rock below the core, as a cut-and cover gallery under the plinth, or within the plinth. *The Board recommends that an optimisation be done on the location of the grouting gallery along the axis.* (Category 3 recommendation).

The width of the gorge at the riverbed level (approximately El. 550 m) is about 20 m. The Board recommends that a concrete plug be constructed in the gorge with a crest width of about 4 m in the upstream-downstream direction and with side slopes of 45°. The side slopes are necessary to reduce the potential for differential settlement and stress concentrations in the embankment. Bituminous protection may be applied to the upstream face of the plug concrete to enhance resistance to attack from low pH water. (Category 3 recommendation).

By locating the gallery in the concrete plug/plinth above the riverbed elevation, access galleries may be driven from the toe area through the abutments in such a way as to ensure gravity drainage of the gallery. This would provide a better environment for instrumentation, and facilitate access for inspection and any remedial works.

The basic section of the WSD embankment, as shown on the drawings, is somewhat schematic but the essential elements are present. However, *the Board recommends that the designer evaluate opportunities to steepen the upstream slope from the currently shown value of 2.25H to 1V when the characteristics of the rockfill are better known.* (Category 3 recommendation). This could permit the inlet of the diversion gallery to be moved downstream, thus reducing the length of the diversion tunnel. The reduced footprint length could permit greater flexibility in the selection of the dam axis location with a view to positioning the grout curtain as much as possible outside of the calcareous formation.

Questions were posed as to the possibility of skewing the axis, also to optimise the grout curtain position. Slightly skewed axes are acceptable as long as due consideration is given to abutment contact stresses and the desirability to create a convergent plane rather than divergent for all of the central zones.

On the upstream face of the dam, an engineered riprap zone of uniformly sized rock fragments should be added from about El. 627 m to the crest. (Category 3 recommendation).

The PFS update documents have indicated areas where optimisation may be made in relation to material utilization in the embankment, particularly in the upstream shell. To date, it has been assumed that rockfill will be obtained from the Sulphurets quarry and will comprise Monzonite that is relatively resistant to degradation in the acidic environment. The potential use of materials from more convenient sources, including required excavations, will be evaluated in terms of the anticipated degradation and dam deformation as determined from finite element analyses. *The Board supports this initiative and suggests that the zonation of the shell be established not only in terms of distance from the central core but also according to the elevation and thus the duration of exposure to acidic water and the cyclic nature of the reservoir fluctuations. The scenario of chemically induced deformations reinforces the need for the high levels of compactive effort to obtain dense fill as is customary for Asphalt Core Rockfill Dams. The required values of compression moduli are greater than for earth core rockfill dams.* (Category 3 recommendation).

The Board notes that spillway channel excavation would proceed in parallel and diversion closure made according to the results of a flood risk/routing study. During the construction phase, the spillway could be excavated to operate at a sill elevation below the final High Water level (HWL) with a subsequent raise by the concrete crest, rollway and chute for the final spillway configuration.

Given the deep narrow valley, cableways would likely figure in the techniques for clearing and delivery of concrete and asphaltic concrete.

5.3.2 WSD Construction Schedule

The document “Appendix III – WSD Construction Schedule Basis and Review of Optimizations”, prepared by EBC Inc and KCB, was reviewed. EBC was one of the contractors of ACRD at Romaine 2 for Hydro-Quebec.

The proposed asphaltic concrete layer thickness is 225 mm with a tolerance of 25 mm and a maximum rate of placement of three layers per day (24 hour period). At the end of each period of 28 days, coring is done in the “cooled” asphalt core for testing and the asphalt placement at this segment of the dam has to be interrupted for 3 to 4 days. As a result, the average placement rate is 0.6 m per day. Since the total height of the asphalt core is 164 m (El. 550 m to El. 714 m), theoretically, a minimum of 275 days are needed. However, space at the top of the dam is limited and it will be difficult to place both asphalt and rockfill (upstream and downstream) simultaneously. In the above referenced document, it is assumed that the final 40 m will present such difficulties. The Board considers this to be a conservative estimate and believes that a consideration of slower work for only the final 20 m, instead of 40 m, would be more realistic. Even allowing for contingency, this results in a more realistic asphalt placement schedule of about 320 days, rather than the 360 days indicated in the report.

According to the temperature and snow estimates based on 8 years at the Sulphurets Creek Climate station, the mean daily temperature above 0°C occurs between April 7 and November 1, which gives about 200 days of suitable conditions temperature wise. Consequently, the Board anticipates a two year period for asphalt core construction. Temporary construction slopes for the placement of the rockfill in advance of the construction of the core may be steepened allowing more volume of rockfill to be placed during the first two years.

5.3.3 Hydrogeology

Hydrogeologic conditions in the left and right abutments are dissimilar. On the right abutment, the water table rises within the valley wall from the creek level. On the left abutment, the water table is generally flat at the elevation of Mitchel Creek. *To confirm that this head distribution reflects a long-term pattern of flow* *in the abutment area, the Board requests that the results from the most recent water level survey be compared with the data synthesis conducted in 2012.* (Category 2 recommendation).

The geometry of the water table at the left abutment is attributed to the presence of higher permeability features (faults, fractures with solution-enhanced permeability) on the left abutment. Further refinement of the hydraulic head distribution and the structure of the hydraulic conductivity variation will be required for FS-level designs. *The Board is also interested in gaining further insight as to how the hydraulic conductivity of the calcareous units could change once acidic water from the storage pond enters the dam foundation, and the extent to which grouting may be necessary to prevent permeability enhancement. Alternatively and as discussed above, consideration could be given to determining if there is any benefit gained by adjusting the orientation of the dam axis to avoid the calcareous rock unit and minimize the potential effect of carbonate dissolution.* (Category 3 recommendation).

The Board would like to gain insight to the potential for a sustained increase in the pH of the pond water as a means of mitigating any tendency for development of solution-enhanced permeability in the calcareous rocks present in the abutments of the dam. Are there relatively simple and cost-effective means of achieving a modified pH? The acidic water will also promote a degree of chemical degradation of the upstream rockfill, which could also be attenuated by raising the pH of the pond water. Quantitative understanding of the expected degree of chemical degradation can be achieved by constructing several field barrels, using samples of proposed construction materials, with a continuous stream of water directed from bottom to top through the barrel. Water for this test could be sourced at one of the acidic seeps in the area of the Mitchell Pit. A standard suite of geotechnical tests (and a mass-loss determination) could be conducted on a monthly cycle to quantify the impacts of chemical alteration. (Category 2 recommendation).

5.3.4 Grouting

The flow of groundwater, originating as seepage from the WSD pond, is required to be less than 1 l/s measured downstream of the Seepage Collection Dam (SCD); a low number by dam construction standards. As a result, one of the most significant risks for the water storage facility is the performance of the grout curtains, particularly for the depth envisaged.

The rock temperatures influence the ability to grout the rock mass and the curing of the mix to ensure long-term efficiency. Normally, the temperature of the rock mass must, at least, be equal to, or above, 4°C to allow for grout curing. The temperature of the rock mass at a depth of about 10 m is usually equal to the mean annual temperature which is approximately 0°C at this site. The temperature and snow estimate analyses done are based on limited data of available weather records at Sulphurets Creek Climate station (see Section 5.1 above). The Design Team has assumed that "near-surface rock would warm to 5°C by May 1st if the snow cover is removed by April 15th and grouting of the near-surface rock would require no special measures". The Board points out that it has not been the experience of the La Romaine Complex on Quebec's North Shore, where the mean annual temperature, which varies from 1° to 3°C, is registered at a depth of about 10 m in the rock. It is most important to verify this situation as soon as possible so as to have enough time to react. Consequently, the Board wishes to emphasise the recommendation of the previous report, i.e., *The Board recommends the installation of thermistor strings to determine the rock temperatures at different depths for planning efficiency of the grouting mixes. Consideration should also be given to carrying out in-situ grout testing. In critical areas for grout curtain integrity, consideration could be given to heating of the bedrock mass. This has been done successfully in Russia and also locally in La Romaine Complex. Heating was by steam injection, although hot water can also be used. This would be a contingency measure only.* (Category 2 recommendation).

The normal high pond elevation in the WSD is 650 m. The emphasis has to be put on the grouting of the rock mass below this elevation. Consideration should be given to a grouting gallery in the abutments at this elevation connecting with the grouting gallery along the axis. Above elevation 650 m, standard grouting may be done through the plinth.

5.3.5 Seepage Collection Dam

Observations of rock exposures on both abutments of the Seepage Collection Dam (SCD), made during the site visit, plus inspection of rock cores from boring KC10-32 indicated the presence of relatively tight siltstone and graphitic shale with occasional, thin interbedded calcareous siltstone at the dam foundation. No springs were observed in the limited field exposures at both abutments, and oxidation stains (indicative of groundwater flow) in the core samples were limited to few, widely spaced fractures. No evidence of dissolution of rock core was detected. Thus, rock mass permeability would be controlled by tight fracture flow. It is the view of the Board that the selected dam site is satisfactory.

Seepage control relies on a multiple line of defense strategy which includes the following elements:

- Excavation of a grout and drainage gallery at both abutments and foundation of the main dam, to control and collect most of the potential seepage;
- Installation of seepage collection tunnels parallel to the river, between the main dam and the seepage collection dam to capture flows bypassing the main dam barrier; and
- Installation of a grouting and drainage gallery at both abutments of the seepage collection dam to capture any residual flows.

