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Technical Memorandum

To:	File	**Date:**	February 12, 2008
cc:		**From:**	Ben Green
Subject:	Assessment of Groundwater Regime at the Valley Tailings Facility	**Project #:**	1CE012.000.0H6

1 Introduction

1.1 Background

The former United Keno Hill Mine (UKHM) site, is located in central Yukon Territory, approximately 350 km (220 miles) due north of Whitehorse in the vicinity of the villages of Elsa and Keno City. Mining of the in the area commenced in 1914, and continued to January, 1989. During this period over 5.3 million tons of ore was mined from over 30 open pit and underground operations, with average grades of about 1,370 g/t (40 oz/ton) Ag, 6.6% Pb and 4.1% Zn. The majority of this ore was processed at the Elsa mill.

Tailings from the Elsa mill were deposited downslope in the upper Flat Creek valley over a period of five decades. Three dams were constructed to contain the tailings and to manage surface water discharge from the facility. The dams, tailings, and related diversions and infrastructure are collectively referred to as the Valley Tailings Facility (VTF). Elsa Reclamation and Development Company Ltd. (ERDC) is in the process of preparing a closure plan for the VTF and the various other components of the UKHM property.

In 2007 Alexco contracted SRK Consulting (Canada) Inc. (SRK) to develop a conceptual understanding of the hydrogeology of the VTF, and to develop estimates of the groundwater flux from the facility. This technical memorandum summarizes the 2007 hydrogeological investigations, review, and analysis leading to an estimate of net groundwater flux through the tailings facility.

1.2 Objective

The principal objective of this work was to develop an understanding of the physical hydrogeology of the VTF to enable an estimation of groundwater flux through the facility to be derived. This flux will be used to estimate current contaminant loadings from the VTA to the receiving environment.

1.3 Approach

The study involved a review of available data, followed by the development of a conceptual hydrogeological model for the site. A geotechnical drilling and sampling program was undertaken by SRK in 2007 to provide information on the unconsolidated materials at the project site. Where site specific data were unavailable, a “Best Engineering Judgement” approach was used and assessed with a sensitivity analysis.

1.3.1 Fieldwork & Drilling Programme

SRK undertook a drilling program from October 16th to 25th 2007, consisting of fifteen drill holes at the Valley Tailings Area (VTA), using a percussion drill, to depths of 10 to 20 m below ground level (mbgl). The drill program included six drill holes located along the upstream and downstream crests of Dam 1, Dam 2 and Dam 3, and six drill holes (3 deep drillholes paired with 3 shallow drillholes) were completed within the tailings deposits. Soil stratigraphy, bedrock characterization, geotechnical conditions and permafrost extent and characterization were investigated and samples were collected for laboratory testing. Monitoring wells were installed in the completed drill holes to monitor water level elevations and water chemistry within the VTF, and thermistors were installed in 5 of 6 dam boreholes to monitor thermal conditions within and below the dams. A full account of the hydrogeological drilling programme can be seen in Appendix A. The borehole layout can be seen in Figure 2.1.

The following observations were taken from the VTA drill program:

- The VTA drill program indicates that Dams 1, 2 and 3 were constructed on top of peat and local deposits of tailings.
- Peat underlies the tailings deposits.
- No permafrost was encountered in any of the drill holes completed within the VTF in 2007.
- Permafrost was encountered under the dams by EBA in 1982, although not by SRK in similar locations in the 2007 programme. This indicates that permafrost degradation has occurred, at least in the disturbed areas within the VTF.
- Permafrost was encountered at a depth of 4 m in undisturbed ground downgradient of the VTF to the west of Dam 3, and at 12 m depth to the northwest of Dam 3.

For the purposes of the hydrogeological investigation, cross-sections of the overburden and bedrock interface were established along the centerline of each of the three tailings dams, to coincide with current and previous investigations.

1.4 Data Reviewed

The following references were reviewed for this study:

- Previous site investigation reports, memos and drill logs.
- Grain size analysis data from selected 2007 boreholes.
- Recent (2006) aerial photography of the facility and surrounding area.
- EBA reports (1982, 2006).

2 Conceptual Understanding of Site Hydrogeology

The VTF is situated within a wide glaciated valley in which the extent of tailings disposal is evident (Figure 2.1). Bedrock exposures have been indicated on the map, as well as areas where permafrost has been intersected by boreholes or test pits.

2.1 Geology

The bedrock geology of the Keno Hill area is underlain by Yukon Group metasedimentary rocks. The rocks include various types of argillite, phyllite, slate, schist and quartzite. Conformable greenstone (altered diorite-gabbro) lenses and sills occur in places and few narrow lamprophyre and quartz-feldspar porphyry dykes occur locally. Granitic bodies have intruded the metasedimentary - greenstone package at several places to the north and south of the Keno Hill -Galena Hill area (Watson 1986).

The metasedimentary sequences trend east-west, and dip 20 to 30 degrees to the south. In the Keno Hill area, they form the southern flank of the McQuesten anticline (Watson 1986).

The site is at the western extent of the most recent Cordilleran ice sheet, and thus the surficial geology is dominated by a complex assemblage of glacial and periglacial landforms and deposits. Valley bottoms are broad and overburden covered, commonly boggy and contain thick peat deposits. Permafrost is widespread though discontinuous.

2.2 Structure

A series of faults, striking northeast and dipping steeply southeast, host the silver-lead-zinc lode deposits. These vein faults exhibit left lateral movement, commonly offsetting the surrounding metasedimentary sequences by over 150 m (Watson 1986).

The vein faults are offset in places by two types of unmineralized faults. The first type, known as cross faults, strikes northwest and dips 40 to 60 degrees southwest. These cross faults are typically normal right lateral faults with apparent horizontal movements ranging from 1 to 610 m. The second type of unmineralized faults are bedding plane thrust faults which exhibit movements ranging from 1 to 30 m. Both cross faults and bedding plane faults show indications of post-ore movement. Several ore zones within the area have been offset by cross faulting. Some limited post-ore movement is also evident within the vein faults (Watson 1986).

2.3 Climate

The climate of the area is typical of continental interior. The mean annual temperature at Mayo is -3°C. Winter temperatures have been recorded to -55°C and summer temperatures to 32°C. There is are only a few hours of daylight in December, and in June there is no true darkness due to the latitude of about 64°N. The average annual precipitation is 285 mm. The area of the property is underlain by widespread discontinuous permafrost.

2.4 Tailings & Water Management

2.4.1 Deposition of Tailings

The tailings from past milling activities were deposited in the upper Flat Creek valley below the Elsa mill site. The main accumulation of tailings is in a swampy area formerly drained by North Fork Flat Creek. Porcupine Creek passes through the southwest portion of the tailings area, with the lower portion of the creek confined to a diversion ditch excavated in 1979. A lesser volume of older tailings is perched on the hillside on both sides of Porcupine Creek, from just below the highway to the valley bottom. The areal extent of tailings is relatively well delineated from recent air photography (Figure 2.1). The total surface area of the impoundment is approximately 75 ha.

Considerable drilling was done in the tailings area by UKHM in a number of campaigns to assess the remaining economic metal content of the tailings. Prior to the construction of Dam 1, tailings were discharged on the hillside directly into Porcupine Creek, and tailings accumulated from the discharge point down the hillside and north across the valley. After Dam 1 was constructed, the tailings discharge was relocated to the hillside at the southeast corner of the VTF and the more recent mass of tailings is distributed along an arcuate path from this discharge point to Dam 1. An isolated area of old tailings occurs in terraces just below the highway to the west of Porcupine Creek.

Dam 2 and Dam 3 were constructed in the 1970s to form polishing ponds intended to increase the residence time of tailings pond water prior to discharge. The soils under all three dams have thawed since construction, resulting in an unknown amount of subsidence of the dams. Addition of mine rock to the low points has been required every few years to compensate for the subsidence.

Results of inspections of the dams can be found in a series of reports by EBA Engineering, the most recent of which was prepared in 2007. These inspection reports note ongoing subsidence of the structures during the 1980s and 1990s, with little evidence of subsidence observed in recent years. The tailings behind Dam 1, where wet, have developed a vegetative cover, but the dry, sandy, upper portions of the tailings deposit is barren. The exposed tailings are subject to wind erosion from time to time.

2.4.2 Water Management

The diversion of Porcupine Creek around the tailings is a complicating factor for closure, in that there is thought to be a significant amount of leakage from the diversion towards Pond 3. Above the diversion, Porcupine Creek cuts through the south edge of the tailings deposit for a distance of about 400 m, and there has historically been erosion of the tailings both prior to and following construction of the diversion.

It is understood that there are diversions on the hillside immediately southeast of the VTF that are intended to intercept shallow flows upgradient of the VTF and convey this water from the VTF catchment into the No Cash Creek catchment to the east. These diversions likely exert little influence on the VTF groundwater regime and are not discussed further.

Incident precipitation and runoff from the local catchment are retained by Dam 1 and form Pond 1 immediately upstream. This water decants to Pond 2 and continues through the Dam 2 decant to Pond 3. A decant through Dam 3 discharges Pond 3 water to the downgradient wetland, with the water ultimately reporting to Flat Creek via surface or shallow subsurface pathways.

2.5 Hydrogeological interpretation

The following interpretations can be taken from the information above:

- The area was originally drained from the east to west by Flat Creek, Brefalt Creek, Porcupine Creek and North Fork Flat Creek.
- Dams have been constructed to hold back tailings and to manage water; these dams have impeded the flows of North Fork Flat Creek. A diversion channel was contracted to divert flows from Porcupine Creek, Brefalt Creek, and Flat Creek around Dam 3. However, seepage from this diversion towards Pond 3 has been recorded.
- The bedrock is likely to have low primary permeability with a relatively high secondary permeability as a result of local fractures and faulting.
- Alluvial and glacial deposits are present above the bedrock units. Groundwater is assumed to flow predominantly through higher permeability zones of these unconsolidated units. The glacial deposits appear to consist of a complex of glacial sediments dominated by a poorly sorted ablation till with high silt content.
- Topography is moderate, with flows channelled within a wide glacial valley. Hydraulic gradients are considered low.
- Runoff from the upgradient catchments is expected to be high due to sparse vegetation, bedrock outcrops and discontinuous permafrost.
- Peat was recorded across the site prior to tailings deposition. Depending on the maturity of the peat, its thickness and compression (from the overlying tailings), hydraulic conductivity values in the range of 10^{-5}m/s to 10^{-6}m/s could be expected. This is significant when considering possible vertical seepage into underlying soils.

3 Assessment of Groundwater Flux

3.1 Methodology

3.1.1 Groundwater Flux Through Dams

Based on the distribution of boreholes across the site, three section lines were selected to coincide with the alignment of Dam 1 (A-A'), Dam 2 (B-B'), and Dam 3 (C-C') as seen in Figure 4.1. Flow lines were constructed through the site from survey and monitoring data. These are also illustrated in Figure 4.1. Hydrogeological interpretations were made based on the information available. The borehole logs and hydrogeological cross sections can be viewed in Figures 4.2 and 4.3.

Permeability data for the materials was estimated using grain size distributions. Hydraulic conductivity (K) values were assigned to the respective unconsolidated sediments logged in the 2007 boreholes. The distribution of the sediments was then interpreted across each of the dam sections. The cross sectional area of the sediments was estimated and then a weighted average for the hydraulic conductivity of that material was derived to produce a net hydraulic conductivity for each section.

A hydraulic gradient was calculated for each of the dams. A Darcy approach was taken to estimate the flow through the unconsolidated cross-section beneath each of the dams.

3.1.2 Estimate of Seepage from Porcupine Creek Diversion Channel

Seepage has been recorded from a section of the Porcupine Diversion into the adjacent tailings south of Pond 3. The channel is located approximately 500m to the south of Pond 3, and extends 800m in an east to west direction. Seepage flows from the channel were estimated by assuming a constant hydraulic head in the ditch, flowing through a shallow permeable material to the surface water in Pond 3.

3.2 Grain Size Analysis

Samples of subsurface materials were collected from the 2007 hydrogeological drilling program. Select samples of representative sediments from each of the dam foundations were sent to the EBA soils laboratory in Whitehorse for grain size analysis. The results of the grain size testwork can be seen in Appendix C.

The results were analysed to estimate a hydraulic conductivity using two methods. The Hazen formula is commonly used to estimate saturated hydraulic conductivity from grain size curves; however, this method assumes a sandy material with the effective grain size D_{10} line (percent passing <10%) lies between the 0.1 mm and 3 mm particle size. These assumptions are not valid for the materials in question. The Hazen formula was therefore considered inappropriate.

The method for estimating hydraulic conductivity that was adopted for this study was to make use of the RETC (version 6) software package developed by van Genuchten et al. (1985) to quantify the hydraulic functions of unsaturated soils using the theoretical pore-size distribution models of Mualem (1953) and Burdine (1986). These models predict the unsaturated hydraulic conductivity function from observed soil water retention data. This method is more appropriate for the fine grained soils underlying the VTF.

The results with the selected analysis method are displayed in Table 3.1. A range of hydraulic conductivity values is given to illustrate the level of confidence in the results.

3.3 Limitations of Data

Percussion drilling creates a grain size bias towards the coarse soil fractions. Even with the highest level of care, the finer fractions can be lost by flushing with water encountered or with the circulating air. This loss of fines can greatly effect the interpretation of grain size analysis results to estimate hydraulic conductivity. During the drilling process, the inspector noted that significant fines were flushed from the samples. These flushed fines represent an unknown proportion of the true silt or clay component of the samples.

A best engineering judgement (BEJ) approach was therefore used to propose a hydraulic conductivity (K) value for each of the samples, to ascertain their probable in-situ permeability. Field observations during the drilling program indicated that a high proportion of silt had been washed from the sample by water. Consequently the BEJ approach was to take the geometric mean of the *lower* K range for each sample, to account for the loss of silt fractions, so that a single hydraulic conductivity for that sediment group could be derived. The results are seen in Table 3.2.

The BEJ hydraulic conductivities were then weighted with respect to the cross sectional area for each of the material. The results can be seen below in Table 3.3. The resulting weighted hydraulic conductivity values are considered reasonable for an in-situ ablation till material.

