2011 Stage 2 Geotechnical and Hydrogeological Assessment for Doris Central and Connector Underground Mines

Prepared for

Hope Bay Mining Ltd.

Prepared by

SRK Consulting (Canada) Inc.
1CT022.001
April 2014

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1 Introduction

SRK Consulting (Canada) Inc. (SRK) was approached by Hope Bay Mining Limited (HBML), a wholly owned subsidiary of Newmont Mining Company, in December 2010 to implement a geotechnical and hydrogeological program at its Hope Bay Gold Project site, located in Nunavut, Canada (Figure 1.1). This program focuses on the Doris deposit within the Hope Bay belt. This document presents the data from the 2011 field program.

SRK's scope was to carry out field investigations designed to characterize geotechnical and hydrogeological conditions and to provide appropriate analysis of such data for use in mine and infrastructure design to support an internal HBML Stage 2 (pre-feasibility) study. This report presents SRK's Stage 2 assessment of the Doris Central and Connector underground mining areas only.

Source: Google Earth

Figure 1.1: Location of the Hope Bay Project Site

2 Background and Brief

2.1 Background of the Project

The following objectives have been satisfied:

- Investigate the structural, hydrogeological, and geotechnical conditions of the deposits and comment on their impacts to the proposed underground mining options
- Provide recommendations for underground mine design to support a HBML Stage 2–level study on the deposits

Broad study objectives for the Doris Underground have previously been established by Phase 1 and 2 scoping studies undertaken by NEM Australia Technical Services (2006a, b) and Stage 2 studies completed by SRK (2009). A scope of work for the current study is detailed in the March 2011 Professional Services Agreement (PSA) document (HBML-CM-PSA-003) between Hope Bay Mining Ltd. and SRK.

3 Program Objectives and Work Program

3.1 Program Objectives

In order to reach the objectives of the study, SRK has completed a number of tasks that are outlined below (refer to the PSA for further details).

These tasks, referenced from the PSA, were tailored during the latter stages of analyses to satisfy specific criteria laid out for Newmont/HBML Stage 2 study requirements (October 2008 version including MIN.S2.160–Hydrogeology and Hydrology Open Pit and Underground and MIN.S2.510–Geotechnical Underground Project). Specific elements, particularly for the underground evaluation, may require additional work to fully meet Stage 2 requirements. These potential shortfalls are presented as recommendations in Section 11.2.

3.1.1 Development of Drilling Program

A joint geotechnical/hydrogeological drilling program was generated to assess the range of ground conditions and the potential adverse fault/alteration areas.

3.1.2 Field Logging and Hydrogeological Testing

Geotechnical and oriented core logging and photography of the core were undertaken by a Hope Bay–selected external contractor under the guidance of senior SRK personnel. Hydrogeological testing was performed by SRK personnel.

3.1.3 Sampling and Testing

Field sampling and testing were conducted to determine several physical properties (i.e., rock strength). Field results were supplemented by laboratory testing (physical properties, moisture content, density).

3.1.4 Structural Geology Study

SRK combined earlier structural geology studies with more recent structural reviews to provide a 3-D structural framework that has been integrated with all subsequent physical analyses for underground geotechnical evaluations.

3.1.5 Data Interpretation, Evaluation, and Design

SRK developed a comprehensive technical assessment based on findings from the geotechnical and hydrogeological field studies. Consideration was given to data collected from the Doris North Underground mining area. Geotechnical guidelines were established for design purposes.

3.1.6 Reporting

SRK has developed a stand-alone, detailed, and accurate technical report for inclusion into the HBML Stage 2 Study Report. This technical report includes data interpretation, evaluation and assessment, and design criteria based on the outcomes of the geotechnical and hydrogeological field program.

3.2 Work Program

A summary of the work program for the Doris Underground project is provided below.

- January 2011
  - Kick-off meetings
  - Initial drill-hole targeting
- February 2011
  - Hydrogeological testing begins at Hope Bay
- March 2011
  - Geotechnical drilling program begins at Hope Bay
- June 2011
  - End of geotechnical drilling program
- August 2011
  - Completion of laboratory testing
  - Ongoing hydrogeological assessment
- September 2011
  - Geotechnical and hydrogeological budgeting for Stage 2 requirements for other deposits at Hope Bay (not part of this report)
  - Geotechnical data interpretation, stability analyses, support guidelines, and reporting
- October 2011
  - Geotechnical data interpretation, stability analyses, support guidelines, and reporting
  - Ongoing hydrogeological assessment
- November 2011
  - Draft geotechnical and hydrogeological report submitted to HBML

4 Previous Work

The current assessment builds on reporting completed by SRK for the Doris Central Underground in 2009. A summary of the most relevant works is described below.

URSA Engineering (1996): URSA issued a letter report entitled Doris Lake–Preliminary Rock Mass Characterization, which summarized existing geotechnical data collected at Doris North. The letter report indicates that RMR values for the deposit, including host rock and veins, are "approximately 45 with a standard deviation of about 5." Intact rock strengths were found to be moderate with an average uniaxial compressive strength (UCS) of approximately 87 MPa for the host rock (volcanics). Quartz vein material was slightly weaker at 55 MPa. The report concluded that the rock appears to be "mechanically sound with a potential for an increase in RMR and RMS as cleaner, more site specific, data are collected." The report goes on to note that the rock mass appears to be cut by a variety of structural sets, dominated by foliation striking north-northeast and dipping to the west. Cross structures are reported as sub-vertical, running east-west, as well as shallow dipping features in a variety of orientations. The report also offers brief comment on rock support (for underground) and permafrost.

Golder Associates (2002): Golder issued a letter report entitled Geotechnical Data Review – Doris Hinge, which presents a review of geotechnical data collected from the Doris Hinge (North) deposit. The report describes the generation of a geotechnical block model which is used to present preliminary design considerations for both open pit and underground mine options. A thorough review of geotechnical data (rock mass and oriented core) is followed by a summary of orientation data, as well as rock mass classification (RMR) by major lithology type. The structural information, based on 1995/96 drilling, is slightly modified from the initial reporting by URSA (1996). RMR values, however, are reported to range between 53 and 71 (as opposed to 45 as detailed in the URSA work). Although detailed design of the open pit was not included as a scope for the Golder reporting, the report does consider west, north, and east pit wall domains (the pit at the time was significantly smaller than the preliminary Stage 2 Phase pit) and suggests that design issues would be restricted to the bench scale. The report also offers brief comment on hydrogeological and permafrost considerations as well as underground design.

AMEC (2008): AMEC conducted a geotechnical review and evaluation for the Hope Bay project to develop design parameters and guidelines for the permanent and temporary underground excavations associated with the Doris, Boston, and Madrid ore bodies. The geotechnical evaluation was conducted using the supplied core log databases and associated reports. The general span/support guidelines were developed using a combination of standard empirical relationships. To account for variability in rock mass properties, as well as limited data, probabilistic methods were employed for each method. The memorandum presents analysis of the data and assumptions made to develop the underground span/support recommendations, limitations to the analysis, and uncertainties in the analysis.

SRK (2009): SRK issued a Stage 2 geotechnical and hydrogeological assessment for the Doris North Open Pit and Doris Central Underground. The assessments were based on field studies completed by SRK, including detailed structural review, hydrogeological investigations, and geotechnical assessments. Geotechnical domains were established based on open pit slope design, underground mine design, excavation sizes, and support requirements. Hydrogeological risks and sensitivities, limitations of the data collection, and recommendations for Stage 3 investigation and evaluation were presented.

Aside from historical geotechnical core logging, no significant sources of geotechnical reporting exist for Doris Central (aside from basic data such as RQD). Golder (2002) summarizes a significant amount of previous work, including URSA (1996), which was completed on the Doris Hinge (Doris North). Additionally, BHP conducted laboratory strength testing on various rock types from Doris Hinge in 1996 (URSA 1996). Extrapolation of this work to Doris Connector and Central was necessary to obtain certain rock mass parameters.

No hydrogeological data were available for the Doris Central area prior to the 2008 program. In 2005, however, a preliminary assessment of potential groundwater inflows to the Doris Central Underground was completed by SRK (SRK 2005). No hydraulic data were available for the 2005 study; therefore, estimates were highly uncertain. In addition to the 2009 Stage 2 report, hydrogeological data collection and reporting completed since 2005 for the Doris area were communicated as described below.

SRK (2011) 2010 Westbay Program Report: SRK conducted a field program in 2010 involving the installation of multiple Westbay multi-level monitoring wells for the purpose of characterizing groundwater quality at Doris North (sub-permafrost), Doris Central (talik), and Boston (talik). Installation methods and as-builts were provided. Hydraulic testing during drilling was assessed. Groundwater quality was characterized for each of the sampled zones.

SRK (2012) Hope Bay 2011 Groundwater Quality Report: SRK provided a report summarizing results of water quality analyses from three Westbay wells (Doris North, Doris Central, and Boston).

SRK (2011) Groundwater Inflows and inflow water quality for the revised Doris North project water license amendment package: SRK provided a memo to HBML summarizing updated water quality and modelled inflow rates for Doris Central and Connector. Water quality results included results from updated baseline sampling. Inflow estimates included results from updated numerical assessments using data from the 2010 drilling and testing program. Methods were provided for inclusion of inflow rates and quality in the Doris North water and load balance, including provision for flow contributions from open exploration drill holes.

5 Data Sources and Quality

This report is based on geotechnical and hydrogeological data sources as described in the following sections.

5.1 Geotechnical Data Sources

5.1.1 Historical Data

The following historical data sources are considered for the current open pit and underground assessment:

- Previous technical reporting
- Historical geotechnical logging data
- Historical bedrock maps and reports

A number of geological and geotechnical drilling campaigns were carried out since the 1990s within the Hope Bay project area, producing geotechnical datasets of varying quality and quantity. Multiple core logging approaches, techniques, and standards were employed throughout this period, yielding several digital file formats for the data. Work carried out as part of the current Doris study focused on compiling and filtering the data to create a more consistent and uniform dataset that can aid in rock mass characterization and classification tasks.

Overall, it is SRK's impression that the historical Doris geotechnical database is of poor to fair quality. Other workers have also reported similar findings (e.g., URSA 1996; AMEC 2008). For instance, the assessment of fracture counts is particularly inconsistent. A comparison of visual estimates of RQD against original Hope Bay logging demonstrates an overestimation of RQD for substantial portions of the Doris geotechnical dataset. Following a review of the dataset, it appears that loggers have, on occasion and throughout the various logging campaigns, misinterpreted natural breaks as mechanical breaks (thus increasing RQD measurements). The assessment of intact rock strength and joint condition parameters also appears to be questionable in certain instances. However, excellent core photos have aided in calibrating geotechnical data for the current study. For a more detailed summary of historical data quality and quantity, please refer to SRK (2008a and 2008b).

In addition to these historical data sources, the following current data sources are utilized:

- 2008 geotechnical logging data (rock mass and oriented core)
- Hydrogeological field testing
- Current laboratory strength testing
- Mapping from the Doris North Underground

Input from historical and updated lithological, structural, and hydrogeological conceptual models.

5.1.2 SRK 2011 Drilling Program and Historical Data Review

Drilling targets for the Doris Connector and Doris Central deposits were initially laid out within the PSA (March 2011). SRK proposed a combined geotechnical/hydrogeological drilling program of 4,225 m over 13 drill holes (Table 5.1). The planned hydrogeological holes for Doris Central and Connector were not completed in 2011 due to HBML's request to pursue resource drilling targets.

Table 5.1: Planned vs. Completed Meterage for 2008 Drilling Program

Deposit	CSA Proposal (March 2011)		Actual Drilled	
	# holes	metres	# holes	metres
Doris Connector	9	2825	6	1768
Doris Central	4	1400	2	640
Totals	13	4225	8	2408

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables

In total, the 2011 geotechnical program at Doris Connector and Central included 2,408 m over eight drill holes. The drill holes are tabulated in Table 5.2 and illustrated in Figures 5.1 and 5.2 for Doris Connector and Central, respectively.

Table 5.2: Doris Central and Connector 2011 Geotechnical Drilling Program

Deposit	Newmont Hole ID	SRK Hole ID	Easting (tUTM)	Northing (tUTM)	Elevation (tUTM)	Length (m)	Azimuth (collar)	Dip (collar)	Core Diameter	Triple Tube	Core Oriented
Doris Connector	11TDD766	11DCGT05	33901	558910	5022	279	271	-62	HQ3	Y	Y
Doris Connector	11TDD768	11DCGT07	33665	558760	5022	299	105	-62	HQ3	Y	Y
Doris Central	11TDD769	11DCGT22	33812	557713	5022	310	246	-67	HQ3	Y	Y
Doris Connector	11TDD771	11DCGT14	33720	558380	5022	294	126	-82	HQ3	Y	Y
Doris Central	11TDD772	11DCH04	33860	557708	5022	321	206	-72	HQ3	Y	Y
Doris Connector	11TDD773	11DCGT09	33582	558468	5022	301	49	-59	HQ3	Y	Y
Doris Connector	11TDD774	11DCGT25A	33665	558790	5021	273	74	-66	HQ3	Y	Y
Doris Connector	11TDD775	11DCGT10A	33607	558476	5022	304	78	-61	HQ3	Y	Y

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables\Table 5.2_Drilling Program Details.xlsx

Geotechnical holes were drilled by Geotech Drilling and Orbit Garant Companies using diamond drilling rigs. A triple tube (split tube) HQ3 drilling method was used for all Doris drill holes generally with a three-metre run length.

All drill holes were surveyed by HBML contractors to provide easting, northing, azimuth, and dip at the collar. Drill-hole dip was monitored during drilling using a Reflex EZ-Shot approximately every 30 m, or once per shift.

As a standard, HBML staff undertake an azimuth / dip hole survey at 30 m into bedrock using the Reflex Maxibor tool. An additional survey is completed at 200 m for holes exceeding 400 m depth. A complete hole survey is also conducted and at the end of the hole using the device. The Maxibor provided X, Y, Z, azimuth, and dip at roughly every three metres along the hole. Data from the Maxibor were calibrated using the surveyed drill-hole collar and the final hole length (based on drill rods used).

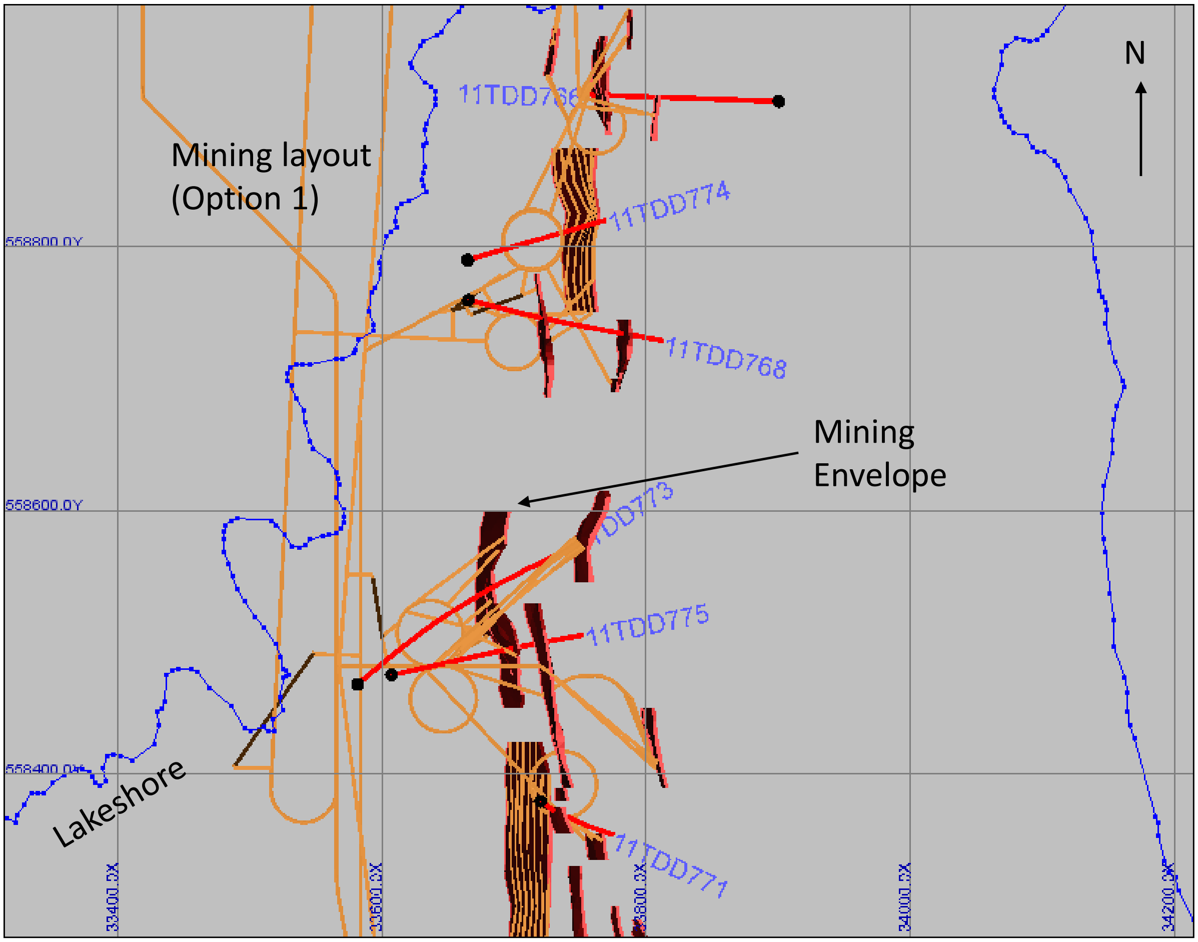


Figure 5.1: 2011 Geotechnical Drilling at Doris Connector Showing Stage 2 Mining Envelopes (November 2010) and Infrastructure

All planned geotechnical drill holes for Doris Connector and Central were completed during the 2011 program. Five hydrogeological-specific drill holes were not completed: these holes were planned for the purpose of vibrating wire piezometer installation to further understand and delineate the talic zone around Doris Lake. These installations should be completed during the 2012 geotechnical/hydrogeological drilling program.

Two drill holes originally planned for the 2008 Doris Central geotechnical drilling program were considered during 2011 planning and drilled as part of the 2011 drilling program.

Appendix A details the logging methodology employed during the 2008 geotechnical drilling program. The complete geotechnical database (in spreadsheet format) is contained in Appendix

B1. This database is complemented by a full suite of drill core logs from the 2011 program (Appendix B2).

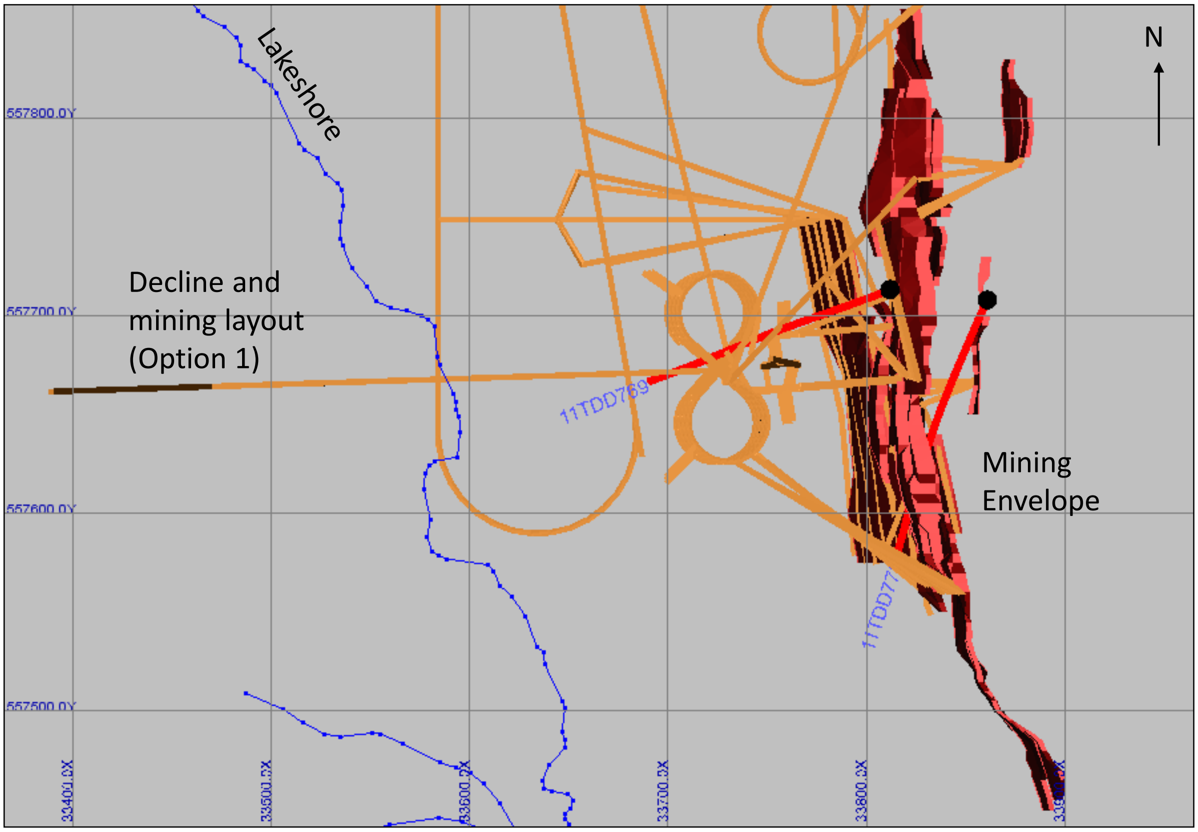


Figure 5.2: 2011 Geotechnical Drilling at Doris Central with Stage 2 Mining Envelopes (November 2010) and Infrastructure

5.2 Hydrogeological Data Sources

Hydrogeological data for the Doris area exist from the 2004, 2008, 2010, and 2011 drill programs. Hydraulic data are available from a total of 11 test holes within the Doris Central deposit and from one hole within the Doris Connector area. Additionally four holes with thermal data were completed within the Doris North deposit and can be used to extrapolate thermal characteristics of the permafrost boundary surrounding Doris Lake. Data from the various programs include single-well injection tests, a multi-well longterm injection test, thermistors, pressure transducers, Westbay monitoring port profiles, and Westbay water samples. The following sections summarize data collected during each field season.

5.2.1 Historical Data

No hydrogeological data exist for the Doris Central deposit prior to the 2008 field program. However, thermistor data are available from two test holes completed in 2004 near Doris North. SRK 50 is complete along the southern extent of the Doris North deposit and targeted deep permafrost. SRK 35 is located to the west of the Doris North deposit beside Doris Creek and was installed to monitor shallow permafrost. Data for the two wells have been collected since 2004.

5.2.2 SRK 2008 Drilling Program

During the 2008 field program, SRK completed hydraulic testing in four test holes within the Doris Central area. An additional two drill holes were completed in the Doris North deposit, which gave valuable information on the talik-permafrost boundary. Table 5.1 summarizes direct hydrogeological and thermal data available from the 2008 field program.

Table 5.3: Hydrogeological and Thermal Data from 2008 Field Program

HBML Drillhole ID	Deposit	Target	Number of Packer Tests	Thermistor/Pressure Transducer	Water Sample
08TDD628	Doris Central	Talik	1	No	No
08TDD630	Doris Central	Talik	5	No	Yes
08TDD631	Doris Central	Talik	2	No	No
08TDD633	Doris Central	Talik	4	No – instrument failed, unknown cause	No
08TDD632	Doris North	Deep Permafrost	4	Yes	No
08TDD634	Doris North	Pit shell	1	No	No

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\field_data_summary_1CH008.054_101811_jm_rev01.xlsx

5.2.3 SRK 2010–2011 Westbay Program

Westbay multi-point monitoring wells were installed in the bore holes at Doris Central (10WBW001), Doris North (10WBW002), and Boston (10WBW004). Installation details are available in Hope Bay 2010 Westbay Program Data Report (SRK 2011). During the drilling at each location, packer testing was conducted along the hole profile to collect hydraulic conductivity data. The hole at Patch14 (proposed 10WBW003) was not completed with a Westbay well in 2010 due to the low hydraulic conductivities encountered during packer testing, which would make water sampling not feasible. During 2011, the Patch14 Westbay was considered once again but no suitable location was found.

The Westbay sampling events that have occurred since installation are outlined in Table 5.4. The most recent sampling occurred in September 2011 but lab results are not yet available. The Doris Central site is in a talik and permits sampling in shallow, moderate, and deep water within the talik boundaries. The Doris North samples are from below permafrost, while Boston samples are collected from below the lake in talik. Water quality details from this program are outlined in Section 8.5. The zones used in each Westbay installation underwent purging and sampling appropriate to their location; details are provided in the Westbay report (SRK 2011).

Table 5.4: Westbay Well Sampling Events

		Dates of Sampling by Location					
Westbay Site		**July 2010**	**August 2010**	**Oct/Nov 2010**	**April 2011**	**June 2011**	**September 2011**
Doris Central	10WBW001	x	x	x	x		x
Doris North	10WBW002	x		x	x	x	x
Boston	10WBW004			x	x	x	x

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Hydrogeo Tables

5.2.4 SRK and HBML 2011 Drilling Programs

The drilling and hydrogeological program was conducted in 2011 as part of the ice drilling season to ensure adequate data were collected for Stage 2 of the Doris deposit. An SRK hydrogeologist was onsite from mid-February to mid-May conducting packer tests in the Doris and Patch14 deposits. By the end of the program, 29 tests had been conducted in Doris, primarily in the talik below Doris Lake, as outlined in Table 5.5.

The program had two components: one was to opportunistically packer test on exploration holes, while the other was to test in geotechnical and hydrogeological specific holes. As previous work did not provide much information on shallow lithology, shallow tests were identified as a high priority. Special attention was also paid to alteration zones, in both Doris and Patch14, and any major structures. More intensive testing was conducted across an unmapped structure in Doris Central. Details of this long-term test are found in Section 8.3.

Table 5.5: Hydrogeological Data from 2011 Field Program

HBML Drillhole ID	Deposit	Single Injection Test	Longterm Injection Test
11TDD763	Doris Central	1	No
11TDD764	Upper Doris Connector	2	No
11TDD766	Doris Central	3	No
11TDD768	Doris Central	6	No
11TDD769	Doris Central	6	Yes
11TDD771	Doris Central	6	No
11TDD772	Doris Central	5	No

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\field_data_summary_1CH008.054_101811_jm_rev01.xlsx

6 Doris Wireframe Models

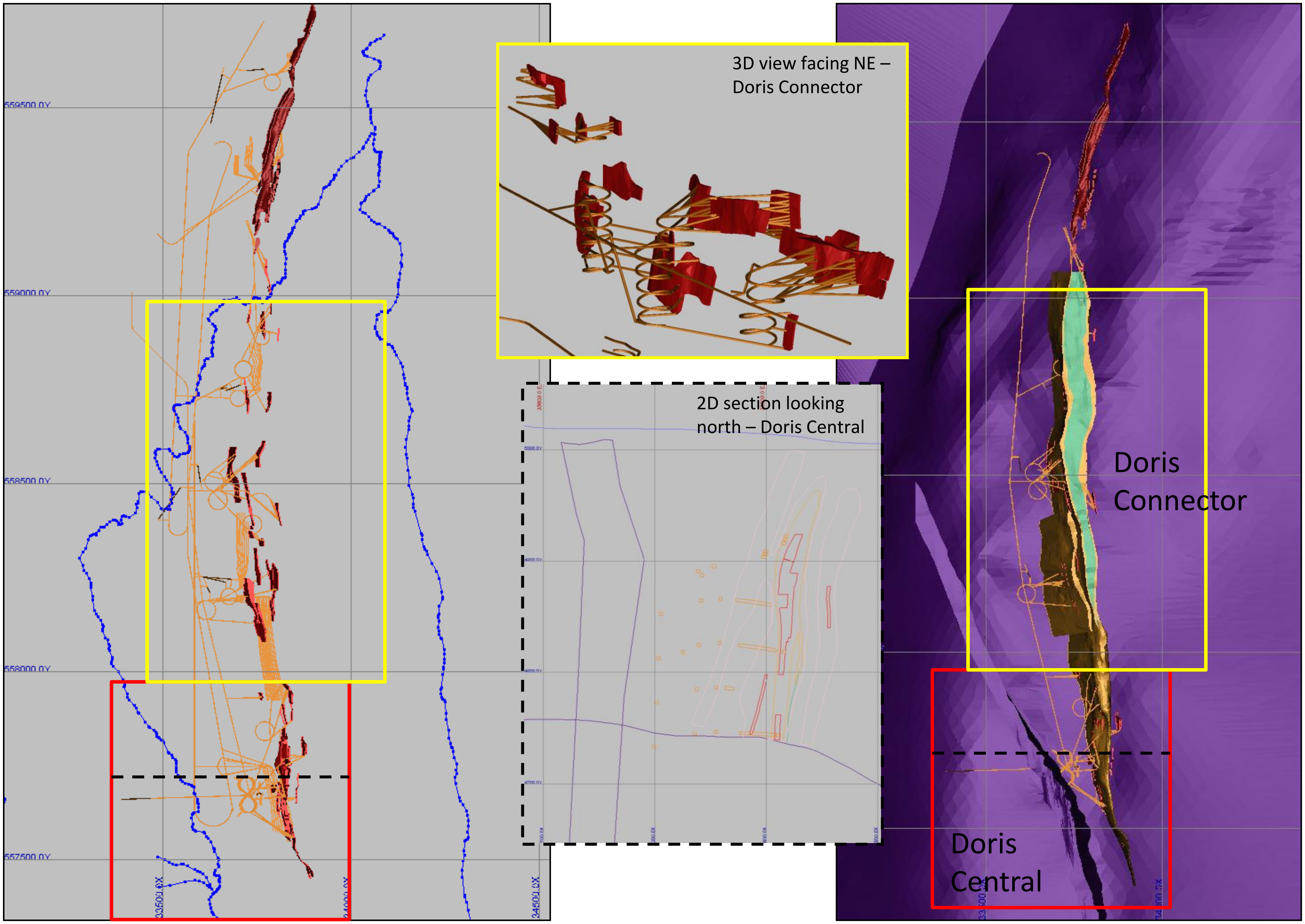
HBML provided an updated geological wireframe model for the Doris area in September 2010, Stage 2 mining envelopes in November 2010, and an updated preliminary structural model in April 2011. A complete list of wireframes referenced in this document is provided in Table 6.1. A copy of each wireframe in digital format (.dxf) is provided in Appendix B.3.

Table 6.1: Wireframes Used for Current Study

Wireframe Type	Doris Area	SRK Name	Description	Date Received
Lithological Wireframes	Connector/ Central	DCenConn_MajAlter	Major alteration envelope	Sep-10
	Connector/ Central	C-Type_Dsouth	C-Type Basalts	Sep-10
	Connector/ Central	C-Type_Dsouth1	C-Type Basalts	Sep-10
	Connector/ Central	VeinWest_Dsouth	Modelled west vein wireframe (south of Doris North)	Sep-10
	Connector/ Central	VeinMain_Dsouth	Modelled main vein wireframe (south of Doris North)	Sep-10
	Connector/ Central	Diabase_Vertical	Steeply dipping diabase striking N-S	Sep-10
	Connector/ Central	Diabase_Solid	Shallow dipping diabase striking ESE	Nov-10
Structural Wireframes	North	P1P2P3	See Section 7 for details	Apr-11
	North	North	See Section 7 for details	Apr-11
	Connector/ Central	Shear1	See Section 7 for details	Apr-11
	Connector/ Central	Shear2	See Section 7 for details	Apr-11
	Central	C3P0	See Section 7 for details	Apr-11
	Connector/North	Ewok	See Section 7 for details	Apr-11
	Connector/ Central	Force1	See Section 7 for details	Apr-11
	Connector	TK421	See Section 7 for details	Apr-11
	Central	NW-06-SRK-FLT	See Section 7 for details	Sep-08
	Central	NW-Flt-04	See Section 7 for details	Sep-08
Underground Wireframes	Connector/ Central	Stopes_DC+Conn	Stage 2 mining solids	Nov-10
	Connector/ Central	Infrastructure_Opt1	Mine infrastructure	Nov-10

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables\Table 6.1_Wireframes .xlsx

The Doris Connector and Central geological wireframes are presented in Figure 6.1. SRK understands that these models are still in a development stage and are the product of a combination of outcrop (limited), drill core, and photograph reviews. Refer to Section 7 for a description of the individual lithological units.



srk consulting

NEWMONT NORTH AMERICA

Geotechnical Assessment
Doris Central and Connector

Doris Connector & Central Wireframe Models

Job No:	1CH008.054	Hope Bay Gold Project	Date: Oct-2011	Approved: RG	Figure: 6.1

7 Structural Review

7.1 Doris Structural Geology Understanding

Gold mineralization at Doris is principally hosted within a quartz vein that has an antiformal shape, with the Central and Lakeshore veins forming the two fold limbs and the Hinge vein forming the fold closure.

Auriferous quartz veins at Doris are hosted by massive and pillowed metabasalt folded around a central coarse gabbroic metavolcanic. All basaltic and gabbroic rocks have been affected by a penetrative foliation (foliation trends typically north-south and dips steeply west); this foliation forms a chlorite schist.

A series of quartz veins associated with an intense deformation zone (well foliated and altered zone) occurs west of the Doris antiform and form the West Valley veins. These veins and associated deformation zones dip steeply west and strike north-south. The quartz veins and the strongly developed schistose zones associated with them may cause stability problems in the underground developments. Strain patterns are not well constrained on the east side of Doris as few boreholes penetrate that area.

Gold mineralization and associated quartz veins at Doris are crosscut by a series of west-northwest-trending (trending ~130°) faults. In 2008, three distinct faults were interpreted in the area by HBML: the Lakeshore Fault, the Glacier Fault, and the Valley Fault. The faults were recognized in outcrop as distinct brittle breaks, which have been preferentially weathered. These faults do not offset or crosscut diabase dikes in the area.

A large diabase dike complex crosscuts the gold mineralization at Doris. This dike system strikes north-northeast and can dip both steeply and shallowly to the east. A number of diabase dikes belonging to this system were intersected during drilling.

7.2 Desktop Review of 2011 Structural Model

The key structural features at Doris as presented in 2008 and the new or modified features since modelled by HBML are summarized in Table 7.1. Additions or modifications to the structural model are highlighted in red font. An overview and a discussion of each structural feature, subdivided by category, are provided below.

7.3 Deformation and Mineralized Zones

The penetrative S_2 foliation at Doris is characterized by the alignment of chlorite, sericite, quartz, and carbonate. This alignment is present in all lithologies except the diabase dikes. The S_2 foliation observed in outcrop has an orientation of 175º–205º with a vertical to 80º dip to the west. Sericitic alteration creates smooth break surfaces planar to undulating.

The main quartz vein hinge zone has an antiformal shape that is doubly plunging: in Doris North it plunges 10° north, whereas in Doris Central it plunges 25° south. Similar to the West Valley Wall, the quartz veining appears to be associated with a zone of high strain a few metres wide. The West Valley Wall deformation zone located west of the main deformation zone is defined by iron-carbonate alteration and discontinuous sub-vertical quartz veins, with penetrative foliation development in a high strain zone. The West Valley Wall deformation zone was not modelled in 3-D and could potentially intersect the underground access ramps to the main mineralized zone at Doris.

7.4 Brittle Faults and Shears

Field evidence suggests that two sets of sub-vertical dipping brittle faults transect all rock types other than the younger diabase at Doris. The general strike of these faults is northwest and northeast, while the dip generally is poorly constrained. In 2008, SRK interpreted a series of these faults based on a detailed ground magnetic survey.

In drill core, all late faults at Doris typically are marked by rubble zones associated with sericitic alteration, slickensides, brecciation, and clay gouge. Most of the drilling at Doris is oriented in an east-west direction at a low angle to the faults, resulting in an unfavourable geometry to penetrate the faults with the drill holes. As such, very few of these fault sets, which don’t outcrop, have been identified and modelled.

The Lakeshore Fault (labelled as Fault tk421 in the new model) located at the southern end of Doris North offsets the main Doris quartz vein and separates the Doris North and Connector zones. It is considered the most prominent known fault within the Doris deposit. This fault was observed on surface as approximately one metre wide, striking 130° and dipping steeply. The new HBML-modelled fault strikes at 155° and also dips steeply. In outcrop, the Lakeshore Fault offsets the Lakeshore Vein and West Valley Wall deformation zones with a sinistral separation of approximately 7–10 m. The true slip length and direction associated with movement along the Lakeshore Fault is unknown.

In 2008, HBML and SRK modelled a series of lower confidence faults, representing structures seen in geophysics and drill core. These structures included the northwest-trending Valley, Glacier, and SRK-NW-02 faults, as well as the southwest-trending NE-1, SRK-SW-01, SRK-SW-02, and SRK-NW-06 faults. Other faults from these two sets were also identified in geophysics in the Doris Connector and Central areas but not modelled in 3-D due to limited surface and drilling information.

In the most current HBML structural model, five faults in addition to the tk421 (Lakeshore) Fault were identified by the displacement of gold mineralization and drill core fault intervals. At Doris North, north-northwest trending faults were modelled. These faults include the North Fault (potentially the previously modelled Valley Fault), which strikes at 345° and dips steeply between 86° and 90°, and the closely spaced P1P2P3 Fault set (potentially the previously modelled Glacier Fault), which strikes at 170° and dips between 65° and 90° to the southwest. These faults are interpreted to be the youngest structures. The confidence level of the presence of these faults is now high due to a good correlation with drilling data.

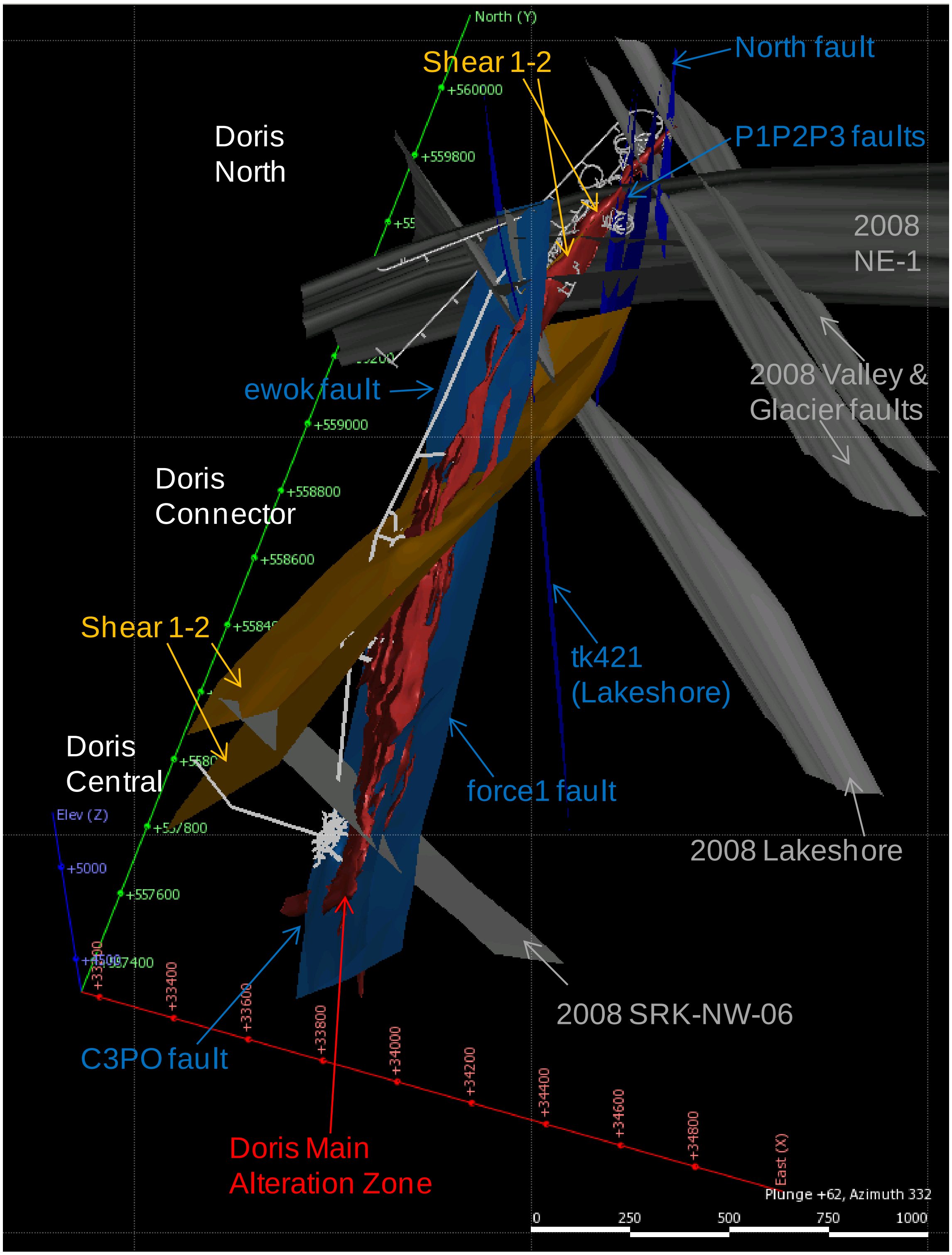


Figure 7.1: Interpreted Faults and Shears in the Doris Deposit

Grey: previous faults; Blue: new or modified faults; Orange: new shears; Red: main alteration zone containing Doris veins; White: planned underground developments

In the area between Doris Connector and Central, HBML has currently modelled three later faults trending north-northwest and dipping west. The Ewok, Force1, and C3PO Faults are sub-parallel to the S_2 foliation and crosscut the main alteration zone without displacing it. These faults are believed to pre-date the mineralization as they displace the B and C tholeiitic basalts in a normal fault relationship.

Four shear zones have been modelled by HBML since the previous SRK 2008 structural review. Two are situated in the Doris North area (Shear1 and Shear2) and another two in the Doris Connector area (Shear1 and Shear2). While not readily apparent in drill core, these shears were modelled by HBML as offsetting the gold mineralization. They are considered late shears that parallel to sub-parallel the dominant foliation.

7.5 Water Producing Structures

During the 2010 geotechnical and hydrogeological drilling programs, many water producing structures were encountered below Doris Lake without known or modelled wireframes. It was noted by onsite geologists that this phenomenon occurred when multiple drills were operating in very close proximity to each other. Nevertheless, this finding indicates that structures are present with high enough permeability to allow for flow to exist.

Close examination of the water-producing intersections suggests they are not located along a single feature, but rather are associated with more than one structure (Figure 7.2). In the Doris Central / Connector area, west of the planned excavations, the flow points appear to follow the orientation of either the steeply dipping diabase dikes or potentially a non-modelled north-northwest striking fault sub-parallel to a north-northwest striking diabase dyke that has not been modelled. In the area between Doris North and Connector, east and below the currently planned excavations, the flow points fall near the steeply dipping tk421 (Lakeshore) Fault. A detailed look at drill core and further modelling of the structures are required.

Table 7.1. List of Structures in the Doris Deposit. Red Information Indicates Additions or Modifications in Stage 2 Structural Model by Hope Bay Mining Ltd.

Deposit	Name	2008 SRK Structure	2008 HBML Structure	2011 HBML Structure	Interpreted by	Orientation		Description	Confidence			Comments
						Strike	Dip		Good	Medium	Low	
Doris	Penetrative S2 Foliation				SRK	175-205	80-90	Penetrative foliation present within all lithologies other than the diabase dikes, defined by the alignment of chlorite, sericite, quartz and carbonate minerals.	◆			Primary cause of mechanical breaks. Planar to undulating surfaces. Smooth surfaces from sericitic alteration would be classified 5 or 8 under Laubscher's roughness scale. Zones of high strain can have apparent high RQD if fabric breaks are marked as mechanical.
Doris	Doris mineralization and fold hinge				HBML	175-200	80-90	Highly strained contact with gold mineralized quartz veins.	◆	□		Parallel to foliation. Variable thickness in the order of 0–10 m on either side of vein. Quartz veins are strong and competent. Iron carbonate or sericite alteration and deformation at contact.
Doris	West Valley Wall Deformation Zone				SRK	180-200	70-90	High strain zone located on western side of Doris North deposit. Penetrative foliation associated with iron carbonate alteration and discontinuous sub-vertical quartz veins less than 0.5m thick.		◆		Limited drill hole information of extent. Limited drilling of pit walls. Alteration plane easily cleaved in areas of highest strain. RQD between 30-70 %. FF/m ~10.
Doris North	Valley		NW-1	North	HBML	314 345	74 86-90	North portion of Doris North deposit.			◆	Loosely defined in drilling by HBML. 95TDD058 not logged by SRK. Poorly constrained. Modelled fault re-oriented to striking 165–345 and steeply dipping. Based on fault intercepts in core and end of mineralization.
Doris North	Glacier	Fault-NW-01	NW-2	P1P2P3	HBML	314 170	70 65-90	North portion of Doris North deposit. Geophysically represented by SRK fault NW-01.		◆	□	Doris fold hinge offset by fault. Poorly constrained in drill core. Modelled fault set (three fault planes) re-oriented to striking 170 and dipping 65 to the west to steeply dipping. Faults displace mineralization. Partially based on fault intercepts in core.
Doris North				Shear1	HBML	201	60-65	Centre of Doris North. Sub-parallel to S2 foliation.		□	□	Modelled based on offset of mineralization.
Doris North				Shear2	HBML	203	90	Centre of Doris North. Parallel to S2 foliation.		□	□	Modelled based on offset of mineralization.
Doris North		Fault-NW-02			SRK	330	70	Southeast side of Doris North pit. Edge of pit wall. Dip orientation of fault is poorly constrained.		□	◆	Defined in geophysics. Limited constraints in drilling. Fault does not outcrop though appears to slightly offset the local stratigraphy; Observed in drill hole 95TDD035 with two small faults logged: small clay gouge oblique to foliation at 51.3 m down-hole; and clay gouge at 136.5 m down-hole depth. Poorly constrained spatially.
Doris North	Lakeshore	Fault-NW-03	NW-3	tk421	HBML	310 155	70 85-90	Southern end of Doris North underground. Crosscutting access ramps. Mapped by Carpenter et al. (2003).	◆	□	□	Defined in outcrop. 1m width. Sub-vertical. Sinistral separation of Lakeshore vein and West Valley Wall deformation zones by approximately 7–10 m on surface. True slip length and direction unknown. Dip and SE extent poorly constrained in drill core. Modelled fault re-oriented to striking 155-335 and steeply dipping. Partially based on fault intercepts in core.
Doris North			NE-1		HBML	055-235	~90	Central portion of Doris North pit. Modelled as dipping N on SW side and changing to S on NE side.	□	□	◆	Loosely defined in drilling by HBML. Not observed in geophysics or mapped in outcrop. Not physically observed in drill core by SRK. DDH TDD245 shows a fault logged at 16.9–16.91 m, 0.5 m wide with possible gouge at top of fault. Poorly constrained.
Doris North		Fault-SW-01			SRK	254	65	Central portion of Doris North pit. Dip orientation of fault is poorly constrained.		□	◆	Defined in geophysics. No outcrop in vicinity of fault. Not physically observed in drill holes. Reviewed DDH 95TDD049A between 0–94 m depth and observed no significant faulting. This suggests the fault may dip to the northwest. Poorly constrained.
Doris North		Fault-SW-02			SRK	245	85	Central portion of Doris North pit. Dip orientation of fault is poorly constrained.		□	◆	Defined in geophysics. Limited drill hole data. No outcrop in vicinity of fault. Possibly observed in DDH TDD203 with rubble zone at 44 m depth, approximately 0.5 m width down-hole, sericitic alteration along brecciated fragments. Similar to smaller SW-NE trending features seen in outcrop.

Deposit	Name	2008 SRK Structure	2008 HBML Structure	2011 HBML Structure	Interpreted by	Orientation		Description	Confidence			Comments
						Strike	Dip		Good	Medium	Low	
Doris Connector				Shear1	HBML	200	55	Doris Connector. Sub-parallel to S2 foliation.		□	□	Modelled based on offset of mineralization.
Doris Connector				Shear2	HBML	200	50	Doris Connector. Sub-parallel to S2 foliation.		□	□	Modelled based on offset of mineralization.
Doris		Fault-SW-03			SRK	045-225	?	Between Doris North and Central.		□	◆	Defined in geophysics. Limited drill hole data. SRK observed a small fault with 3 cm of gouge and 10 cm of rubble at 120.8 m depth of DDH TDD300 could be from this fault but could also be from SRK Fault-NW-04.
Doris		Fault-NW-04			SRK	124-304	?	Between Doris North and Central.		□	◆	Defined in geophysics. Poorly constrained. No faults logged in drill hole TDD304 indicates fault may be slightly more to the south.
Doris Connector				Ewok	HBML	175	44	Doris Connector. Sub-parallel to S2 foliation.		□	□	Modelled by HBML as old pre-mineralization fault based on drilling intercepts. Crosscuts, but does not displace, alteration and mineralized zones. Does however displace the lithological contact of B and C tholeiites in a normal fault relationship.
Doris Connector & Central				Force1	HBML	172	48	From Doris Connector to Doris Central. Sub-parallel to S2 foliation.		□	□	Modelled by HBML as old pre-mineralization fault based on drilling intercepts. Crosscuts, but does not displace, alteration and mineralized zones. Does however displace the lithological contact of B and C tholeiites in a normal fault relationship.
Doris Central				C3PO	HBML	173	61	Doris Central. Sub-parallel to S2 foliation.		□	□	Modelled by HBML as old pre-mineralization fault based on drilling intercepts. Crosscuts, but does not displace, alteration and mineralized zones. Does however displace the lithological contact of B and C tholeiites in a normal fault relationship.
Doris Central		Fault-SW-09			SRK	060-240	?	Across undergound mine plan of Doris Central.		□	◆	Defined in geophysics. No outcrop in vicinity of fault. Limited drill hole data. Possibly observed in drill hole TDD408 with two possible fault zones: 52.5–56.5 m depth contains two small distinct rubble zones with slickenlines and areas of brecciation; 174–178 m depth contains rubble zone with smooth and undulating surfaces. Breaks parallel to foliation. Poorly constrained spatially.
Doris Central		Fault-NW-06			SRK	300	60	North of undergound mine plan of Doris Central. Dip orientation of fault is poorly constrained.		□	◆	Defined in geophysics. No outcrop in vicinity of fault. Elevation of mineralization changes drastically in litho model. DDH 08TDD630 has two possible fault zones: 20 cm rubble zone at 24 m depth with minor clay gouge and slickenlines; and rubble zones 43.5–49 m depth are considered mechanically induced near quartz-carbonate veins. Poorly constrained spatially.
Doris		Diabase-A		Diabase1	HBML	010	25-33	Intercepts bottom of Doris Central mine plan. RQD generally > 90%. Low FF/m	◆			Defined in outcrop, geophysics and drill core. 08TDD623.
Doris Central	Diabase-B		NW-4		HBML	162-342	90	Intercepts Doris Central mine plan & Diabase A. RQD generally > 90%. Low FF/m	◆			Defined in geophysics and drill core. 08TDD623.

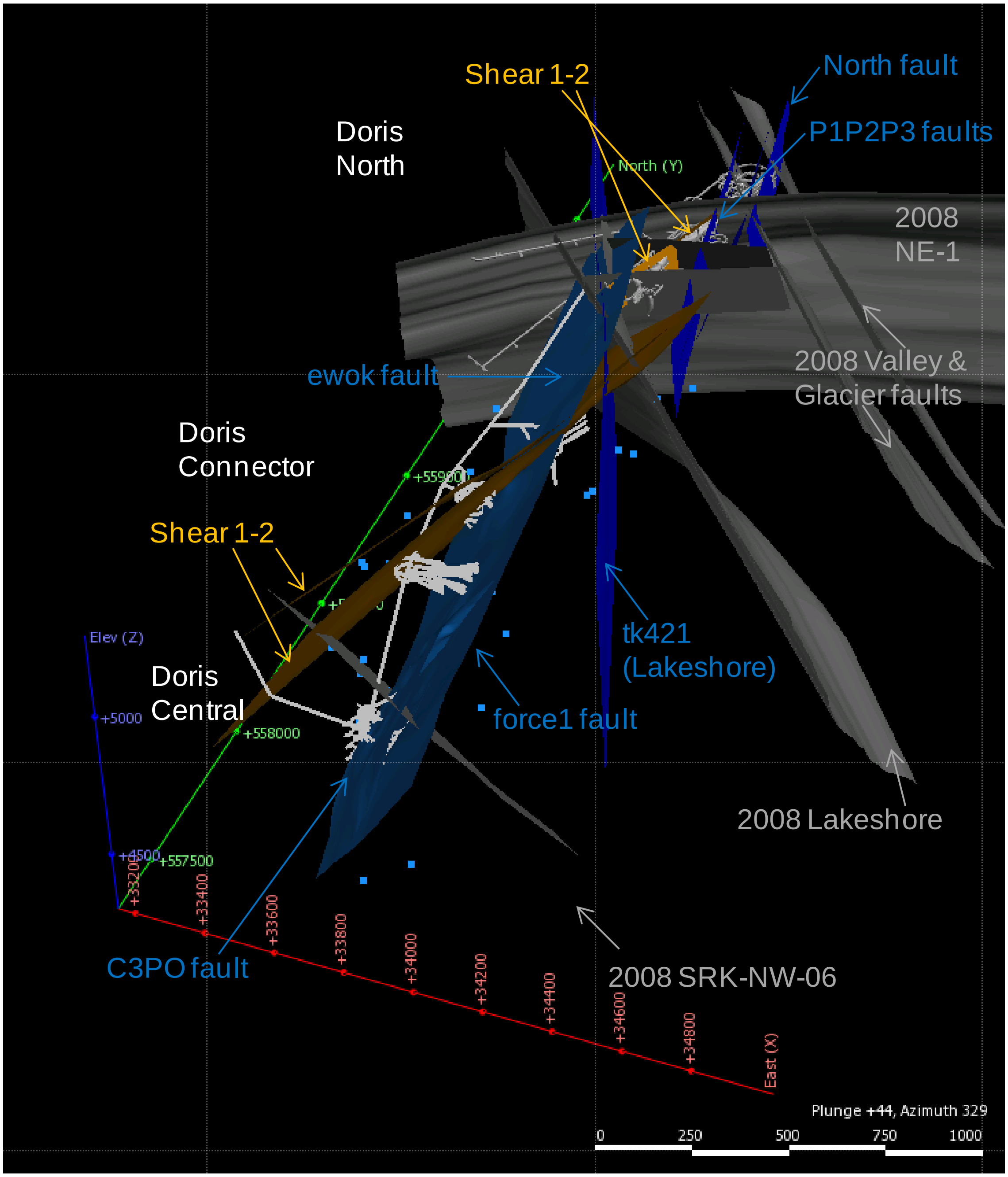


Figure 7.2: Water-producing Features in relation to Current and Previous Structural Models of Doris Deposit

Light blue points: Water-producing features intersected in drilling; Grey: previous faults; Blue: new or modified faults; Orange: new shears; White: planned underground developments

7.6 Discussion and Recommendations

The new structural geology model produced by HBML is, in many respects, an improvement to the previous model available during the Stage 1 study in 2008. It takes into greater account the faults logged in drill core and the displacement of lithological contacts such as the main Doris quartz vein and the different tholeiitic basalts. However, it fails to expand on the previously interpreted structures in the geophysical data and drill core in 2008.

Understandably, most of the drilling at Doris is oriented in an east-west direction at a low angle to the faults resulting in an unfavourable geometry to intersect the faults observed in geophysics and in outcrop, particularly those striking east-northeast. As such, most of the faults are interpreted as nearly perpendicular to the drilling fences or sub-parallel to the foliation. This is also evident in the re-alignment of the Lakeshore Fault by 25° to the south, which slightly contradicts what is observed in outcrop and geophysics.

The structural review on available data for the Doris deposit suggests the potential presence of additional northwest- and northeast-trending structures crosscutting the deposit area. It is recommended that the planned geotechnical drilling assess these interpreted structures to better define the associated potential geotechnical and hydrogeological risks. At present, most of the planned HBML and SRK drill holes are oriented in the same east-west plane making the identification of these faults more difficult.

8 Permafrost and Hydrogeology Conditions

Hydrogeological conditions, including the presence or absence of permafrost, were assessed to update estimates of inflow rates and quality, as well as any requirements for inflow mitigation measures. The initial hydrogeological conceptual model, constructed by SRK as part of the 2008 combined geotechnical/hydrogeological Stage 2 report, considered the groundwater system to be a low-flux, lake-dominated flow system. Permafrost was assumed to act as an impermeable layer restricting recharge, discharge, and movement of groundwater, effectively creating a confining layer over the lower groundwater system. Thermal data indicated that permafrost may extend to depths in excess of 500 m. However, connections to the lower groundwater system were found to occur within taliks situated beneath larger lakes. Hydraulic gradients were assumed to be controlled by the elevation of these lakes, resulting in a regional groundwater flow direction oriented south to north. Hydraulic conductivity was assumed to be generally low (10^{-8} m/s), with relatively higher values in shallow rock. Permeability testing on geological structures did not reveal specific concerns, but the presence of such structures was anticipated. Estimated groundwater inflows were considered relatively low.

During the 2010 and 2011 field programs, SRK conducted further investigations of the permafrost and hydrogeological conditions at the Doris Central and Connector deposits in order to update the initial hydrogeological conceptual model, inflow rates, inflow water quality, and pit water pressures. Specific focus was placed on geological structures and shallow bedrock. Testing methods included short duration packer injection tests to provide improved information on the spatial distribution of hydraulic conductivity and a long-term injection test to explore the connectivity characteristics of the fracture network and vertical hydraulic conductivity. Water samples were collected to assess groundwater quality. Finally, thermal and pore pressure analyses were conducted using data collected from the Doris North and Central.

Based on the updated hydrogeological conceptual model, 3-D numerical models were constructed in order to update the potential range of inflow rates based on varying underground mining arrangements. SRK considers that the conclusions presented in this report are sufficient for a Stage 2 study, as defined by HBML.

8.1 Data coverage

Data were collected at the Doris Central and Connector deposits over the 2004, 2008, 2010, and 2011 field programs. Data exist for eight drill holes within the Doris Central deposit and four holes within the Doris Connector deposit. Additionally, thermal data exist from four drill holes within the Doris North deposit. A summary of the locations of the boreholes is presented in Table 8.1 and Figure 8.1.

Table 8.1: Summary of the Drill Hole Locations with Hydrogeological Data

Area	Drill Hole	Date	Length (m)	Easting tUTM	Northing tUTM	Elevation tUTM	Azimuth	Dip
Doris Central	08TDD628	2008	141	33868	557746	5022	262.0	-61.3
	08TDD630	2008	317	33823	557652	5022	261.3	-67.0
	08TDD631	2008	122	33859	557605	5022	260.9	-81.4
	08TDD633	2008	401	33402	557646	5066	80.9	-55.4
	10WBW001	2010	564	33778	557537	5026	121.6	-65.2
	11TDD764	2011	341	33652	557804	5022	82.4	-56.2
	11TDD769	2011	310	33812	557713	5022	249.0	-65.1
	11TDD772	2011	330	33861	557708	5023	199.7	-65.1
Doris Connector	11TDD763	2011	285	33615	558178	5022	82.0	-51.8
	11TDD766	2011	297	33901	558910	5022	272.1	-60
	11TDD768	2011	299	33665	558760	5022	102.0	-59.8
	11TDD771	2011	294	33720	558380	5022	115.7	-78.0
Doris North (thermal)	SRK35	2004	10	34037	559479	5022	0	-90
	SRK50	2004	200	33807	559177	5038	0	-90
	08TDD632	0208	401	33915	559370	5031	276.2	-60.8
	10WBW002	2010	601	33913	559375	5030	277.6	-74.4

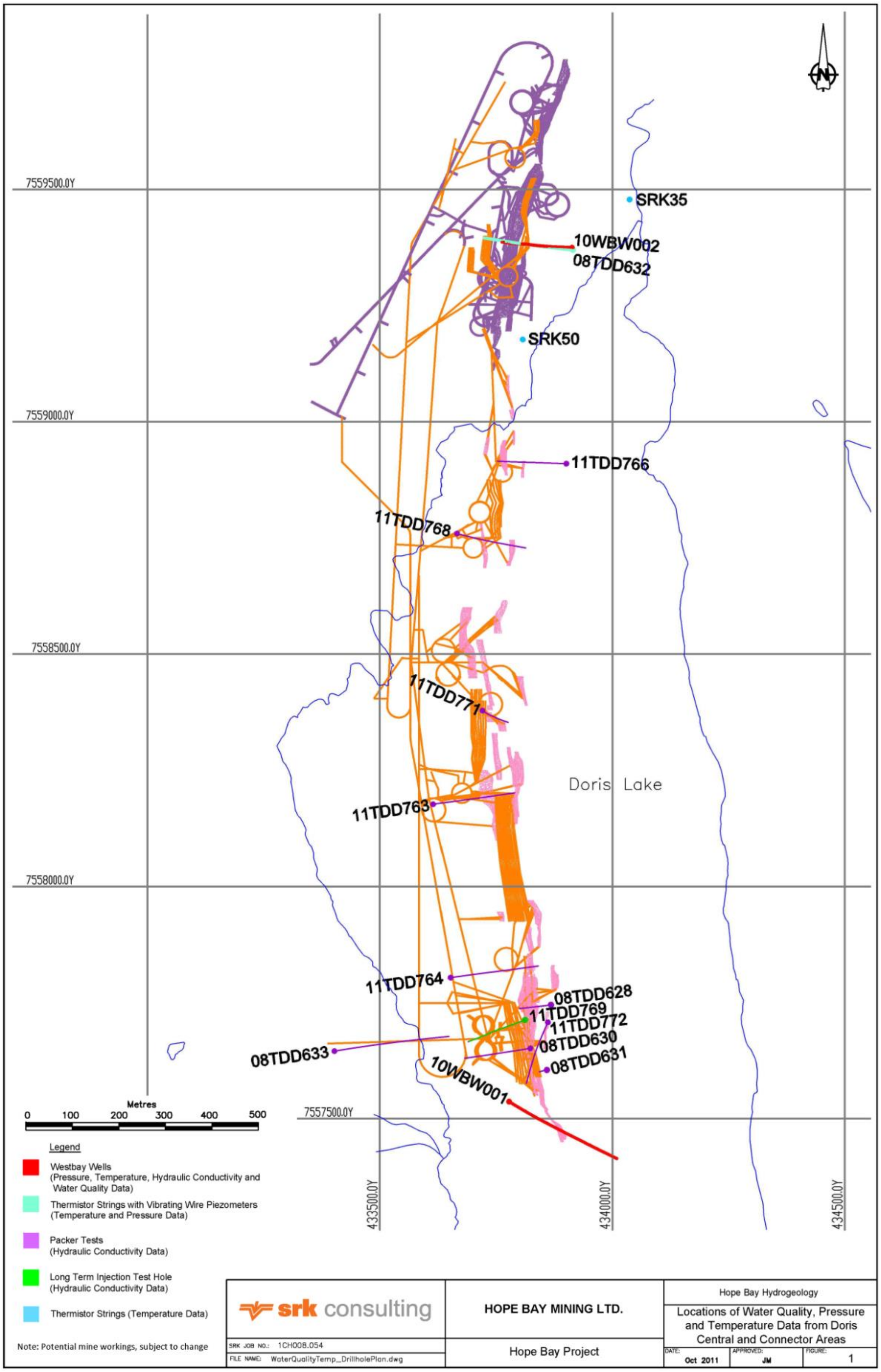


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Figure 8.1: Locations of Drill Holes with Hydrogeological Information

8.2 Permafrost

Thermal data for the Doris area are available from four locations and are listed in Table 8.1 with locations shown on Figure 8.1. Thermal data in the Doris Central/Connector areas are available from the Doris Central Westbay Well (10WBW001), which is located at the southern end of the proposed mining area. Two additional talik thermistor strings planned for the northern end of Doris Lake, in the vicinity of where the decline will enter the lake, were deferred to the 2012 program. A summary of all thermistor data for the Doris Corridor is provided in Appendix C.

Thermal data from 10WBW001 indicate that ground temperatures below Doris Lake, at least in the vicinity of 10WBW001, are consistently above 0°C and support the interpretation of an open talik below Doris Lake (Figure 8.2). Based on the locations of proposed mine workings, the majority of underground developments in the Doris Central and Connector deposits will be located within unfrozen ground associated with the Doris talik. Exceptions exist for the northern-most portions of the Doris Central and Doris North Connector declines, where frozen conditions are expected close to the Doris Lake shoreline.

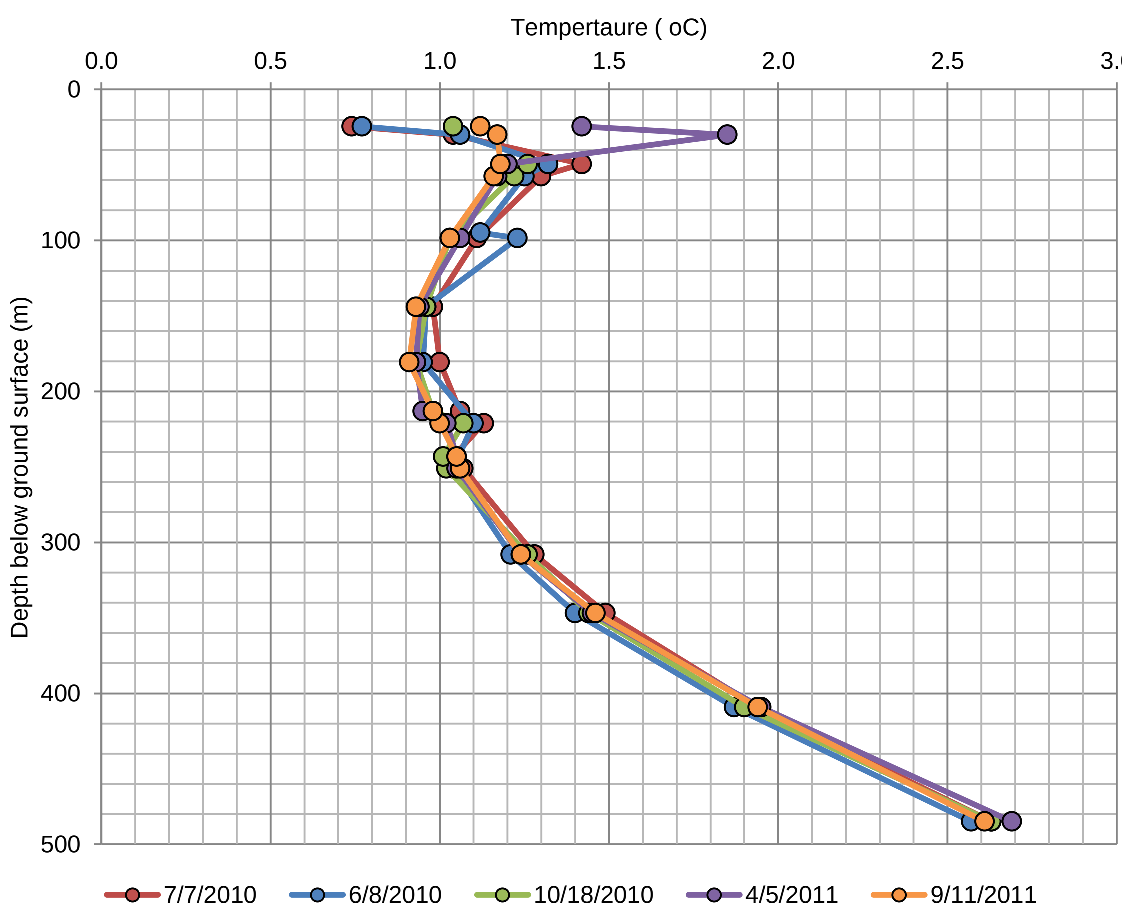

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Figure 8.2: Thermal Data from Measurement Ports in Westbay Well 10WBW001

Water quality data collected from the Doris Central Westbay well (10WBW001) indicate the presence of saline connate water. These data are generally comparable to water quality observed at Boston and can reasonably be assumed to be indicative of water quality that may be observed within the Doris Lake talik and below the base of permafrost. Based on measured concentrations of dominant parameters, saline water is considered to induce a freezing point depression. Table 8.2 summarizes calculated freezing point depression based on Doris Central water quality. These results suggest that water will freeze at a temperature of -2^{o}C, indicating the intersection with frozen ground in the decline areas may occur inland from the shoreline.

Table 8.2: Isotherm Depression Estimates based on Water Samples from 10WBW001

Sample Name		10WBW001 – Zone 1 (548 m)	10WBW001 – Zone 6 (246 m)	10WBW001 – Zone 10 (63 m)
Development Stage		Zone Volumes Developed = 29.1	Zone Volumes Developed = 48.3	Zone Volumes Developed = 11.6
Where Sample was taken from		**Upper Measurement Port**	**Upper Measurement Port**	**Upper Measurement Port**
Parameter	**Units**			
Alkalinity	mg/L	2	44.2	49.7
Calcium	mg/L	4960	749	1010
Magnesium	mg/L	69.5	702	849
Potassium	mg/L	39	117	160
Sodium	mg/L	7290	4130	5400
Chloride	mg/L	1900	9130	11500
Sulphate	mg/L	981	940	1160
Calculated Salinity	%	3.2	1.6	2.0
Calculated Theoretical Freezing Point	^{o}C	-1.9	-0.9	-1.2

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\freezing_point_depression_1CH008.054_101811_jm_rev01.xlsx

8.3 Hydraulic Conductivity

Hydraulic conductivity data are available from over 50 tests along the length of the Doris Central/Connector mining areas. Hydraulic testing included short duration packer injection tests (packer tests) and one longterm (about 12 hour) constant head injection test (injection test). Packer tests were completed in both geotechnical and exploration drill holes using HQ and NQ IPI SWiPS hydraulic packer equipment. Testing targets included different lithologies and structural features, as well as different depth ranges. The main objective of hydraulic testing was to allow refinement of the hydrogeological conceptual model, in terms of hydraulic conductivity distribution, for inflow estimates.

8.3.1 Short Duration Tests

Over 50 short duration (10–30 minute) packer injection tests (packer tests) were completed (Appendix D). Between May 2008 and May 2011, 42 packer tests were completed within the area of the Doris Central deposit and 14 were conducted within the Doris Connector deposit. Test zone depths varied between 11 m and 498 m below the overburden-bedrock contact or ground surface. Tests incorporated various geological units (i.e., mafic volcanics, alteration zones, diabase dykes, etc.) in order to characterize the spatial variability in hydraulic conductivity. It should be noted that the SWiPS packer testing system used by SRK is capable of testing to below 1 X 10^{-9} m/s, but data are considered less certain due to potential measurement errors associated with very low flow rates corresponding to hydraulic conductivity values of about 10^{10} m/s (i.e., small leaks in drill rods, metering accuracy, etc.). As a result, SRK recommends that hydraulic conductivity estimates below 1 X 10^{-9} m/s be considered as an upper limit and not as a precise value.

Hydraulic conductivity estimates from all packer tests conducted within the Doris talik revealed a geometric mean of 3 X 10^{-8} m/s, with a standard deviation of 5 X 10^{-7} m/s (Figure 8.3). A slight increase in the geometric mean was observed in shallow bedrock (<100 m)—6 X 10^{-8} m/s with a standard deviation of 5 X 10^{-7} m/s. This finding suggests that under non-frozen conditions higher inflow rates are more probable near the top of excavations.

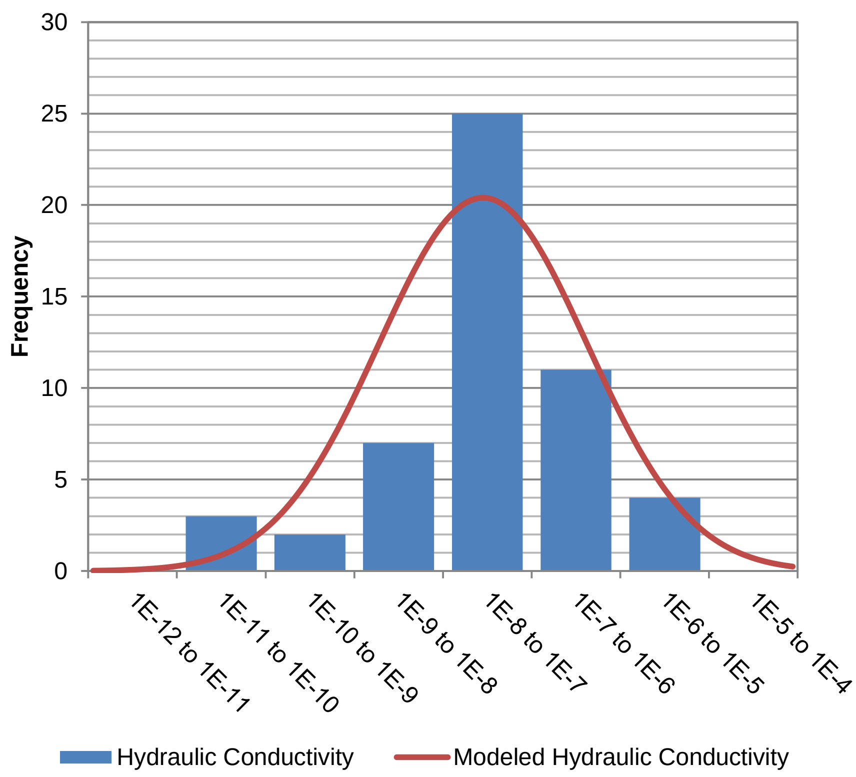

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Figure 8.3: Distribution of Hydraulic Conductivity and Modelled Log-normal Distribution

Statistical analysis of hydraulic conductivity versus depth indicated that a statistically significant, weak correlation exists between the two variables (regression coefficient = -0.42; decrease in hydraulic conductivity with increasing depth (Figure 8.4). Data were considered statistically significant in this study when the probability of an incorrect null hypothesis is less than five percent. The negative relationship is consistent with observations made in similar fractured rock aquifers and is attributed to increasing confining pressure at depth (Singhal and Gupta 2010). However, due to the weakness of the correlation, prediction of hydraulic conductivity based on depth alone is not recommended.