The Board suggests that drains could be installed in the diversion tunnel downstream of the plug in order to enhance collection of seepage bypassing the main dam barrier system. The location of the drainage features requires careful thought so as not to create high hydraulic gradients that could increase the seepage quantities and exacerbate the potential dissolution of the grout and the rock in the region of the curtain. Moreover, hydrodynamic containment can be helped or hindered by the points at which pressure reduction is attempted particularly if deep well pumping is involved. (Category 3 recommendation).

5.3.6 River Debris and Bedload Accommodation by the Water Storage Dam Construction Diversion Tunnel

The Design Team has further developed the design of the WSD construction temporary diversion tunnel. The capacity of the tunnel has been increased to pass the 50-year return period peak flood flow which was a recommendation by the Board. The Design Team as also shortened the tunnel by 200 m to avoid an avalanche prone area at its inlet, and have added an access road, a trash rack to prevent floating debris from entering the tunnel and a sliding gate to close off the tunnel after the construction of the dam is completed. The Board is of the opinion that this level of detail is adequate for the updated PFS.

Aspects that still need to be dealt with include refining the method for collecting and removing floating debris before it enters the tunnel and as it collects on the trash screen, as well as measures to minimize the entry of gravel and boulders that are transported as bedload by the river during flood conditions as these can damage the tunnel liner.

<u>*For purpose of the FS the Board recommends that further consideration be given to refining the design to reduce the risk of clogging by debris by providing a mechanism for removing accumulated debris from the front of the trash rack, considering a smaller tunnel designed to flow with a head (depth) of water over the top of the tunnels soffit at peak flow conditions, or a combination of the two. With the larger depth of water over the tunnel soffit, floating debris would collect on the water surface where it can be removed.*</u>

Consideration also needs to be given to providing protection berms in front of the tunnel to minimize entry of bedload which includes gravels and cobbles during flood conditions. (Category 3 recommendation)

5.3.7 Potential RCC Dam Alternative

The Board suggests that the Roller Compacted Concrete (RCC) dam construction technology may be an attractive alternative for the WSD. Relevant information concerning an RCC dam at the KSM WSD site is presented below.

RCC dam construction is fast due to its low heat of hydration and the construction methods that it employs which utilize earthwork type equipment. Conveyors with chutes are often utilized to deliver RCC material to the fill surface on the dam which is attractive for tight, confined sites such the WSD at the KSM mine site. The small fill volume and rapid construction may offer a schedule advantage over the ACRD.

The narrow, steep sided valley at the KSM WSD site with shallow bedrock and suitable borrow sources located nearby provides a suitable setting for an RCC dam. RCC dams usually incorporate a spillway over the top of the dam which is economical compared to a side channel spillway that is proposed for the ACRD adopted for the PFS. However, in this case the installations for the collection of seepage water have also to be considered in the valley bottom.

Conventional concrete is used for the upstream facing of an RCC dam and for placement on exposed surfaces of the spillway to enhance durability. Because of the vertical upstream face and steep downstream slope, the low level outlet works is short and typically very economical compared to longer outlet structures that are required for embankment and rockfill dams.

HDPE and PVC geomembrane liners are sometimes used to avoid chemical attack when acidic solutions are impounded by an RCC structure. A high quality geomembrane manufactured by Carpi could be used for lining of the upstream face of the dam and the Board's experience is that it performs well in very cold climates where it is in contact with ice on the reservoir.

The normal operating reservoir water level for the project is low, resulting in most of the upstream slope being exposed most of the time. This would facilitate repairs to the liner on the upstream face of the dam, if required.

Galleries are commonly incorporated in the design of RCC Dams This facilitates foundation grouting and can accelerate the construction schedule. It is noted that the SCD could also be constructed as an RCC dam.

Based on discussions of this alternative with SG/FP and the project consultants, there are some negative factors associated with the RCC alternative which may make this alternative inferior to the asphalt concrete core rockfill dam proposed in the PFS. These include:

- The ACRD has been proposed and accepted by the regulators (Note that Bitumen and Asphaltic concrete have been demonstrated to be suitable for long term containment of waste impoundments including mildly acidic conditions);
- It was indicated that there was a negative perception of RCC by regulators involved with KSM project and the Alaska authorities in particular;
- Cracking has occurred in some cases, but is generally associated with poor design and construction or poor foundation conditions;

- The Carpi lining may require maintenance or replacement, although it is expected that this would be on a very infrequent basis;
- The asphalt concrete core has intrinsic chemical resistance to the projected pH 3.5 solution that will be impounded upstream;
- RCC that comes in contact with the pH 3.5 solution, could deteriorate, although a well-constructed upstream conventional concrete face with effective construction joints and Carpi lining are expected to essentially eliminate seepage through the dam itself, and
- A cost estimate at the PFS level indicated a significant cost advantage for the ACRD over RCC.

Nevertheless, the Board recommends that a trade-off study be performed for the FS to confirm the choice between the ACRD and an RCC alternative. A specialty RCC dam construction contractor could be engaged to provide input on construction methodology and on construction cost and schedule. An aspect that needs to be considered in the comparison is the expected vs required lifespan of the WSD which could greatly exceed the economic life span of water retaining structures constructed for other purposes. (Category 2 recommendation).

5.4 ROCK STORAGE FACILITY

5.4.1 High Concentration Selenium Flow Collection

In its previous report, (the Board had recommended further development of the plans for collecting higher selenium concentration waters emanating from the Rock Storage Facility (RSF). In response, the Design Team presented designs for a 1.3 million m^2 impermeable liner and drainage system to be placed within the RSF at an elevation just above the maximum design water level in the WSD. The intent of this system is to capture up to 500 l/s of mostly waste rock leachate containing higher selenium concentrations before it comingles with other flows entering the WSD. This allows these higher concentration flows to be selectively treated for selenium before entering the WSD, which is necessary to remove sufficient selenium to meet water quality goals in the downstream receiving waters. The areal extent of the liner/drain systems is based on approximate estimates of the precipitation infiltration rate through the waste rock above it.

In discussions with the Design Team, it was also mentioned that the capture of additional sources of high selenium waters such as those in the Mitchell Glacier area and from the pits as they are developed, will be considered.

The Board anticipates that there will be two limitations associated with the proposed liner/drain system. The first is that it will be difficult to determine whether sufficient high selenium concentration leachate can be collected since the liner will settle unevenly given that waste rock placement will be ongoing at different locations, resulting in unpredictable leachate flow patterns within the RSF.

The second limitation is that settlement of the rock fill poses a threat to the integrity of the liner, particularly along the advancing toe of the lift of waste rock placed on top of the liner/drain systems where significant differential settlement can occur. Settlement can result in tearing of the liner and hence loss of leachate collection efficiency.

In furthering the design of the selenium water collection system, the Board recommends the following design aspects be considered as well other design approaches, in order to ensure sufficient high selenium concentration leachate is collected. These are Category 3 recommendations and include:

- *Improving the robustness of the proposed liner/drain system. Options that can be considered include:*
  - *Modifying the alignment of the drainage systems and pipes within the liner/drain systems to minimize exposure to differential settlement at the toe of the dumped waste rock. For example, running the collection drains across, rather than along the long axis of the RSF would expose them to less differential settlement;*
  - *Providing for adding further liner/drain systems above the initially installed systems to increase the amount of leachate collected as necessary.*
- *Considering other methods of collecting leachate from within the RSF, including for example:*
  - *During mining it may also be possible to identify specific blocks of waste rock that contain higher levels of selenium, and that can be placed on separately construction liner/drainage systems;*
  - *Use of a leachate collection structure incorporated into the toe of the RSF and with a crest elevation just above the maximum operating water level elevation in the WSD (not necessarily the maximum flood level) and providing for seepage cut-off below the structure using slurry wall or in-situ soil mixing technologies. It will not be necessary to completely cut-off all seepage. Leachate would collect behind it and can be conveyed out by a pipe systems constructed over the crest of the structure, for example;*
  - *Providing for a series of "shingle" liners along the sides of the RSF that are sloped towards the center of the RSF. These would be tied into the abutments and placed in layers as the waste pile is constructed. Leachate collecting on these would cascade downward to a main leachate collection liner/drain system constructed along the bottom of the RSF, above the drain rock. There is precedence for this approach at another mine site. Note that it is suggested by the Board that the collection/conveyance liner be installed just above the drain rock layer at the base of the RSF rather than just above the normal HWL as is shown on current drawings. Elevation 706 m (HWL) is approximately mid-height of the RSF at which point settlement under the self-weight of the rockfill would be the maximum. A liner installed above the base rock drain would be subject to only the compression of this layer even though the load (height of fill above) is greater;*
  - *Covering the top of the drain rock layer placed beneath the waste rock in order to minimize mixing of the leachate with cleaner natural groundwater. Leachate that collects on the liner would be conveyed out the front face of the RSF using pipes buried in the abutments to protect them from crushing. It is likely this method will only be effective for the upper reaches of the RSF where the drain rock is above the normal maximum operating level of water stored behind the WSD;*
- *Develop plans for collecting and piping higher selenium concentration waters that can be collected above, or from within, the Mitchell Pit as well and Sulphurets and Kerr Pits, as well as naturally occurring seeps with high selenium concentrations.*

It is important to avoid measures that increase the volume or concentration of the source of selenium, such as for example by creating infiltration ponds on the surface of the RSF. While such measure can increase the amount of selenium impacted water collected it will also unnecessarily increase the amount of water that needs to be collected and treated to meet the overall water quality controls and therefore provide no benefits and merely increase selenium treatment costs. (Category 3 recommendation).