Table 3.1: Details and Results of Grain Size Analysis

Dam	Borehole Number	Sample Number	Depth (m)	Description	Hydraulic Conductivity (m/s)		Analysis Method
					From	To	
Dam 3	GT12	GS-5	8	Gravel	6.7 E-06	6.7 E-04	RETC
Dam 3	H2	GS-2-5	6 - 8	Silty- sandy gravel	6.6 E-07	6.6 E-05	RETC
Dam 1	GT7	GS-7	14	Silty- sandy gravel	6.3 E-07	6.3 E-05	RETC
Dam 2	GT8	GS-6	16-18	Silty- sandy gravel	8.7 E-07	8.7 E-05	RETC
Dam 3	GT12	GS-9	14	Silty- sandy gravel	6.6 E-07	6.6 E-05	RETC
Dam 2	GT8	GS-6	8	Sandy Gravel	6.4 E-06	6.4 E-04	RETC
Dam 3	GT12	GS-6	10	Sandy Gravel	1.8 E-06	1.8 E-04	RETC
Dam 1	GT7	GS-6	12	Sandy Gravel	7.5 E-06	7.5 E-04	RETC
Dam 3	H11	GS-4	8	Sandy Gravel	2.9 E-06	2.9 E-04	RETC
Dam 3	GT10	GS-4	8	Sandy Gravel	6.7 E-06	6.7 E-04	RETC
Dam 2	GT9	GS-7	11	Sand	7.8 E-06	7.8 E-04	RETC
Dam 3	H2	GS-8	10	Silty sand	1.3 E-06	1.3 E-04	RETC

Table 3.2: Hydraulic Conductivities of Overburden Materials Derived from Grain Size Analysis

Material Type Description (Lab)	Hydraulic Conductivity (K) range (m/s)		BEJ Hydraulic Conductivity (K) range (m/s)	Comments
	Lower	Upper		
Gravel	6.7 E-5	6.7 E -3	6.7 E-5	Geometric mean of lower K value used as BEJ to account for fines loss
Sandy Gravel	1.8 E-6	7.5 E-4	4.0 E-6	Geometric mean of lower K value used as BEJ to account for fines loss
Sandy Silty Gravel	6.3 E-7	8.7 E-5	7.0-07	Geometric mean of lower K value used as BEJ to account for fines loss

Table 3.3: Weighted Average Hydraulic Conductivities Calculated for Overburden Cross-Sections beneath VTF Dams

	Material Type	VTA Dam		
		Dam 1	**Dam 2**	**Dam 3**
Gravel	Area in section (m^2)	1,003	4,959	600
	Hydraulic Conductivity [m/s] (weighted)	6.7 E-06	6.7 E-05	6.7 E-05
Sandy Gravel	Area in section (m^2)	1,369	1,257	5,120
	Hydraulic Conductivity [m/s] (weighted)	4.9 E-06	4.9 E-06	4.9 E-06
Silty Sandy Gravel	Area in section (m^2)	10,377	8,238	17,205
	Hydraulic Conductivity [m/s] (weighted)	7.0 E-07	7.0 E-07	7.0 E-07
Weighted Average Hydraulic Conductivity (m/s)		**8.4 E-07**	**1.2 E-06**	**9.0 E-07**

3.4 Groundwater Flux Calculation

3.4.1 VTA Dams

To derive a groundwater flux (Q), a Darcy approach was taken (Equation 3.1). The main components of this equation are summarised below:

Equation 3.1: Darcy Equation

$$\mathbf{Q = -K \times A \times \frac{dh}{dx}}$$

Where:

Q = Groundwater flux or discharge (m^3/day
K = Hydraulic Conductivity (m/day)
A = Area through cross section (m^2)
$\frac{dh}{dx}$ = Hydraulic gradient

A flux for each of the dams was calculated using the Darcy Equation and the properties of the respective cross-sections from Table 3.3.

Hydraulic gradients were calculated for each of the sites using various surface water and groundwater level elevations. An arithmetic mean of the gradients was used to derive an overall hydraulic gradient for each dam site.

The Darcy equation was then used to calculate a groundwater flux through for each Dam. The results are tabulated in Table 3.4.

3.4.2 Diversion Channel

The Porcupine Creek diversion channel is understood to lose water via a groundwater pathway via a zone of old tailings material between the diversion and Pond 3 (Figure 4.1). A section was produced across the estimated seepage face along the diversion channel. From the findings from Borehole H4D, the depth to bedrock is in the region of 5m. A similar Darcy approach to estimating groundwater flux through the dams was taken to derive a seepage flux from the diversion channel. This flux, of approximately 4 m^3/day is likely to enter the system upstream of Dam 3. It is likely that a component of this will feed into Pond 3.

From this analysis, a net groundwater flux in the region of 18 m^3/day could be expected through the base of Dam 3.

3.4.3 Sensitivity Analysis

A sensitivity analysis was carried out to determine what input parameters were sensitive to the outcome of the model. The following were investigated, with the degree of confidence noted for each parameter:

- Hydraulic Conductivity (low- moderate, 2 orders magnitude);
- Area of material in cross section (high, +/- 10%); and
- Hydraulic gradient (moderate to high +/-20%);

The results of the sensitivity analysis indicate that the main uncertainty in the estimate of flux from the VTF stems result from the adopted values of hydraulic conductivity. Table 3.4 lists the minimum, maximum and BEJ seepage flux estimates for the area, based on the ranges of hydraulic conductivity area and gradient. The flux used in the study was derived based on the best engineering judgement (BEJ).

Table 3.4: Seepage Flux Estimates at Select Locations in the VTF

Dam	Area (m^2)	Hydraulic Conductivity (m/sec)	Hydraulic Gradient	Min Flux Q (m^3/day)	Max Flux Q (m^3/day)	BEJ Flux Q (m^3/day)
Dam 1	12,749	8.4 E-07	0.02	0.1	2075.6	**15.6**
Dam 2	14,454	1.2 E-06	0.01	0.1	2066.2	**15.6**
Dam 3	22,925	9.0 E-07	0.01	0.1	2354.7	**17.8**

4 Conclusions

This study used grain size data for samples collected during hydrogeological investigations at the Valley Tailings Facility to estimate hydraulic characteristics of the unconsolidated materials beneath the tailings and the dams. Using these data, a groundwater flux was calculated through the unconsolidated sediments beneath each of the dams. A net flux of **18 m^3/day** was estimated to leave the VTF via groundwater flow beneath Dam 3.

The flux was estimated using data that was not collected under ideal conditions for a hydrogeological investigation, and was analysed using methods that are suitable for scoping level assessments. The sensitivity analysis indicates that the resulting flux is sensitive to changes in hydraulic conductivity. Although a full hydrogeological study is not warranted, further information should be collected from the site to increase the hydrogeological understanding.

4.1 Discussion and Recommendations

The sampling methodology (using a percussion drill) was not a recommended one for collection of representative samples for grain size analysis. This limitation was recognized in advance and was accepted as a reasonable trade-off for procuring drilling services on short notice. The loss of a portion of the sample due to the percussive nature of the drilling method results in an under representation of the finer fractions, which in turn results in a systematic bias towards a higher estimate of hydraulic conductivity. In this study, to partially overcome this bias, the lower value in the range of hydraulic conductivities estimated for each soil type was used.

The following actions are recommendations to increase the confidence in the conclusions of the analyses presented in this memorandum. It is hoped that these can be undertaken and, with field observations, the results can be used to continuously modify and update the model.

- Refinement of the site water balance to allow better estimates of seepage losses from the Porcupine Diversion.
- Slug testing in the existing wells to attempt to derive a better estimate of hydraulic conductivity in the overburden soils beneath the VTF.

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Reviewed by

Michael Royle

Michael Royle
Principal Consultant

5 References

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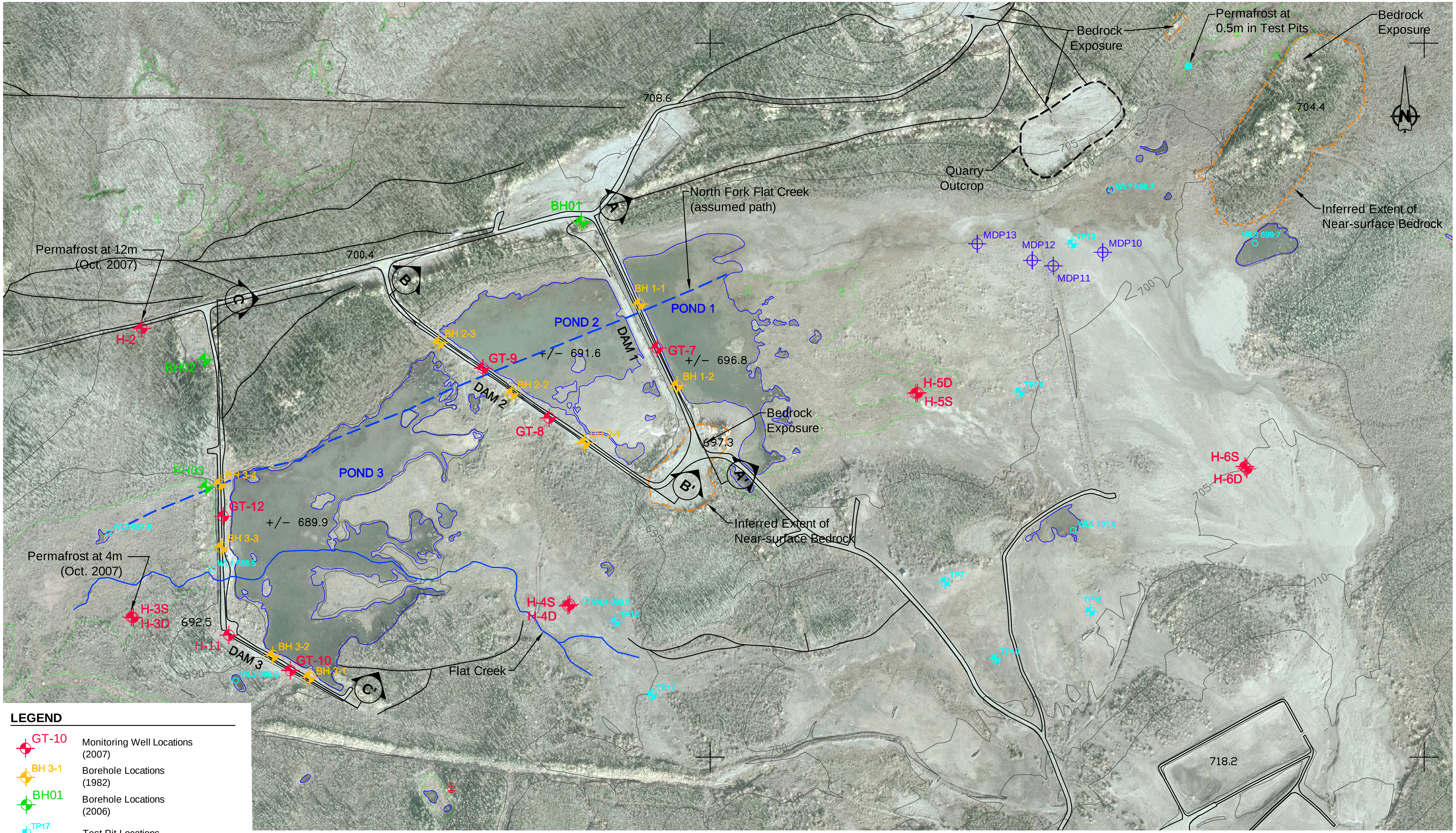
Figures



LEGEND

GT-10	Monitoring Well Locations (2007)
BH 3-1	Borehole Locations (1982)
BH01	Borehole Locations (2006)
TP17	Test Pit Locations
MDP10	Manual Drive Points

Note:
GT-* locations also contain Thermistor Strings
H-* locations are Monitoring Wells only

NOTES

1. Base drawing and orthophoto provided by ERDC. Orthophoto prepared by AeroGeometric, from photos flown September 2006 by Geodesy Remote Sensing Inc, Calgary, Ab.
2. Coordinate projection is NAD83, UTM projection.
3. Contour interval is 1 metre.

0 50 100 150 200 250
Scale in Metres

SRK Consulting
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Vancouver B.C.

ERDC

SRK JOB NO.: 1CE12.000.GT2
FILE NAME: 1CE012_000−GT2−7.dwg

Keno Hill Project

Assessment of Groundwater Regime
at the Valley Tailings Facility

Drillhole Locations

DATE: Feb. 2008
APPROVED: BG
FIGURE: 2.1

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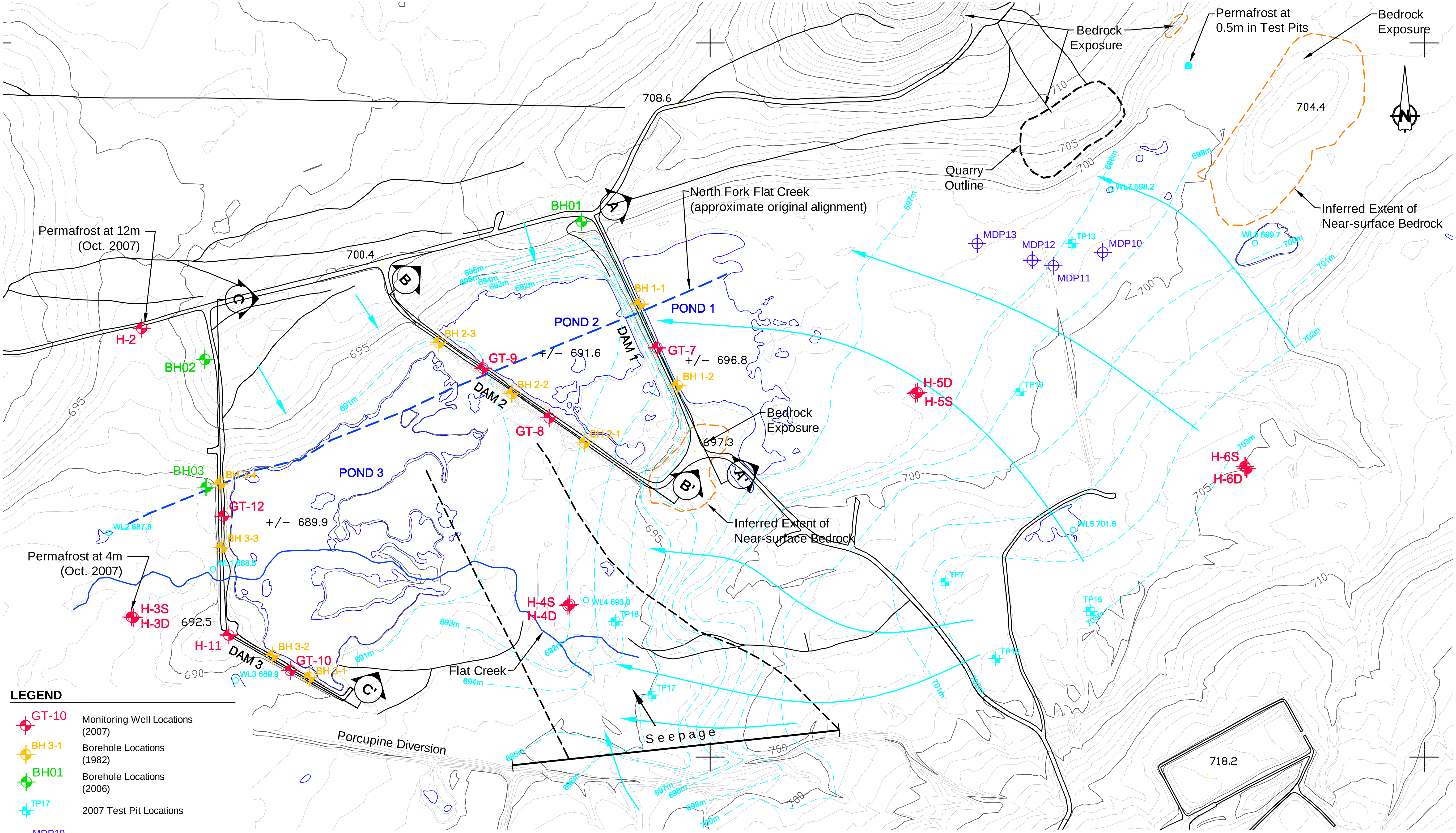

LEGEND

GT-10	Monitoring Well Locations (2007)
BH 3-1	Borehole Locations (1982)
BH01	Borehole Locations (2006)
TP17	2007 Test Pit Locations
MDP10	Manual Drive Points
– – –	Inferred Groundwater Contour
◀—	Inferred Groundwater Flow Line

Note:
GT-* locations also contain Thermistor Strings
H-* locations are Monitoring Wells only

NOTES

1. Base drawing and orthophoto provided by ERDC. Orthophoto prepared by Aero Geometrics, from photos flown September 2006 by Geodesy Remote Sensing Inc, Calgary, AB.
2. Coordinate projection is NAD83, UTM projection.
3. Contour interval is 1 metre.