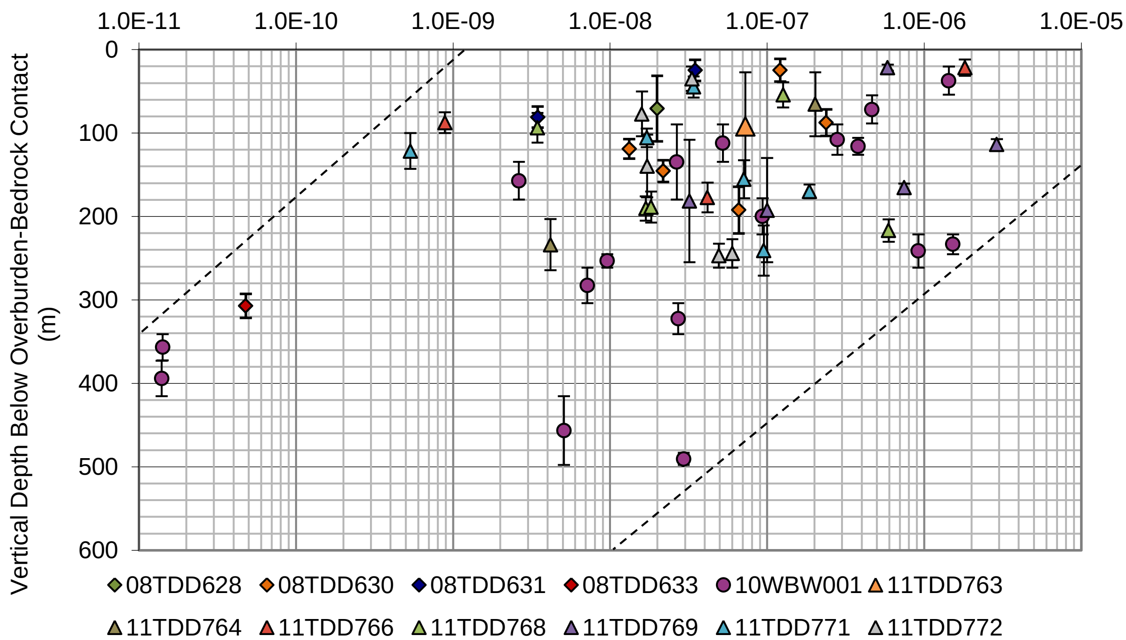

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Figure 8.4: Hydraulic Conductivity for Tests in Non-permafrost Conditions vs. Depth of the Packer Test Interval

Comparisons of the hydraulic conductivity versus fracture frequency indicated that a statistically significant, weak correlation exists between the two variables (regression coefficient = 0.33; higher fracture frequency correlates to higher hydraulic conductivity; Figure 8.5). This relationship is consistent with studies in other fracture rock aquifers, which have observed a weak relationship between the two variables (Singhal and Gupta 2010). However, the weakness of the correlation means that researchers are unable to use it to accurately predict hydraulic conductivity based on fracture spacing. This shortcoming is typically assumed to be the result of an inability to characterize the aperture (openness of fractures) and connectivity of the fracture sets, which are theoretically assumed to have a larger influence on the hydraulic conductivity than fracture spacing. Regardless, the weak relationship suggests an increased probability of encountering higher hydraulic conductivities within heavily fractured areas.

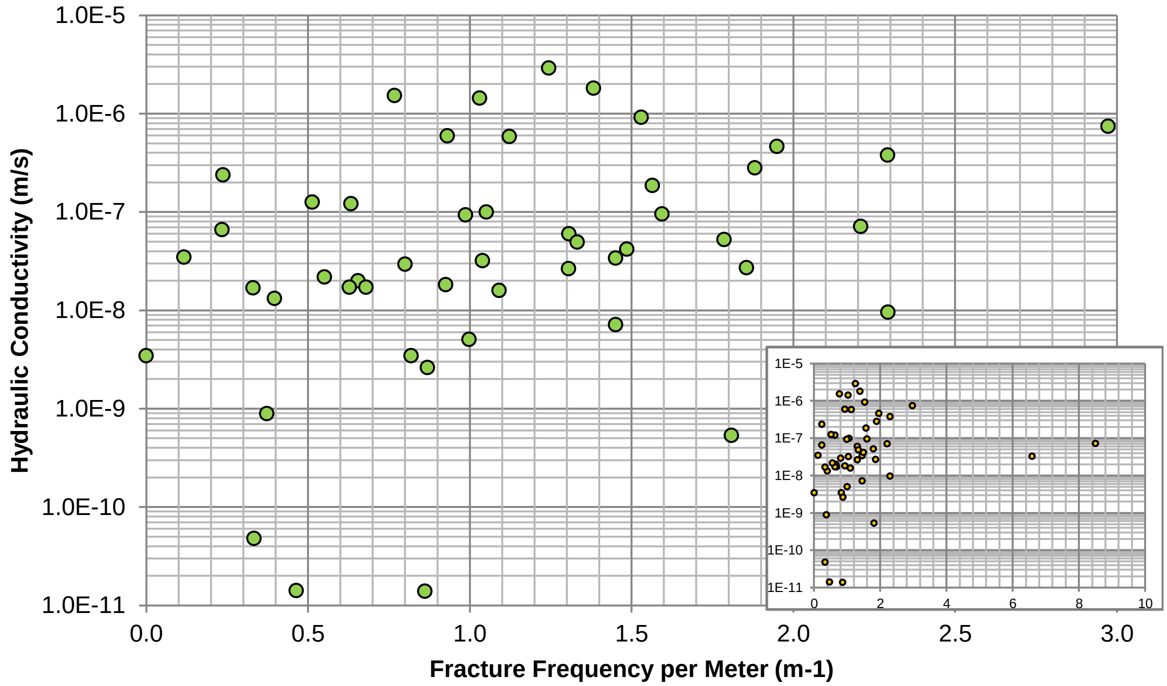

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Figure 8.5: Hydraulic Conductivity for Tests in Non-permafrost Conditions vs. Average Fracture Frequency

Note: Outliers 11TDD772 Test 1 and 11TDD763 Test 1 were removed from main plot. Inset map shows the location of outliers.

Many packer test zones targeted or included structural features. Structural features included a wide range of features, from gouge-filled fractures to rubble zones. Sixteen tests were considered to represent the influence of structural features and are listed in Table 8.3. Figure 8.6 shows hydraulic conductivity versus depth for these tests.

Table 8.3: Testing Zones Incorporating Structures

Drillhole	Test Interval (Depth along drill hole in meters)			Vertical Depth (m)	Hydraulic Conductivity	Test Zone Description
	Top	Bottom	Interval length	Test mid-point	(m/s)	
08TDD633	357.2	401	43.8	310.5	4.8E-11	Diabase/foliated basalt contact, mostly in diabase; RZ at 357 m along upper contact.
10WBW001	252	279	27	235.1	1.5E-06	Basalt, quartz and dolomite veins (2 m) with fractures (no recovery). Main ore body. Loss of pressure during drilling, artesian flow source, and also reach limit of injection rate.
10WBW001	252	297	45	243.0	9.2E-07	
10WBW001	279	297	18	255.0	9.6E-09	Basalt, a few rubble zones or small faults between the altered basalt zones.
10WBW001	297	345	48	284.2	7.2E-09	Altered foliated basalt, intermediate dyke with broken contact, unaltered basalt.
10WBW001	103	204.8	101.8	136.3	2.7E-08	Competent basalt, small shears possible including Force 1 Fault, foliation. Test result determined by subtracting result from test 6a from test 5.
11TDD769	30.4	38.2	7.8	31.6	5.9E-07	Mafic volcanic pillow (foliated basalt); major structure (20 cm) shear zone.
11TDD769	129.4	143.2	13.8	123.5	2.9E-06	Mafic volcanic pillow (foliated basalt); major joints with gouge present.
11TDD769	189.4	200.2	10.8	175.1	7.5E-07	Mafic volcanic pillow (foliated basalt); natural rubble zone present.
11TDD771	118.3	162	43.7	137.1	5.3E-10	Primarily quartz (discontinuous) with mafic volcanic pillow (153–162 m); small structure.
11TDD771	151.3	198	46.7	170.8	7.1E-08	Primarily volcanic pillow w quartz (ore zone, 166–171 m); structure at ore zone contact.
11TDD771	181.3	198	16.7	185.5	1.9E-07	Primarily quartz (discontinuous) with mafic volcanic pillow (181–186 m); structure at contact with ore.
11TDD772	55.3	87.2	31.9	64.6	3.3E-08	Mafic volcanic pillow with quartz (ore zone, 57–59 m); fault C3PO, NW6.
11TDD772	283.3	321.2	37.9	273.9	6.0E-08	Mafic volcanic pillow (foliated basalt) with quartz (ore zone); Force 1 Fault.
08TDD632	48.2	122	73.8	74.4	3.0E-10	Foliated Basalt.
08TDD632	174.2	245	70.8	183.3	1.4E-10	Foliated to Massive Basalt; diabase contact; structure 178.7–180.2 m; fault and gouge.

Source: V:\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\Doris_Central_PackerSummary_1CH008.054_101811_jm_rev01

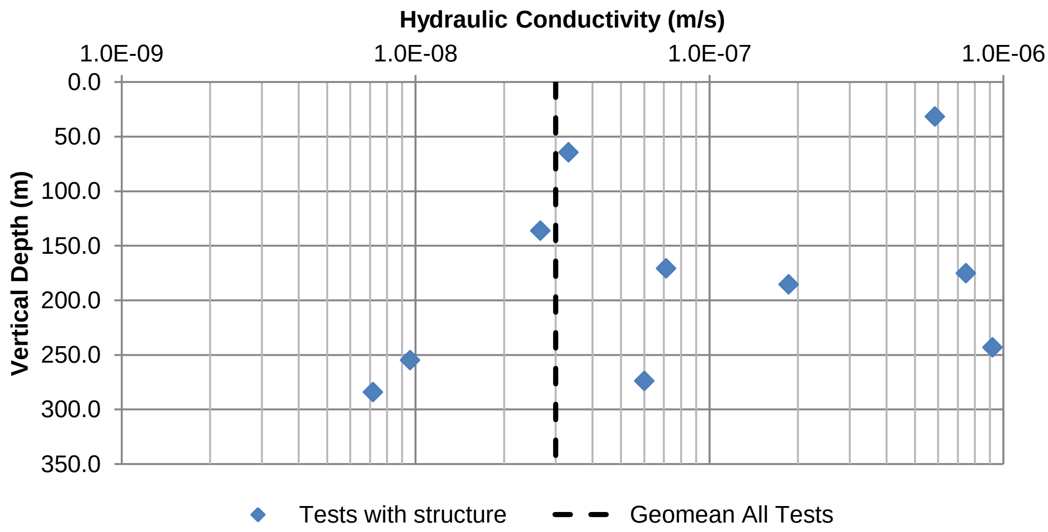

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Figure 8.6: Hydraulic Conductivity vs. Depth for Test Zones Incorporating Structures

Of the six tests that are notably above the geometric mean for all tests, all are from drill holes within the Doris Central area, with the exception of one—11TDD771—which is in the Doris Connector area and had a hydraulic conductivity value of about 2 X 10^{-7} m/s.

Two of the three highest conductivity values were recorded in testing from the 10WBW001 Zone 6 area and were tentatively interpreted to be an effect of the Force 1 Fault. Other structures included rubble zones, shears, and joints with gouge. The relatively high value from 11TDD771 was from a test zone incorporating a structure at the contact between mafic volcanics and veining or alteration.

The test data from these zones suggest that not all structures necessarily correlate to high hydraulic conductivity, but that it is likely. More than 50% of these test zones had hydraulic conductivity greater than the geometric mean of all data.

Doris Lake Sediment

During the 2008 overburden investigations, pressure dissipation tests were conducted in sediments lining the base of Doris Lake at three locations close to the northern end of Doris Lake as a component of the cone penetrometer (CPT) drilling method. These tests were conducted as part of earlier site investigations assessing alternate mine plan options (SRK 2009). Locations were not in the immediate vicinity of the proposed mine development, but within the general area.

Results of CPT pressure dissipation tests were interpreted for hydraulic conductivity using the method of Parez & Fauriel (1988):

$$k_h = \left(\frac{1}{251 \times t_{50}}\right)^{1.25}$$

Where,

k_h = horizontal hydraulic conductivity in cm/s
t_{50} = the time in seconds to reach 50% pressure dissipation recovery

Table 8.4 summarizes the results of the 2008 overburden investigation.

It should be noted that the t_{50} value is supposed to represent the time taken to reach 50% pressure recovery between the induced pressure increase and static, or equilibrated, pressure. In the case of low permeability sediments, the equilibrated pressure was often not achieved within the monitored recovery period. Therefore, the t_{50} value used is high and results can be considered conservative. As a consequence, the actual permeability would be lower than presented here.

Table 8.4: Doris Lake Sediment Hydraulic Conductivity

Drill Hole	Duration (s)	Test Depth (m)	Lithology	t50 (s)	Max t50 (s)	K (cm/s)	K (m/s)	t50 comment
SRKCPT08-06	2000	10	Clayey silt	250		1E-06	1E-08	good
SRKCPT08-06	700	11.95	Silty sand/sand		50	8E-06	8E-08	est. max.
SRKCPT08-07	2000	5	Sensitive fines	1200		1E-07	1E-09	min.
SRKCPT08-07	600	7.78	Silty sand/sand	100		3E-06	3E-08	good
SRKCPT08-08	1600	15	Sensitive fines	500		4E-07	4E-09	min.
SRKCPT08-08	3600	20.6	Silty sand/sand	800		2E-07	2E-09	min.

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables

8.3.2 Longterm Packer Injection Test Results

A 14-hour injection test was performed within drill hole 11TDD769 to better assess large-scale hydraulic conductivity, including vertical conductivity, and fracture connectivity. Within the test hole, the injection zone was isolated using a single packer, resulting in a test zone 152.0–290.2 m along the borehole, which correlated to the western limb of the Doris antiform. During injection, pressure responses were monitored at Zones 1–12 in the Doris Central Westbay (10WBW001), which is situated 180 m south of 11TDD769 and dips in the opposite direction (10WBW001 dips 62^o towards 118^o; 11TD769 dips 65^o towards 249^o). The drill hole locations are illustrated in Figure 8.1. Diagnostic plots are presented in Appendix E.

The results of the injection test were analyzed using both analytical and numerical modelling methods. Numerical modelling was completed using the Sandia National Laboratories software nPre version 2.41a (nSites). These results were compared with those obtained using the Cooper Jacob Method (Cooper and Jacob 1946).

Prior to modelling, the heterogeneity of the test zone was examined through the construction of a Cooper Jacob Method III plot (Figure 8.7). The test was conducted in bedrock where the groundwater was fracture-controlled. Use of the Cooper Jacob method, which is designed for porous media (e.g., sand), for test analysis is recognized to be a limitation of that method, but it provides useful insight into a large-scale hydraulic response that may dominate groundwater flows over large areas and long time periods. The assumption of equivalent porous media is required for many analyses, particularly or most numerical groundwater modelling software. Interestingly, despite the fact that the Doris groundwater system is fracture-controlled, the hydraulic response tended to show radial or spherical response in a relatively short amount of time during testing.

Within a homogenous and isotropic aquifer, the results should plot along the same trend line. Deviation of data from a common trend indicates heterogeneity and/or anisotropy within the aquifer. Based on this analysis, the Doris Central ore zone can be considered a vertically heterogeneous system. The results were then clustered based on spatial locations within the Cooper Jacob III plot and compared with cross sections generated from geological models in order to define hydrogeological units. Six units were defined through this analysis and are described in Table 8.5.

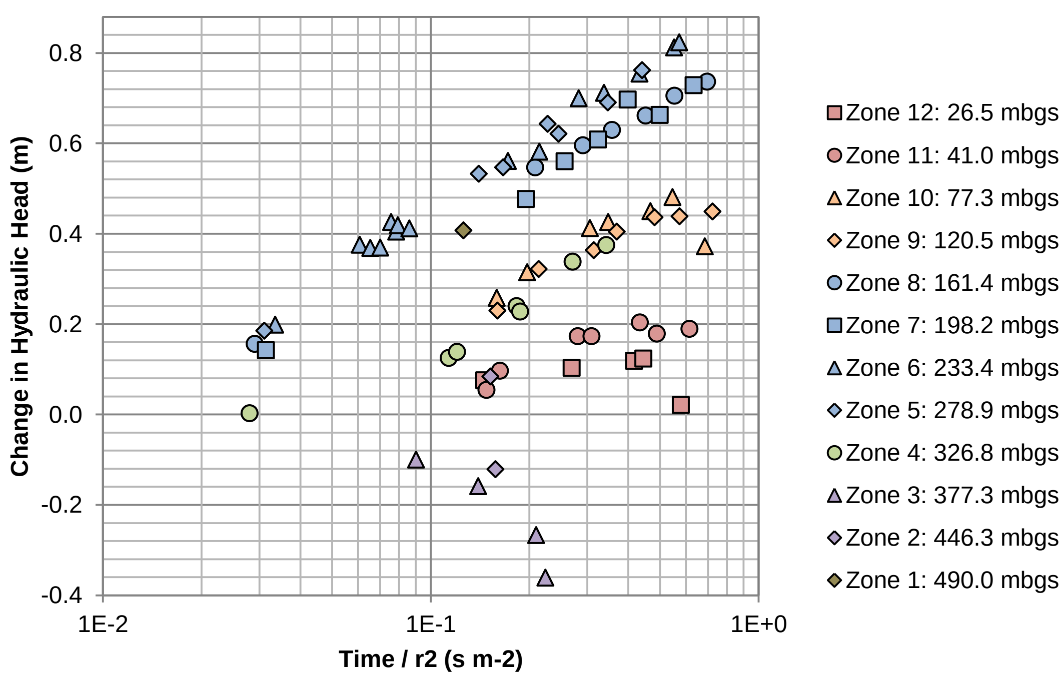

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Figure 8.7: Cooper Jacob Method III Plot of Observations at Westbay Well 10WBW001 during Longterm Injection Test

NOTE: Depths in legend represent the midpoints of the zones. The injection well is situated from 142.1 to 279.0 meters below ground surface.

Table 8.5: Hydrogeological Units Observed in Longterm Injection Test at Doris Central Westbay Well

Hydrogeological Unit	Westbay Zone(s)	Generalized Geological Setting	Hydraulic Response to Injection Test
Western Limb Zone	11, 12	Fracture basalts situated in the western limb of the Doris Antiform.	Data are affected by constant head boundary induced from overlying Doris Lake.
Hinge Zone	9, 10	Mineralized zones associated with quartz veining in basaltic host rock. Structurally situated in the hinge zone of the Doris Antiform.	Early time data show a radial response. Later time data are affected by the constant head boundary from Doris Lake (constant head observed at zone 9 at ~17,000 s and zone 10 at ~15,000 s).
Eastern Limb Zone	5, 6, 7, 8	Mineralized and altered zones associated the eastern limb of the Doris Antiform.	Data show infinite acting radial flow behaviour.
Contact Zone	4	Basalt-diabase contact.	Later time data show infinite acting radial flow behaviour (radial flow after ~3,000 s). However, response is delayed compared with eastern limb zone.
Diabase Zone	2, 3	Lower diabase dyke, very low fracture frequency.	Odd behaviour, as zone 3 shows a decrease in piezometric level during injection. Response is likely due to experimental error.
Lower Basalt Zone	1	Foliated basalts located below the lower diabase dyke.	Increase in piezometric level indicates hydraulic connections across lower diabase dyke. Due to the limited data points, analytical analysis of hydraulic properties is not possible.

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\long_term_injection_test_1CH008.054_101811_jm_rev01.xlsx

Hydraulic conductivity estimates based on numerical modelling of the defined hydrogeological units vary between 3 X 10^{-6} and 8 X 10^{-6} m/s. These results are within experimental error of Cooper Jacob estimates (2.6 x 10^{-6} m/s to 3.1 x 10^{-6} m/s). A summary of the hydraulic conductivity estimates for the hydrogeological units are presented in Table 8.6. Results were not calculated for the diabase and lower basalt zones due to an insufficient number of data points.

Table 8.6: Hydraulic Conductivity and Specific Storage Estimates for Hydrogeological Units

Hydrogeological Unit	Westbay Zone(s)	Hydraulic Conductivity (m/s)	Specific Storage (m^{-1})
Western Limb Zone	11, 12	5.5E-06	1.5E-07
Hinge Zone	9, 10	7.7E-06	1.3E-07
Eastern Limb Zone	5, 6, 7, 8	3.6 E-06	1.3E-07
Contact Zone	4	2.7E-06	4.0E-07
Diabase Zone	2, 3	n/a	n/a
Lower Basalt Zone	1	n/a	n/a

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\long_term_injection_test_1CH008.054_101811_jm_rev01.xlsx

The geometric mean hydraulic conductivity of the longterm injection test was two orders of magnitude larger than packer test results from the same location (geomean of longterm injection test = 6 X 10^{-6} m/s; geomean of packer tests = 8 x 10^{-8} m/s). Alternatively, only a single order of magnitude increase was observed from arithmetic means (arithmetic mean of longterm injection test = 5 X 10^{-6} m/s; arithmetic mean of packer tests = 4 x 10^{-7} m/s). The arithmetic mean may be more appropriate for fractured rock environments. These results indicated that the use of a geometric mean for packer test results may be underestimating the hydraulic conductivity for certain areas or features by more than an order of magnitude. This underestimate may result from the different area of influence for different testing methods. As the area of influence of injection tests is larger than that of packer tests, the injection tests have a higher likelihood of including discrete high-permeability features.

Packer testing within the Doris Central Westbay indicates that a high hydraulic conductivity feature(s) exists near Zone 6 (about 250 m drill depth). A comparison of both packer and injection test results shows that a similar hydraulic conductivity was estimated by both testing methods (packer test K = 1.5 x 10^{-6} m/s; injection test K = 2.9 x 10^{-6} m/s). It is likely that the same feature(s) is/are responsible for the high hydraulic conductivity observed in both tests. An examination of the geology near Zone 6 shows no increase in fracture frequency, major lithological change, or obvious structural feature(s). However, a large (2.23 m wide) quartz vein was observed in the drill core and was associated with increased alteration and foliation development. Fractures formed along the edges of this vein may be the source of the high hydraulic conductivity; however, this is only speculation, as other unidentified features may be responsible (i.e., nearby faults, other fractures, etc.). As shown in Figure 7.1, the Force 1 Fault may trend through this area.

Pressure head observations on the opposite side of the diabase dyke from the injection well showed a hydraulic response after eight hours. This was unexpected as diabase dykes are assumed to have a low bulk-rock hydraulic conductivity. As a result, feature(s) (fractures and/or faults) with high, relative permeability are assumed to crosscut the diabase dyke, facilitating hydraulic connection(s) between the upper and lower aquifer systems. Unfortunately, due to a limited number of observations, an estimation of the hydraulic conductivity of the feature(s) is not possible.

8.3.3 Hydraulic Conductivity Domains

A review of geological, structural, and hydrogeological information was completed in an attempt to classify hydrogeological domains within the Doris Central and Connector areas. Summaries of lithological features included in each packer test are provided in Appendix F. Most packer tests included more than one lithological unit (i.e., shallow basalt and alteration near mineralized zone), resulting in an averaging of any influence of each feature or lithology over the test zone interval. Figure 8.8 summarizes the geometric mean hydraulic conductivity and standard deviation for different lithological units. Additional summary statistics for each lithological unit are provided in Appendix F. The following discussion summarizes the results of the hydrogeological domain investigation.

Early interpretations of the hydraulic test data by SRK assumed a high relative hydraulic conductivity within the alteration halos surrounding the main ore bodies. This assumption was based on the presence of a higher fracture frequency and a lower rock quality designation (RQD) within the halos compared with unaltered basalts, as well as high relative hydraulic conductivity estimates from early packer tests. Updated hydraulic conductivity statistics show a geometric mean for the alteration zone of 3×10^{-8} m/s, increasing to 4×10^{-8} m/s in heavily fractured areas surrounding large quartz veins. These results are not statistically different from the geometric mean hydraulic conductivity for all packer test results (3×10^{-8} m/s). As a result, it is unlikely that the alteration halos, as a whole, will be a source of higher inflows. However, it is possible that geological structures formed within the zone due to increased strain may facilitate higher inflows.

High hydraulic conductivity estimates from packer testing at 10WBW001 Zone 6 and the longterm injection testing suggests that a high permeability feature(s) is/are present within the ore zone at Doris Central. Based on the lack of a discernible difference between the hydraulic conductivity of the alteration zone and mafic volcanics, it appears the high permeability feature(s) is/are likely structural in nature. This increased hydraulic conductivity may be the result of a fault system such as the Force1 Fault, high permeability structures along the edges of quartz veins, increased fracturing near the hinge zone of the Doris Antiform, and/or an unknown feature.

Geotechnical studies identified joint sets in three dominant orientations (refer to Section 9.1):

1. Sub-vertical dip
2. Intermediate dip
3. Shallow dip

The orientation of joints will have an effect on hydrogeological conditions. Sub-vertical dipping features include foliation parallel joints. Intermediate dipping features are considered orthogonal joints. Increased jointing was also observed in the vicinity of structures and shears. If a sufficient number of joints from different joint orientation sets are present, the potential for a higher degree of connectivity exists. Hydraulic conductivity does correlate to fracture frequency, albeit not strongly, supporting this potential. Ultimately, from the perspective of hydraulics, the potential for a widely connected fracture system cannot be ruled out.

Diabase dykes appear to have a lower bulk rock hydraulic conductivity based on packer test results (10^{-11} m/s). However, only two packer tests were conducted exclusively within the diabase dykes so hydrogeological characterization cannot be made with any statistical confidence. During longterm injection testing, hydraulic responses were observed across the lower diabase dyke, suggesting high permeability conduits crosscut the dyke. As a result, dykes may not act as a barrier to groundwater flow at the local scale. As poor characterization currently exists on the frequency and distribution of these conduits, further testing of dykes is required in order to reduce the spatial uncertainty in its hydraulic characteristics.

HBML and SRK geologists observed increased vug/dissolution cavities within the diabase dyke–mafic volcanic contact zone. This zone, which extends approximately 30 m into the mafic volcanic unit, is likely to have a higher hydraulic conductivity than surrounding rocks. As of 2011, only one packer test has been conducted within this zone. This test indicated a hydraulic conductivity of 5.1×10^{-9} m/s, although this value may not be representative of all vuggy areas.

During the 2010 geotechnical and hydrogeological drilling program, HBML geologists noted the presence of water producing structures during drilling when multiple drills were operating in very close proximity to each other. This finding indicated that structures were present with high enough permeability to allow for flow between boreholes. SRK structural geologists noted that near the proposed Doris Central and Connector areas, these features may be associated with either the steeply dipping diabase dike or potentially a non-modelled north-northwest striking fault sub-parallel to a north-northwest striking diabase dyke that has not been modelled.

The vug/dissolution zone observed by HBML and SRK geologists occurs within the same area as the high permeability feature described by SRK structural geologists and may be related to the same feature. Consequently, the dissolution zone may act as a flow conduit. There is substantial uncertainty regarding the specific features controlling flow however, limiting the ability to make correlations of sufficient strength to make broad-based assumptions about the hydraulic properties of individual geological units.

Therefore, the hydrogeological domains presented herein are considered sufficient as the base case, but sensitivity analyses should consider localized areas or zones of relatively high hydraulic conductivity.

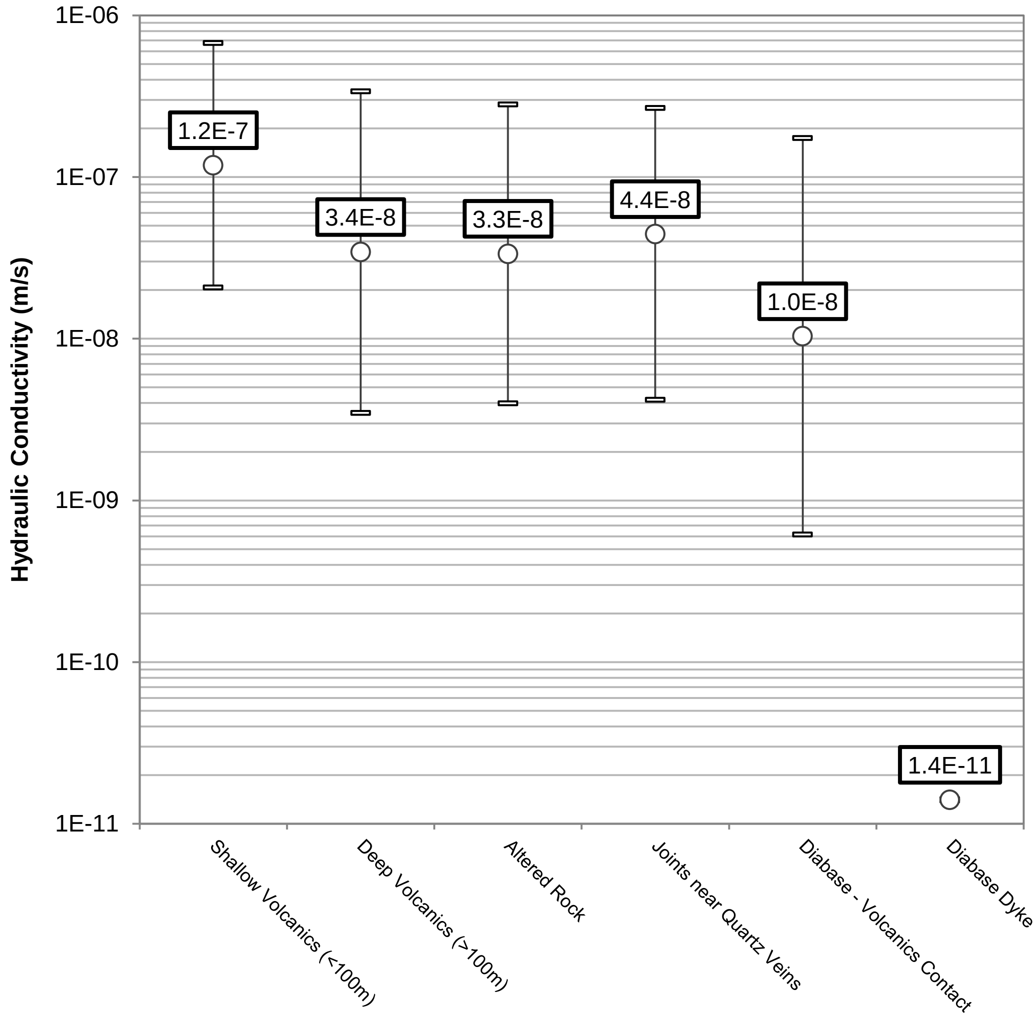

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Figure 8.8: Summary of Hydraulic Conductivity by Hydrogeological Unit

NOTE: Circles indicate geometric mean with value noted; error bars show one standard deviation.

8.3.4 Pore Pressure

Available Data

Information on pore pressure is available from two Westbay wells, installed at 10WBW001 and 10WBW002 (Figure 8.1), as well as from observations of artesian conditions from exploration drill holes. The Westbay well 10WBW001 is located on the eastern edge of the proposed Doris Central underground. Twelve monitoring ports were installed in 10WBW001 at depths ranging from 27.0 m to 548.0 m. Monitoring ports within 10WBW002 are located at depths ranging from 27.5 m to 594.4 m below ground surface, adjacent to the proposed Doris North underground. Pressure profiles within the Westbay wells were conducted approximately every four months since installation. The Westbay sample probe has a range of 13.8 MPa (2,000 PSI), with an accuracy of 0.1% of the full scale, or 0.0138 MPa (2.00 PSI). Hydraulically, this is equivalent to 1.37 m of variability in water level, assuming a density of 1,024 kg/m^3.

Flowing artesian conditions were observed within a number of drill holes below Doris Lake. During the 2010 geotechnical and hydrogeological drill program, HBML geologists documented these occurrences in an effort to characterize the source(s) of these features.

Pore Pressures and Gradients

Observations of flowing artesian conditions during exploration drilling provide some insight into the presence of elevated pore pressures and upwards gradients. During drilling, onsite geologists noted that this phenomenon occurred when multiple drill rigs were situated in close proximity. As a result, it is possible that these observations did not represent true artesian conditions and instead may have been the result of higher permeability zones facilitating flow between boreholes. Observations indicated that artesian flows sometimes declined or stopped when nearby drills stopped pumping water, suggesting that artesian conditions encountered in previous programs were also the result of pressurization from nearby drill rigs.

Pore pressure data from the Doris Central Westbay Well (10WBW001) indicated that piezometric levels are near the ground surface, with only a slight increase observed near the diabase dyke–mafic volcanics contact (Figure 8.9). Pressures near the contact do not exceed 3 m above ground surface, assuming a groundwater density of 1,024 kg/m^3. An assumed density of 1,024 kg/m^3 was based on average laboratory results from the Westbay sampling program. However, true densities are likely to fluctuate slightly, resulting in minor errors in the calculated hydraulic head.

Results from the Doris North Westbay Well (10WBW002) showed similar results, with piezometric levels near the ground surface for zones below the assumed permafrost boundary (Figure 8.10). Results within the permafrost zone indicated piezometric levels hundreds of metres above the ground surface. However, this finding is probably the result of thermal expansion during freezing and does not reflect actual pore pressures within the permafrost zone. Increased hydraulic head in the lowest port may also be incorrect, as it likely reflects increasing density at depth. As a result, piezometric levels within this zone are inferred to be near or only slightly elevated from ground surface.

The presence of piezometric levels near the ground surface indicates that the aquifer system beneath Doris Lake and permafrost is controlled by lake levels. As a result, the probability of encountering over-pressurized zones is somewhat greater at depth but overall appears to be low at this time. However, further pore pressure measurements would be required to reduce spatial uncertainty in this assumption.

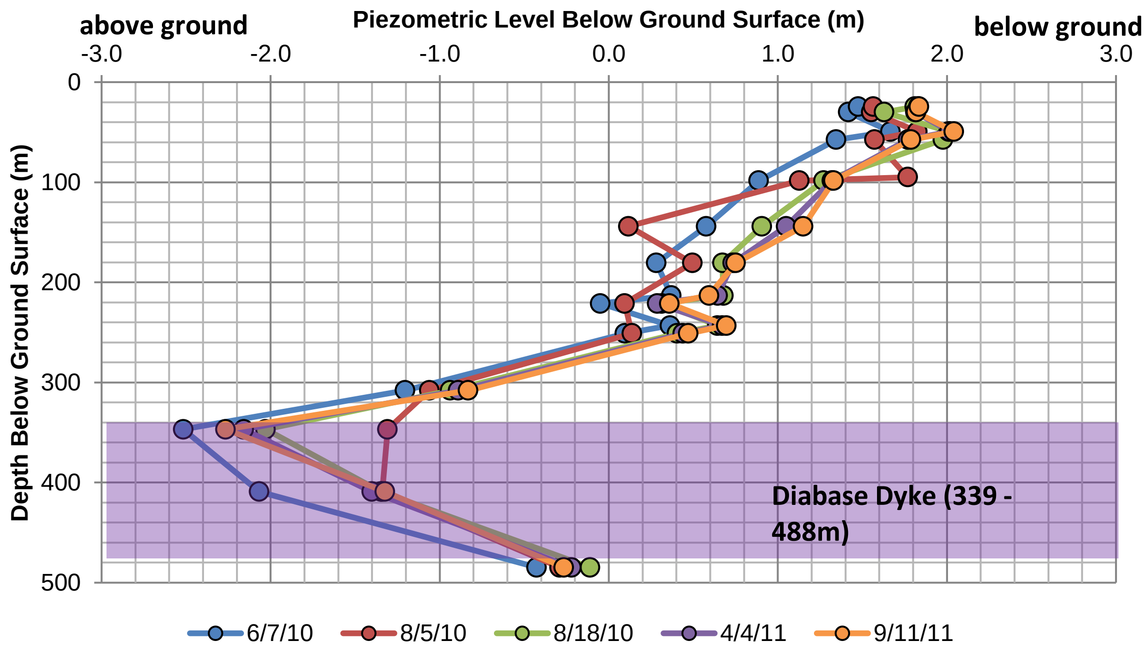

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Figure 8.9: Pressure Profile for Doris Central Westbay Well 10WBW001

NOTE: Constant density of 1024 kg/m2 assumed based on average density of samples collected from Westbay wells

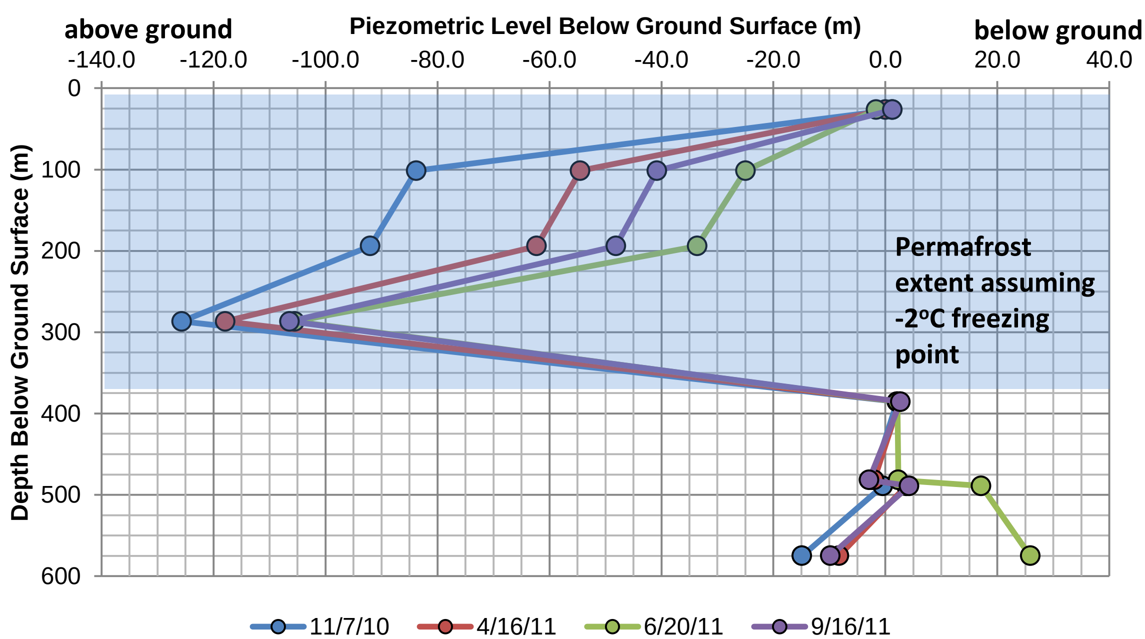

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Figure 8.10: Pressure Profile for Doris North Westbay Well 10WBW002

NOTE: Constant density of 1024 kg/m2 assumed based on average density of samples collected from Westbay wells

8.4 Ground Water Quality

Estimates of groundwater quality that may be observed during operations are currently based on results from Westbay well 10WBW001. The Doris Central Westbay well was designed to provide water quality, pressure, and temperature profiles throughout the talik under Doris Lake. The monitoring zones in the Doris North Westbay are located at depths below the base of permafrost. Table 8.7 lists sampling zones and the characteristics of the zones they represent.

In 10WBW001, the deepest sampling zone was set below the diabase to provide water quality at depth. The middle sampling zone was set in an area of observed high hydraulic conductivities. The shallowest zone is close to the bottom of Doris Lake. Monitoring zones are numbered from the bottom up so that Zone 1 is at the bottom of the well and higher numbered zones are shallower.

Doris North is below the permafrost and targets deep groundwater quality where vertical water movement is inhibited by permafrost conditions. Figure 8.11 shows the depths of the targeted zones in relation to the mine workings.

Table 8.7: **Westbay Sampling Zones**

Well	Zone	Vertical depth (m)	Deposit	Representative of
10WBW001	10	57–97 m	Doris Central	Shallow talik water, near the upper parts of the proposed Doris Central stopes.
	6	221–246 m		Medium depth talik water, around the area of the proposed Doris Central stopes, possibly influenced by nearby faults.
	1	485–495 m	Doris Central Lower	Deep talik water, below the diabase.
10WBW002	1	575–578 m	Doris North Lower	Deep sub permafrost groundwater at Doris North Lower.

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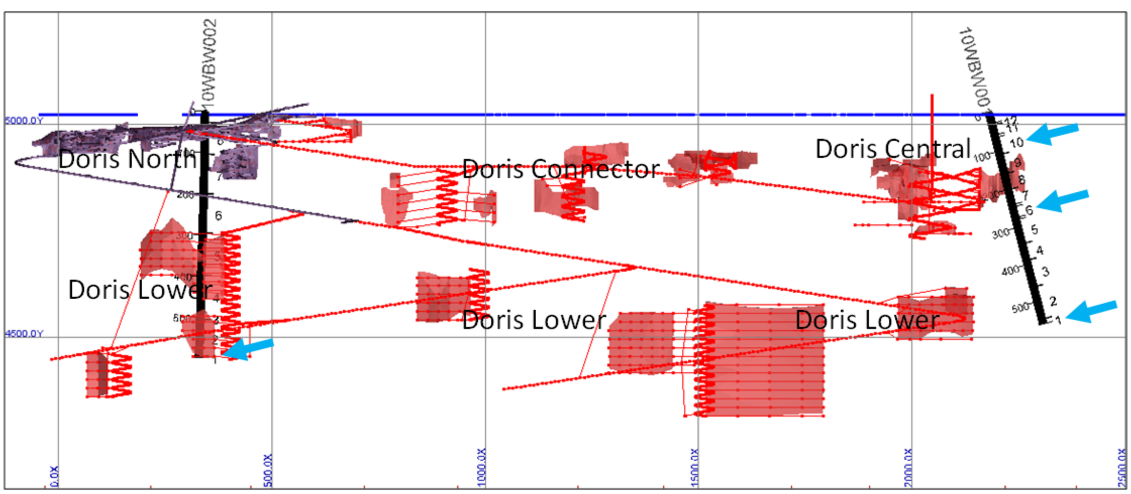

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Figure 8.11: Cross Section through Doris Mining Areas Showing Westbay Sampling Zones (blue arrows)

8.4.1 Well Design and Development

The Westbay wells can be thought of as multilevel piezometers. That is, each installation has multiple screen zones at various depths allowing sampling, water level measurement, or hydraulic testing at each point. The zones are designed during drilling and allow virtually complete flexibility over length and position. Each zone is separated from others by pneumatic packers that are inflated following strict QA/QC guidelines. After installation, all of the zones are accessed through a single PVC standpipe via a wireline tool and surface-operated sampling device. A benefit of this system, which is of particular importance in the Canadian north, is that the inside of the PVC is hydraulically isolated from all of the sampling zones, allowing the internal volume to be protected from freezing; unlike a conventional piezometer, water does not rise up inside the PVC to the static water level. Water pressure can be measured at all monitoring zones and provides a vertical pressure profile.

SRK field staff purged the drilling water from each of the target zones, monitoring field parameters and taking laboratory samples to measure water quality changes as the drill water in the zone was replaced with formation water. The speed of the purging process, the purging and sampling method, and the number of samples taken varied by location, depending on the presence or absence of permafrost in the hole and on the hydraulic conductivity of the rock within the zone.

Table 8.8 shows the volumes purged and the methods used at each of the targeted sampling zones.

The following purging methods were used:

The airlift pumping method: This procedure involved opening the pumping port in a target zone and then injecting compressed air into the internal Westbay PVC pipe at a depth above that of the pumping port to eject water and lower the water level inside the pipe. This process caused water to flow from the zone into the Westbay internal pipe to replace the water removed. Initially the discharged water from the airlift system is the glycol water that was sitting inside the Westbay pipe, but over time the recharging groundwater provides a continuous flow of water up through the Westbay.

The sample bottle method: This procedure involved using the Mosdax sampler probe with attached sampling water bottles to land at the measurement ports and take 1 L samples. The bottle was then returned to the surface, emptied, re-attached, and sent down the hole again to grab another 1 L from the formation. This process continued for days, or weeks in some cases, to purge water from the zones. While slow, the benefit of this method is that the glycol water mix inside the Westbay is not displaced by the formation water (as is the case with the airlift pumping method) and the Westbay wells located in permafrost do not freeze solid.

Table 8.8: Purging Volumes and Methods Used

Deposit	Well	Zone	Volume of One Zone (L)	Volume Removed (L)	# of Zone Volumes Removed*	Significant Permafrost in Hole?	Purging Method
Doris Central	10WBW001	10	264.0	3014	11.0	No	Airlift
		6	168.0	Initially 8,096; after bulk sample 13,592	Initially 46.6 after bulk sample 79.3		Airlift
		1	96.0	3192	27.5		Airlift
Doris North	10WBW002	1	37.2	52	1.4	Yes	Westbay Sampler

Source: \01_SITES\Hope.Bay\1CH008.013_2010_Westbay_Installation\080_Reporting\20110125 Westbay Data Report\Tables\Table 3 Purging volumes all targeted zones.xlsx

Note that for zones purged using the airlift method, the volume of glycol water purged from inside the Westbay was subtracted from the calculation of # of zone volumes removed.

8.4.2 Water Quality Results

A summary of groundwater sampling results is presented in Table 8.9. Samples were analyzed for standard parameters (conductivity, pH, etc.), cations (chloride, sulphate, etc.), and dissolved and total metals. In addition, stable isotopes (O and H) were analyzed to provide improved QA/QC on well purging and development, as well as to assess potential variation in water source types. Complete groundwater results for all the Hope Bay samples are provided in Appendix G.

Table 8.9: Summary of Hope Bay Water Quality (75th Percentile[1])

	Parameters	Units	DORIS CENTRAL ZONE 10 and 6 ONLY (DORIS UPPER) n=14	DORIS CENTRAL ZONE 1 ONLY (DORIS LOWER) n=6	DORIS NORTH[2] ZONE 1 n=5	BOSTON[3] ZONE 6 n=5
Field Parameters	pH	pH units	7.67	8.24	9.01	7.1225
	EC	S/cm	57.65	52.49	>99.9	33.83
	DO	g/L	12.1	11.4	19.5	13.6
	Salinity	%	3.63	3.5	>4.0%	2.075
	ORP	mV	-68.8	32.4	251.0	12.9
Lab Parameters	Conductivity (EC)	uS/cm	48125	47425	182250	36500
	Density	kg/m^3	1.03	1.03	1.16	1.02
	pH	pH	7.59	7.68	8.11	7
	Total Dissolved Solids (gravimetric)	mg/L	37375	46200	204500	38800
	Alkalinity, Total (as CaCO3)	mg/L	96.9	0.4	190	35.4
	Ammonia as N	mg/L	3.57	0.063	7.83	2.44
	Chloride (Cl)	mg/L	18950	19000	138000	14700
	Sulfate (SO4)	mg/L	2000	980	61	385
Dissolved Metals	Aluminum (Al)	mg/L	-0.005	-0.0025	0.041	-0.005
	Arsenic (As)	mg/L	-0.0020	-0.0020	-0.005	-0.002
	Cadmium (Cd)	mg/L	-0.00002	0.00009	0.0005	-0.00005
	Calcium (Ca)	mg/L	1560	4930	78800	4690
	Chromium (Cr)	mg/L	-0.0001	-0.00010	-0.00075	-0.0001
	Cobalt (Co)	mg/L	0.0002	0.0000	0.00038	0.0035
	Copper (Cu)	mg/L	-0.0005	0.00071	0.014	-0.0005
	Iron (Fe)	mg/L	4.87	0.061	0.004	10
	Lead (Pb)	mg/L	-0.0003	-0.0003	0.0023	-0.0003
	Lithium (Li)	mg/L	0.21	0.38	0.40	0.05
	Magnesium (Mg)	mg/L	1428	70	118	492
	Manganese (Mn)	mg/L	2.02	1	0.017	0.89
	Mercury (Hg)	mg/L	-0.00001	-0.00001	0.00005	-0.00004
	Molybdenum (Mo)	mg/L	0.032	0.012	0.19	0.10
	Nickel (Ni)	mg/L	0.0010	0.0018	0.0097	0.014
	Potassium (K)	mg/L	250	39	200	51
	Selenium (Se)	mg/L	-0.002	-0.002	0.015	-0.002
	Sodium (Na)	mg/L	9018	7223	1495	2890
	Strontium (Sr)	mg/L	20	57	52	28
	Uranium (U)	mg/L	0.0001	-0.0001	0.00038	0.00823
	Zinc (Zn)	mg/L	0.07	0.14	0.18	0.15

Source: \\van-svr0.van.na.srk.ad\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\[2011-06-06 Water Quality Table Rev05.xlsx]

Notes:

1 Statistics were calculated by assuming that all values below detection limit were at the detection limit. Some samples taken early in the program had high detection limits (as shown in grey highlighting) and were therefore excluded from the statistical summary.

2 Doris North samples likely still contain drilling fluids as the zone has not been successfully purged. As such, these results are not accurate indications of water quality.

3 Boston samples were collected from upper and lower ports within the same zone. These results represent the 75th percentile of the 2 most recent sets of samples from each port.

The sample results suggest that the water encountered during mining, at least initially, will be saline and that the chemistry may vary with depth.

- Samples from Zones 6 and 10 were sodium-magnesium-chloride-dominated waters, whereas, samples from Zone 1, which is below the diabase (where the Doris Lower deposits are located), were calcium-sodium-chloride-dominated waters.
- Water chemistry at the two upper zones (Zones 6 and 10) in the Doris Upper mining area were similar, although the isotope data suggest that the water from Zone 10 is different to the waters from Zone 6. Zone 6 waters may be a mixture of water from Zone 10 and from a third source or a different formation, as the isotope signature varies with each sampling round (SRK April & June 2011).
- Isotope data from Zones 1 and 10 were not similar, suggesting that the water in these zones were from two different sources (SRK April & June 2011).
- Samples from Zones 6 and 10 contain somewhat elevated ammonia. Given the age of these waters, this finding is unexpected. However, further laboratory testing has validated that it is likely to be present.
- Samples from Zones 6 and 10 also contain elevated concentrations of dissolved iron, manganese, and zinc. As these waters oxidize, the iron and manganese are expected to precipitate as oxyhydroxide minerals and may scavenge other metals from solution. These compounds may contribute to suspended sediments in the groundwater.

The 75th percentile concentration from post-purging sample results for Zones 6 and 10 are assumed to be representative of the expected initial range in inflowing water quality at Doris Central and Connector mine areas above the diabase (collectively referred to as Doris Upper). The 75th percentile concentration results from Zone 1 are assumed to be representative of the initial inflows to the Doris Lower mine areas.

8.4.3 QA/QC

The quality assurance and quality checking procedures for this data collection program comprised the following:

- Collecting and analyzing duplicate samples to evaluate field variability and to test consistency in lab analytical methods.
- Calculating cation and anion balances to check completeness of analytical results.
- Requesting the lab to analyze blank samples of the DI water used to rinse the Westbay sample bottles before it was sent to site. This practice confirmed that the water used is low in the parameters of interest for the groundwater samples.
- Comparing samples taken using different collection methods (airlifted samples vs. port samples) to understand how the method of collection affects the results.
- Comparing repeated samples over time to determine variability of results.

- Collecting and analysing background samples of lake water used for drilling, drilling brines, and the glycol/water mix inside the Westbay wells for comparison with groundwater samples taken from the Westbay ports.

Further details of the QA/QC and results can be found in the Westbay Data Report (SRK 2011) outlining the results from the duplicates, blanks, and other associated verification QA/QC processes.

8.4.4 Variability

Groundwater chemistry is subject to natural variability. To measure some of this natural variability, samples were repeated from the same port over time. A comparison of repeated samples was provided in the chemistry results in the Westbay Data Report (SRK 2011). Overall, considerable variability was observed, indicating that a range of values should be used in the interpretation of groundwater chemistry data until further data are available.

The Westbay wells are designed with multiple sampling ports within one zone and variance can occur within the same zone by using different ports. At the Boston Westbay well, groundwater samples were collected from both the top and the middle ports of Zone 6 to test for consistency or stratification of water quality within the zone. The middle port, near the midpoint of the zone, initially had higher concentrations of most parameters than the upper port, indicating that a stagnant or stratified area may occur within the Westbay Zone. This finding could potentially be the result of groundwater flowing along fractures in only one part of the zone and not fully mixing with the drilling water. Over the purge, the concentrations between the ports became more similar, but not the same. This fact is important to consider when reviewing the data from other zones where only one measurement port has been sampled, typically at the top of the zone.

During purging, two methods were employed—airlift and sample port—as discussed in the previous section. As one of these methods introduces significant aeration to the sample, it is not possible to determine if the chemistry from both methods is the same. From the initial purging and sampling at Doris Central (Appendix G), chemistry between the two methods is difficult to compare as lab analyses were also different (some were sampled as water, others as seawater). However, the most notable differences are:

- The airlifting method tended to have 30–80% higher concentrations of many parameters compared with the samples from the measurement ports (i.e., higher TDS, EC, hardness, alkalinity, sulphate, chloride, bromide, silicate, total arsenic, boron, calcium, lithium, magnesium, manganese, potassium, sodium, and strontium).
- Total iron concentrations were higher in the airlifted sample (4.5 mg/L airlifted compared with 2.3 mg/L from measurement ports).
- The difference between total and dissolved iron was much less in the airlifted sample. The measurement port method had large differences between average total iron (2.3 mg/L) and dissolved iron (0.23 mg/L), whereas the airlifted method yielded a small difference (4.5 mg/L, total iron; 4.4 mg/L, dissolved iron).
- Lower pH was present in the airlift samples.
- Lower turbidity was found in the airlift samples.

8.4.5 Background

Two background samples were collected from Doris Lake and one from Spyder Lake: one sample was collected from drill water used at Doris Central (no salt added); two drilling water brine samples were collected at different stages of the drilling process at Boston. The drilling water and lake water samples were compared with samples taken from the measurement ports to determine purging progress. Spyder Lake and Doris Lake had low anion, cation, and metals concentrations. The drilling water for Doris Central also had low concentrations. The drilling water from Boston was a brine—to prevent the rods from freezing—and had high calcium, chloride, and sodium concentrations. Lake and drilling water were notably different from samples collected from the monitoring zones, indicating that the sampled waters were not drilling water.

8.4.6 Discussion

In general, these water quality data suggest that salinity is greatest at depth, below the diabase sill. Salinity is relatively low at depths above 250 m, but still elevated. Zones 6 and 10 likely provide the best indication of groundwater quality that will be encountered, at least during early phases of mining. Later in mining, it is currently assumed that water quality will trend towards that of Doris Lake, but the timing and extent of this trend are uncertain. Upwelling of the deeper, more saline water is possible but will be limited by the diabase dike, which may act as an aquitard according to hydraulic conductivity data.

The isotope values from Doris Central show that the drilling water and the water from Zones 1, 6, and 10 had different isotopic signatures, indicating the water present in the zones is not drilling water but likely formation water. Each of the zones had different isotopic signatures, indicating that the water in those zones is from different sources. Zone 6 had similar isotope values to Zone 10, suggesting that some of the water in Zone 6 may have come from Zone 10.

8.5 Hydrogeological Conceptual Model

In general, the baseline hydrogeological system for the entire Hope Bay belt can be considered a low-flux, lake-dominated flow system. This is consistent with hydrogeological conceptual models for other mines in northern Canada.

At a regional scale, groundwater flow within the Hope Bay Belt is controlled by topography, distribution of hydraulic conductivity, and location of larger lakes. On a regional scale, topography generally slopes gently northward towards the ocean, with local variations due to differences in the erosion characteristics of various geological domains. Regional groundwater gradients are assumed to be controlled by lake elevations, with the overall groundwater flow direction mimicking topography and flowing northward. Regionally, bedrock hydraulic conductivity is considered to be low, resulting in an overall low groundwater flux.

On a smaller scale, groundwater flow is controlled by the presence of permafrost, distribution of hydraulic conductivity, and location of lakes. Thermal data indicate that, away from lakes, permafrost may exceed depths of 500 m below ground surface and act as a confining layer inhibiting groundwater-surface water interaction. However, the area beneath Doris Lake is an open talik.

Groundwater recharge is generally fixed as lakes provide the only connection to the groundwater system, and lake levels do not change significantly on an annual basis in relation to the distances between lakes. Underground workings may experience a relatively constant groundwater flux from overlying lakes, once steady state conditions are achieved.

At the deposit scale, groundwater flow is controlled by relatively high permeability fractures and other geological structures (i.e., faults) within an otherwise lower permeability bedrock matrix. Hydraulic conductivity appears to follow a log-normal distribution with a geometric mean of 3×10^{-8} m/s and standard deviation of 5×10^{-7} m/s based on packer test results. A weak spatial relationship between hydraulic conductivity and depth exists, with higher hydraulic conductivity at shallower depths due to a reduced confining pressure. Specific storage estimates from the longterm injection test indicate a geometric mean of 1×10^{-7} m^{-1}.

Relationships between hydraulic conductivity and lithology are poorly understood, but data suggest that lithology may exhibit some influence on the spatial distribution of hydraulic conductivity.

Fault zones characterization and hydraulic conductivity characteristics are poorly understood throughout the Hope Bay belt. However, the presence of high hydraulic conductivity features within the Doris Central and Connector areas indicate that

1. The presence of a conduit or combined conduit-barrier-type fault may exist in the Doris Central area. This feature is likely hydraulically connected to the lake itself, at least from a pore pressure perspective. The potential for such features or zones to connect to the lake exists and must be considered during planning.
2. Geological structures, in general, should still be considered as the highest risk features for inflows.

The presence of relatively lower hydraulic conductivity features, such as diabase dykes, may result in compartmentalization of flow, which could increase the rate of depressurization and dewatering in the vicinity of stopes.

8.6 Inflow Estimation Methods and Sensitivities

Estimates of groundwater inflow quantity were determined using available hydraulic conductivity data, along with a combination of analytical and numerical calculation methods. At this stage, the exact location of discrete structures or fractures along which flow may occur is generally uncertain, thus multiple approaches were used to allow assessment of the range of potential inflows and to focus on relative risk from a flow management perspective.

This section presents the methodologies used to assess inflow and the sensitivity of inflow to variations in hydrogeological assumptions. Quantitative inflow results are presented in Section 8.8.

8.6.1 Sources of inflows

Doris Lake

It is predicted that Doris Lake will have a significant influence on inflows. The surface water elevation of the lake will be a primary control on gradient towards underground workings. Water within the lake will represent a large source of available recharge to the underlying bedrock groundwater system. Sediments lining the bottom of the lake typically have a significant silt or clay component and may act to impede the rate of recharge.

Fractured bedrock

Water flowing within the fracture network will permeate into the stopes and tunnels under a pressure gradient from Doris Lake. Development within the Doris Central and Connector mining areas will extend to depths of approximately 250 m below the level of Doris Lake and be completely within the Doris Lake talik. Hydraulic testing data suggest that shallow bedrock may have relatively high hydraulic conductivities compared with deeper bedrock. Available data indicate that the diabase sill underlying the area of development may significantly lower hydraulic conductivity, which may reduce the inflows to Doris Lower at depths of 300–750 m below the lake. Inflow from bedrock is anticipated.

Structures

Multiple geological structures intersect underground workings, some of which may have relatively high permeability. Within the Doris Central ore zone, relatively high hydraulic conductivity is anticipated along uncharacterized structure(s). Dissolution features along diabase dyke contacts may produce water when intersected by mining developments such as stopes, ramps, or crosscuts. The likelihood of intersecting such structures is considered high, although uncertainty exists regarding specifically where or if these structures will act as conduits.

Former Exploration Drill Holes

A large number of exploration drill holes were completed within the Doris Central area. The condition of a majority of these is unknown. Development will intersect some of these drill holes. The potential for inflow from open drill holes to Doris Central was discussed in the report Geotechnical and Hydrogeological Assessment for the Doris North Open Pit and Doris Central Underground (SRK, June 2009b). Potential inflow from open drill holes will be sensitive to many parameters (roughness of the drill hole, actual head differences, drill-hole length etc.), but initial estimates suggest flows for a single NQ drill hole could range from approximately 2,700 to 3,700 m^3/day.

8.6.2 Methodology

Numerical models were constructed using Feflow, a commercially available code produced by DHI-Wasy of Germany. Feflow has been used for numerous mine-related groundwater assessments around the world. As with most groundwater numerical models, Feflow assumes equivalent hydraulic parameters for a given cell within the numerical grid (hydraulic conductivity, storage, etc.) and does not explicitly assess flow along individual fracture planes. As a result an “equivalent porous medium approach” was used to estimate fractured bedrock inflows. This approach assumes that the fractured bedrock can be represented by a bulk hydraulic conductivity, similar to a porous medium such as sand. This approach is considered reasonable for mine-scale inflow estimates and has been applied at many other mine sites in Canada.

In addition to these models, the effects of open exploration drill holes must be considered. These features may represent the greatest risk from an inflow perspective. The models do not explicitly incorporate drill holes, but flow estimates were determined using two different models.

1. A 3-D model with multiple configurations was constructed to assess variation in inflow from bulk rock to underground workings of different geometric shape (i.e., length, vertical height, and width) and depth below Doris Lake. Correlations between inflow rate, geometric shape, and depth were then developed based on the numerical results to allow estimation of bulk bedrock inflow to any given stope. The primary benefit of this approach is that it provides the ability to add inflows from individual stopes in any order or combination. Figure 8.12 is an oblique view of the 3-D model domain illustrating the general model arrangement.

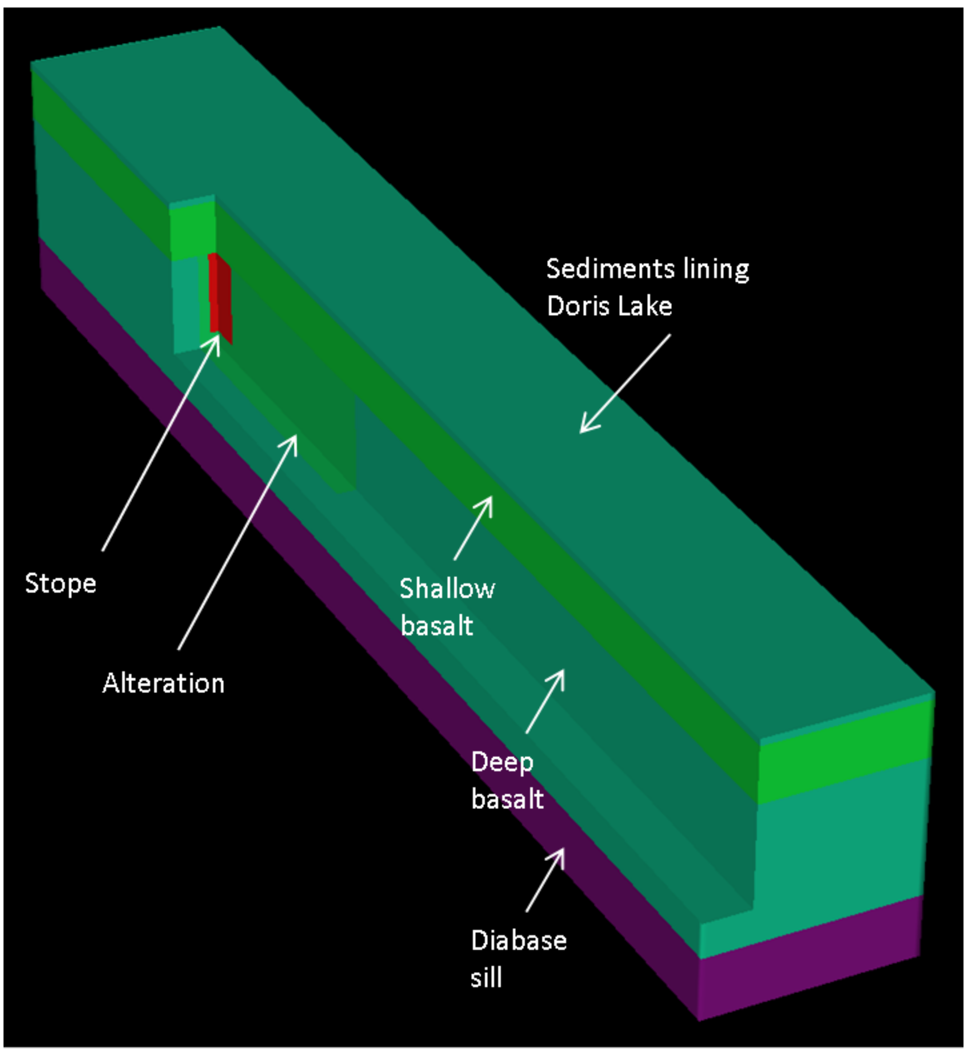

Figure 8.12: 3-D Numerical Model for Bulk Rock Inflows

The model domain has dimensions of 4,700 m X 680 m X 420 m (length X width X depth). The following points summarize model inputs for the base case model:

- Reference stope with dimensions of 144 m X 36 m X 140 m (length X width X height). This stope (Stope H) is shown in Figure 8.13.
- Hydraulic conductivity by domain
  - Shallow Bedrock (0–100 m below lake bottom) $9x10^{-8}$ m/s
  - Deep Bedrock (100–300 m below lake bottom) $2x10^{-8}$ m/s
  - Alteration/ore zone (100–300 m below lake bottom) $5x10^{-8}$ m/s
  - Diabase sill (300–400 m below lake bottom) $2x10^{-11}$ m/s
- Doris Lake is a fixed head boundary (i.e., constant lake elevation)
  - Doris Lake sediments hydraulic conductivity $2x10^{-8}$ m/s
- Permafrost surrounding Doris Lake is impermeable.
- Stope is fully developed (i.e., inflow estimates are for an entire stope area).
- The decline and ramps are fully developed (i.e., simulated for maximum length).
- Stope backfill has no effect on limiting inflow.
- No water management strategies are assumed to be implemented (i.e., inflow is unimpeded).

Inflow to mine development (i.e., decline, ramps, and spirals) was determined using the same numerical domain, but with development incorporated using what are called discrete elements in Feflow terminology. Discrete elements are essentially pipes of infinite hydraulic conductivity and a set cross-sectional area that can be inserted in the numerical mesh to simulate tunnels (e.g., the main decline).

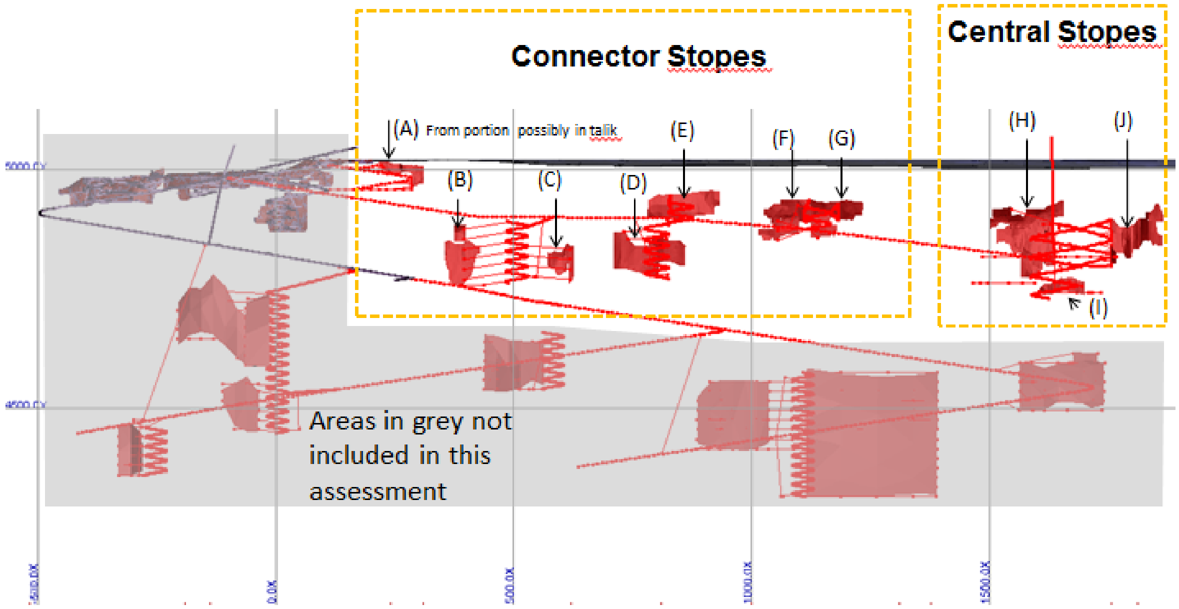

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Figure 8.13: Mining Areas for Inflow Estimates

2. As part of the 2008/09 Stage 2 assessment, a 2-D cross-sectional numerical model was developed for inflow estimation. One of the sensitivity runs conducted was to represent a vertical geological structure (i.e., fault). This model is still considered reasonable for assessing the range of possible inflows that could result from a structure connected to Doris Lake.

Figure 8.14 shows the layout of the 2-D numerical model. The section is oriented east-west across Doris Lake and utilizes stope dimensions as available in 2009. In this model, the structure is assumed to intersect the workings along the entire surface area. This assumption is highly conservative but useful for the purposes of sensitivity analyses. The model orientation is considered reasonable as there are no known structures that may intersect mine development along the entire north-south strike length. In effect, this model represents the scenario of a fault crossing a stope.

Use of an equivalent porous media model to estimate inflow from an individual structure is reasonable if appropriate parameters are used. Individual fractures may have very high hydraulic conductivity but very limited width (aperture), often in the order of microns. Fault structures are frequently visualized as zones of higher fracture density, but characterization of fault hydraulic parameters is inhibited by variation along strike length—a reality that is often difficult to quantify due to the limited number of drill holes that intersect a structure. Therefore, a sensitivity approach is considered reasonable from the perspective of identifying the need for water management mitigations.

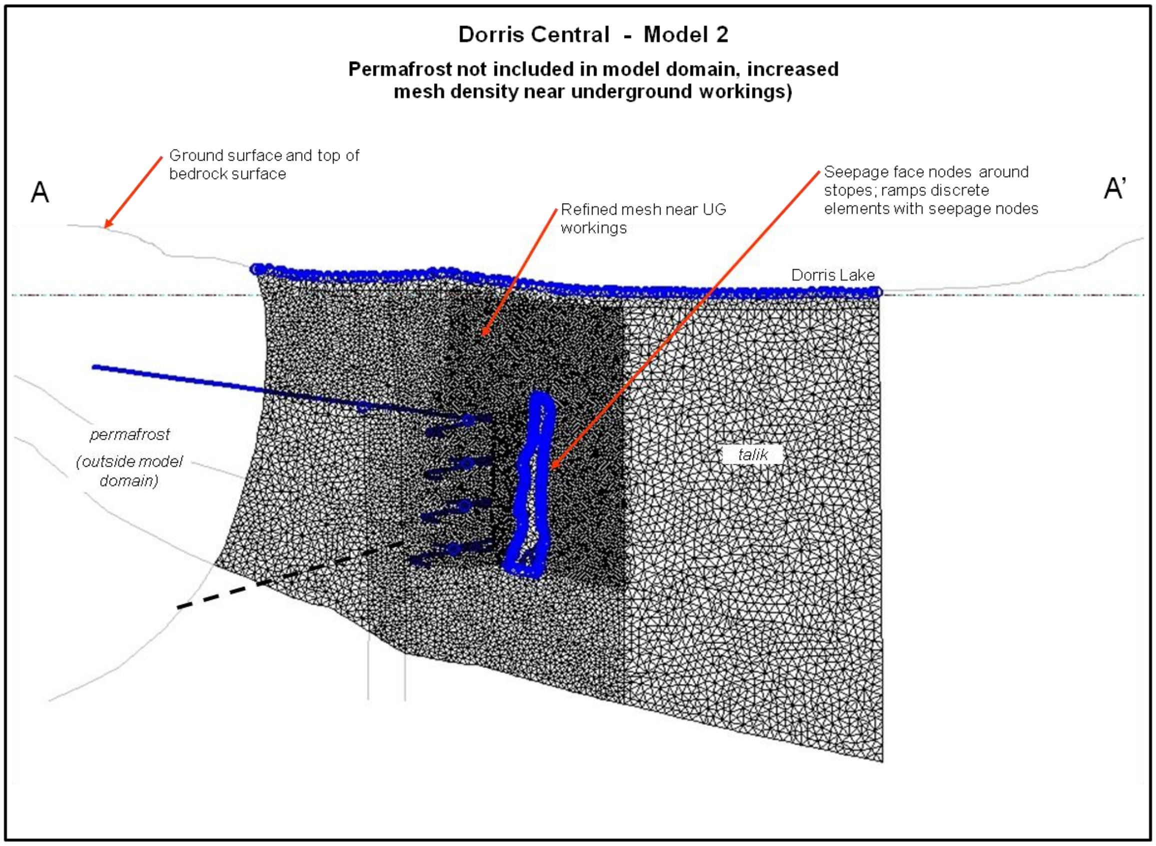

Figure 8.14: 2-D Numerical Model for Fault Inflows

8.6.3 Sensitivity to Bulk Rock Inflow

The inflow to the reference stope (Stope H on Figure 8.15) under the base case conditions listed in the previous section was 1,049 m^3/d. It should be noted that this does not represent cumulative inflow to the entire Central/Connector mining area.

To assess the sensitivity of inflow to variation in the hydraulic conductivity of a given domain, a suite of model runs was completed using different hydraulic conductivity values based on the range of observed values in the dataset. Sensitivity run variation in hydraulic conductivity included

- Increase and decrease K of Doris Lake bottom sediments
- Increase and decrease K of shallow basalt materials (i.e., crown pillar zones)
- Increase and decrease K of deep basalt materials
- Incremental shallowing of alteration zone (i.e., high K zone incorporates increasingly shallow depths closer to lake)

Figure 8.15 illustrates the results of the sensitivity runs as percentage change from base case.