5.5 MINE PITS

5.5.1 Water Collection below the Mitchell Glacier

The goal of water collection in the general area of the leading edge of the Mitchell Glacier is targeted at:

a) Preventing surface flow from the glacier and its adjacent catchment area from draining into the proposed Mitchell Pit;

b) Collecting as much clean (i.e. non-contact) seepage and runoff water as possible so that it can be directly discharged back into the natural drainages; and

c) Separately collecting impacted runoff and seepage for treatment.

These goals are achieved by the following:

- Installing the Mitchell diversion tunnels and raise bores under the glacier to collect clean water from within the glacier and conveying it to Sulphurets Creek; and
- A drainage ditch, and later a tunnel, that collects the remaining mixture of natural and mine impacted (contact) water and conveys it to the WSD and ultimately to the Water Treatment Plant (WTP).

During the field visit, the Board members observed the following site conditions:

- Much of the impacted water is derived from the mineralized area situated west of the Brucejack Fault. This area extends over an approximately 1.5 km width between the pit limits and the fault and is located under the toe of the glacier;
- The poor quality seepage predominantly occurs along the south side of the Mitchell Glacier and within the above referenced mineralized area; and
- The toe of the glacier has retreated significantly over the past several years at an approximate rate of 30 m to 40 m horizontally per year.

These observed field conditions indicate that there may be opportunities to further optimize the clean and impacted water diversion systems in this area during the FS and later design stages, and importantly on closure of the mine. *Examples of what may be possible are listed below. These are Category 3 recommendations:*

- *Creating a second diversion system (ditches and pipes) along the base of the north slope to divert clean water into Sulphurets Creek. In later years this clean water system could be integrated into the North Pit Wall Dewatering Adit or conveyed through the Mitchell Pit via pipelines or lined ditches;*
- *Providing for selective capture of clean and impacted water in the North Pit Wall Dewatering Adit;*
- *Providing for selective capture and pumping of high selenium seeps encountered in the Mitchell (and other) Pits;*
- *Considering ice tunneling into the glacier to construct clean water capture systems. Aside from a case history the design team provided, the Board is not aware of any precedence but considers it worth investigating. Any systems designed would need to be sufficiently robust to cope with glacial creep that continually occurs; and*

- *Adopting an adaptive management approach to the collection of the clean water emanating from the glacier as it retreats by installing surface capture systems (trenches and ponds) both before, during the mine operating period and on closure.*

These, and potentially other measures, could result in reductions in the amount of impacted water requiring treatment and reduced costs.

The Board recommends that for the FS phase of the work, more detailed water flow and sampling be conducted to characterize individual sources of clean and impacted water in and around the glacier toe area, and that further measures, such as those discussed above, and others, be evaluated and incorporated into the design, as appropriate. (Category 2 recommendation).

5.6 TUNNELS

5.6.1 Tunnels General

The site visit provided an opportunity to observe large rock exposures along the valley walls, in the vicinity of the main tunnels currently contemplated in the Project. The site observations indicate the presence of competent, relatively tight rock at least at the portal areas and probably along the tunnel alignments, confirming the Board's opinion on the adequacy of the selected tunnel routings and the absence of exceptional construction risks.

Furthermore, in the Board's view, there may be better than anticipated rock mass quality along some alignments, i.e., Mitchell-Sulphurets tunnel alignment. This provides an opportunity to optimize the current tunnel design and defer the excavation of a second tunnel until the commencement of block caving mining operations. (Category 3 recommendation).

5.6.2 Water Storage Dam Diversion Tunnel

The 1.2 km long, water dam diversion tunnel located on the right abutment is designed to accommodate peak flows with a 50 year return period operating as a gravity flow structure. The tunnel alignment is perpendicular to the strike of the steeply inclined bedding, which includes slightly metamorphosed calcareous siltstone and black shale formations. The current design contemplates an unlined tunnel, with rock treatment and/or lining installed in local areas of weaker materials.

The Board suggests that the design of the diversion tunnel be adjusted to operate under pressure during peak flows, and that an invert liner be installed, which provides for a larger discharge capacity and might reduce the potential for erosion of the less competent rock. Also, after closure plug installation, it is suggested that the tunnel downstream of the plug be considered as a location for drain holes drilled to capture potential, contaminated seepage flows bypassing the grout curtain of the dam. Again, this has to be carried out with due consideration for the hydraulic gradients that pressure relief may generate. (Category 3 recommendation).

5.6.3 Mitchell Tunnel

The current design considers installation of two 5 m diameter, 8.5 km long tunnels to divert non-contact water from upstream of the Mitchell pit to the adjacent Sulphurets creek. The tunnels are designed to accommodate peak flows with a 200-year return period, and to provide the option for repair and maintenance of the unlined tunnels during the low flow season when a single tunnel can accommodate the reduced flows.

The site visit provided the opportunity to appreciate the quality of the rock mass in the large exposures of rock along the valley walls in the area of the tunnel portals. As indicated in photo 15, taken of the Sulphurets valley wall, the igneous rock mass is very competent with stable, 300 m to 400 m high, steep slopes, with no evidence of significant seeps. A similar rock type was exposed at tunnel portal elevation in the Mitchell pit area.

Based on these considerations, the Board recommends studying the option of excavating a larger diameter tunnel capable of accommodating the 200-year flood, and operating this facility during the open pit operations carrying out required maintenance during the low flow winter months. A second tunnel to accommodate peak flows with a longer return period, say 1 in 1,000 years, and provide additional protection for the block caving operation can be excavated at a later stage. Liner installation in one of these tunnels can be carried out gradually throughout operations to increase long-term reliability and flow capacity. (Category 3 recommendation).

The Board also considers it pertinent to confirm that the potential adjustments to the size of the pit, and block caving operations, currently contemplated at the Mitchell and Kerr deposits would not affect the proposed tunnel alignment.

5.7 TAILINGS MANAGEMENT FACILITY

5.7.1 CIL Liner Underdrainage Optimization

The Carbon-In-Leach (CIL) residue containment cell is to be lined with a geomembrane. On the lower flanks and in bottom of the valley, the CIL cell is located within a groundwater discharge zone. In Report No. 1, the Board discussed the potential floating of the liner by groundwater trapped between the valley walls and the liner. In response to an earlier Board comment, the PFS design has been modified to rely upon a drainage blanket and network of drainage pipes placed beneath the liner, rather than the proposed use of temporary depressurization wells during both liner placement and prior to burial by tailings. The drains will need to be extended up the side-slopes as liner placement moves to higher elevations on the valley flanks.

During the site inspection it was observed that drainage from the valley side slopes disappeared into the alluvial and debris fans formed at the base of valley side drainages. This shallow interflow in the fans emerges as groundwater discharge in the base of the valley. A large increase in flow was observed in the flow to Teigen Creek between the southern end of the footprint of the CIL Saddle dam and the footprint of what will be the Northern toe of the North Dam. Some of this flow would have been from snowmelt, but a significant proportion can be attributed to groundwater discharge or interflow. The groundwater discharge in the valley bottom and lower valley slopes that will be covered by the liner is large and expected to be seasonally variable and rainfall dependent.

An underdrainage system has been provided for the liner, with pumps to evacuate this water so that uplift pressures on the liner can be controlled. The system design was presented to the Board and the basis of design was discussed. The Board anticipates that the seepage flows that will report to the underdrainage system will be large with local areas of high yield and possibly pressures. A robust underdrainage system will be required. *The Board recommends that in the Feasibility Design phase of the project development, that the groundwater flows be investigated, quantified, and liner and drain systems be designed that allow for the actual slope geometry.* (Category 3 recommendation). Batters and berms may be required for both drain construction and liner support on steeper slopes.

The Board noted that it is desirable to maintain hydrodynamic containment to reduce the gradient for seepage out of the lined impoundment. Hydrodynamic containment would assist in reducing the potential for seepage through liner imperfections and liner damage. To maintain hydrodynamic containment, it is necessary to raise the water pressure head between the liner and the valley side as the CIL pond level rises. Means for such water head control were discussed. A gravity drainage system with pipes through the Saddle Dam has the advantage that it is responsive to large changes in discharge requirements, and power failures can be tolerated without risk of liner failure. *It is recommended that gravity drainage be adopted with a pressure control outlet; such as a rising decant to provide passive control.* (Category 3 recommendation). Provision will also be required to capture such seepage and pump it back to the CIL cell, should water quality testing show that the water does not meet discharge criteria.

5.7.2 Cyclone Sand Requirements and Tailings Material Balance

In Report No. 1, the Board noted several factors that could negatively affect the tailings material balance and consequently the required quantities and schedule for production of cyclone underflow sands. These included:

The density of compacted underflow. For the PFS the average dry density of compacted underflow was assumed to be 1.51 t/m^3 while the Board's experience is that average values of 1.60 to 1.65 t/m^3 may be more representative.

The average dry density of impounded tailings. The average dry density assumed in the PFS for the impounded tailings was 1.53 t/m^3. The Board's experience is that the average dry density for the initial stages of deposition can be as low as 1.0 t/m^3, increasing gradually to about 1.2 t/m^3 in 2 years and to a maximum density of about 1.4 t/m^3 in about 5 years.