0 50 100 150 200 250
Scale in Metres

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Keno Hill Project

Assessment of Groundwater Regime
at the Valley Tailings Facility

Groundwater Contours

DATE: Feb. 2008
APPROVED: BG
FIGURE: 4.1

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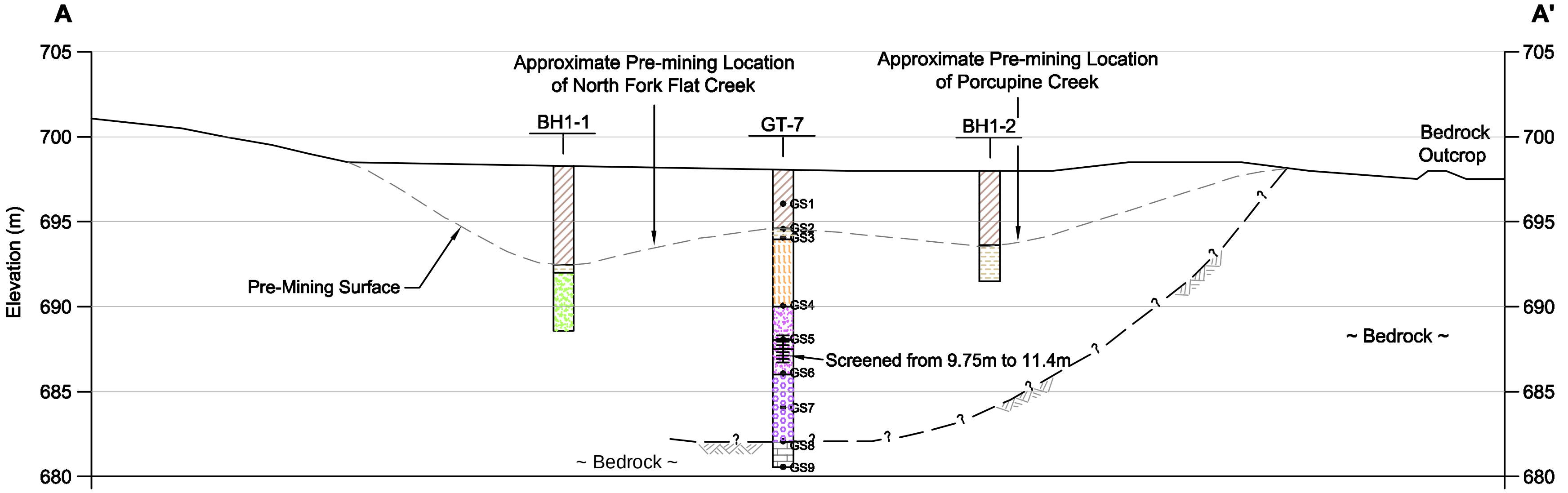
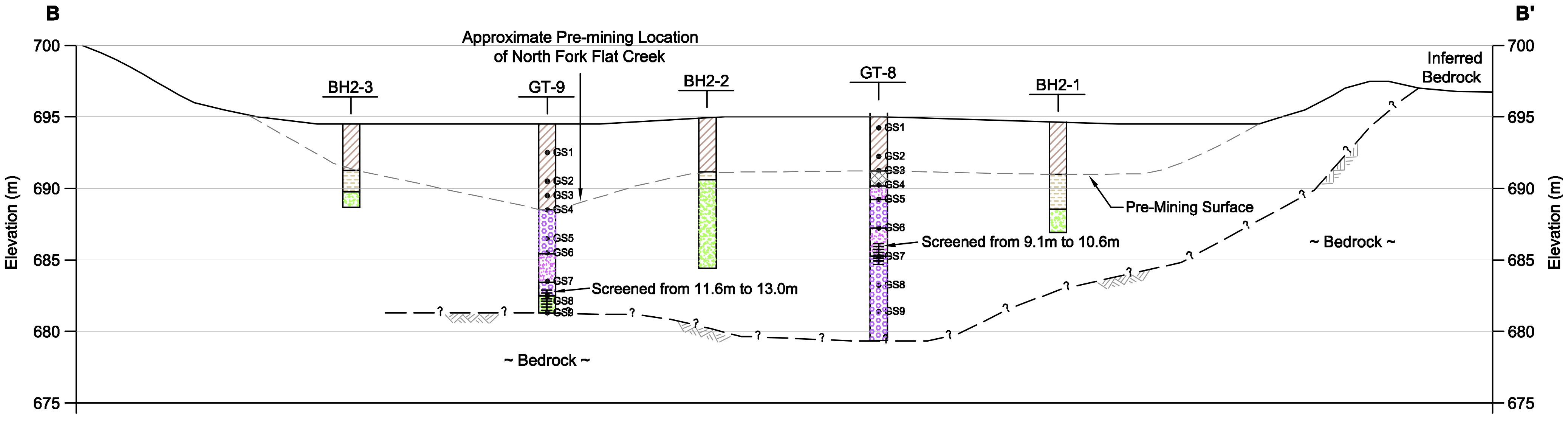


A CROSS SECTION A

Vertical Scale Exaggeration x5



B CROSS SECTION B

Vertical Scale Exaggeration x5

LEGEND

▨	Dam Fill	▨	Peat (Pt)	▥	Drill Hole Screen Interval
▨	Peat / Tailing	▨	Gravel with coarse sand	● GS1	Grab Sample Location
▨	Sand with few Gravels or Pebbles	▨	Gravel with silt		
▨	Fine-grained silty Till with few gravel	▨	Gravel with silt/clay		
▨	Silty/clay Till with few gravel	▨	Well-graded Gravel		
▨	Peat and Organic Silt	▨	Poorly Graded Gravel		
▨	Bedrock (Br)	🟦	Till Permafrost		
			Inferred Stratigraphy Contact		

0 20 40 60 80 100

Scale in Metres

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Assessment of Groundwater Regime
at the Valley Tailings Facility

Sections A and B

SRK JOB NO.: 1CE12.000.H3
FILE NAME: 1CE012_000–GT2–7.dwg

Keno Hill Project

DATE: Feb. 08
APPROVED: BG
FIGURE: 4.2

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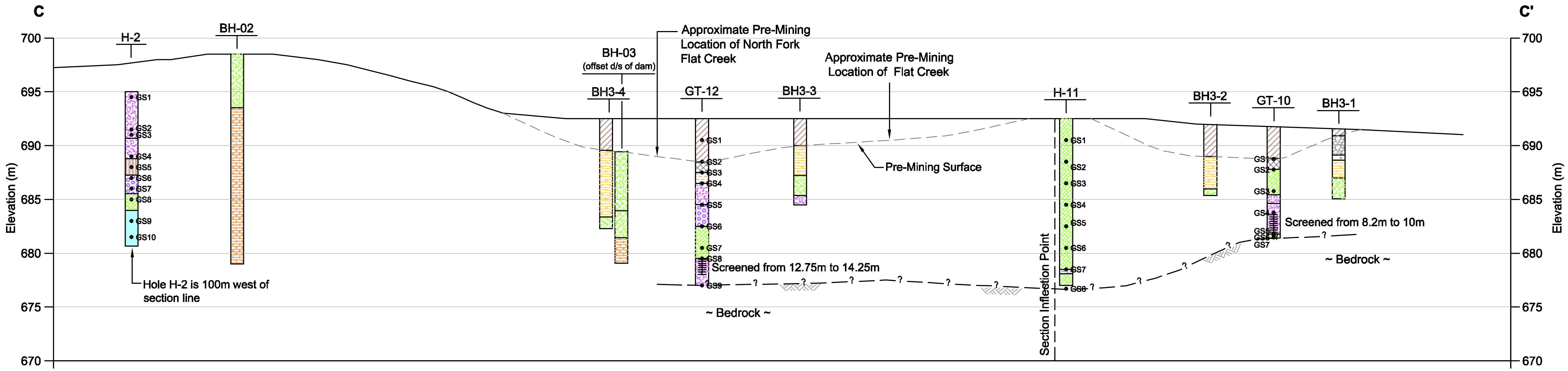

CROSS SECTION C

Vertical Scale Exaggeration x5

LEGEND

- ▨ Dam Fill
- ▩ Peat / Tailing
- ▦ Sand with few Gravels or Pebbles
- ▦ Fine-grained silty Till with few gravel
- ▤ Silty/clay Till with few gravel
- ▦ Peat and Organic Silt
- ▤ Bedrock (Br)
- ▦ Peat (Pt)
- ▩ Gravel with coarse sand
- ▦ Gravel with silt
- ▥ Gravel with silt/clay
- ▦ Well-graded Gravel
- ▥ Poorly Graded Gravel
- ☐ Till Permafrost
- Inferred Stratigraphy Contact
- Drill Hole Screen Interval
- • GS1 Grab Sample Location

0 20 40 60 80 100

Scale in Metres

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Engineers and Scientists
Vancouver B.C.

SRK JOB NO.: 1CE12.000.H3

FILE NAME: 1CE012_000-GT2-7.dwg

ERDC

Keno Hill Project

Assessment of Groundwater Regime
at the Valley Tailings Facility

Section C

DATE: Feb. 08

APPROVED: BG

FIGURE: 4.3

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Appendix A

2007 Hydrogeological Field Investigation

SRK Consulting
Engineers and Scientists

SRK Consulting (Canada) Inc.
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Technical Memorandum

To:	File	**Date:**	March 31, 2008
cc:		**From:**	Lowell Wade
Subject:	2007 Hydrogeological Field Investigation, Keno Hill, YT	**Project #:**	1CE012.000.0H6

1 Drilling

All boreholes were drilled using a Becker Hammer Drill mounted on a Komatsu MST-2600 rubber track platform. All boreholes were vertical and were completed using double-walled drill steel with compressed air return in a manner that is very similar to a reverse circulation drill. Specifically, air is pumped down the double-walled drill steel, and the air and any drill cuttings return to a cyclone at surface via the interior of the drill steel. The internal and external diameter of the rods was 76.2 mm and 139.7 mm, respectively. Samples were collected in a 20 L pail placed under the cyclone at defined intervals and stratigraphic changes. Drilling was carried out by Glacier Dredge Drilling from Whitehorse, using a single 2-person crew, working 10-hour shifts.

For unconsolidated and loosely consolidated silts and clays, the drill rods were allowed to fall under their own weight while clearing the bit with compressed air. The soft ground conditions did not provide sufficient resistance to create compression in the hammer cylinder to cycle the hammer for the next blow. The cold temperatures required the use of an ether injector to cycle the hammer. Very poor sample recovery was obtained in unconsolidated and loosely consolidated soils. Once consolidated sediments were encountered the hammer was started with moderate air pressure. Excellent sample recovery was achieved. Refusal was usually in bedrock or permafrost.

SRK engineer Mr. Lowell Wade, E.I.T. supervised the drill, logged the recovered material, and collected representative soil samples for geotechnical testing. Mr. Dave Desmarais of Access Consulting Group assisted with the drill program. Samples were shipped to EBA Engineering’s soil testing laboratory in Whitehorse. All remaining soil was discarded next to the respective borehole.

The borehole locations were initially marked set out according to co-ordinates provided by SRK, but final locations were adjusted to suit field conditions. The surveyed coordinates, depth and orientation of the completed boreholes are provided in Table 1.

Table 1: Borehole Coordinates

Hole ID	Northing[1]	Easting[1]	Collar Elevation (m)	Depth (m)	Inclination[2]
H2	7088602.338	474202.234	696.851	13.52	-90°
H3 Deep	7088197.266	474190.402	690.512	4.59	-90°
H3 Shallow	7088197.862	474187.827	690.383	2.48	-90°
H4 Deep	7088213.765	474799.317	694.810	6.71	-90°
H4 Shallow	7088215.632	474801.615	694.840	3.00	-90°
H5 Deep	7088512.259	475289.087	700.002	12.46	-90°
H5 Shallow	7088511.299	475286.450	699.992	5.00	-90°
H6 Deep	7088405.545	475750.178	706.714	5.55	-90°
H6 Shallow	7088408.575	475747.520	706.601	2.00	-90°
H11	7088170.765	474325.887	692.893	15.80	-90°

1. UTM Projection NAD 83 Zone 8.
2. Relative to the horizontal plane.

2 Summary of Borehole Profiles

A complete log of the completed hydrogeological boreholes and the installation details for the slotted monitoring wells are provided in Appendix A. The following sections summarize the results of the hydrogeological drilling program.

2.1 H2

Borehole H2 was drilled to refusal in a topographic low northwest of Dam #3 (Figure 1) to a depth of 13.52 m to establish a background monitoring station. Sample recovery from H2 was excellent over the entire length of the borehole with permafrost encountered at 13.5 m and the hole was dry at the bottom. Refusal was in gravel. The permafrost was classified as well bonded with 5% excess ice (NRC, 1963). A monitoring well was installed in this borehole to evaluate background water quality and water levels.

2.2 H3D and H3S

Boreholes H3D and H3S were drilled downstream of Dam #3 adjacent to the Flat Creek floodplain (Figure 1). These two boreholes were drilled to install monitoring wells down gradient of Dam #3. A pair of wells was installed in an effort to monitor the vertical pressure profile at this location to allow an evaluation of whether an upward gradient existed within the ground water downstream of the dam. H3D was drilled to refusal at a depth of 4.59 m. Sample recovery from H3D was excellent over the entire length of the borehole and the hole was dry at the bottom. Refusal was in gravel. The permafrost appears to be well bonded with 5% excess ice. H3S was drilled ~2 m to the southeast of H3D. This borehole, which was 2.48 m deep, intersected the same stratigraphy as H3D.

2.3 H4D and H4S

Boreholes H4D and H4S were drilled in the old subaerial tailings south of Pond #3, as shown on Figure 1. A pair of monitoring wells was installed to monitor water level elevations and porewater chemistry both in the tailings and in the overburden immediately beneath the tailings at this location. H4D was drilled to refusal at a depth of 6.71 m. Sample recovery from H4D was excellent except for poor recovery of the tailings just above the water table. Recovered overburden was unfrozen and no permafrost features were observed. Refusal was on bedrock, although no bedrock sample was recovered. A monitoring well was installed to evaluate groundwater elevation beneath the tailings. H4S was drilled approximately 2 m to the west of H4D to a depth of 3.0 m and was equipped with a monitoring well.

2.4 H5D and H5S

Boreholes H5D and H5S were drilled upstream of Dam #1, east of the south abutment, as shown on Figure 1. A pair of monitoring wells was installed to monitor water level elevations and porewater chemistry both in the tailings and in the overburden immediately beneath the tailings at this location. H3D was drilled to refusal at a depth of 12.46 m. Sample recovery from H5D was poor in the tailings but was excellent for the remainder of the borehole, with refusal in bedrock. Recovered overburden was unfrozen and no permafrost features were observed. H5S was drilled approximately 2 m to the west of H5D.