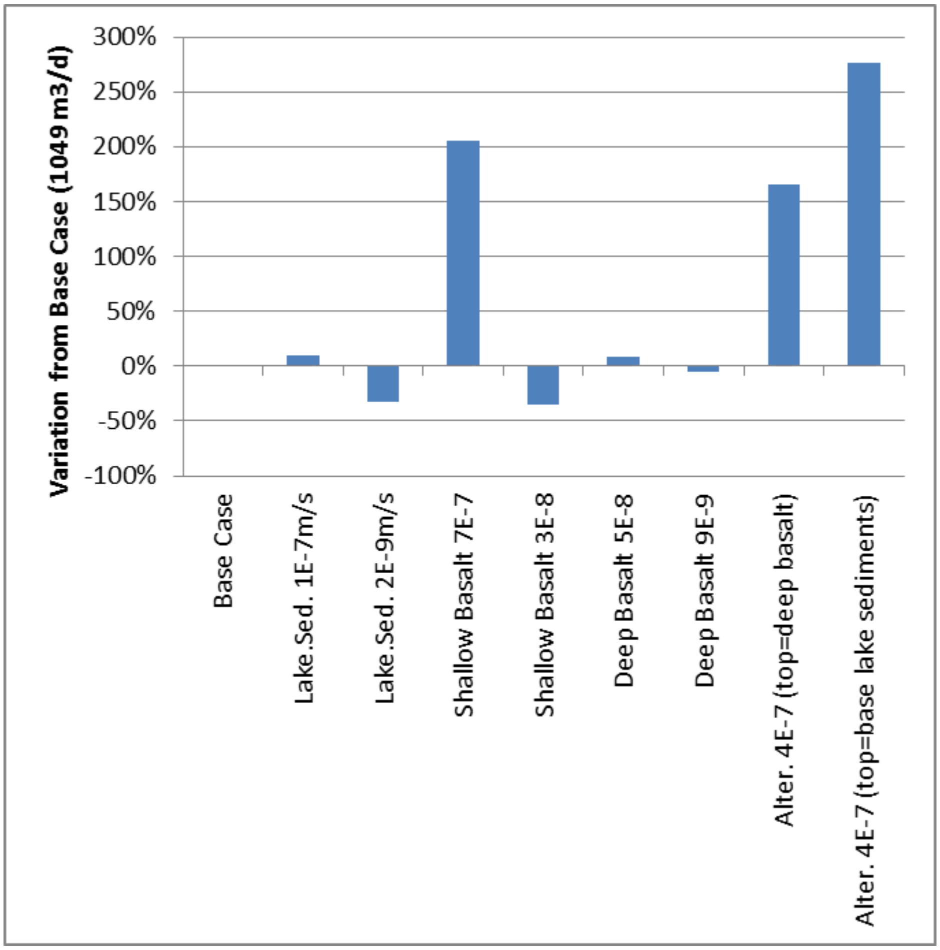

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Figure 8.15: 3-D Numerical Model Sensitivity Results

The results indicate the greatest sensitivity to shallow basalt (i.e., the crown pillar) and how shallow the relatively high permeability alteration zone reaches.

8.6.4 Sensitivity to Fault Inflow

For Model 2, the fault model, five hydraulic conductivity scenarios were assessed:

1. Fault K = 3 X 10^{-6} m/s (max packer test value) and lake bottom sediment K = 1 X 10^{-7} m/s
2. Fault K and lake bottom sediment K = 3 X 10^{-6} m/s
3. Very high fault K = 1 X 10^{-5} m/s and lake bottom sediment K = 1 X 10^{-7} m/s
4. Very high fault K = 1 X 10^{-5} m/s and higher lake bottom sediment K = 1 X 10^{-6} m/s
5. Very high fault and lake bottom sediment K = 1 x 10^{-5} m/s

For each of these scenarios, fault width was varied between 0.25, 0.5, and 1 m.

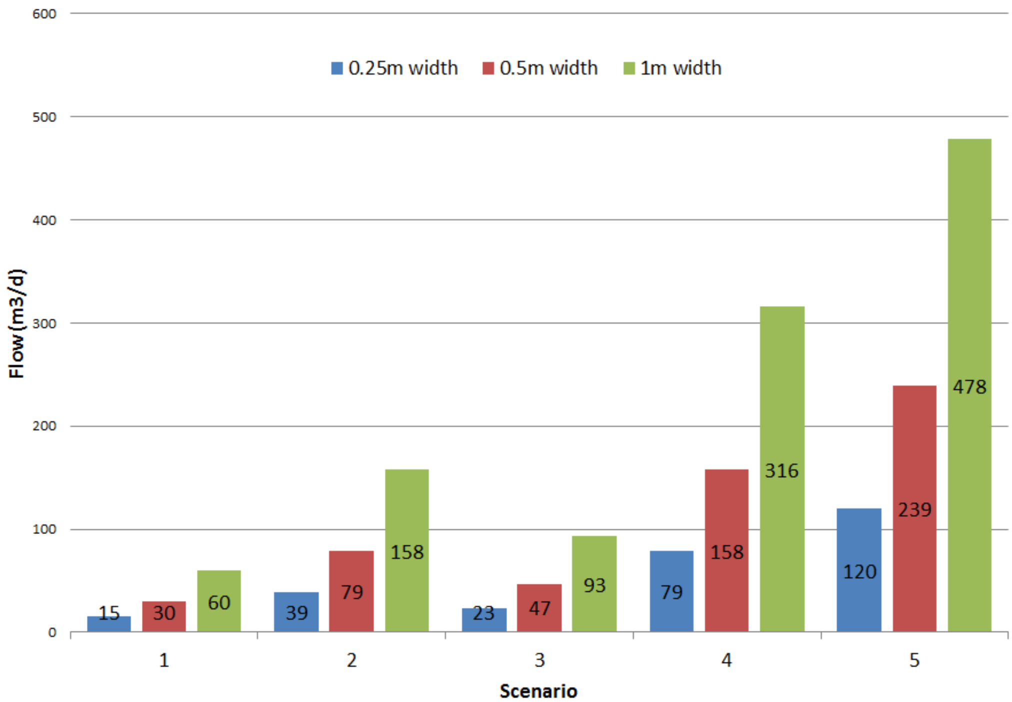

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Figure 8.16: 2-D Numerical Model Sensitivity Runs

These results of these sensitivity runs, as shown in Figure 8.16, suggest that if a fault zone were of sufficient width and hydraulic conductivity, the inflow from only the fault could be equivalent to 50% of inflow to an entire stope. These results are not surprising in light of experiences at other mines in the Canadian north and illustrate the risk that exists in relation to flow along structures.

8.6.5 Sensitivity to Flow from Exploration Drill Holes

Considerable uncertainty exists regarding the potential for inflow through exploration drill holes connecting the Doris stopes directly to Doris Lake. A certain number are known to have not been cemented. Also, SRK has been informed that no written records of methods for cementing are available, nor are there as-built-type descriptions of what was actually done.

It is understood that the method involved setting a Van Ruth–type plug approximately 35 m into bedrock, then emplacing cement on top of the plug. This method was not observed during the 2008 field program, nor did any of the drilling foremen questioned recall abandoning a drill hole with this method. The same method was used in 2010.

Flow through one open NQ-diameter exploration drill hole (75.7 mm) was calculated based on the Darcy-Weisbach equation as 2,680 m^3/day.

The following paragraphs describing the probability of encountering drill holes at Doris Central were taken directly from SRK's 2008/09 Stage 2 Geotechnical/Hydrological report. These sections have been included here to re-emphasize the importance of open drill holes as a risk to operations.

Based on the existing exploration drill hole database and available underground development layout for Doris Central, intersections with exploration drill holes and the proximity of others to developments were tabulated. Table 8.10 summarizes tabulated drill holes by direct intersection and increasing distance to margin of the available development layout.

Table 8.10 Drill Hole Intersection Summary for Doris Central

Counts of drill holes by mine level (each 10 m vertical height) and distance to preliminary Stage 2 development					
Mine Level (m in tUTM)	**Level Elevation (m asl)**	**Distance = 0 m**	**0 m > Distance ≤ 5 m**	**5 m > Distance ≤ 10 m**	**Distance > 10 m**
4900	-100	4	10	4	0
4980	-110	11	5	5	0
4880	-120	5	3	5	0
4870	-130	4	7	6	1
4860	-140	2	6	5	0
4850	-150	5	5	4	0
4840	-160	2	3	0	0
4830	-170	1	5	2	0
4820	-180	6	4	2	0
4810	-190	2	4	1	1
4800	-200	1	1	1	1
4790	-210	1	1	1	4
4780	-220	0	1	0	2
4770	-230	0	0	3	3
4760	-240	1	0	2	2
4750	-250	0	1	2	0
4740	-260	0	0	1	0
4730	-270	0	0	1	0
Totals		**45**	**56**	**45**	**14**

To further define the potential impact of historical drill holes on underground inflow, a statistical analysis was completed. The analysis required an assumed probability of interception for each interval distance away from the proposed Doris Central development. The following probabilities were assigned:

Table 8.11: Distance from Mine Development Assigned to Drill Hole Interception Probability

Probability of Interception	Distance from Proposed UG Development
95%	0 m
50%	0 m < dist ≤ 5 m
15%	5 m < dist ≤ 10 m
2%	dist > 10 m

The probability of interception was then coupled with an assumed probability of 25% that any given drill hole is open and connected to a water source (Doris Lake) and will discharge at the maximum rate. This probability is assumed and, as conditions of exploration boreholes cannot be assessed, must be viewed cautiously. The probability of flow from these drill holes could be significantly higher.

The probability of encountering flowing drill holes during the development of Doris Central was derived using a binomial distribution to determine the combined probability of drill-hole interception and the probability of drill-hole connection to a water source. The results of this analysis are summarized in Figure 8.17, Figure 8.18, and Figure 8.19, which display the probability of discharge at the maximum rate versus the number of drill holes intercepted with flowing water.

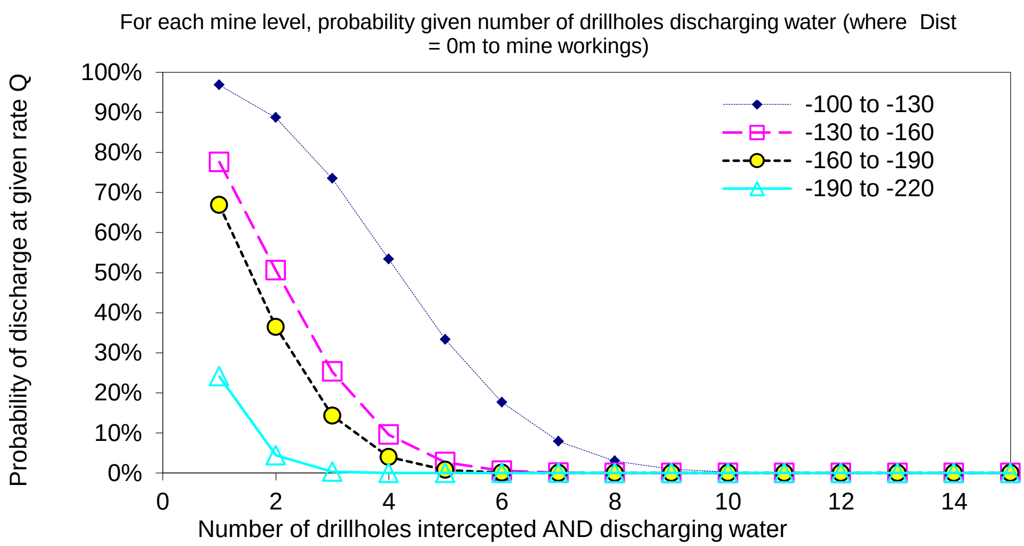


Figure 8.17: Probability of Drill Hole Discharge for Distance to Development = 0 m

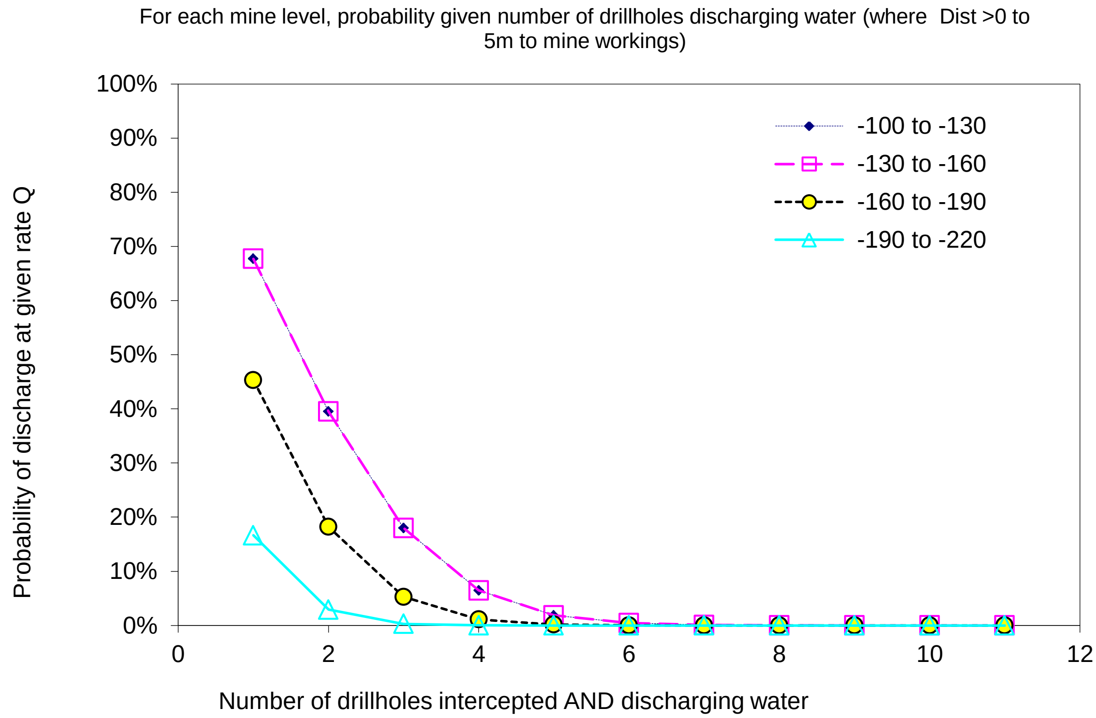


Figure 8.18: Probability of Drill Hole Discharge for Distance to Development = >0 to 5 m

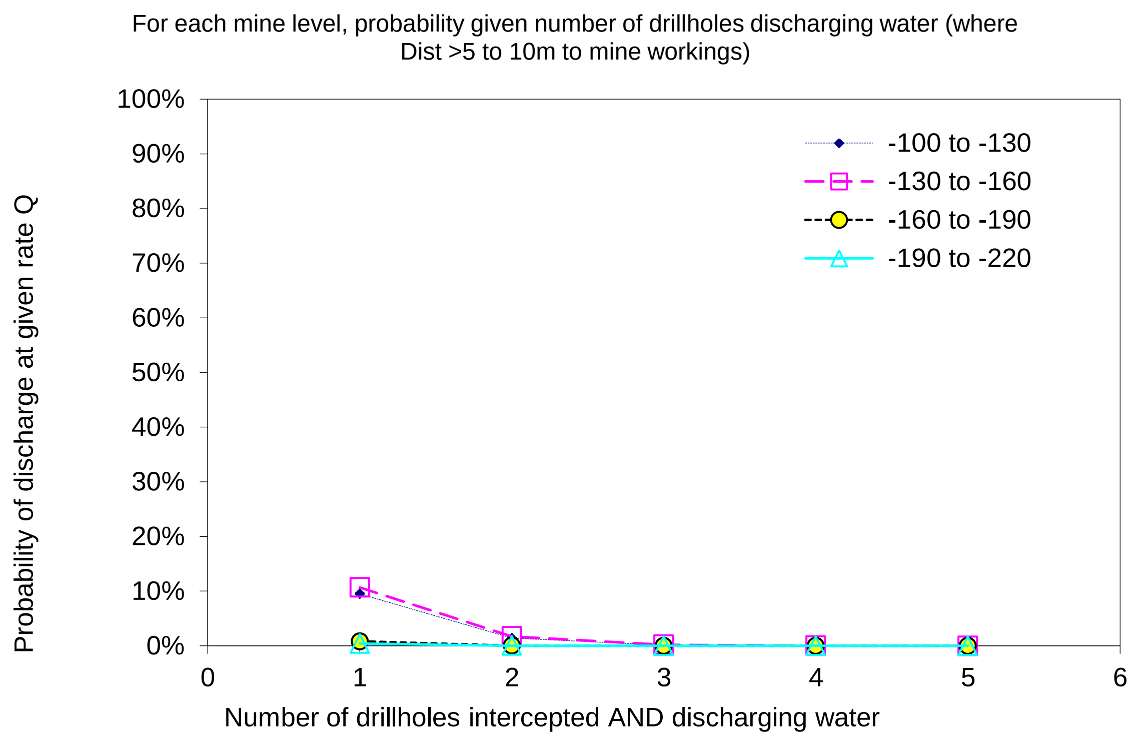


Figure 8.19: Probability of Drill Hole Discharge for Distance to Development = >5 m to <10 m

Based on the probability analysis, the number of flowing drill holes encountered could likely be far less than that indicated by the total number of exploration drill holes intersected, in both number and flow rate, at any given mine level. However, due to the assumptions based upon best engineering judgment for drill-hole interception probability and drill-hole condition probability, significant uncertainty and risk remain. SRK has assumed that high inflows are likely to be encountered.

The preceding descriptions of drill-hole intersection and flow potential focused on Doris Central only. At this time, the same probability of occurrence should be assumed for Doris Connector, as the risks associated with these high inflows are the same.

Inflow from a single NQ exploration drill hole has the potential to be on the order of the bulk bedrock flow from two relatively large stopes (NQ drill hole = 2,700 m^3/d; reference stope H = 1,049 m^3/d).

8.7 Water Management

Available data and sensitivity analyses suggest uncontrolled flows from drill holes and high permeability structures have the greatest potential to add significant inflow for any given individual stope. For drill holes, based on the current state of knowledge of drill-hole condition and potential inflow volumes, the combination of reasonable probability and potentially major-to-catastrophic consequences make this a significant risk.

High inflows could occur in stopes, declines, or ramps. The height at which a drill hole was intersected could make it relatively difficult to plug, even if proper equipment were available. For instance, intersecting a drill hole that is immediately above the floor would be virtually impossible to plug without further blasting. Additionally, operational challenges exist for water handling.

Furthermore, there are other factors that need to be considered. Water would likely be pumped up a decline that passes through permafrost and sub-zero ventilation temperatures are maintained, possibly for long distances. Pumping equipment and lines may require heating. Inflow water quality, at least during initial mining in a given area, will have elevated salinity, requiring specific management. Lastly, intersection of open drill holes in a decline or ramp heading could flood that area, if sufficient pumping equipment were not available, leading to significant lost time.

In any inflow scenario, the mine planning needs to consider the risk of uncontrolled inflow as a consequence of procedural or equipment failures and to have a contingency plan in place to deal with this situation. Situations in which inflows have caused significant problems or loss of the mine can usually be traced back to incomplete pre-planning for the event and/or a failure to conform to mine plan and operating procedures related to mitigating these large inflows.

8.7.1 Structurally Controlled Inflows

It is essential that potential inflow from structural features be part of the ongoing risk analysis for mining in areas of known or suspected structure. This inflow needs to be considered during mining, planning, mitigation, and contingency measures. The measures required will need to consist of, but not be limited to:

- Geological mapping and modelling of structure in the mine envelope,
- Mine planning to incorporate geological modelling to avoid or reduce exposure to these features,
- Probe drilling and grouting programs to be part of standard mining practice when approaching known or suspected features,
- Contingency measures in place to allow for excessive inflow,
- Ability to pump excessive inflows, and
- Ability to treat and/or store sufficient short-term volumes to avoid environmental discharge non-compliance.

8.7.2 Inflow Related to Historical Drill Holes

Inflow from intersected exploration drill holes will need to be planned for and dealt with in a similar fashion to structural inflows. However, mitigation techniques may differ significantly. The mine plan needs to consider known and suspected locations of drill holes and integrate appropriate mitigation measures. These measures need to consist of, but not be limited to

- Integration of drill-hole plans with ongoing mine planning to avoid or reduce exposure to these features.
- Probe drilling and grouting programs to be part of standard mining practice.
- When encountered, a flowing drill hole should be remediated prior to continuing work.

Standard mining procedures in these areas need to ensure that specialized equipment and techniques are available for stopping flowing drill holes and sealing sufficiently to allow for safe operation to continue. Contingency measures should include:

- The ability to pump excessive inflows, and
- The ability to treat and/or store sufficient short-term volumes to avoid environmental discharge non-compliance/

8.7.3 Cold Weather Management

Due to the low average annual air temperatures, all water collection systems will require some form of heating if exposed to outside air. Pipelines, retaining tanks, and, if necessary, pumping stations may require heat tracing of sufficient wattage to allow unrestricted flow at extremely cold temperatures (<-40°C) and all pipelines should be free-draining. Sufficient backup systems should be available in the case of any failures.

8.7.4 Additional Mitigation Options

Additional inflow mitigation options exist that could be incorporated into the mine plan. Such options could include

- Planning development and stopes to avoid areas of known higher permeabilities or exploration hole densities
- Grouting over individual stopes
- Installing watertight bulkheads at key locations
- Scheduling mining to minimize the total area open at a given time by sealing off areas that are mined out
- Using a mined-out stope to provide surge capacity
- Constructing drainage adits at highest stope elevations prior to development, with mining commencement at lowest elevations

These options integrate mine planning directly with water management. Instead of dealing with high inflows solely on a case-by-case basis, modification of the mine plan to integrate water management features, if economically feasible, would provide the best form of risk reduction.

Implementation of a number of these strategies would provide flexibility in the manner of response to a high-inflow event. In practice, due to the heterogeneous nature of the fractured bedrock groundwater system, most inflow locations to the mine will not be known until mining is underway. Ultimately, management plans will aim to minimize the total inflow at any given time.

8.7.5 Water Discharge

Baseline water quality indicates high salinity and, potentially, slightly elevated concentrations of certain nutrients (e.g., nitrogen) and dissolved metals (e.g., zinc). While it is anticipated that inflow water quality at any given area will trend towards fresher, lower-concentration water quality as recharge from Doris Lake infiltrates into the groundwater system, handling and discharge of inflow water will require special treatment.

HBML is currently in the process of assessing a marine discharge option for the Doris area. In general, under this plan, water from the underground will be pumped to Tail Lake, from where it will be directed to a diffuser in Robert’s Bay. Treatment options are being investigated to handle nitrates and certain other parameters in the tailings water.

8.8 Mitigated Inflows and Dewatering Sequence

Realized inflows will be a function of the hydrogeological setting and of the specific water management mitigation strategies that are implemented. Proper mitigation strategies will reduce, though likely not eliminate, the potential for sudden problematic high inflows. Assuming that water management plans are developed for handling open exploration drill holes and individual geological structures, bulk rock inflow will define water handling requirements over the life of mine.

Cumulative inflows for the entire mining area were calculated using the base case hydrogeological conditions presented in Section 8.5 by adding inflows for individual stopes and related access development plus the decline. Stope areas used for cumulative inflow estimation are shown in Section 8.6.

For the purpose of estimating cumulative inflows and the dewatering sequence, each of the stopes was assumed to be developed on an incremental basis. That is, only one stope is mined at any given time, and inactive stopes are backfilled but the backfill is assumed to have no effect on reducing inflow. The decline was assumed to be constructed prior to mining and thus inflow from the decline is constant. Ramps (including drifts, crosscuts, etc.) are assumed to be developed in direct proportion to each mining area, thus ramp inflow increases as each additional stope is opened. Stopes are assumed to be completely developed.

Table 8.12 summarizes inflows into 10 individual stopes and development access using the 3-D model (Model 1). Values in the Total Flow column represent cumulative inflow to a given stope number plus inflow to any preceding stope (e.g., Total Flow for Stope 10 equals the inflow to stope 10 plus inflow from Stopes 1 to 9).

Table 8.12: Summary of Inflows

Stope	Stope Vol. (m^3)	Flow Stope (m^3/d)	Flow Backfill (m^3/d)	Flow Decline (m^3/d)	Flow Ramp (m^3/d)	Total Flow (m^3/d)
A	6,000	270	0	975	185	1430
B	45,000	553	270	975	370	2168
C	18,000	278	823	975	370	2446
D	45,000	411	1101	975	555	3042
E	35,000	442	1512	975	555	3485
F	76,000	661	1955	975	740	4330
G	78,750	461	2615	975	740	4791
H	725,760	1049	3076	975	925	6024
I	60,000	624	4124	975	925	6648
J	15,000	172	4748	975	925	6820

Source: U:\1CH008.053_GW Mgt & Phase 2 GW\020_Project_Data\SRK\3D Doris Model\HOPE BAY_Flow Estimation_20110416.GF.xls

Notes:

1. Flow Stope represents inflow to a given stope at full size.
2. Flow Backfill represents cumulative inflow to stopes up to that specific number (e.g., for Stope 3, the Flow Backfill represents flow into Stopes 1 and 2, which are assumed to be mined and backfilled. Backfill has no effect on inflow rate.
3. Flow Decline represents inflow to the main decline when fully developed.
4. Flow Ramp represents inflow to spiral and ramp associated with a given stope.
5. Total Flow is the cumulative inflow for any row in a table. Total flow for Stope 1 represents inflow to that specific stope, the decline, and the ramps. Total flow for Stope 10 represents cumulative inflow to all stopes, plus the decline and cumulative flow to all ramps and spirals.

It is recommended that the final cumulative inflow number of ~7,000 m^3/day be used for planning purposes. In terms of incremental flow from open drill holes or geological structures, planning for 7,000 m^3/day provides spare capacity for at least the first two-thirds of this mine schedule. If additional water management mitigations can be integrated into the mine plan, such as bulkheads, cemented backfill, grout covers, etc., cumulative inflows should be less than estimated here, providing capacity to manage high flows even towards the end of operations.

This approach to inflow estimation is dependent on a thorough and properly implemented water management plan.

8.9 Water Rights

Water rights for the project will be obtained through application for a water license from the Nunavut Water Board (NWB). The application will be reviewed by NWB with input from the Nunavut Impact Review Board and the Nunavut Planning Commission.

HBML is in the process of amending the current water license to allow development within the Doris Lake talik.

8.10 Estimated Capital and Operating Expenditures

Capital and operating costs for water management are being developed independently by Hatch and HBML and are not presented here.

8.11 Hydrogeological Risk and Sensitivities

SRK has identified the following risks and sensitivities associated with hydrogeological conditions within the Doris Central and Connector deposits:

- Possible catastrophic inflows associated with the high hydraulic conductivity feature(s) found within the Doris Central ore zone. If the feature(s) has/have a direct hydraulic connection to the overlying Doris Lake, then inflows could exceed pumping capacity and result in unscheduled delays and costs.
- Presence of unidentified high hydraulic conductivity structures. Presently only a single high-hydraulic conductivity feature has been identified within the Doris Central and Connector deposits; however, data are currently insufficient to rule out the possibility of additional structures. Should mine workings encounter a large unidentified, high-permeability structure, then inflow could exceed pumping capacity causing unscheduled mine closures. Probe drilling and grouting programs will need to be followed.
- Hydraulic compartmentalization. The presence of lower hydraulic conductivity zones could restrict inflows to certain underground areas, leading to slower dewatering and, subsequently, relatively high pore pressures existing for longer than estimated from current models. The possibility exists for diabase dykes to cause compartmentalization if across-dyke conduits have limited spatial extent. Unidentified low permeability faults or lithologies could also lead to hydraulic compartmentalization.

- Packer test intervals are typically selected to identify high hydraulic conductivity features. This sampling procedure could lead to bias in hydraulic conductivity statistics causing overestimation in inflow estimates from numerical models.
- Underestimation of hydraulic conductivity due to scale effects. Packer tests typically only sample a very small volume of the aquifer, with the zone of influence typically only extending approximately 10 m into the formation (Bliss and Rushton 1984). As a result, large spatially restricted, high-hydraulic conductivity features, which would otherwise be incorporated by larger scale testing methods (i.e., longterm injection testing), may be missed.
- Interception of multiple unplugged historical drill holes. When encountered, these features should be plugged to eliminate inflow before continuing mining. Failure to properly plug boreholes could lead to mine workings intersecting multiple flowing boreholes, thereby causing inflows to exceed pumping capacity.
- High inflows related to drill holes or structures could cause local effects on Doris Lake or, potentially, short-term lowering of Doris Lake water levels to a marginal degree.
- Groundwater quality will likely be saline, requiring treatment or marine discharge.

Recommendations for Stage 3 data collection are summarized in Section 11.

9 Underground Geotechnical Assessment for Doris Central and Connector

The current review of Doris Connector and Central deposits focused on confirming, refining, and increasing confidence in the structural and rock mass understanding. In general, rock types within the Doris Connector and Central area are strong, falling within the Fair to Good rating for RMR_{90}. In terms of rock quality, the competency of the hanging wall (HW), mineralized zone, and footwall (FW) is relatively homogenous both along strike and down dip.

The Stage 2 geotechnical assessment for underground design at Doris Connector and Central utilized the following approach:

- **Selection of structural domains and structural feature sets:** Prevailing large-scale structures, as discussed in Section 7, were used as a framework for the review and development of structural domains. Representative large- and small-scale structural sets were assigned to each domain.
- **Rock mass assessment and generation of geotechnical parameters:** A rock mass assessment was undertaken to review the variability of rock mass quality at Doris Connector and Central. Because of the simple nature of the rock mass, geotechnical domains were not constructed, but rather geotechnical parameters were applied to the main lithological wireframes present in the current 3-D model.
- **Kinematic evaluation:** A kinematic assessment was performed utilizing the small-scale features derived from the structural and oriented core evaluations.

After obtaining representative rock mass and structural parameters, the excavation design parameters were derived using the same approach as detailed in previous work to ensure consistency (AMEC 2008, SRK 2009).

9.1 Structural Domains and Selection of Structural Feature Sets

Structural domains and related structural feature sets were defined based on a combination of findings presented in Section 7 and the oriented core analyses conducted through the geotechnical investigation.

Based on the small sizes of the Doris Connector and Central mining areas and on the fact that the majority of structures are steeply dipping to sub-vertical, a simple division of two structural domains was created (Figure 9.1). This preliminary division is based on where the Shear 1 and 2 structures potentially influence local rock fabric around the mining areas (roughly defined as the northern extent of the Doris Central area). The geology of the Doris Connector and Central areas is also relatively homogenous, conforming to a basic structural framework.

9.1.1 Rock Fabric Assessment

Orientation of joints and foliation was extracted from 2008 and 2011 drilling data (Figure 9.1). Figure 9.2and Figure 9.3 present the results of oriented core drilling per drill hole; Figure 9.4 and Figure 9.5 present the deposit scale foliation assessment with depth and along strike. Major foliation and joint sets indicate strong correlation between previous findings and the 2008 drilling program. Table 9.1 and Table 9.2 list the joint sets, per structural domain, that were selected for use in the kinematic assessment. These tables do not include the interpreted major structures as discussed in Section 7 and presented in Figure 7.x.

Although a number of fault structures are observed to pass through the area of major infrastructure, these are not expected to be too difficult to traverse using conventional mining and support practices, which may include shotcrete. These structures will probably have a localized influence on stability; disturbance zones of less than one metre are noted for major structures in the Doris North area.

The rock fabric interpretation for Doris Central has been improved on the 2008 work, refining and therefore reducing selected joint sets. A review of mapping data collected at Doris North underground shows that 3–4 dominant joint sets are present. The variation of joint sets seen along the strike length of the Doris deposit is potentially influenced by the proximity of drill holes to major structures. As additional data are gained through underground development and future geotechnical programs, the exact orientation of joint sets used in evaluations could likely be improved.

Table 9.1: Summary of Joint Sets for Doris Connector (excludes major structures)

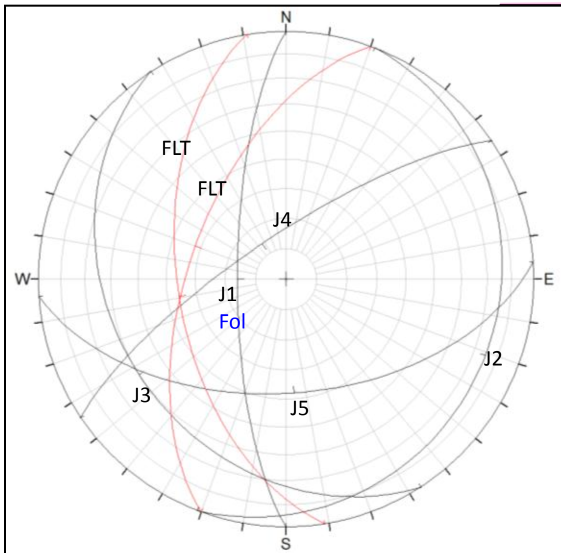
Joint Set	Dip (°)	Dip Direction (°)	Description	Friction Angle (°)	Comments
1	74	270	Foliation	26	Foliation parallel joint set
2	15	111	Joint	32	Prominent sub-horizontal joint set with variable dip direction range
3	30	237	Joint	32	Prominent shallow dipping joint set in west-dipping drill hole
4	76	326	Joint	32	Shear 1-2 parallel set masked by drilling bias
5	52	177	Joint	32	Scattered joint set observed in north-east dipping drill hole; including to account for drilling bias

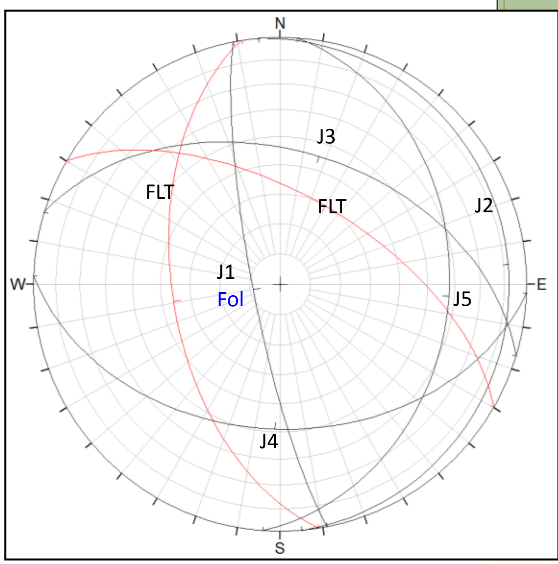
Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables\Table 9.1_Connnector Joint Sets.xlsx

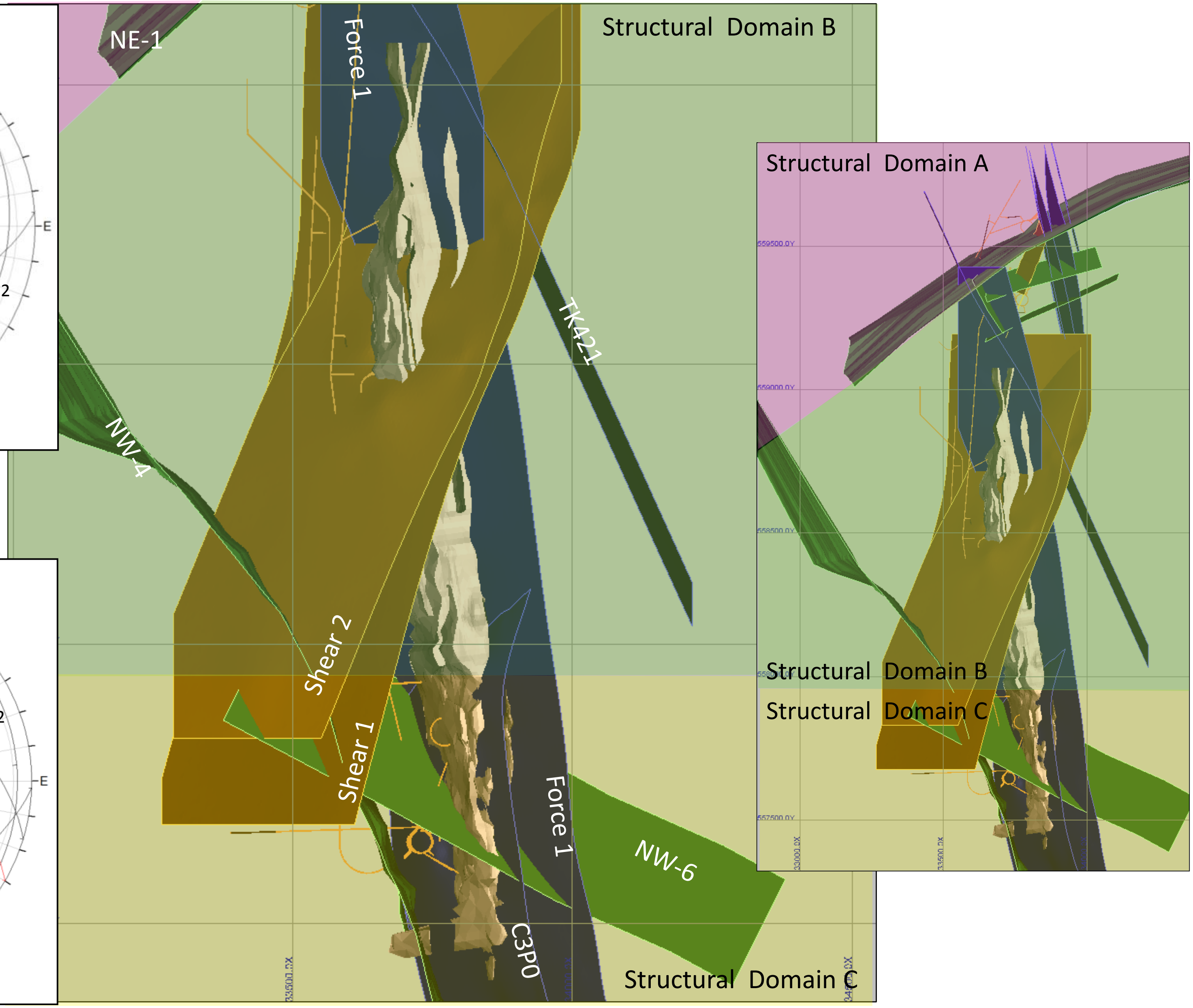
Table 9.2: Summary of Joint Sets for Doris Central (excludes major structures)

Joint Set	Dip (°)	Dip Direction (°)	Description	Friction Angle (°)	Comments
1	81	259	Foliation	26	Foliation parallel joint set
2	8	85	Joint	32	Prominent sub-horizontal joint set with variable dip direction range
3	45	17	Joint	32	Orthogonal joint set
4	41	182	Joint	32	Orthogonal joint set, conjugate to J3
5	32	94	Joint	32	Low angle, joint set observed in west-dipping drill holes

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables\Table 9.2_Central Joint Sets.xlsx







Inset shows relationship to 2008 structural domain A and B (division between domains based on NE-1 fault

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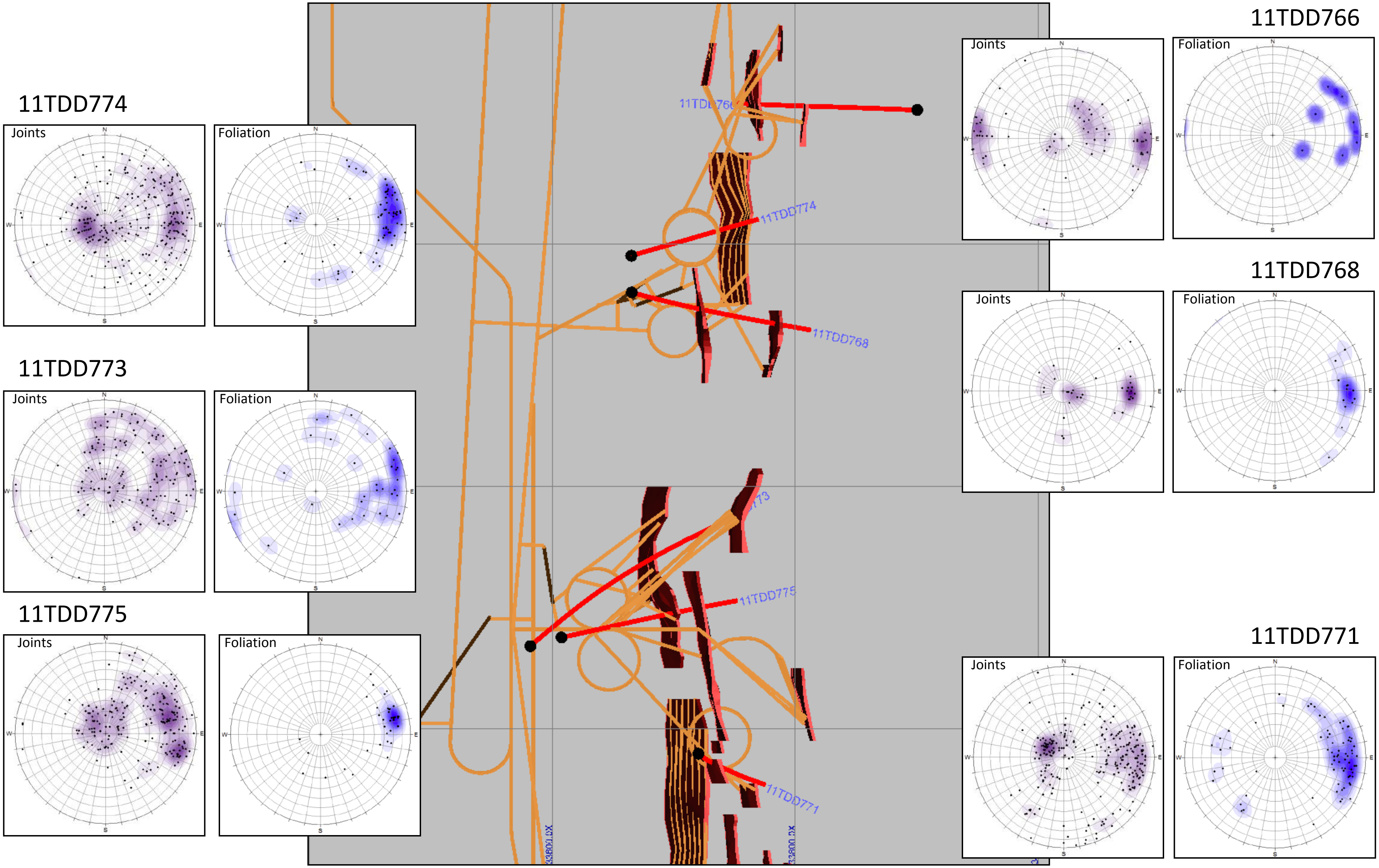
Doris Central and Connector

Doris Connector & Central Structural Domains

Job No: 1CH008.054
Filename: Figure9.1_Structural Domains

Hope Bay Gold Project

Date:	Approved:	Figure:
Oct-2011	RG	9.1



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Doris Connector Stereonet Profiles by Drill Hole

Job No: 1CH008.054

Filename: Figure9.2_DConnector Stereonets

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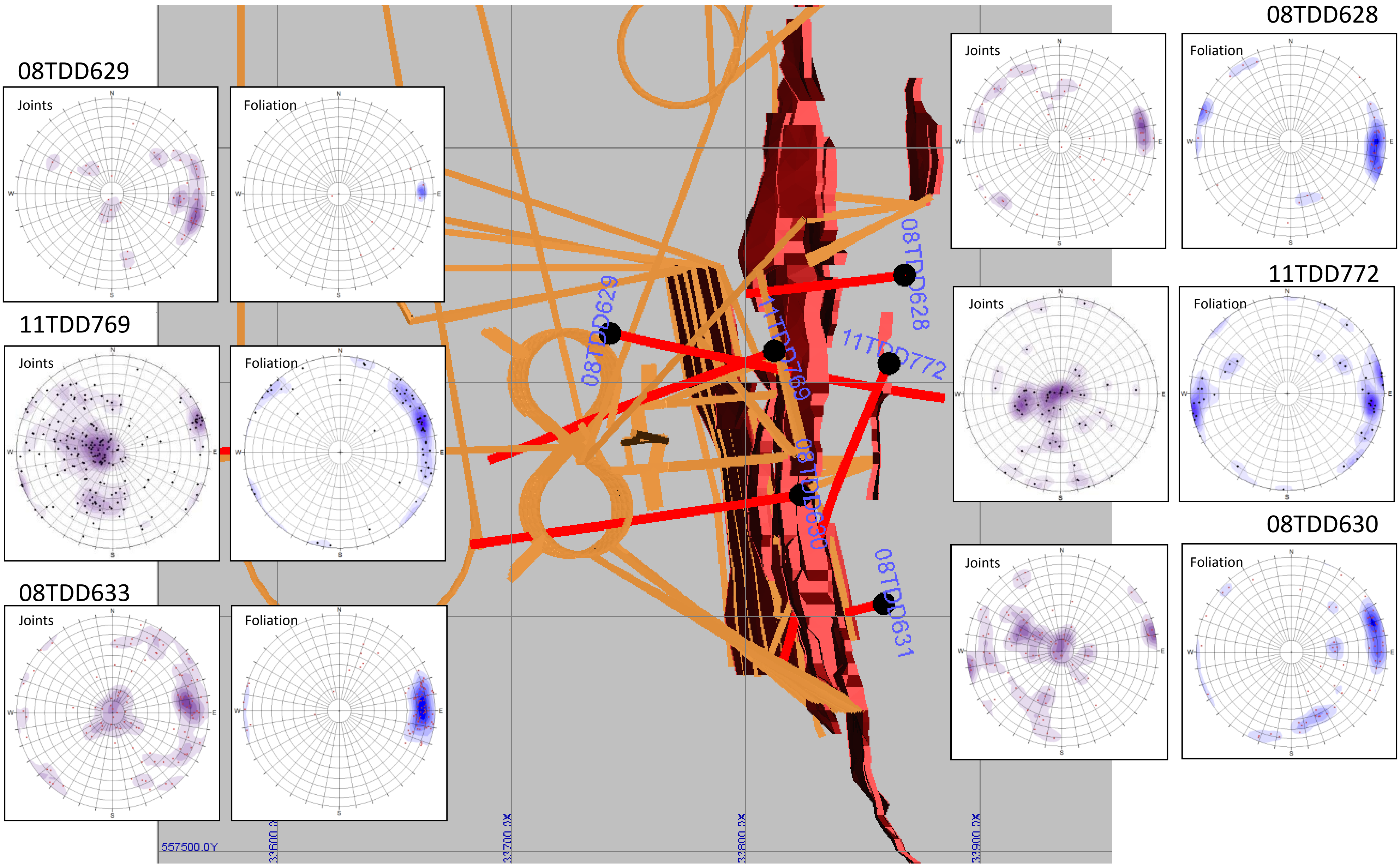
Date: Oct-2011

Approved: RG

Figure: 9.2



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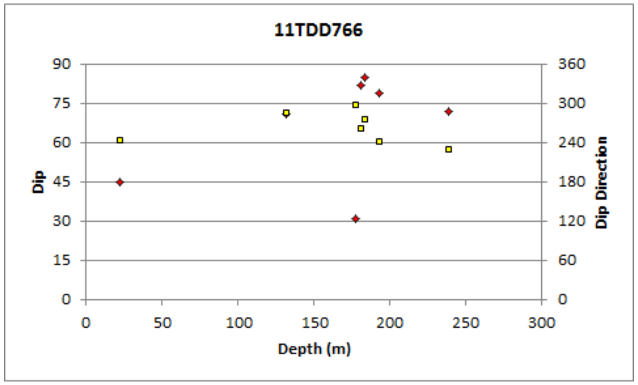
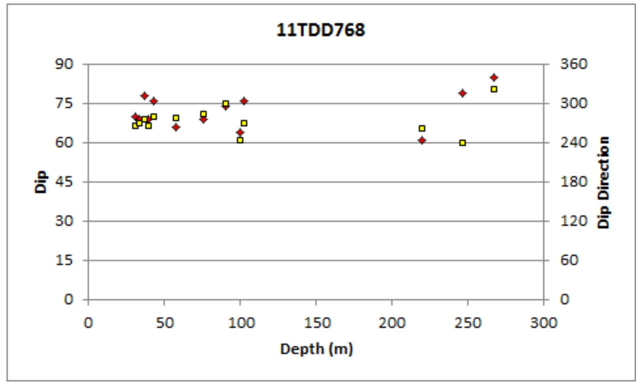
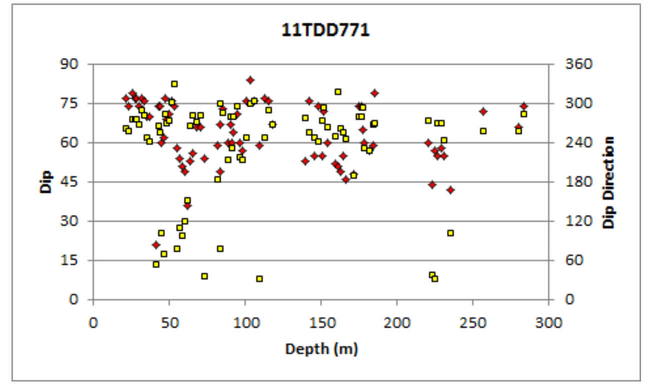
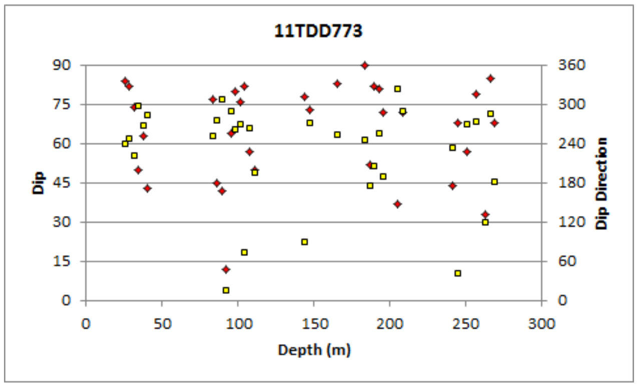
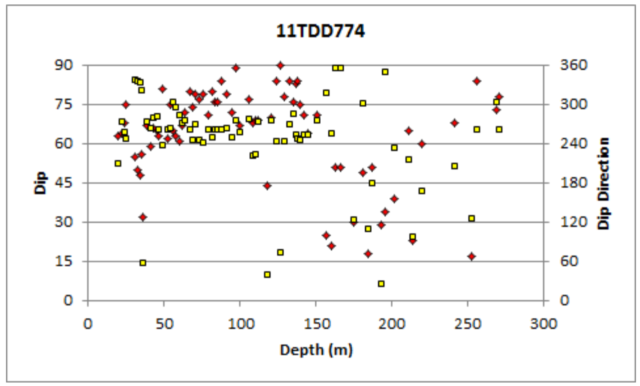
		Doris Central Stereonet Profiles by Drill Hole (2008 & 2011)
Job No: 1CH008.054 Filename: Figure9.3_DCentral Stereonets	Hope Bay Gold Project	Date: Oct-2011 / Approved: RG / Figure: 9.3

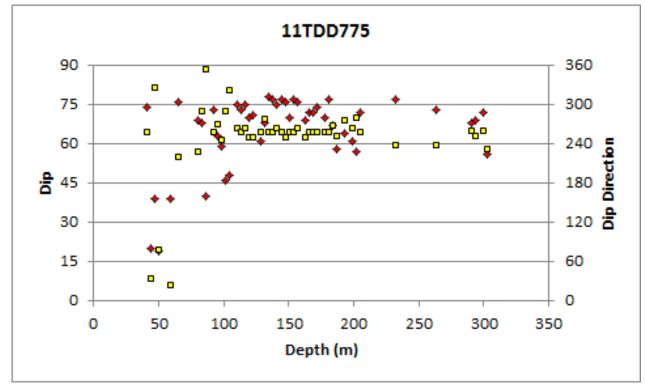












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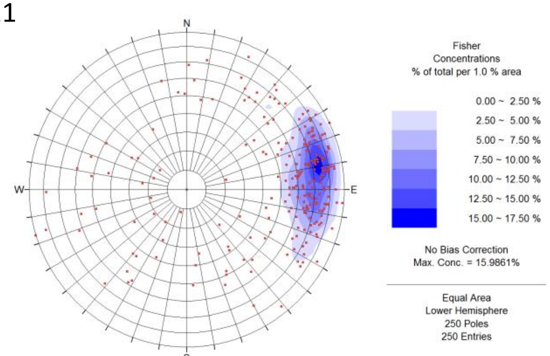

Foliation poles represent foliation dip and dip direction measured once per drilling run (3m) in oriented core holes

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Doris Connector Down Hole Foliation 2011 Data

Job No: 1CH008.054

Filename: Figure 9.4_Dconnector Foliation Data

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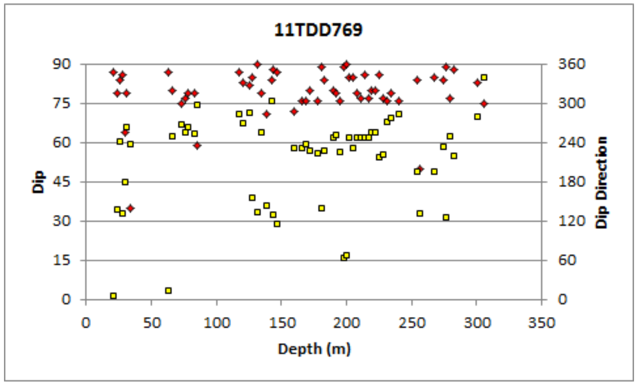
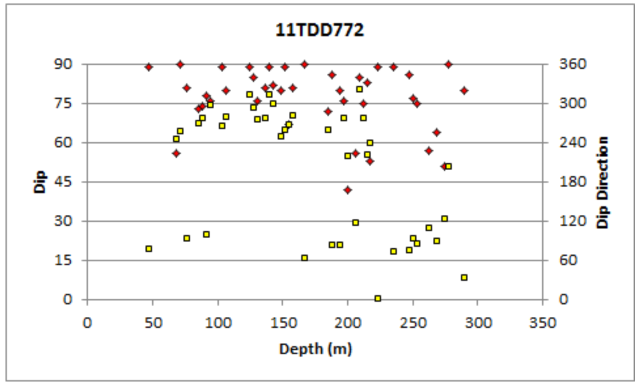
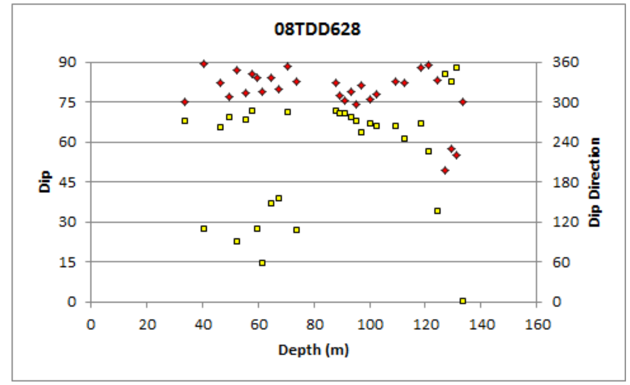
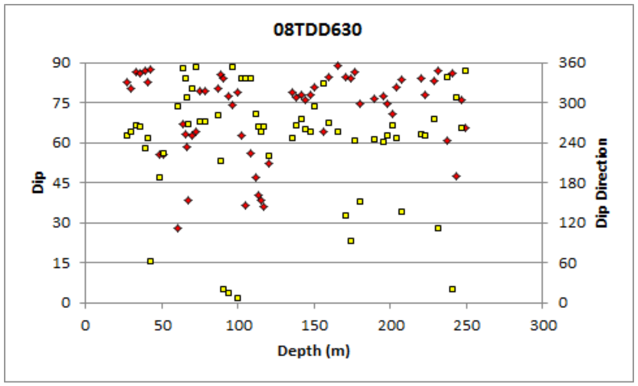
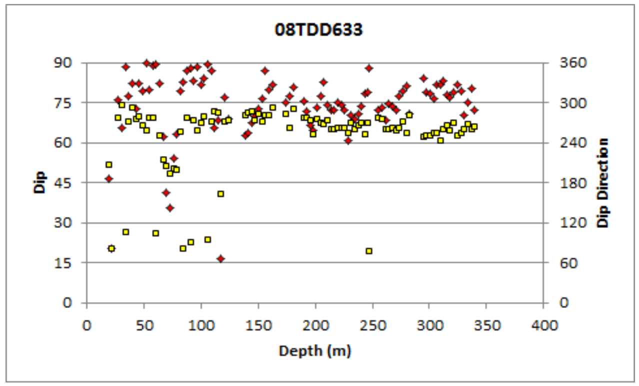
Figure: 9.4

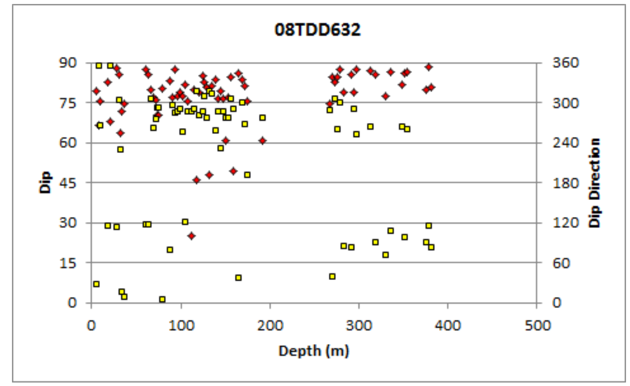




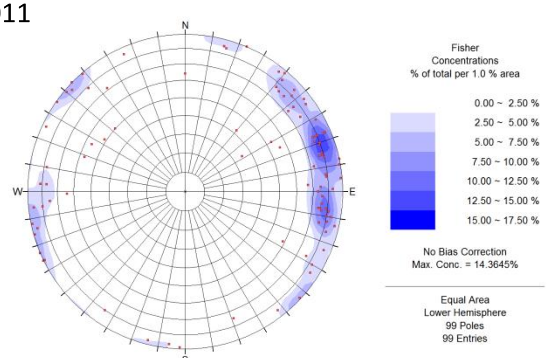




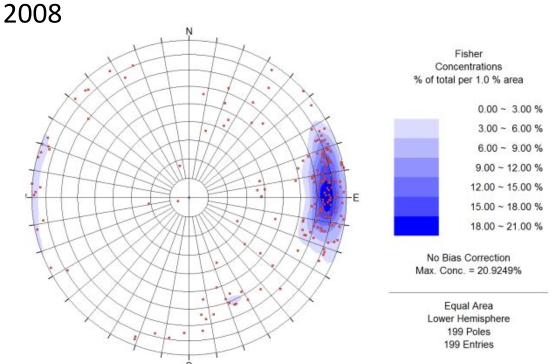




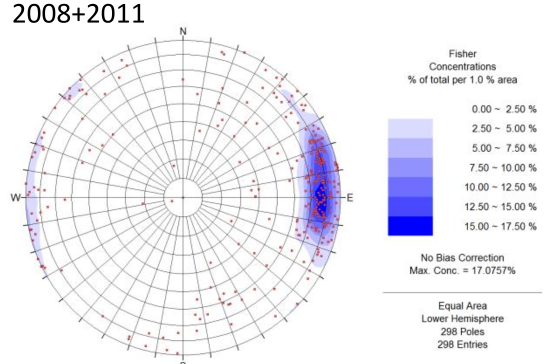
2011



2008



2008+2011



Foliation poles represent foliation dip and dip direction measured once per drilling run (3m) in oriented core holes

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Doris Central and Connector

Doris Central Down Hole Foliation 2008 & 2011 Data

Job No: 1CH008.054
Filename: Figure9.5_DCentral Foliation Data

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Date: Oct-2011 | Approved: RG | Figure: 9.5

9.1.2 Joint Conditions

Joint conditions, including roughness, (wall) alteration, and fill, were logged using the Laubscher rock mass rating system (Laubscher 1990). The results presented here take into account rock types, along with their applicable friction angles (for input into the kinematic analyses).

Joint conditions within the undifferentiated mafics and C-type basalts were logged as being fairly similar, with a wide range of roughness and fill ratings. A roughness rating of 7 (planar rough) was established for both, with an average fill rating of 7 (non-softening medium) used to represent the spread of fill ratings between soft fill and no fill. Alteration of wall rock is largely absent. Using this combination of joint conditions, a friction angle for the mafics and basalts was established at 32° (also refer to Barton et al. 1974 and Barton 2002).

Foliation is present, is locally pervasive, and constitutes a high percentage of measured joints and mechanical breaks. Joints along foliation are typically planar smooth surfaces, with typical fill conditions of chloritic sheen to no fill. Data from the 2008 and 2011 programs also indicate relatively consistent foliation dip, with the dip direction following vein trend and extending to depth.

Based on findings from the structural review, the detailed rock mass evaluation, and laboratory results from fault gouge material at Doris North (tested in 2008), a friction angle of 26° is considered representative for all fault zones.

9.2 Rock Mass Assessment

A thorough analysis of the geotechnical database was undertaken for the Doris Connector and Central areas. Parameters assessed include rock quality designation (RQD), fracture frequency per metre (FF/m), empirical field estimates of intact rock strength (IRS), field (point load) and laboratory strength (uniaxial compressive strength (UCS)), and RMR_{90} (after Laubscher 1990).

In addition to the consideration of previous work, the following resources were used to determine rock mass parameters for the major rock types at Doris:

- Appendix H: Point load and laboratory UCS results
- Appendix I: Detailed core photo review

The rock mass assessment was completed based on the HBML-supplied lithological wireframe model. Where possible, SRK and historical HBML geotechnical data were evaluated together to optimize parameter definition. Geotechnical domains were created by considering varying lithological, structural, and geotechnical conditions; however, as continuity within geotechnical parameters is strong along the Doris system, the lithological wireframes form the basis for the geotechnical domains.

The review of historical and current geotechnical data suggests that rock mass quality is lowest in highly foliated intervals and fault zones. However, highly foliated zones are typically localized to narrow high-strain zones associated with ductile shearing and vein emplacement and are not expected to have a significant control on stability. As discussed in Section 7, brittle fault zones are also considered to be modest with narrow damage zones (less than one metre). Rock mass character is summarized below with regard to geotechnical domain.

Undifferentiated Mafics

The undifferentiated mafics geotechnical domain forms the majority of the Doris North rock mass (Figure 9.6). The mafics, which include pillow basalts and gabbros, are typically competent, exhibit a well-defined foliation, host a fracture frequency averaging 1.3, and possess an RQD exceeding 95%.

C-type Basalts (Vein separation)

The C-type basalts between the main veins form a relatively minor percentage of rock mass within the Doris Connector and Central deposits. As only minor rock mass data exist for this domain, parameters were adopted from the undifferentiated mafics domain. This arrangement has been confirmed through a detailed core photo and drilling database review.

One noticeable variation between the C-type basalts and the undifferentiated basalts is the relative lack of foliation intensity. The average RMR for this domain is 63.

Vein

The vein domain, defining an approximate area of mineralization, forms only a minor volume of the rock mass. Data gained during the 2011 evaluation were combined with previous reporting to generate rock mass parameters laid out in Table 9.4. The vein domain is considered competent, with fracture frequencies below 1.0 FF/m and RQD exceeding 95%.

Some conflicting information is available for rock mass strength within the vein domain. Golder (2002) estimated strengths of 91 MPa, whereas URSA (1996) reported values of 55 MPa. Considering the current evaluation produced no UCS results for this small domain, the conservative approach has been taken, with 70 MPa being selected for the rock mass evaluation.

Foliation is weakly defined and is not considered to impact rock mass quality.

Diabase Dyke

As noted in Section 7, the diabase dyke is a highly competent geotechnical domain with no overprinting fabric. Rock mass data indicate the dyke typically hosts <0.5 fractures/m with correspondingly high RQD (>95%). Limited laboratory strength data suggest the dyke may exceed 200 MPa; 150 MPa has been adopted as the design strength. Design RMR is set to 70.

Contact Zone with Diabase Dyke

Although drilling data (Section 5) suggest that the diabase dyke contact (with the undifferentiated mafics) is generally competent, selected drill holes indicate that the contact may be locally weakened relative to the adjacent rock masses. Consequently, slightly conservative design values were adopted for the domain with fracture frequency, RQD, rock strength, and RMR set to 3.0, 85, 60 and 55, respectively.

Variability in rock quality between these domains was reviewed in detail through core logs, photographs, and laboratory results from current and historical drill holes. In general, variability is not found to be significant.

Findings from this review included apparent foliation strengthening from HW and FW rocks, directly adjacent to the mineralized zone (veins). Although rock mass conditions appear to benefit from alteration related to vein emplacement, it remains unclear whether these improved conditions will have a significant impact on mining or dilution at this stage.

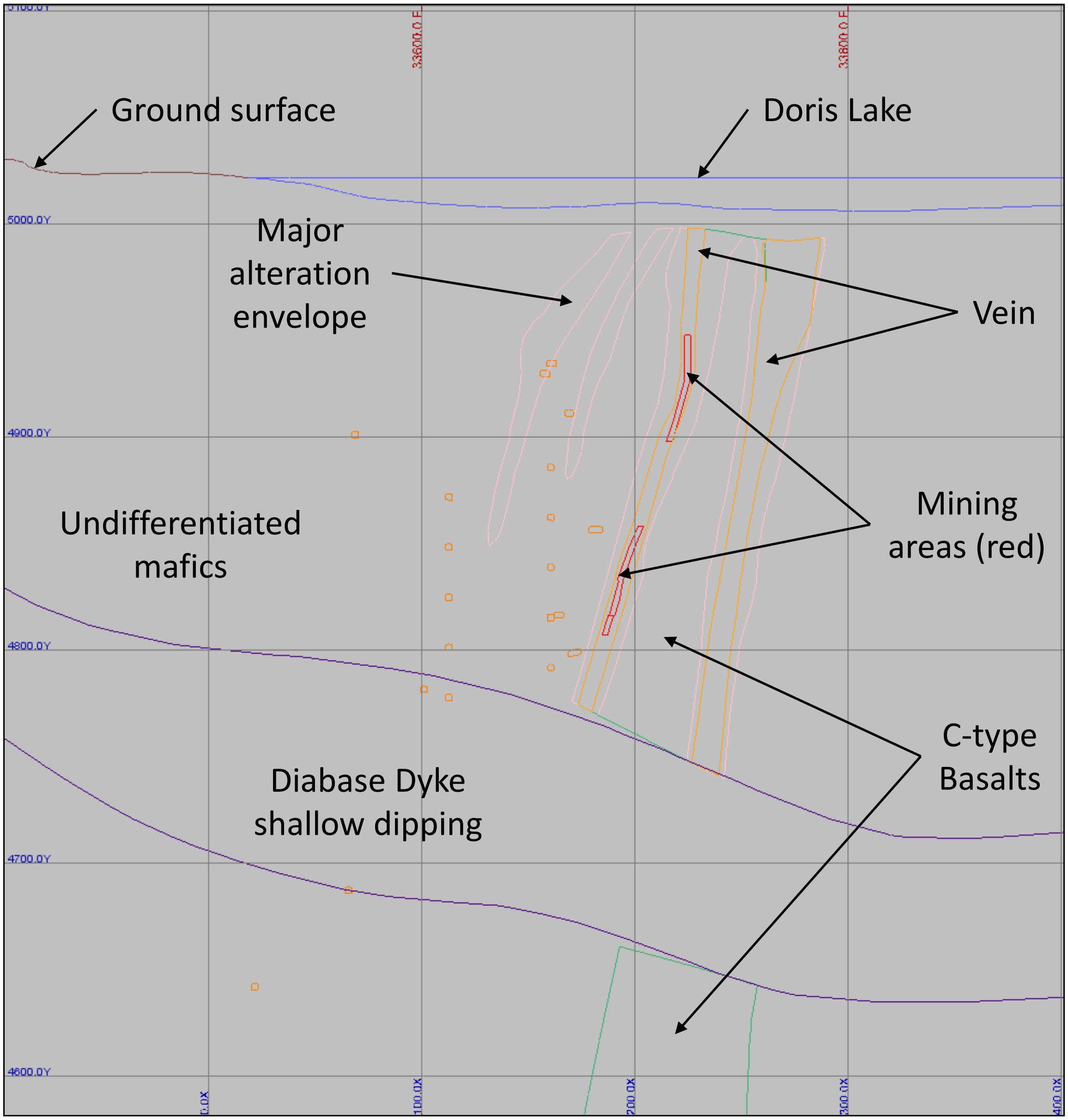


Figure 9.6: Doris Connector Geotechnical Domains (vertical section 558500N)

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\040_Figures\Geotech Figures

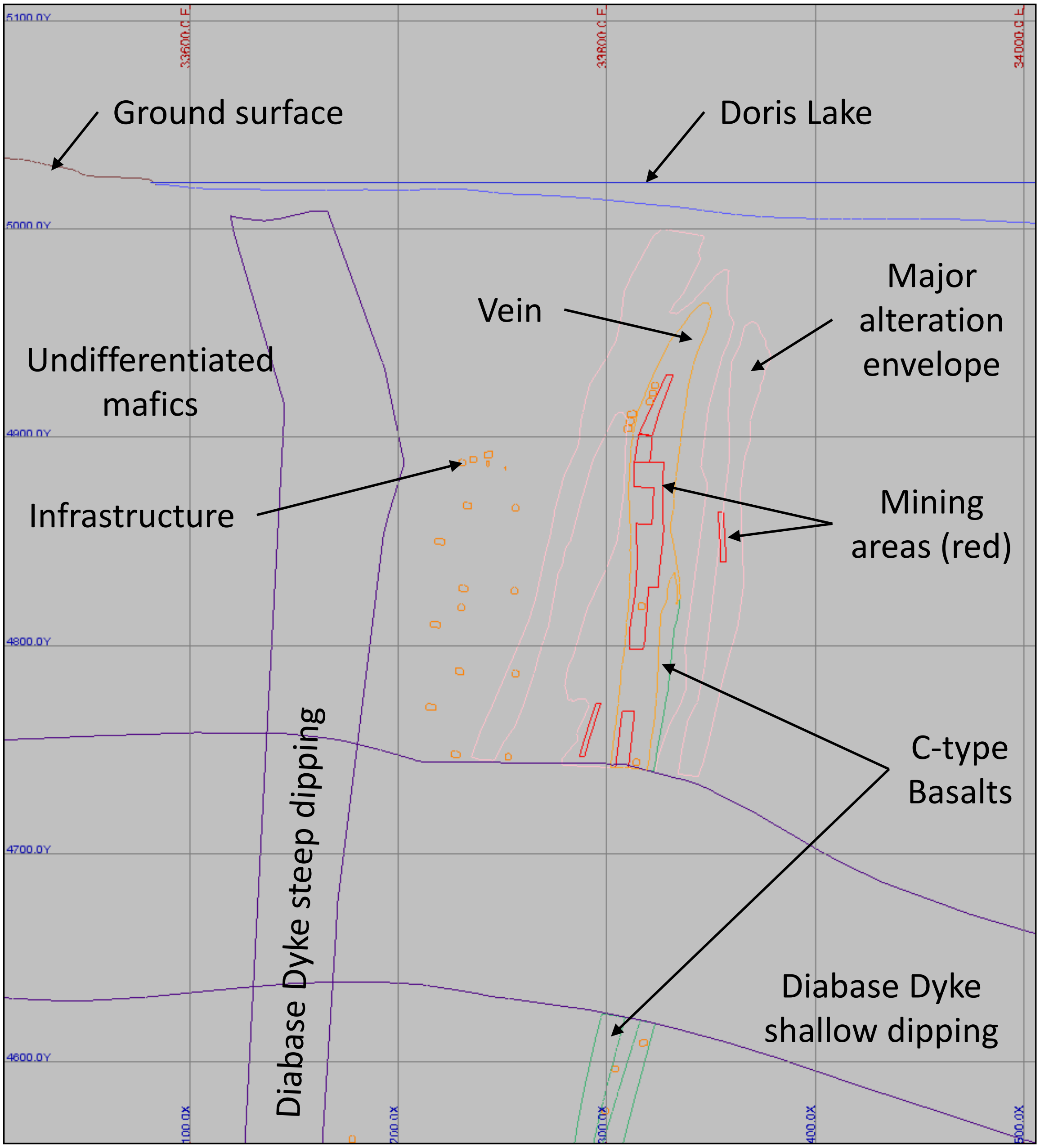


Figure 9.7: Doris Central Geotechnical Domains (vertical section 557680N)

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\040_Figures\Geotech Figures

Intact rock strength was estimated at 90 MPa for all undifferentiated mafics (based on URSA 1996, Golder 2002, and field tests during 2008 geotechnical logging). Recent laboratory strength testing from the 2011 sampling program suggests that this value is reasonable (Table 9.3); therefore, a HW and FW rock strength of 90 MPa is used during assessment. Strength anisotropy perpendicular and parallel to foliation is evident, with historical results indicating significantly stronger results normal to foliation—roughly 4:1 (URSA 1996).

As noted in the 2008 field program, the mineralized zone was under-sampled due to a lack of drill intersections and an average strength of 100 MPa was calculated. Drill intersections of mineralized zones were significantly improved in the 2011 program, and an average strength of 125 MPa was calculated. When considering the historical UCS data (range 26–91 MPa), a value of 75 MPa was used for design purposes in this assessment.

Rock mass parameters based on Barton's Q system were adopted for the evaluation and are presented in Table 9.4. This assessment considers all 2008 geotechnical drilling at Doris Central and additional photographic reviews undertaken on previous drill holes.