Decoupling the Splitter Dam and CIL Cell. It was suggested to modify the design cross section of the Splitter Dam to be constructed with compacted underflow for its full section in order to remove the construction schedule dependence of the Splitter Dam on that the CIL Cell.

Design Storm Event and Required Freeboard. The Board recommended a reassessment of the starter dam and final stage dam heights based on the design storm event and required freeboard taking into account water gains and losses during critical runoff periods.

Cyclone Sand Placement Upstream of Till Cores. There is a need to place a considerable width of cyclone sands upstream of the till cores in the various TMF embankments to prevent cracking of the cores.

Freeboard Requirements Going into Winter. Initially 20 to 25 m of freeboard will be required going into the winter to provide enough storage for winter deposited tailings and accumulated water and to provide storage for the design flood. This requirement will reduce to 10 m at maturity of the TMF. The crest widths of the dams above the impounded tailings needs to be widened in order to provide sufficient space to place materials in these areas to produce this amount of freeboard.

The Board received information on additional analyses that have been performed by KCB to individually evaluate several, but not all, of the above referenced factors in order to assess their impacts on tailings material balance and cyclone sand requirements.

Results of the additional analyses indicate the following:

- The addition of a 50-m width of compacted underflow sand upstream of the crests of the various TMF embankments with cores increases the sand demand by 34 Mm^3 over the life of the TMF, while the addition of a 100-m width increases the demand by 70 Mm^3;

- Decoupling the construction schedule for the Splitter Dam and the CIL Cell is estimated to require 9.1 Mm^3 of cyclone sand over the life of the TMF; and
- Increasing the assumed average dry density of the compacted underflow sand to 1.65 t/m^3 reduces the sand supply by 16 Mm^3 over the life of the TMF.

Additional studies concluded that varying the initial settled density of the impounded tailings will affect the required height of the starter dams. It was estimated that reducing the settled density to 1.0 to 1.2 t/m^3 would require an 8-m raise in the height of the North Starter Dam and a 3-m increase in the height of the Starter Dam for the Saddle Dam. The studies also acknowledged that other variables influencing starter dam heights will include time of start-up, delays in cyclone commissioning, delays to production ramp up, delays in water control structures, and difficulties with winter cycloning.

While the PFS design of the TMF is considered adequate for this stage of project development, more rigorous material and water balance analyses will be required in the next phases of project development in order to refine the project configuration and to size the project components. (Category 3 recommendation).

At the Feasibility Study stage of the project, it will be important to develop a material balance that accounts for the cumulative effect of all factors that will influence requirements for cyclone sand. The material balance should be developed with monthly time steps and incorporate projected volume requirements for cyclone sand to satisfy all requirements for TMF construction including construction timing and sequence. For start-up and commissioning, the concentrator ramp up schedule should be incorporated and very detailed deposition plans must be developed in order to make realistic assessments of sand placement rates which will in turn influence starter dam heights. (Category 3 recommendation).

Cyclone station availability for sand production and available areas for sand placement need to be considered throughout the life of the TMF when performing the material balance analysis. Seasonal weather and climate conditions at the site will not only limit the number of months per year when cycloning can proceed (currently assumed to be 6 months per year), but will also have dramatic effects on water balance and pond volumes for the TMF. Therefore, it will be important to analyze project requirements on a seasonal basis.

Since the timing of inflows to and outflows from the TMF will be required for the material balance, it is suggested that the material balance and water balance, both with monthly time steps, be linked to one another. If the results could indicate a shortage of sand at critical pinch points, design details and contingency plans should be developed to comfortably satisfy requirements for cyclone sand. (Category 3 recommendation)

5.7.3 East Catchment Valley Diversion

The Board inspected the location and nature of the slide zones in East Catchment Valley that could move and potentially result in blockage of the East Catchment Valley drainage. Water impoundment and subsequent release by a breach of a dam formed by the blockage could ensue. The KSM Project designers have provided for dams and a tunnel to divert water around the location of potential blockage. This potential slide zone is a natural hazard unaffected by the TMF development. The greatest risk is sudden failure triggered by a rise in water table or by an earthquake.

The Board notes that a prior slide produced a ‘dam’ of modest height, which would impound only a limited height and volume of water. A breach would release a limited water volume and the ‘breach power’ of the released water would also be limited. For the years of operation until the South Dam is constructed the downstream development that would be at risk is the loss of the Southern Seepage Collection Pond with low consequences. The embankment and toe of the Saddle Dam could be protected by a modest deflection berm, should it be needed. It is the Boards opinion that the risk of a 'dam' formed by a slide is low for the operating period and that water accumulation behind the 'dam' will be sufficiently slow to allow installation of a controlled water overflow structure.

The Board is of the opinion that the risk of an event with high consequences is low provided a Trigger Action Response Plan (TARP) is developed that includes the following:

- *Investigation and analysis of the failure to assess possible volumes;*
- *Monitoring to have an early warning of potential failure. This should include piezometers to monitor the artesian pressure beneath the slide mass;*
- *A response plan for potential slope failure events, to prevent dam breach developing from the blocked drainage.*

With the development of the TARP, the East Catchment Valley tunnel can likely be omitted. (Category 3 recommendation).

5.7.4 East Catchment Valley Fan

The East Catchment Valley drainage flows have deposited a large alluvial fan that covers the foundation area of the Saddle dam (South Dam of the CIL cell). The deposit is saturated by the East Catchment Valley drainage flows. Exploration programs including SPT and CPT and shear wave velocity measurements indicate that this deposit consists of interbedded layers of loose to medium dense clean and silty sands, some of which are susceptible to liquefaction under the anticipated ground motions.

The current design contemplates installation of a stability berm over the fan deposit to minimize the potential for liquefaction during the first 25 years of operations prior to the confinement provided by the construction of the South TMF cell. *In the Board's view, the design of this berm should also consider the additional upward hydraulic gradient induced within the fan deposit by the large head that could develop behind the CIL liner during the 25 year period prior to the construction of the South cell. This additional gradient would reduce the strength of the deposit under static loads, would increase the potential for liquefaction, and could also trigger erosion of fines into the berm. A filter and drain layer at the base of the berm would ameliorate the potential development of these phenomena. The Board also suggests evaluation of the potential for excavating the fan material and using the products as borrow.* (Category 3 recommendation).

5.7.5 Suggested Saddle Dam Alternative

The current design concept for the Saddle Dam that provides confinement along the south side of the CIL cell is to construct it as a starter dam with a central till core and to raise it as a centreline sand dam with a low permeability core including a geomembrane installed in a zigzag pattern. *The Board suggests that consideration be given to using the downstream dam construction method to construct the saddle dam and incorporating a geomembrane lining on its upstream face.* (Category 3 recommendation). *Advantages of this alternative include:*

- *Simpler liner construction compared to the zigzag liner approach;*
- *Easier connections to the CIL cell liner at both abutments; and*
- *An opportunity to construct the Saddle Dam embankment with local borrow (such as borrow material from the nearby East Catchment Valley fan) to replace cyclone sand if there is a sand shortage.*

A modified section and downstream toe would need to be considered to raise the embankment when the South cell of the TMF starts in about year 25 of the project.

If the designer agrees that this alternative might be preferable to the PFS concept, it could be considered in the Feasibility Study phase of the project. (Category 3 recommendation).

5.7.6 Splitter and Saddle Dam Operating Basis for Hydraulic Containment

Seepage and solute fluxes from the North Cell through the foundation and abutments of the Splitter Dam will be influenced by the hydraulic head that is established in the underdrain system. Similarly, any leakage that occurs through the CIL cell liner during operations will report to the underdrain system, and the rate at which this occurs will vary with the hydraulic head maintained in the underdrains.

The Board recommends that estimates of the seepage flows be updated during the FS to ensure an adequate drain capacity to carry these flows, and those that originate on the valley flanks. (Category 3 recommendation)

With the revised design of the under-drainage system, it will be necessary to update and re-run the hydrogeological model of the TMF basin to assess potential changes to hydrodynamic containment through the life of mine and to re-confirm that the seepage collection dams are located in their optimal location. This will require the re-assessment of contaminant pathways and solute fluxes for the proposed operating rules applied to the underdrain system. This work should be completed as part of the FS. (Category 3 recommendation)

5.7.7 Long Duration Wet Period Water Management Plan

In its previous report, the Board had recommended that the Design Team incorporate hydro-meteorological data (primarily precipitation) for the maximum period of data available, and suggested they consider longer duration flood events in preparing the Probable Maximum Flood (PMF) event for sizing the water storage capacity for the TMF. In response, the Design Team has analysed additional site precipitation data collected between 2011 and 2015 and considered longer period PMF events. Their analyses have indicated that the current revised estimates of annual average precipitation were close enough to the prior estimates not to warrant any re-analysis for the PFS. The Board concurs with this conclusion.

In estimating the TMF water storage requirements, the Design Team considered a 150-day Probable Maximum Precipitation (PMP) on top of a 100-year snowmelt event and a pump and pipe discharge system to remove water during this event and discharge it to Treaty Creek. This analysis also assumes that the surface diversion ditches along the TMF have failed allowing the catchment water to drain into the facility. The East Diversion Tunnel remains operational.

The Design Team estimates that up to 90 Mm^3 of water storage capacity needs to be provided on the TMF when all three disposal cells are operating. Although no quantitative estimates have been made of how the associated discharges would affect the water quality of Treaty Creek, the Design Team anticipates that the large amount of freshwater dilution that occurs in the TMF and the correspondingly large flow increases in Treaty Creek, would allow significant discharges to take place without exceeding the water quality goals established for the creek.