2.5 H6D and H6S

Boreholes H6D and H6S were drilled upstream of Dam #1 near the south-eastern margin of the VTF (Figure 1). A pair of monitoring wells was installed to monitor water level elevations and porewater chemistry both in the tailings and in the overburden immediately beneath the tailings at this location. H6D was drilled to refusal at a depth of 5.55 m. Sample recovery from H5D was good, with refusal in bedrock. Recovered overburden was unfrozen and no permafrost features were observed. H6S was drilled to a depth of 2.0 m approximately 2 m to the west of H6D.

2.6 H11

Borehole H11 was drilled to refusal at 15.8 m on the gravel knob on the downstream side of the elbow in Dam #3 (Figure 1). Sample recovery from H11 was generally good. Recovered overburden was unfrozen and refusal was in bedrock. The bottom of the borehole was wet at completion. No monitoring well or thermistor string was installed at this location.

3 Reference

Pihlainen, J.A.; Johnston, G.H. 1963. Guide to a Field Description of Permafrost for Engineering Purposes. NRCC Tech. Memo. 79. 21 pp

Appendix B

2007 Borehole Logs and Hydrogeological Cross-Sections

BOREHOLE LOG LEGEND

▧	Ice lens [Vs]
▨	Gravel, grey, well graded, trace fines [GW].
▨	Gravel, light brown, well graded, trace fines, some organics (~10%) [GW]
▨	Gravel, grey, well graded, trace fines, wet [GW]
▭	Peat, black, fibrous [Pt]
▭	Peat, black, fibrous with wood fragments, wet [Pt]
▤	Bedrock, greenstone
▭	Sand, coarse, light grey, some gravel [SP]
▥	Silty sand, grey [SM]
▨	Silty sand, brown, compact [SM]
▨	Sand, grey, well graded, wet [SW]
▤	Tailings, silty sand, brown [SM]
▤	No recovery [assumed tailings and peat, SM/Pt]
▤	No recovery, water returned [assumed tailings and peat, SM/Pt]
▤	Tailings, silty sand, brown, very loose, wet [SM]

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SRK JOB NO.: 1CE12.000.GT2
FILE NAME: DrillLogLegend.dwg

ERDC

Keno Hill

2007 Geotechnical Report and
Hydrogeological Field Investigation

Borehole Log Legend

DATE: Feb. 08
APPROVED: LW
FIGURE: -

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BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Adjacent to access road NW of VTF, NW of Dam #3
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-18 **TO** 2007-10-19
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088600.52 N 474203.79 E **DATUM:** NAD83

BOREHOLE: H2
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

SAMPLE CONDITION

- ☒ Remoulded
- ▨ Undisturbed
- ■ Lost
- ◧ Core

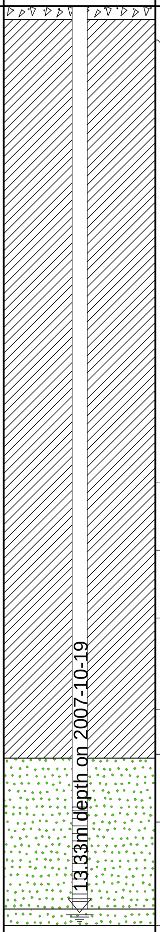
TYPE OF SAMPLER

DC	Diamond core barrel
GS	Grab sample
SS	Split spoon

LABORATORY AND IN SITU TESTS

C	Consolidation	Ku	Thermal conductivity Unfrozen (W / m°C)
D	Bulk density (kg/m3)	Kf	Thermal conductivity Frozen (W / m°C)
Dr	Specific gravity	PS	Particle size analysis
Ksat	Saturated hydraulic cond. (cm/s)		

WELL DETAILS & WATER LEVEL - m



STRATIGRAPHY

ELEVATION - m / DEPTH - m	DESCRIPTION
695.01 0.00	Organic root mat, black [Pt]
694.51 0.50	Sand, coarse, light grey, minor fines, gravels [SW]
688.01 7.00	Sand, coarse, light grey, some gravel [SP]
687.01 8.00	Sand, coarse, light grey, trace gravel and ice fragments [SP]
686.01 9.00	Gravel, grey, trace fines, some coarse sand [GP]
684.66 10.35	Silty gravel, grey, well graded, with fines. [GM] Encountered water at 10.35 m
684.01 11.00	Silty gravel, grey, well graded with fines [GM]
683.01 12.00	Silty gravel, grey, well graded with fines [GM]. Permafrost [Nbe (5%)]
681.49 13.52	Refusal in silty gravel

SAMPLES

TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD
GS-1	☒		
GS-2	☒		
GS-3	☒		
GS-4	☒		
GS-5	☒	0	0
GS-6	☒		
GS-7	☒		
GS-8	☒		
GS-9	☒		
GS-10	☒		

LABORATORY and IN SITU TESTS

20 drill blows between 1.7 - 2.0 m

38 drill blows between 6.5 - 6.8 m

Temperature (°C) -2 0 2 4 6 8

WATER CONTENT and LIMITS (%) W_P W W_L 20 40 60 80 100 120

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BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Downstream of Dam #3
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-24 **TO** 2007-10-25
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088195.45 N 474191.96 E **DATUM:** NAD83

BOREHOLE: H3 DEEP
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

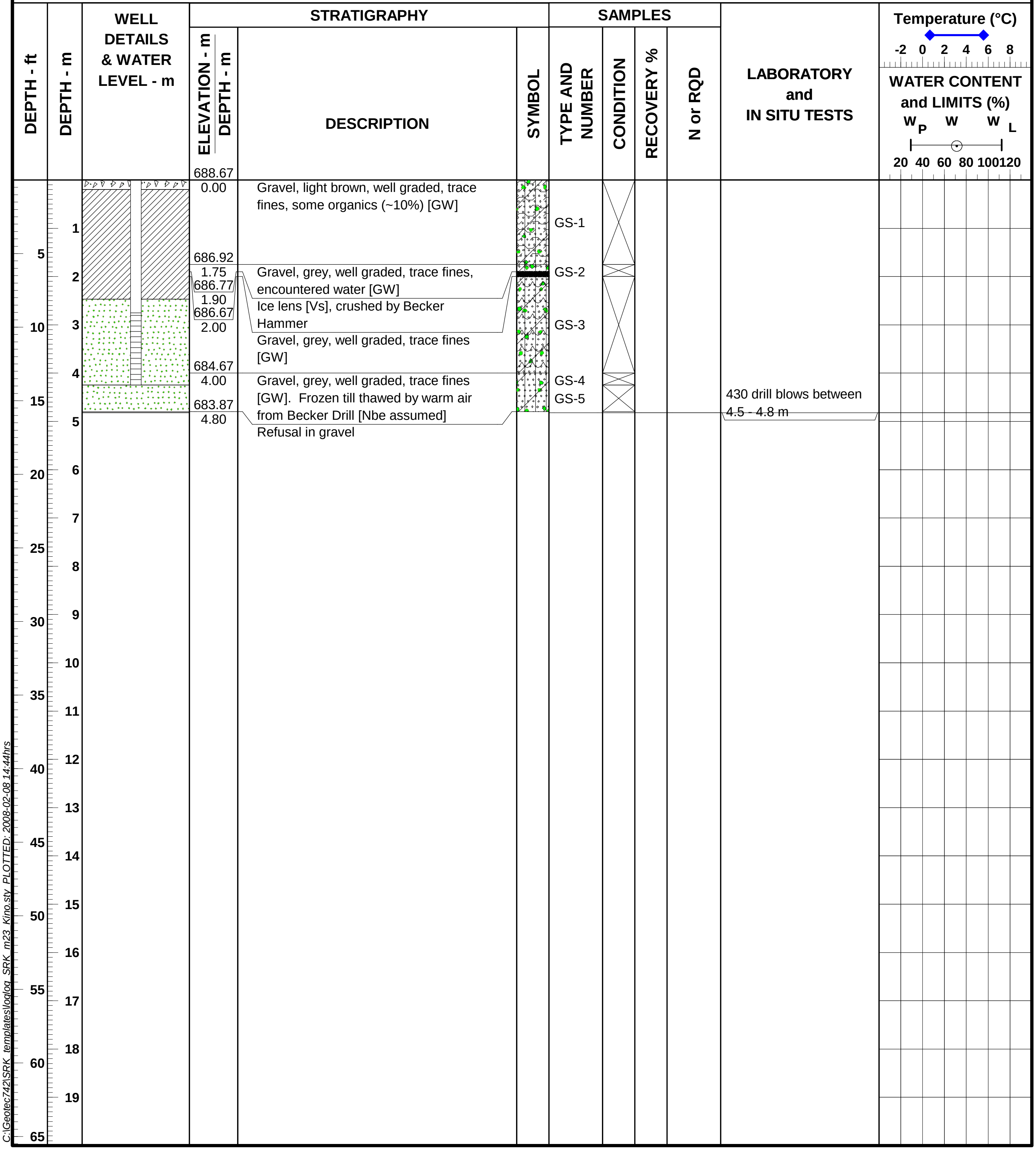
SAMPLE CONDITION
- ☒ Remoulded
- ▨ Undisturbed
- ■ Lost
- ◧ Core

TYPE OF SAMPLER

DC	Diamond core barrel
GS	Grab sample
SS	Split spoon

LABORATORY AND IN SITU TESTS

C	Consolidation	Ku	Thermal conductivity Unfrozen (W / m°C)
D	Bulk density (kg/m3)	Kf	Thermal conductivity Frozen (W / m°C)
Dr	Specific gravity	PS	Particle size analysis
Ksat	Saturated hydraulic cond. (cm/s)		



STRATIGRAPHY

ELEVATION - m / DEPTH - m	DESCRIPTION	SAMPLES TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS
688.67 0.00	Gravel, light brown, well graded, trace fines, some organics (~10%) [GW]	GS-1	☒			
686.92 1.75	Gravel, grey, well graded, trace fines, encountered water [GW]	GS-2	☒			
686.77 1.90	Ice lens [Vs], crushed by Becker Hammer					
686.67 2.00	Gravel, grey, well graded, trace fines [GW]	GS-3	☒			
684.67 4.00	Gravel, grey, well graded, trace fines [GW]. Frozen till thawed by warm air from Becker Drill [Nbe assumed]	GS-4 GS-5	☒ ☒			430 drill blows between 4.5 - 4.8 m
683.87 4.80	Refusal in gravel					

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BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: ~2m southeast of H3 Deep
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-25 **TO** 2007-10-25
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088196.04 N 474189.38 E **DATUM:** NAD83

BOREHOLE: H3 SHALLOW
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

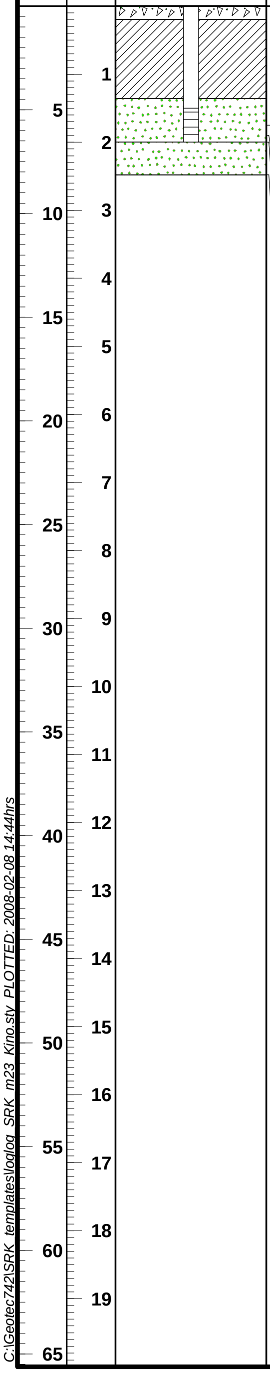
SAMPLE CONDITION
- ☒ Remoulded
- ▨ Undisturbed
- ■ Lost
- ◧ Core

TYPE OF SAMPLER

DC	Diamond core barrel
GS	Grab sample
SS	Split spoon

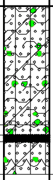
LABORATORY AND IN SITU TESTS

C	Consolidation	Ku	Thermal conductivity Unfrozen (W / m°C)
D	Bulk density (kg/m3)	Kf	Thermal conductivity Frozen (W / m°C)
Dr	Specific gravity	PS	Particle size analysis
Ksat	Saturated hydraulic cond. (cm/s)		



STRATIGRAPHY

ELEVATION - m DEPTH - m	DESCRIPTION
688.54 0.00	Gravel, light brown, well graded, trace fines, some organics (~10%) [GW]
686.79 1.75	Gravel, grey, well graded, trace fines, encountered water [GW]
686.64 1.90	Ice lens [Vs], crushed by Becker Hammer
686.54 2.00	Gravel, grey, well graded, trace fines [GW]
686.06 2.48	End of hole



SAMPLES

TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD

LABORATORY and IN SITU TESTS

Temperature (°C)
-2 0 2 4 6 8

WATER CONTENT and LIMITS (%)
W_P W W_L
20 40 60 80 100120

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BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Old tailings South of Pond #3
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-23 **TO** 2007-10-23
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088211.95 N 474800.87 E **DATUM:** NAD83

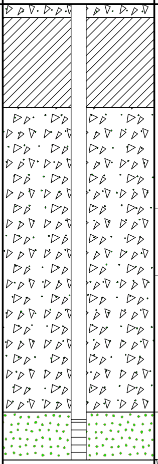
BOREHOLE: H4 DEEP
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

SAMPLE CONDITION
- ☒ Remoulded
- ▨ Undisturbed
- ■ Lost
- ◧ Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS

C	Consolidation
D	Bulk density (kg/m3)
Dr	Specific gravity
Ksat	Saturated hydraulic cond. (cm/s)
Ku	Thermal conductivity Unfrozen (W / m°C)
Kf	Thermal conductivity Frozen (W / m°C)
PS	Particle size analysis



ELEVATION - m DEPTH - m	DESCRIPTION	TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS
692.97 0.00	Tailings, silty sand, brown [SM], water encountered at 1.75 m	GS-1	☒			w = 7.5%
		GS-2	☒			w = 6.7%
		GS-3	☒			w = 23.3%
689.97 3.00	Peat, black, fibrous with wood fragments, wet [Pt]	GS-4	☒			
688.97 4.00	Peat, black, fibrous [Pt]	GS-5	☒			
		GS-6	☒			
686.97 6.00	Silty gravel, grey, well graded, compact [GM]	GS-7	☒			w = 6.1%
		GS-8	☒			
686.26 6.70	Silty sand, grey [SM]	GS-9				
686.26 6.71	Refusal - no sample collected [assumed bedrock based on drill response]					

Temperature (°C): -2 0 2 4 6 8

WATER CONTENT and LIMITS (%): W_P W W_L; 20 40 60 80 100 120

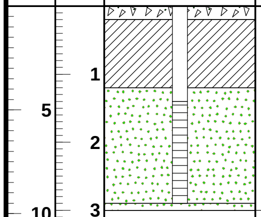
BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Old tailings South of Pond #3
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-23 **TO** 2007-10-23
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088213.81 N 474803.17 E **DATUM:** NAD83

BOREHOLE: H4 SHALLOW
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

SAMPLE CONDITION		**TYPE OF SAMPLER**		**LABORATORY AND IN SITU TESTS**			
☒	Remoulded	DC	Diamond core barrel	C	Consolidation	Ku	Thermal conductivity Unfrozen (W / m°C)
▨	Undisturbed	GS	Grab sample	D	Bulk density (kg/m3)	Kf	Thermal conductivity Frozen (W / m°C)
■	Lost	SS	Split spoon	Dr	Specific gravity	PS	Particle size analysis
◧	Core			Ksat	Saturated hydraulic cond. (cm/s)		

DEPTH - ft	DEPTH - m	WELL DETAILS & WATER LEVEL - m	ELEVATION - m / DEPTH - m	DESCRIPTION	SYMBOL	TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS	Temperature (°C) -2 0 2 4 6 8 / WATER CONTENT and LIMITS (%) W_P W W_L 20 40 60 80 100120
			693.00 0.00	Tailings, brown, silty sand [SM], water encountered at 1.75 m							
			690.00 3.00	End of hole							



Depth scale: ft 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65; m 1–19.