Table 9.3: Laboratory Testing UCS Results Summary

Major Rock Types based on wireframe			2011	2008		All years
			Mafic Volcanics	**Mafic Volcanics**	**Diabase**	**Mafic Volcanics**
UCS, Density and Moisture Content	All Results (MPa)	Avg	87	57	192	68
		Stdev	39	30	122	36
		#	15	26	4	41
	Excluding failure on existing plane (MPa)	Avg	99	80	285	91
		Stdev	34	39	63	33
		#	12	9	2	20
	Wet Density (Kg/m^3)	Avg	2855	2898	2908	2893
		Stdev	91	143	121	118
	Dry Density (Kg/m^3)	Avg	2849	2896	2891	2888
		Stdev	99	143	140	123
	Moisture Content (%)	Avg	0.21%	0.07%	0.62%	0.17%

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables\Table 9.3_UCS Summary.xlsx

Table 9.4: Rock Mass Parameter Summary for Doris Connector and Central

Major Rock Types (based on wireframes)		Undifferentiated mafics	C-type basalts	Vein	Diabase	Contact zone: mafics and diabase
		Range	Range	Range	Range	Range
Field Parameters	RQD (%)	75-100	85-100	85-100	90-100	50-100
	FF/m	0-2.5	0-3.0	0-1.3	0-2.5	0-20.0
	Emperical IRS (R value)	R4-R5	R4-R5	R3-R5	R4-R5	R3-R4
Laboratory Parameters	UCS (MPa)	60-120	90-190	26-91	152-329	-
	Dry Density (Kg/m^3)	2623-3157	2801-2899	2622-2674	2987-3157	-
	Moisture content (%)	0.0-1.6%	-	0.04-0.1	-	-
Design strength (MPa)		90	90	70	150	60
RMR_{90}		53-80	48-81	49-80	53-81	26-70

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables\Table 9.4_Rock Mass Parameters.xlsx

Note:

1. All data consider both historical and current geotechnical data. Refer to text for methodology description.
2. UCS results do not consider failures on existing planes (i.e. veins or foliation)
3. Accepted design strength is based on previous and current empirical and laboratory results.
4. (-) indicates that ranges were not determined; generally given the lack or absence of data

10 Underground Excavation Design

The design of underground excavations benefits from a number of well-established empirical and semi-empirical rules. These rules enable estimates to be made of the expected mining conditions and support requirements on the basis of a detailed description of the rock mass. The design procedure involves two steps: the quality of the rock mass is rated using a pre-defined classification system; the expected performance of the underground openings is predicted using an empirically derived correlation with the rock quality. This section discusses the excavation design methodology and recommendations based upon the rock mass characterization discussed above, the in-situ stress regime, and proposed mining methods.

The assessment of stope stability and support requirements considered stope size and potential support/reinforcement requirements for both unsupported and supported stoping methods.

The good rock quality at Doris Connector and Central suggests that the deposit is amenable to unsupported stoping methods, such as sublevel or longhole open stoping under normal conditions. However, the strong possibility that a substantial portion of the surface exploration holes are inadequately sealed and linked to Doris Lake above will require a mining method that allows access to the intersections of these holes and the underground excavations, unless the lake is drained. As a consequence, the preferred mining method at the time of writing this report is one that allows man entry into the stopes during mining, such as cut and fill (C&F). This approach will allow access to sections of stopes that intersect surface exploration holes; if required, they could be sealed to prevent inflows from the lake. ***SRK strongly recommends that non man-entry or large open stopes are not considered unless the lake is drained*.**

10.1 Design Parameters and Considerations

Rock mass parameters based on Barton's Q rock mass classification system were adopted for use in support stability graphs for underground excavation design (Table 10.1). Joint roughness (Jr) and joint alteration (Ja) values were converted from geotechnical parameters collected using the Laubscher (1990) rock mass classification system. The derived Q' parameter assumes joint water (Jw) and the strength reduction factor (SRF) are equal to 1.

Table 10.1: Underground Evaluation Rock Mass Parameters

Orebody	Domain	RQD Lower	RQD Upper	Jn	Jr	Ja	Jw	Q' Lower	Q' Upper	RMR* Lower	RMR* Upper
Doris Connector and Central	C-Type	85	100	9	1.5	1.5	1	9.44	11.11	64	66
	Vein	85	100	9	2	2	1	9.44	11.11	64	66
	Undif. Volcanics	75	100	12	1.5	1.5	1	6.25	8.33	60	63

Notes: *RMR=9lnQ+44

10.2 In-situ Stresses

The performance of an excavation is also influenced by the in-situ stresses in the rock mass. A database of Canadian crustal stresses is maintained by CANMET—Mining and Mineral Sciences

Laboratories (Arjang 2006). This database was used to determine expected in-situ stresses at the project location. The stress gradient and magnitudes used in the analyses (for an average mining depth of 135 m) are presented in Table 10.2.

Table 10.2: Accepted Stress Gradients and Magnitudes for Doris Connector and Central

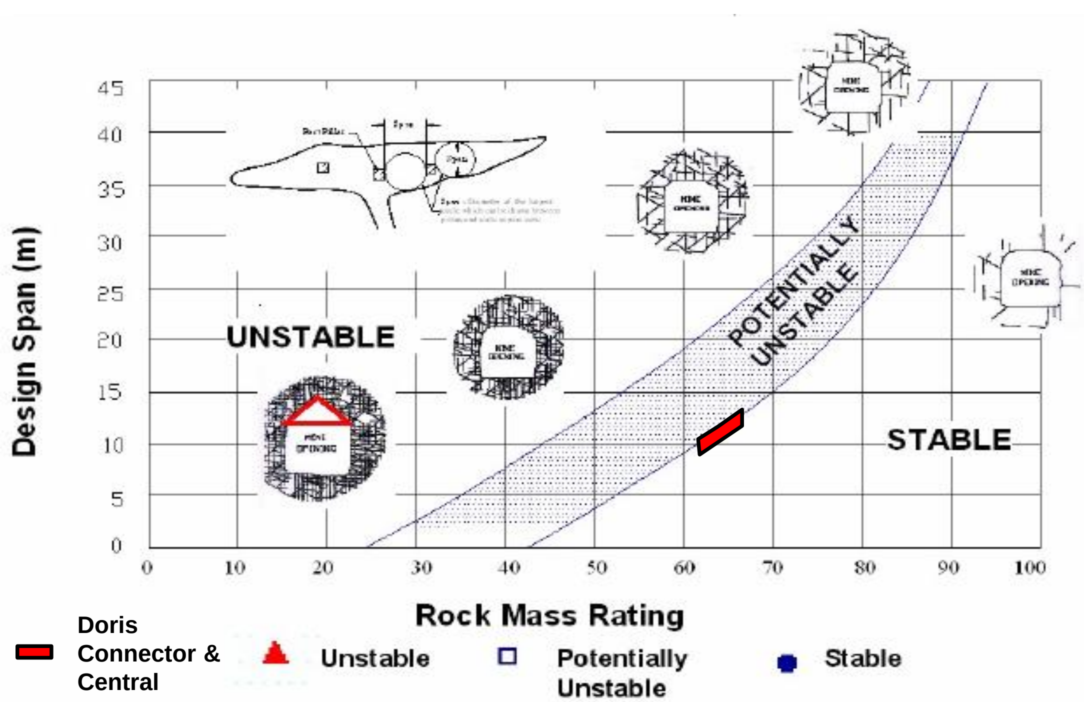
Stress	Gradient (MPa/m)	Intercept (MPa)	Depth (m)	Stress Magnitude (MPa)
σ_1	0.0344	13.5	135	18.1
σ_2	0.0233	8	135	11.1
σ_3	0.0180	3	135	5.4

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables\Table 10.2_Stress.xlsx

Within the Canadian Shield, both the maximum and minimum horizontal stresses typically exceed the vertical stress. Therefore, in excavation analyses in which the effect of stress is considered, σ_1 (the maximum principal stress) is assumed to be perpendicular to the strike of mineralization, σ_2 parallel to mineralization, and σ_3 vertical.

10.3 Man Entry Openings

Man entry design spans were reviewed based on the critical span curve presented in Ouchi et al. (2004) as shown in Figure 10.1. The calculated back span for man-entry excavations at Doris Connector and Central is 9–12 m. These spans lie on the boundary between stable and potentially unstable back conditions and should be considered as optimistic. Support recommendations for man-entry excavations are discussed below.



Source: Ouchi et al. 2004

Figure 10.1: Ouchi (2004) Critical Span Curve for Doris Connector and Central

Revised wireframe ore-body outlines provided by HBML for Doris Central show that potential stope widths of 18–20 m are possible at Doris Central. This region is considered to be at higher risk of inflow due to unsealed exploration boreholes and, as such, will need to be mined using a man-entry method with maximum open spans limited to 7–10 m. To mine the full mineralized width, multiple passes using a drift and fill mining method will be required. The installation of cable bolts in the excavation back as mining progresses across the ore-body width is strongly recommended.

The five-metre access development span recommendation is based on experience in mines in similar foliated volcanics. This span is considered appropriate for the conditions expected at Doris Central. Excavation spans can be increased for the main ramps, intersections, and permanent infrastructure areas of the mine, but must be supported accordingly. Support recommendations for the main development are discussed in Section 10.6

10.4 Non-man Entry Openings

Using the modified Matthews stability curve after Potvin and Hadjigeorgiou (1998, further modified by Trueman et al in 1997), non-man entry excavation design parameters were established for the range of unsupported stope spans, heights, and lengths presented in Table 10.3. The results of the analyses are plotted on the stope stability chart in Figure 10.2. The blocks marked on the chart represent the range of values considered for Q' adjusted to the stability number (N'), and the calculated hydraulic radius (HR) values, using the ranges of stope dimensions considered. All of the stope boundaries considered plot in the stable zone of the chart with the back, HW, and FW encroaching on the failure zone with a stope length of 60 m.

Table 10.3: Design Summary of Non-man-entry Openings

Orebody	Surface	Q' Lower	Q' Upper	N' Lower	N' Upper	HR Lower	HR Upper	Level Spacing (m)	Mineralization Width (m)	Stope Length (m)
Doris Connector & Central (75° stope dip)	HW	6.25	8.33	19.0	25.3	3.8	8.5	15 to 25	3 to 7	15 to 60
	FW	9.44	11.11	19.9	23.4	3.8	8.5			
	Stope Ends	9.44	11.11	2.3	2.7	1.3	2.8			
	Back/Orebody	9.44	11.11	0.8	1.2	1.3	3.1			

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables\Table 10.3_Non-Entry Design Parameters.xlsx

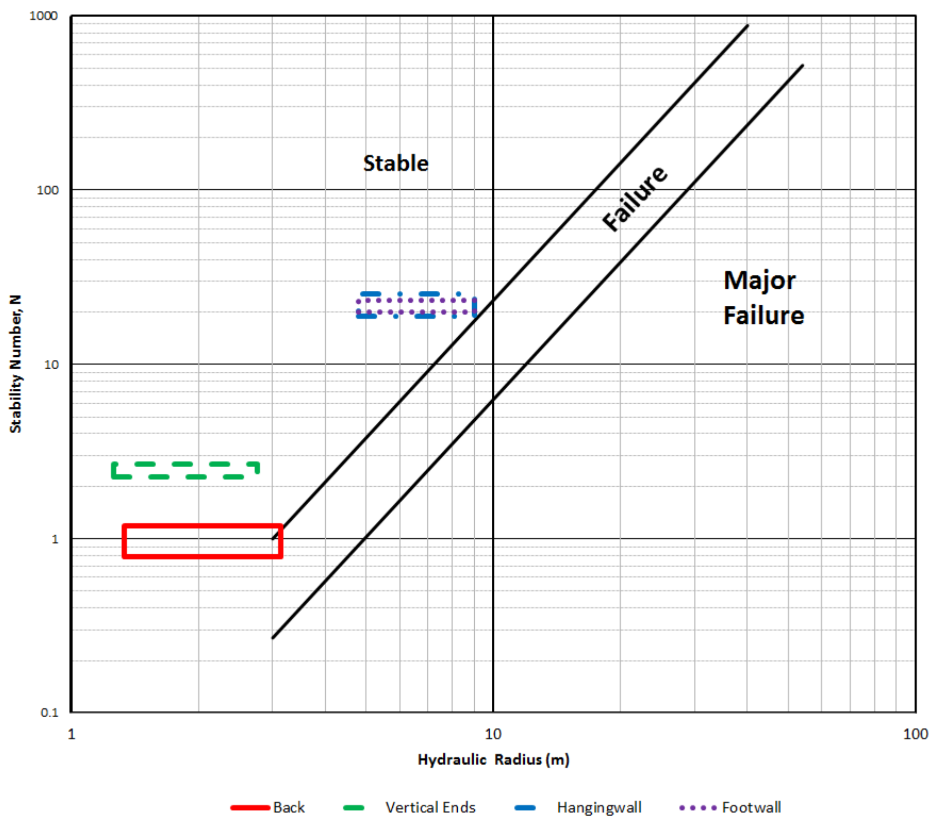


Figure 10.2: Stope Stability Plot for Doris North Underground (for unsupported stopes after Trueman et al. 1997)

Tabulated details of the non-man entry openings, provided in Table 10.4, are based on the stability of the HW. A maximum stope length is based on the assumed level spacing and range of mineralization widths. It should be noted that in all cases the back surface controls the stope stability. Back support will be required to carry spans wider than approximately seven metres, and should be considered optimistic.

Table 10.4: Summary of Stope Strike Length (HW limited)

Level Spacing (m)	Back Width (m)			
	3	5	7	
15	60	60	60	Max Stope Length* (m)
20	60	56	56	
25	55	54	*50*	
30	45	42	*40*	
35	40	35	*30*	
40	35	30	30	

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables\Table 10.4_Open Stope Dimensions.xlsx

Note: *Stope lengths in red indicate stability controlled by surface other than hanging wall

These stope openings assume the use of rib and sill pillars that clamp the edges of the various stope surfaces. If an avoca method is used as a continuous extraction method, these stope strike lengths and stope heights will need to be reduced, as the stopes will be unconfined on possibly two sides. Stope heights would need to be limited to 20 m. Recommended stope lengths include an approximately 8–12 m length of the previous stope where the rock fill is not considered to be consolidated.

In the case of open stoping, the use of cable bolting to increase spans and heights of stopes was used with varying degrees of success and may enable greater stope heights to be achieved at Doris Connector and Central. Cable bolting to increase the potential height of stopes generally falls into two categories: pattern bolting across the full span or height of the stope from cable bolting drifts located adjacent to the stopes or targeted cable bolting to locally improve the rock mass.

Hutchinson and Diederichs (1996) discussed the work of Nickson (1992) where the use of localized high-density cable bolting has allowed an increased total stope span (or height) by reducing the unsupported span. The theory behind this approach is that a block of reinforced rock on the stope perimeter has an effect similar to that of a pillar and provides localized support. Smaller sub spans are then formed between these reinforced blocks, allowing greater total spans to be opened up.

The blocks marked on Figure 10.3 represent the zones where cable bolting is considered appropriate for potential improvement to stope height. This diagram shows that, based on the range of Q’ values and calculated hydraulic radius values, some improvement to the stope height is likely possible.

However, this work is based on an empirical criterion that used a relatively limited data set. The work suggests that it would be possible to increase the stope heights by the installation of support from a sublevel, but this is best done following a monitoring program of unsupported stope performance to assess stope stability and the applicability of this method to the ground conditions encountered.

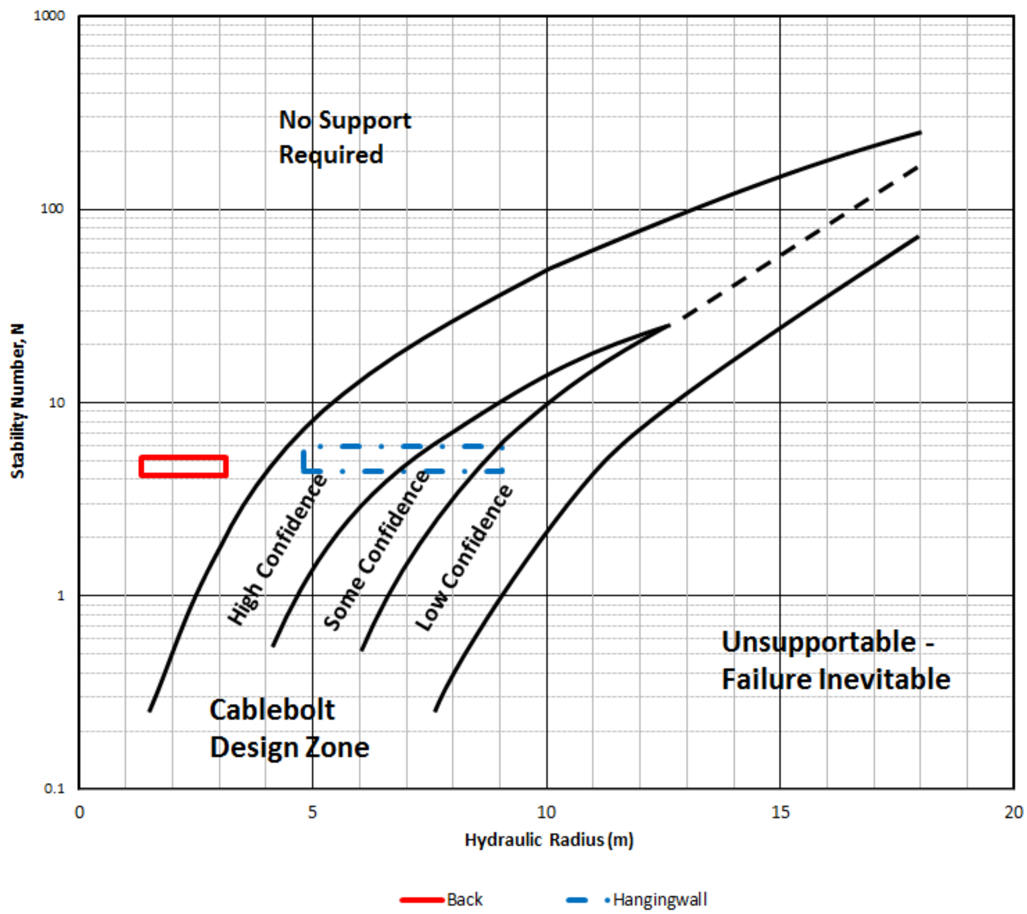


Figure 10.3: Design Zones for Open Stopes Using Stability Graph Method

10.5 Kinematic Wedge Analysis

Orientation of joints and foliation was extracted from 2008 and 2011 drilling data (Figure 9.1, Figure 9.2, and Figure 9.3) and compared against mapping data from the Doris North underground. Major foliation and joint sets indicate a reasonable correlation between Doris North, and improvements have been made from the 2008 drilling program with the addition of the 2011 oriented core data. As the Doris North underground continues to develop, the joint orientations used in the evaluations could likely be optimized.

Table 9.1 and Table 9.2 list the dominant small-scale structures selected, from which the four most prominent sets were utilized for the kinematic analyses.

The RocScience program UNWEDGE was used for the analysis. The software assumes that the joints are ubiquitous, continuous, and planar; as such, it does not take into consideration joint spacing and persistence. This omission usually results in a lower factor of safety and a more conservative assessment of the excavation geometry.

Values for cohesion and tensile strength were set to zero for both the foliation and joints in the analysis, and the field stress was set to 1 MPa lithostatic to prevent the formation of unrealistically high aspect ratio wedges in the analysis.

10.5.1 Doris Connector Wedge Analysis

Wedge analysis for main infrastructure excavations was conducted using a tunnel size of 5 X 5 m. The effect of decreasing the back span from 5 m to 3 m in the man-entry stopes decreases the apex height of potential wedges but does not affect the wedge geometry. The analysis was conducted without support; where unstable blocks were identified the analysis was then conducted using the ground support recommended in Section 10.6 below. The general orientations (trend and plunge) of the development and mineralization were used in the analysis. The effect of larger spans formed at intersections was not considered.

Lateral Development

Key observations from the analysis are

- The formation of potentially unstable wedges occurs in the back and walls of the excavation related to foliation/joint set combinations.
- The least favourable orientation for the lateral development occurs at around 200° azimuth. This orientation occurs in infrequent mineralization ramp accesses.

Vertical Development

Kinematic analysis of vertical development openings was completed using a 4 X 4 m opening with a range of plunge from 60–90°. Key observations are

- Unstable wedges are formed related to the sub-vertical foliation and joint sets J2 and J4.
- The apex height of the identified wedge is controlled by the plunge of the infrastructure relative to foliation. This height is generally less than 0.4 m.
- The ground support recommended in Section 5 provides sufficient support pressure to prevent the wedges generated from being released.

Unsupported Stopes

Stopes with hanging wall and footwall angles of 75°, aligned with the strike of the mineralized zone were considered in the analyses. Nine stope sections were considered with spans ranging from 3 m to 15 m and vertical heights of 15 m to 25 m.

Key observations from the analysis are summarized below.

- The wedges formed in the hanging wall of the 40 m high stopes are considered to be the greatest source for potential dilution. The wedges are high aspect in shape and are formed by joint sets J1 (foliation), J2, and J3 with approximate volume of 7 m^3. However, these types of wedges are indicated to be stable under the current assumptions. Limited trace lengths were applied to joint sets 2 and 3 to account for the lack of continuity assumed for these joints.
- The wedges formed in the stope ends have a low apex height and are not considered to impact the dimensions for rib pillars.

10.5.2 Doris Central Wedge Analysis

Lateral development

Key observations from the analysis are

- The formation of potentially unstable wedges occurs in the back and walls of the excavation related to foliation/joint set combinations. Small-scale structure with similar orientation to NW-06 fault play a role in the formation of potentially unstable wedges; these wedges may only form proximal to the actual structure.
- The least favourable orientation for the lateral development occurs at 080°–120° and at 260°–305° azimuth. These orientations will be encountered primarily in the mineralization ramp accesses.

In the cases noted above, the ground support recommended in Section 10.6 provides sufficient support pressure to prevent the wedges generated from falling out of the wall and back. Local improvements to the support standard may be required to ensure stability in ramp accesses.

During pre-production development, these areas should be evaluated on a case by case basis.

Vertical Development

Kinematic analysis of vertical development openings was completed using a 4 X 4 m opening with a plunge range of 60°–90°. Key observations are

- Potential wedges with an apex height of approximately 3.1 m form in the walls of the vertical development around 60° azimuth. However, these wedges are indicated to be stable.
- Small potentially unstable wedges (apex height 0.5 m) are indicated in the back of the vertical infrastructure.
- The ground support recommended in Section 5 provides sufficient support pressure to prevent the wedges generated from being released.

Unsupported Stopes

Key observations from the analysis are summarized below.

- Small unstable wedges are formed in the hanging wall of the stopes and will be a small source for potential dilution. The wedges are high aspect in shape and are formed by joint sets J1 (foliation), J2, and J4 with a volume <$1m^3$. Limited trace lengths were applied to joint sets 2 and 3 to account for the lack of continuity assumed for these joints.
- The wedges formed in the stope ends are also high-aspect wedge shapes and are not considered to impact the dimensions for rib pillars.

10.6 Support Requirements

The recommended support requirements for the production excavations are based on the Q Support Chart of Grimstad and Barton (1993), Laubscher (1984) guidelines, and practical experience (e.g., for 5 m wide tunnel, excavation support ration (ESR) = 2 for semi-permanent mine openings). The chart estimated values are tempered by the fact that the jointing and foliation orientations are not considered in the empirical guidelines (Figure 10.4 and Table 10.5).

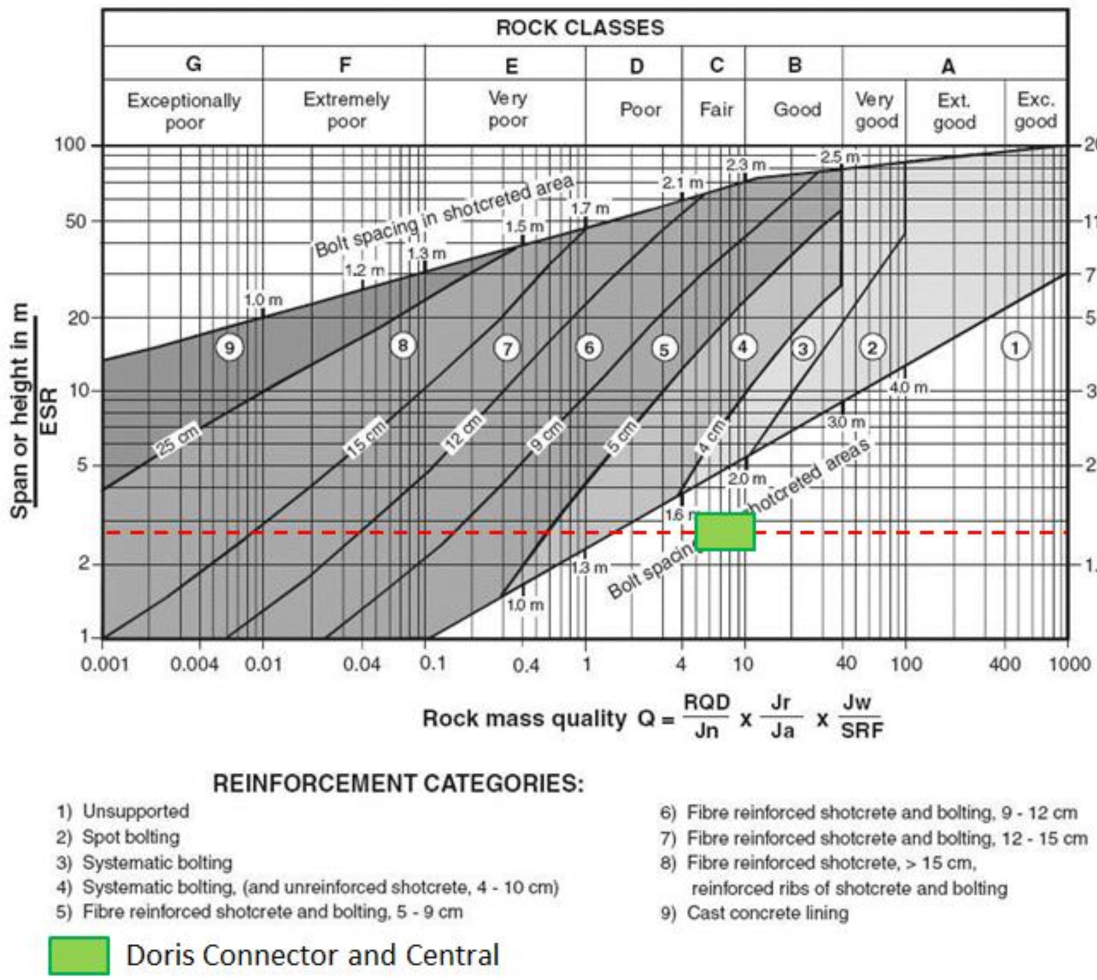


Figure 10.4: Recommended Support Requirements for the Production Excavations (Q Support Chart of Grimstad and Barton 1993)

Table 10.5: Minimum Support Recommendations

Area	Type	Approximate Dimensions WxH (m)	Support Requirements	Comments
Lateral Development	Main Decline/ Accesses	5.0x5.0	• 2.4 m threaded rebar (22 mm) on a 1.2 m diamond spacing (8 or 9 anchors in a ring) • Welded wire mesh across back and down walls to 1.8 m from the floor • If required: 25-50 mm shotcrete	Shotcrete may be required when fault zones are intersected. Friction anchors may be substituted when headings are not considered to be open for the long term scenario.
	Ramps	4.0x4.5	• 2.4 m threaded rebar (22 mm) on a 1.2 m diamond spacing (7 or 8 anchors in a ring) • Welded wire mesh across back and down walls to 1.3 m from the floor • If required: 25-50 mm shotcrete	Shotcrete may be required when fault zones are intersected. Friction anchors may be substituted when headings are not considered to be open for the long term scenario.
Vertical Infrastructure	Alimak Raise	4.0x4.0	• 1.8 m threaded rebar (22 mm) or Swellex (39 mm) on a 1.2 m spacing (10 to 12 anchors in a ring) • Galvanized chain link mesh (#6 gauge) down to floor level	Evaluation of anchor performance will be required for vertical infrastructure. Mesh likely not required for final support in ore/waste pass or ventilation raises.
	Open Raise	2.5x2.5	• 1.2 m Resin rebar/swellex/mechanical anchors on a 1.2 m spacing (8 to 9 anchors in a ring) • Galvanized chain link mesh (#6 gauge) down to floor level	
Man Entry Openings	-	4.0x4.0	• 1.8 m threaded rebar (22 mm) on a 1.2 m x 1.2 m spacing • If required: weld wire mesh across back and shoulders	Rockbolt length should be increased as excavation spans increase. The 1/3 span guideline is considered appropriate for excavations up to 8 m span at this stage. Bolt and ring spacing shall remain the same.

Source: \\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\070_Reporting\Stage 2 Doris Geotech Hydro Report\020_Tables\Geotech Tables\Table 10.5_Support Recommendations.xlsx

For liability reasons, most mines are moving towards the installation of mesh and rock bolts throughout all parts of the mine in which personnel access is required. Without the use of mesh, a formal documented scaling process is required and must be incorporated into the support standards for the mine. Welded wire mesh, with a maximum mesh size of 100 mm (4”) square, constructed from #8 gauge wire or thicker is preferred.

The main access decline providing access to the deposit is located in permafrost until it passes beneath Doris Lake. Low temperatures can impact the performance of the rock bolt resin. It is important therefore that the specifications for the rock bolt resin are carefully chosen to minimize any deleterious effect on the performance of the support system that the permafrost may have. Oil-based resins are preferred as they do not freeze when inserted into the bolt hole. Resin-grouted rock bolts are being successfully used in permafrost conditions at the Raglan Mine in Quebec, while rock bolts and cable bolts are employed at the Svea Longwall Coal mine in Spitzbergen, Norway, which is also in permafrost conditions.

10.7 Crown Pillar

The influence of the depth below surface needs to be considered when assessing the potential design spans at Doris Connector. Based on 3-D mineralization solids provided to SRK (received November 2010), potential stope widths of 6–10 m are indicated in the upper mining areas at the northern extent of Doris Connector. This region is closest to the surface (15–60m below ground surface; Figure 10.5) and will need to be mined using a man-entry method.

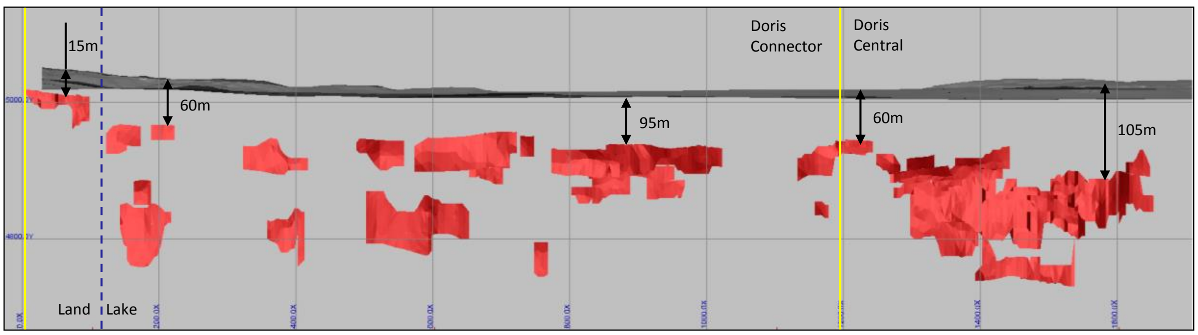


Figure 10.5: Long Section through Doris Connector and Central Crown Pillar

The minimum crown pillar thickness recommended is 13 m. Based on the scaled span crown pillar analysis of Carter (2000), maximum open spans at this thickness should be limited to 7 m. Below 24 m depth, the maximum span can likely be increased to 10 m, in accordance with the recommendations of Ouchi et al. Table 10.6 summarizes the requirements for crown pillar thickness for a range of mining spans. The significance of the crown pillar in this case was considered to be medium term (Class E), and a design factor of safety of 1.8 was used based on the recommendations of Carter (2000).

Table 10.6: Summary of Crown Pillar Requirements

Crown Pillar Span (m)	Crown Pillar Thickness (m)	Span Ratio (S_R)	Dip of Orebody	FoS (lower bound)	PoF (lower bound)
7	13	0.35	90	1.8	1.8
8	17	0.4	90	1.82	1.7
10	24	0.5	90	1.8	1.8
12	32	0.6	90	1.8	1.8

10.8 Dilution

Sources of dilution of the mined ore are influenced by two key factors: geotechnical, which considers the quality of the rock mass and the excavation and ground support design, and operational, where the influence of blasting, mining, geology, and survey controls are included. Where stopes are mined in narrow-vein type deposits, dilution of ore due to geotechnical factors is often small in relation to the dilution realized from operational factors.

The potential dilution effects were considered using the method developed by Clark (1998) where the modified stability number N’ and the hydraulic radius is related to the equivalent linear overbreak/slough (ELOS). This can then be used to calculate a percentage dilution. The range of values for N’ and the hydraulic radius calculated for the HW and FW in Section 10.4 were used in the dilution assessment and are represented by the shaded zones on the ELOS dilution design chart in Figure 10.6. The stope back and ends were not considered as they are both within the mineralized zone.

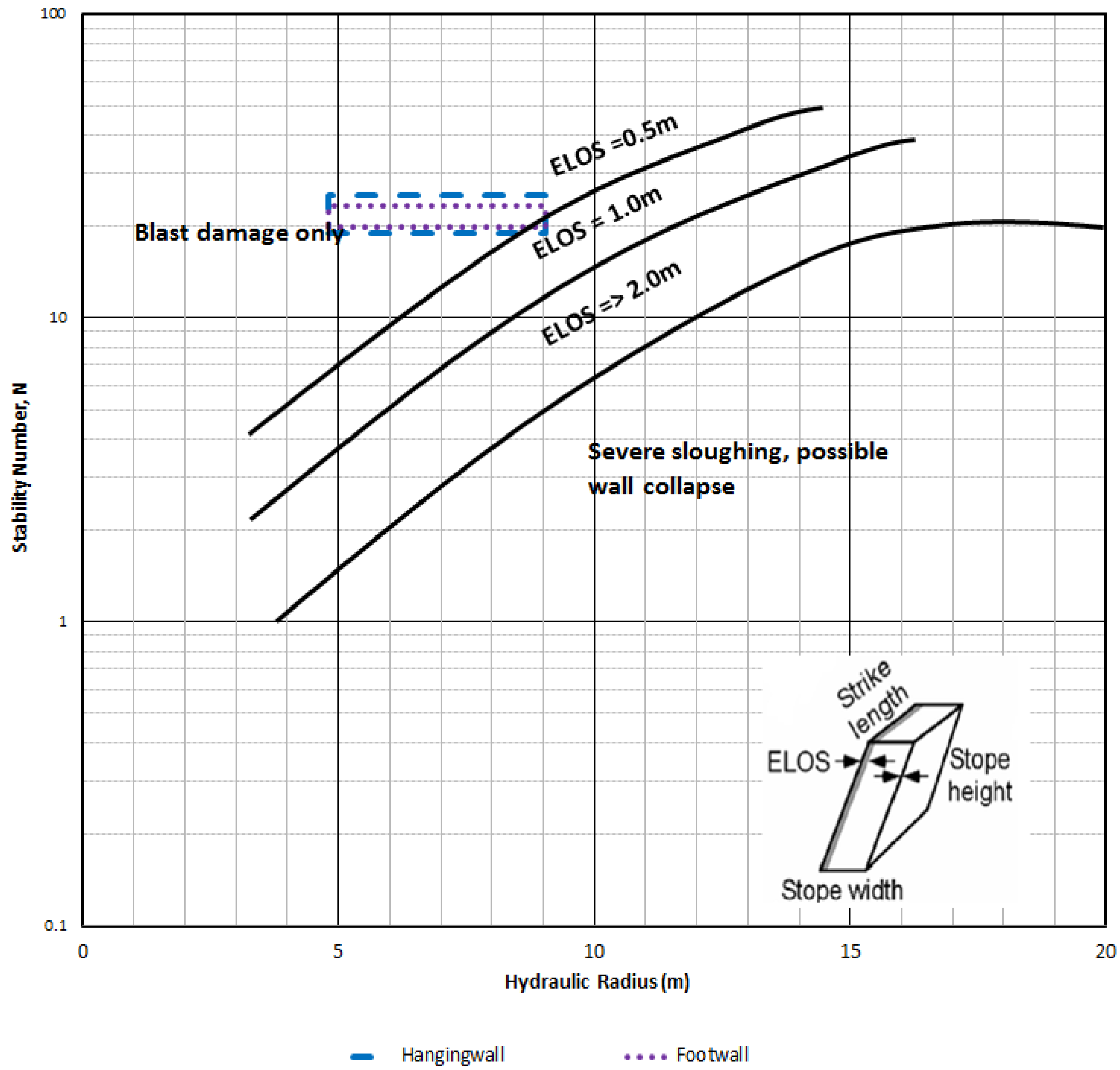


Figure 10.6: ELOS Dilution Design Chart for Open Stoping Areas

For the majority (>80%) of the range of values considered, the excavations plot in the region of the ELOS graph in which blast damage is the principle source of dilution. Geotechnical sources of dilution occur in the remainder of the range with maximum ELOS of approximately 0.5 m for the HW and 0.5 m for the FW occurring at the upper values of hydraulic radius and lower values of stability number N'.

The combined ELOS for the stope is 1.0 m. Using the maximum open stope dimensions considered in Section 10.4 (25 m high X 60 m long X 15 m wide), the maximum anticipated unplanned dilution is estimated at approximately 7%.

10.9 Backfill

Placement of backfill in the mined-out stopes is required to provide regional support and to maximize extraction of the ore body. Overhand cut and fill stoping can be adequately supported using a combination of uncemented rock fill for the majority of the fill material, with localized use of cemented rock fill (CRF) where higher strength or fill stability is considered necessary.
The relatively low total volume of the voids formed by the stopes and the small volume of fill material required for each lift within a stope are more suited to the use of a combination of uncemented waste rock and CRF than paste fill. The capital costs associated with an enclosed and heated surface paste fill plant and the associated underground infrastructure are expected to be considerably greater than that of a modest underground CRF plant.

Placement of the backfill should be sequenced such that CRF is placed at the bottom and ends of each mining block. Uncemented rock fill can then be used for filling the majority of the stope. The CRF at the stope ends is required to allow mining of adjacent primary or secondary stopes against a previously mined out and backfilled stope. The width of the CRF zones at each end of the stope should be a minimum of three metres or equal to the stope width, whichever is the greater.

The recovery of closure sill pillars during primary extraction is considered to be possible if a reinforced or stronger cemented rock fill is placed when starting a new stope to form a sill mat. The thickness of the sill mat would be dependent on the stope width; at this stage of the project, a minimum thickness guideline is the greater of 4 m or 2.5 times the stope width. The extracted sill pillar stope would then need to be filled with CRF on retreat or to be flood-filled with cemented hydraulic fill after complete extraction.

An alternative would be to adopt drift and fill mining to recover the sill pillars. This would involve the mining of a four metre-wide drift to recover the mineral and then slashing and tight filling with CRF on retreat. Recovery of larger pillars may be more problematic using this method: as the remaining pillar decreases in size, there will be an increase in stresses.

CRF and waste rock fill have the considerable advantage that specialist material handling and placement equipment are not required, thus simplifying the mining cycle. The one disadvantage identified was that if Doris Lake is not drained and an unsealed borehole located close to stoping began to leak after the stope had been filled, the CRF would provide little resistance to any flows. Water flowing through the uncemented fill may result in the fine material being washed out into active stopes.

These comments should only be considered as guidelines. A full assessment of the strength required of the backfill and an appropriate design must be completed when sources of available fill material have been identified.

10.10 Stope Design and Mining Discussion

When considering stope dimensions, several factors influence the design process, including, but not limited to, geotechnical properties of the rock mass, hydrogeology, mining method, production rate, and scheduling.

Analyses of the geomechanical properties of the rock mass and the stope dimensions conducted by SRK as discussed in the preceding sections shows the mineralized zone is considered amenable to mining with the following methods:

- Overhand Cut and Fill: This method should be utilized in sections of the mine where there is an increased risk of encountering surface exploration holes that are suspected of being poorly sealed. This method allows secure man-entry access to intersections of the holes with the mine workings such that they can be adequately sealed.
- Drift and Fill: This method should be employed in the wider sections of mineralization present in selected areas of the Doris Connector and Central mineralization. Mining should start on the western edge of the mineralization to ensure that any potential leaking boreholes are intersected in the first pass mining.
- Overhand Longhole Stoping: In sections of the mine where the risk associated with surface drill hole intersection is considered to be minimal, overhand longhole stoping is recommended. The use of a primary and secondary extraction sequence (with primary stopes tightly filled with CRF) allows the recovery of rib pillars. The resulting secondary stopes should be rock-filled.
- Modified AVOCA Stoping: The AVOCA stoping method could also be applied where conditions allow longhole stoping. Stope dimensions would be the same as for longhole stoping, although longer stope lengths along strike between rib pillars could be achieved using AVOCA, provided that distance between the fill material and retreating longhole slices is kept to a minimum.

The mining of wider sections of Doris Central, by careful sequencing of extraction and placement of high quality cemented rock, aggregate fill, or shotcrete pillars, could lead to significant upside potential. The extraction methodology anticipated to allow higher productivity in the wider sections of the mineralization is briefly outlined below.

- Overhand cut and fill mining along the western edge of the ore zone for each sublevel of four lifts, with the placement of high quality cemented rock or aggregate fill on each lift. Leaky boreholes can readily be dealt with as mining progresses.
- The remaining portion of the ore zone is then considered to be amenable to mining using conventional longhole open stoping or modified AVOCA stoping. Installation of cable bolts in the back of the top lift on each mining level will likely allow wider stope widths to be mined.

Further detailed assessment is considered necessary to be able to achieve the potential gains presented by this extraction methodology. Recommended stages in this assessment comprise

- Additional geotechnical characterization of the ore zone, hanging wall, and footwall rock
- Assessment of achievable backfill strengths from available materials
- Detailed numerical modelling of the extraction sequence to assess backfill and stope stability

For the options discussed above, the sizing of pillars is probably influenced more by the practicality of mining rather than the geomechanical aspects. The following minimum pillar dimension recommendations are based on the pillars being confined by good quality cemented rock fill.

- For stope spans of up to 5 m, a minimum rib pillar length along strike of 7 m is suggested.
- For stope spans of up to 15 m, a minimum rib pillar length along strike of 15 m is suggested.

Sill pillars are not considered to be necessary if good quality cemented rock fill is placed after primary extraction. However, sill pillars are recommended in closure areas of the mine. In these areas, sill pillar dimensions are calculated using a ratio of 1.33 times the stope thickness based on the work conducted by Itasca Consulting for CAMIRO (2000). Therefore, sill pillars above stoping with a span of up to 5 m should be 7 m thick, while those for stope spans of 15 m should be 20 m thick.

The geometry of the mineralization is such that small (1.5 – 5 m) pillars can be formed between diverging limbs of the mineralized veins. Scheduling of the mining should be such that open stopes are not formed either side of these small pillars to reduce dilution and minimize the risk to personnel and equipment when working adjacent to these pillars. Where the mineralization geometry could result in the formation of small pillars, it is recommended that the FW limb is mined and backfilled with CRF prior to mining of the HW limb.

10.10.1 Infrastructure and Development Location

At this stage in the project, the standoff distance for major development from the stoping areas is recommended at 30 m. Where weaker rock is encountered in the footwall, an increase in standoff distances is proposed; current evidence suggests an increase in standoff distance to 40 m.

Vertical infrastructure excavations, such as ventilation and service raises and ore passes, were shown on the development models provided by HBML. Development of the vertical infrastructure is considered amenable to conventional overhand raising and Alimak raising. Any decision on vertical infrastructure needs to take into account rock quality, the final use of the raise, and the vertical distance from the top to the bottom of the raise. The rock quality is a significant controlling factor in the decision making process, but the final use of the raise and the vertical distance from the top to the bottom of the raise are also major factors.

10.10.2 Excavation Sequencing

The sequence in which stopes are extracted and their spatial location relative to each other can significantly affect excavation performance. Indications of planned development schedules, stope sequencing, and production rates were not provided to SRK; therefore, the following comments are general in nature.

The geometry, sequence, and method of excavation influence the long- and short-term stability of underground openings. If pillars that are to be extracted as secondary mining are damaged by poor quality excavation practices (such as over excavation or blast damage) during the mining of primary stopes, then it will become more difficult to extract secondary stopes. Care must be taken during the planning phase that secondary extraction is not adversely impacted by poor scheduling or mining performance.

Concurrent mining of adjacent stopes, either along or parallel to the strike of the mineralization, is not recommended with the current knowledge of the rock mass and stress regime at the project location.

11 Doris Central & Connector Underground: Conclusions and Recommendations

11.1 Conclusions

The Doris Connector and Central underground design was considered for C&F (cut-and-fill) and open-stoping mining methods (including mining spans, support requirements, and dilution estimates). Based on the integration of geotechnical, structural, and hydrogeological inputs, the following interim conclusions are reached. In SRK's opinion, the greatest risk concerns the presence of open exploration drill holes that could act as flow conduits connecting Doris Lake to workings. It is also SRK's opinion that these drill holes argue for C&F; the conclusions and recommendations reflect this risk.

Structure and Geology

- Several faults (SRK-modelled Fault-NW-06; HBML-modelled Shear 1 and 2, Force1, and C3P0) are interpreted to pass through the Doris Connector and Central areas. These faults were predicted using a combination of ground magnetic data and drill hole reviews. Other faults were logged in drilling. At this time, the spatial constraints of these faults are poorly understood.
- The diabase dykes modelled by HBML appear to cut off the mineralization. Even though the dyke contacts appear intact and un-deformed, artesian flow was observed in the vicinity of the proposed spiral ramp at Doris Central.

Hydrogeology

- The Central and Connector mining areas will be within the Doris Lake talik.
- Groundwater inflow can be expected from all portions of underground development. Inflow will occur from the background bedrock and possibly from exploration drill holes and structures.
- Cumulative inflow from bedrock alone for the entire mining area is approximately 7,000 m^3/day (1,285 USgpm), not including flow from structures or drill holes.
- Flow from an individual fault could reach approximately 500 m^3/day.
- A large number of exploration drill holes exist, many of which may not have been properly cemented and could convey significant flow rates (2,700 m^3/day for one NQ drill hole). A probabilistic analysis of drill hole intersections for Doris Central, assuming that 25% can flow at full capacity, indicates that there is a high likelihood that at least some drill holes will experience both intersection and flow. At this time, the likelihood should be assumed for both Central and Connector, so all plans will be required to consider this risk.
- Inflow water quality will have high salinity. Salinity may decrease over time, but available data should be used for planning purposes. Water management strategies must consider inflow water quality.

- The mine planning will need to consider the risk of uncontrolled inflow as a consequence of procedural or equipment failures and have a contingency plan in place to deal with this situation. Situations in which inflows have caused significant problems or loss of the mine can usually be traced back to incomplete pre-planning for the event and/or a failure to conform to mine plan and operating procedures related to mitigating these inflows.
- Water management system design, as well as CAPEX and OPEX, are being developed separately from this study by HBML and Hatch.

Geotechnical

- Although the units of the Doris Connector and Central deposits are considered geotechnically suitable for open stoping, the hydrogeological risk is considered significant enough to discount a non-man-entry mining method. For this reason a man-entry cut-and-fill method is recommended.
- Ground conditions in the HW access are fair to good, and all accesses should be reasonably stable and require conventional development and support requirements.

Mining

- *SRK strongly recommends that non-man-entry or large open stopes should not be considered unless Doris Lake is drained due presence of open exploration drill holes that could act as flow conduits connecting Doris Lake to workings.* Overhand cut and fill is the recommended mining method for the upper levels of the underground, with design spans typically exceeding the mineralized width.
- The use of good quality back filling practices, utilizing a combination of uncemented waste rock fill and localized cemented rock fill, will allow high levels of extraction to be achieved employing the overhand cut-and-fill mining method.
- Unsupported stopes are considered in the deeper sections of the mining area, but the risks are significant due to the likelihood of encountering surface exploration holes that are not sealed and are potentially connected to Doris Lake.
- Potential wedge-type instabilities were identified around development and stoping areas. These instabilities can be managed using levels of ground support typical for a fair rock mass.
- Dilution is expected to be low, provided that proper blasting techniques are employed.
- In addition to the review of current mining wireframes, maximum permitted hydraulic radii were established for each stope boundary within the given mining areas using a range of mining heights and spans. Maximum stope lengths along strike were determined based on these findings.
- A primary and then secondary stope extraction sequence is proposed if backfill is utilized and would enable high levels of extraction to be achieved. It is estimated that 80–90% extraction ratios could be achieved.

11.2 Recommendations for Stage 3 Study

Geotechnical

- An underground bulk sample is assumed to be planned as part of Stage 3 / Feasibility–level studies. During pre-mining development, detailed geotechnical mapping of all development and stoping areas is recommended to supplement the data collected from drill holes.
- Measurement of the pre-mining stresses is strongly suggested for development of the project into Stage 3. Measurement should initially be conducted away from major geological structures and should target competent geotechnical units, such as the basalts. The stress measurement should be conducted from underground development and stoping associated with collection of a bulk sample.
- Additional rock testing will be required in the Stage 3 geotechnical evaluations. The bulk of the testing should be uniaxial (approximately 10 per lithology), with some triaxial compressive strength tests. Provided there is little scatter in the strength values from the UCS testing, five triaxial strength tests per geotechnical unit for each deposit is recommended.
- The collection of geotechnical data from the additional Stage 3 investigations will allow the confirmation of proposed development, stope, and ground control guidelines. These should include:
  - A detailed kinematic study using the discontinuity data collected from underground mapping and oriented core drilling.
  - An empirical analysis of excavation stability and support requirements.
  - A confirmation of empirical designs using numerical analysis techniques. Numerical analysis of the underground excavations is recommended to better understand the issues and impacts that the mining schedule will have on underground stability. This is an important aspect that requires additional detailed investigation and analysis as the project progresses into Stage 3 / Feasibility.

Hydrogeology

SRK recommends that the following additional work be completed to further reduce risk and increase confidence in the hydrogeological assessment:

- Completion of thermistor drill holes deferred to 2012.
- Additional assessment of the risk of inflow from underground drill holes must be completed. Confidence in the probability of exploration drill holes allowing unrestrained flow must be improved through further comparison with similar sites. Methods for handling of flowing drill holes must be further assessed to develop a feasible and effective management plan.
- Additional hydraulic testing of geological structures, the alteration/ore zones, and shallow bedrock. Specifically,
  - Consideration should be given to testing exploration drill holes, as well as geotechnical and hydrogeological investigation drill holes, based upon location and depth.

- – Testing of structural features should include both those already identified and those identified during future drilling.
- – Additional longterm injection tests should be completed along the strike of the ore body to better constrain larger scale estimates of hydraulic parameters. These tests should be designed to allow assessment of anisotropy, both along and across strike of the ore body, into the country rock.
- – Testing plans should consider assessing the groutability of the lower crown pillar areas, above individual stopes.

- Continued sampling of Westbay wells 10WBW001 and -002 to better constrain inflow water quality.
- A transient 3-D numerical model should be completed for Doris Central and Connector to improve estimation of groundwater inflow over time. The model should simulate density-dependent or mass transport flow by incorporating all available hydrogeological data, the geological model (particularly structures), reasonable representations of proposed mine developments and timelines, mining methods, and, if necessary, water quality effects. The model should be calibrated to results from longterm injection tests.
- Methods for management of flowing drill holes should be further assessed.
- Water management costs should be updated based on inflow risk assessment. This should include a trade-off study of various mitigation methods that could be integrated with the mine plan.

12 Closure

This report, ***"2011 Stage 2 Geotechnical and Hydrogeological Assessment for Doris Central and Connector Underground Mine"***, was prepared by

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All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

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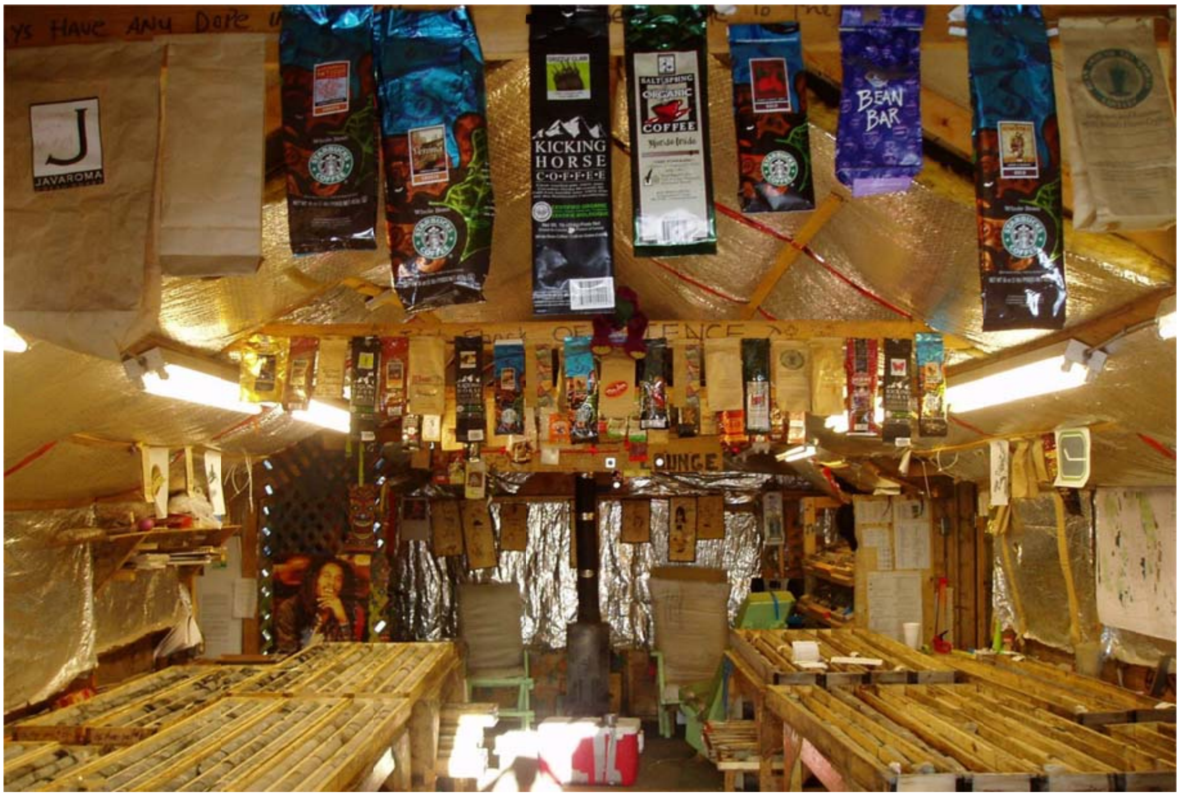
Appendix A – Hope Bay 2011 Geotechnical Logging Manual



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PART B) STEPS FOR LOGGING CORE FROM SPLIT TUBES AT THE RIG

STEP 1: DETERMINE THE ORIENTATION

- Using the Ace Orientation Tool, the driller's helper will mark the bottom of the hole on the core stub (see reference section).
- Place the split tube in the split tube holder on the front of the core logging table.
- Remove the top split.

STEP 2: PHOTOGRAPH THE CORE

- Clean the core with a brush and water if necessary.
- With a whiteboard marker (NOT a permanent marker!), write on the photo board the drill hole name, the from and to depths for the photo, date, your name, and whether the core is wet or dry.
- Position the photo board on the left 1.5m of the 3m split tube, take a photo.
- Move the photo board to the right 1.5m of the 3m split tube, adjust the from and to depths accordingly, and take a second photo.
- **Check that the photos are in focus**.
- Download and rename your split tube photos on the laptop.

STEP 3: MARK THE ORIENTATION LINE

- Using the angle iron provided, draw a solid green line on the core to indicate the bottom of hole, based on the orientation mark for that run made using the Ace Orientation Tool.
- Put arrows on the line to indicate the down hole direction.
- If there is evidence of drill spin, or any location where the core does not match together, you can not carry the orientation line through the whole run.
- In these cases, carry the orientation line down from the previous run.
- If it is not possible to match the previous run to the current run, write 'orientation lost' on the core.

STEP 4: MEASURE ANY OFFSET

- Take the last piece of the run before with orientation already marked, and match it up with the beginning of the run in the split tube.
- Measure any offset between the orientation lines for the two runs. The offset is recorded in degrees as the rotation from the top piece to the bottom piece, in a clockwise direction, looking down the hole (see example).
- Write the offset on the bottom piece of core (the piece in the split tube).

STEP 5: TOTAL CORE RECOVERY

- Determine the ‘from’ and ‘to’ depths based on information from the driller.
- Measure the total core recovery (TCR) for each run (i.e. the length of core recovered from each run).
- Open the ‘General Geotech Form’ in the geotechnical database. Enter the ‘from’ and ‘to’ depths, and the TCR.

STEP 6: MARKING DRILL CORE

- Review the core and mark it as follows:
    - Joints: Green line beside the joint and write J on the core
    - Cemented Joints: Green line beside the cement and write CJ on the core
    - Machine Breaks: Yellow line across the break ———
    - Foliation Breaks: Blue line across the break ———
    - Core Handling breaks: Yellow X on either side of the break
    - Natural Rubble Zones: Mark on either side of the rubble zone with a vertical blue line and ‘RZ’
    - Mechanical Rubble Zones: Mark on either side of the rubble zone with a vertical blue line and ‘MRZ’

STEP 7: MEASURE RQD

Now that you have determined which breaks are joints, you can measure RQD:

- Measure the length of core in the run, EXCLUDING:
    - Sections of core between two joints that are less that 10cm long;
    - Natural rubble
    - Soft core (R0 or R1 strength rating)

I.e. Measure only the pieces of core that are naturally longer than 10cm long.

- Enter RQD into the geotechnical database (General Geotech form).

STEP 8: TRANSFER TO CORE BOX

- Piece by piece, move the core from the split tube to the core box, with the orientation line on top.
- You will need to break the core at 1.5m to fit it into the box.
- Mark this break with two yellow crosses to indicate that it is a core handling break.
- Using a black permanent marker, write the hole ID on the top left of the box, followed by the box number, and the ‘from’ and ‘to’ depths.

- Write on the bottom right of the box the ‘to’ depth.
- Give the split tube back to the driller’s helper.

STEP 9: DESCRIBE JOINTS

- For each joint you identify, determine:
    - Depth, e.g. 135.7m
    - Alpha angle, e.g. 25 degrees
    - Beta angle, e.g. 214 degrees
    - Roughness, e.g. 4 - Undulating rough
    - Alteration, e.g. 1 – Joint wall equals rock hardness
    - Joint filling, e.g. 6 – Non softening fine
- This information is being recorded on a paper log at the drill prior to entry into the geotechnical database.
- Some people like to describe the joints as they go, others prefer to identify all the joints first, and then go back through and describe them.

STEP 10: IDENTIFY DOMAINS

- Identify if there are any domain breaks within the run.
- Domains are equal to the drilling run length (3m), although may be shorter if there is a change in:
    - lithology,
    - alteration,
    - structure or
    - rock strength.
- The minimum domain length is 0.5m.
- Mark the domain break on the core with two vertical blue lines and a D.
- For each domain, count the open fractures, foliation breaks, joints and cemented joints, and note them on the core, or a piece of paper in this order: OF / FB / J / CJ (you will need this info later at step 12).

STEP 11: OTHER DETAILED GEOTECH

- Open the ‘Detailed Geotech ‘ form.
- Enter the ‘from’ and ‘to’ depths for each domain.
- Determine the Intact Rock Strength (IRS) for the majority of the domain (Strong R), and any softer sections (Weak R), noting the % of the domain that is represented by the ‘weak’ rating.
- Enter in the counts for open fractures, foliation, joints and cemented joints as noted down earlier.
- Determine the cemented joint strength and enter this.
- Determine and enter the micro defect intensity and strength.
- Determine and enter the foliation alpha and beta angles (paper log/spreadsheet).

STEP 12: JOINT SETS

- Using the joints list you wrote for each domain, group your joints together by similar alpha angles.
- The range of alpha angles in each joint set should not be more than 30 degrees.
- For each joint set, average the other characteristics, i.e. roughness, alteration, fill.
- Enter this information into your palm pilot.
- Note that the ‘imaginary’ joints attributed to natural rubble zones also need to be included in a joint set. Group all of the rubble zone joints into one joint set. You should make a best guess of their characteristics of alpha, roughness, alteration and fill.
- In the comment for that domain, indicate which joint set is a rubble zone, i.e. JS1 = RZ.

STEP 13: MAJOR STRUCTURES

- Open the ‘Major Structures’ form in the database.
- Enter the ‘from’ and ‘to’ depths for each major structure.
- Describe the major structure using the quality field, as either ‘jointed’, ‘broken’, ‘sheared’ or ‘gouge’.
- Enter the alpha and beta angles.
- Enter the total number of joints for each major structure
- Note any comments you have about the structure.

STEP 14: ORIENTED CORE LOG

- Open the ‘Oriented Core Log’ form in the database. Enter the information for each joint, as noted on a piece of paper earlier.

STEP 15: WHAT’S NEXT?

- The core box from and to depths need to be marked on the core box, and recorded in the ‘sample box’ form. Core boxes need to be tapped shut, and put in order on a pallet, where it will be brought into camp at the end of the shift.
- You have now finished entering most of your geotechnical data into the database.
- At the end of shift, close all programs on the laptop and copy all the hole data to your memory stick! Very important! Bring this back to camp and leave on the SRK desk along with the paper copy logs from the previous shift.
- At the end or beginning of every shift you should chat with the SRK person on site regarding any changes or issues with data collected from the previous day.

STEP 16: WHAT HAPPENS BACK AT CAMP?

- The geologist will then do his/her logging of the box at camp.
- Another geotech at camp will then do the following:
    - Magnetic susceptibility, specific gravity and graphitic conductivity – these will be entered on a piece of paper and the database will be updated.
    - Make metal box tags and staple them on the boxes.
    - Photograph the core in the box
    - Review the core box photographs and rename the files
- The SRK person will be checking the data each day, and will take samples for geotechnical testing.

PART C) REFERENCE MATERIAL

Geotechnical Core Logging Training
Hope Bay 2011

srk consulting

NEWMONT
The Gold Company

Introduction

- Geotechnical data provides information on **rock mass characteristics**, which is used to design the walls of open pits and underground structures for mining the gold deposits at Hope Bay.
- It is important that the data collected is **accurate and precise**, so that SRK can assist to design a safe, but cost effective mine design for Newmont.

2011 Data Collection

- During the 2011 field season, Newmont are collecting geotechnical data from both their exploration drill holes, and from 'geotechnical' drill holes, which are targeting specific underground mining areas.
- The core from the **exploration holes** is put into boxes by the drillers, and brought back to camp for geotechnical and geological logging.
- The **geotechnical holes** are drilled using a different method, where the core comes out in a 3m long split tube, or triple tube. The core is logged in the split tube, within a core logging shack at the rig. The core is then put into boxes and brought into camp for geological logging.
- The split tube method combined with the larger core diameter on the geotechnical holes will result in less drill damage to the core, and more accurate geotechnical data.

Training Method

- The order of the logging steps is different when logging the split tubes at the drill, than when logging from core boxes in camp. The concepts are the same, but the process is slightly different.

- To train you on the geotechnical logging methods for 2011, we will:
  - Work through this presentation, discussing **concepts and definitions** that you will need to be familiar with when logging the core (PART A).
  - Work through the logging manual at the core boxes with **step by step instructions** for each process (PART B).

- The manual provided also contains other useful reference information, including:
  - ACT tool instructions
  - Tips for using the geotechnical database
  - Geotechnical database structure

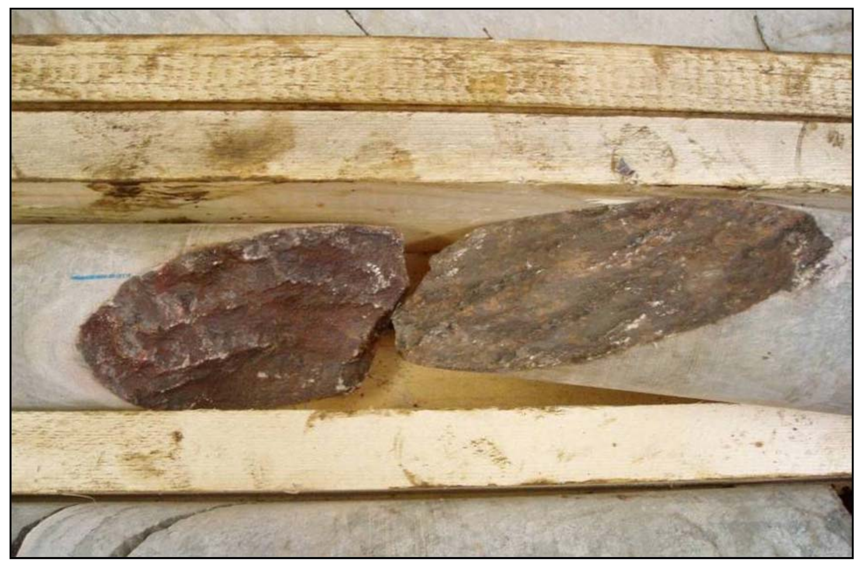
Contents

A) Identifying Fractures

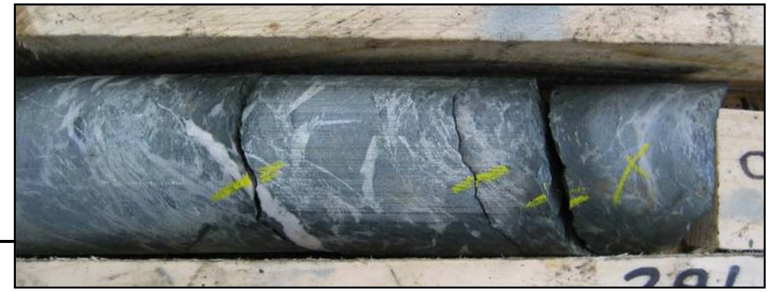
Joints

- Joints are fractures in the rock, caused by pressures in the ground.
- In most cases, joints have groundwater moving through them, which can result in some mineral deposition and staining in the joint.
- In the core, indications of a joint include:
  - Freshness – Joints tend not to look fresh.
  - Staining – Joints often are stained or have some type of coating or fill.
  - No tensile strength – Joints separate solid (intact) core pieces and exhibit no tensile strength.
  - Roughness of break – The edges of a joint usually do not match back together as seamlessly as a mechanical break.
  - Angle of break – Low angle breaks are more likely to be joints than mechanical breaks.

Examples of Joints

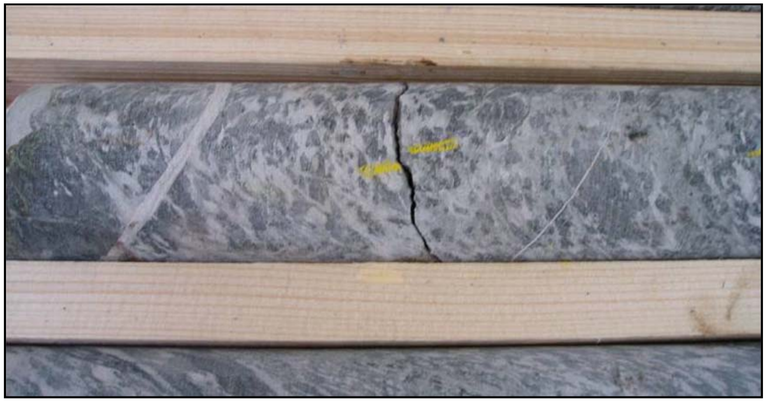


Mechanical Breaks



- Mechanical breaks are artificial breaks in the core that have been created by the drilling process (i.e. fresh breaks).
- Indications of a mechanical break include:
  - Freshness – A fresh looking surface could indicate artificial break
  - Angle of break – A break perpendicular to the core axis could be an indication of an artificial break
  - Roughness – A rough surface could indicate artificial break
  - Coating - No coating or fill could indicate artificial break
  - Spin marks from the drill.
- Mechanical breaks are often found near the end of the drilling run, or near the end of the box row, where the driller's helper has hit the core to fit it in the box.
- If you are really unsure if something is a joint or a mechanical break, you should err on the side of caution and call it a joint.

Examples of Mechanical Breaks



Note high angle, very fresh break indicating drill damage.

Cluster of foliation sub-parallel fractures – roughness and angularity indicate mechanical damage.

Although sub-parallel to foliation, roughness and angularity of break indicate mechanical damage.

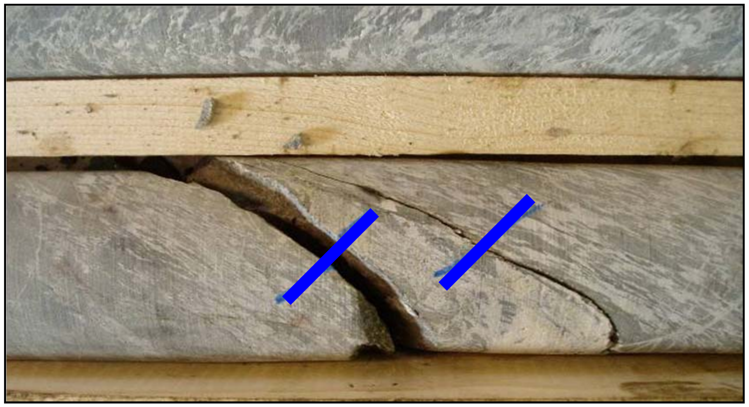
"Drill spin" is an obvious indication of mechanical damage.

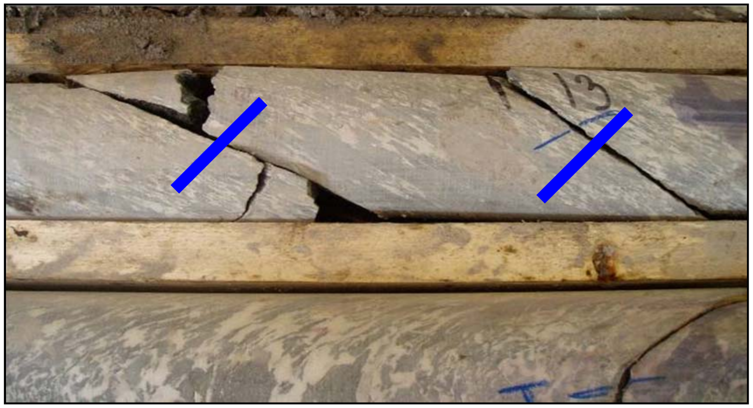
Foliation Breaks

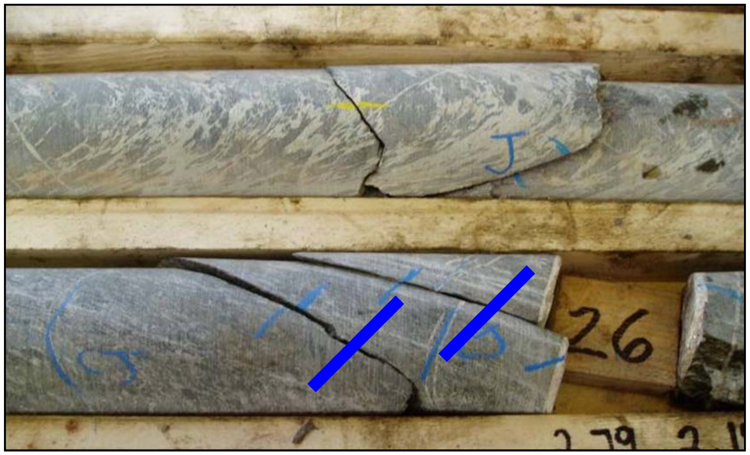
- Foliation breaks are breaks in the core caused by the drilling process along weak foliation layers. They are a type of mechanical break.
- Foliation breaks are not open in the ground; if there are indications that a break along the foliation was naturally open in the ground (i.e. staining, fill etc.), it would be called a joint.
- It can be difficult to assess the difference between naturally open and machine induced breakage along foliation.
  - If you are certain that a break along the foliation was machine induced, mark it as a foliation break.
  - If you see evidence of staining (fluid flow) or cementation, which would suggest open space prior to drilling, mark it as a joint.
- At Hope Bay we sometimes see drilling induced breaks along a vein. These are called mechanical breaks, not foliation breaks. Foliation is a result of layering in the rock, and is not the same as veining.

Part A: Concepts

Examples of Foliation Breaks



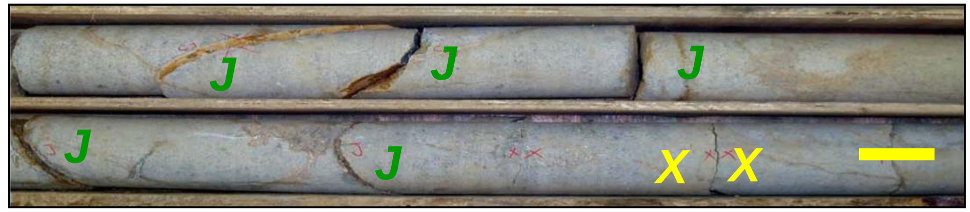




Cemented Joints

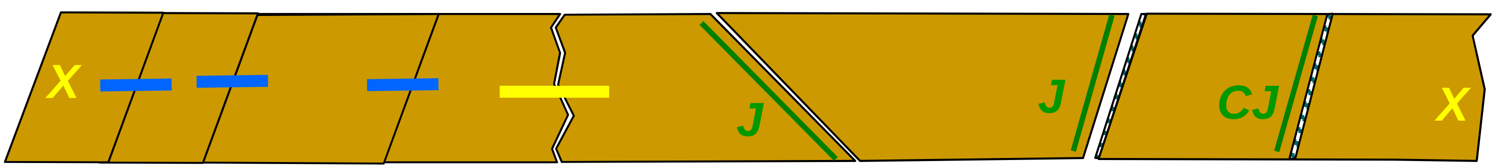
- Cemented joints are joints that have been cemented back together. The 'cement' is minerals that have deposited on the joint walls, from groundwater moving through the fracture.
- At Hope Bay, the 'cement' is normally calcite.
- Be careful not to confuse cemented joints with thin quartz veins. Veins are often irregular looking, and may not go all the way through the core. Cemented joints tend to be more regular, and can be observed as a line all the way around the core.
- To assist with identifying cemented joints from veins, we have a rule that a cemented joint should be less than **2mm** wide.
- In some cases, a cemented joint may have been opened by the drilling process. For our purposes, we count this as a joint. In other words, only closed cemented joints in the core are called cemented joints.