While the above approximate water balance analyses and discharge plan are adequate for PFS purposes, a significant amount of additional analyses and design refinement will be necessary during the FS stage for the project. The Board recommends these analyses focus on reducing the amount of storage to be provided on the TMF and need to consider, amongst other aspects, the following Category 3 recommendations:

- *The assimilative capacity of Treaty Creek; including an assessment of the potential permit requirements for these discharges;*
- *Incorporating the PMF design event in the multi-year water balance simulations to assess carry over-year effects of this design event;*
- *Incorporating the overall project water balance in the analyses in order to take into account other water balance components that influence storage, such as the water entrained in the tailings and water consumed by the concentrator;*
- *Providing for contingency and TARP measures including ditch repairs, added temporary pumping capacity, etc. to minimize water accumulation in the TMF; and*
- *Establishing operations procedures and guidelines that establish water storage trigger and associated water management actions. The procedures should also include requirements for performing regular future water balance projections under different frequency wet and dry cycles to improve the short-term water management decisions and actions.*

5.7.8 Diffuser

The braided channel of Treaty Creek meanders and displaces frequently in the reach where water will be discharged through a diffuser. The mixing zone, between the point of discharge and the monitoring point, is relatively short and very efficient mixing is required. The current diffuser design is to install a buried diffuser pipe (below the scour depth) that discharges across the braided channel width. The Board notes that such a discharge would result in different and variable discharge/stream flow ratios in each channel of the braided stream. Mixing will not be uniform and the distance of flow before uniform mixing is obtained will vary with braid patterns and flow quantity. *The Board recommends that consideration be given to dividing the trench length into sections (5 to 10) that permit the discharge to be controlled to each section. The flows in the diffuser could then be controlled to discharge into each braid from the appropriate section or sections such that there is better proportioning of discharge to each braid.* (Category 3 recommendation)

Consideration could also be given to constraining the creek bed by guide walls though such structures need to be sufficiently substantial to resist water born debris and periodic extreme flows. In either case, this could constitute a high maintenance facility and access for remedial work should be ensured. (Category 3 recommendation)

5.7.9 Treaty Creek Diversion Sediment Control Dams

The Board received a presentation on the design concept for the control of debris and sediment from gullies entering the North Treaty and South Teigen Creek diversion channel. These dams are proposed to be constructed at three creek crossings along the Treaty Creek Access Road. The access road is located along the hillside slope west of the TMF.

Embankment or zoned rockfill dams are being considered for the sediment control dams. The dams would serve the following purposes:

- Accommodate vehicular traffic where the road crosses three creeks,
- Divert flows from the creeks to the south away from the TMF, and
- Retain sediment and debris flows.

The Board considers the concept presented to be appropriate for the PFS.

However, for the Feasibility Study, the Board recommends that hard fill dams be considered and evaluated as an alternative to the PFS concept. Hardfill dams are built using cemented sand and gravel material known as hardfill. Construction is simple, quick and relatively economical. The dam structures would have a symmetrical, trapezoid-shaped cross section with an upstream concrete face slab providing erosion protection to prevent water from penetrating into the dam body. Typical upstream and downstream slopes are 0.7H:1V. The steeper slopes would provide a relatively small footprint on the steep valley sideslope and a spillway could be provided as a swale over the top of the dam through which vehicles could pass. This type of spillway would be easy to construct and would likely be more economical than the concrete spillway proposed in the current PFS design. Trash grids could be provided to allow smaller soil particles and sediments to pass into the diversion channel, but could be oriented to deflect larger debris and potentially pass it over the dam structures. As for other structures, the longevity and maintenance issues should be part of the evaluation. (Category 3 recommendation).

5.8 BAT STUDY

The report describing the evaluation and selection study, performed by KCB, of alternative sites and technologies for tailing disposal for the Project was provided to and presented to the Board. In the report the selection of a tailings site and the most appropriate technology for tailings disposal was re-evaluated taking into account the recommendations included in the Report from the Commission into the Mount Polley tailings dam failure. This study was wide in scope (sites and technologies) and comprehensive in depth of evaluation and assessment. Each site and technology was adequately optimized so that comparisons were made without bias. *The Board agrees with both the methodology and comparison basis.*

The following are some specific observations from the Board:

The study recognizes the conflict that exists between best available technology (BAT) for physical stability and BAT for chemical stability. Mount Polley recommendations address only physical stability but chemical stability requirements are a major operating and long term driver for both site and technology selection on the KSM Project. The study appropriately balances the conflicting BAT requirements and value assessments in selecting the best options for the Site topography, climate and material considerations.

The Board points out that there are the following additional complexities and difficulties associated with filtered tailings. The requirements for long-term underdrainage of filtered tailings stacks is very difficult to ensure, particularly where drain performance is determined by high flows that occur during wet periods, and geochemical clogging and aggregate degradation are important considerations that need to be dealt with.

The large side slopes associated with filtered stacks are long term dust and erosion generators as well as providing surface for residual sulphides oxidation. The increase in risk and impact for each of these three sources of contaminants is roughly proportional to the height of the stack squared times the width (h2xw). If the perimeter of exposed stack or tailings dam is broken into 100 m widths and the h2xw values summed, then this would serve as a ‘vulnerability’ index for each of the three contaminant sources.

The Board supports the outcome of this BAT and the TMF site selection study.

5.9 OTHER OBSERVATIONS AND COMMENTS

5.9.1 Geohazards

The Board was given a presentation of the Geohazards pertaining to the KSM site and various works. This, plus the ability to observe the conditions first hand during the site visit, enhanced the Board's appreciation of the importance of this issue. Design of all the facilities with a view to long term performance under the conditions imposed by the geohazards and the ability to carry out maintenance will be paramount. The Board views the methodology and results of the geohazards study to be a state-of-art level evaluation, and a sound basis for anticipating design and protection requirements for KSM project development.

5.9.2 Water Quality Modeling

ERM provided a PowerPoint summary of the water quality modeling for the KSM project that was completed as part of the 2013 EA submission. This material was provided as background information for the Board to facilitate a better understanding of how the geochemical system at the mine site and the tailings management facility could impact design decisions and functionality of the geotechnical structures.

The Board is supportive of the general approach that was taken to develop predictions of solute concentrations at compliance locations in South Teigen Creek (TEC2), Treaty Creek (TRC2), Sulphurets Creek (SC3) and Unik River (UR1, UR2). The predictions of solute concentrations involved a synthesis of many processes that influence solute concentrations in the streams; including source concentrations, surface water flows and groundwater fluxes, storage locations and storage volumes, and re-circulation of process water through the plant. These calculations are appropriately conservative as they do not take into account any geochemical reactions that would serve to lower the predicated concentrations. The predictive model is founded on the water balance model and mixing calculations based on loading estimates. Modeling was carried out using a Goldsim platform to take account of climatic variability; and provide minimum, average and maximum concentration estimates at compliance points. Simulation results were also completed for an expected case (using mean leaching rates from the geochemical data base) and an upper case (using 95 percentile values for leaching rates). The methodology adopted is consistent with a standard of good practice the Board has seen employed during pre-feasibility level investigations in other mine projects.

5.9.3 Sediment Control during Construction

The Feasibility Study must consider sediment control during construction since this is an important requirement for environmental protection and since it often does require significant planning and thought, including Best Management Practices as well ancillary engineered structures or facilities. (Category 3 recommendation)

6. Conclusion and Acknowledgements

The Board expresses its appreciation for the effective organization of an intensive helicopter facilitated site inspection, the extensive work done to prepare presentations of large amounts of information in a concise and insightful way by well-prepared presenters and for the frank and open discussions.

7. Next Meeting

The next Board meeting is schedule for the week of August 7, 2017.

Attachment 1

Agenda of Meeting

Attachment 1. Agenda of Meeting

Table 1. Overall Agenda Site Tour

Day	Time	Subject
Monday, June 6	8:30 am	Arrive 8:30am for a 9:00 am departure Signature Flight Support FBO in Vancouver, located at 5360 Airport Road South
	8:30 - noon	Charter to Bob Quinn. Refuel in Smithers. Helicopter transfer to KSM camp from Bob Quinn. Arrive at camp at noon.
	12:30 - 1:30 pm	Lunch (approximate time)
	2:00 - 6:00 pm	General site tour
	6:30 - 7:30 pm	Dinner (approximate time)
	7:30 - 8:30 pm	Presentations
Tuesday, June 7	7:30 - 8:30 am	Breakfast (approximate time)
	8:30 am - 12:30 pm	Helicopter facility Tours Separated into WSD and TMF groups Backup plan is presentations
	12:30 - 1:30 pm	Lunch (approximate time)
	1:30 - 6:00 pm	Helicopter facility Tours Separated into WSD and TMF groups Presentations
	6:30 - 7:30 pm	Dinner (approximate time)
	7:30 - 8:30 pm	Presentations
Wednesday, June 8	7:30 - 8:30 am	Breakfast (approximate time)
	8:30 am - 12:30 pm	Rock Core Viewing
	12:30 - 1:30 pm	Lunch (approximate time)
	1:30 - 6:00 pm	Helicopter to Bob Quinn with stop at Kerr, and Charter to Vancouver