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BOREHOLE LOG

PROJECT: Keno Hill

LOCATION: Subaerial tailings East of Dam #1

FILE No: UNITED KENO HILL (1CE012.000)

BORING DATE: 2007-10-22 **TO** 2007-10-22

DIP: 90.00 **AZIMUTH:**

COORDINATES: 7088510.44 N 475290.64 E **DATUM:** NAD83

BOREHOLE: H5 DEEP

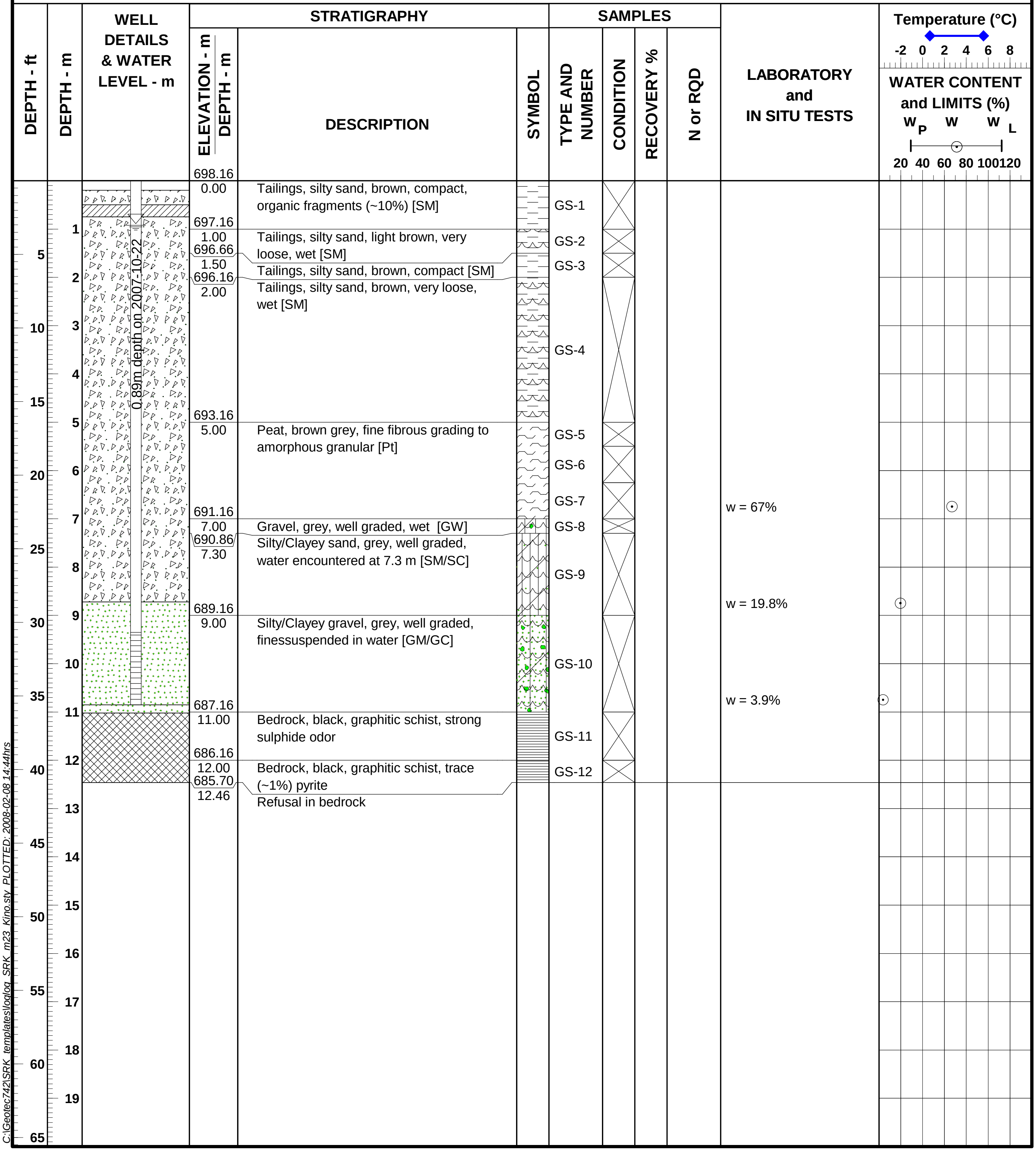
PAGE: 1 **OF** 1

DRILL TYPE: Air Return

DRILL: Becker Hammer

CASING: Double Walled

SAMPLE CONDITION		TYPE OF SAMPLER		LABORATORY AND IN SITU TESTS			
☒	Remoulded	DC	Diamond core barrel	C	Consolidation	Ku	Thermal conductivity Unfrozen (W / m°C)
▨	Undisturbed	GS	Grab sample	D	Bulk density (kg/m3)	Kf	Thermal conductivity Frozen (W / m°C)
■	Lost	SS	Split spoon	Dr	Specific gravity	PS	Particle size analysis
◧	Core			Ksat	Saturated hydraulic cond. (cm/s)		



ELEVATION - m DEPTH - m	DESCRIPTION	TYPE AND NUMBER	LABORATORY and IN SITU TESTS
698.16 0.00	Tailings, silty sand, brown, compact, organic fragments (~10%) [SM]	GS-1	
697.16 1.00	Tailings, silty sand, light brown, very loose, wet [SM]	GS-2	
696.66 1.50	Tailings, silty sand, brown, compact [SM]	GS-3	
696.16 2.00	Tailings, silty sand, brown, very loose, wet [SM]	GS-4	
693.16 5.00	Peat, brown grey, fine fibrous grading to amorphous granular [Pt]	GS-5 GS-6 GS-7	w = 67%
691.16 7.00	Gravel, grey, well graded, wet [GW]	GS-8	
690.86 7.30	Silty/Clayey sand, grey, well graded, water encountered at 7.3 m [SM/SC]	GS-9	w = 19.8%
689.16 9.00	Silty/Clayey gravel, grey, well graded, finessuspended in water [GM/GC]	GS-10	w = 3.9%
687.16 11.00	Bedrock, black, graphitic schist, strong sulphide odor	GS-11	
686.16 12.00	Bedrock, black, graphitic schist, trace (~1%) pyrite	GS-12	
685.70 12.46	Refusal in bedrock		

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BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Subaerial tailings East of Dam #1
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-22 **TO** 2007-10-22
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088509.48 N 475288.00 E **DATUM:** NAD83

BOREHOLE: H5 SHALLOW
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

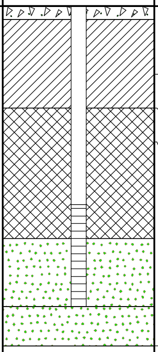
SAMPLE CONDITION
- ☒ Remoulded
- ▨ Undisturbed
- ■ Lost
- ◧ Core

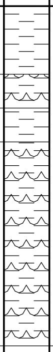
TYPE OF SAMPLER

DC	Diamond core barrel
GS	Grab sample
SS	Split spoon

LABORATORY AND IN SITU TESTS

C	Consolidation	Ku	Thermal conductivity Unfrozen (W / m°C)
D	Bulk density (kg/m3)	Kf	Thermal conductivity Frozen (W / m°C)
Dr	Specific gravity	PS	Particle size analysis
Ksat	Saturated hydraulic cond. (cm/s)		





ELEVATION - m DEPTH - m	DESCRIPTION	TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS
698.15 0.00	Tailings, silty sand, brown, compact, organic fragments (~10%) [SM]					
697.15 1.00	Tailings, silty sand, light brown, very loose, wet [SM]					
696.65 1.50	Tailings, silty sand, brown, compact [SM]					
696.15 2.00	Tailings, silty sand, brown, very loose, wet [SM]					
693.15 5.00	End of hole					

DEPTH - ft: 5 10 15 20 25 30 35 40 45 50 55 60 65

DEPTH - m: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

WELL DETAILS & WATER LEVEL - m

SYMBOL

STRATIGRAPHY

SAMPLES

Temperature (°C): -2 0 2 4 6 8

WATER CONTENT and LIMITS (%): W_P W W_L: 20 40 60 80 100120

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SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Subaerial tailings near SE margin of VTF
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-23 **TO** 2007-10-23
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088403.73 N 475751.73 E **DATUM:** NAD83

BOREHOLE: H6 DEEP
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

SAMPLE CONDITION

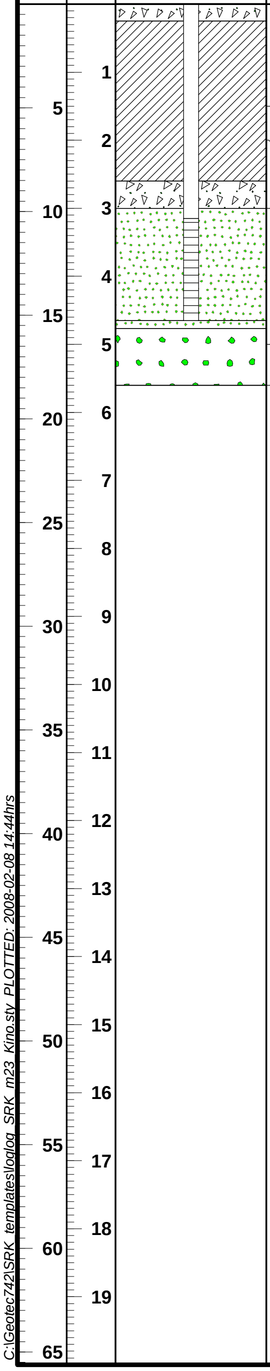
☒	Remoulded
▨	Undisturbed
■	Lost
◧	Core

TYPE OF SAMPLER

DC	Diamond core barrel
GS	Grab sample
SS	Split spoon

LABORATORY AND IN SITU TESTS

C	Consolidation	Ku	Thermal conductivity Unfrozen (W / m°C)
D	Bulk density (kg/m3)	Kf	Thermal conductivity Frozen (W / m°C)
Dr	Specific gravity	PS	Particle size analysis
Ksat	Saturated hydraulic cond. (cm/s)		



STRATIGRAPHY			SAMPLES					
ELEVATION - m DEPTH - m	DESCRIPTION	SYMBOL	TYPE AND NUMBER	CONDITION	RECOVERY %	N or RQD	LABORATORY and IN SITU TESTS	Temperature (°C) -2 0 2 4 6 8 WATER CONTENT and LIMITS (%) W_P W W_L 20 40 60 80 100 120
704.87 0.00	Tailings, silty sand, brown (from 0.0 to 1.0 m), grey (from 1.0 to 1.5 m), loose [SM]		GS-1 GS-2	☒ ☒				
703.37 1.50	Peat, brown, fine fibrous, [Pt]		GS-3	☒				
702.87 2.00	Gravel, light brown/grey, well graded, moist [GW]		GS-4	☒			w = 5.6%	⊙
701.87 3.00	Sand, dark grey, well graded. Encountered water at 3.0 m [SM/SC]		GS-5	☒				
699.87 5.00	Bedrock, black, graphitic schist, trace (~1%) pyrite		GS-6 GS-7	☒ ☒				
699.27 5.60	Refusal in bedrock							

C:\Geotec742\SRK templates\loglog SRK m23 Kino.sty PLOTTED: 2008-02-08 14:44hrs

SRK Consulting
Engineers and Scientists

BOREHOLE LOG

PROJECT: Keno Hill
LOCATION: Subaerial tailings near SE margin of VTF
FILE No: UNITED KENO HILL (1CE012.000)
BORING DATE: 2007-10-23 **TO** 2007-10-23
DIP: 90.00 **AZIMUTH:**
COORDINATES: 7088406.76 N 475749.08 E **DATUM:** NAD83

BOREHOLE: H6 SHALLOW
PAGE: 1 **OF** 1
DRILL TYPE: Air Return
DRILL: Becker Hammer
CASING: Double Walled

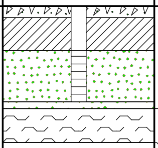
SAMPLE CONDITION
- ☒ Remoulded
- ▨ Undisturbed
- ■ Lost
- ◧ Core

TYPE OF SAMPLER
- DC Diamond core barrel
- GS Grab sample
- SS Split spoon

LABORATORY AND IN SITU TESTS

C	Consolidation
D	Bulk density (kg/m3)
Dr	Specific gravity
Ksat	Saturated hydraulic cond. (cm/s)
Ku	Thermal conductivity Unfrozen (W / m°C)
Kf	Thermal conductivity Frozen (W / m°C)
PS	Particle size analysis

DEPTH - ft	DEPTH - m	WELL DETAILS & WATER LEVEL - m	STRATIGRAPHY ELEVATION - m / DEPTH - m	STRATIGRAPHY DESCRIPTION	STRATIGRAPHY SYMBOL	SAMPLES TYPE AND NUMBER	SAMPLES CONDITION	SAMPLES RECOVERY %	SAMPLES N or RQD	LABORATORY and IN SITU TESTS	Temperature (°C) -2 0 2 4 6 8; WATER CONTENT and LIMITS (%) W_P W W_L 20 40 60 80 100 120
			704.76 0.00	Tailings, silty sand, brown (from 0.0 to 1.0 m), grey (from 1.0 to 1.5 m),loose [SM]							
			703.26 1.50	Peat, brown, fine fibrous, [Pt]							
			702.76 2.00	End of hole							



DEPTH - ft: 5 10 15 20 25 30 35 40 45 50 55 60 65

DEPTH - m: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

Appendix C

Laboratory Analyses of Grain Size Distributions

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project: **SRK Soil Testing**
Client: SRK Consulting Inc.
Project No.: W14101104
Location: United Keno Hill Mine
Sample No.: H2 (GS 2-5)
Depth: 6.0 m & 8.0 m (combined)
Description**: GRAVEL - silty, sandy, trace clay