Core Marking



FIVE sources of fractures can be found in the drill core, and are marked as follows:

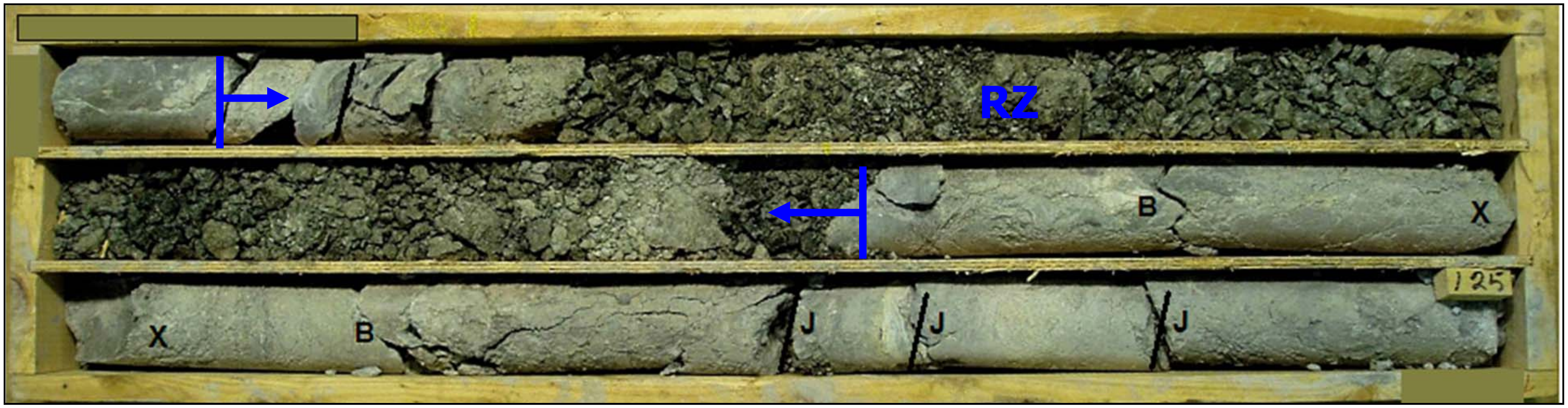
- Artificial breaks induced by the core handling process should be marked with a yellow (X).
- Artificial breaks induced by the drilling process (mechanical breaks) are marked with a yellow line ( ) across the break.
- Foliation breaks, induced by the drilling process, are marked with a blue line ( ) across the break.
- Closed cemented joints that are marked with a green (CJ) and a line along the joint.
- Natural joints that are present in the rock mass are marked with a green (J) and a line along the joint.



Rubble Zones

- Rubble zones are sections of core that are broken, very jointed, sheared, or filled with gouge. Rubble zones could be caused by a series of joints close together, or could be part of a fault.
- Rubble zones are either:
  - <u>Natural Rubble Zones</u> (RZ), which are created by a fault or series of <u>joints</u> in close succession; or
  - <u>Mechanical Rubble Zones</u> (MRZ), which are created artificially by the drilling process, and are essentially a series of <u>mechanical breaks</u> in close succession.
- Natural Rubble Zones often have staining or fill, and look weathered. Mechanical Rubble Zones are often jagged and fresh looking, with no staining or fill.
- If you are unsure whether a rubble zone is natural or mechanical, call it a natural rubble zone.

Examples of Rubble Zones



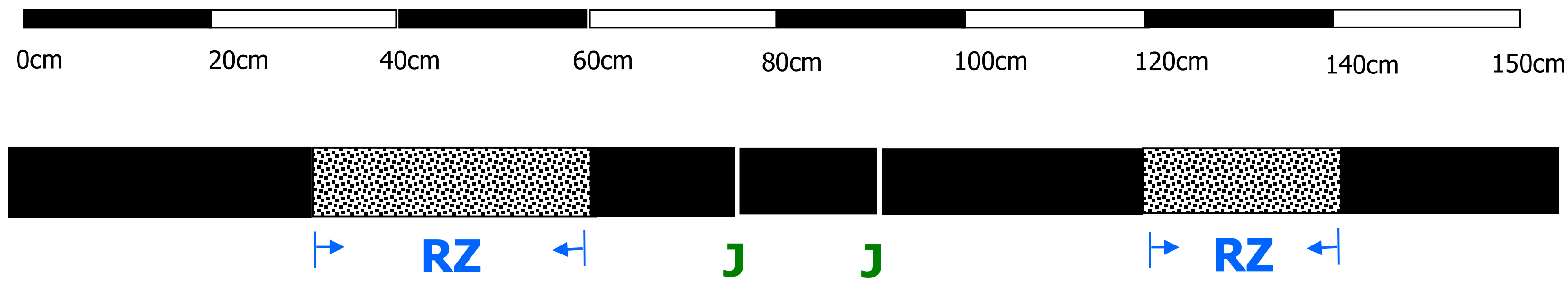
Rubble Zones – How To Count

- It is not possible to actually count the joints or mechanical breaks in rubble zones, therefore we log the rubble zones as follows:
  - Natural Rubble Zones (RZ) are assumed to have 4 joints per 10cm of rubble zone.
  - Mechanical Rubble Zones (MRZ) are assumed to have 4 mechanical breaks per 10cm of rubble zone.

- Often rubble zones are interspersed with short sections of competent core, or competent core with a few joints. If the competent sections between the rubble are less than approximately 30cm long, mark it as one rubble zone.

- You should use your judgment to determine an appropriate joint count for these rubble zones – i.e. do not apply the 4J/10cm rule across sections of competent rock between rubble - see example on next page.

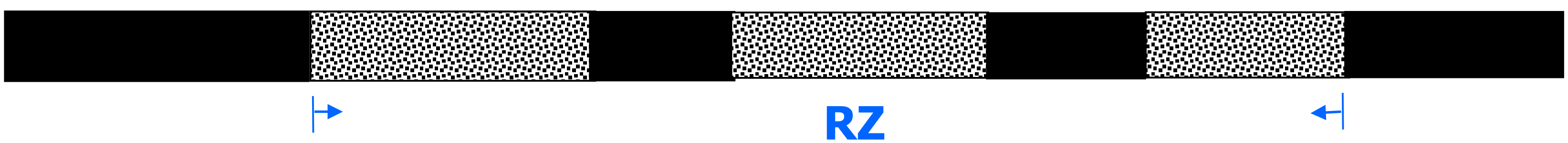
Example of how to count...



25cm = 10 J

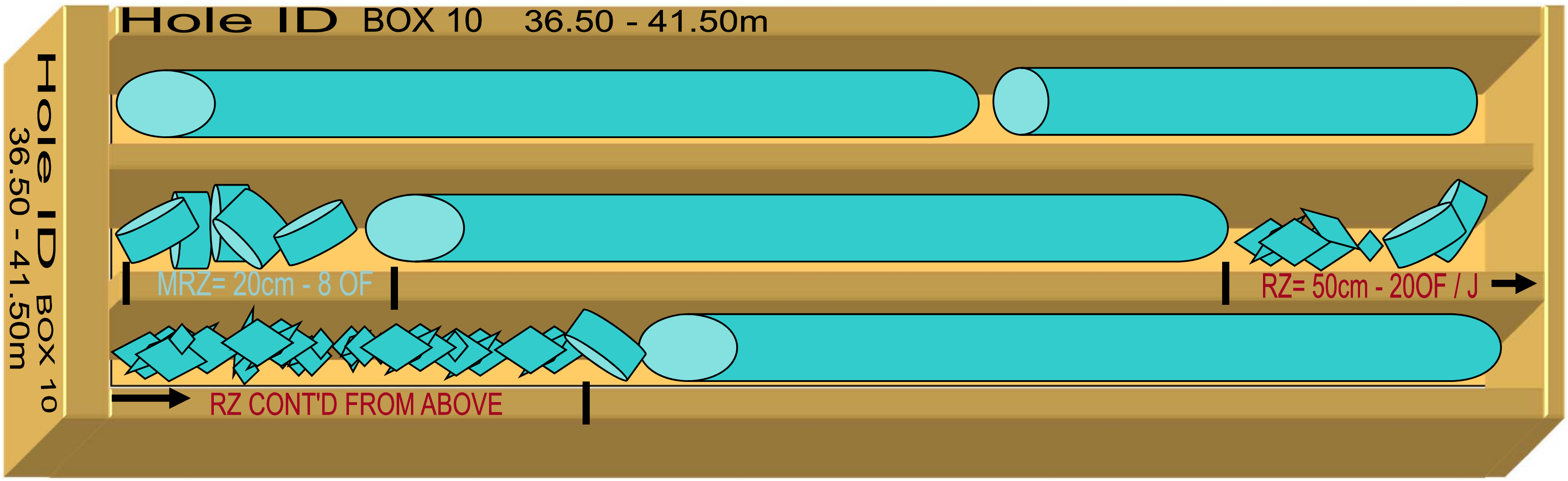
20cm = 8 J

Total joints in the above section = 10 + 2 + **8 =** 20 joints



The above rubble zone is 110cm long, but the actual rubble makes up
25cm + 24cm + 21cm = 70cm,
so we use our judgement in applying the 4J/10cm rule,
and give the rubble zone 28 joints in this case.

Rubble Zones Summary



Natural Rubble Zone (RZ)

- Include all Natural Rubble Zones as well as those you are unsure of.
- 4 counts are added to the open fractures count and the joint count (discussed later).
- Natural Rubble Zones must be marked in the Major Structures Tab of the palm pilot (discussed later).
- Natural Rubble Zones are taken out of RQD measurements (discussed later).

Mechanical Rubble Zone (MRZ)

- Mechanical Rubble Zones are induced by the drilling process. Consider a rubble zone mechanical only if you are 100% sure it was caused by drilling!
- 4 counts are added to the open fractures count. Nothing is added to the joint count.
- **Mechanical** rubble zones are not marked in the Major Structures Tab or taken out of RQD measurements.

B) Basic Logging

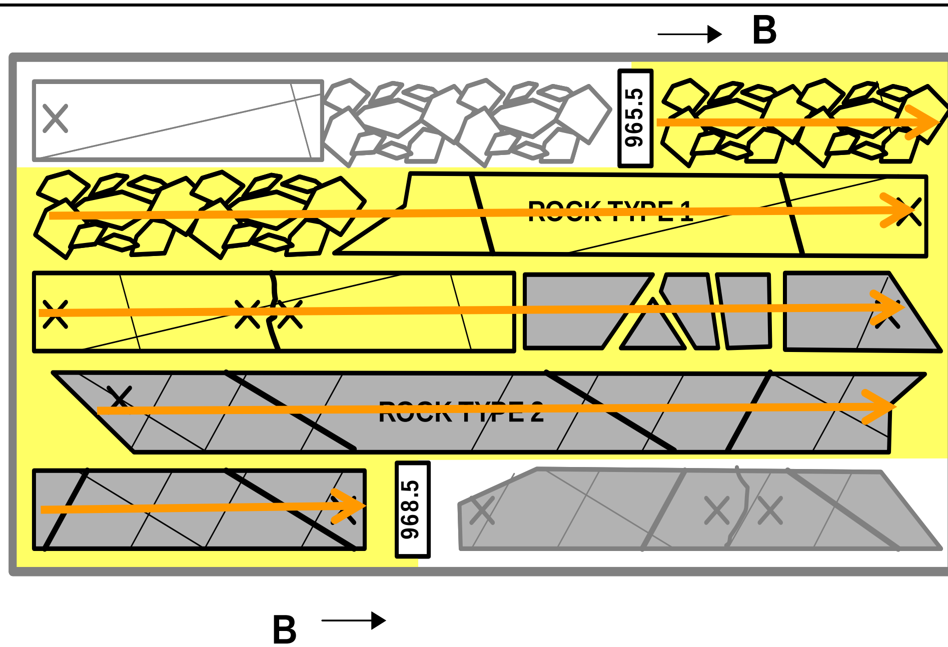
Runs

- Basic logging is conducted for every run.
- The drilling run is the length of core that fits within the core barrel.
- At the end of every drilling run, the driller brings the core barrel to the surface to empty. Core barrels at Hope Bay in 2011 are 3m long.
- The driller's helper will mark the end of each run by putting a wooden block in the core box, indicating the depth of the run end.

Total Core Recovery

- Total Core Recovery (TCR) is the sum of **all measurable core recovered in one drill run**.
- TCR is measured for each run length drilled.
- To measure TCR:
  - **Fit the core together** as best as possible;
  - For the broken zones, **push the broken pieces together** so that it approximately resembles a core volume;
  - **Measure** the total length of core recovered, including the solid and broken zones.
- The actual distance of the run is also recorded, and is obtained from the driller, using the rod measurements.
- The TCR ratio (the ratio of core recovered to run length) is very important in the weaker rock types, where core loss can be expected.

Total Core Recovery Example

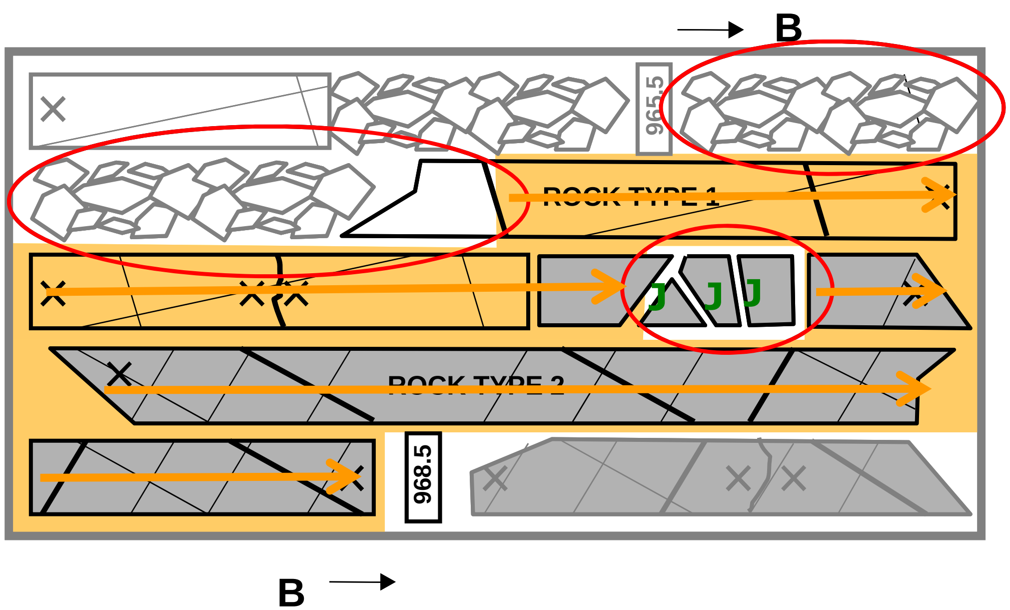


• In the example above, Run B (highlighted in yellow) is indicated by the drillers block marks to be 3m long.
• To calculate the TCR, you would measure the actual core recovered, by measuring where the orange arrows indicate.
• The **TCR** of interval B is approximately 2.4m, while the indicated drill run is 3.0m. Your palm pilot will calculate the TCR ratio from this, i.e. 2.4 / 3.0 x 100 = 80%.

Rock Quality Designation

- Rock Quality Designation (RQD) is an indication of **how jointed and weak the rock is**, measured as the total length of core pieces that are **longer than 10cm.**
- The geotechnical database will compare this to the run length to calculate the RQD for you.
- To determine RQD for each run, you should measure the **length of core recovered, EXCLUDING**:
  - Sections where there are **joints closer than 10cm** together
  - **Natural rubble zones**
  - **Soft core**, with a strength rating of R0 or R1 (discussed later)
- Note:
  - Machine breaks and core handling breaks should be considered solid core, i.e. they are included in the RQD measurement
  - Joints along the core axis should be considered solid core, i.e. included in the RQD measurement.

RQD example



The RQD of interval B in the example is approximately 1.5m (1.5 / 3.0 x 100 = 50%).

Areas not counted are circled.

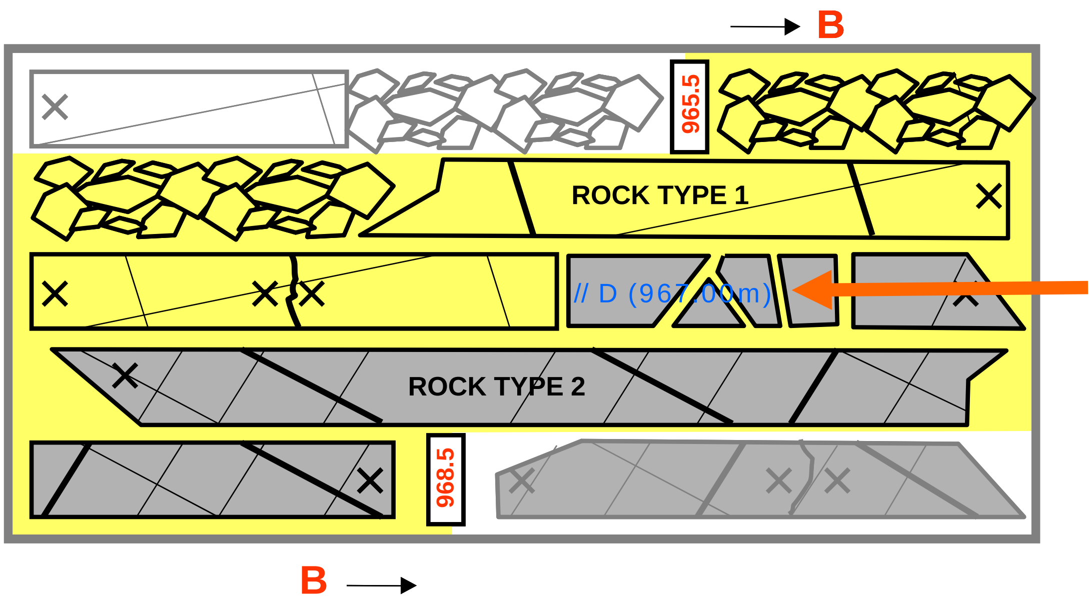
Areas that are measured are indicated with orange arrows.

C) Detailed Logging

Domains

- The **detailed log** is conducted on a domain basis.
- A domain is **an interval of core where the geotechnical qualities are the same**.
- Domain changes commonly correspond to changes in:
  - **Lithology** (e.g. basalt vs. argillite)
  - **Alteration** (e.g. hydrothermally altered metavolcanics vs. unaltered metavolcanics)
  - **Structure** (e.g. faulted basalt vs. unfaulted basalt)
  - Intact **rock strength**
- When logging from **split tubes at the rig**, domain length max is **3m**, and min is **0.5m**.

Example of Domain Change



Remember:

Domain changes correspond to changes in structure, intact rock strength (IRS), lithology and alteration.

Change in domain at 967.00m

Domains are marked on the core box by: // D (depth)

SAMPLE DRILL RUN: B = 965.50 – 968.50m
ROCK TYPE 1: Gabbro, Intact Rock Strength =R3, rubble zones
ROCK TYPE 2: Pillow basalt, Intact Rock Strength =R5, increased joints and cemented joints, solid core.

The changes in geotechnical qualities of run B are significant enough that the run must be split into two separate domains. The resulting changes will be reflected in the 'Detailed Geotech Form' by defining a new domain. The Basic Geotech data input sheets will not be affected.

Open Fractures

- For each domain, we count the ‘open fractures’.
- The ‘open fracture’ count includes all of the fractures that are open in the core, including:
  - **Joints**;
  - Breaks induced by the drill (**mechanical breaks**); and
  - Breaks induced by the drill along foliation (**foliation breaks**).
  - ‘Imaginary’ mechanical breaks that have been attributed to **mechanical rubble zones**.
  - ‘Imaginary’ joints that have been attributed to **natural rubble zones**.
- The ‘open fracture’ count does not include breaks caused by someone hitting the core with a hammer, i.e. core that is purposely broken to fit it into the core boxes, or to test it’s strength.

Fracture Counts Per Domain

- The following items are **counted** during core logging:
  - **Open Fractures**: a total count of all fractures in the domain, not including handling breaks.
  - **Foliation Breaks**: a total count of all foliation breaks in the domain
  - **Joints**: a total count of all joints in the domain
  - **Cemented Joints**: a total count of closed cemented joints in the domain.
- **Natural rubble zone** (RZ) 'imaginary' joints are added to both the **open fractures** count and the **joints** count (assuming ~4 joints/10cm) .
- **Mechanical rubble zone** (MRZ) 'imaginary' mechanical breaks are added to the **open fractures** count only (assuming ~4 mechanical breaks/10cm).

Cemented Joint Strength

- As part of the detailed log, you need to rate the strength of cemented joints for each domain (if there are any)
- The strength of the fill of cemented joints can be determined by gently hitting the cemented joint with a rock hammer.

- The strength of the cemented joints in a domain is rated as either:
  - 0 = **Strong** (none of the CJs break)
  - 1 = **Moderate** (some of the CJs break)
  - 2 = **Weak** (all of the CJs breaks)

Intact Rock Strength

- Intact rock strength is a measure of the strength of individual rock pieces. This doesn't consider breaks that occur through existing features (e.g. cemented joints, foliation, veining etc.) as a result of hitting the core.
- IRS is evaluated for each domain by three tests as follows:

Thumb test:

- If it can be **indented** by your **thumb** = **R0** (extremely weak)

Rock **pick** hit test:

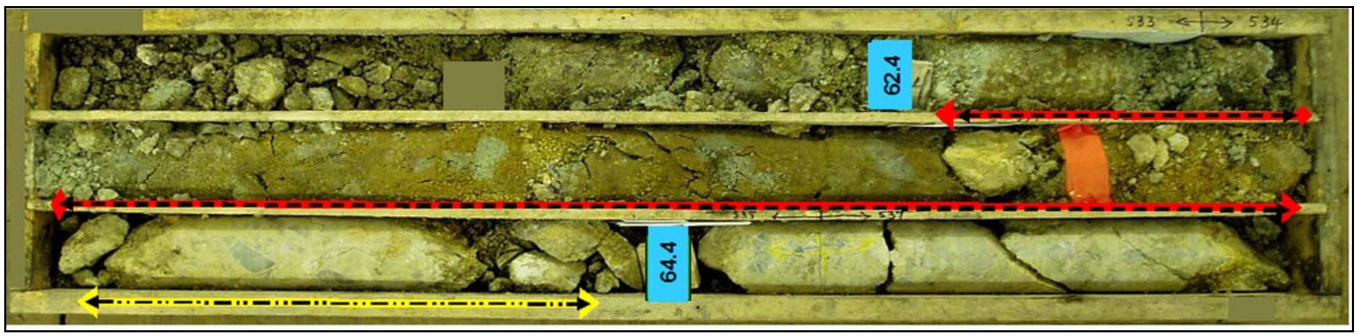
- If it **crumbles** under firm blow of the **pick**, or can be peeled with a pocketknife = **R1** (very weak)
- If the **pick** makes a **shallow indentation** = **R2** (weak)

Rock **hammer** hit test:

- If it breaks on the **first hit** = **R3** (med-strong)
- If it breaks on the **second hit** = **R4** (strong)
- If it breaks on the **third, fourth, or fifth hits** = **R5** (very strong)
- If it **does not break** after **five hits** = **R6** (extremely strong)

Intact Rock Strength Continued…

- Up to two values for IRS are given for each domain. The **'strong rock strength'**, and the **'weak rock strength'** values are entered, as well as a **'percentage weak'** to indicate how much of the rock is represented by the 'weak' rock strength value.



- In the example above, 80% of the rock is rated as R0, and 20% is rated as R3, and this is entered like this:

IRS		
Strong	Weak	% Weak
R3	R0	80

Intact Rock Strength Continued…

- If you have weak rock in your domain, rated as **R0 or R1**, you also need to **further classify** it's characteristics **in the comments section**.
- Use the table below to further describe the weak rock as **S1 – S6**.

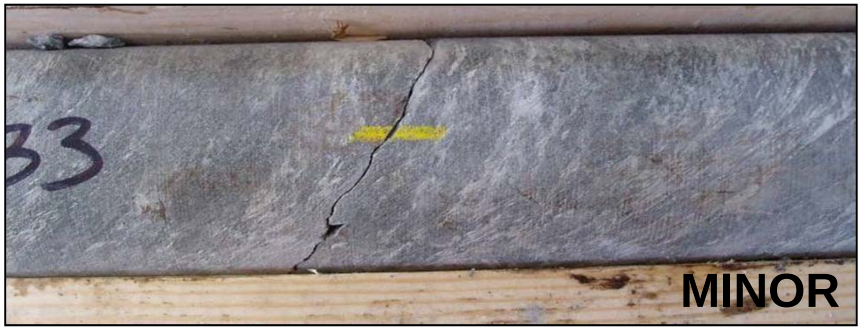
ISRM STANDARD - FIELD ESTIMATE OF ROCK STRENGTH

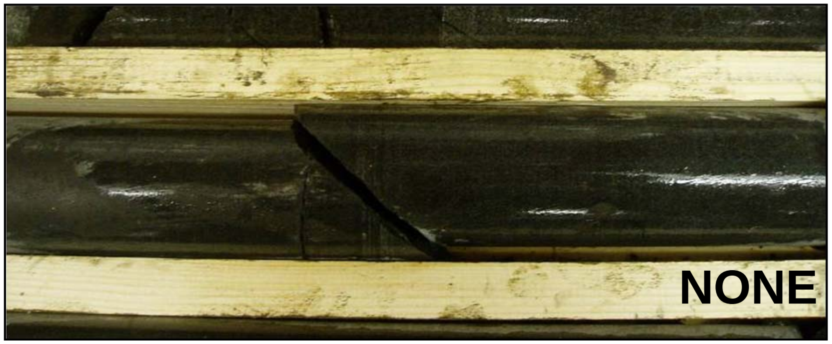
Index Abrv.	Description	Field Test	Approximate Range Uniaxial Compressive Strength (MPa)
S1	Very Soft Clay	Easily penetrated several inches by fist	< 0.025
S2	Soft Clay	Easily penetrated several inches by thumb	0.025 - 0.05
S3	Firm Clay	Penetrated several inches by thumb with mod. effort	0.05 - 0.10
S4	Stiff Clay	Indented with thumb, but penetrated with great effort	0.10 - 0.25
S5	Very Stiff Clay	Readily indented with thumbnail	0.25 - 0.50
S6	Hard Clay	Indented with difficulty with thumbnail	> 0.50

Micro-Defects

- Micro-defects are features caused by mineral alteration of the rock. These are typically non-linear, discontinuous features in the rock.
- Micro-defects are rated for each domain, as part of the detailed log, using the table below.

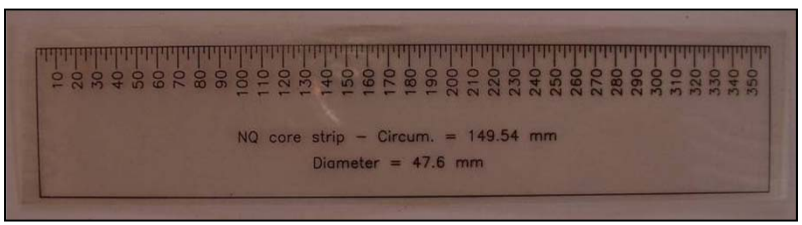
MICRODEFECTS - QUANTITY	
CODE	*DESCRIPTION*
0	NONE
1	MINOR
2	MODERATE
3	HEAVY





Foliation Angle

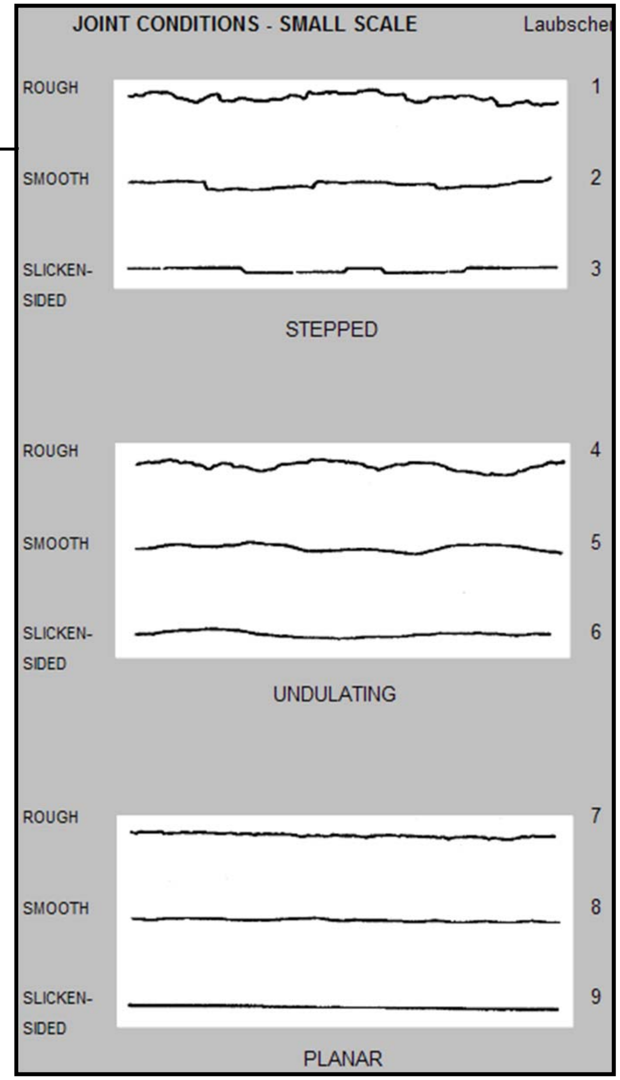
- Foliation angle is measured for each domain using the ‘crocodile angle’.
- The alpha angle relative to the core axis is measured on a break in the foliation, as shown in the picture below.
- The alpha angle must be between 0 degrees (parallel with the core axis) and 90 degrees (perpendicular to the core axis).
- Where possible, the beta angle should be also recorded.



Joint Roughness

To describe the conditions of the joint, we rate the **roughness**, **alteration** of joint walls, and **infill**.

The **roughness** is evaluated on a scale of 1 to 9 by using the chart on the right (the lines on the chart are 10cm long at full scale).



Examples of Joint Roughness

Joint Wall Alteration

Joint wall alteration results from fluids moving along the joint and **altering** the **surrounding rock** composition.

Alteration of the rock on either side of the joint is evaluated as follows:

1 = The altered joint wall is the **same strength** as the rock around the joint.

2 = The altered joint wall is now **stronger** than the rock around the joint

3 = The altered joint wall is now **weaker** than the rock around the joint

Joint Fill

Joint fill is also rated according to the scale on the right.

'**Softening**' refers to soft deposits that can be **pushed off** the joint with your finger.

'**Non-softening**' refers to harder deposits stuck onto the joint walls that need to be **chipped off**.

Fine, medium and coarse refer to the grain size within the fill.

Gouge is a clay-like joint filling.

Description	Code
GOUGE THICKNESS > AMPLITUDE	1
GOUGE THICKNESS < AMPLITUDE	2
SOFTENING - FINE	3
SOFTENING - MEDIUM	4
SOFTENING - COARSE	5
NON SOFTENING - FINE	6
NON SOFTENING - MEDIUM	7
NON SOFTENING - COARSE	8
STAINING ONLY	9
NONE	10

Lower numbers on the scale represent softer, thicker fill, which reduces friction on joint surfaces, resulting in a lower rock mass strength.

Joint Sets

- For each domain, joints are grouped together by **similar alpha angles**.
- The range of alpha angles in each joint set should not be more than **30 degrees** (in alpha and beta).
- For each joint set, roughly **average** the other **characteristics** - roughness, alteration, fill.
- Note that the ‘imaginary’ joints attributed to natural **rubble zones** also need to be **included in a joint set**. Group all of the rubble zone joints into one joint set. You should make a best guess of their characteristics of alpha, roughness, alteration and fill.
- In the comment for the domain, indicate which joint set is a rubble zone, i.e. JS1 = RZ.

Major Structures

- Major structures are key **weak areas** of the core that we need to highlight in the log. It will be used as a reference during the detailed evaluation of the structural features.

- Major structures include **rubble zones, faults, or fault zones** (which may contain many rubble zones).

- For each major structure, you must describe:
  - the total **length** (m) of the major structure;
  - the **alpha** and **beta** angles of the structure, if possible.
  - the **type** of structure (described as either **jointed**, **broken**, **sheared** or **gouge**, with gouge being the most intensely deformed). These terms should be strictly structural in nature.
  - the **total joints** in the major structure.

D) Oriented Core Logging

Core Orientation

- For angled holes, the drillers use a reflex product called an ACT or "Ace Tool" to determine the bottom of the hole (BOH) for each run.
- They mark the BOH (low side of the hole) on the end of the core for that run.
- The geotech will use this mark to draw the BOH orientation line on the core. Step by step instructions for this are provided in the manual.
- From this information, we can measure the orientation of joint planes, called the 'beta' angles.

Orientation Line Offset

- If the orientation tool is being used correctly, and the geotech ensures that the rock is matched together when the orientation line is drawn, the bottom-of-hole orientation lines marked on each run should correspond from one run to the next.

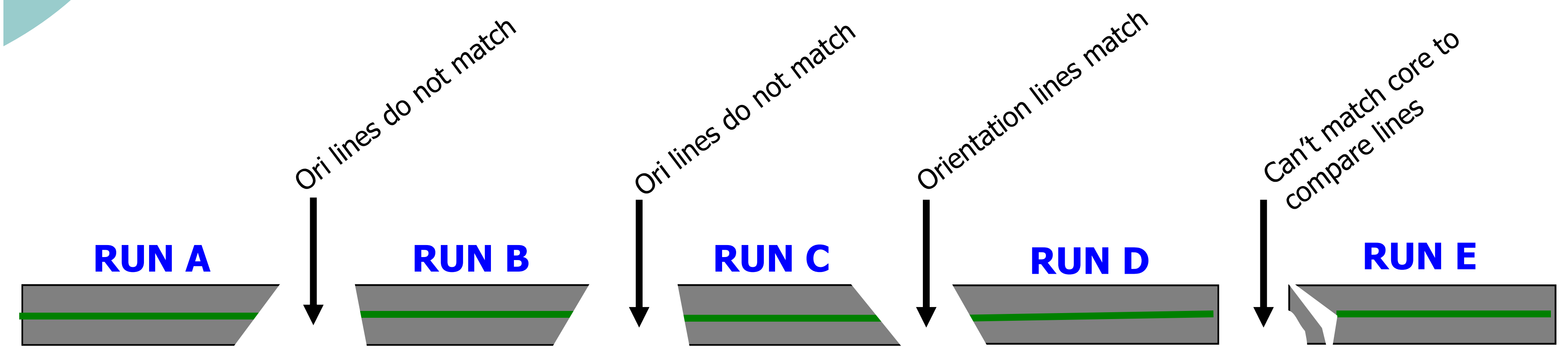
- If the lines do not match, there is an 'offset', which is measured in degrees around the core, from the up-hole line to the down-hole line, in a clockwise direction looking down the hole.

- The offset is recorded as a number between zero degrees and 360 degrees:
  - Offset = 0 would indicate a perfect match between two orientation lines
  - Offset = 10 would indicate that the run is rotated clockwise by 10 degrees from the previous run
  - Offset = 350 would indicate that the run is rotated clockwise by 350 degrees (or anticlockwise by 10 degrees) from the previous run

- The offset '-1' means that there is no offset value for that run. This could be for the following reasons:
  - Orientation line is marked on this run, but no offset could be measured because the run above did not have an orientation line.
  - Orientation line is marked on this run, but no offset could be measured because the core from the run above did not match well with this run.
  - No orientation line for this run.

Orientation Line Offset Cont…

The geotech should make a comment about the orientation line, including their confidence in the offset measured. For example, if a section of the run was broken and difficult to put together, the geotech would indicate low confidence in the orientation for that run. A comment on whether the orientation line looks correct based on foliation is also useful. If offset -1 is written, a reason must be given.



Good orientation line: Offset = 0 from previous run.

Bad orientation line: Offset = 30° between runs A and B

Good orientation line: Offset = 330° between runs B and C. Line now correctly placed.

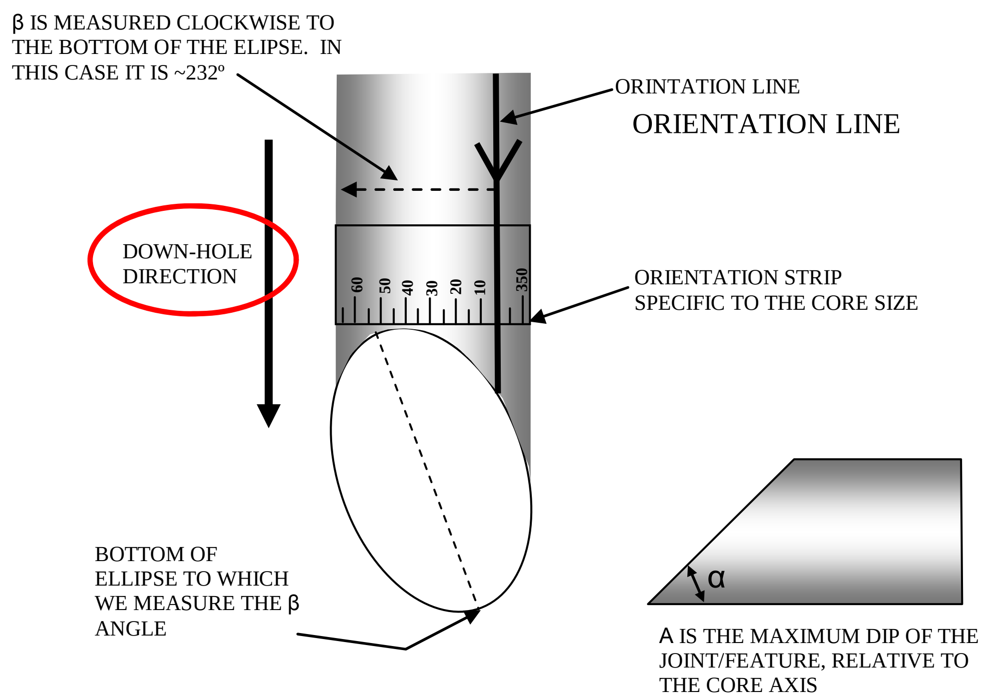
Good orientation line: Offset = 0 between runs C and D.

Core from runs D and E does not match so can't compare orientation lines. Offset = -1

Alpha and Beta Angles

We measure two angles on a joint:

- Alpha angles measure the joint dip, and are measured on every joint
- Beta angles measure orientation of the joint plane, and are only measured on joints with an orientation line



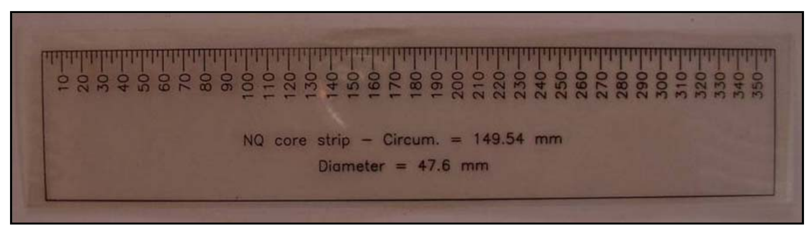
Measuring Alpha and Beta Angles

- Measuring the required orientation parameters is done using a graduated strip and a carpenters angle.

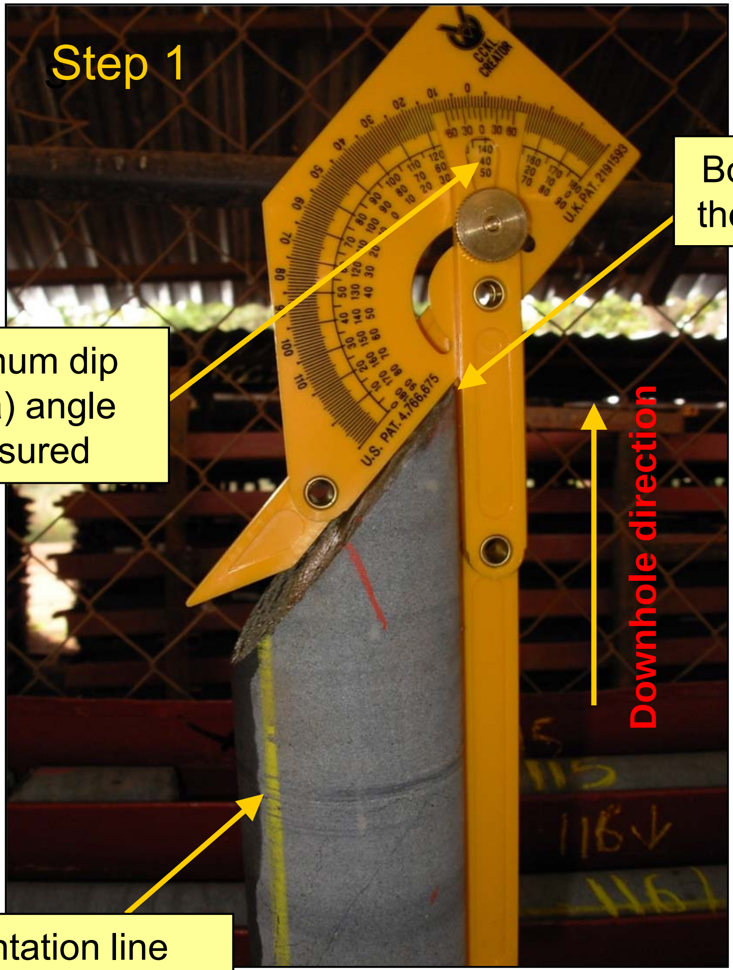
- **<u>Alpha angle (α)</u>**: the carpenter angle is used to measure the **maximum dip** (α) of the feature relative to the core axis.

- **<u>Beta angle (β)</u>**: The plastic calibrated strip is placed with the "0" on the orientation line of the same piece of core and the tape is wrapped clockwise around the core so that the 360º point returns to the orientation line. The angle (β) is then measured, **clockwise**, **from the orientation line to the most down hole part of the ellipse**.

Downhole direction



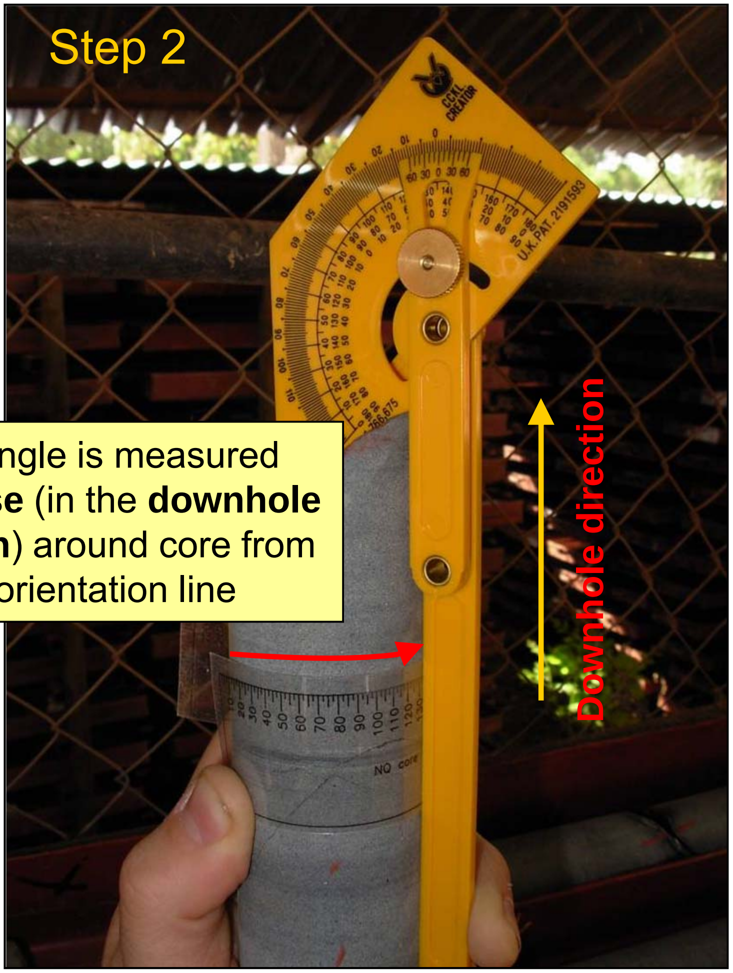
Measuring Alpha and Beta Angles



Maximum dip (alpha) angle measured

Bottom of the ellipse

Orientation line (marked previously)



Beta angle is measured **clockwise** (in the **downhole direction**) around core from the orientation line

Alpha = 42°   Beta = 134°

Appendix B - Geotechnical Data

Appendix B1 - Geotechnical Database (Excel format)

Appendix B2 - Geotechnical Drill Hole Logs

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BOREHOLE LOG: 11PSD276

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/13/2011 **TO:** 4/14/2011
DIP: -58 **AZIMUTH:** 262
COORDINATES: 546630.162N 35500.125E **DATUM:** Nad83

TOTAL DEPTH: 103
PAGE: 1 **OF** 2
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth scale (ft): 120, 140, 160, 180, 200, 220, 240, 260, 280
Depth scale (m): 36, 40, 44, 48, 52, 56, 60, 64, 68, 72, 76, 80, 84, 88

FF/m	Joint Condition Rating	RMR_{90}
0.9	22	60
1.2	10	54
0.3	10	59
0.3	22	66
5.6	4	39
3.6	19	57
0.3	22	77
1.6	18	62
1.3	18	63
0.3	22	81
1.0	22	67
0.3	22	81
0.7	19	70
0.3	19	78
0.7	15	59
0.7	16	56
0.3	16	65
0.7	12	56

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BOREHOLE LOG: 11PSD276

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/13/2011 **TO:** 4/14/2011
DIP: -58 **AZIMUTH:** 262
COORDINATES: 546630.162N 35500.125E **DATUM:** Nad83

TOTAL DEPTH: 103
PAGE: 2 **OF** 2
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
300	92						0.3		16	65	
							0.3		18	67	
	96						0.7		19	73	
320							0.3		22	81	
	100						0.7		17	71	
340	104										

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BOREHOLE LOG: 11PSD276A

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/14/2011 **TO:** 4/22/2011
DIP: -58 **AZIMUTH:** 260
COORDINATES: 546629.949N 35500.111E **DATUM:** Nad83

TOTAL DEPTH: 399
PAGE: 1 **OF** 8
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

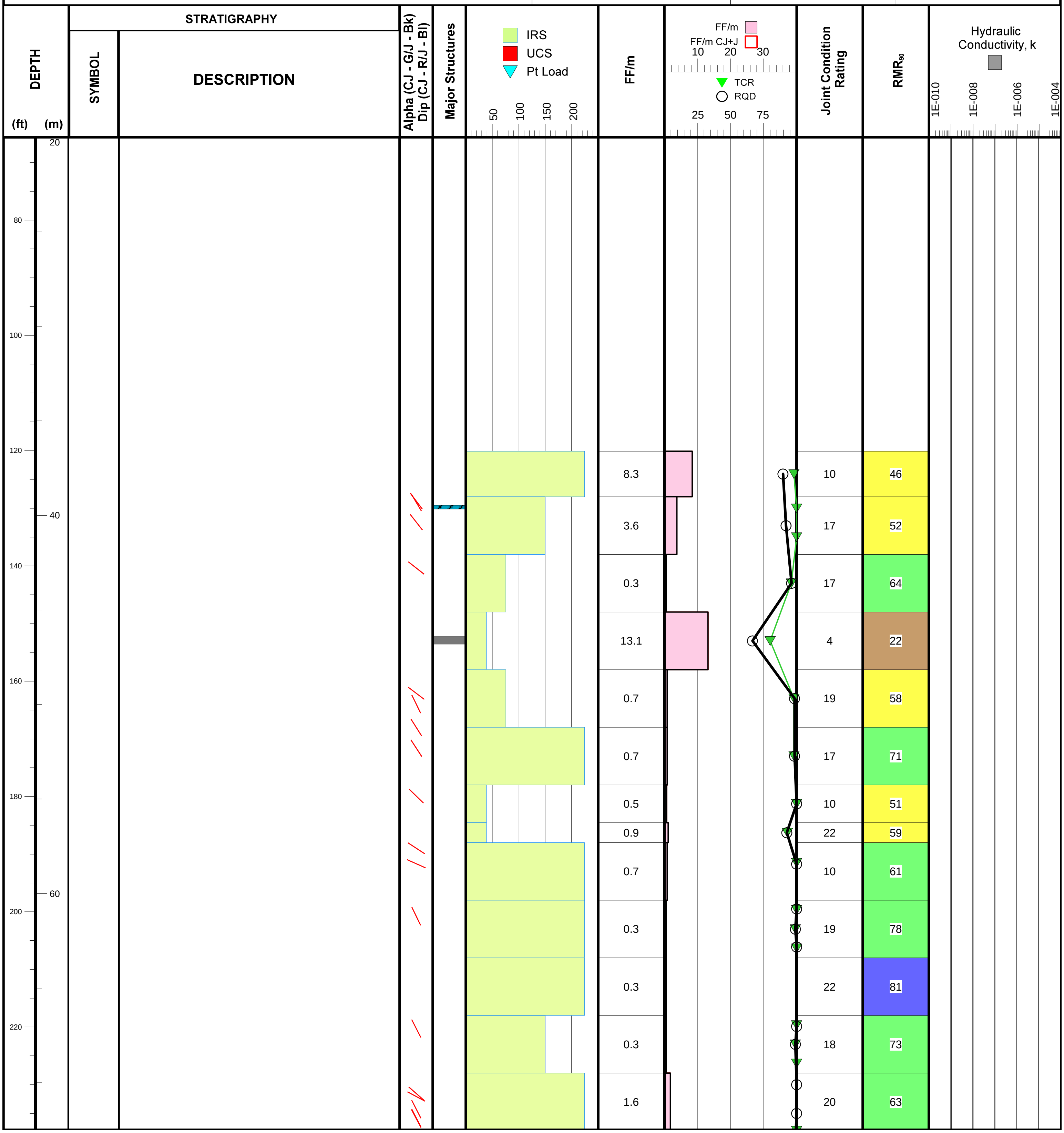
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR$_{90}$
8.3	10	46
3.6	17	52
0.3	17	64
13.1	4	22
0.7	19	58
0.7	17	71
0.5	10	51
0.9	22	59
0.7	10	61
0.3	19	78
0.3	22	81
0.3	18	73
1.6	20	63

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BOREHOLE LOG: 11PSD276A

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/14/2011 **TO:** 4/22/2011
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TOTAL DEPTH: 399

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
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LEGEND OF RMR

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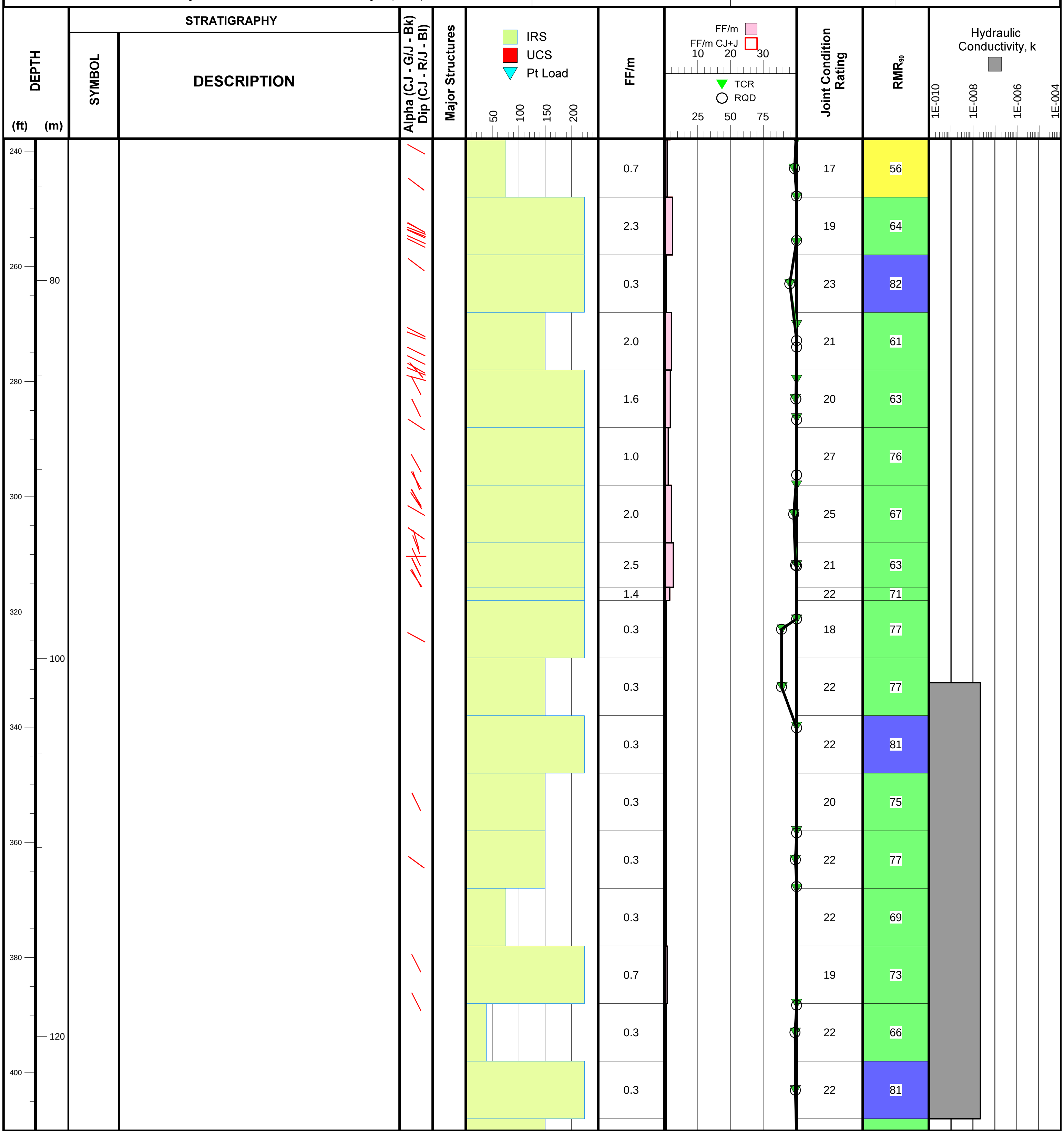

FF/m	Joint Condition Rating	RMR_{90}
0.7	17	56
2.3	19	64
0.3	23	82
2.0	21	61
1.6	20	63
1.0	27	76
2.0	25	67
2.5	21	63
1.4	22	71
0.3	18	77
0.3	22	77
0.3	22	81
0.3	20	75
0.3	22	77
0.3	22	69
0.7	19	73
0.3	22	66
0.3	22	81

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BOREHOLE LOG: 11PSD276A

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/14/2011 **TO:** 4/22/2011
DIP: -58 **AZIMUTH:** 260
COORDINATES: 546629.949N 35500.111E **DATUM:** Nad83

TOTAL DEPTH: 399
PAGE: 3 **OF** 8
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

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GOUGE
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BROKEN
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LEGEND OF RMR

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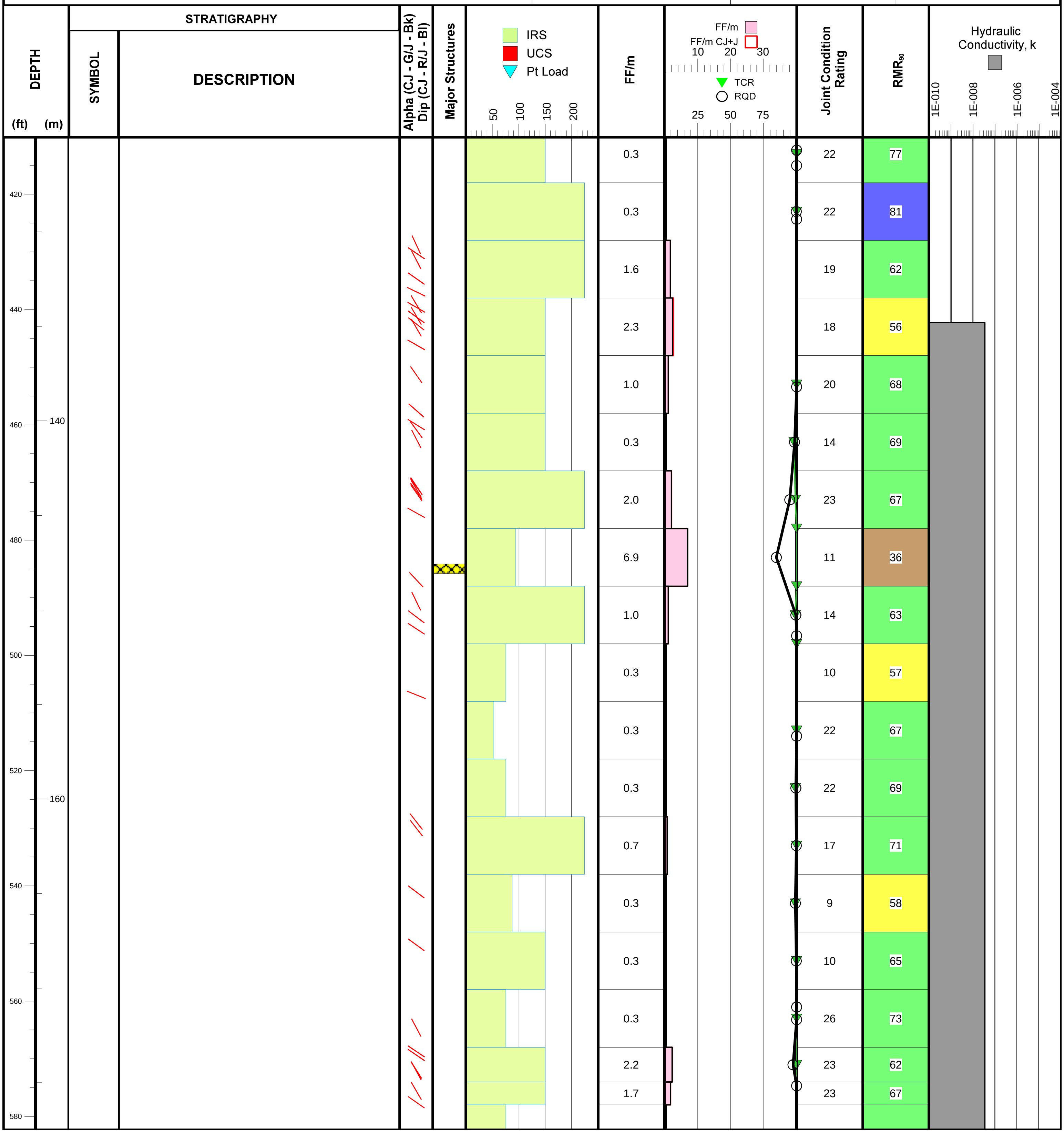
81 - 100



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BOREHOLE LOG: 11PSD276A

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/14/2011 **TO:** 4/22/2011
DIP: -58 **AZIMUTH:** 260
COORDINATES: 546629.949N 35500.111E **DATUM:** Nad83

TOTAL DEPTH: 399

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
	180						0.3		26	73	
							0.3		22	69	
600							0.3		22	69	
							0.3		10	57	
620							1.0		17	57	
							0.6		22	65	
							0.8		22	61	
640							0.4		12	57	
							1.2		22	68	
	200						0.7		12	54	
660							0.8		12	53	
							1.5		22	58	
							0.7		26	68	
							0.6		22	64	
680							0.3		10	57	
							0.7		12	51	
700							0.3		22	66	
							0.6		22	73	
							0.7		22	72	
720	220						0.3		22	69	
							0.3		22	69	
740							0.3		22	69	
							0.3		15	62	

BOREHOLE LOG: 11PSD276A

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study	**TOTAL DEPTH:** 399
LOCATION: Hope Bay, Nunavut	**PAGE:** 5 **OF** 8
SITE & PROJECT No: HOPE BAY 1CH008.054	**DRILL TYPE:** Diamond Drill
BORING DATE: 4/14/2011 **TO:** 4/22/2011	**CORE DIA.:** HQ3
DIP: -58 **AZIMUTH:** 260	**CASING DEPTH:**
COORDINATES: 546629.949N 35500.111E **DATUM:** Nad83	**PLAN No:**

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
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BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m)	STRATIGRAPHY: SYMBOL	DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
760						0.3		22	69	
						0.3		16	63	
780						0.7		23	65	
240						0.5		22	66	
						0.8		23	64	
800						0.3		22	69	
						1.0		17	54	
820						0.7		16	52	
						1.3		15	60	
840						1.0		11	59	
260						0.3		14	69	
860						0.7		12	51	
						0.3		12	59	
880						0.3		15	62	
						0.7		23	65	
900						0.3		22	69	
						1.0		21	58	
920 / 280						0.3		22	69	

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BOREHOLE LOG: 11PSD276A

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/14/2011 **TO:** 4/22/2011
DIP: -58 **AZIMUTH:** 260
COORDINATES: 546629.949N 35500.111E **DATUM:** Nad83

TOTAL DEPTH: 399
PAGE: 6 **OF** 8
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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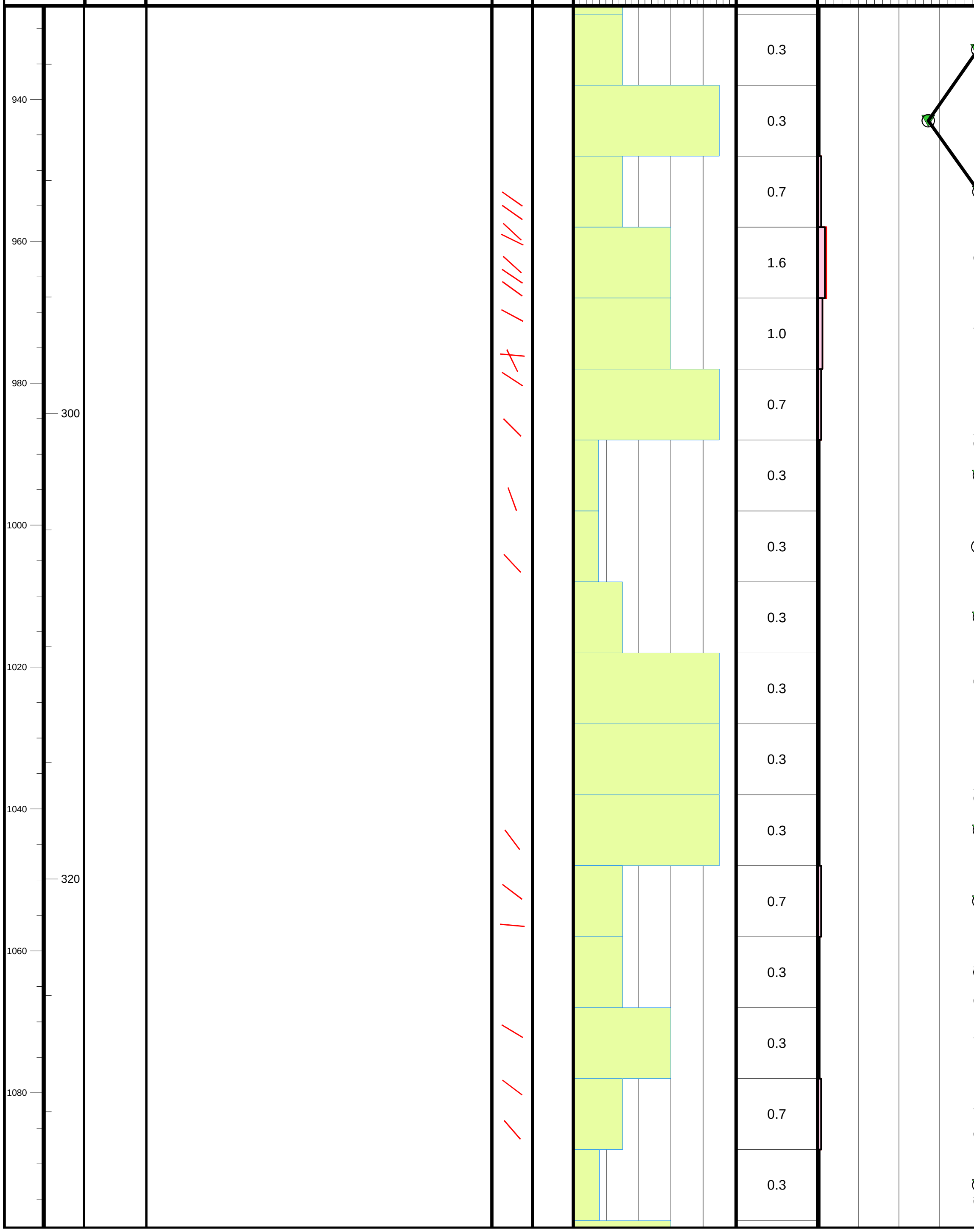
LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)



FF/m	Joint Condition Rating	RMR_{90}
0.3	22	69
0.3	22	81
0.7	16	58
1.6	16	57
1.0	11	54
0.7	17	68
0.3	20	64
0.3	9	53
0.3	22	69
0.3	22	81
0.3	22	81
0.3	22	81
0.7	17	56
0.3	22	69
0.3	14	69
0.7	18	60
0.3	22	66

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BOREHOLE LOG: 11PSD276A

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
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SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/14/2011 **TO:** 4/22/2011
DIP: -58 **AZIMUTH:** 260
COORDINATES: 546629.949N 35500.111E **DATUM:** Nad83

TOTAL DEPTH: 399

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
1100							0.3		17	72	
	340						0.4		24	82	
1120							0.4		22	80	
							0.8		20	73	
							0.3		9	64	
1140							0.3		17	72	
							0.3		22	69	
1160							0.3		22	69	
							1.6		4	40	
1180	360						0.3		22	77	
							0.3		22	69	
1200							0.3		22	77	
							0.7		22	72	
							0.6		22	65	
1220							0.3		22	69	
							0.3		22	69	
1240	380						2.0		10	54	
							1.0		10	58	
1260							3.0		12	38	

BOREHOLE LOG: 11PSD276A

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/14/2011 **TO:** 4/22/2011
DIP: -58 **AZIMUTH:** 260
COORDINATES: 546629.949N 35500.111E **DATUM:** Nad83

TOTAL DEPTH: 399

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
1280							1.3		26	73	
							1.6		15	56	
1300							0.3		22	66	
	400						0.3		22	66	

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study

LOCATION: Hope Bay, Nunavut

SITE & PROJECT No: HOPE BAY 1CH008.054

BORING DATE: 4/23/2011 **TO:** 5/1/2011

DIP: -57 **AZIMUTH:** 255

COORDINATES: 546774.491N 35527.769E **DATUM:** Nad83

TOTAL DEPTH: 444

PAGE: 1 **OF** 8

DRILL TYPE: Diamond Drill

CORE DIA.: HQ3

CASING DEPTH:

PLAN No:

srk consulting

BOREHOLE LOG: 11PSD279

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
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81 - 100

DEPTH (ft)	(m)	STRATIGRAPHY SYMBOL	DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
	40										
140											
160							0.7		22	76	
							1.7		17	62	
							1.3		19	68	
180							0.3		22	81	
							0.3		22	81	
200	60						0.9		17	69	
							1.4		22	67	
							1.3		17	62	
220							0.3		22	77	
							0.3		7	62	
240							0.3		22	77	
							0.7		21	71	
260	80						0.3		22	69	
							0.3		27	82	
280							0.7		17	67	
							1.3		13	57	
300							0.7		13	64	

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BOREHOLE LOG: 11PSD279

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/23/2011 **TO:** 5/1/2011
DIP: -57 **AZIMUTH:** 255
COORDINATES: 546774.491N 35527.769E **DATUM:** Nad83

TOTAL DEPTH: 444

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

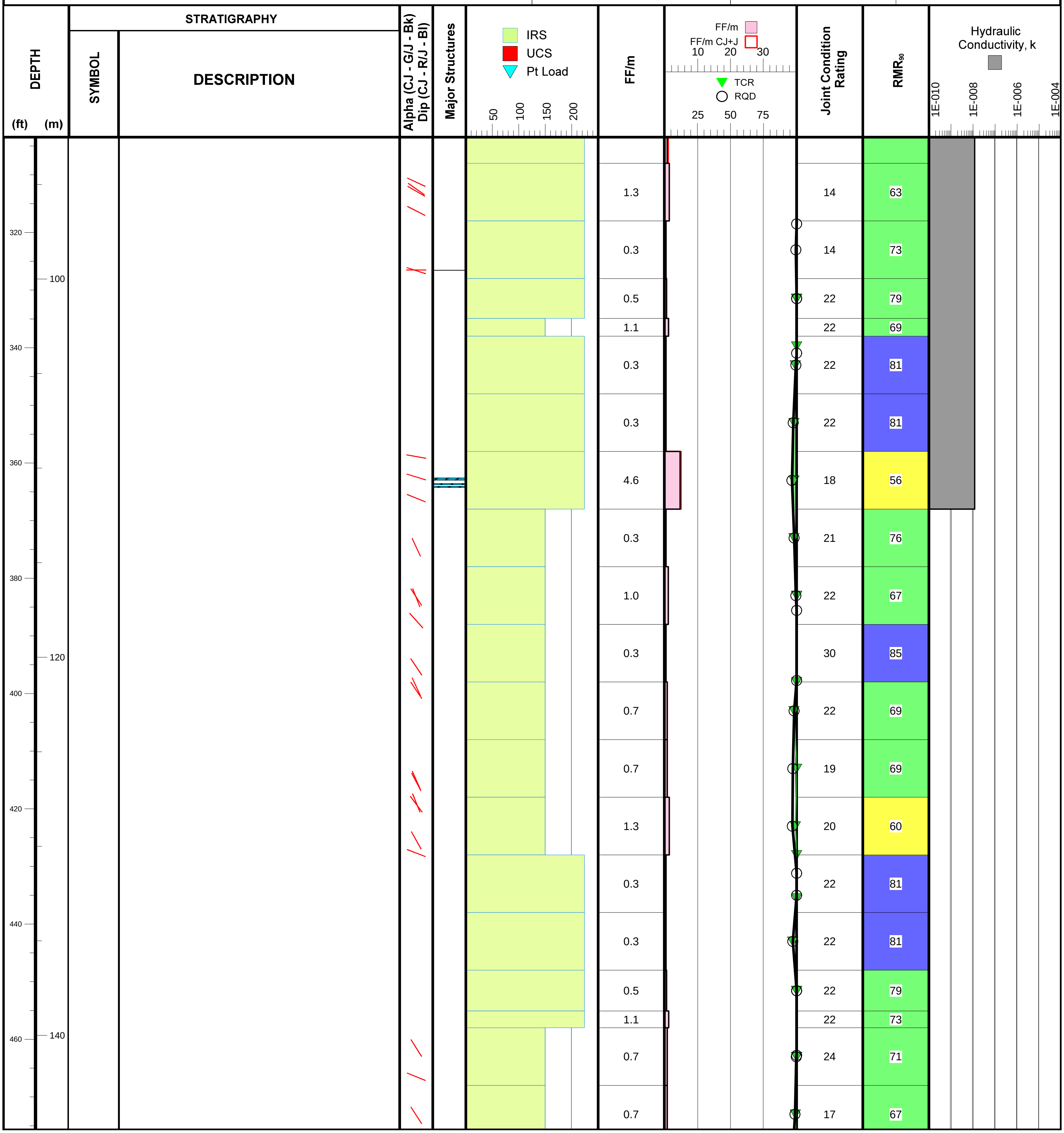
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR
1.3	14	63
0.3	14	73
0.5	22	79
1.1	22	69
0.3	22	81
0.3	22	81
4.6	18	56
0.3	21	76
1.0	22	67
0.3	30	85
0.7	22	69
0.7	19	69
1.3	20	60
0.3	22	81
0.3	22	81
0.5	22	79
1.1	22	73
0.7	24	71
0.7	17	67

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BOREHOLE LOG: 11PSD279

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/23/2011 **TO:** 5/1/2011
DIP: -57 **AZIMUTH:** 255
COORDINATES: 546774.491N 35527.769E **DATUM:** Nad83

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CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
480							1.6		15	56	
							1.3		17	66	
500							0.7		19	70	
							0.3		17	76	
520	160						1.0		21	66	
							0.7		21	72	
540							1.0		26	71	
							0.3		22	77	
560							1.3		24	69	
							0.3		22	77	
580							1.0		24	69	
	180						0.3		22	77	
600							0.3		19	74	
							0.7		24	74	
620							1.0		16	61	
							0.7		19	69	
640							0.3		22	77	

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BOREHOLE LOG: 11PSD279

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study

LOCATION: Hope Bay, Nunavut

SITE & PROJECT No: HOPE BAY 1CH008.054

BORING DATE: 4/23/2011 **TO:** 5/1/2011

DIP: -57 **AZIMUTH:** 255

COORDINATES: 546774.491N 35527.769E **DATUM:** Nad83

TOTAL DEPTH: 444

DRILL TYPE: Diamond Drill

CORE DIA.: HQ3

CASING DEPTH:

PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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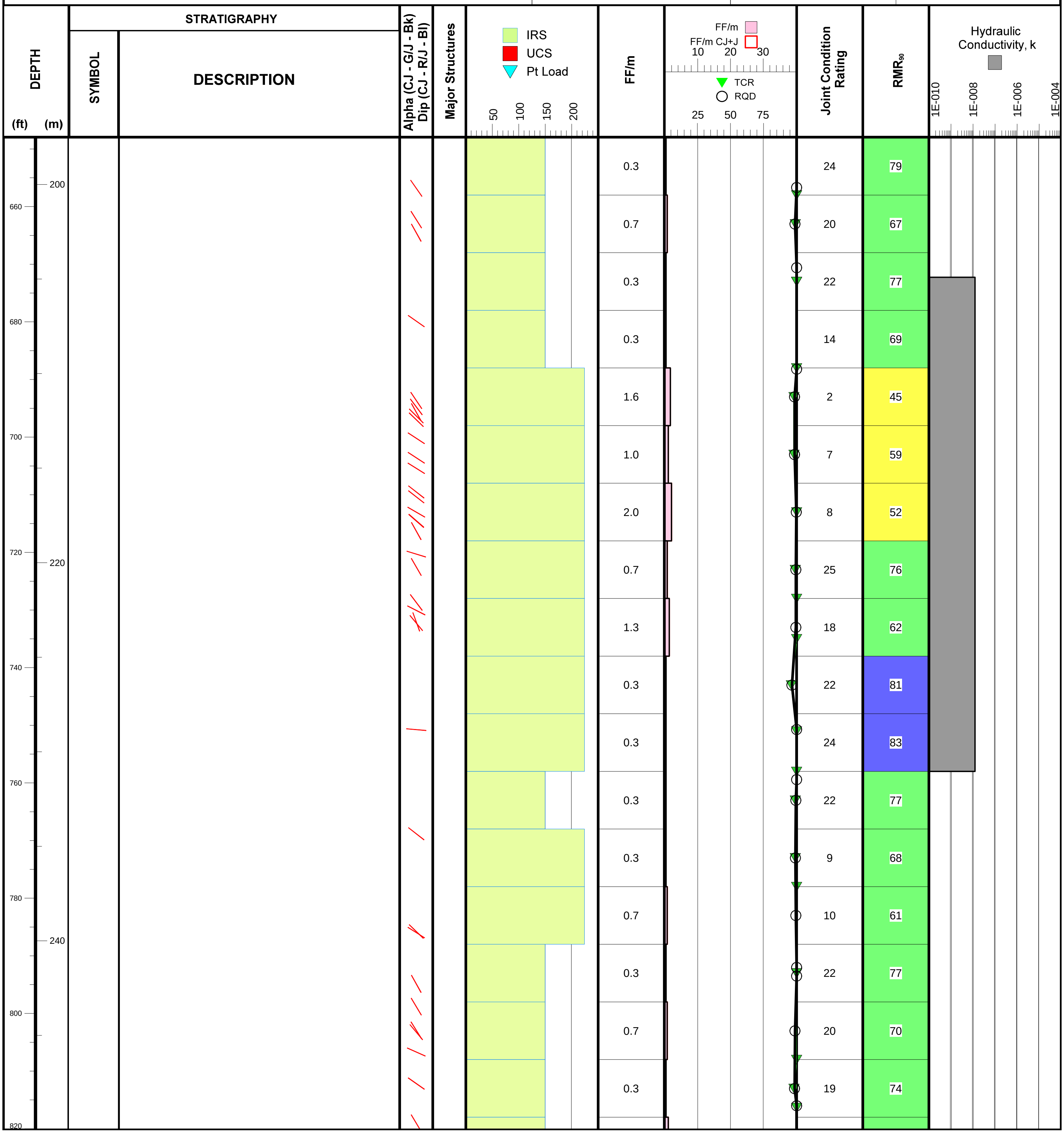
LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR_{90}
0.3	24	79
0.7	20	67
0.3	22	77
0.3	14	69
1.6	2	45
1.0	7	59
2.0	8	52
0.7	25	76
1.3	18	62
0.3	22	81
0.3	24	83
0.3	22	77
0.3	9	68
0.7	10	61
0.3	22	77
0.7	20	70
0.3	19	74

BOREHOLE LOG: 11PSD279

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PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/23/2011 **TO:** 5/1/2011
DIP: -57 **AZIMUTH:** 255
COORDINATES: 546774.491N 35527.769E **DATUM:** Nad83

TOTAL DEPTH: 444

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth scale: 820, 840, 860, 880, 900, 920, 940, 960, 980 (ft); 260, 280, 300 (m)

FF/m	Joint Condition Rating	RMR_{90}
1.0	19	67
0.3	22	77
0.3	22	77
0.3	19	78
0.3	22	81
1.0	14	62
2.3	13	51
2.6	12	44
1.0	13	58
2.0	19	46
3.0	9	33
1.3	18	61
0.3	29	84
0.3	22	69
0.3	21	65
2.0	24	56
0.3	24	79

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BOREHOLE LOG: 11PSD279

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/23/2011 **TO:** 5/1/2011
DIP: -57 **AZIMUTH:** 255
COORDINATES: 546774.491N 35527.769E **DATUM:** Nad83

TOTAL DEPTH: 444
PAGE: 6 **OF** 8
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth scale: 1000, 1020, 1040, 1060, 1080, 1100, 1120, 1140, 1160 (ft); 320, 340 (m)

FF/m	Joint Condition Rating	RMR_{90}
0.7	27	77
1.0	24	76
0.7	29	76
0.7	27	63
1.0	18	52
0.3	22	69
0.7	26	68
0.7	23	65
0.7	23	65
0.3	22	69
0.3	22	69
3.0	14	43
0.7	15	54
0.3	22	69
0.3	22	69
0.3	22	69
0.7	11	49
1.0	9	43

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BOREHOLE LOG: 11PSD279

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/23/2011 **TO:** 5/1/2011
DIP: -57 **AZIMUTH:** 255
COORDINATES: 546774.491N 35527.769E **DATUM:** Nad83

TOTAL DEPTH: 444

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth scale: (ft) 1180, 1200, 1220, 1240, 1260, 1280, 1300, 1320; (m) 360, 380, 400

FF/m	Joint Condition Rating	RMR_{90}
0.3	22	66
0.3	26	73
0.3	22	66
0.3	22	77
0.3	26	81
0.3	19	63
0.3	22	69
0.3	22	77
0.3	22	77
0.3	9	64
0.3	22	77
0.3	22	69
0.3	22	69
1.0	20	57
0.3	17	64
0.3	22	66
0.3	13	60

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BOREHOLE LOG: 11PSD279

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/23/2011 **TO:** 5/1/2011
DIP: -57 **AZIMUTH:** 255
COORDINATES: 546774.491N 35527.769E **DATUM:** Nad83

TOTAL DEPTH: 444
PAGE: 8 **OF** 8
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

- GOUGE
- SHEARED
- BROKEN
- JOINTED

LEGEND OF RMR

- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100

DEPTH (ft)	(m)	STRATIGRAPHY: SYMBOL	DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
1340							0.6		22	65	
							0.8		22	60	
							0.3		14	58	
1360							0.3		22	69	
							0.3		29	84	
1380	420						0.3		22	77	
							0.3		22	77	
1400							0.3		22	71	
							0.3		22	81	
1420							0.3		22	77	
							2.3		10	51	
1440	440						0.3		22	77	
							0.3		9	64	
1460											
1480											
1500	460										

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BOREHOLE LOG: 11PSD284

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/11/2011
DIP: -67 **AZIMUTH:** 262
COORDINATES: 546709.537N 35486.475E **DATUM:** Nad83

TOTAL DEPTH: 515
PAGE: 1 **OF** 10
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

- GOUGE
- SHEARED
- BROKEN
- JOINTED

LEGEND OF RMR

- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100

DEPTH (ft) (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
						8.4		12	32	
						0.3		22	77	
						0.3		22	81	
						0.3		22	77	
						0.3		22	81	
						0.3		22	77	
						0.3		22	77	
						0.3		22	77	
						0.3		20	75	

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BOREHOLE LOG: 11PSD284

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/11/2011
DIP: -67 **AZIMUTH:** 262
COORDINATES: 546709.537N 35486.475E **DATUM:** Nad83

TOTAL DEPTH: 515
PAGE: 2 **OF** 10
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
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DEFINTIONS

IRS: Intact Rock Strength (field est.)
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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
							0.7		20	70	
180							0.3		29	84	
							0.3		19	74	
200							0.7		17	71	
							1.0		23	75	
220							0.3		20	79	
							0.7		17	71	
240							0.7		23	77	
							0.3		23	82	
260	80						0.3		17	76	
							0.3		23	78	
280							0.3		22	77	
							0.3		22	77	
300							1.0		17	65	
							1.3		19	54	
320							0.7		17	66	
							1.0		26	75	
340							1.6		23	56	

srk consulting

BOREHOLE LOG: 11PSD284

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/11/2011
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LEGEND OF MAJOR STRUCTURES

- GOUGE
- SHEARED
- BROKEN
- JOINTED

LEGEND OF RMR

- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100

Column headings: DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth marks: 360, 380, 400, 420, 440, 460, 480, 500 (ft); 120 (m)

FF/m	Joint Condition Rating	RMR_{90}
0.7	17	71
1.0	28	65
1.3	19	66
1.3	23	66
0.3	22	81
0.3	22	81
0.3	20	79
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	77
0.3	22	81
1.3	22	57
0.3	29	84
1.0	19	59
1.6	22	61
0.3	20	79

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BOREHOLE LOG: 11PSD284

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/11/2011
DIP: -67 **AZIMUTH:** 262
COORDINATES: 546709.537N 35486.475E **DATUM:** Nad83

TOTAL DEPTH: 515

DRILL TYPE: Diamond Drill
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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR₉₀	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
520	160						0.3		19	78	
							0.3		22	77	
540							0.7		19	70	
							0.3		19	78	
560							1.0		19	68	
							0.3		15	74	
580							0.3		19	74	
							0.3		24	83	
600							1.3		21	68	
							1.0		19	68	
620							0.3		22	77	
							0.3		22	81	
640							0.7		20	74	
							0.7		26	80	
660	200						1.0		24	76	
							0.3		22	77	
680							0.3		22	77	

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BOREHOLE LOG: 11PSD284

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/11/2011
DIP: -67 **AZIMUTH:** 262
COORDINATES: 546709.537N 35486.475E **DATUM:** Nad83

TOTAL DEPTH: 515
PAGE: 5 **OF** 10
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
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UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

- GOUGE
- SHEARED
- BROKEN
- JOINTED

LEGEND OF RMR

- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
							0.3		22	77	
700							1.0		23	68	
							0.3		22	77	
720							0.7		23	70	
							0.3		22	77	
740							0.7		18	72	
							0.3		20	75	
760							0.3		22	81	
							0.3		19	78	
780							0.3		26	85	
	240						0.3		22	69	
800							0.3		24	71	
							0.3		23	70	
820							1.6		19	52	
							2.3		19	52	
840							0.3		22	69	
							0.3		22	77	
860											

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BOREHOLE LOG: 11PSD284

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/11/2011
DIP: -67 **AZIMUTH:** 262
COORDINATES: 546709.537N 35486.475E **DATUM:** Nad83

TOTAL DEPTH: 515

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR₉₀ | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth marks: 880, 900, 920, 940, 960, 980, 1000, 1020 (ft); 280 (m)

FF/m	Joint Condition Rating	RMR
0.7	21	71
1.3	21	70
0.3	17	76
0.3	17	76
0.3	20	79
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	77
1.6	20	56
0.7	22	64
1.0	20	65
1.3	20	55
0.3	17	72
1.6	14	50
1.0	14	54
0.3	18	73

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BOREHOLE LOG: 11PSD284

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study	**TOTAL DEPTH:** 515
LOCATION: Hope Bay, Nunavut	**PAGE:** 7 **OF** 10
SITE & PROJECT No: HOPE BAY 1CH008.054	**DRILL TYPE:** Diamond Drill
BORING DATE: 5/3/2011 **TO:** 5/11/2011	**CORE DIA.:** HQ3
DIP: -67 **AZIMUTH:** 262	**CASING DEPTH:**
COORDINATES: 546709.537N 35486.475E **DATUM:** Nad83	**PLAN No:**

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m)	STRATIGRAPHY: SYMBOL	DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
						1.0		22	67	
						1.0		30	75	
						0.7		24	74	
						0.3		22	77	
						0.3		21	76	
						0.3		24	79	
						0.7		20	70	
						0.3		22	77	
						1.3		15	60	
						0.7		26	73	
						0.3		22	77	
						0.3		22	77	
						0.3		22	77	
						0.3		22	77	
						0.7		12	62	
						1.0		17	62	
						0.3		14	69	

Depth scale (ft): 1040, 1060, 1080, 1100, 1120, 1140, 1160, 1180, 1200; (m): 320, 360

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BOREHOLE LOG: 11PSD284

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study

LOCATION: Hope Bay, Nunavut

SITE & PROJECT No: HOPE BAY 1CH008.054

BORING DATE: 5/3/2011 **TO:** 5/11/2011

DIP: -67 **AZIMUTH:** 262

COORDINATES: 546709.537N 35486.475E **DATUM:** Nad83

TOTAL DEPTH: 515

PAGE: 8 **OF** 10

DRILL TYPE: Diamond Drill

CORE DIA.: HQ3

CASING DEPTH:

PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth marks: 1220, 1240, 1260, 1280, 1300, 1320, 1340, 1360 (ft); 400 (m)

FF/m	Joint Condition Rating	RMR_{90}
0.3	11	58
0.7	14	64
0.3	22	77
0.3	30	85
0.3	23	78
0.3	27	82
0.3	30	77
0.7	15	65
0.3	22	69
0.7	24	71
0.3	17	72
0.3	15	70
0.3	15	70
0.3	29	84
0.3	29	84
0.3	11	70
0.3	22	77

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BOREHOLE LOG: 11PSD284

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/11/2011
DIP: -67 **AZIMUTH:** 262
COORDINATES: 546709.537N 35486.475E **DATUM:** Nad83

TOTAL DEPTH: 515

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth (ft): 1380, 1400, 1420, 1440, 1460, 1480, 1500, 1520, 1540
Depth (m): 440

FF/m	Joint Condition Rating	RMR_{90}
0.3	22	77
0.3	22	77
0.3	22	77
0.3	22	77
1.3	20	60
0.3	24	79
0.7	23	70
1.3	23	63
0.3	23	78
0.3	29	84
1.6	15	48
0.3	24	79
0.3	22	77
0.3	22	77
0.3	22	81
0.7	16	70
0.2	22	78

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BOREHOLE LOG: 11PSD284

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/11/2011
DIP: -67 **AZIMUTH:** 262
COORDINATES: 546709.537N 35486.475E **DATUM:** Nad83

TOTAL DEPTH: 515

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth (ft): 1560, 1580, 1600, 1620, 1640, 1660, 1680, 1700
Depth (m): 480, 520

FF/m	Joint Condition Rating	RMR_{90}
3.3	12	51
0.3	22	77
0.3	22	77
0.3	29	84
0.3	22	77
0.3	22	77
0.3	22	81
0.3	22	81
0.3	24	83
0.3	22	81
0.7	26	80
0.3	22	77
0.3	22	81
0.3	22	81

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BOREHOLE LOG: 11TDD766

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 3/21/2011 **TO:** 3/26/2011
DIP: -62 **AZIMUTH:** 271
COORDINATES: 558910.169N 33900.605E **DATUM:** Nad83

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

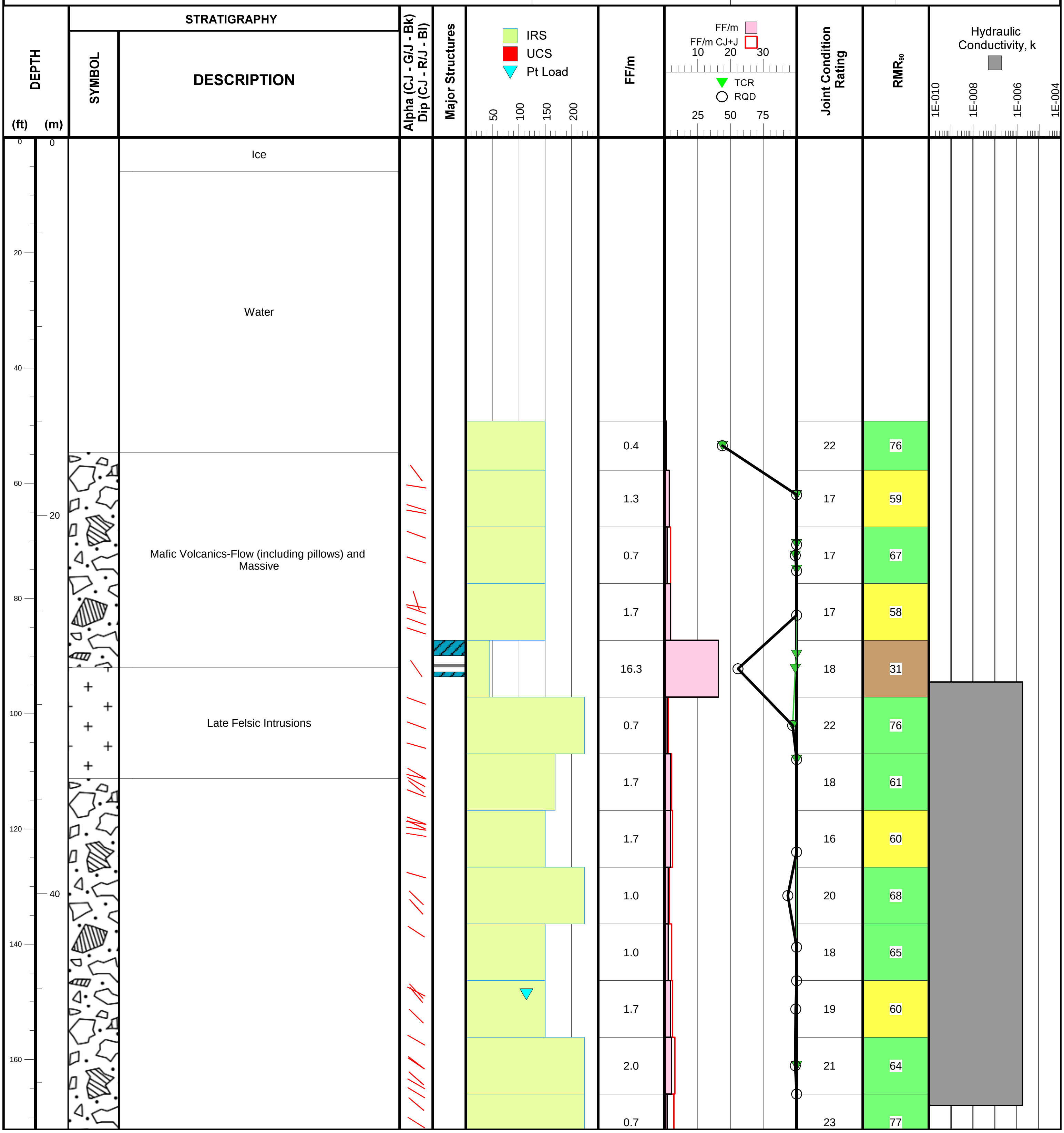
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

- GOUGE
- SHEARED
- BROKEN
- JOINTED

LEGEND OF RMR

- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100



FF/m	Joint Condition Rating	RMR_{90}
0.4	22	76
1.3	17	59
0.7	17	67
1.7	17	58
16.3	18	31
0.7	22	76
1.7	18	61
1.7	16	60
1.0	20	68
1.0	18	65
1.7	19	60
2.0	21	64
0.7	23	77

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BOREHOLE LOG: 11TDD766

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 3/21/2011 **TO:** 3/26/2011
DIP: -62 **AZIMUTH:** 271
COORDINATES: 558910.169N 33900.605E **DATUM:** Nad83

TOTAL DEPTH: 297

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

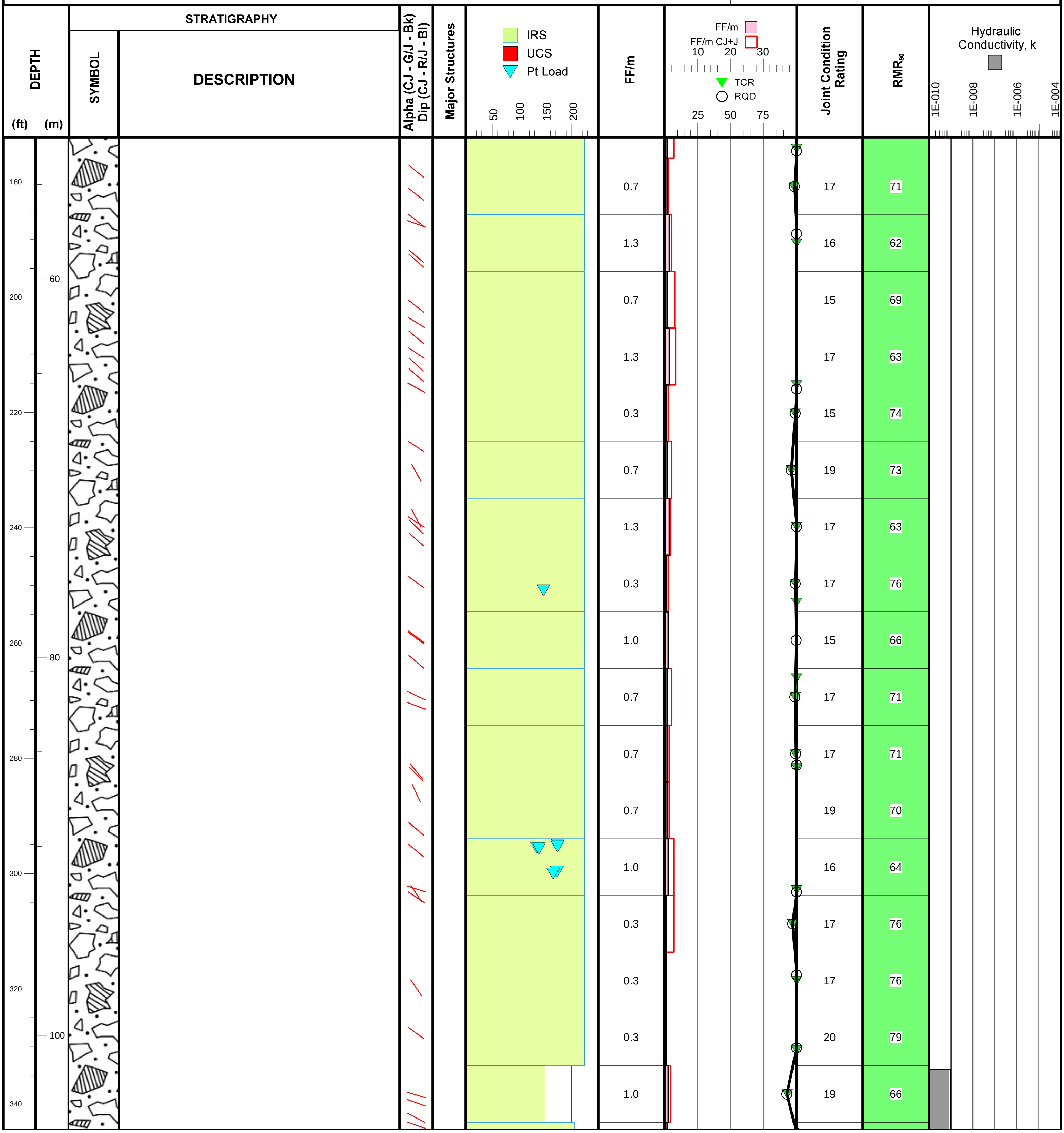
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR_{90}
0.7	17	71
1.3	16	62
0.7	15	69
1.3	17	63
0.3	15	74
0.7	19	73
1.3	17	63
0.3	17	76
1.0	15	66
0.7	17	71
0.7	17	71
0.7	19	70
1.0	16	64
0.3	17	76
0.3	17	76
0.3	20	79
1.0	19	66

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BOREHOLE LOG: 11TDD766

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 3/21/2011 **TO:** 3/26/2011
DIP: -62 **AZIMUTH:** 271
COORDINATES: 558910.169N 33900.605E **DATUM:** Nad83

TOTAL DEPTH: 297

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth (ft): 360, 380, 400, 420, 440, 460, 480, 500
Depth (m): 120, 140

Description: Mafic Volcanics-Flow (including pillows) and Massive

FF/m	Joint Condition Rating	RMR_{90}
0.7	23	77
0.3	22	69
0.3	18	73
0.3	22	77
0.3	22	77
0.3	22	69
0.3	15	62
0.3	22	69
0.3	15	66
0.3	22	69
0.3	22	77
1.0	21	65
0.3	22	77
0.3	16	60
0.3	22	66
0.3	22	66
0.3	22	66
0.3	22	66

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BOREHOLE LOG: 11TDD766

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 3/21/2011 **TO:** 3/26/2011
DIP: -62 **AZIMUTH:** 271
COORDINATES: 558910.169N 33900.605E **DATUM:** Nad83

TOTAL DEPTH: 297

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth (ft): 520, 540, 560, 580, 600, 620, 640, 660, 680
Depth (m): 160, 180, 200

FF/m	Joint Condition Rating	RMR_{90}
0.3	22	66
0.3	22	66
0.3	22	66
0.7	20	74
0.7	15	67
0.3	29	84
0.7	19	61
0.3	27	74
0.7	20	59
1.0	19	66
0.3	22	77
0.3	22	71
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81

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BOREHOLE LOG: 11TDD766

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 3/21/2011 **TO:** 3/26/2011
DIP: -62 **AZIMUTH:** 271
COORDINATES: 558910.169N 33900.605E **DATUM:** Nad83

TOTAL DEPTH: 297

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | SYMBOL | STRATIGRAPHY: DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth marks (ft): 700, 720, 740, 760, 780, 800, 820, 840, 860; (m): 220, 240, 260

Stratigraphy (lower part of interval): VEIN; Mafic Volcanics-Flow (including pillows) and Massive; VEIN; Mafic Volcanics-Flow (including pillows) and Massive; VEIN

FF/m	Joint Condition Rating	RMR_{90}
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81
5.7	8	43
0.3	9	68
0.3	27	86
6.7	7	41
3.7	8	47
0.3	22	77
0.3	21	80
0.3	22	77
5.3	7	34
0.3	22	81
2.0	9	45
2.0	7	49
4.7	7	35

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BOREHOLE LOG: 11TDD766

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 3/21/2011 **TO:** 3/26/2011
DIP: -62 **AZIMUTH:** 271
COORDINATES: 558910.169N 33900.605E **DATUM:** Nad83

TOTAL DEPTH: 297

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | SYMBOL | STRATIGRAPHY: DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth (ft): 880, 900, 920, 940, 960, 980
Depth (m): 280, 300

VEIN
Mafic Volcanics-Flow (including pillows) and Massive
Diabsase

FF/m	Joint Condition Rating	RMR_{90}
0.3	17	76
0.3	22	81
0.3	22	81
0.3	22	81
0.3	20	79
0.3	22	81
0.3	22	81
0.3	20	79
0.3	22	81
0.3	22	81
0.3	22	81

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BOREHOLE LOG: 11TDD768

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 3/27/2011 **TO:** 4/4/2011
DIP: -62 **AZIMUTH:** 105
COORDINATES: 558759.739N 33665.488E **DATUM:** Nad83

TOTAL DEPTH: 299
PAGE: 1 **OF** 6
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20 | 21 - 40 | 41 - 60 | 61 - 80 | 81 - 100

Columns: DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth scale (ft): 0, 20, 40, 60, 80, 100, 120, 140, 160; (m): 0, 20, 40

Description	FF/m	Joint Condition Rating	RMR_{90}
Ice			
Overburden			
Mafic Volcanics-Flow (including pillows) and Massive	0.3	22	67
	1.0	22	58
	0.7	21	68
	1.0	16	60
	0.3	22	77
	3.0	25	64
	0.3	19	74
	0.3	22	77
	0.3	22	69
	0.3	22	77

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BOREHOLE LOG: 11TDD768

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 3/27/2011 **TO:** 4/4/2011
DIP: -62 **AZIMUTH:** 105
COORDINATES: 558759.739N 33665.488E **DATUM:** Nad83

TOTAL DEPTH: 299

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth (ft): 180, 200, 220, 240, 260, 280, 300, 320, 340
Depth (m): 60, 80, 100

Mafic Volcanics-Flow (including pillows) and Massive

Intermediate Volcanics-Flow (including pillows) and Massive

Mafic Volcanics-Flow (including pillows) and Massive

FF/m	Joint Condition Rating	RMR_{90}
0.3	22	69
0.3	22	77
0.3	22	77
0.3	17	76
1.3	23	72
0.3	18	77
0.3	22	81
0.7	21	72
0.3	22	81
0.3	20	79
0.3	22	81
0.3	22	81
0.3	22	66
1.3	7	56
0.3	22	81
0.3	22	81
1.0	19	67

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BOREHOLE LOG: 11TDD768

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SITE & PROJECT No: HOPE BAY 1CH008.054
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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth scale (ft): 360, 380, 400, 420, 440, 460, 480, 500
Depth scale (m): 120, 140

DESCRIPTION

VEIN
Mafic Volcanics-Flow (including pillows) and Massive
VEIN
Mafic Volcanics-Flow (including pillows) and Massive
VEIN
Mafic Volcanics-Flow (including pillows) and Massive
VEIN

FF/m	Joint Condition Rating	RMR_{90}
1.3	16	62
0.3	19	78
0.7	17	71
1.0	15	66
0.3	12	71
4.7	7	41
0.3	22	81
0.3	22	71
0.3	22	81
0.3	22	81
0.7	18	72
0.7	20	71
0.3	22	81
0.3	22	81
0.3	15	74
1.0	19	67
0.7	20	74
0.7	20	74

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BOREHOLE LOG: 11TDD768

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
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SITE & PROJECT No: HOPE BAY 1CH008.054
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TOTAL DEPTH: 299
PAGE: 4 **OF** 6
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

- GOUGE
- SHEARED
- BROKEN
- JOINTED

LEGEND OF RMR

- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50 100 150 200)	FF/m	FF/m, FF/m CJ+J (10 20 30); TCR, RQD (25 50 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010 1E-008 1E-006 1E-004)
520–680	160–200		Mafic Volcanics-Flow (including pillows) and Massive								

FF/m	Joint Condition Rating	RMR_{90}
0.3	27	86
1.0	20	68
0.3	22	81
0.3	22	81
1.3	22	68
0.3	26	85
0.3	14	73
0.3	22	81
0.3	16	75
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81
4.3	12	48
1.0	19	70
0.3	17	76

Depth scale (ft): 520, 540, 560, 580, 600, 620, 640, 660, 680
Depth scale (m): 160, 180, 200

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BOREHOLE LOG: 11TDD768

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 3/27/2011 **TO:** 4/4/2011
DIP: -62 **AZIMUTH:** 105
COORDINATES: 558759.739N 33665.488E **DATUM:** Nad83

TOTAL DEPTH: 299

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: DESCRIPTION
700		Mafic Volcanics-Flow (including pillows) and Massive
		VEIN
		Mafic Volcanics-Flow (including pillows) and Massive
		VEIN
720	220	
740		Mafic Volcanics-Flow (including pillows) and Massive
760		
780		VEIN
800	240	
820		Mafic Volcanics-Flow (including pillows) and Massive
840		
860	260	

Column headings: Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl); Major Structures; IRS / UCS / Pt Load (50, 100, 150, 200); FF/m; FF/m, FF/m CJ+J (10, 20, 30), TCR, RQD (25, 50, 75); Joint Condition Rating; RMR_{90}; Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

FF/m	Joint Condition Rating	RMR_{90}
0.7	17	71
0.3	20	79
0.3	22	81
0.3	22	81
0.3	22	81
0.3	19	78
8.7	8	37
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	77
0.3	15	74
0.3	22	81
0.3	22	81
0.3	22	81

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BOREHOLE LOG: 11TDD768

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 3/27/2011 **TO:** 4/4/2011
DIP: -62 **AZIMUTH:** 105
COORDINATES: 558759.739N 33665.488E **DATUM:** Nad83

TOTAL DEPTH: 299
PAGE: 6 **OF** 6
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

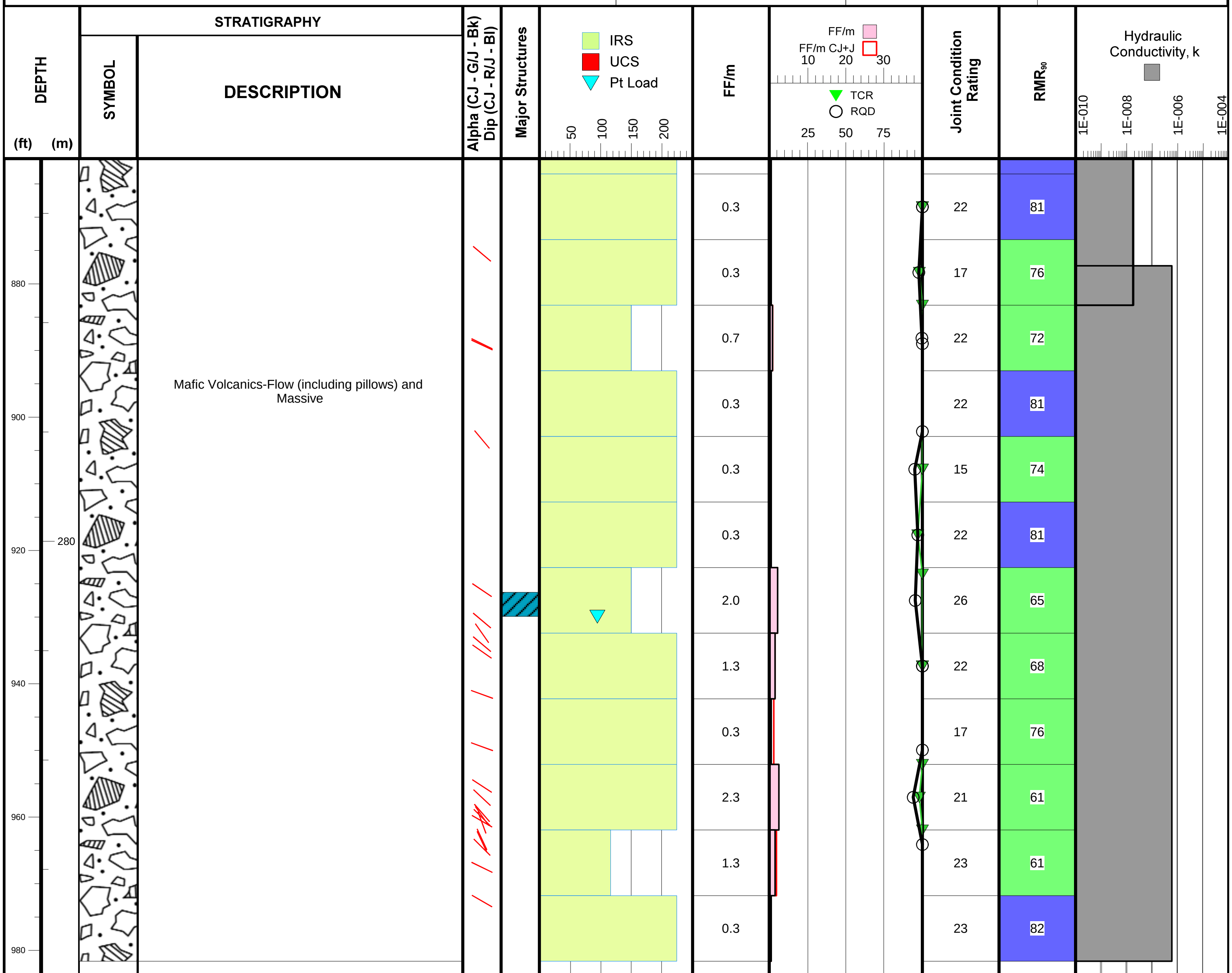
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



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BOREHOLE LOG: 11TDD769

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study

LOCATION: Hope Bay, Nunavut

SITE & PROJECT No: HOPE BAY 1CH008.054

BORING DATE: 4/5/2011 **TO:** 4/13/2011

DIP: -67 **AZIMUTH:** 246

COORDINATES: 557713.3N 33811.965E **DATUM:** Nad83

TOTAL DEPTH: 310

DRILL TYPE: Diamond Drill

CORE DIA.: HQ3

CASING DEPTH:

PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20 | 61 - 80
21 - 40 | 81 - 100
41 - 60

DEPTH (ft) (m) | SYMBOL | STRATIGRAPHY: DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS / UCS / Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth axis: 0, 20, 40, 60, 80, 100, 120, 140, 160 (ft); 0, 20, 40 (m)

Stratigraphy: Ice; Water; Overburden; Mafic Volcanics-Flow (including pillows) and Massive

FF/m	Joint Condition Rating	RMR_{90}
0.3	9	65
0.3	22	77
2.0	0	43
0.6	22	78
0.8	22	75
0.5	18	74
0.5	22	78
0.8	22	75
4.0	17	58
0.7	22	76
0.7	22	76
0.6	23	75
2.0	22	68
1.5	18	66
0.3	24	83
0.4	22	75
0.4	22	79
0.7	22	76
0.6	22	76
0.6	26	77
0.6	19	70
0.3	22	77

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BOREHOLE LOG: 11TDD769

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
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DIP: -67 **AZIMUTH:** 246
COORDINATES: 557713.3N 33811.965E **DATUM:** Nad83

TOTAL DEPTH: 310

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
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FF/m: Fracture Frequency per metre
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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth (ft): 180, 200, 220, 240, 260, 280, 300, 320, 340
Depth (m): 60, 80, 100

Late Mafic Intrusions

Mafic Volcanics-Flow (including pillows) and Massive

FF/m	Joint Condition Rating	RMR_{90}
0.4	26	83
0.5	18	70
0.6	18	73
0.5	18	71
0.4	16	70
1.1	15	59
1.0	15	66
1.0	23	70
0.7	9	56
0.7	20	74
0.7	18	72
1.8	15	59
1.0	15	62
1.3	12	58
1.0	12	56
2.0	22	64
1.3	22	67
0.9	18	67
1.1	22	73
0.7	26	80
0.7	18	65
0.3	26	85
1.0	23	74

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CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | SYMBOL | STRATIGRAPHY DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS / UCS / Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth marks: 360, 380, 120 m, 400, 420, 440, 460, 140 m, 480, 500

VEIN

Mafic Volcanics-Flow (including pillows) and Massive

FF/m	Joint Condition Rating	RMR_{90}
1.7	21	62
1.3	17	59
0.7	18	72
1.0	19	70
0.3	18	73
0.3	18	77
0.6	22	77
2.3	21	66
1.9	18	65
0.7	24	78
0.9	18	67
0.7	18	72
0.6	18	70
0.6	18	73
0.9	15	67
3.3	22	65
0.9	6	54
0.8	22	75
0.3	6	65
1.0	23	62
0.5	7	60
0.4	22	80

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BOREHOLE LOG: 11TDD769

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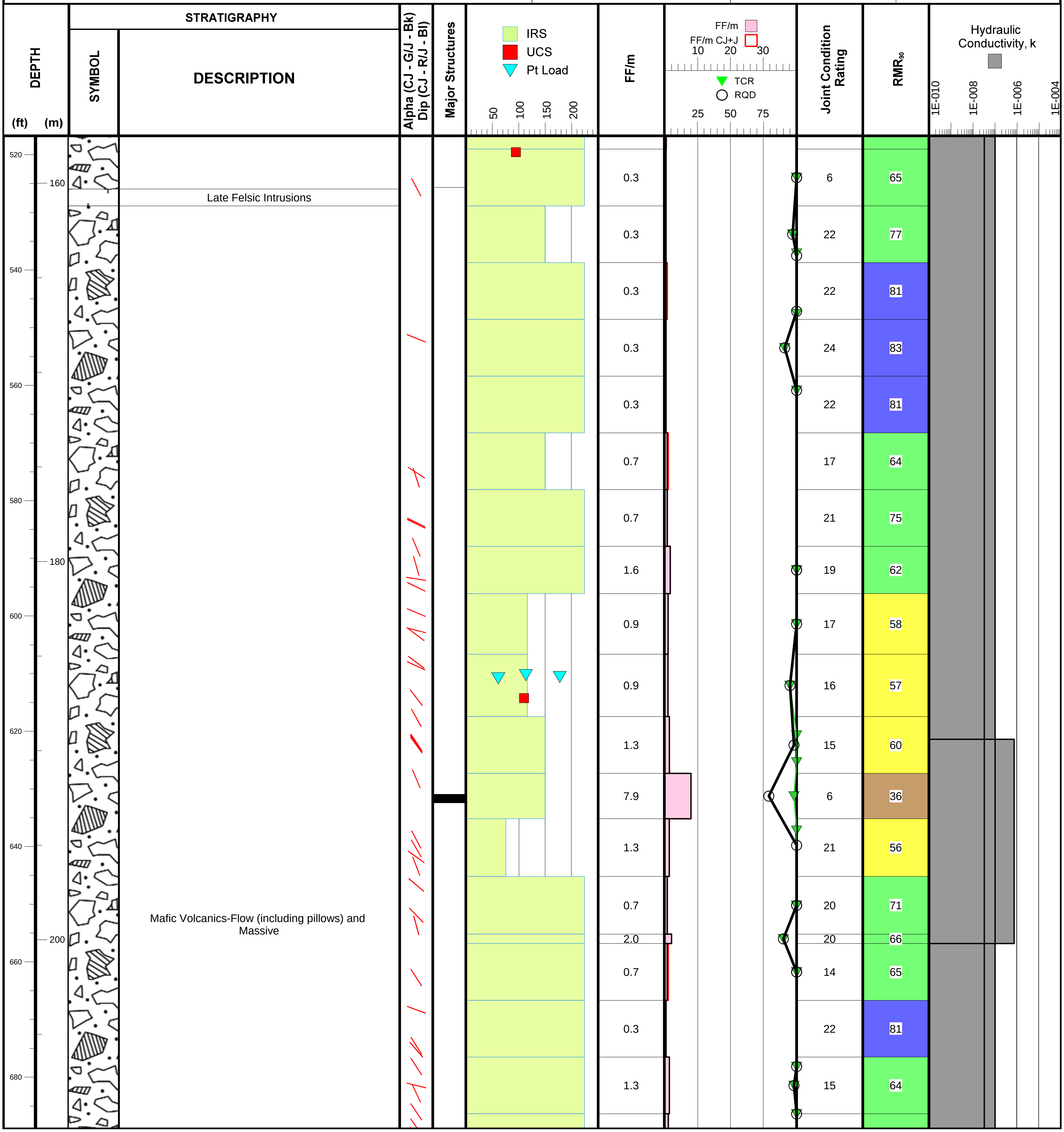
LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR90
0.3	6	65
0.3	22	77
0.3	22	81
0.3	24	83
0.3	22	81
0.7	17	64
0.7	21	75
1.6	19	62
0.9	17	58
0.9	16	57
1.3	15	60
7.9	6	36
1.3	21	56
0.7	20	71
2.0	20	66
0.7	14	65
0.3	22	81
1.3	15	64

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BOREHOLE LOG: 11TDD769

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study

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CORE DIA.: HQ3

CASING DEPTH:

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DEFINTIONS

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Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
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FF/m: Fracture Frequency per metre
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RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

- GOUGE
- SHEARED
- BROKEN
- JOINTED

LEGEND OF RMR

- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

FF/m	Joint Condition Rating	RMR_{90}
1.0	22	70
1.3	20	66
1.7	18	61
0.4	24	82
0.3	22	70
0.3	24	84
0.6	6	61
1.9	19	62
0.7	20	74
2.7	19	63
2.3	17	53
0.7	17	71
0.7	15	69
2.0	18	53
1.0	17	54
1.6	18	63
0.6	18	69
0.7	21	71
0.3	22	69

Depth (ft): 700, 720, 740, 760, 780, 800, 820, 840, 860
Depth (m): 220, 240, 260

Stratigraphy descriptions (top to bottom):

- Late Mafic Intrusions
- Mafic Volcanics-Flow (including pillows) and Massive
- Diabsase
- VEIN

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BOREHOLE LOG: 11TDD769

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study

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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) / (m)	SYMBOL	STRATIGRAPHY DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50 100 150 200)	FF/m	FF/m, FF/m CJ+J (10 20 30); TCR, RQD (25 50 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010 1E-008 1E-006 1E-004)
880 ft; 900 ft; 920 ft / 280 m; 940 ft		Mafic Volcanics-Flow (including pillows) and Massive				0.7		17	64	
						1.3		18	52	
						0.5		19	60	
						0.3		17	77	
						0.9		22	59	
						1.3		17	55	
						0.8		22	60	
						0.4		21	63	
						0.3		22	77	
						0.7		16	52	
960 ft; 980 ft; 300 m		Mafic Volcanics-Flow (including pillows) and Massive				0.3		22	77	
						1.3		14	55	
						0.3		19	78	
						0.7		20	74	
						2.0		20	61	
1000 ft		Diabsase				0.3		22	81	
						0.3		19	78	
						0.5		12	69	
1020 ft										

BOREHOLE LOG: 11TDD769

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/5/2011 **TO:** 4/13/2011
DIP: -67 **AZIMUTH:** 246
COORDINATES: 557713.3N 33811.965E **DATUM:** Nad83

TOTAL DEPTH: 310

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY SYMBOL	DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
1040	320										

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BOREHOLE LOG: 11TDD771

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/17/2011 **TO:** 4/30/2011
DIP: -82 **AZIMUTH:** 126
COORDINATES: 558379.566N 33720.266E **DATUM:** Nad83

TOTAL DEPTH: 294
PAGE: 1 **OF** 6
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

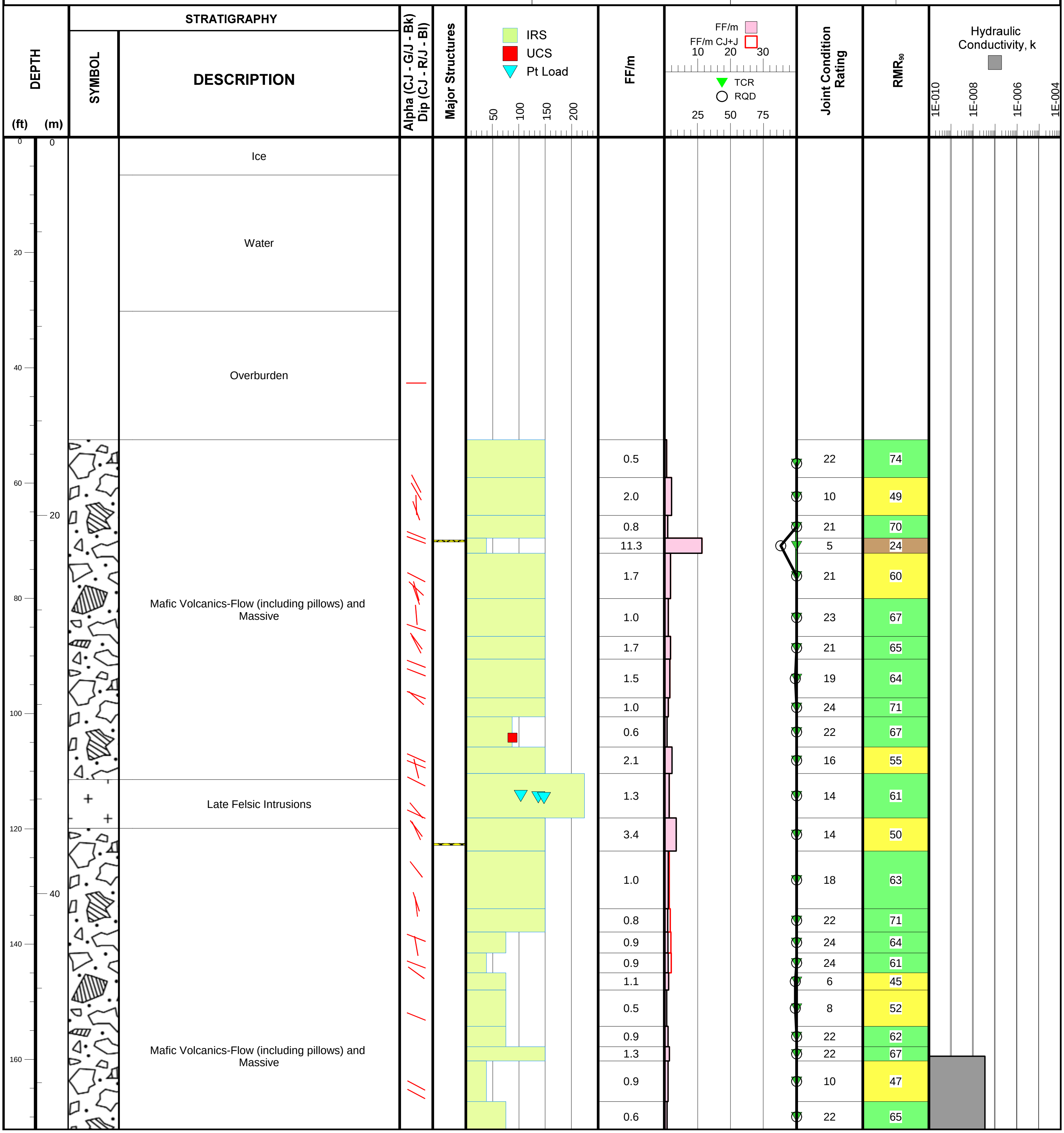
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR
0.5	22	74
2.0	10	49
0.8	21	70
11.3	5	24
1.7	21	60
1.0	23	67
1.7	21	65
1.5	19	64
1.0	24	71
0.6	22	67
2.1	16	55
1.3	14	61
3.4	14	50
1.0	18	63
0.8	22	71
0.9	24	64
0.9	24	61
1.1	6	45
0.5	8	52
0.9	22	62
1.3	22	67
0.9	10	47
0.6	22	65

BOREHOLE LOG: 11TDD771

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/17/2011 **TO:** 4/30/2011
DIP: -82 **AZIMUTH:** 126
COORDINATES: 558379.566N 33720.266E **DATUM:** Nad83

TOTAL DEPTH: 294

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

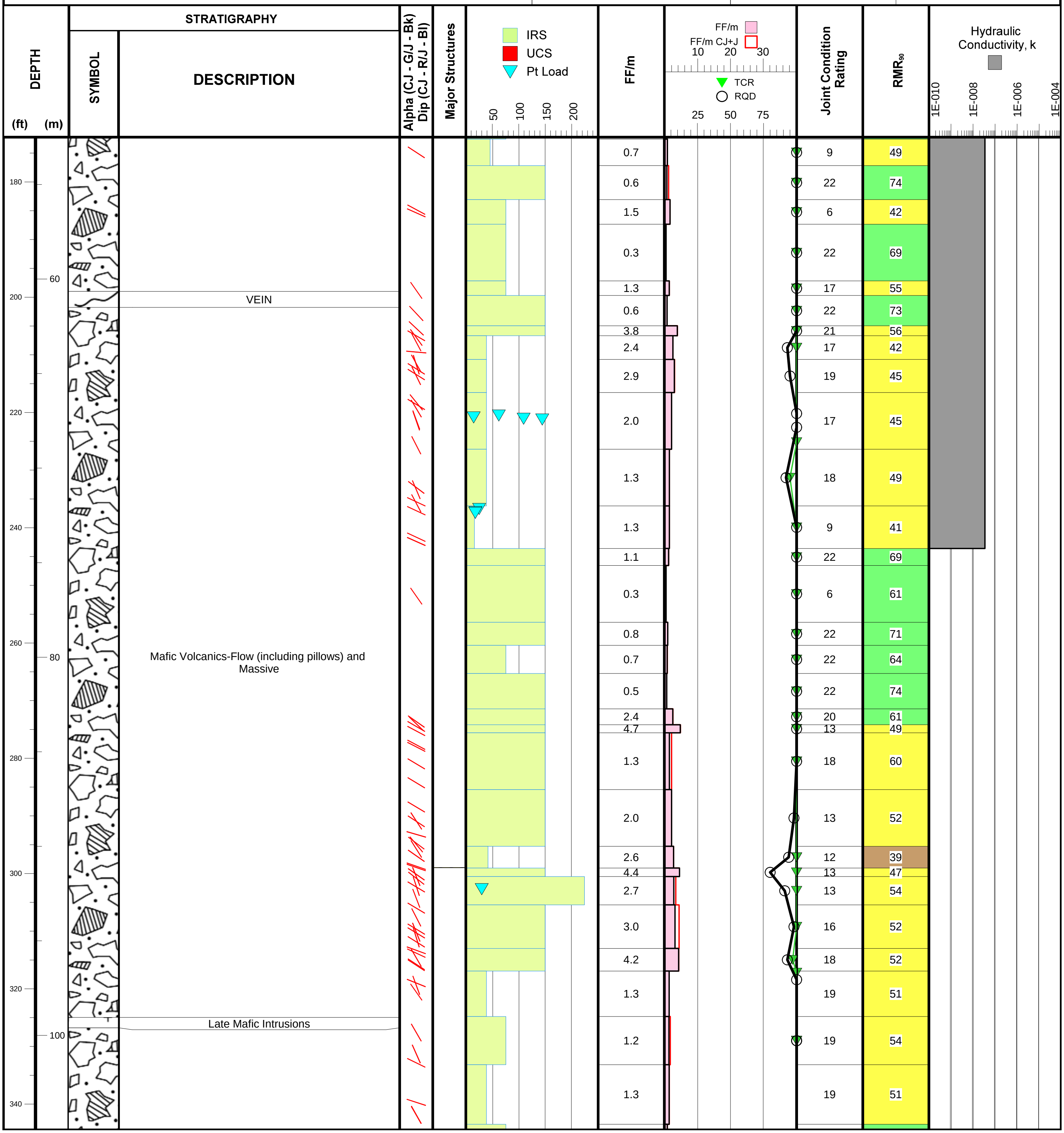
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR_{90}
0.7	9	49
0.6	22	74
1.5	6	42
0.3	22	69
1.3	17	55
0.6	22	73
3.8	21	56
2.4	17	42
2.9	19	45
2.0	17	45
1.3	18	49
1.3	9	41
1.1	22	69
0.3	6	61
0.8	22	71
0.7	22	64
0.5	22	74
2.4	20	61
4.7	13	49
1.3	18	60
2.0	13	52
2.6	12	39
4.4	13	47
2.7	13	54
3.0	16	52
4.2	18	52
1.3	19	51
1.2	19	54
1.3	19	51

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BOREHOLE LOG: 11TDD771

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/17/2011 **TO:** 4/30/2011
DIP: -82 **AZIMUTH:** 126
COORDINATES: 558379.566N 33720.266E **DATUM:** Nad83

TOTAL DEPTH: 294
PAGE: 3 **OF** 6
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

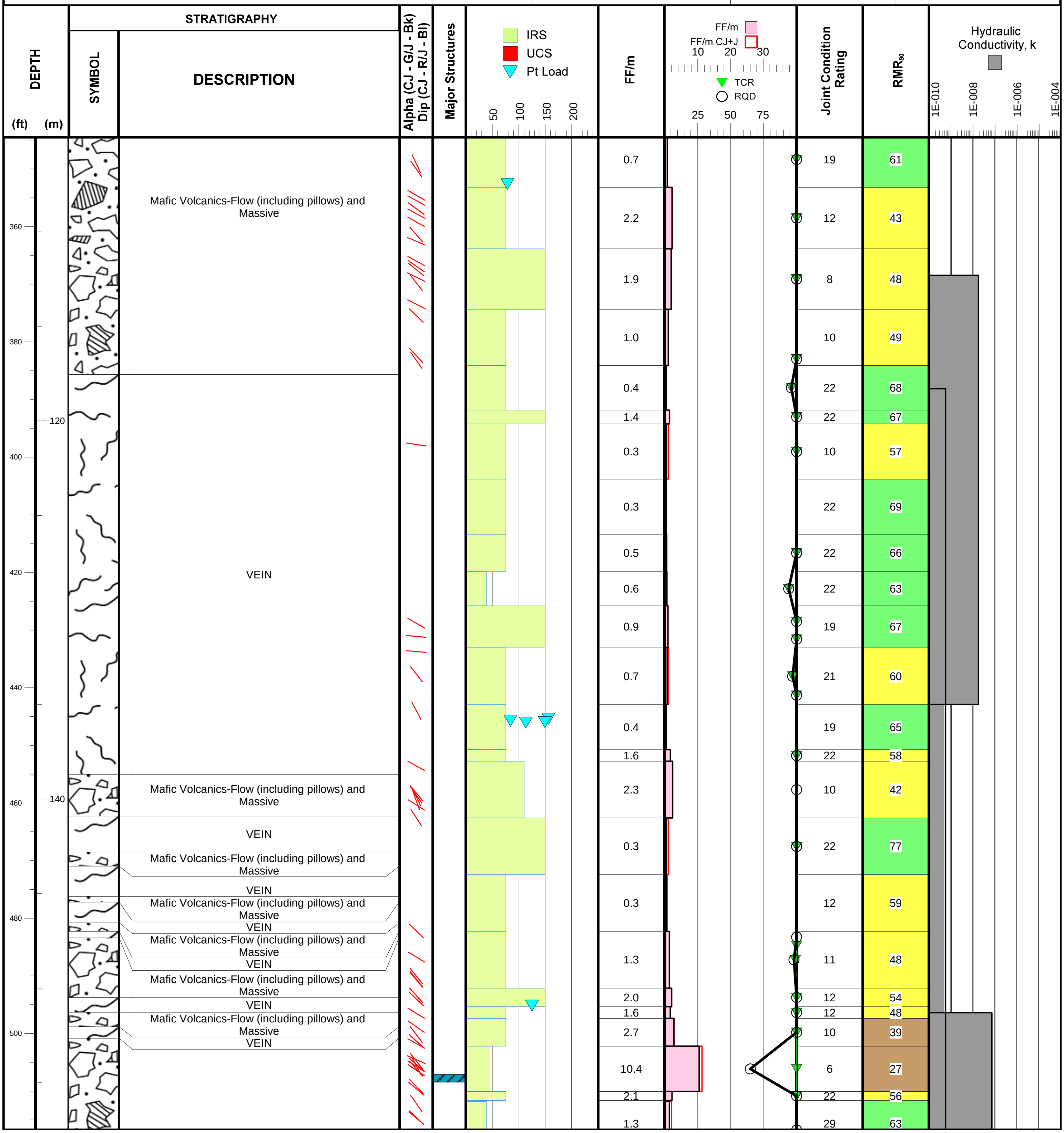
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



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BOREHOLE LOG: 11TDD771

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/17/2011 **TO:** 4/30/2011
DIP: -82 **AZIMUTH:** 126
COORDINATES: 558379.566N 33720.266E **DATUM:** Nad83

TOTAL DEPTH: 294

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

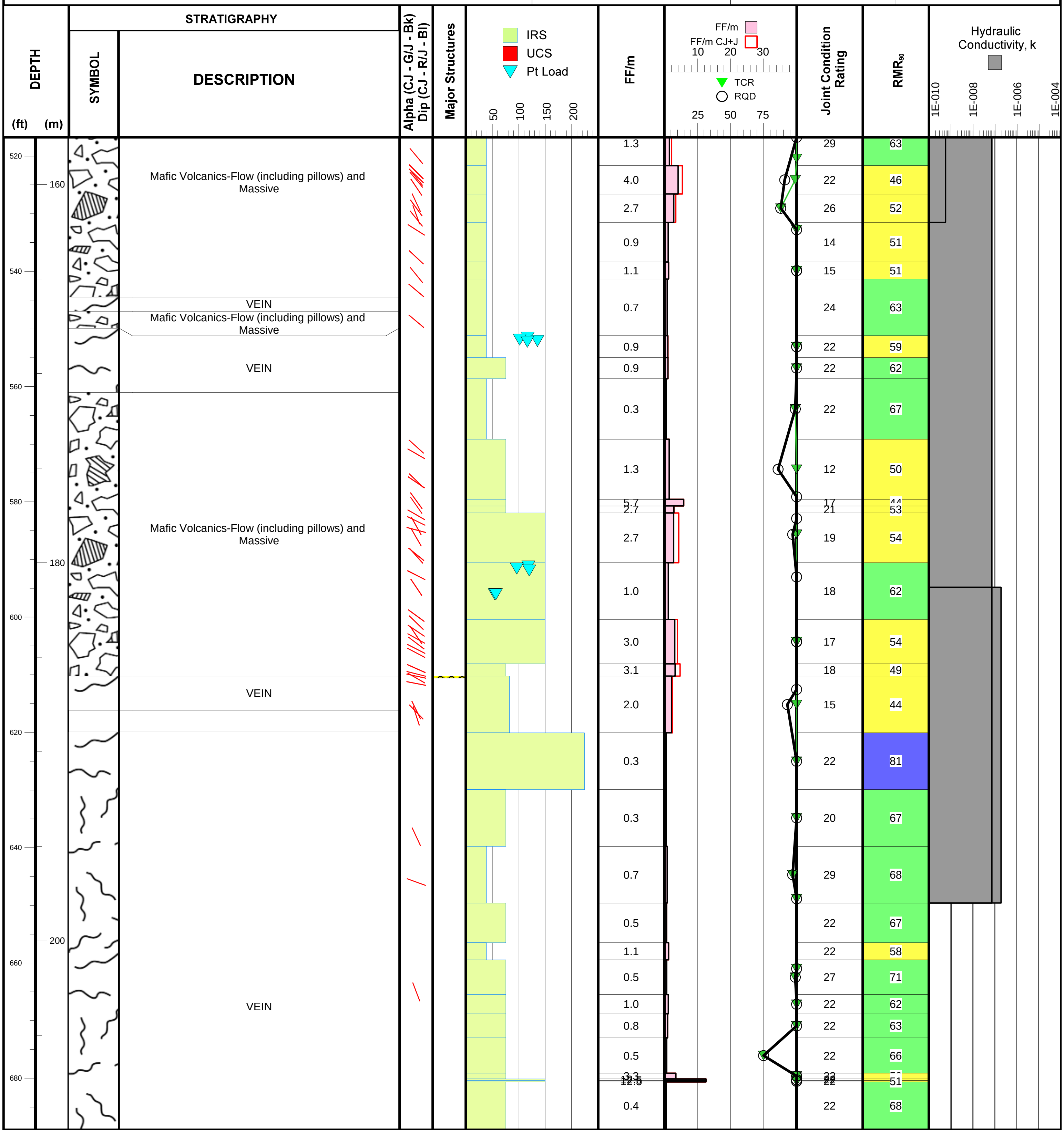
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



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BOREHOLE LOG: 11TDD771

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/17/2011 **TO:** 4/30/2011
DIP: -82 **AZIMUTH:** 126
COORDINATES: 558379.566N 33720.266E **DATUM:** Nad83

TOTAL DEPTH: 294
PAGE: 5 **OF** 6
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth marks: 700, 720, 740, 760, 780, 800, 820, 840, 860 (ft); 220, 240, 260 (m)

Description: Mafic Volcanics-Flow (including pillows) and Massive

FF/m	Joint Condition Rating	RMR_{90}
0.3	22	69
0.7	26	65
0.3	15	74
2.3	15	48
4.6	17	45
5.0	15	43
5.3	17	39
1.5	19	53
2.9	22	54
3.0	16	43
1.3	17	48
0.7	18	57
0.3	16	60
0.7	15	57
1.0	19	66
1.0	19	66
0.5	22	75
0.3	19	78
3.0	10	37
1.0	23	74
1.0	23	71

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BOREHOLE LOG: 11TDD771

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 4/17/2011 **TO:** 4/30/2011
DIP: -82 **AZIMUTH:** 126
COORDINATES: 558379.566N 33720.266E **DATUM:** Nad83

TOTAL DEPTH: 294
PAGE: 6 **OF** 6
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

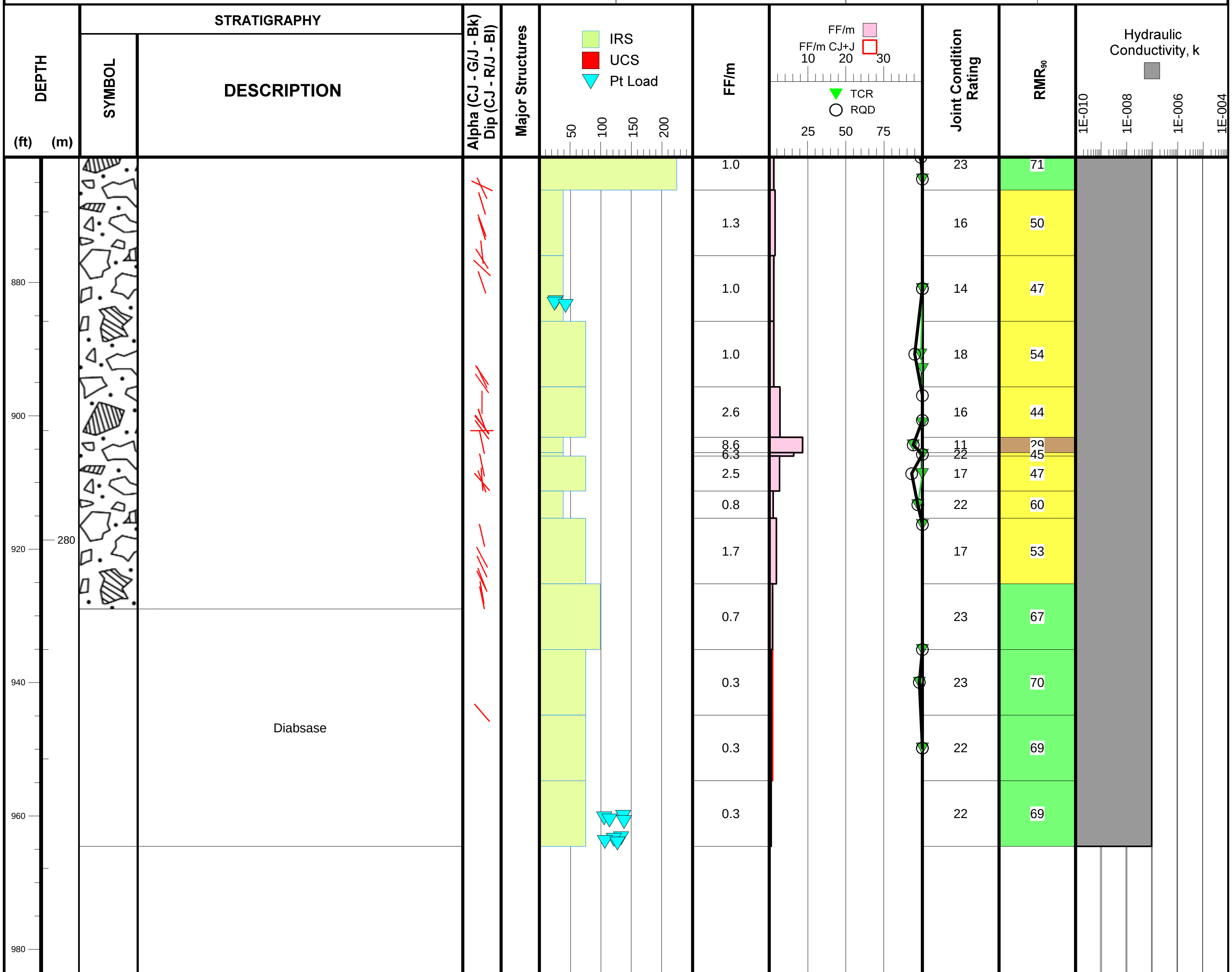
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



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BOREHOLE LOG: 11TDD772

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/10/2011
DIP: -72 **AZIMUTH:** 206
COORDINATES: 557707.552N 33860.212E **DATUM:** Nad83

TOTAL DEPTH: 321
PAGE: 1 **OF** 7
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	SYMBOL	STRATIGRAPHY DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
0	0		Ice								
20, 40, 60, 80	20		Water								
100			Mafic Volcanics-Flow (including pillows) and Massive				0.2		22	82	
							2.9		22	66	
							0.5		22	66	
120							6.7		15	53	
	40						26.4		15	28	
							0.5		22	67	
140							0.3		22	77	
							0.3		12	71	
160							0.6		27	69	

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BOREHOLE LOG: 11TDD772

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/10/2011
DIP: -72 **AZIMUTH:** 206
COORDINATES: 557707.552N 33860.212E **DATUM:** Nad83

TOTAL DEPTH: 321
PAGE: 2 **OF** 7
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

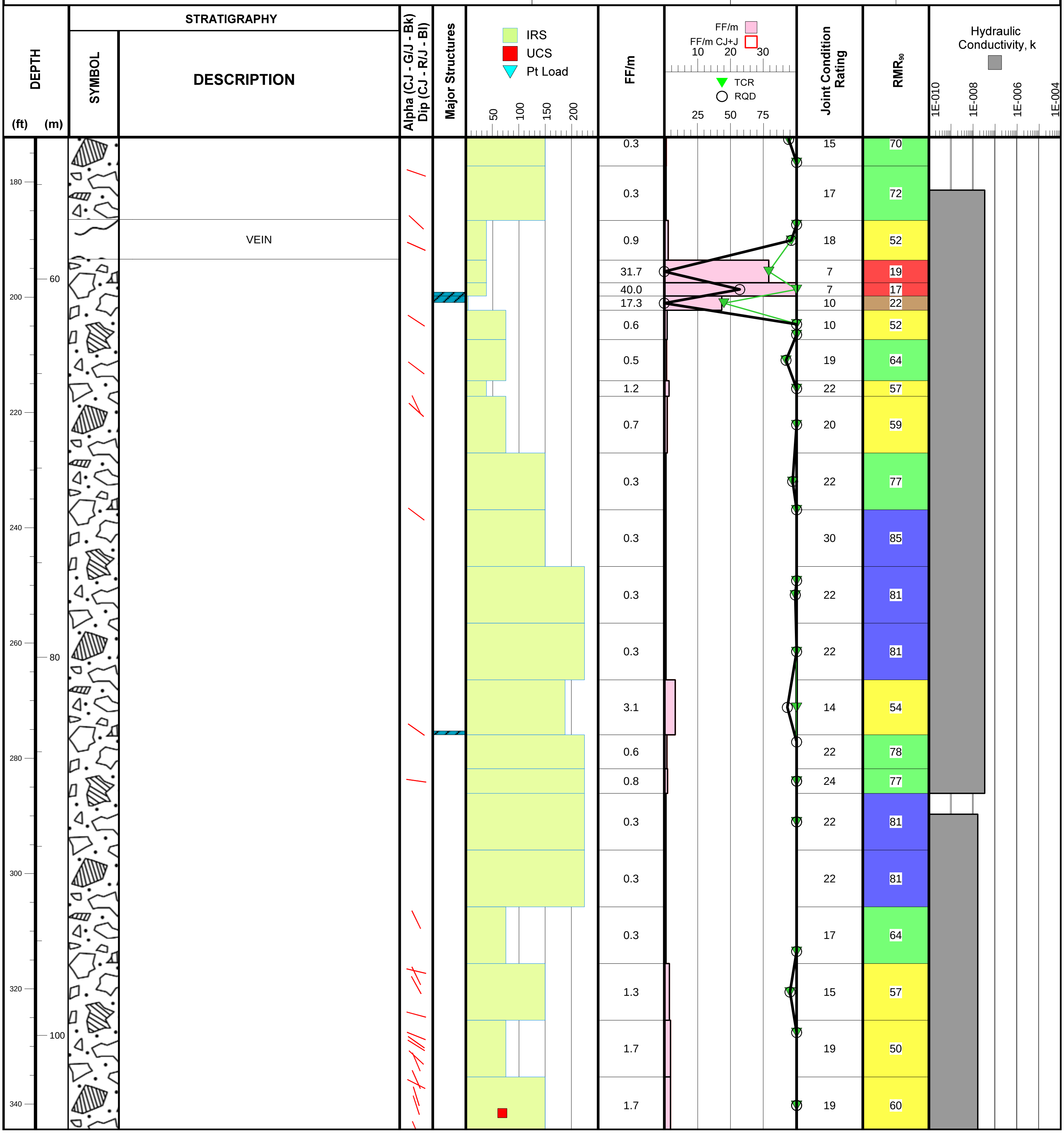
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR_{90}
0.3	15	70
0.3	17	72
0.9	18	52
31.7	7	19
40.0	7	17
17.3	10	22
0.6	10	52
0.5	19	64
1.2	22	57
0.7	20	59
0.3	22	77
0.3	30	85
0.3	22	81
0.3	22	81
3.1	14	54
0.6	22	78
0.8	24	77
0.3	22	81
0.3	22	81
0.3	17	64
1.3	15	57
1.7	19	50
1.7	19	60

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BOREHOLE LOG: 11TDD772

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/10/2011
DIP: -72 **AZIMUTH:** 206
COORDINATES: 557707.552N 33860.212E **DATUM:** Nad83

TOTAL DEPTH: 321

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: DESCRIPTION	FF/m	Joint Condition Rating	RMR_{90}
			0.3	22	69
360			0.3	17	64
			3.3	22	53
			1.9	19	57
380			1.0	24	75
	120		0.3	22	81
400			6.7	24	62
			0.3	22	81
420		Mafic Volcanics-Flow (including pillows) and Massive	0.3	22	81
			0.3	22	81
440			0.3	26	85
			0.3	22	81
460	140		0.3	22	81
			0.3	22	81
480			0.3	22	81
			0.3	22	81
500			0.3	22	81
			1.0	14	62

Column headings: Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl); Major Structures; IRS / UCS / Pt Load (50, 100, 150, 200); FF/m; FF/m / FF/m CJ+J (10, 20, 30); TCR / RQD (25, 50, 75); Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

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BOREHOLE LOG: 11TDD772

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/10/2011
DIP: -72 **AZIMUTH:** 206
COORDINATES: 557707.552N 33860.212E **DATUM:** Nad83