Table 2. Overall Agenda June 9-10, Kipling Room KCB Office

Day	Time	Subject
Thursday, June 9	9:00 - 9:15am	Safety Share
	9:15 am - 12:30 pm	Board requests to design team for further explanations, presentations and discussions
	12:30 - 1:00 pm	Lunch
	1:00 - 5:00 pm	Board deliberation and report writing
	5:00 - 8:00 pm	Presentation on BAT and BAP studies
Friday, June 10	9:00 am - 12:30 pm	Board deliberation and report writing
	12:30 - 1:00 pm	Lunch
	1:00 - 2:00 pm	Board deliberation and report writing
	2:00 - 5:00 pm	Board Report out of draft report

Attachment 2

List of Meeting Participants

Attachment 2. List of Meeting Participants

Table 1. Attendance at June Meetings Held at KSM Site Exploration Camp and KCB Offices, Vancouver

Name	Affiliation	Site June 6 to 8	Vancouver June 9 and 10
Jay Layman	Seabridge	YES	YES
Brent Murphy	Seabridge	YES	YES
Mike Skurski	Seabridge	YES	YES
Jessy Chaplin	Seabridge	YES	YES
Graham Parkinson	KCB	YES	YES
Neil Singh	KCB	YES	YES
Gary Stephenson	KCB	YES	YES
Kris Holm	BGC	YES	NO
Clem Pelletier	ERM	YES	YES
Kelsey Norlund	ERM	NO	YES
Deborah Muggll	ERM	NO	YES
Terry Eldridge	Board (Golder)	YES	NO
Ian Hutchinson	Board (SLR)	YES	YES
Gabriel Fernandez	Board (Independent)	YES	YES
Jim Obermeyer	Board (MWH)	YES	YES
Anthony Rattue	Board (Independent)	YES	YES
Andrew Robertson	Board (RGC)	YES	YES
Leslie Smith	Board (Independent)	YES	YES
Jean-Pierre Tournier	Board (Hydro-Québec)	YES	YES

Attachment 3

Photographs Taken during Site Visit

Attachment 3. Photographs Taken during Site Visit

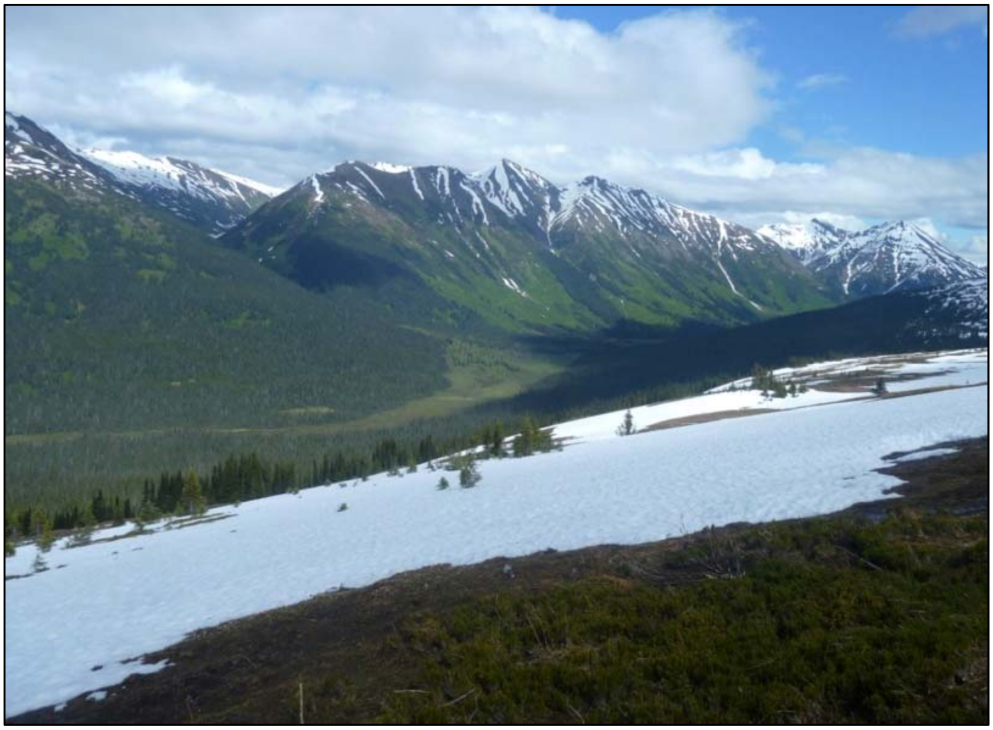

Photo 1. Teigen-Treaty valleys, view from location above the west side of planned North Cell.

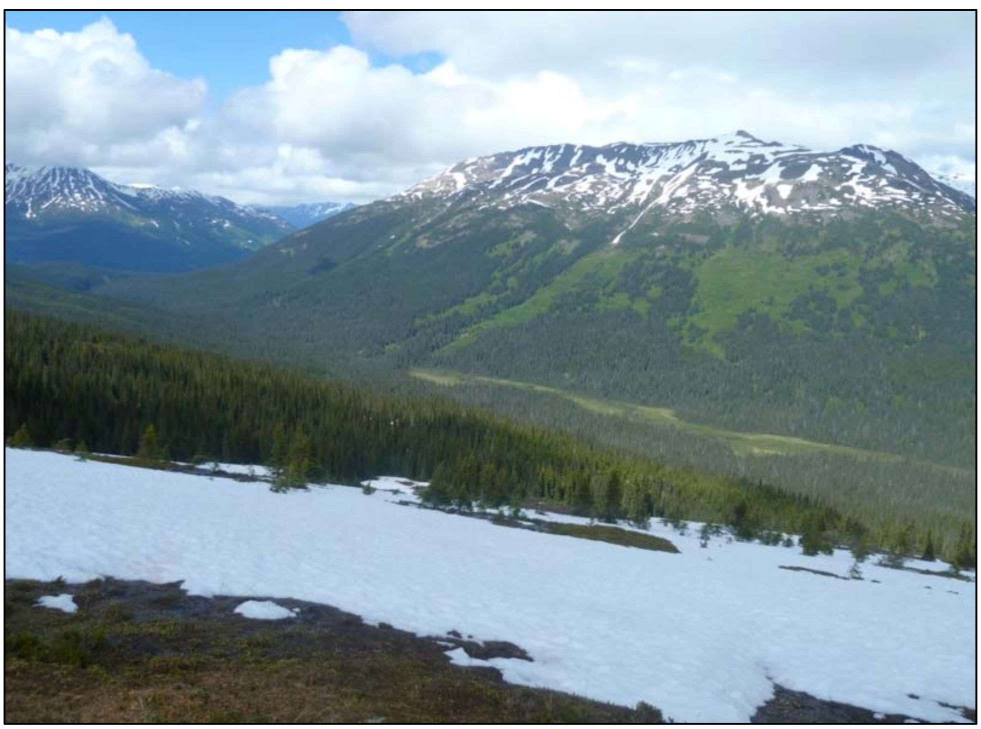

Photo 2. Teigen Valley, view from location above the west side of planned North Cell.

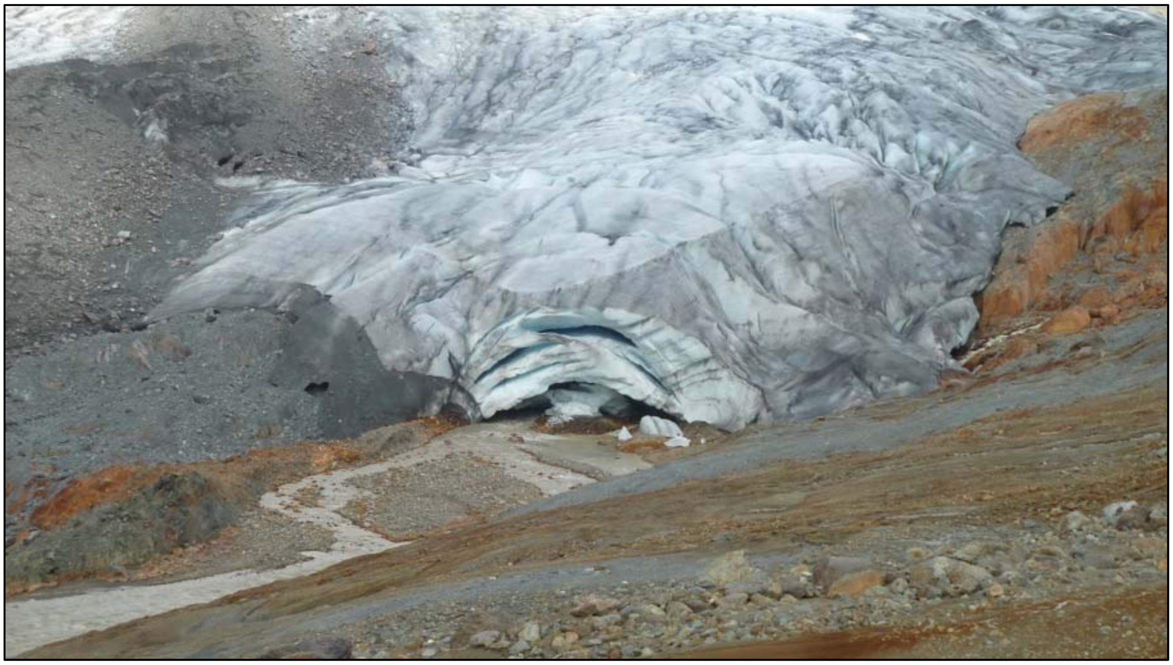

Photo 3. Drainage at the toe of Mitchell glacier.