Date Tested: 2008/01/20

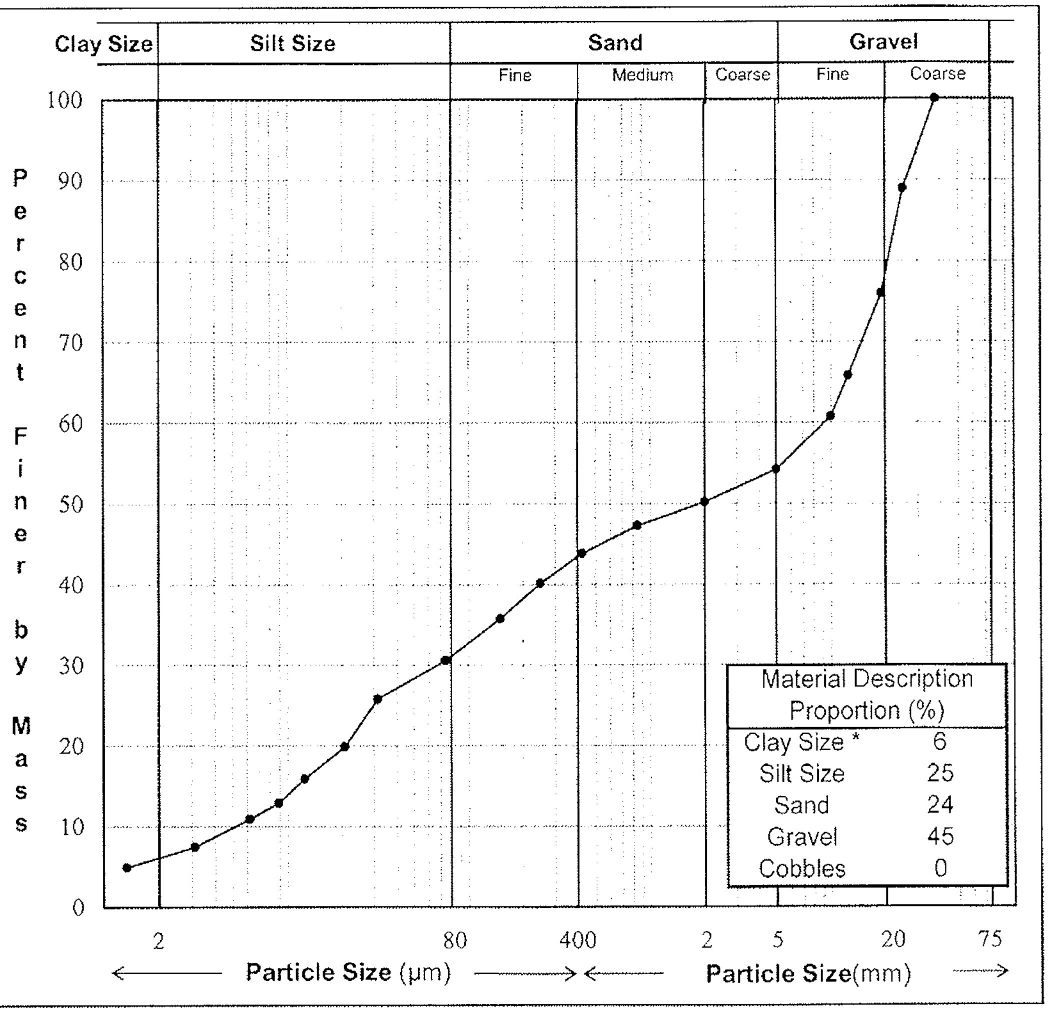
Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	100
25 mm	89
19 mm	76
13 mm	66
10 mm	61
5 mm	54
2 mm	50
850 µm	47
425 µm	44
250 µm	40
150 µm	36
75 µm	31
31 µm	26
21 µm	20
12 µm	16
9 µm	13
6 µm	11
3 µm	7
1 µm	5

GRAVEL

SAND

SILT

CLAY



Material Description	Proportion (%)
Clay Size *	6
Silt Size	25
Sand	24
Gravel	45
Cobbles	0

Remarks: * The upper clay size of 2 µm, per the Canadian Foundation Engineering Manual.
** The description is visually based & subject to EBA description protocols.

Reviewed By:

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project: **SRK Soil Testing**

Date Tested: 2008/01/20

Client: SRK Consulting Inc.

Project No.: W14101104

Location: United Keno Hill Mines

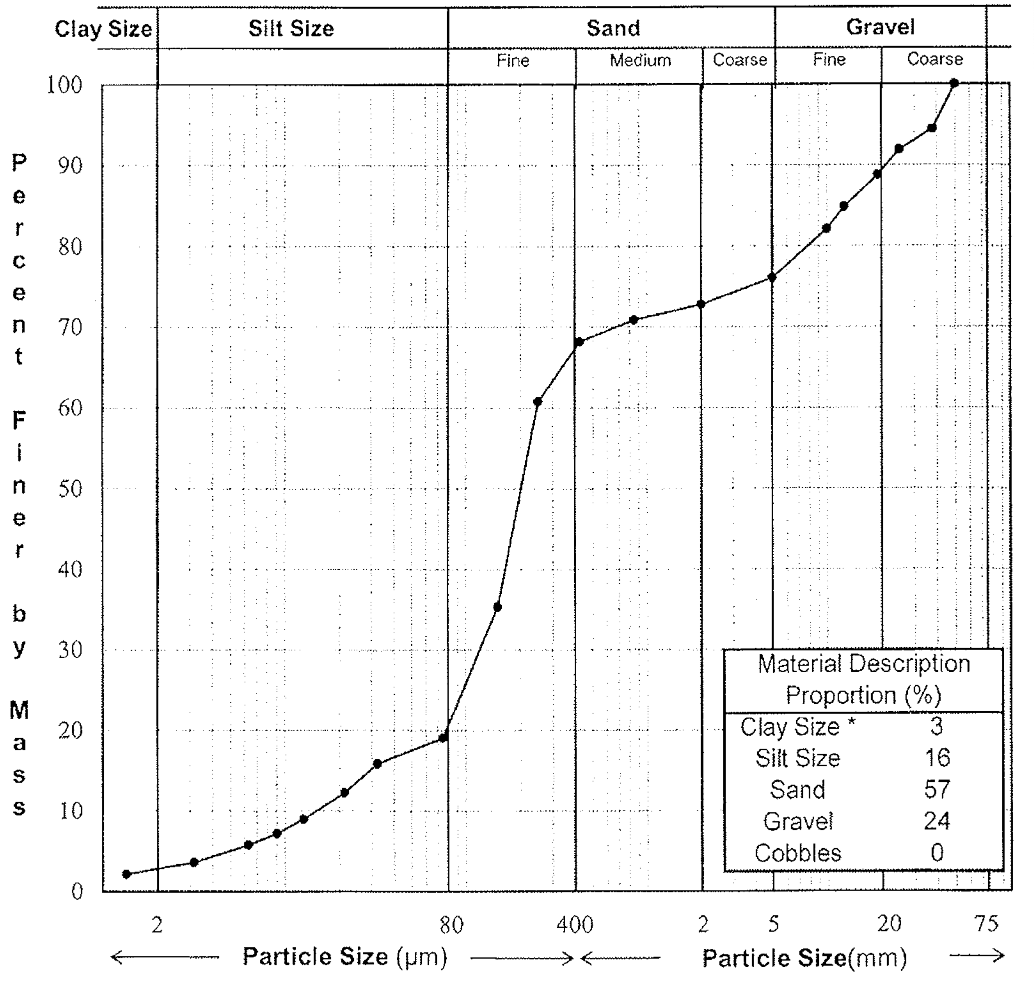
Sample No.: H2 (GS 8)

Depth: 10.0 m

Description**: SAND - some gravel, some silt, trace clay

CLAY | SILT | SAND | GRAVEL

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	94
25 mm	92
19 mm	89
13 mm	85
10 mm	82
5 mm	76
2 mm	73
850 μm	71
425 μm	68
250 μm	61
150 μm	35
75 μm	19
32 μm	16
21 μm	12
13 μm	9
9 μm	7
6 μm	6
3 μm	4
1 μm	2



Material Description	Proportion (%)
Clay Size *	3
Silt Size	16
Sand	57
Gravel	24
Cobbles	0

Remarks: * The upper clay size of 2 μm, per the Canadian Foundation Engineering Manual.

** The description is visually based & subject to EBA description protocols.

Reviewed By:

EBA Engineering Consultants Ltd.

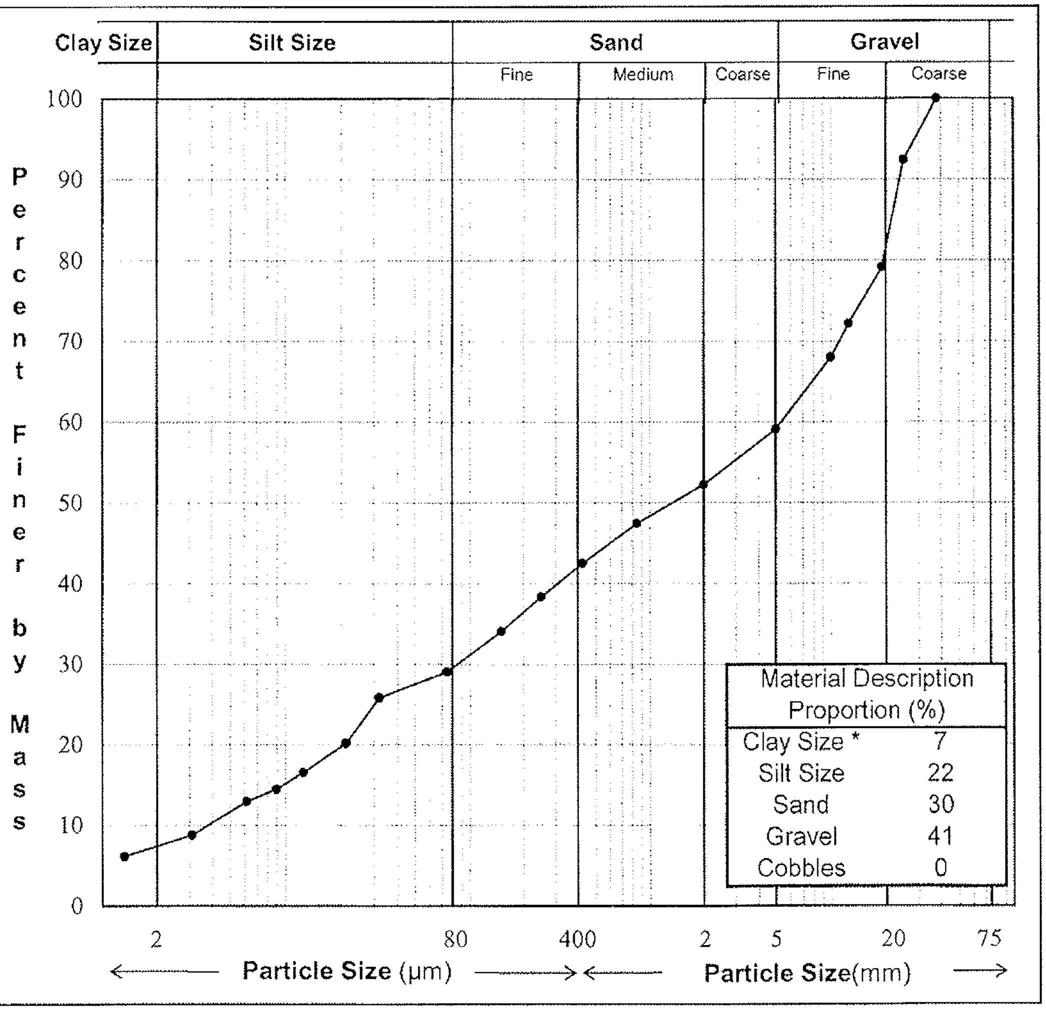
PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mines		
Sample No.:	GT 7 (GT 7)		
Depth:	14.0 m		
Description**:	GRAVEL - sandy, silty, trace clay		

GRAVEL
SAND
SILT
CLAY

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	100
25 mm	92
19 mm	79
13 mm	72
10 mm	68
5 mm	59
2 mm	52
850 µm	47
425 µm	43
250 µm	38
150 µm	34
75 µm	29
32 µm	26
21 µm	20
13 µm	17
9 µm	14
6 µm	13
3 µm	9
1 µm	6



Material Description	Proportion (%)
Clay Size *	7
Silt Size	22
Sand	30
Gravel	41
Cobbles	0

Remarks: * The upper clay size of 2 µm, per the Canadian Foundation Engineering Manual.
** The description is visually based & subject to EBA description protocols.

Reviewed By:

EBA Engineering
Consultants Ltd.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

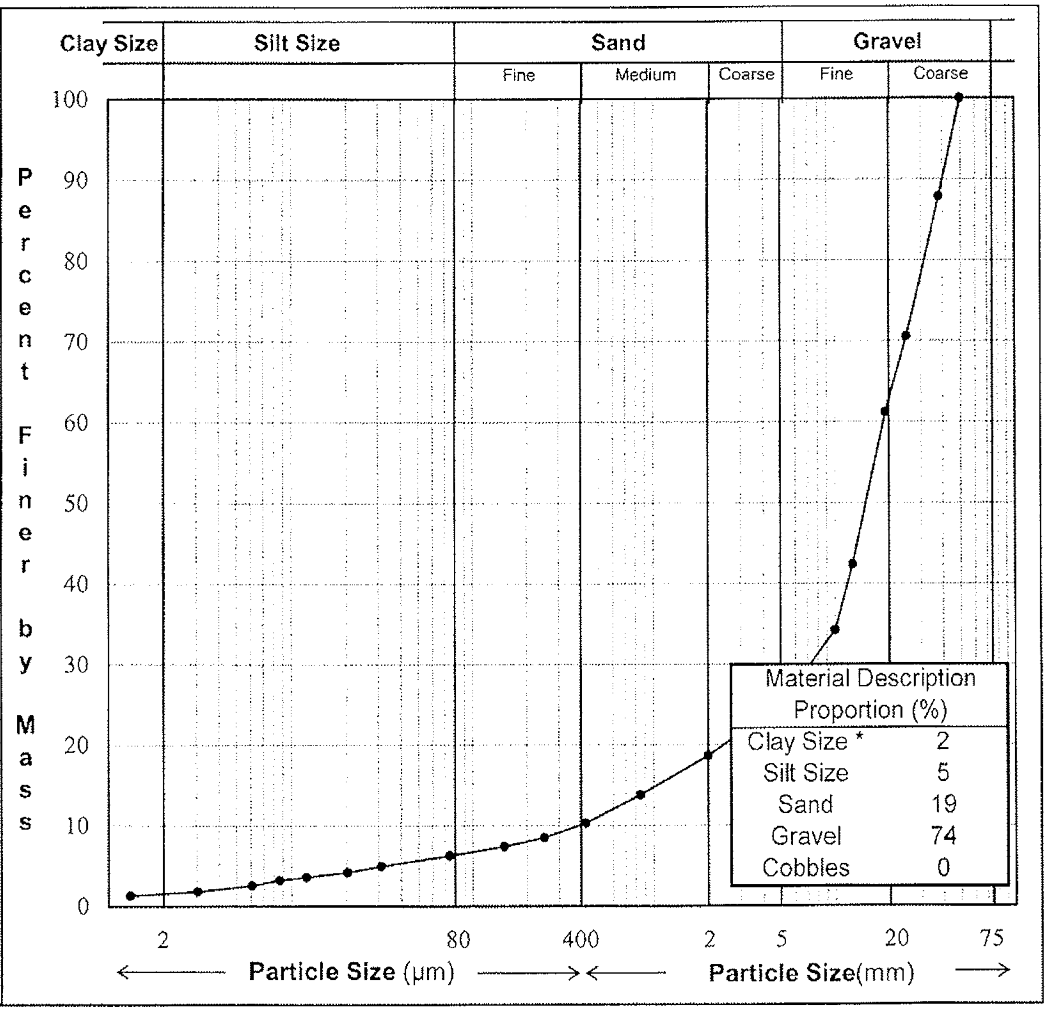
ASTM D422

Project: **SRK Soil Testing**
Client: SRK Consulting Inc.
Project No.: W14101104
Location: United Keno Hill Mines
Sample No.: GT 8 (GS6)
Depth: 8.0 m
Description**: GRAVEL - some sand, trace silt, trace clay

Date Tested: 2008/01/20

GRAVEL
SAND
SILT

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	88
25 mm	71
19 mm	61
13 mm	42
10 mm	34
5 mm	25
2 mm	19
850 µm	14
425 µm	10
250 µm	9
150 µm	7
75 µm	6
31 µm	5
20 µm	4
12 µm	4
9 µm	3
6 µm	3
3 µm	2
1 µm	1



Material Description	Proportion (%)
Clay Size *	2
Silt Size	5
Sand	19
Gravel	74
Cobbles	0

Remarks: * The upper clay size of 2 µm, per the Canadian Foundation Engineering Manual.