TOTAL DEPTH: 321

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

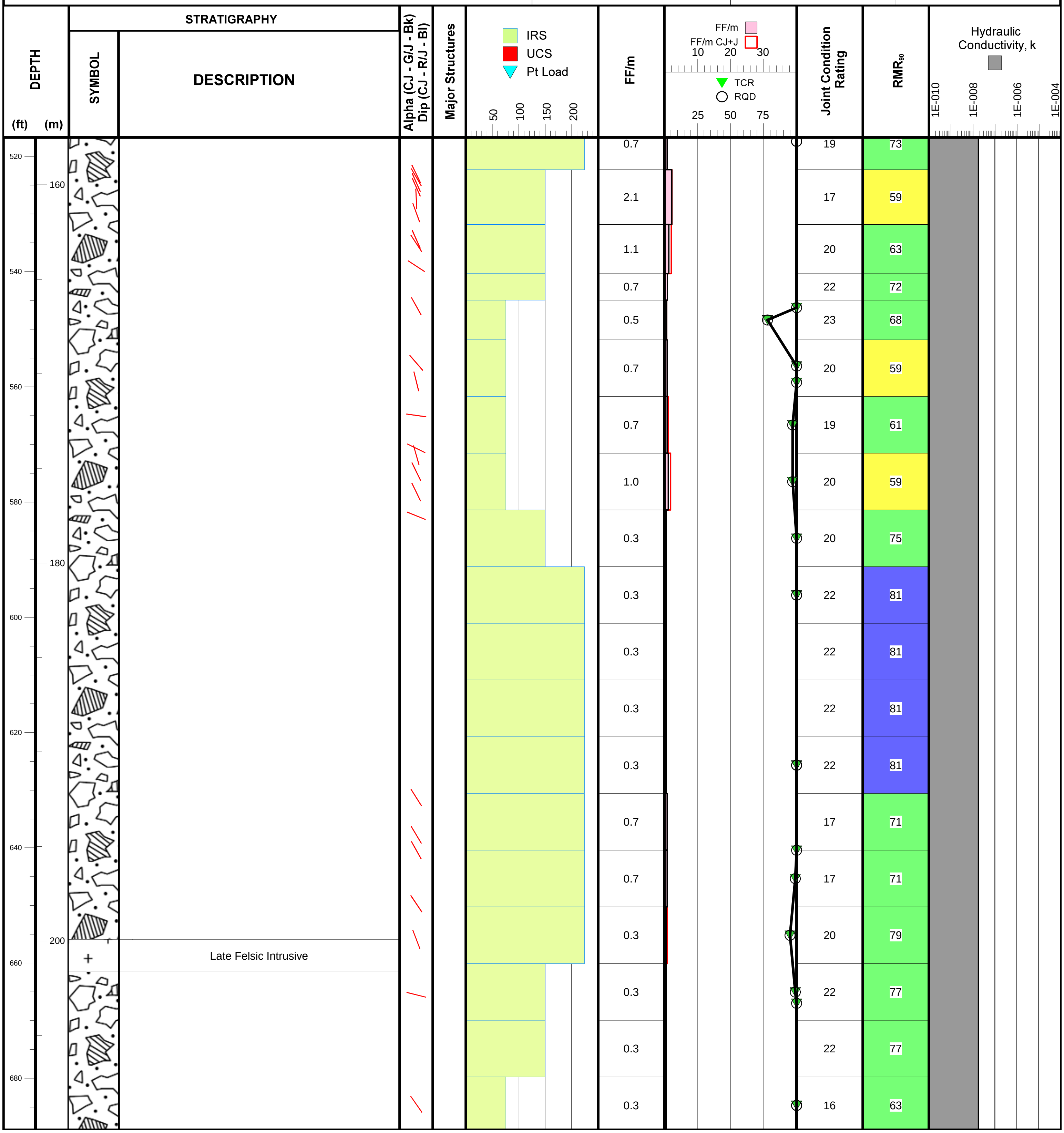
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR_{90}
0.7	19	73
2.1	17	59
1.1	20	63
0.7	22	72
0.5	23	68
0.7	20	59
0.7	19	61
1.0	20	59
0.3	20	75
0.3	22	81
0.3	22	81
0.3	22	81
0.3	22	81
0.7	17	71
0.7	17	71
0.3	20	79
0.3	22	77
0.3	22	77
0.3	16	63

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BOREHOLE LOG: 11TDD772

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/10/2011
DIP: -72 **AZIMUTH:** 206
COORDINATES: 557707.552N 33860.212E **DATUM:** Nad83

TOTAL DEPTH: 321

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
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UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY – DESCRIPTION	FF/m	Joint Condition Rating	RMR_{90}
		Mafic Volcanics-Flow (including pillows) and Massive	0.3	22	69
700			0.3	17	64
			0.5	22	67
			2.2	17	51
720	220		1.0	22	61
			0.5	17	61
			0.3	18	65
740			0.3	22	77
		VEIN	1.0	22	73
			0.5	22	78
760			0.3	22	77
		Mafic Volcanics-Flow (including pillows) and Massive	0.3	22	77
780			0.3	22	66
	240	VEIN	0.6	22	74
			0.8	22	63
800		Mafic Volcanics-Flow (including pillows) and Massive / VEIN	0.3	22	77
			0.4	22	69
820		Mafic Volcanics-Flow (including pillows) and Massive	4.1	23	49
			0.7	16	55
840		VEIN	0.7	14	50
	260	Mafic Volcanics-Flow (including pillows) and Massive	0.3	23	67
860					

Column headings: SYMBOL; Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl); Major Structures; IRS, UCS, Pt Load (50, 100, 150, 200); FF/m; FF/m, FF/m CJ+J (10, 20, 30), TCR, RQD (25, 50, 75); Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

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BOREHOLE LOG: 11TDD772

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/10/2011
DIP: -72 **AZIMUTH:** 206
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TOTAL DEPTH: 321
PAGE: 6 **OF** 7
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | SYMBOL | STRATIGRAPHY | DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth marks (ft): 880, 900, 920, 940, 960, 980, 1000, 1020; (m): 280, 300

Stratigraphy (top to bottom):

Late Felsic Intrusive

Mafic Volcanics-Flow (including pillows) and Massive

VEIN

Mafic Volcanics-Flow (including pillows) and Massive

VEIN

Mafic Volcanics-Flow (including pillows) and Massive

Late Felsic Intrusive

Mafic Volcanics-Flow (including pillows) and Massive

VEIN

Mafic Volcanics-Flow (including pillows) and Massive

FF/m	Joint Condition Rating	RMR_{90}
0.4	18	65
0.6	17	69
0.3	22	82
0.3	22	69
0.3	16	63
1.3	20	57
0.6	22	65
0.7	22	64
0.3	22	69
2.0	17	46
0.3	18	65
1.0	21	65
0.7	22	64
0.6	22	65
0.3	22	66
0.3	22	77
7.7	22	50
2.0	13	52
1.0	19	55
0.3	22	69

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BOREHOLE LOG: 11TDD772

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/3/2011 **TO:** 5/10/2011
DIP: -72 **AZIMUTH:** 206
COORDINATES: 557707.552N 33860.212E **DATUM:** Nad83

TOTAL DEPTH: 321

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	SYMBOL	DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
1040							0.3		22	69	
	320		Diabsase				0.3		22	81	
1060											
1080											
1100											
	340										

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BOREHOLE LOG: 11TDD773

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/18/2011 **TO:** 5/22/2011
DIP: -59 **AZIMUTH:** 49
COORDINATES: 558468.255N 33581.89E **DATUM:** Nad83

TOTAL DEPTH: 301

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

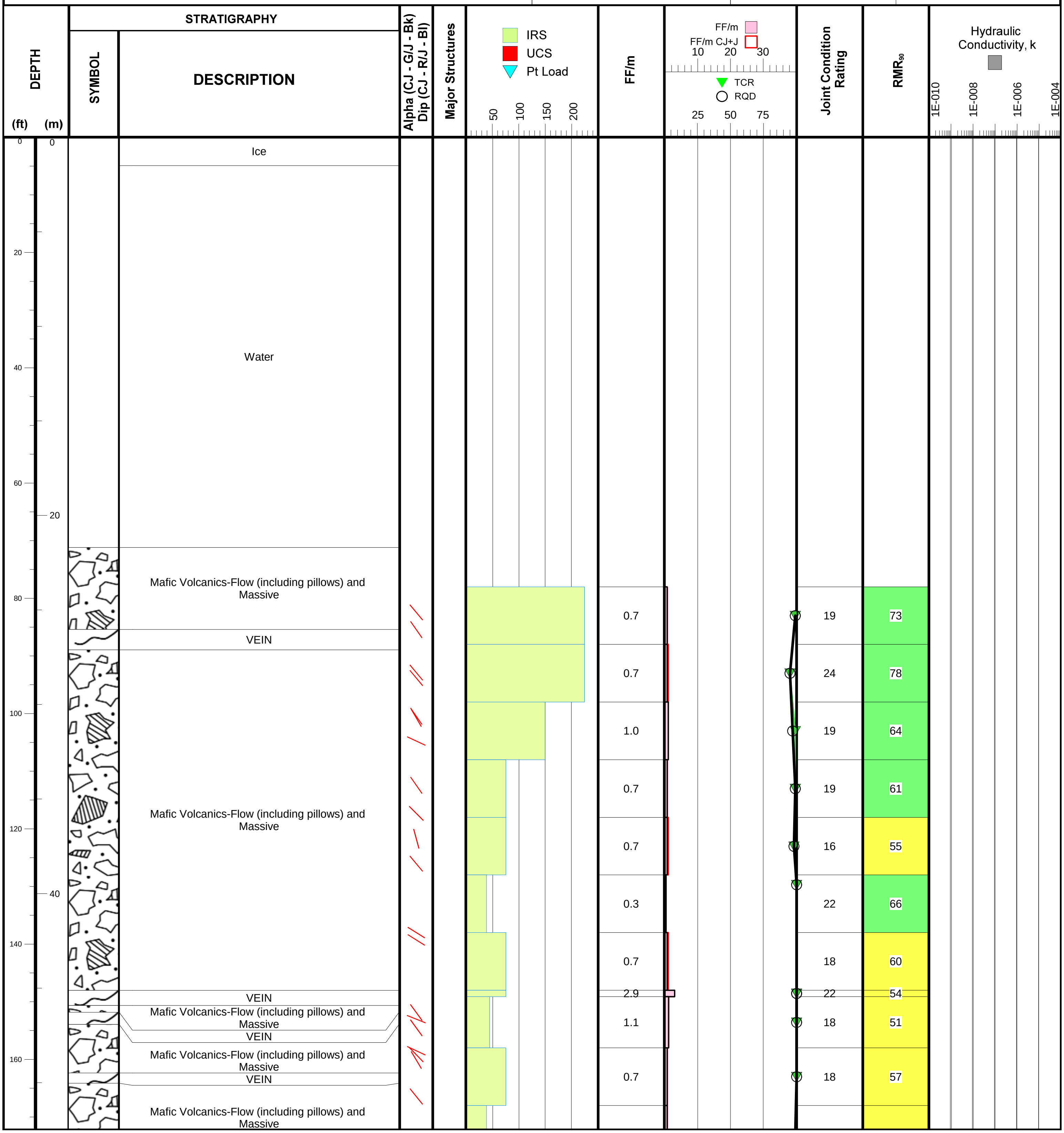
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



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BOREHOLE LOG: 11TDD773

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/18/2011 **TO:** 5/22/2011
DIP: -59 **AZIMUTH:** 49
COORDINATES: 558468.255N 33581.89E **DATUM:** Nad83

TOTAL DEPTH: 301

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
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UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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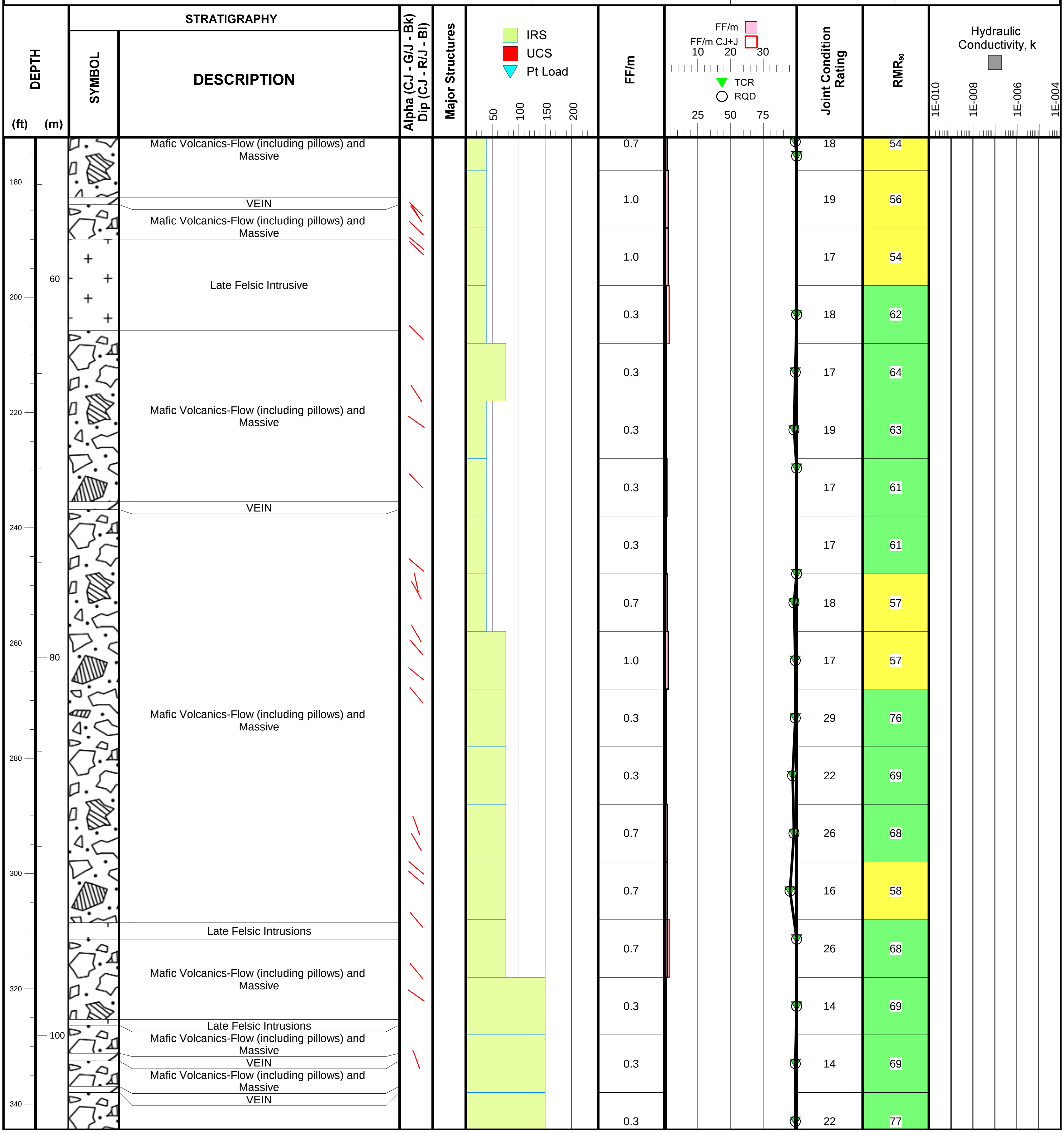
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



Stratigraphy (top to bottom):

- Mafic Volcanics-Flow (including pillows) and Massive
- VEIN
- Mafic Volcanics-Flow (including pillows) and Massive
- Late Felsic Intrusive
- Mafic Volcanics-Flow (including pillows) and Massive
- VEIN
- Mafic Volcanics-Flow (including pillows) and Massive
- Late Felsic Intrusions
- Mafic Volcanics-Flow (including pillows) and Massive
- Late Felsic Intrusions
- Mafic Volcanics-Flow (including pillows) and Massive
- VEIN
- Mafic Volcanics-Flow (including pillows) and Massive
- VEIN

FF/m	Joint Condition Rating	RMR_{90}
0.7	18	54
1.0	19	56
1.0	17	54
0.3	18	62
0.3	17	64
0.3	19	63
0.3	17	61
0.3	17	61
0.7	18	57
1.0	17	57
0.3	29	76
0.3	22	69
0.7	26	68
0.7	16	58
0.7	26	68
0.3	14	69
0.3	14	69
0.3	22	77

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BOREHOLE LOG: 11TDD773

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/18/2011 **TO:** 5/22/2011
DIP: -59 **AZIMUTH:** 49
COORDINATES: 558468.255N 33581.89E **DATUM:** Nad83

TOTAL DEPTH: 301

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	(m)	STRATIGRAPHY: DESCRIPTION
360		Mafic Volcanics-Flow (including pillows) and Massive
380		VEIN
400	120	Mafic Volcanics-Flow (including pillows) and Massive
420		
440		VEIN
460	140	Mafic Volcanics-Flow (including pillows) and Massive
		VEIN
480		
500		

Column headings: Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl); Major Structures; IRS / UCS / Pt Load (50, 100, 150, 200); FF/m; FF/m, FF/m CJ+J (10, 20, 30), TCR, RQD (25, 50, 75); Joint Condition Rating; RMR_{90}; Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

FF/m	Joint Condition Rating	RMR_{90}
0.3	22	77
1.3	18	50
1.3	18	63
0.3	20	67
0.7	18	57
0.3	22	66
0.3	22	69
0.3	22	69
0.3	17	64
0.5	17	61
0.3	22	70
0.3	22	69
0.7	22	64
0.3	20	79
1.6	23	67
1.0	19	67
1.3	21	67

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BOREHOLE LOG: 11TDD773

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/18/2011 **TO:** 5/22/2011
DIP: -59 **AZIMUTH:** 49
COORDINATES: 558468.255N 33581.89E **DATUM:** Nad83

TOTAL DEPTH: 301

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m)	SYMBOL	DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50 100 150 200)	FF/m	FF/m, FF/m CJ+J (10 20 30); TCR, RQD (25 50 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010 1E-008 1E-006 1E-004)
520		Mafic Volcanics-Flow (including pillows) and Massive				0.6		18	72	
160						2.8		21	58	
						0.8		22	60	
540						0.3		26	70	
						4.6		11	35	
560						0.7		20	62	
						1.6		21	51	
580						1.3		21	56	
						0.8		22	63	
180						1.0		17	62	
600						0.3		24	79	
		VEIN				1.3		20	63	
620		Mafic Volcanics-Flow (including pillows) and Massive				1.0		20	59	
						1.3		19	57	
640						1.3		23	68	
200						4.6		17	41	
660						1.0		20	57	
						4.0		18	40	
680						3.6		18	40	

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BOREHOLE LOG: 11TDD773

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/18/2011 **TO:** 5/22/2011
DIP: -59 **AZIMUTH:** 49
COORDINATES: 558468.255N 33581.89E **DATUM:** Nad83

TOTAL DEPTH: 301

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

Columns: DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS / UCS / Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth scale (ft): 700, 720, 740, 760, 780, 800, 820, 840, 860; (m): 220, 240, 260

Stratigraphy:

VEIN

Mafic Volcanics-Flow (including pillows) and Massive

Late Felsic Intrusions

FF/m	Joint Condition Rating	RMR_{90}
1.6	22	50
1.3	16	45
0.7	22	61
0.3	22	69
0.3	20	64
0.3	22	69
0.3	19	66
1.6	21	54
1.3	21	63
0.3	30	77
1.0	21	55
2.0	26	58
1.6	21	54
2.6	18	48
1.6	24	60
0.6	20	63
1.8	24	56

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BOREHOLE LOG: 11TDD773

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/18/2011 TO: 5/22/2011
DIP: -59 AZIMUTH: 49
COORDINATES: 558468.255N 33581.89E DATUM: Nad83

TOTAL DEPTH: 301

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | SYMBOL | STRATIGRAPHY DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS / UCS / Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth ticks: 880, 900, 920 (280 m), 940, 960, 980 (300 m), 1000, 1020

Mafic Volcanics-Flow (including pillows) and Massive

Mafic Volcanics-Flow (including pillows) and Massive

FF/m	Joint Condition Rating	RMR_{90}
1.6	19	52
2.6	19	49
2.6	19	49
1.6	15	51
1.0	18	55
1.6	16	47
1.3	20	57
1.3	20	60
1.3	17	60
0.7	18	65
1.0	20	55
1.3	19	51
1.3	21	61

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BOREHOLE LOG: 11TDD773

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/18/2011 **TO:** 5/22/2011
DIP: -59 **AZIMUTH:** 49
COORDINATES: 558468.255N 33581.89E **DATUM:** Nad83

TOTAL DEPTH: 301

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
1040	320										

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BOREHOLE LOG: 11TDD774

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/21/2011 **TO:** 5/26/2011
DIP: -66 **AZIMUTH:** 74
COORDINATES: 558789.99N 33664.99E **DATUM:** Nad83

TOTAL DEPTH: 273

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

Column headings: DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Stratigraphy (depth 0 to approx. 172 ft):

- Ice
- Water
- Mafic Volcanics-Flow (including pillows) and Massive
- VEIN

FF/m	Joint Condition Rating	RMR_{90}
1.3	19	69
1.3	20	66
0.9	15	67
1.0	22	73
2.9	26	66
2.5	23	61
1.9	26	69
0.4	24	77
1.4	24	69
2.6	20	61
2.7	27	64
1.4	22	67
2.9	28	65
0.8	19	72
5.7	19	54
0.9	17	65
2.5	15	60
0.3	21	80
0.8	18	71
1.1	19	67
1.0	15	62
0.3	23	82

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BOREHOLE LOG: 11TDD774

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study

LOCATION: Hope Bay, Nunavut

SITE & PROJECT No: HOPE BAY 1CH008.054

BORING DATE: 5/21/2011 **TO:** 5/26/2011

DIP: -66 **AZIMUTH:** 74

COORDINATES: 558789.99N 33664.99E **DATUM:** Nad83

TOTAL DEPTH: 273

DRILL TYPE: Diamond Drill

CORE DIA.: HQ3

CASING DEPTH:

PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

Column headings: DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth marks: 180, 200, 220, 240, 260, 280, 300, 320, 340 (ft); 60, 80, 100 (m)

STRATIGRAPHY (top to bottom)

DESCRIPTION
Mafic Volcanics-Flow (including pillows) and Massive
VEIN
Mafic Volcanics-Flow (including pillows) and Massive
VEIN
Mafic Volcanics-Flow (including pillows) and Massive
Late Felsic Intrusions
Mafic Volcanics-Flow (including pillows) and Massive
Late Felsic Intrusions
Mafic Volcanics-Flow (including pillows) and Massive
VEIN
Mafic Volcanics-Flow (including pillows) and Massive
VEIN
Mafic Volcanics-Flow (including pillows) and Massive
VEIN
Mafic Volcanics-Flow (including pillows) and Massive

INTERVAL DATA (top to bottom)

FF/m	Joint Condition Rating	RMR_{90}
0.5	15	71
0.9	22	74
0.4	19	78
0.7	14	68
0.6	22	78
0.7	27	77
3.3	22	61
2.4	27	69
3.3	27	63
2.5	29	74
3.0	6	41
1.7	26	65
2.0	23	62
3.3	27	63
1.4	27	72
1.3	27	74
1.0	27	74
1.0	19	63
2.0	22	68
0.4	22	80
0.3	19	78
0.7	19	70
0.3	22	77

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BOREHOLE LOG: 11TDD774

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/21/2011 **TO:** 5/26/2011
DIP: -66 **AZIMUTH:** 74
COORDINATES: 558789.99N 33664.99E **DATUM:** Nad83

TOTAL DEPTH: 273

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

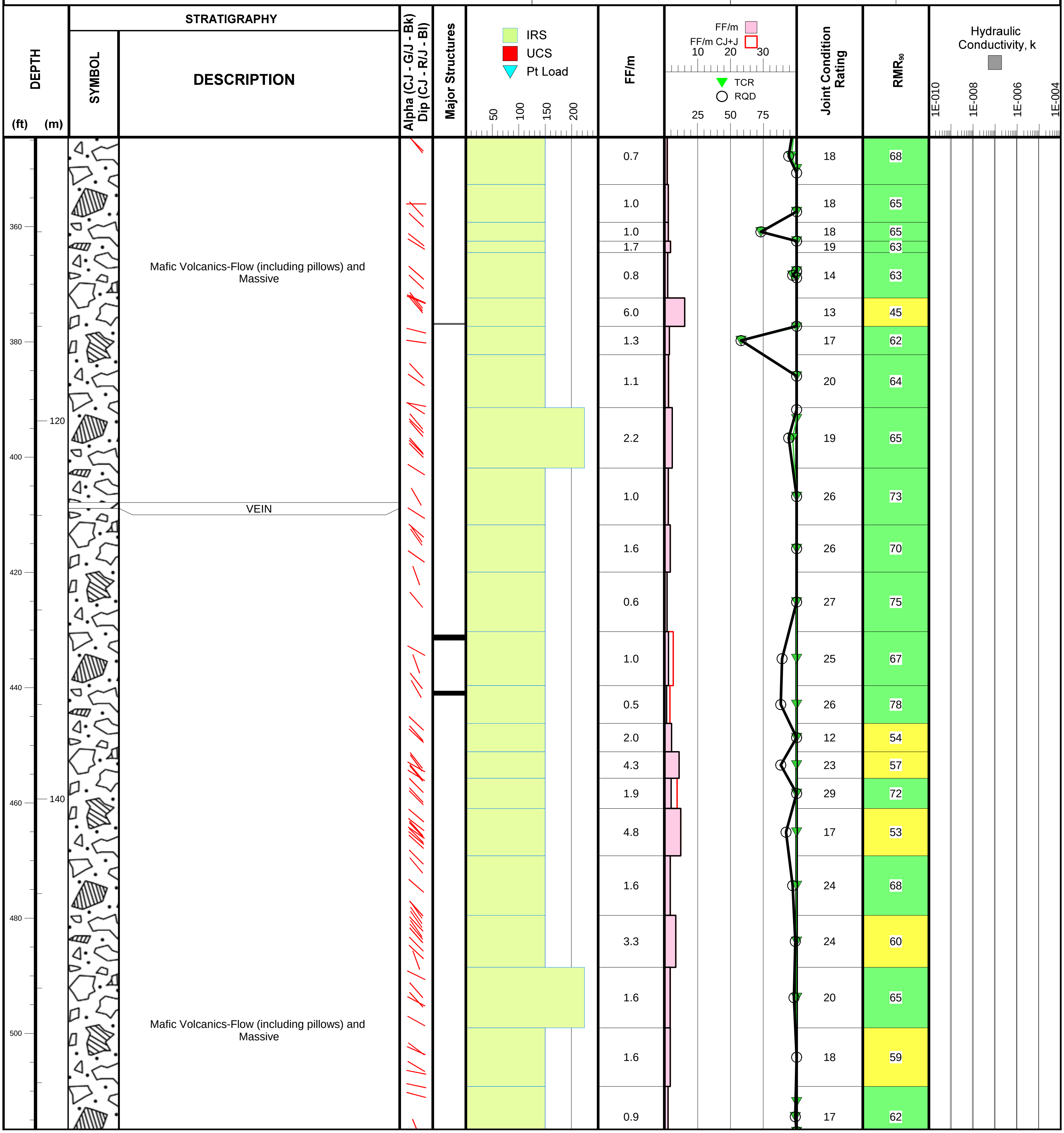
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR90
0.7	18	68
1.0	18	65
1.0	18	65
1.7	19	63
0.8	14	63
6.0	13	45
1.3	17	62
1.1	20	64
2.2	19	65
1.0	26	73
1.6	26	70
0.6	27	75
1.0	25	67
0.5	26	78
2.0	12	54
4.3	23	57
1.9	29	72
4.8	17	53
1.6	24	68
3.3	24	60
1.6	20	65
1.6	18	59
0.9	17	62

BOREHOLE LOG: 11TDD774

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/21/2011 **TO:** 5/26/2011
DIP: -66 **AZIMUTH:** 74
COORDINATES: 558789.99N 33664.99E **DATUM:** Nad83

TOTAL DEPTH: 273
PAGE: 4 **OF** 6
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
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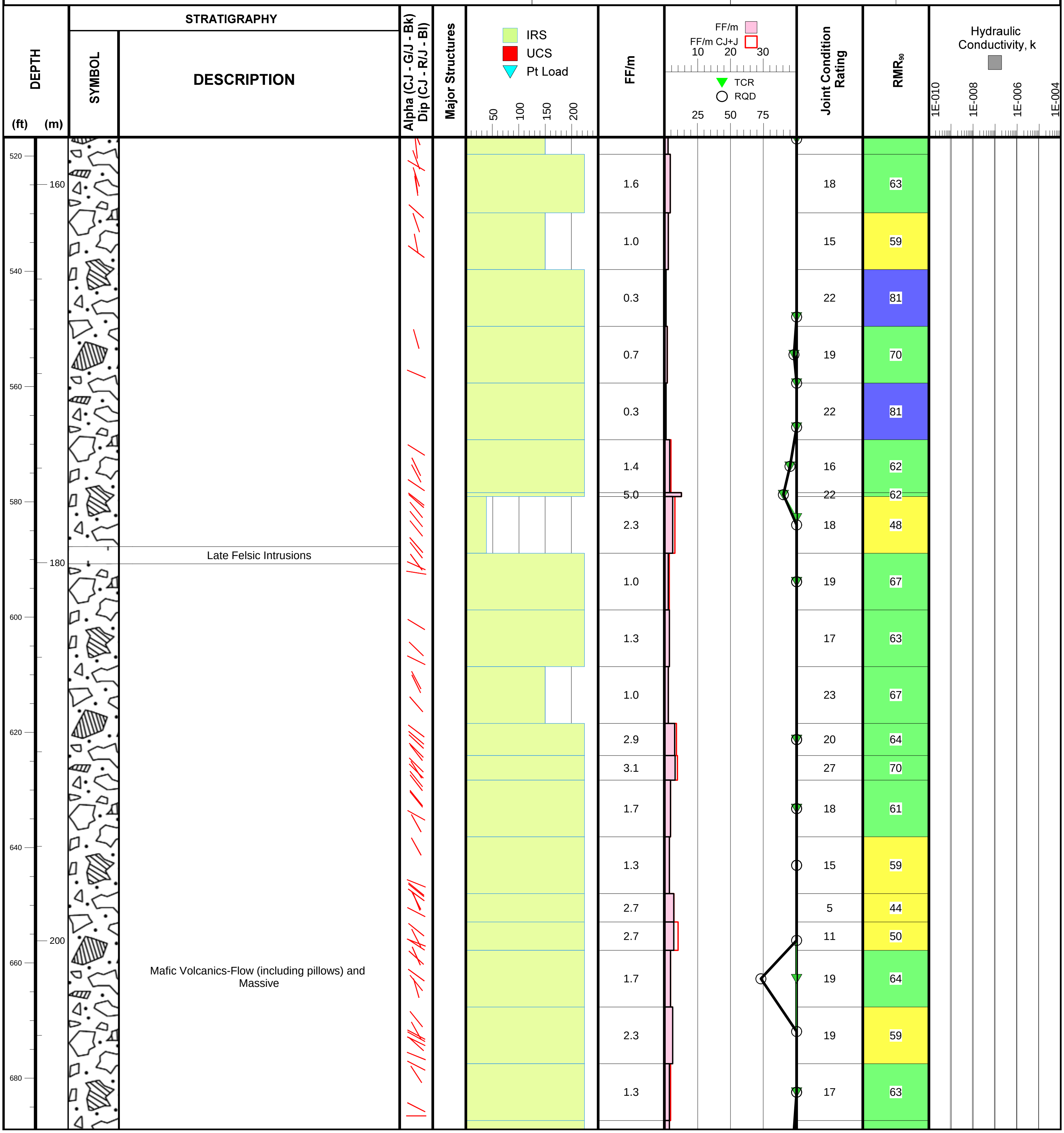
LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR90
1.6	18	63
1.0	15	59
0.3	22	81
0.7	19	70
0.3	22	81
1.4	16	62
5.0	22	62
2.3	18	48
1.0	19	67
1.3	17	63
1.0	23	67
2.9	20	64
3.1	27	70
1.7	18	61
1.3	15	59
2.7	5	44
2.7	11	50
1.7	19	64
2.3	19	59
1.3	17	63

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BOREHOLE LOG: 11TDD774

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/21/2011 **TO:** 5/26/2011
DIP: -66 **AZIMUTH:** 74
COORDINATES: 558789.99N 33664.99E **DATUM:** Nad83

TOTAL DEPTH: 273
PAGE: 5 **OF** 6
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

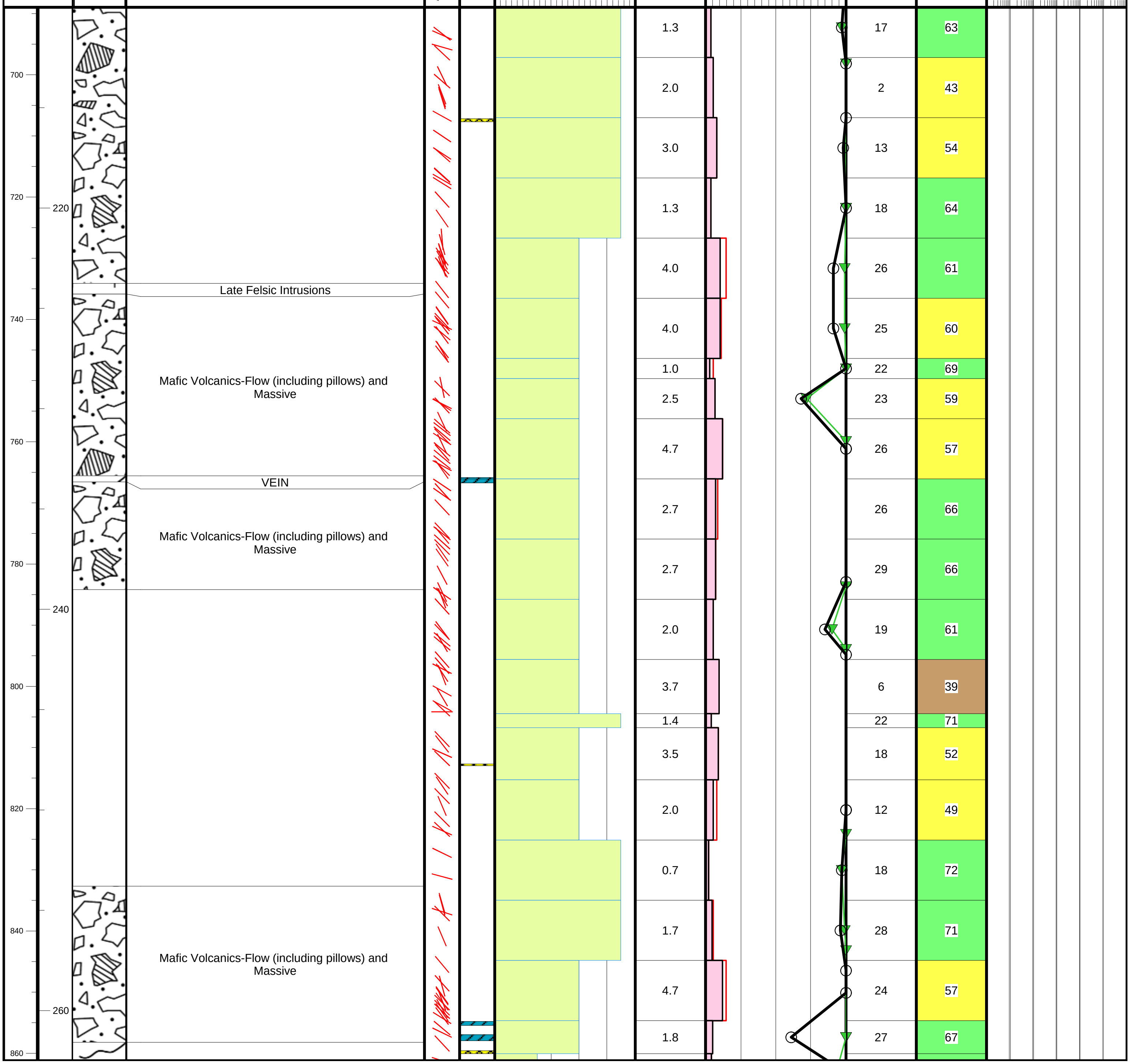
LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m)	SYMBOL	STRATIGRAPHY / DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)



FF/m	Joint Condition Rating	RMR_{90}
1.3	17	63
2.0	2	43
3.0	13	54
1.3	18	64
4.0	26	61
4.0	25	60
1.0	22	69
2.5	23	59
4.7	26	57
2.7	26	66
2.7	29	66
2.0	19	61
3.7	6	39
1.4	22	71
3.5	18	52
2.0	12	49
0.7	18	72
1.7	28	71
4.7	24	57
1.8	27	67

BOREHOLE LOG: 11TDD774

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/21/2011 **TO:** 5/26/2011
DIP: -66 **AZIMUTH:** 74
COORDINATES: 558789.99N 33664.99E **DATUM:** Nad83

TOTAL DEPTH: 273
PAGE: 6 **OF** 6
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

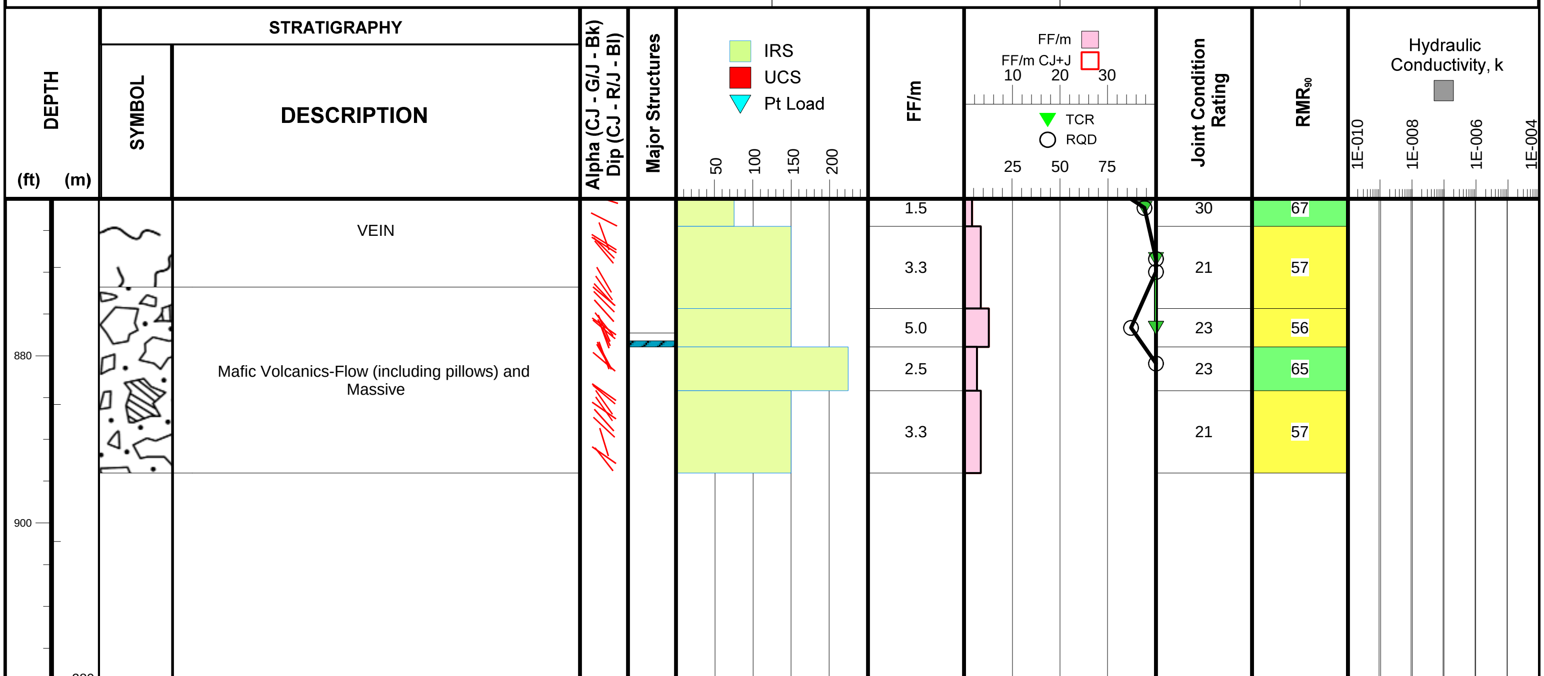
IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100



FF/m	Joint Condition Rating	RMR
1.5	30	67
3.3	21	57
5.0	23	56
2.5	23	65
3.3	21	57

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BOREHOLE LOG: 11TDD775

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/24/2011 **TO:** 5/28/2011
DIP: -61 **AZIMUTH:** 78
COORDINATES: 558475.51N 33607.48E **DATUM:** Nad83

TOTAL DEPTH: 304

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY: SYMBOL	STRATIGRAPHY: DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
0	0		Ice								
			Water								
			Mafic Volcanics-Flow (including pillows) and Massive				1.0		22	58	
							0.7		22	58	
							1.0		19	64	
							0.7		19	58	
							2.0		21	53	
							1.0		24	72	
							1.3		26	63	
							0.7		29	71	
							1.3		29	74	

Depth scale (ft): 0, 20, 40, 60, 80, 100, 120, 140, 160
Depth scale (m): 0, 20, 40

BOREHOLE LOG: 11TDD775

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PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/24/2011 **TO:** 5/28/2011
DIP: -61 **AZIMUTH:** 78
COORDINATES: 558475.51N 33607.48E **DATUM:** Nad83

TOTAL DEPTH: 304

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	(m)	STRATIGRAPHY DESCRIPTION	FF/m	Joint Condition Rating	RMR_{90}
180		Late Mafic Intrusions	0.3	26	73
			1.0	26	78
	60	Mafic Volcanics-Flow (including pillows) and Massive	1.3	23	70
200			0.3	22	77
		VEIN	1.0	17	62
220			0.8	19	60
			0.3	22	67
240			1.3	20	52
			1.0	14	59
260	80		0.3	21	68
			0.7	22	61
280			0.3	22	66
			0.3	22	66
300			0.3	22	66
			0.3	19	66
320			1.3	24	66
	100		0.7	22	58
340			1.0	18	55

Column headings: SYMBOL; Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl); Major Structures; IRS / UCS / Pt Load (50, 100, 150, 200); FF/m; FF/m, FF/m CJ+J (10, 20, 30), TCR, RQD (25, 50, 75); Joint Condition Rating; RMR_{90}; Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

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BOREHOLE LOG: 11TDD775

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/24/2011 **TO:** 5/28/2011
DIP: -61 **AZIMUTH:** 78
COORDINATES: 558475.51N 33607.48E **DATUM:** Nad83

TOTAL DEPTH: 304
PAGE: 3 **OF** 7
DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m) | STRATIGRAPHY: SYMBOL, DESCRIPTION | Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl) | Major Structures | IRS, UCS, Pt Load (50, 100, 150, 200) | FF/m | FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75) | Joint Condition Rating | RMR_{90} | Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

Depth scale: 360, 380, 400, 420, 440, 460, 480, 500 (ft); 120, 140 (m)

Description: Mafic Volcanics-Flow (including pillows) and Massive

FF/m	Joint Condition Rating	RMR_{90}
0.7	30	77
0.3	29	84
1.0	29	76
0.7	26	65
1.1	24	70
0.7	25	64
0.7	19	61
0.3	18	65
0.3	19	74
0.3	22	69
0.7	18	68
0.3	22	69
0.3	22	69
1.0	17	57
0.3	22	69
0.7	10	57

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BOREHOLE LOG: 11TDD775

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/24/2011 **TO:** 5/28/2011
DIP: -61 **AZIMUTH:** 78
COORDINATES: 558475.51N 33607.48E **DATUM:** Nad83

TOTAL DEPTH: 304

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	(m)	STRATIGRAPHY DESCRIPTION	FF/m	Joint Condition Rating	RMR_{90}
520			0.3	22	66
	160		0.3	22	69
540			1.0	19	59
			0.3	22	69
560			0.3	22	66
			0.7	20	67
580			0.3	19	67
	180		1.0	26	71
600			1.0	19	67
			0.7	30	72
620			1.0	24	60
		VEIN	0.3	22	69
640		Mafic Volcanics-Flow (including pillows) and Massive	1.3	19	54
	200		1.3	21	53
660		VEIN Mafic Volcanics-Flow (including pillows) and Massive VEIN	1.0	20	57
			0.3	16	60
680			1.3	20	63

Column headings: DEPTH (ft) (m); STRATIGRAPHY: SYMBOL, DESCRIPTION; Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl); Major Structures; IRS, UCS, Pt Load (50, 100, 150, 200); FF/m; FF/m, FF/m CJ+J (10, 20, 30), TCR, RQD (25, 50, 75); Joint Condition Rating; RMR_{90}; Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)

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BOREHOLE LOG: 11TDD775

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/24/2011 **TO:** 5/28/2011
DIP: -61 **AZIMUTH:** 78
COORDINATES: 558475.51N 33607.48E **DATUM:** Nad83

TOTAL DEPTH: 304

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) / (m)	STRATIGRAPHY – SYMBOL	DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
700 ft		Mafic Volcanics-Flow (including pillows) and Massive				0.3		21	68	
						0.3		22	69	
						0.3		9	53	
720 ft / 220 m						2.3		19	49	
		Mafic Volcanics-Flow (including pillows) and Massive				0.7		21	63	
740 ft						0.3		20	67	
		Mafic Volcanics-Flow (including pillows) and Massive				0.3		20	67	
760 ft						1.0		7	56	
		Late Mafic Intrusions				2.6		6	48	
780 ft						1.6		4	49	
240 m						2.6		13	53	
800 ft						4.3		13	49	
						3.3		29	69	
820 ft		Mafic Volcanics-Flow (including pillows) and Massive				3.6		22	61	
						5.6		21	51	
840 ft						3.6		22	57	
260 m						5.3		21	54	
860 ft										

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BOREHOLE LOG: 11TDD775

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/24/2011 **TO:** 5/28/2011
DIP: -61 **AZIMUTH:** 78
COORDINATES: 558475.51N 33607.48E **DATUM:** Nad83

TOTAL DEPTH: 304

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft) (m)	SYMBOL	STRATIGRAPHY DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50, 100, 150, 200)	FF/m	FF/m, FF/m CJ+J (10, 20, 30); TCR, RQD (25, 50, 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010, 1E-008, 1E-006, 1E-004)
						2.0		15	55	
						1.0		20	65	
880		VEIN				0.4		22	80	
						1.6		22	70	
						0.3		22	77	
900						1.0		24	69	
						2.3		26	64	
920 / 280		Mafic Volcanics-Flow (including pillows) and Massive				3.9		24	57	
						3.0		26	66	
940						2.6		24	60	
						1.6		25	66	
960						2.3		27	65	
						1.6		22	66	
980 / 300						2.0		24	64	
						1.3		19	63	
1000										
1020										

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BOREHOLE LOG: 11TDD775

PROJECT: Hope Bay Stage 2 Geotech-Hydro Study
LOCATION: Hope Bay, Nunavut
SITE & PROJECT No: HOPE BAY 1CH008.054
BORING DATE: 5/24/2011 **TO:** 5/28/2011
DIP: -61 **AZIMUTH:** 78
COORDINATES: 558475.51N 33607.48E **DATUM:** Nad83

TOTAL DEPTH: 304

DRILL TYPE: Diamond Drill
CORE DIA.: HQ3
CASING DEPTH:
PLAN No:

DEFINTIONS

IRS: Intact Rock Strength (field est.)
Pt Load: Point Load Test (MPa)
TCR: Total Core Recovery
IRMR: Intact Rock Mass Rating
UCS: Uniaxial Compressive Strength (MPa)
FF/m: Fracture Frequency per metre
RQD: Rock Quality Designation
RBS: Rock Block Strength (MPa)

LEGEND OF MAJOR STRUCTURES

GOUGE
SHEARED
BROKEN
JOINTED

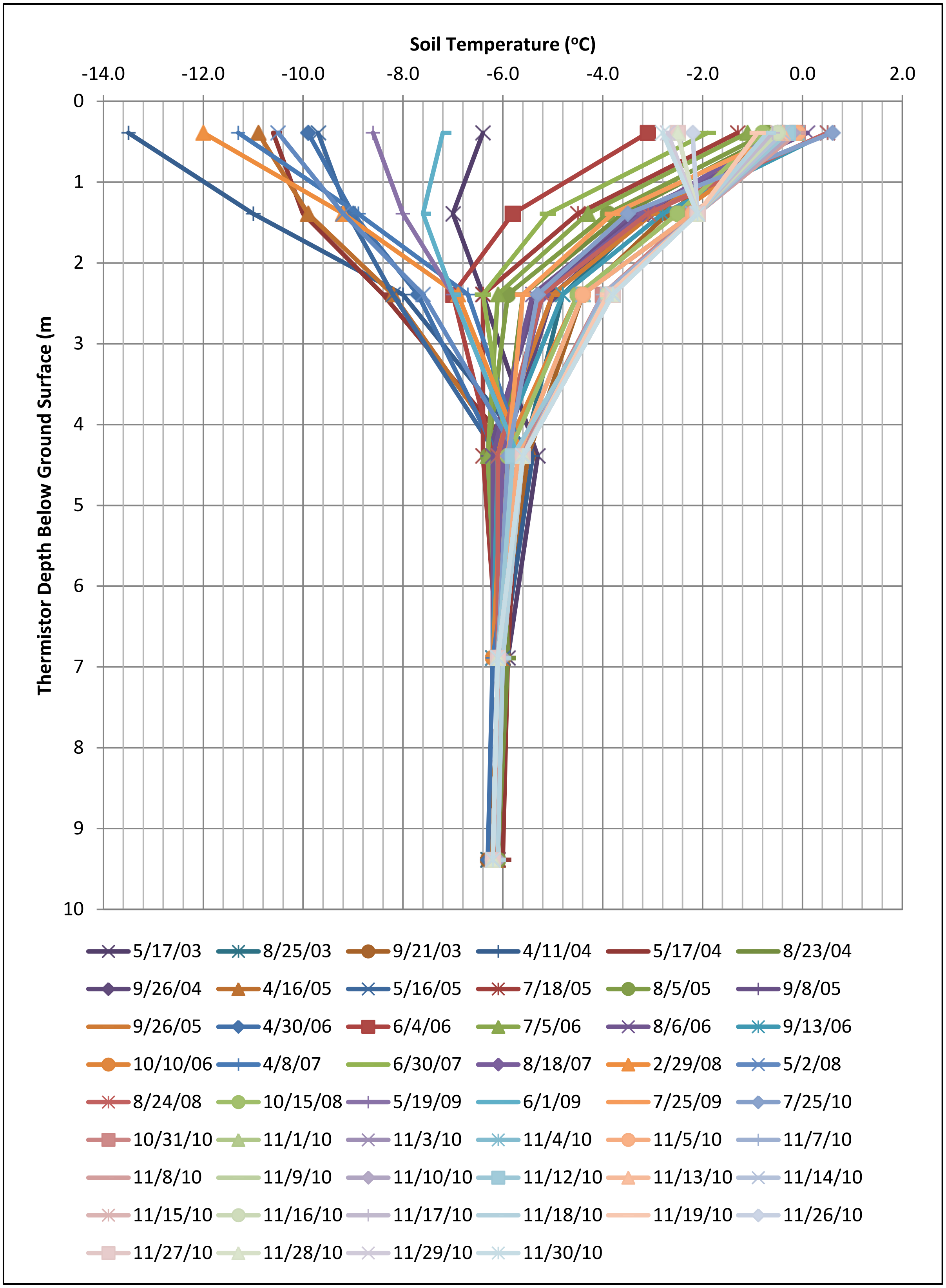
LEGEND OF RMR

0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

DEPTH (ft)	DEPTH (m)	STRATIGRAPHY SYMBOL	DESCRIPTION	Alpha (CJ - G/J - Bk) Dip (CJ - R/J - Bl)	Major Structures	IRS / UCS / Pt Load (50 100 150 200)	FF/m	FF/m, FF/m CJ+J (10 20 30); TCR, RQD (25 50 75)	Joint Condition Rating	RMR_{90}	Hydraulic Conductivity, k (1E-010 1E-008 1E-006 1E-004)
1040	320										

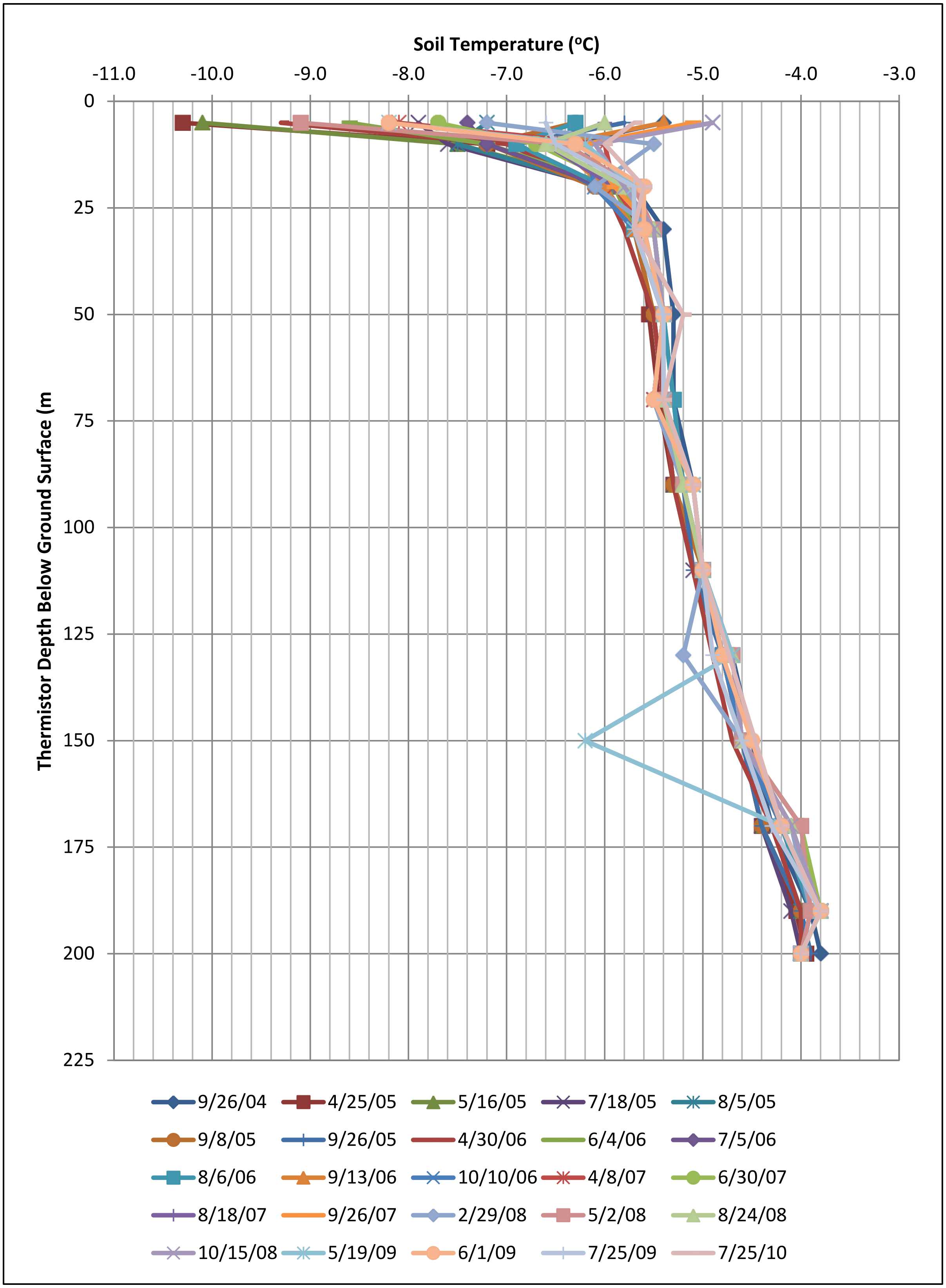
Appendix B3 Wireframe Models (AutoCAD format)

Appendix C - Thermal Data



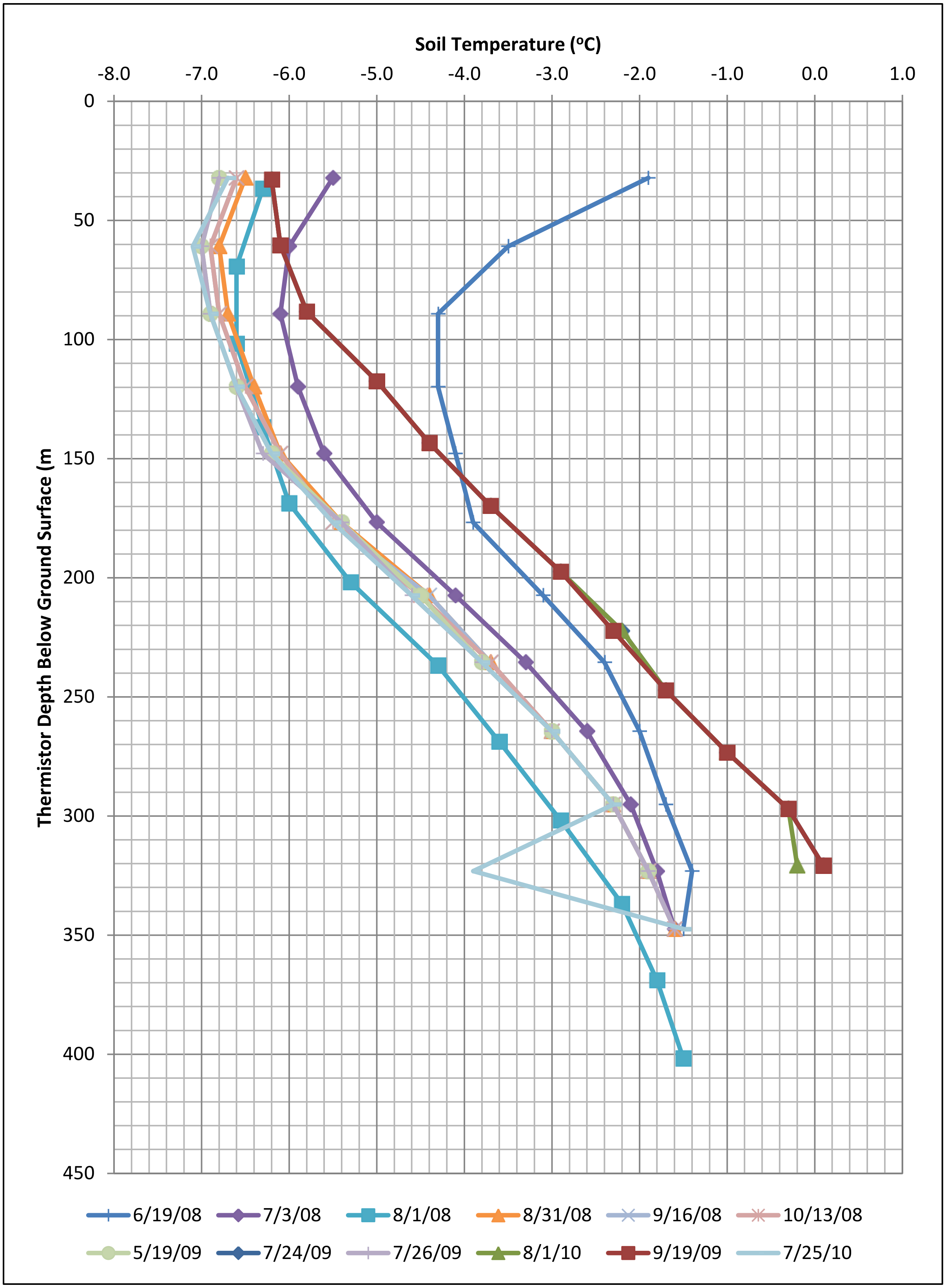
\\VAN-SVR0\Projects\01_SITES\Hope.Bay\!Project_Data (Not Job Specific)\01 Thermistor Data\!Master thermistor database\HopeBayMasterThermistorData.Last Modified 20110203_ja_rev05.accdb

Figure 1: Thermistor data for SRK-35.



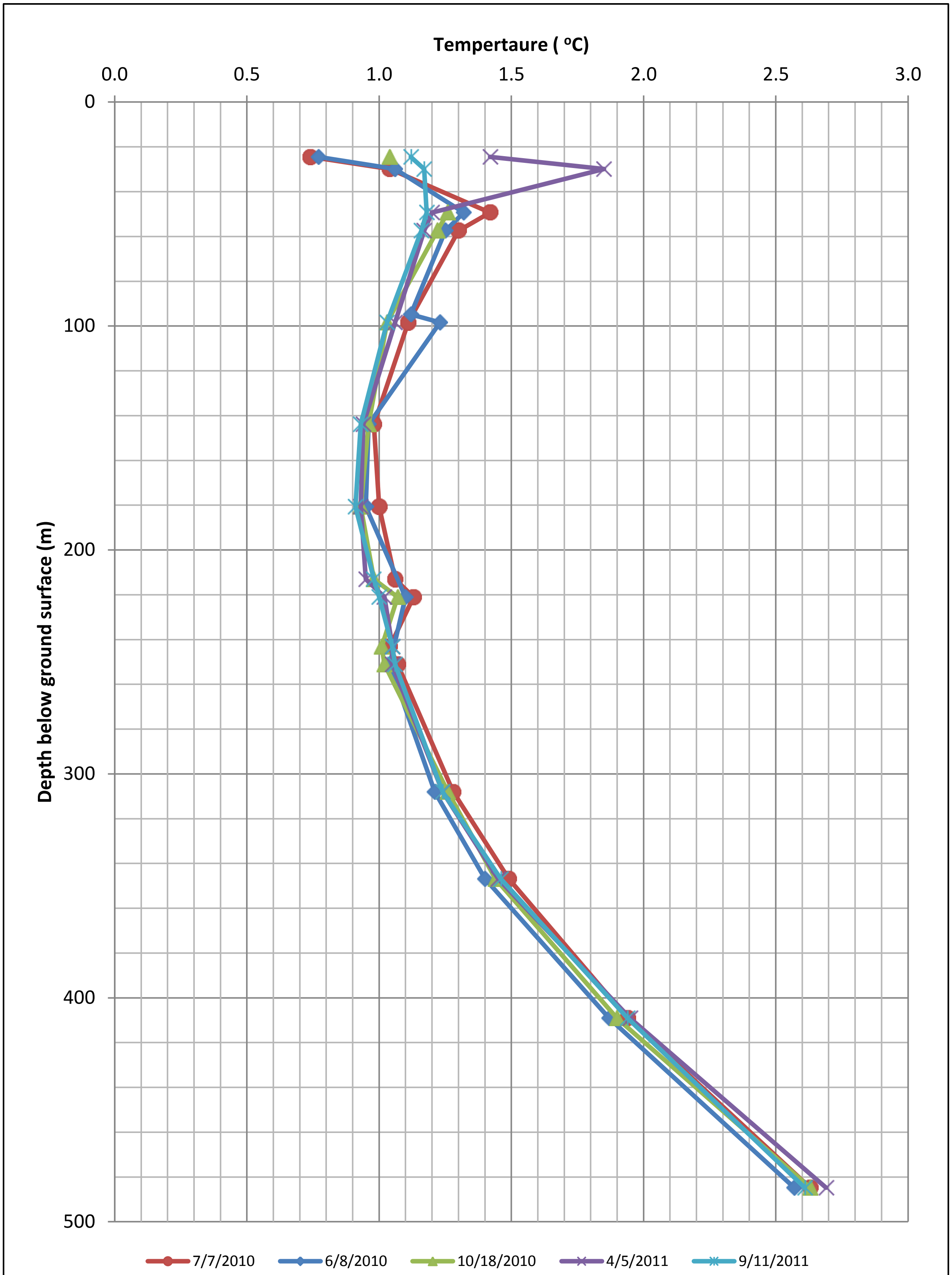
\\VAN-SVR0\Projects\01_SITES\Hope.Bay\!Project_Data (Not Job Specific)\01 Thermistor Data\!Master thermistor database\HopeBayMasterThermistorData.Last Modified 20110203_ja_rev05.accdb

Figure 2: Thermistor data for SRK-50.



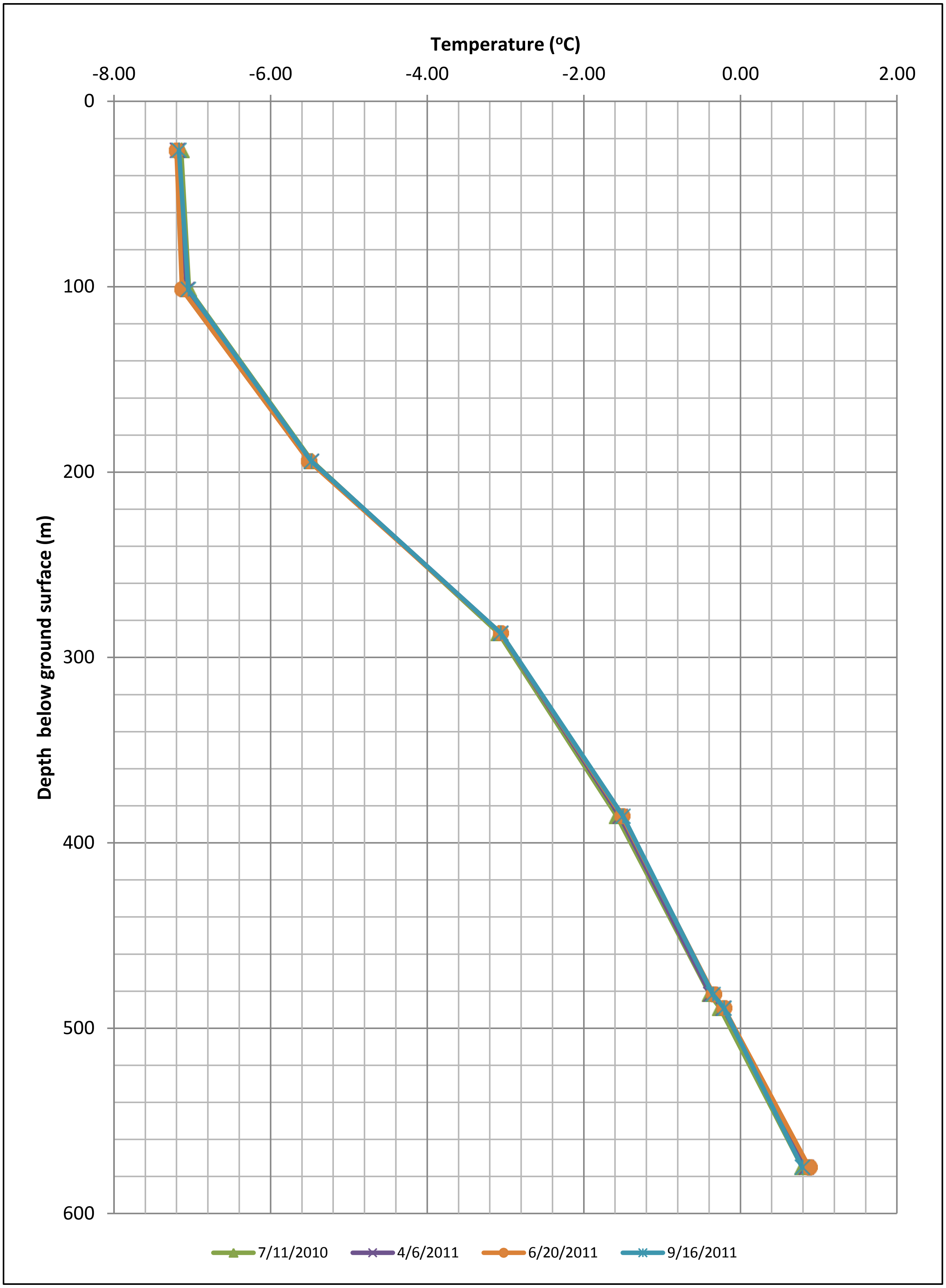
\\VAN-SVR0\Projects\01_SITES\Hope.Bay\!Project_Data (Not Job Specific)\01 Thermistor Data\!Master thermistor database\HopeBayMasterThermistorData.Last Modified 20110203_ja_rev05.accdb

Figure 3: Thermistor data for 10TDD632.



\\VAN-SVR0\Projects\01_SITES\Hope.Bay\!Project_Data (Not Job Specific)\03 Westbay Pressure Temp Profiles\10WBW001_All_Pressure_Profiles_20110911.xls

Figure 4: Thermal data for Westbay Well 10WBW001.



\\VAN-SVR0\Projects\01_SITES\Hope.Bay\!Project_Data (Not Job Specific)\03 Westbay Pressure Temp Profiles\10WBW002_All_Pressure_Profiles_20110916.xls

Figure 5: Thermal data for Westbay Well 10WBW002.