Photo 4. View down Mitchell Valley, toward the location of the planned RSF.

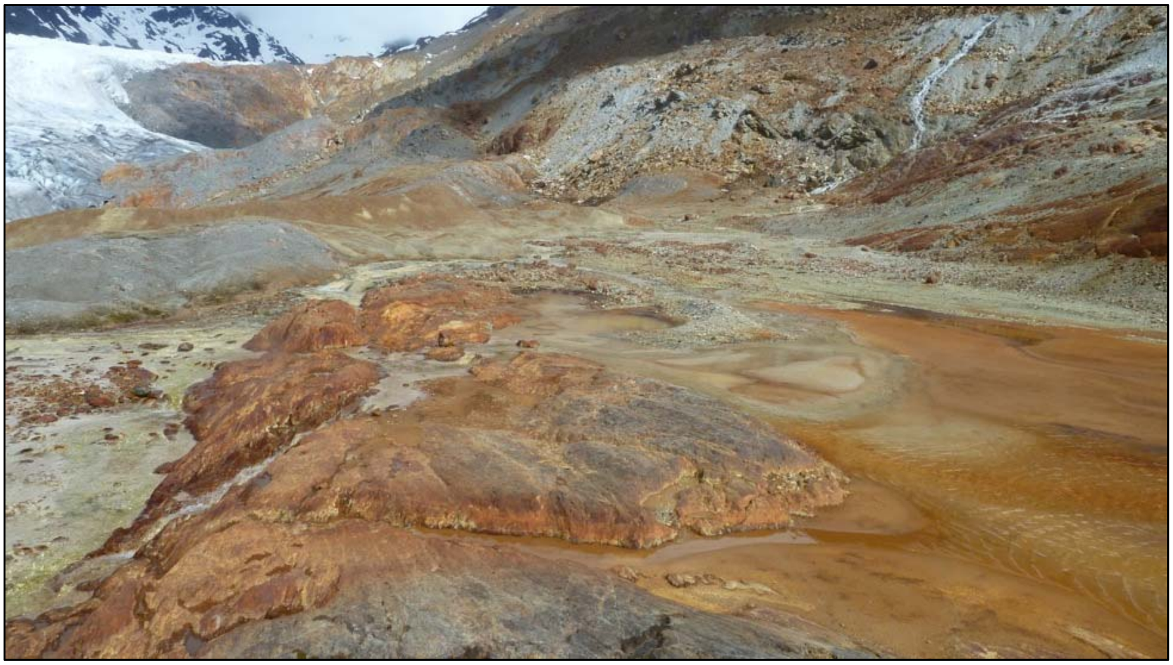

Photo 5. Naturally acidic water pools near toe of Mitchell Glacier.

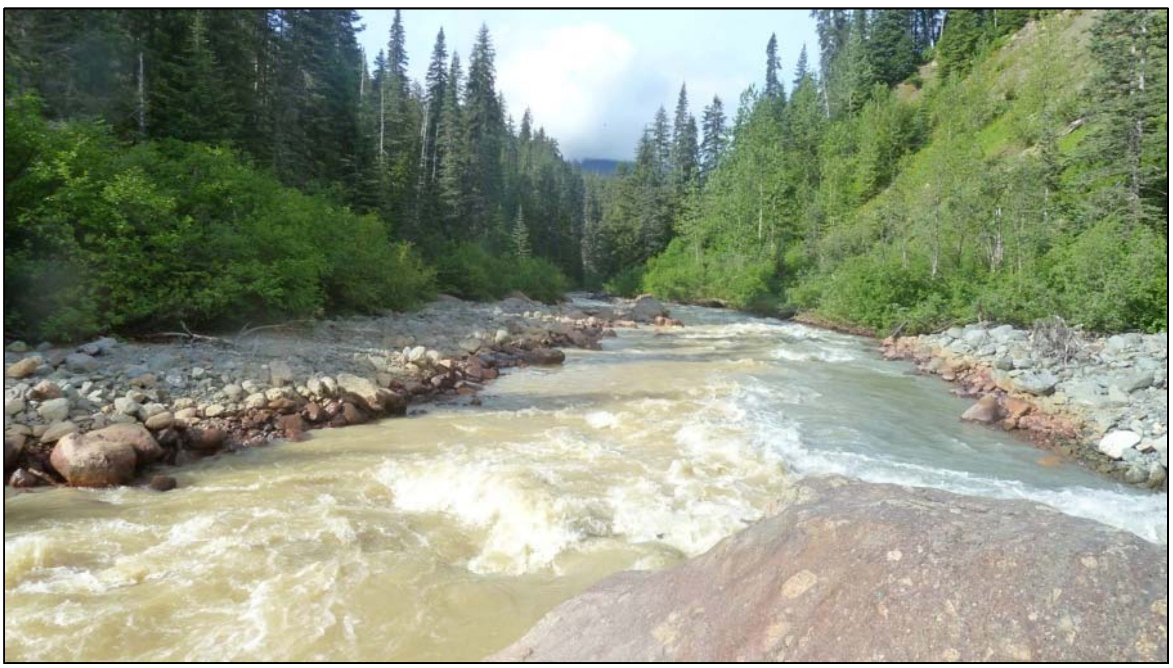

Photo 6. Confluence of Mitchell (left side) and McTagg Creeks (right side).

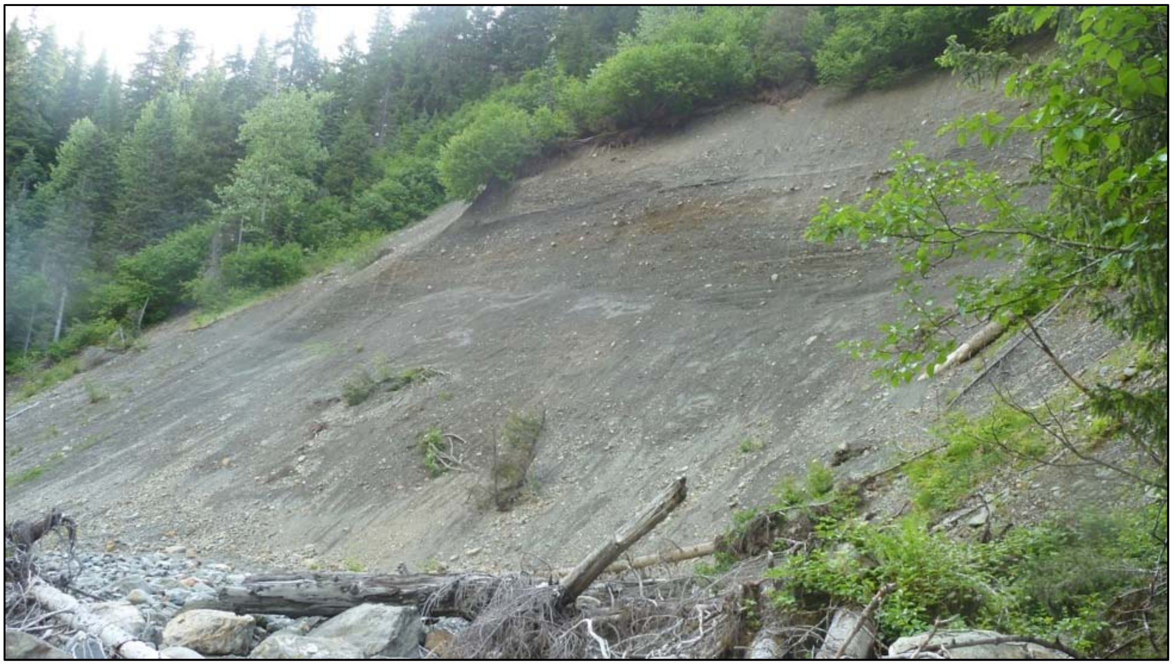

Photo 7. Sand and gravel deposit near confluence of McTagg and Mitchell Creeks.

Photo 8. Outcrop in Mitchell Canyon, near the left abutment of the planned Seepage Collection Dam.

Photo 9. Plateau above planned North Cell, plant site location.

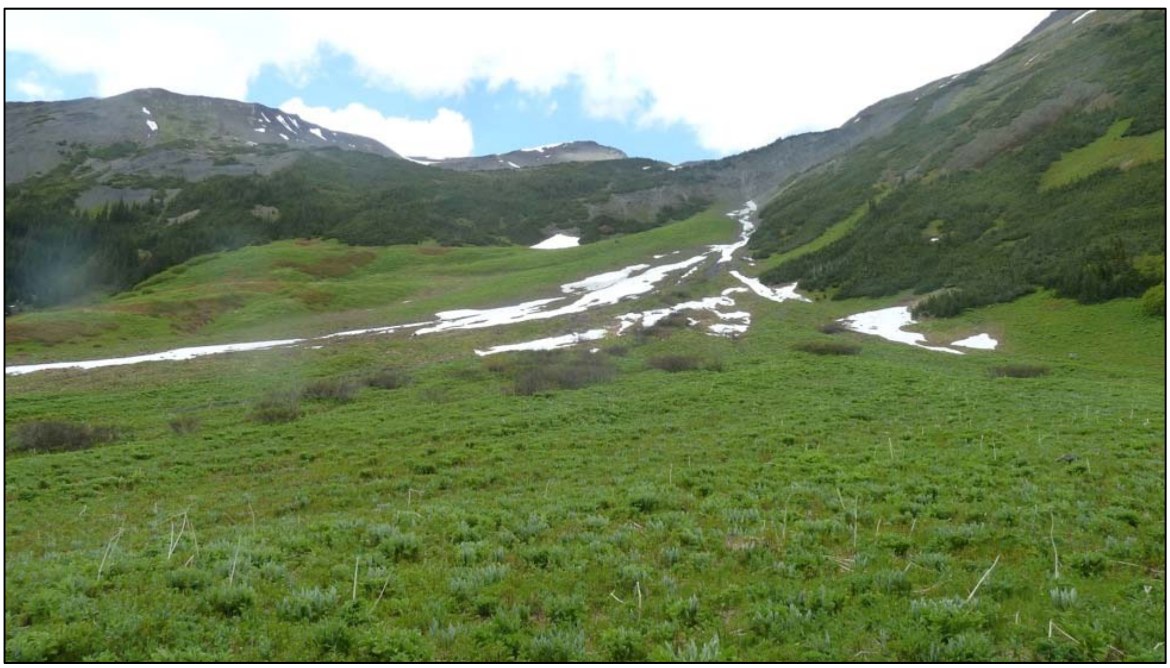

Photo 10. Slope movement on north side of East Catchment Valley.