** The description is visually based & subject to EBA description protocols.

*** Sample appears to be segregated - may not be representative

Reviewed By:

EBA Engineering
Consultants Ltd.

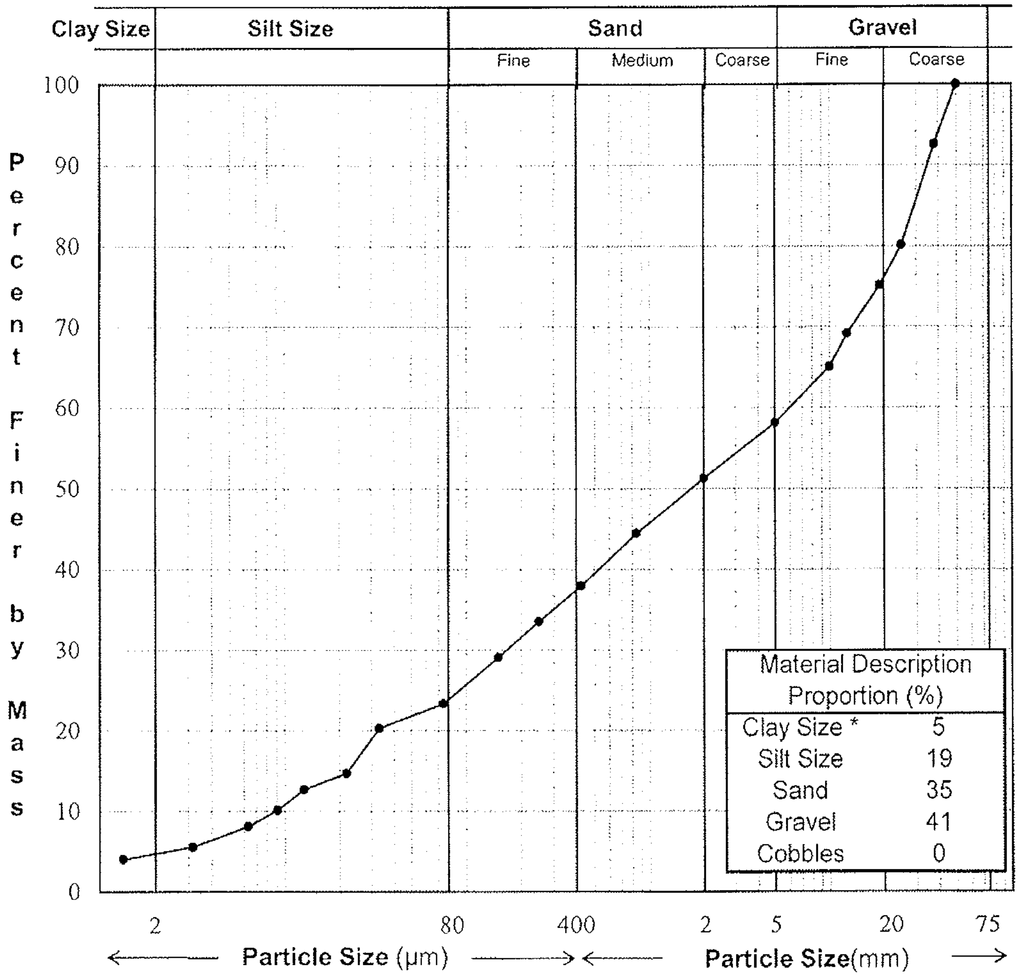
PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mines		
Sample No.:	GT 8 (GS 6)		
Depth:	16.0 m & 18.3 m (Combined)		
Description**:	GRAVEL AND SAND - some silt, trace clay		

GRAVEL
SAND
SILT
CLAY

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	93
25 mm	80
19 mm	75
13 mm	69
10 mm	65
5 mm	58
2 mm	51
850 µm	44
425 µm	38
250 µm	34
150 µm	29
75 µm	23
33 µm	20
22 µm	15
13 µm	13
9 µm	10
6 µm	8
3 µm	6
1 µm	4



Material Description	Proportion (%)
Clay Size *	5
Silt Size	19
Sand	35
Gravel	41
Cobbles	0

Remarks: * The upper clay size of 2 µm, per the Canadian Foundation Engineering Manual.
** The description is visually based & subject to EBA description protocols.

Reviewed By:

EBA Engineering Consultants Ltd.

PARTICLE SIZE DISTRIBUTION

ASTM C136 & D422

Project: **SRK Soil Testing**

United Keno Hill Mines

Project Number: W14101104

Date Tested: 11/17/2007

Borehole Number: GT 10 (GS 4)

Depth: 8 m

Soil Description: GRAVEL - sandy, trace of silt

Cu:

Cc:

Natural Moisture Content: 6.1%

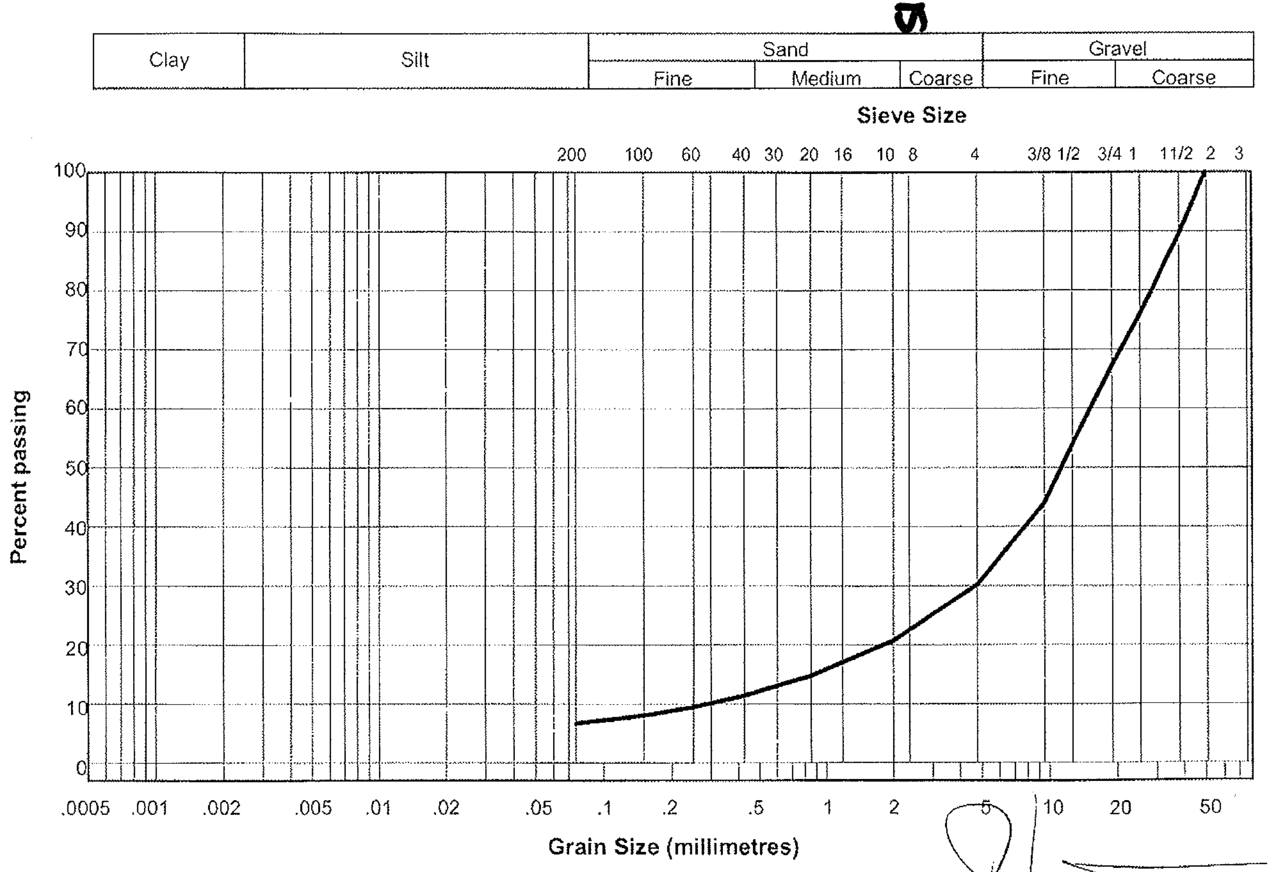
Remarks:

Sieve Size	Percent Passing
50.000	100
37.500	89
25.000	75
19.000	67
12.500	53
9.500	44
4.750	30
2.000	21
0.850	15
0.425	11
0.250	9
0.150	8
0.075	6.7

GRAVEL

SAND

SILT



Reviewed By:

EBA Engineering Consultants Ltd.

PARTICLE SIZE DISTRIBUTION

ASTM C136 & D422

Project: **SRK Soil Testing**

United Keno Hill Mines

Project Number: W14101104

Date Tested: 1/20/2008

Borehole Number: GT 9 (GS 7)

Depth: 11 m

Soil Description: SAND - some gravel, trace of silt

Cu:

Cc:

Natural Moisture Content: 12.0%

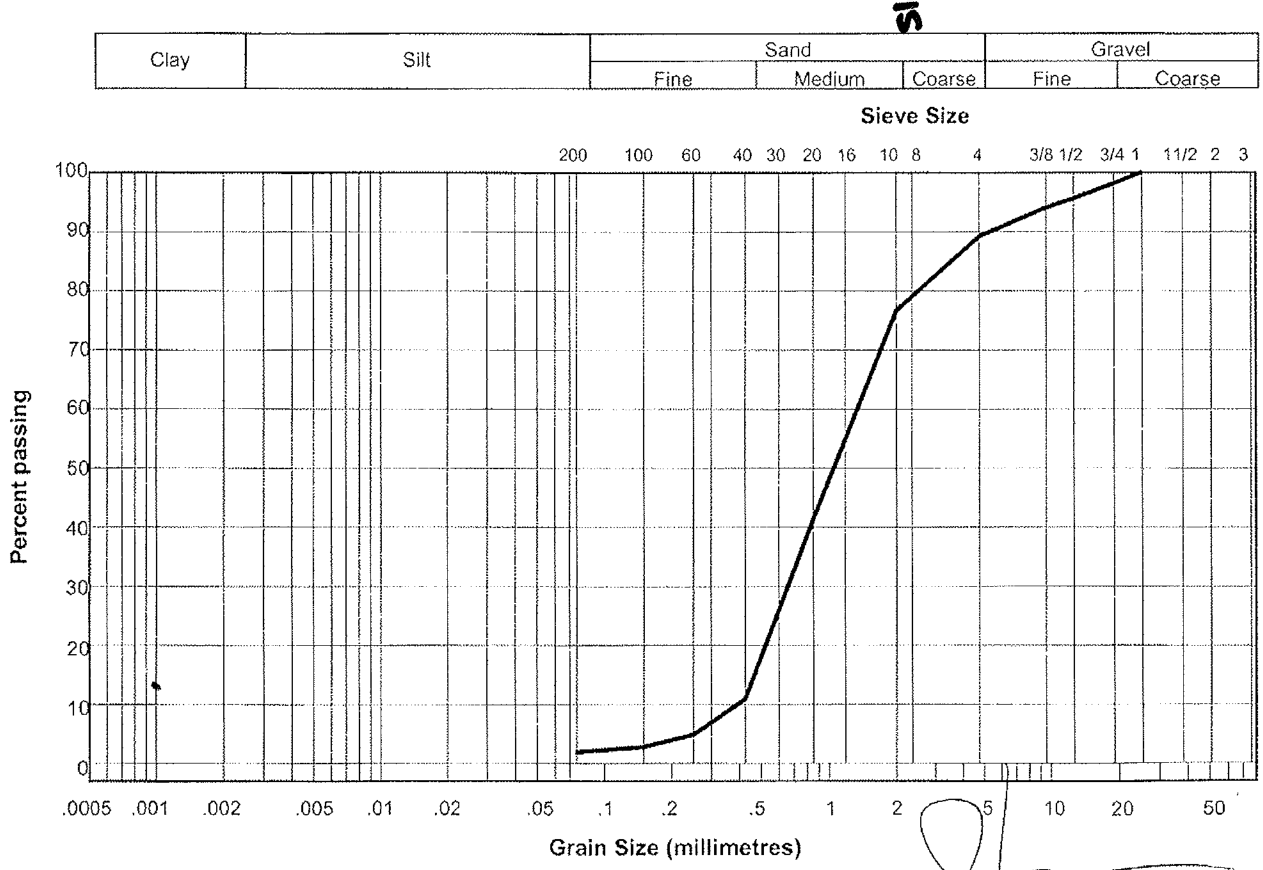
Remarks:

Sieve Size	Percent Passing
50.000	#N/A
37.500	#N/A
25.000	100
19.000	98
12.500	96
9.500	94
4.750	89
2.000	77
0.850	41
0.425	11
0.250	5
0.150	3
0.075	2.0

GRAVEL

SAND

SILT



Reviewed By:

EBA Engineering
Consultants Ltd.

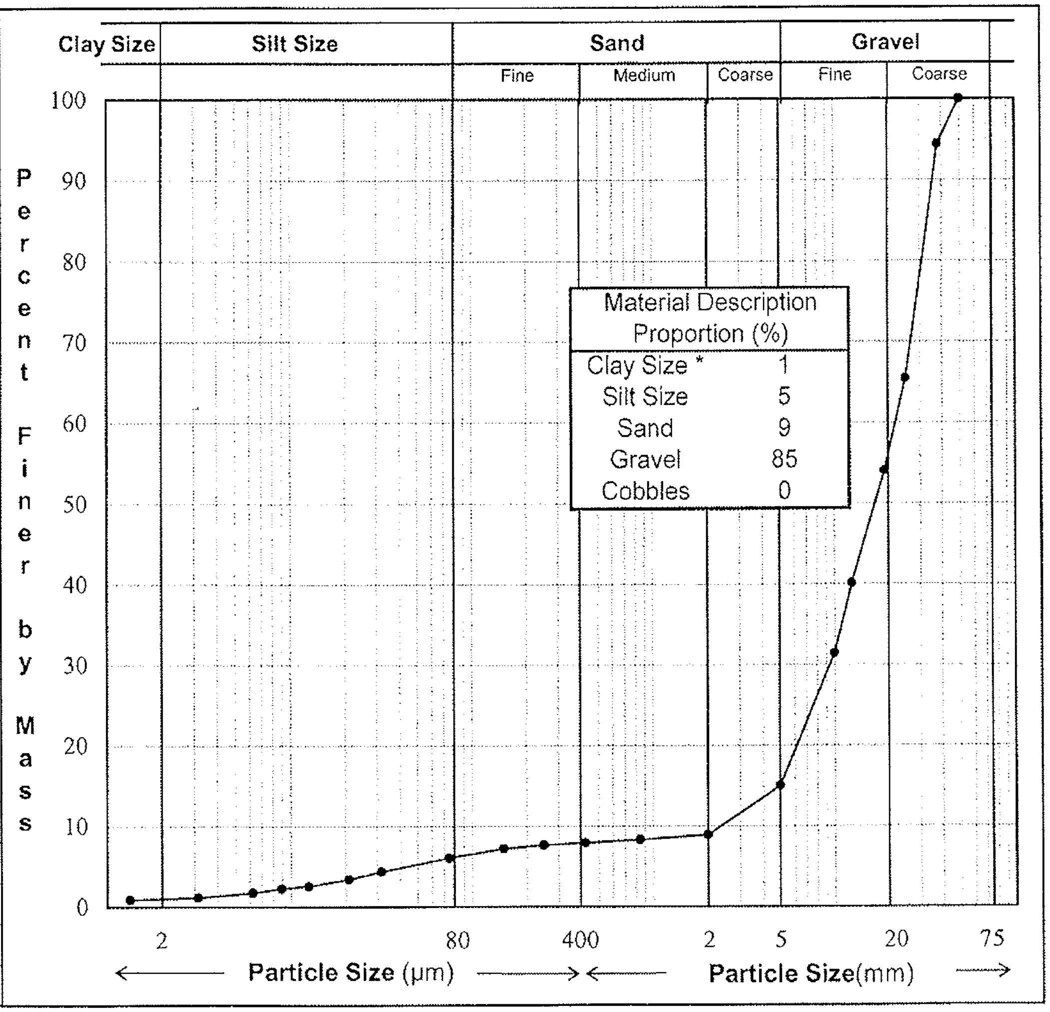
PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mines		
Sample No.:	GT 12 (GS 5)		
Depth:	8.0 m		
Description**:	GRAVEL - trace sand, trace silt, trace clay		

CLAY | SILT | SAND | GRAVEL

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	94
25 mm	65
19 mm	54
13 mm	40
10 mm	31
5 mm	15
2 mm	9
850 µm	8
425 µm	8
250 µm	8
150 µm	7
75 µm	6
32 µm	4
21 µm	3
13 µm	3
9 µm	2
6 µm	2
3 µm	1
1 µm	1



Material Description	Proportion (%)
Clay Size *	1
Silt Size	5
Sand	9
Gravel	85
Cobbles	0

Remarks: * The upper clay size of 2 µm, per the Canadian Foundation Engineering Manual.

** The description is visually based & subject to EBA description protocols.

***Sample appears segregated - may not be representative

Reviewed By:

EBA Engineering
Consultants Ltd.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

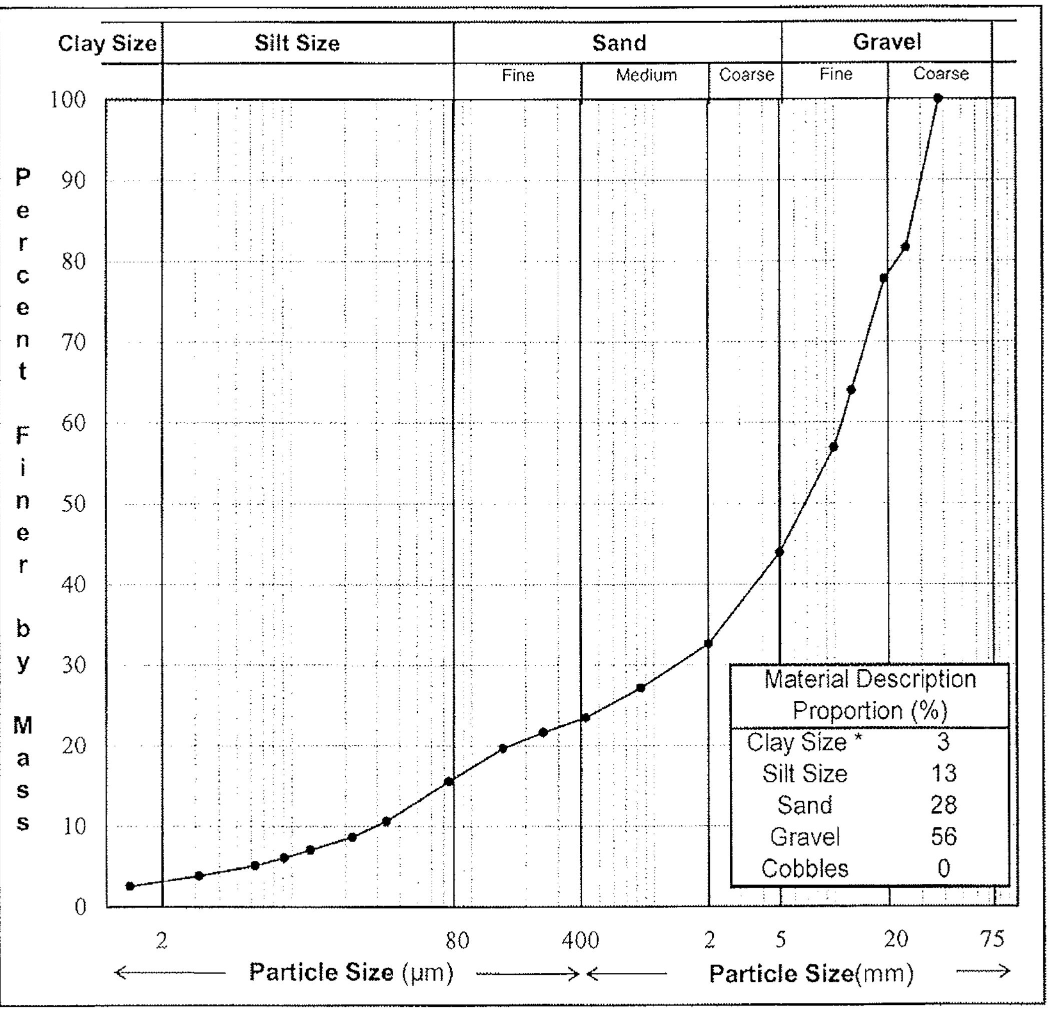
ASTM D422

Project: **SRK Soil Testing**
Client: SRK Consulting Inc.
Project No.: W14101104
Location: United Keno Hill Mines
Sample No.: GT12 (GT 6)
Depth: 10.0 m
Description**: GRAVEL - sandy, some silt, trace clay

Date Tested: 2008/01/20

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	100
25 mm	82
19 mm	78
13 mm	64
10 mm	57
5 mm	44
2 mm	33
850 µm	27
425 µm	24
250 µm	22
150 µm	20
75 µm	16
34 µm	11
22 µm	9
13 µm	7
9 µm	6
6 µm	5
3 µm	4
1 µm	3

GRAVEL | SAND | SILT | CLAY



Material Description	Proportion (%)
Clay Size *	3
Silt Size	13
Sand	28
Gravel	56
Cobbles	0

Remarks: * The upper clay size of 2 µm, per the Canadian Foundation Engineering Manual.
** The description is visually based & subject to EBA description protocols.

Reviewed By:

EBA Engineering Consultants Ltd.

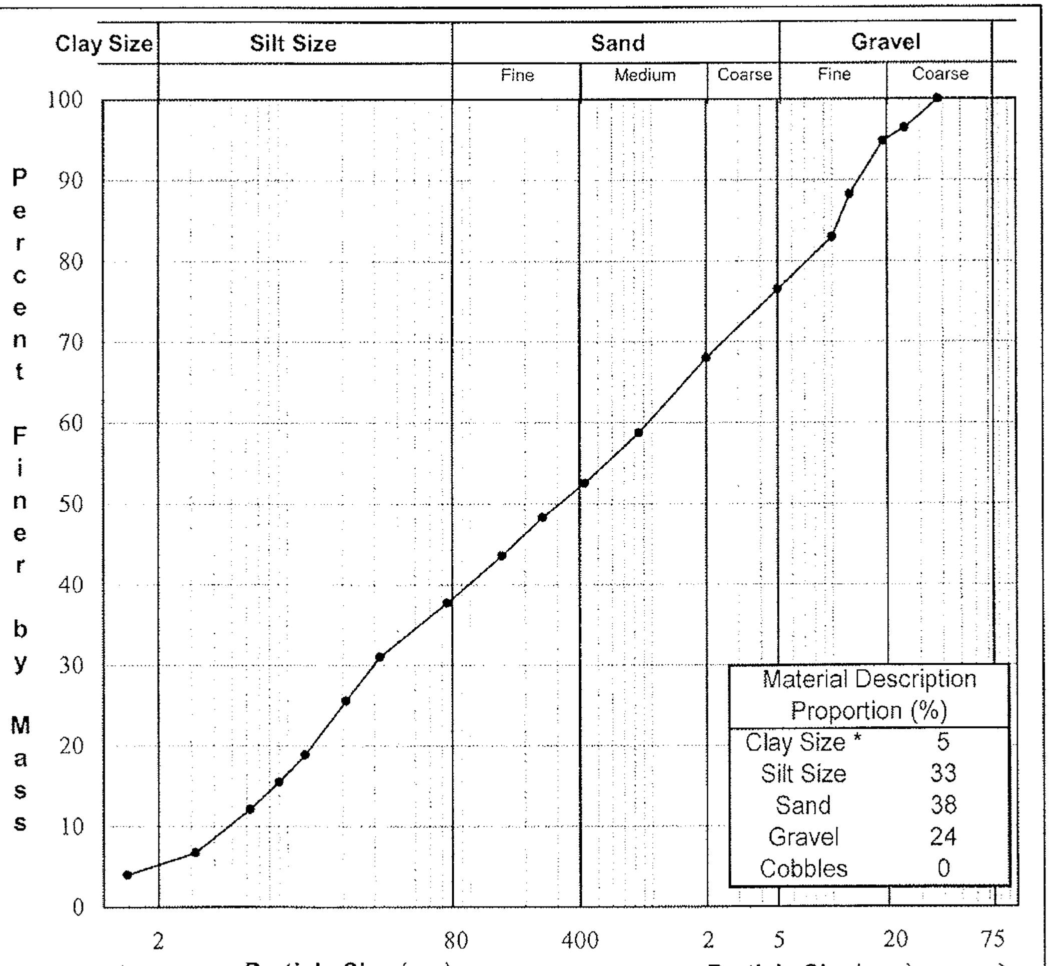
PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mines		
Sample No.:	GT 12 (439)		
Depth:	14.0 m		
Description**:	SAND - silty, gravelly, trace clay		

CLAY | SILT | SAND | GRAVEL

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	100
25 mm	96
19 mm	95
13 mm	88
10 mm	83
5 mm	77
2 mm	68
850 μm	59
425 μm	53
250 μm	48
150 μm	44
75 μm	38
32 μm	31
21 μm	26
13 μm	19
9 μm	15
6 μm	12
3 μm	7
1 μm	4



Material Description	Proportion (%)
Clay Size *	5
Silt Size	33
Sand	38
Gravel	24
Cobbles	0

Remarks: * The upper clay size of 2 μm, per the Canadian Foundation Engineering Manual.
** The description is visually based & subject to EBA description protocols.

Reviewed By:

EBA Engineering
Consultants Ltd.

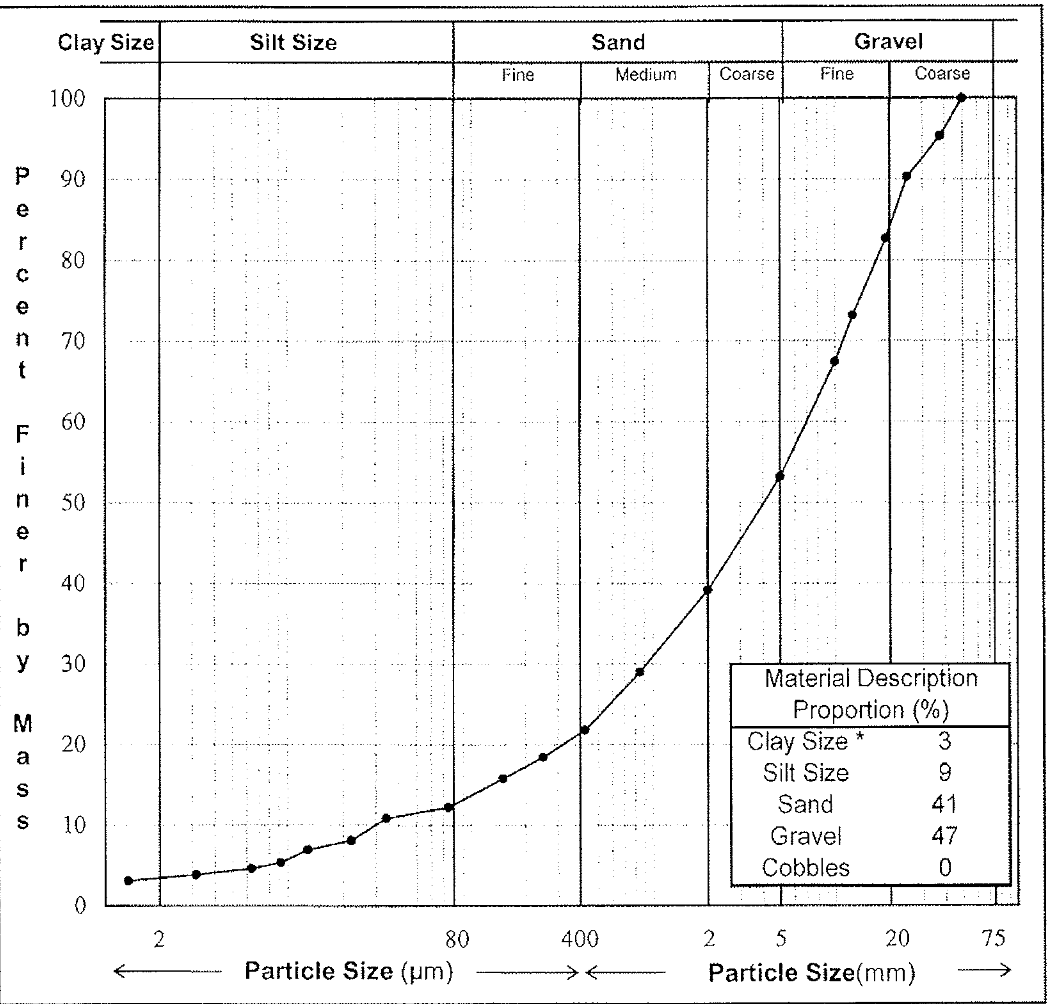
PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D422

Project:	**SRK Soil Testing**	Date Tested:	2008/01/20
Client:	SRK Consulting Inc.		
Project No.:	W14101104		
Location:	United Keno Hill Mines		
Sample No.:	H 11 (GS 4)		
Depth:	8.0 m		
Description**:	GRAVEL AND SAND - trace silt, trace clay		

CLAY / SILT / SAND / GRAVEL

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	95
25 mm	90
19 mm	83
13 mm	73
10 mm	67
5 mm	53
2 mm	39
850 µm	29
425 µm	22
250 µm	18
150 µm	16
75 µm	12
34 µm	11
22 µm	8
13 µm	7
9 µm	5
6 µm	5
3 µm	4
1 µm	3



Material Description	Proportion (%)
Clay Size *	3
Silt Size	9
Sand	41
Gravel	47
Cobbles	0

Remarks: * The upper clay size of 2 µm, per the Canadian Foundation Engineering Manual.

** The description is visually based & subject to EBA description protocols.

Reviewed By:

EBA Engineering Consultants Ltd.