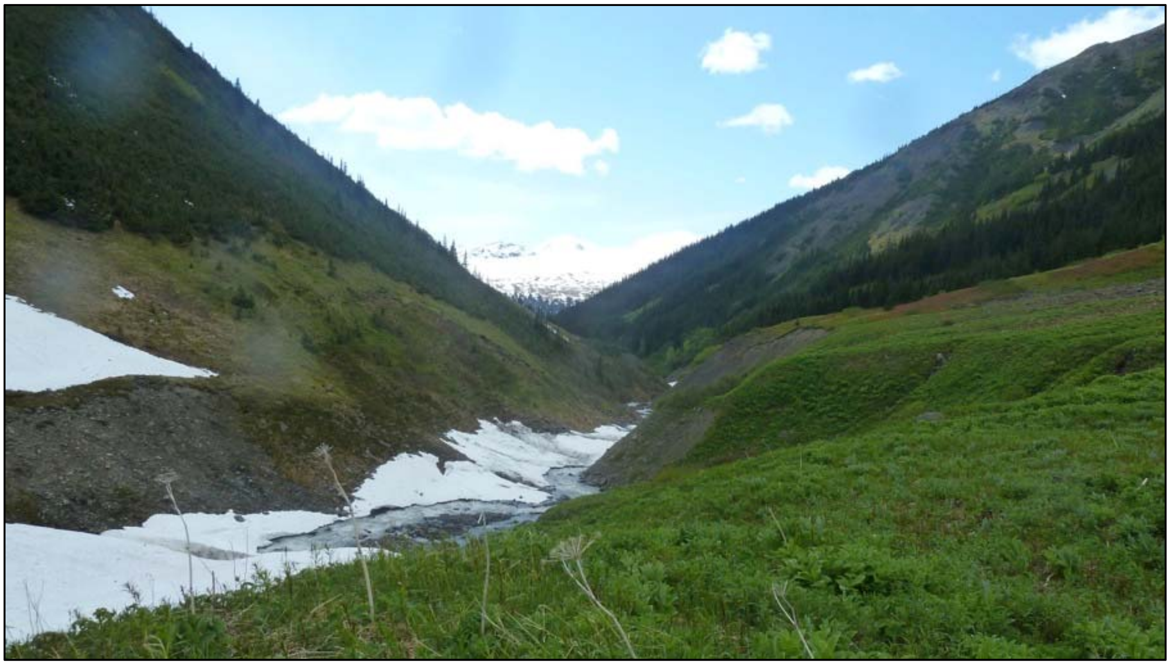

Photo 11. Area where mass slope movement had crossed East catchment Valley bottom and dammed creek in past.

Photo 12. Fan at divide between Treaty-Teigen valleys at outlet from East Catchment Valley.

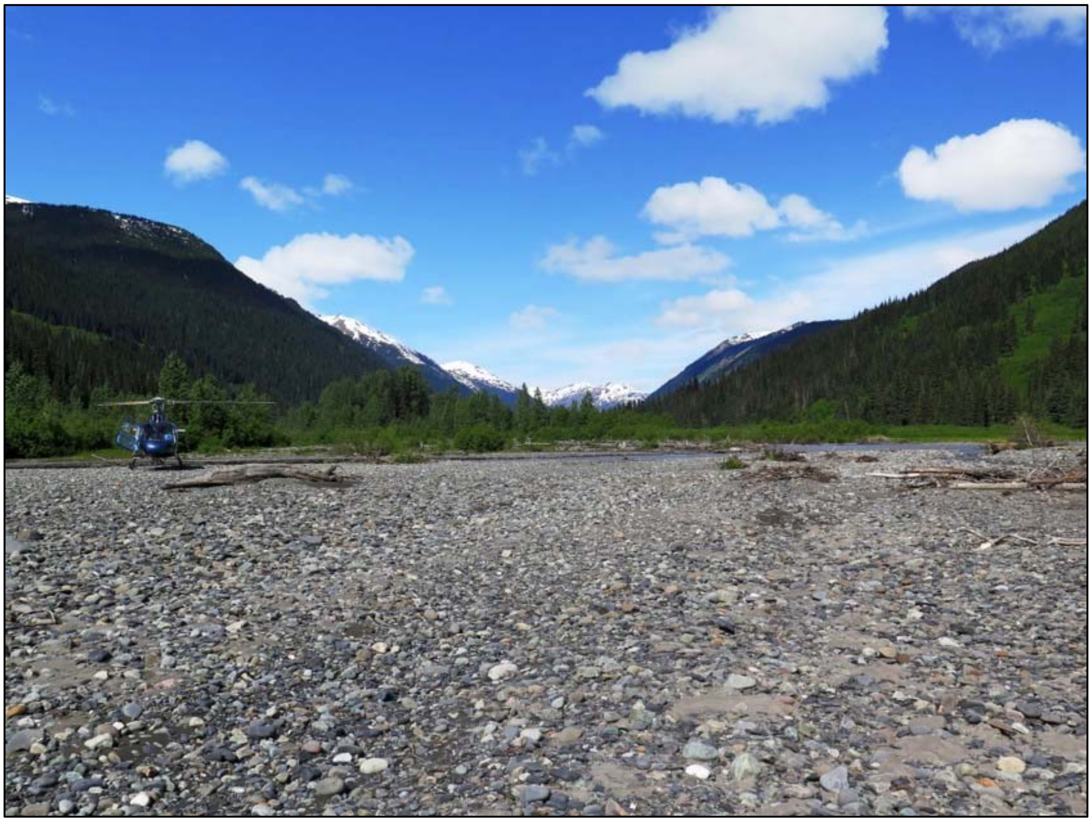

Photo 13. Proposed diffuser location in Treaty Creek.

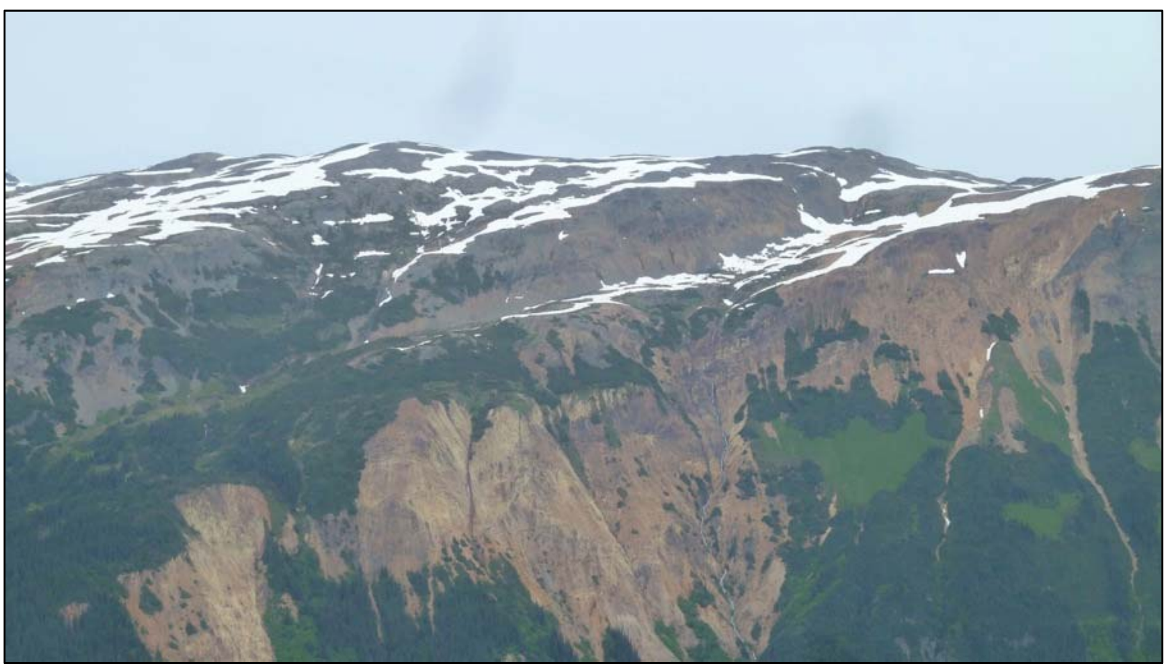

Photo 14. View towards planned Sulphurets pit with monzonite cap.

Photo 15. View from top of planned Kerr to right bank of Sulphurets Creek.