Appendix D - 2011 Packer Test Data

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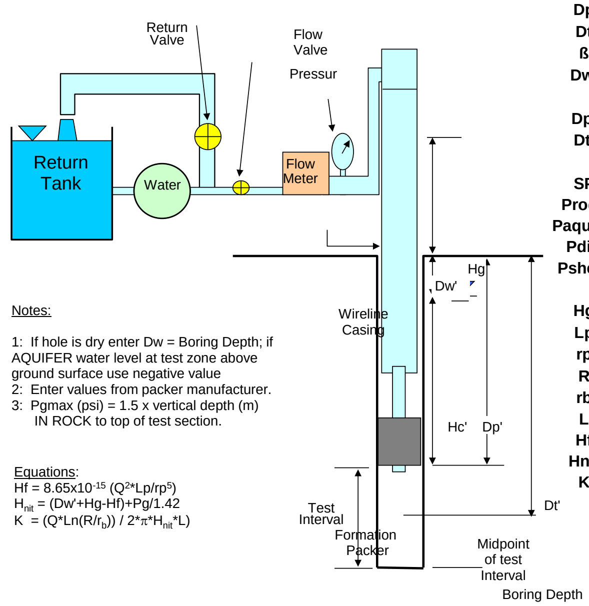
PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay 2011**	**Test Interval (m):**	52.3	to	207.0	**Drillhole Nº**	11TDD763
UTM (x,y)	**558177.792, 33614.742**	**Start Date:**	11-Mar-11	**Time:**	12:30 PM	**Deposit**	Doris
Datum:	**NAD83, zone 13**	**End Date:**	11-Mar-11	**Time:**	2:40 PM	**Test Nº**	1
GS Elevation:	**5021.623**	**Supervisor:**	R Bowden			**DH Depth (m)**	207.0

Max Injection P (psi): 66

Depth to wedge: 0 m



Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	19.9	m
Dp	Measured depth to packer	52.3	m
Dt	Measured depth to midpoint of test	129.7	m
ß	Inclination from horizontal (degrees)	57	º
Dw'	Vertical depth to static water level	0.1	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	43.9	m
Dt'	Vertical depth to midpoint of test	108.7	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	62	psi
Paquifer	Water column pressure in aquifer (unc.)	62	psi
Pdiff	Existing differential shear pressure	0	psi
Pshear	Shear pressure required at pump	500	psi
Hg	Gauge height	1.5	m
Lp	Length of discharge pipe	1.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.038	m
L	Length of test section	154.7	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

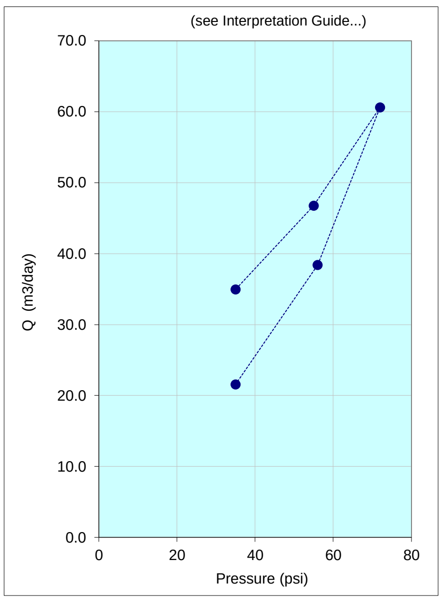
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65 \times 10^{-15} (Q^2 * Lp/rp^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q * Ln(R/r_b)) / 2 * \pi * H_{nit} * L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁵ cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	35	56	72	55	35
1	15.20	26.80	42.00	33.50	24.50
2	15.70	27.70	42.50	33.50	24.10
3	14.30	25.60	42.00	31.00	
4					
5					
Stable Q **(L/min)**	15.00	26.70	42.15	32.50	24.30
Leak Q (L/min)	0.03	0.04	0.07	0.04	0.03
Q (m³/day)	21.6	38.4	60.6	46.7	34.9
Hf (m)	0.01	0.04	0.10	0.06	0.03
Hnit (m)	26.2	41.0	52.2	40.3	26.2
K (m/day)	4.7E-03	5.4E-03	6.7E-03	6.7E-03	7.6E-03
K (m/s)	**5.5E-08**	**6.2E-08**	**7.7E-08**	**7.7E-08**	**8.9E-08**
+/- (m/s)	1.9E-08	9.4E-09	3.1E-09	-5.5E-09	-1.5E-08
+/- order of mag.	0.13	0.06	0.02	-0.03	-0.08



Field Observations

zone geology: basalt to 207m, small qz veins at 172m and 176m
zone fracture freq & quality (from core): text
packer seal quality: excellent
flow meter system problems: none. Gauges were kept warm
measurement accuracy: as noted below
other problems that may affect results: none

Test Interpretation

K values: 5.5 E-08 to 8.9E-08**m/s**

Increasing hydraulic conductivity as test progressed

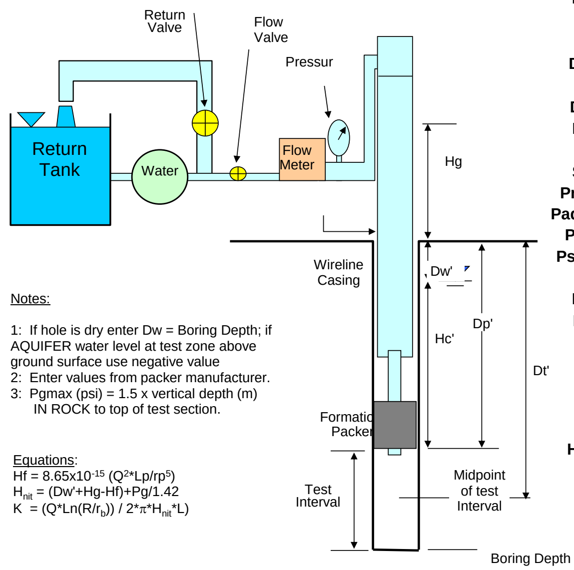
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay 2011**	**Test Interval (m):**	41.4	**to**	131.1	**Drillhole Nº**	11TDD764
UTM (x,y)	**557805, 33652**	**Start Date:**	14-Mar-11	**Time:**	12:00 PM	**Deposit**	Doris Und Con
Datum:	**Nad83, zone 13**	**End Date:**	14-Mar-11	**Time:**	1:35 PM	**Test Nº**	1
GS Elevation:	**5021.768**	**Supervisor:**	R Bowden			**DH Depth (m)**	131.1

Max Injection P (psi) 53

Depth to wedge 0 m



Notes:

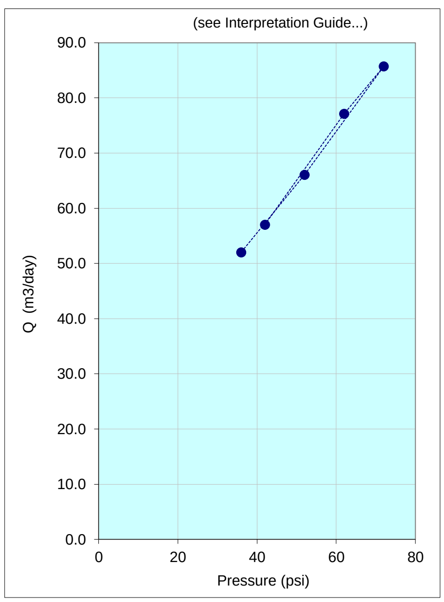
1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65x10^{-15} (Q^2 \cdot Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q \cdot Ln(R/r_b)) / 2 \cdot \pi \cdot H_{nit} \cdot L)$

Symbol	Description	Value	Unit
Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	10.0	m
Dp	Measured depth to packer	**41.4**	m
Dt	Measured depth to midpoint of test	**86.3**	m
ß	Inclination from horizontal (degrees)	59	º
Dw'	Vertical depth to static water level	**0.1**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**35.5**	m
Dt'	Vertical depth to midpoint of test	**73.9**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**50**	psi
Paquifer	Water column pressure in aquifer (unc.)	**50**	psi
Pdiff	Existing differential shear pressure	**0**	psi
Pshear	Shear pressure required at pump	**500**	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	1.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.038	m
L	Length of test section	**89.7**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁵ cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	42	62	72	52	36
1	40.00	54.00	59.00	46.00	36.00
2	39.00	54.00	60.00	46.00	35.80
3	40.00	53.00	60.00		36.40
4					
5					
Stable Q **(L/min)**	39.70	53.70	59.70	46.00	36.20
Leak Q (L/min)	0.10	0.15	0.18	0.12	0.08
Q (m^3/day)	57.0	77.1	85.7	66.1	52.0
Hf (m)	0.09	0.16	0.19	0.11	0.07
Hnit (m)	30.6	44.6	51.6	37.6	26.4
K (m/day)	1.8E-02	1.7E-02	1.6E-02	1.7E-02	2.0E-02
K (m/s)	**2.1E-07**	**2.0E-07**	**1.9E-07**	**2.0E-07**	**2.3E-07**
+/- (m/s)	2.1E-08	1.2E-08	8.6E-09	8.4E-09	8.4E-09
+/- order of mag.	0.04	0.02	0.02	0.02	0.02



Field Observations

zone geology: Mafic volcanic pillow. Foliated. With Gabbro intrusion (95-114m), occasional mafic dyke
zone fracture freq & quality (from core): unavailable
packer seal quality: excellent
flow meter system problems: none
measurement accuracy: as shown
other problems that may affect results: none

Test Interpretation

K values: 2E-07 m/s

"type curve" interpretation: ideal

PACKER INJECTION TEST *(modified from HCI)*

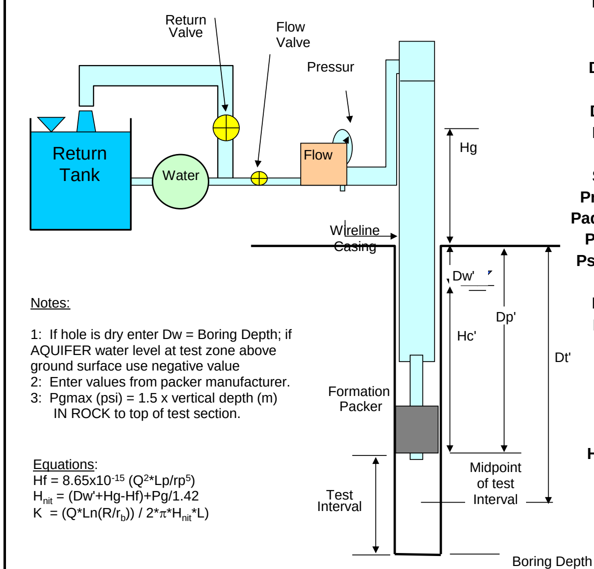
srk consulting

Project:	**Hope Bay 2011**	**Test Interval (m):**	**264.3**	**to**	**341.1**	**Drillhole Nº**	11TDD764
UTM (x,y)	**557805, 33652**	**Start Date:**	**19-Mar-11**	**Time:**	**2:30 PM**	**Deposit**	Doris Und Con
Datum:	**Nad83, zone 13**	**End Date:**	**19-Mar-11**	**Time:**	**6:00 PM**	**Test Nº**	**2**
GS Elevation:	**5021.768**	**Supervisor:**	**R Bowden**			**DH Depth (m)**	**341.1**

Max Injection P (psi) **317**

Depth to wedge 0 m

Symbol	Description	Value	Unit
Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	10.0	m
Dp	Measured depth to packer	**264.3**	m
Dt	Measured depth to midpoint of test	**302.7**	m
ß	Inclination from horizontal (degrees)	53	º
Dw'	Vertical depth to static water level	**0.1**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**211.1**	m
Dt'	Vertical depth to midpoint of test	**241.7**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**300**	psi
Paquifer	Water column pressure in aquifer (unc.)	**300**	psi
Pdiff	Existing differential shear pressure	**0**	psi
Pshear	Shear pressure required at pump	**500**	psi
Hg	Gauge height	1.5	m
Lp	Length of discharge pipe	1.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.038	m
L	Length of test section	**76.8**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		



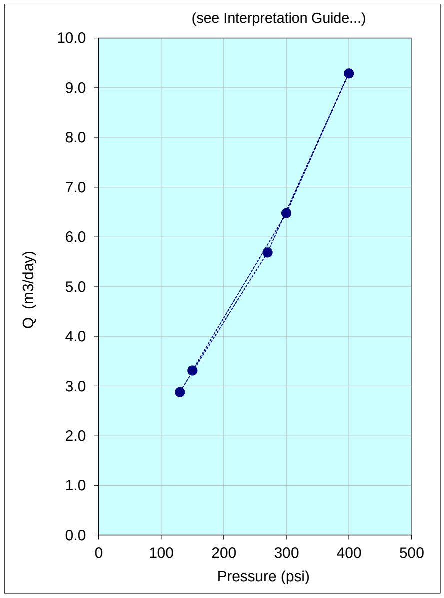
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65x10^{-15} (Q^2*Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q*Ln(R/r_b)) / 2*\pi*H_{nit}*L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^5 cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	150	**300**	**400**	**270**	**130**
1	**2.30**	**4.40**	**6.00**	**3.50**	**1.90**
2		**4.40**	**6.40**	**3.95**	**2.05**
3		**4.60**	**6.50**	**3.95**	**2.05**
4					
5					
Stable Q **(L/min)**	**2.30**	**4.50**	**6.45**	**3.95**	**2.00**
Leak Q (L/min)					
Q (m³/day)	3.3	6.5	9.3	5.7	2.9
Hf (m)	0.00	0.00	0.00	0.00	0.00
Hnit (m)	107.2	212.8	283.3	191.7	93.1
K (m/day)	3.6E-04	3.5E-04	3.8E-04	3.4E-04	3.6E-04
K (m/s)	**4.1E-09**	**4.1E-09**	**4.4E-09**	**4.0E-09**	**4.1E-09**
+/- (m/s)	9.4E-10	6.7E-10	8.0E-10	7.8E-10	9.4E-10
+/- order of mag.	0.09	0.07	0.07	0.08	0.09



Field Observations

zone geology: interval encompassed altered Mafic pillow flow basalt, ore zone, east and west limbs, unaltered deep basalt
zone fracture freq & quality (from core): approx 5 FFM, mostly foliation breaks, very few joints
packer seal quality: excellent on 4th attempt
flow meter system problems: none
measurement accuracy: high
other problems that may affect results: water flowed from the casing during injection testing, proportional to pressure. Flow estimates = 1-2 l/min (Steps 1, 5), 3-4 l/min (Steps 2,4) and 5-6 l/min (Step 3). K values above conservatively assume that all flows from the casing were injected into the

Test Interpretation

K values: 4.2E-9 m/s (conservative estimate. See notes regarding casing flow in Field Observations and Comments

"type curve" interpretation: ideal

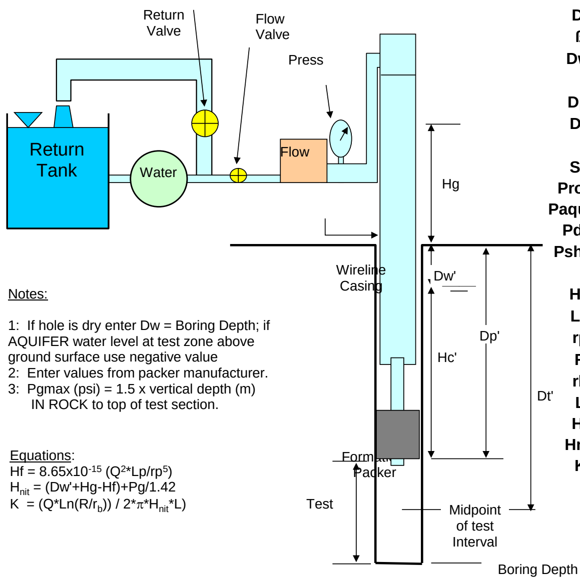
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	**310.3**	**to**	**322.0**	**Drillhole Nº**	**10TDD765**
UTM (x,y)	**34146, 559744**	**Start Date:**	**23-Mar-11**	**Time:**	**16:30**	**Deposit**	**Doris, Near Mine**
Datum:	**NAD83, Zone 13**	**End Date:**	**23-Mar-11**	**Time:**	**18:30**	**Test Nº**	**1**
GS Elevation:	**24**	**Supervisor:**	**JA**			**DH Depth (m)**	**322.0**

Max Injection P (psi) 329

Depth to wedge 0 m



Notes:

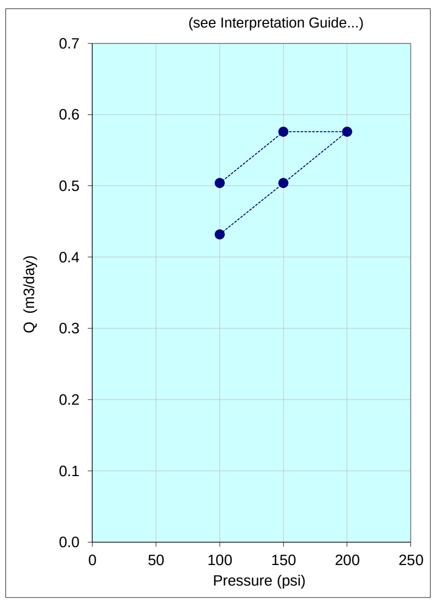
1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65 \times 10^{-15} (Q^2 * Lp/rp^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q * Ln(R/r_b)) / 2 * \pi * H_{nit} * L)$

Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	12.0	m
Dp	Measured depth to packer	**310.3**	m
Dt	Measured depth to midpoint of test	**316.2**	m
ß	Inclination from horizontal (degrees)	45	º
Dw'	Vertical depth to static water level	**0.7**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**219.4**	m
Dt'	Vertical depth to midpoint of test	**223.6**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**312**	psi
Paquifer	Water column pressure in aquifer (unc.)	**311**	psi
Pdiff	Existing differential shear pressure	**1**	psi
Pshear	Shear pressure required at pump	**499**	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.038	m
L	Length of test section	**11.7**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁵ cm/sec

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	100	**150**	**200**	**150**	**100**
1	**0.15**	**0.15**	**0.25**	**0.20**	**0.15**
2	**0.10**	**0.20**	**0.20**	**0.15**	**0.10**
3	**0.15**	**0.15**	**0.35**	**0.20**	**0.05**
4			**0.20**	**0.20**	**0.20**
5					**0.20**
Stable Q **(L/min)**	**0.30**	**0.35**	**0.40**	**0.40**	**0.35**
Leak Q (L/min)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Q (m^3/day)	0.4	0.5	0.6	0.6	0.5
Hf (m)	0.00	0.00	0.00	0.00	0.00
Hnit (m)	73.1	108.3	143.6	108.3	73.1
K (m/day)	4.5E-04	3.5E-04	3.0E-04	4.0E-04	5.2E-04
K (m/s)	**5.2E-09**	**4.1E-09**	**3.5E-09**	**4.7E-09**	**6.0E-09**
+/- (m/s)	2.0E-09	1.2E-09	6.4E-10	6.4E-10	1.1E-09
+/- order of mag.	0.14	0.11	0.07	0.06	0.07



Field Observations

zone geology: contact between diabase and altered, vuggy, basalt at 318m
zone fracture freq & quality (from core): diabase - 2FF/m
packer seal quality: good
flow meter system problems: none
measurement accuracy: 0.05L
other problems that may affect results: none

Test Interpretation

K values: 4E-9 m/s

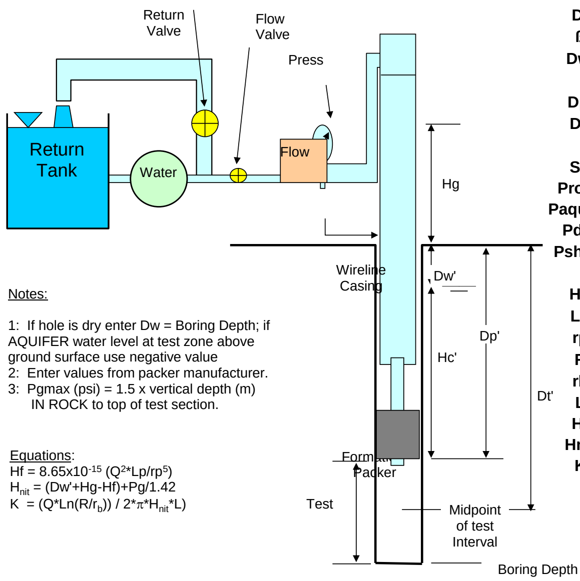
"type curve" interpretation: type c - clogging features

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	**398.1**	**to**	**437.2**	**Drillhole Nº**	**10TDD765**
UTM (x,y)	**34146, 559744**	**Start Date:**	**26-Mar-11**	**Time:**	**15:30**	**Deposit**	**Doris, Near Mine**
Datum:	**NAD83, Zone 13**	**End Date:**	**26-Mar-11**	**Time:**	**17:00**	**Test Nº**	**2**
GS Elevation:	**24**	**Supervisor:**	**JA**			**DH Depth (m)**	**437.2**

Max Injection P (psi): **415**

Depth to wedge: 0 m



Symbol	Description	Value	Unit
Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	15.0	m
Dp	Measured depth to packer	398.1	m
Dt	Measured depth to midpoint of test	417.7	m
ß	Inclination from horizontal (degrees)	44	º
Dw'	Vertical depth to static water level	0.7	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	276.5	m
Dt'	Vertical depth to midpoint of test	290.1	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	393	psi
Paquifer	Water column pressure in aquifer (unc.)	392	psi
Pdiff	Existing differential shear pressure	1	psi
Pshear	Shear pressure required at pump	499	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	1.50	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.038	m
L	Length of test section	39.1	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

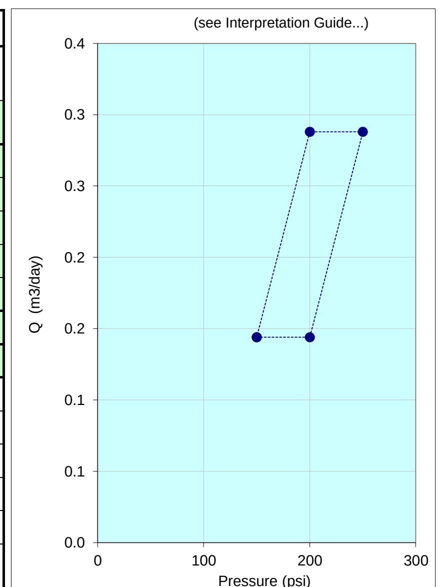
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65\times10^{-15}\,(Q^2 \cdot L_p/r_p^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q \cdot \ln(R/r_b)) / 2 \cdot \pi \cdot H_{nit} \cdot L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm^2 = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^5 cm/sec

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	150	200	250	200	150
1	0.10	0.05	0.10	0.10	0.15
2	0.05	0.05	0.20	0.10	0.05
3					
4					
5					
Stable Q **(L/min)**	0.10	0.10	0.20	0.20	0.10
Leak Q (L/min)	0.00	0.00	0.00	0.00	0.00
Q (m^3/day)	0.1	0.1	0.3	0.3	0.1
Hf (m)	0.00	0.00	0.00	0.00	0.00
Hnit (m)	108.3	143.5	178.8	143.5	108.3
K (m/day)	3.0E-05	2.3E-05	3.7E-05	4.6E-05	3.0E-05
K (m/s)	**3.5E-10**	**2.6E-10**	**4.2E-10**	**5.3E-10**	**3.5E-10**
+/- (m/s)	2.1E-10	3.1E-10	1.5E-10	4.2E-11	2.1E-10
+/- order of mag.	0.21	0.33	0.13	0.03	0.21



Field Observations

zone geology: mafic volanic pillow basalt
zone fracture freq & quality (from core): 0-2 FF/m
packer seal quality: none
flow meter system problems: none
measurement accuracy: 0.05L
other problems that may affect results: in permafrost - no flow

Test Interpretation

K values: 4E-10 m/s

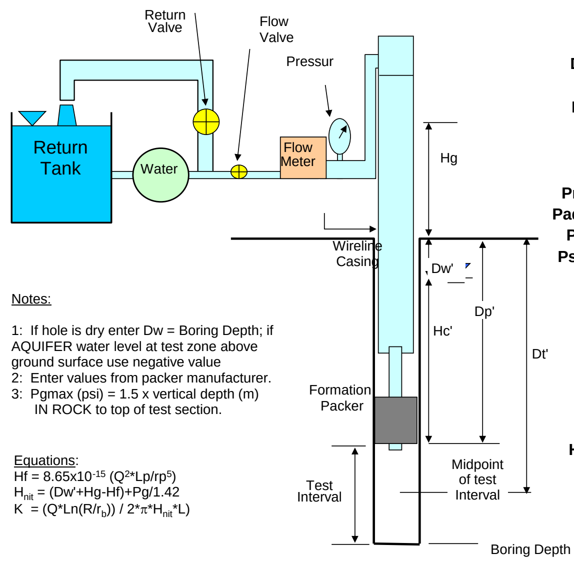
"type curve" interpretation: type c - clog

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	28.8	to	51.2	**Drillhole Nº**	11TDD766
UTM (x,y)	**33901, 558910**	**Start Date:**	22-Mar-11	**Time:**	14:00	**Deposit**	Doris Central
Datum:	**UTM**	**End Date:**	22-Mar-11	**Time:**	16:00	**Test Nº**	1
GS Elevation:	**22**	**Supervisor:**	JA			**DH Depth (m)**	51.2

Max Injection P (psi): 37

Depth to wedge: 0 m



Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	16.7	m
Dp	Measured depth to packer	28.8	m
Dt	Measured depth to midpoint of test	40.0	m
ß	Inclination from horizontal (degrees)	60	º
Dw'	Vertical depth to static water level	0.9	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	24.9	m
Dt'	Vertical depth to midpoint of test	34.6	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	35	psi
Paquifer	Water column pressure in aquifer (unc.)	34	psi
Pdiff	Existing differential shear pressure	1	psi
Pshear	Shear pressure required at pump	499	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	22.4	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

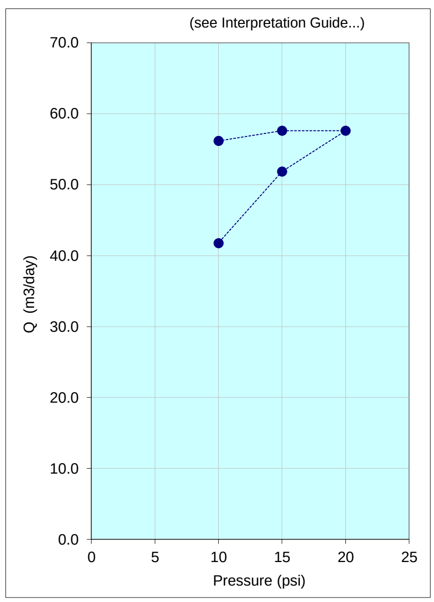
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65\times10^{-15}\,(Q^2 \cdot L_p/r_p^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q \cdot \ln(R/r_b)) / 2\cdot\pi\cdot H_{nit} \cdot L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^{-5} cm/sec

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	10	15	20	15	10
1	20.50	22.00	24.00	20.00	16.00
2	20.50	22.00	22.50	20.00	15.50
3	21.00		22.00	20.00	15.00
4					
5					
Stable Q **(L/min)**	41.00	44.00	45.00	40.00	31.00
Leak Q (L/min)	2.00	4.00	5.00	4.00	2.00
Q (m³/day)	56.2	57.6	57.6	51.8	41.8
Hf (m)	0.17	0.17	0.17	0.14	0.09
Hnit (m)	9.7	13.3	16.8	13.3	9.8
K (m/day)	2.2E-01	1.6E-01	1.3E-01	1.5E-01	1.6E-01
K (m/s)	**2.5E-06**	**1.9E-06**	**1.5E-06**	**1.7E-06**	**1.9E-06**
+/- (m/s)	7.8E-08	1.4E-07	1.6E-07	3.4E-07	7.4E-07
+/- order of mag.	0.01	0.03	0.04	0.08	0.15



Field Observations

zone geology: Mafic volcanic flow w felsic dyke (28-34m)
zone fracture freq & quality (from core): 2-12 FF/m, 3 FF/m typical; broken CJ and moderate mechanical breaks
packer seal quality: good
flow meter system problems: good
measurement accuracy: 0.5L/min; fast flow
other problems that may affect results: after the pin was blown, water started leaking out of the casing, approx 2-5L/min proportional to pressure. Not sure where this water is coming from, but it acts as though the packer is being bypassed. Connected fractures?

Test Interpretation

K values: 2E-6 m/s

"type curve" interpretation: clogging features, but at low pressure, the slight changes in pressure may have more weight on the result

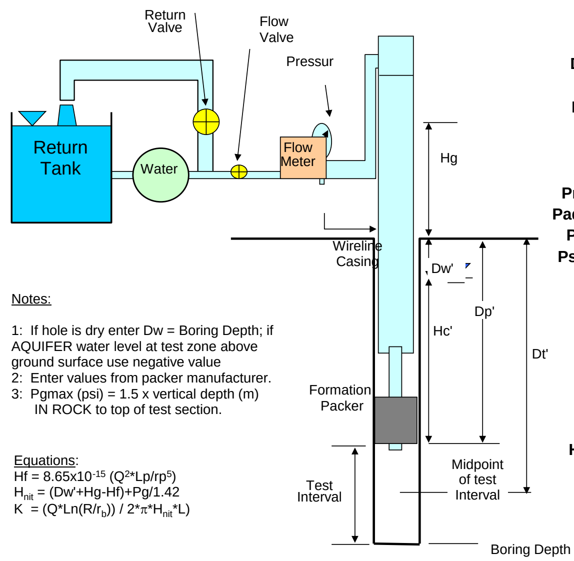
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	**101.8**	**to**	**130.5**	**Drillhole Nº**	**11TDD766**
UTM (x,y)	**33901, 558910**	**Start Date:**	**23-Mar-11**	**Time:**	**14:45**	**Deposit**	**Doris Central**
Datum:	**UTM**	**End Date:**	**23-Mar-11**	**Time:**	**16:00**	**Test Nº**	**2**
GS Elevation:	**22**	**Supervisor:**	**JA**			**DH Depth (m)**	**130.5**

Max Injection P (psi)
132

Depth to wedge
0 m



Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	16.7	m
Dp	Measured depth to packer	**101.8**	m
Dt	Measured depth to midpoint of test	**116.1**	m
ß	Inclination from horizontal (degrees)	60	º
Dw'	Vertical depth to static water level	**0.9**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**88.1**	m
Dt'	Vertical depth to midpoint of test	**100.5**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**125**	psi
Paquifer	Water column pressure in aquifer (unc.)	**124**	psi
Pdiff	Existing differential shear pressure	**1**	psi
Pshear	Shear pressure required at pump	**499**	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	**28.7**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

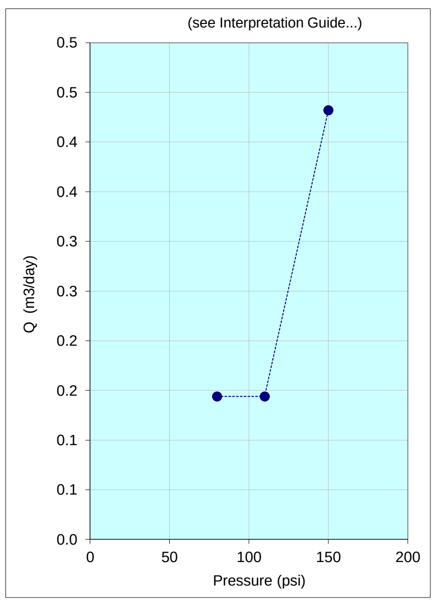
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65\times10^{-15}\,(Q^2{*}L_p/r_p^5)$
$H_{nit} = (D_w'+H_g-H_f)+P_g/1.42$
$K = (Q{*}\ln(R/r_b)) / 2{*}\pi{*}H_{nit}{*}L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm^2 = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^{-5} cm/sec

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	80	110	150	110	80
1	0.19	0.10	0.15		
2	0.05	0.10	0.17		
3	0.04				
4					
5					
Stable Q **(L/min)**	0.10	0.10	0.30	0.00	0.00
Leak Q (L/min)	0.00	0.00	0.00	0.00	0.00
Q (m^3/day)	0.1	0.1	0.4	#N/A	#N/A
Hf (m)	0.00	0.00	0.00	#N/A	#N/A
Hnit (m)	59.2	80.3	108.5	#N/A	#N/A
K (m/day)	7.2E-05	5.3E-05	1.2E-04	#N/A	#N/A
K (m/s)	**8.3E-10**	**6.1E-10**	**1.4E-09**	**#N/A**	**#N/A**
+/- (m/s)	5.0E-10	3.5E-10	3.4E-10	#N/A	#N/A
+/- order of mag.	0.20	0.20	0.10	#N/A	#N/A



Field Observations

zone geology: Mafic volcanic pillow, foliated.
zone fracture freq & quality (from core): < 1FF/m
packer seal quality: good
flow meter system problems: none
measurement accuracy: 0.05L
other problems that may affect results: Likely in permafrost, so results may not be entirely indicative of tight rock, but it's still possible

Test Interpretation

K values: 9e-10 m/s

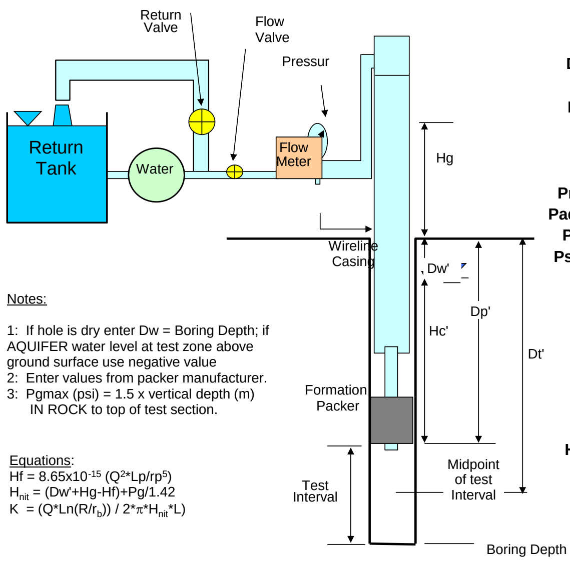
"type curve" interpretation: type c - clogging fractures

PACKER INJECTION TEST *(modified from HCI)*

Project:	Hope Bay	Test Interval (m):	198.9	to	240.3	Drillhole Nº	11TDD766
UTM (x,y)	33901, 558910	Start Date:	25-Mar-11	Time:	11:00	Deposit	Doris Central
Datum:	UTM	End Date:	25-Mar-11	Time:	13:00	Test Nº	3
GS Elevation:	22	Supervisor:	JA			DH Depth (m)	240.3

Max Injection P (psi): 258

Depth to wedge: 0 m



Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	16.7	m
Dp	Measured depth to packer	198.9	m
Dt	Measured depth to midpoint of test	219.6	m
ß	Inclination from horizontal (degrees)	60	º
Dw'	Vertical depth to static water level	0.9	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	172.2	m
Dt'	Vertical depth to midpoint of test	190.1	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	245	psi
Paquifer	Water column pressure in aquifer (unc.)	243	psi
Pdiff	Existing differential shear pressure	1	psi
Pshear	Shear pressure required at pump	499	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	41.4	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

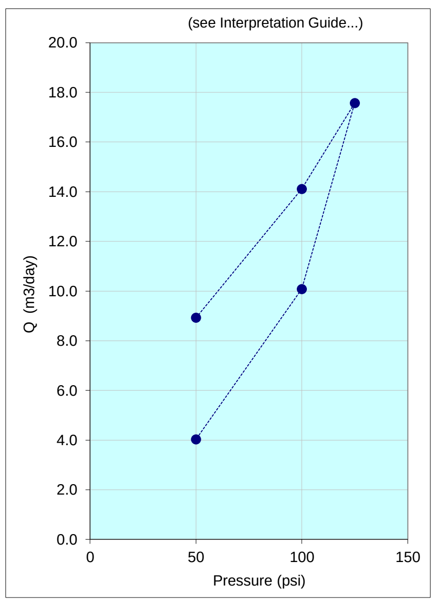
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65\times10^{-15} (Q^2 \cdot Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q \cdot Ln(R/r_b)) / 2 \cdot \pi \cdot H_{nit} \cdot L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^{-5} cm/sec

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	50	100	125	100	50
1	3.20	4.20	6.30	3.70	1.40
2	3.00	5.00	6.10	3.50	1.40
3	3.10	4.80	6.00	3.50	1.40
4	3.10	4.90			
5		4.90			
Stable Q **(L/min)**	6.20	9.80	12.20	7.00	2.80
Leak Q (L/min)	0.00	0.00	0.00	0.00	0.00
Q (m^3/day)	8.9	14.1	17.6	10.1	4.0
Hf (m)	0.00	0.01	0.02	0.01	0.00
Hnit (m)	38.1	73.3	90.9	73.3	38.1
K (m/day)	4.8E-03	4.0E-03	4.0E-03	2.8E-03	2.2E-03
K (m/s)	**5.6E-08**	**4.6E-08**	**4.6E-08**	**3.3E-08**	**2.5E-08**
+/- (m/s)	-5.0E-09	6.1E-10	8.9E-09	1.4E-08	2.6E-08
+/- order of mag.	-0.04	0.01	0.08	0.15	0.30



Field Observations

zone geology: Mafic volcanic flow, foliated basalt
zone fracture freq & quality (from core): 0-7 FF/m
packer seal quality: none
flow meter system problems: none
measurement accuracy: 0.1L
other problems that may affect results: none

Test Interpretation

K values: 4e-8 m/s

"type curve" interpretation: type c - clogging

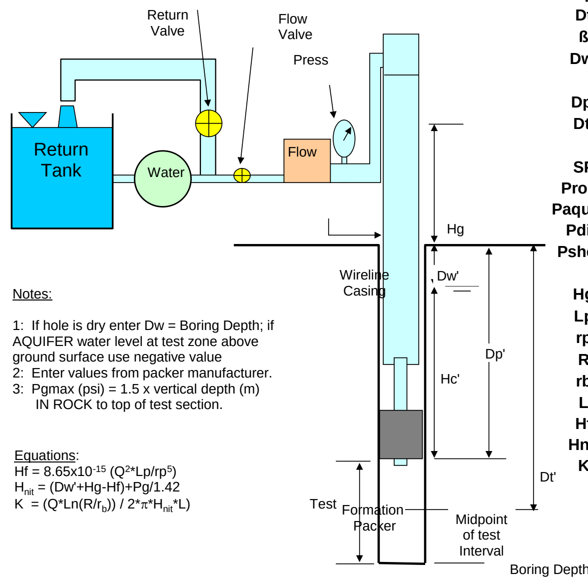
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	69.4	to	104.2	**Drillhole Nº**	11TDD768
UTM (x,y)	**33665, 558760**	**Start Date:**	30-Mar-11	**Time:**	13:15	**Deposit**	Doris Central
Datum:	**UTM**	**End Date:**	30-Mar-11	**Time:**	14:30	**Test Nº**	1
GS Elevation:	**22**	**Supervisor:**	JA			**DH Depth (m)**	104.2

Max Injection P (psi): 91

Depth to wedge: 0 m



Notes:

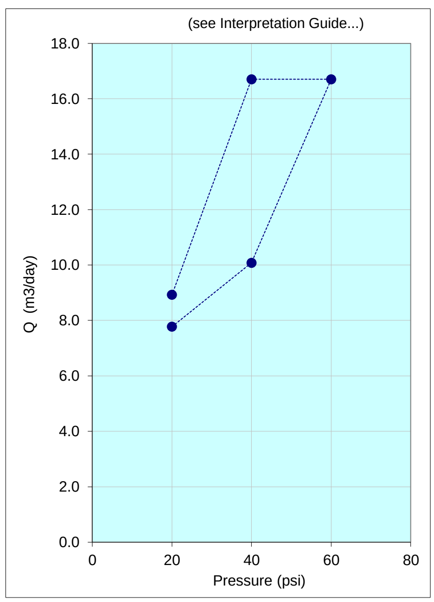
1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65x10^{-15} (Q^{2*}Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q*Ln(R/r_b)) / 2*\pi*H_{nit}*L)$

Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	24.8	m
Dp	Measured depth to packer	**69.4**	m
Dt	Measured depth to midpoint of test	**86.8**	m
ß	Inclination from horizontal (degrees)	61	º
Dw'	Vertical depth to static water level	**0.9**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**60.7**	m
Dt'	Vertical depth to midpoint of test	**75.9**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**86**	psi
Paquifer	Water column pressure in aquifer (unc.)	**85**	psi
Pdiff	Existing differential shear pressure	**1**	psi
Pshear	Shear pressure required at pump	**499**	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.038	m
L	Length of test section	**34.8**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁵ cm/sec

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	20	**40**	**60**	**40**	**20**
1	**2.80**	**3.70**	**5.80**	**6.00**	**3.30**
2	**2.90**	**3.70**	**6.10**	**6.00**	**3.30**
3	**2.90**	**3.70**	**6.00**	**6.10**	**3.50**
4	**2.90**				
5					
Stable Q **(L/min)**	**5.80**	**7.40**	**12.00**	**12.00**	**6.60**
Leak Q (L/min)	**0.40**	**0.40**	**0.40**	**0.40**	**0.40**
Q (m^3/day)	7.8	10.1	16.7	16.7	8.9
Hf (m)	0.00	0.01	0.01	0.01	0.00
Hnit (m)	17.0	31.0	45.1	31.0	17.0
K (m/day)	1.2E-02	8.3E-03	9.4E-03	1.4E-02	1.3E-02
K (m/s)	**1.4E-07**	**9.6E-08**	**1.1E-07**	**1.6E-07**	**1.6E-07**
+/- (m/s)	1.2E-07	2.4E-07	1.8E-07	1.8E-07	9.7E-08
+/- order of mag.	0.27	0.55	0.43	0.33	0.21



Field Observations

zone geology: Mafic volcanic pillow foliated basalt w volcanic flow feldspar (82-86m)
zone fracture freq & quality (from core): < 1 FF/m
packer seal quality: good - no water movement in rods
flow meter system problems: leak measurement - overestimated - it was 0.4L/min at 200 psi
measurement accuracy: 0.1L
other problems that may affect results: significant fluctuation for pressure readings

Test Interpretation

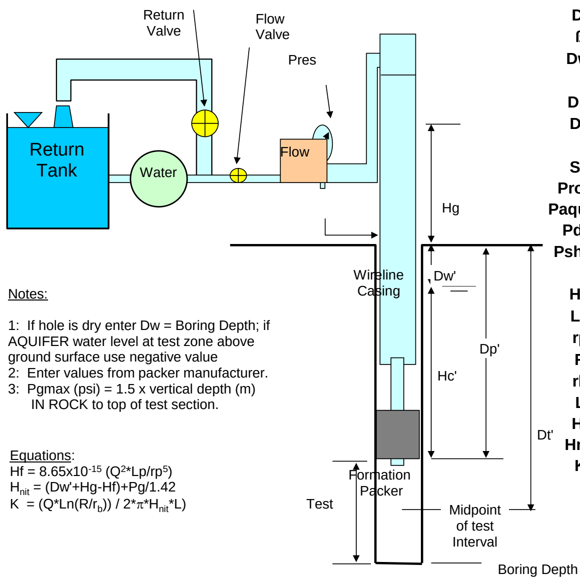
K values: 1E-7 m/s

"type curve" interpretation: type c - but more like type a (ideal) as the pressure fluctuated significantly and the flow was responsive to pressure changes

srk consulting	PACKER INJECTION TEST *(modified from HCI)*					
Project: Hope Bay	**Test Interval (m):**	111.4	to	152.2	**Drillhole Nº**	11TDD768
UTM (x,y) 33665, 558760	**Start Date:**	31-Mar-11	**Time:**	9:15	**Deposit**	Doris Central
Datum: UTM	**End Date:**	31-Mar-11	**Time:**	10:45	**Test Nº**	2
GS Elevation: 22	**Supervisor:**	JA			**DH Depth (m)**	152.2

Max Injection P (psi) 146

Depth to wedge 0 m



Notes:

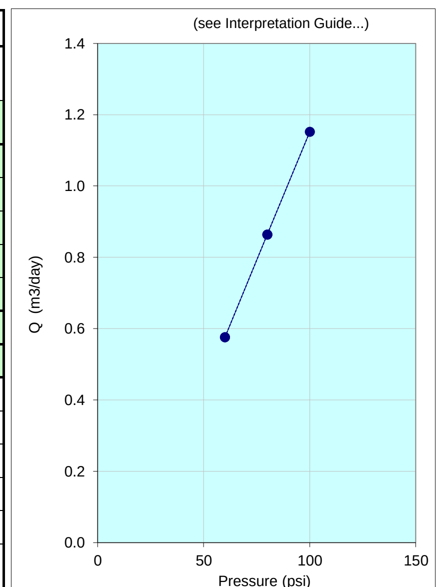
1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65 \times 10^{-15} (Q^2 * Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q*Ln(R/r_b)) / 2*\pi*H_{nit}*L)$

Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	24.8	m
Dp	Measured depth to packer	111.4	m
Dt	Measured depth to midpoint of test	131.8	m
ß	Inclination from horizontal (degrees)	61	º
Dw'	Vertical depth to static water level	0.9	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	97.4	m
Dt'	Vertical depth to midpoint of test	115.3	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	138	psi
Paquifer	Water column pressure in aquifer (unc.)	137	psi
Pdiff	Existing differential shear pressure	1	psi
Pshear	Shear pressure required at pump	499	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	40.8	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁵ cm/sec

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	60	80	100	80	60
1	0.20	0.30	0.40	0.30	0.20
2	0.20	0.30	0.40	0.30	0.20
3	0.20	0.30	0.40	0.20	0.20
4				0.30	
5					
Stable Q **(L/min)**	0.40	0.60	0.80	0.60	0.40
Leak Q (L/min)	0.00	0.00	0.00	0.00	0.00
Q (m^3/day)	0.6	0.9	1.2	0.9	0.6
Hf (m)	0.00	0.00	0.00	0.00	0.00
Hnit (m)	45.1	59.2	73.3	59.2	45.1
K (m/day)	2.7E-04	3.0E-04	3.3E-04	3.0E-04	2.7E-04
K (m/s)	**3.1E-09**	**3.5E-09**	**3.8E-09**	**3.5E-09**	**3.1E-09**
+/- (m/s)	2.5E-09	1.9E-09	3.1E-09	1.9E-09	2.5E-09
+/- order of mag.	0.26	0.18	0.26	0.18	0.26



Field Observations

zone geology: Mafic volcanic pillow (foliated basalt) w ore zone (122-131m) and 2 major structures (shear/broken zones)
zone fracture freq & quality (from core): < 1 FF/m, broken/shear zones at 120.78-120.99m and 121.38-121.53m
packer seal quality: good
flow meter system problems: none
measurement accuracy: 0.1L
other problems that may affect results: none

Test Interpretation

K values: 3E-9 m/s

"type curve" interpretation: type a

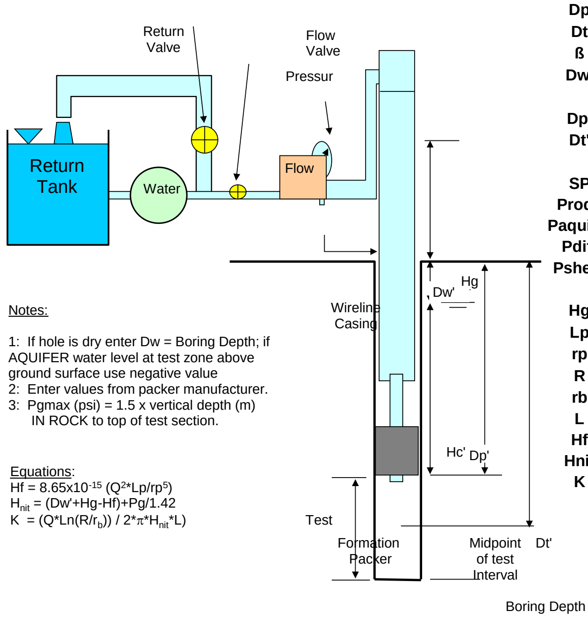
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	225.4	to	269.2	**Drillhole Nº**	11TDD768
UTM (x,y)	**33665, 558760**	**Start Date:**	3-Apr-11	**Time:**	11:30 AM	**Deposit**	Doris Central
Datum:	**UTM**	**End Date:**	3-Apr-11	**Time:**	12:45 PM	**Test Nº**	4
GS Elevation:	**22**	**Supervisor:**	R Bowden			**DH Depth (m)**	269.2

Max Injection P (psi) 284

Depth to wedge 0 m



Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	24.8	m
Dp	Measured depth to packer	225.4	m
Dt	Measured depth to midpoint of test	247.3	m
ß	Inclination from horizontal (degrees)	57	º
Dw'	Vertical depth to static water level	0.1	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	189.0	m
Dt'	Vertical depth to midpoint of test	207.4	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	268	psi
Paquifer	Water column pressure in aquifer (unc.)	269	psi
Pdiff	Existing differential shear pressure	0	psi
Pshear	Shear pressure required at pump	500	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	1.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.038	m
L	Length of test section	43.8	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

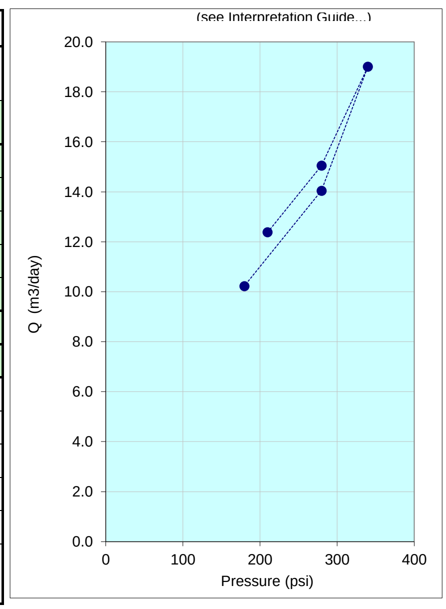
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65\times10^{-15}\ (Q^2 \cdot Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q \cdot \ln(R/r_b)) / 2\pi H_{nit} L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm^2 = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^{-5} cm/sec
1 US gpm = 3.785 lit/min = 5.45 m^3/day

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	210	280	340	280	180
1	7.40	11.40	14.20	10.70	7.15
2	9.00	11.30	14.20	10.60	7.05
3	9.70		14.60		
4					
5					
Stable Q **(L/min)**	9.30	11.35	14.40	10.65	7.10
Leak Q (L/min)	0.70	0.90	1.20	0.90	
Q (m^3/day)	12.4	15.0	19.0	14.0	10.2
Hf (m)	0.00	0.01	0.01	0.01	0.00
Hnit (m)	149.0	198.3	240.5	198.3	127.8
K (m/day)	1.7E-03	1.5E-03	1.6E-03	1.4E-03	1.6E-03
K (m/s)	**1.9E-08**	**1.8E-08**	**1.9E-08**	**1.7E-08**	**1.9E-08**
+/- (m/s)	3.1E-09	1.7E-09	3.3E-09	2.9E-09	3.8E-09
+/- order of mag.	0.06	0.04	0.07	0.07	0.08



Field Observations

zone geology: Mafic volcanic pillow (foliated basalt) w ore zone (231-247m)
zone fracture freq & quality (from core): 0-3, FF/m, typ < 1 FF/m
packer seal quality: excellent
flow meter system problems: none
measurement accuracy: see below
other problems that may affect results: none

Test Interpretation

K values: 1.8E-08 m/s

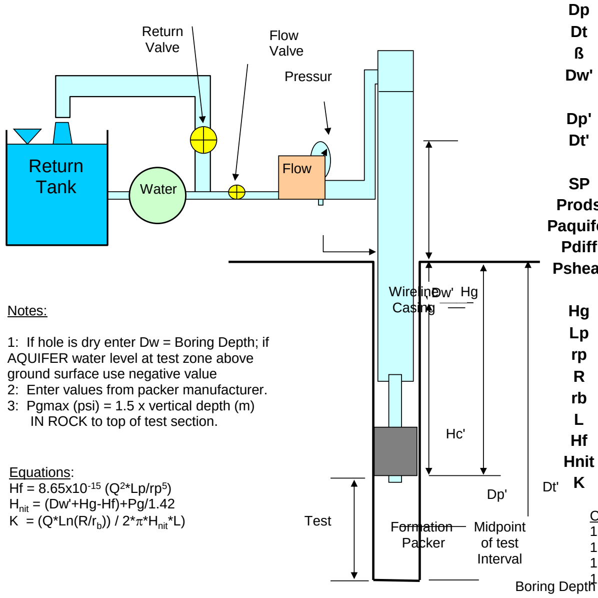
"type curve" interpretation: ideal

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	**234.4**	**to**	**269.2**	**Drillhole Nº**	**11TDD768**
UTM (x,y)	**33665, 558760**	**Start Date:**	**3-Apr-11**	**Time:**	**1:10 PM**	**Deposit**	**Doris Central**
Datum:	**UTM**	**End Date:**	**3-Apr-11**	**Time:**	**2:30 PM**	**Test Nº**	**5**
GS Elevation:	**22**	**Supervisor:**	**R Bowden**			**DH Depth (m)**	**269.2**

Max Injection P (psi): **295**

Depth to wedge: 0 m



Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	24.8	m
Dp	Measured depth to packer	**234.4**	m
Dt	Measured depth to midpoint of test	**251.8**	m
ß	Inclination from horizontal (degrees)	57	º
Dw'	Vertical depth to static water level	**0.8**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**196.6**	m
Dt'	Vertical depth to midpoint of test	**211.2**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**279**	psi
Paquifer	Water column pressure in aquifer (unc.)	**278**	psi
Pdiff	Existing differential shear pressure	**1**	psi
Pshear	Shear pressure required at pump	**499**	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	1.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.038	m
L	Length of test section	**34.8**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

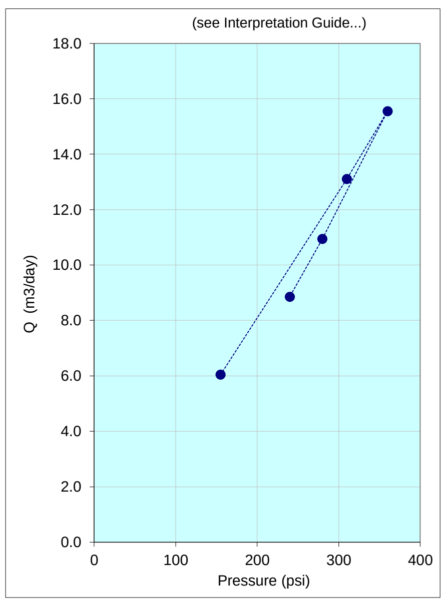
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65\times10^{-15} (Q^2 * Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q*Ln(R/r_b)) / 2*\pi*H_{nit}*L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^{5} cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	155	**310**	**360**	**280**	**240**
1	**4.40**	**9.10**	**11.40**	**8.45**	**6.20**
2	**3.50**	**8.80**	**11.00**	**7.95**	**6.00**
3	**4.60**	**7.70**	**10.75**	**7.30**	**6.30**
4	**4.20**	**10.40**		**7.40**	
5	**4.10**	**9.20**			
Stable Q **(L/min)**	**4.20**	**9.10**	**10.80**	**7.60**	**6.15**
Leak Q (L/min)					
Q (m³/day)	6.0	13.1	15.6	10.9	8.9
Hf (m)	0.00	0.00	0.01	0.00	0.00
Hnit (m)	111.0	220.1	255.4	199.0	170.9
K (m/day)	1.4E-03	1.5E-03	1.6E-03	1.4E-03	1.3E-03
K (m/s)	**1.6E-08**	**1.8E-08**	**1.8E-08**	**1.6E-08**	**1.5E-08**
+/- (m/s)	8.7E-10	5.0E-10	1.2E-09	1.8E-09	1.7E-09
+/- order of mag.	0.02	0.01	0.03	0.05	0.04



Field Observations

zone geology: Mafic volcanic pillow (foliated basalt) w ore zone (231-247m)
zone fracture freq & quality (from core): 0-1, FF/m, typ 0 FF/m
packer seal quality: excellent
flow meter system problems: none
measurement accuracy: see below
other problems that may affect results: none

Test Interpretation

K values: 1.7E-08 m/s

"type curve" interpretation: classic

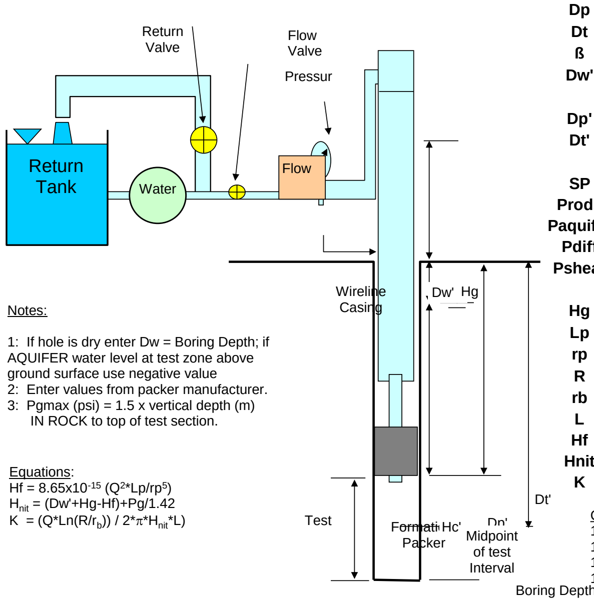
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	**267.4**	**to**	**299.2**	**Drillhole Nº**	**11TDD768**
UTM (x,y)	**33665, 558760**	**Start Date:**	**4-Apr-11**	**Time:**	**8:00 PM**	**Deposit**	**Doris Central**
Datum:	**UTM**	**End Date:**	**4-Apr-11**	**Time:**	**11:00 PM**	**Test Nº**	**6**
GS Elevation:	**22**	**Supervisor:**	**R Bowden**			**DH Depth (m)**	**299.2**

Max Injection P (psi): 336

Depth to wedge: 0 m



Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	24.8	m
Dp	Measured depth to packer	**267.4**	m
Dt	Measured depth to midpoint of test	**283.3**	m
ß	Inclination from horizontal (degrees)	57	º
Dw'	Vertical depth to static water level	**0.1**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**224.3**	m
Dt'	Vertical depth to midpoint of test	**237.6**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**318**	psi
Paquifer	Water column pressure in aquifer (unc.)	**319**	psi
Pdiff	Existing differential shear pressure	**0**	psi
Pshear	Shear pressure required at pump	**500**	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	1.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.038	m
L	Length of test section	**31.8**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

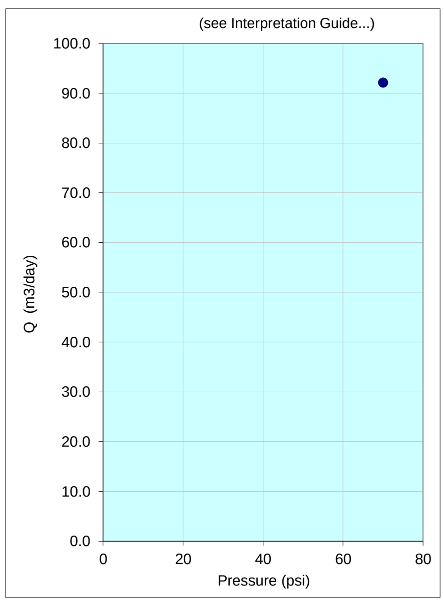
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65 \times 10^{-15} (Q^2 \cdot Lp/rp^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q \cdot Ln(R/r_b)) / 2 \cdot \pi \cdot H_{nit} \cdot L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^{-5} cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	70				
1	**60.00**				
2	**64.00**				
3	**64.00**				
4					
5					
Stable Q **(L/min)**	**64.00**				
Leak Q (L/min)					
Q (m³/day)	92.2	#N/A	#N/A	#N/A	#N/A
Hf (m)	0.22	#N/A	#N/A	#N/A	#N/A
Hnit (m)	50.2	#N/A	#N/A	#N/A	#N/A
K (m/day)	5.1E-02	#N/A	#N/A	#N/A	#N/A
K (m/s)	**5.9E-07**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
+/- (m/s)	2.2E-08	#VALUE!	#VALUE!	#VALUE!	#N/A
+/- order of mag.	0.02	#VALUE!	#VALUE!	#VALUE!	#N/A



Field Observations

zone geology: Mafic volcanic pillow (foliated basalt)
zone fracture freq & quality (from core): < 1 FF/m, typ 0 FF/m, no major structures.
packer seal quality: excellent
flow meter system problems: none. Used RST datalogger. See separate data.
measurement accuracy: see below
other problems that may affect results: none

Test Interpretation

K values: 5.9E-07 m/s

Single step test.

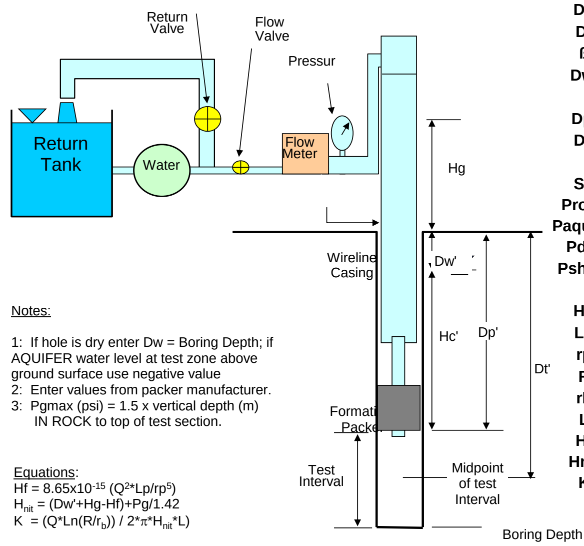
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay 2011**	**Test Interval (m):**	**30.4**	**to**	**38.2**	**Drillhole Nº**	**11TDD769**
UTM (x,y)	**557713, 33811**	**Start Date:**	**7-Apr-11**	**Time:**	**5:00 PM**	**Deposit**	**Doris Connector**
Datum:	**NAD83, zone 13**	**End Date:**	**7-Apr-11**	**Time:**	**10:30 PM**	**Test Nº**	**1**
GS Elevation:	**22**	**Supervisor:**	**R Bowden**			**DH Depth (m)**	**38.2**

Max Injection P (psi)
42

Depth to wedge
0 m



Symbol	Description	Value	Unit
Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	11.0	m
Dp	Measured depth to packer	**30.4**	m
Dt	Measured depth to midpoint of test	**34.3**	m
ß	Inclination from horizontal (degrees)	67	º
Dw'	Vertical depth to static water level	**0.1**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**28.0**	m
Dt'	Vertical depth to midpoint of test	**31.6**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**40**	psi
Paquifer	Water column pressure in aquifer (unc.)	**40**	psi
Pdiff	Existing differential shear pressure	**0**	psi
Pshear	Shear pressure required at pump	**500**	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	1.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	**7.8**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

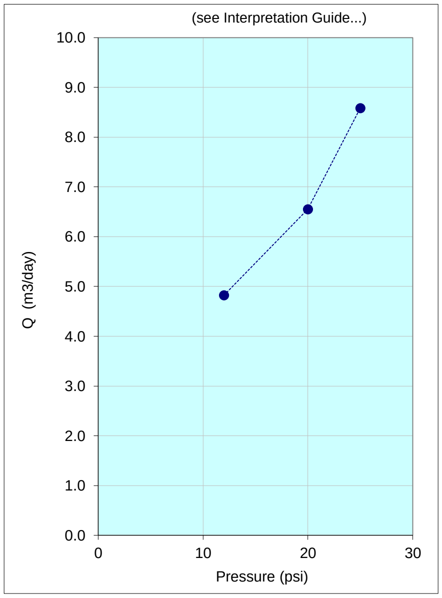
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65\times10^{-15}\ (Q^2 * L_p/r_p^5)$
$H_{nit} = (Dw'+Hg-H_f)+P_g/1.42$
$K = (Q*\ln(R/r_b)) / 2*\pi*H_{nit}*L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4×10^{-5} cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	12	20	25		
1	3.35	4.55	5.85		
2	3.35	4.45	5.85		
3	3.30	4.30	6.05		
4					
5					
Stable Q **(L/min)**	3.35	4.55	5.96		
Leak Q (L/min)					
Q (m³/day)	4.8	6.6	8.6	#N/A	#N/A
Hf (m)	0.00	0.00	0.00	#N/A	#N/A
Hnit (m)	9.5	15.2	18.7	#N/A	#N/A
K (m/day)	5.5E-02	4.7E-02	5.0E-02	#N/A	#N/A
K (m/s)	**6.4E-07**	**5.4E-07**	**5.8E-07**	**#N/A**	**#N/A**
+/- (m/s)	9.2E-08	7.7E-08	7.3E-08	#N/A	#N/A
+/- order of mag.	0.06	0.06	0.05	#N/A	#N/A



Field Observations

zone geology: basalt
zone fracture freq & quality (from core): mod FF/M. few natural joints. 20cm maj str sheared zone at 30m
packer seal quality: excellent
flow meter system problems: none
measurement accuracy: see RST data and below
other problems that may affect results: none

Test Interpretation

K values: 5.9E-07 m/s

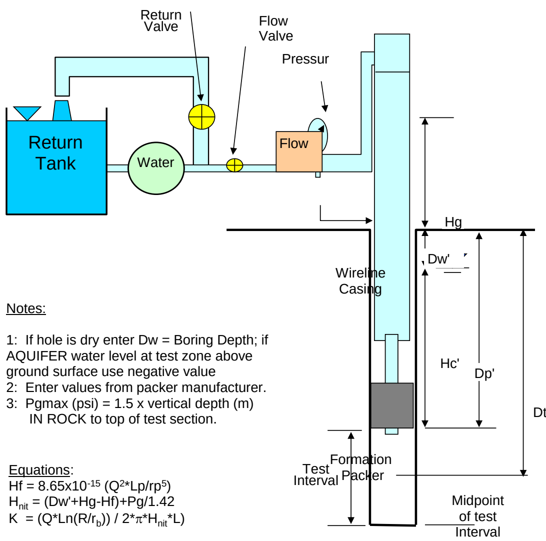
"type curve" interpretation:

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay 2011**	**Test Interval (m):**	129.4	to	143.2	**Drillhole Nº**	11TDD769
UTM (x,y)	**557713, 33811**	**Start Date:**	9-Apr-11	**Time:**	3:50 PM	**Deposit**	Doris Connector
Datum:	**NAD83, zone 13**	**End Date:**	9-Apr-11	**Time:**	6:30 PM	**Test Nº**	2
GS Elevation:	**22**	**Supervisor:**	R Bowden			**DH Depth (m)**	143.2

Max Injection P (psi) 176

Depth to wedge 0 m



Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	11.0	m
Dp	Measured depth to packer	129.4	m
Dt	Measured depth to midpoint of test	136.3	m
ß	Inclination from horizontal (degrees)	65	º
Dw'	Vertical depth to static water level	0.1	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	117.3	m
Dt'	Vertical depth to midpoint of test	123.5	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	167	psi
Paquifer	Water column pressure in aquifer (unc.)	167	psi
Pdiff	Existing differential shear pressure	0	psi
Pshear	Shear pressure required at pump	500	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	1.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	13.8	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

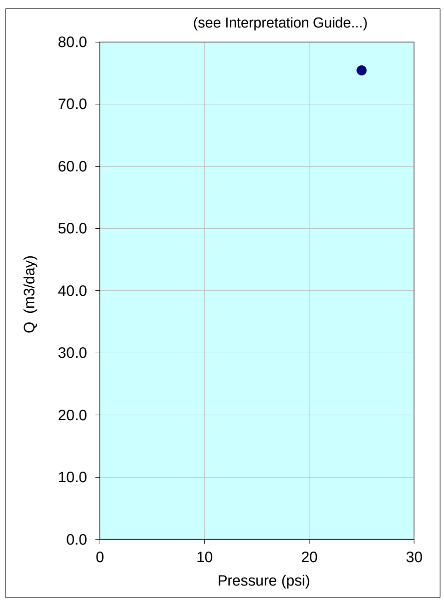
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65x10^{-15} (Q^2*Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q*Ln(R/r_b)) / 2*\pi*H_{nit}*L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁻⁵ cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	25				
1	53.00				
2					
3					
4					
5					
Stable Q **(L/min)**	53.00				
Leak Q (L/min)	0.60				
Q (m³/day)	75.5	#N/A	#N/A	#N/A	#N/A
Hf (m)	0.15	#N/A	#N/A	#N/A	#N/A
Hnit (m)	18.5	#N/A	#N/A	#N/A	#N/A
K (m/day)	2.5E-01	#N/A	#N/A	#N/A	#N/A
K (m/s)	**2.9E-06**	**#N/A**	**#N/A**	**#N/A**	**#N/A**
+/- (m/s)	3.6E-07	#VALUE!	#VALUE!	#VALUE!	#N/A
+/- order of mag.	0.05	#VALUE!	#VALUE!	#VALUE!	#N/A



Field Observations

zone geology: altered foliated basalt
zone fracture freq & quality (from core): flow thought to be dominated by a single joint ta 130.0m
packer seal quality: excellent
flow meter system problems: none
measurement accuracy: used RST datalogger - see result
other problems that may affect results: none

Test Interpretation

K values: 3.1E-06 m/s

"type curve" interpretation: single-step test.
See RST datalogger file for complete
P-Q data.

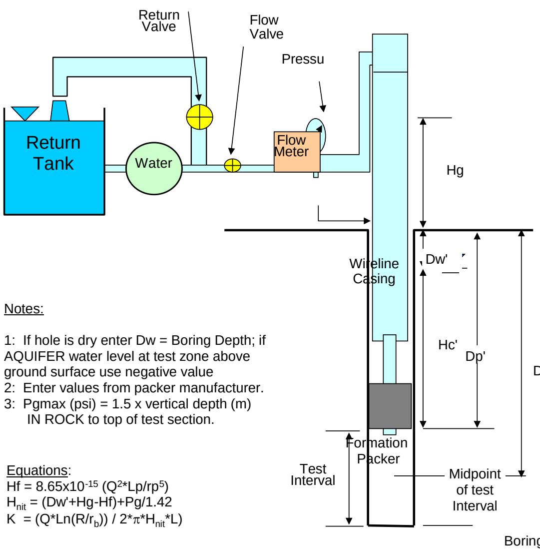
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay 2011**	**Test Interval (m):**	**189.4**	**to**	**200.2**	**Drillhole Nº**	**11TDD769**
UTM (x,y)	**557713, 33811**	**Start Date:**	**10-Apr-11**	**Time:**	**2:00 PM**	**Deposit**	**Doris Connector**
Datum:	**NAD83, zone 13**	**End Date:**	**10-Apr-11**	**Time:**	**4:00 PM**	**Test Nº**	**3**
GS Elevation:	**22**	**Supervisor:**	**R Bowden**			**DH Depth (m)**	**200.2**

Max Injection P (psi): **255**

Depth to wedge: 0 m



Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	11.0	m
Dp	Measured depth to packer	**189.4**	m
Dt	Measured depth to midpoint of test	**194.8**	m
ß	Inclination from horizontal (degrees)	64	º
Dw'	Vertical depth to static water level	**0.1**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**170.2**	m
Dt'	Vertical depth to midpoint of test	**175.1**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**242**	psi
Paquifer	Water column pressure in aquifer (unc.)	**242**	psi
Pdiff	Existing differential shear pressure	**0**	psi
Pshear	Shear pressure required at pump	**500**	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	1.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	**10.8**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

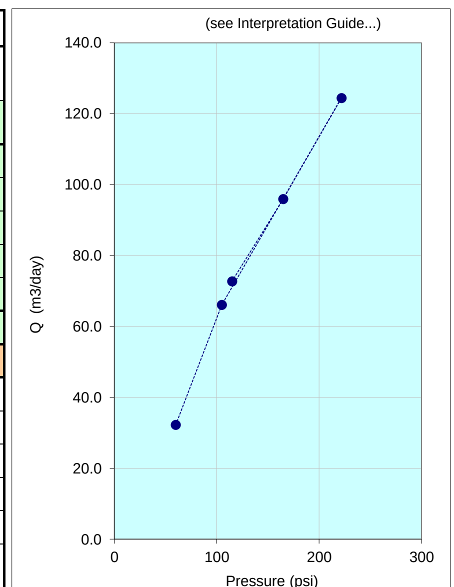
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65 \times 10^{-15} (Q^2 {*} L_p / r_p^5)$
$H_{nit} = (D_w' + H_g - H_f) + P_g / 1.42$
$K = (Q {*} \ln(R/r_b)) / 2 {*} \pi {*} H_{nit} {*} L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁻⁵ cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	60	**105**	**222**	**165**	**115**
1	**23.2**	**47.0**	**90.0**	**68.0**	**51.5**
2	**23.6**	**47.0**	**86.0**	**68.0**	**51.5**
3	**23.7**	**47.0**	**88.0**	**67.0**	**51.5**
4	**21.5**		**88.0**		
5					
Stable Q **(L/min)**	**23.0**	**47.0**	**88.0**	**68.0**	**51.5**
Leak Q (L/min)	**0.60**	**1.10**	**1.60**	**1.40**	**1.00**
Q (m^3/day)	32.3	66.1	124.4	95.9	72.7
Hf (m)	0.03	0.11	0.41	0.24	0.14
Hnit (m)	43.3	74.9	157.0	117.0	81.9
K (m/day)	5.9E-02	6.9E-02	6.2E-02	6.4E-02	7.0E-02
K (m/s)	**6.8E-07**	**8.0E-07**	**7.2E-07**	**7.5E-07**	**8.1E-07**
+/- (m/s)	1.1E-07	7.5E-08	3.6E-08	1.3E-07	-1.9E-08
+/- order of mag.	0.07	0.04	0.02	0.07	-0.01



Field Observations

zone geology: altered foliated basalt, occ quartz
zone fracture freq & quality (from core): natural rubble zone
packer seal quality: excellent
flow meter system problems: none. Used RST datalogger. See file
measurement accuracy: see below. Used RST datalogger. See file
other problems that may affect results: none

Test Interpretation

K values: 7.5E-07 m/s

"type curve" interpretation: linear

srk consulting

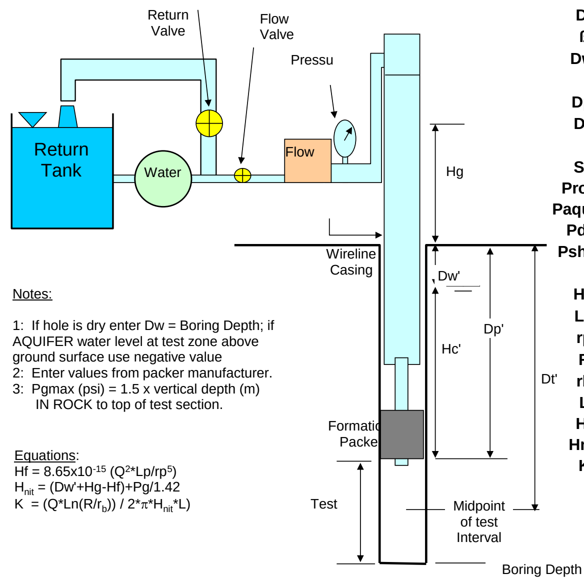
PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	48.6	to	74.3	**Drillhole Nº**	11TDD771
UTM (x,y)	**NAD 83, Zone 13**	**Start Date:**	21-Apr-11	Time:	17:00	**Deposit**	Doris
Datum:	**558380, 33720**	**End Date:**	21-Apr-11	Time:	18:45	**Test Nº**	1
GS Elevation:	**22**	**Supervisor:**	JA			**DH Depth (m)**	74.3

Max Injection P (psi) 72

Depth to wedge 0 m

Symbol	Description	Value	Unit
Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	15.8	m
Dp	Measured depth to packer	48.6	m
Dt	Measured depth to midpoint of test	61.4	m
ß	Inclination from horizontal (degrees)	80	º
Dw'	Vertical depth to static water level	1.0	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	47.9	m
Dt'	Vertical depth to midpoint of test	60.5	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	68	psi
Paquifer	Water column pressure in aquifer (unc.)	67	psi
Pdiff	Existing differential shear pressure	1	psi
Pshear	Shear pressure required at pump	499	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	3.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	25.7	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		



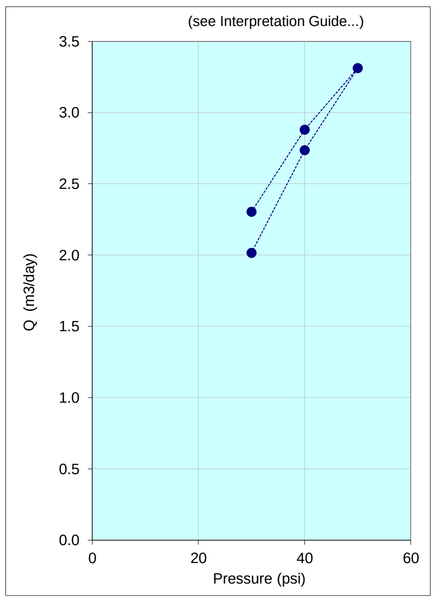
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65\times10^{-15} (Q^2 * Lp/rp^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q * Ln(R/r_b)) / 2*\pi*H_{nit}*L$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm^2 = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^5 cm/sec

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	30	40	50	40	30
1	0.75	1.00	1.15	0.95	0.35
2	0.80	1.00	1.20	1.00	0.65
3	0.80	1.00	1.15	0.90	0.70
4					0.70
5					
Stable Q **(L/min)**	1.60	2.00	2.30	1.90	1.40
Leak Q (L/min)	0.00	0.00	0.00	0.00	0.00
Q (m^3/day)	2.3	2.9	3.3	2.7	2.0
Hf (m)	0.00	0.00	0.00	0.00	0.00
Hnit (m)	24.1	31.2	38.2	31.2	24.1
K (m/day)	3.2E-03	3.1E-03	2.9E-03	2.9E-03	2.8E-03
K (m/s)	**3.7E-08**	**3.5E-08**	**3.3E-08**	**3.4E-08**	**3.2E-08**
+/- (m/s)	1.0E-08	5.5E-09	5.0E-09	7.3E-09	1.5E-08
+/- order of mag.	0.11	0.06	0.06	0.09	0.17



Field Observations

zone geology: **Mafic volcanic pillow** (foliated basalt)
zone fracture freq & quality (from core): 0-4 FF/m, typ 2 FF/m
packer seal quality: good
flow meter system problems: none
measurement accuracy: 0.1L
other problems that may affect results: none

Test Interpretation

K values: **3E-8 m/s**

"type curve" interpretation: **type a**

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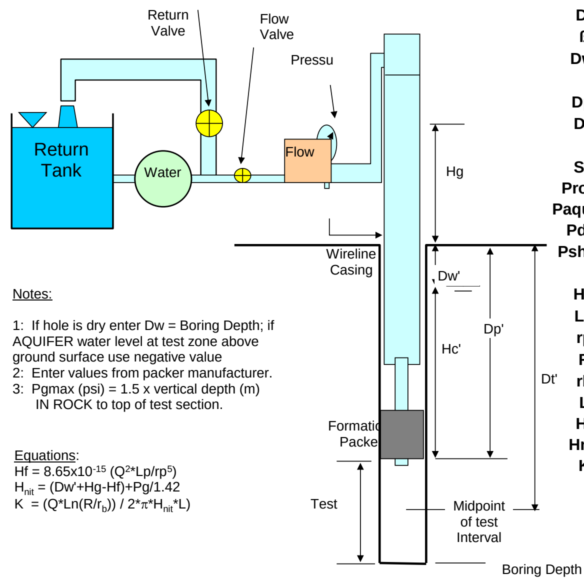
PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	112.3	**to**	135.0	**Drillhole Nº**	11TDD771
UTM (x,y)	**NAD 83, Zone 13**	**Start Date:**	24-Apr-11	**Time:**	15:15	**Deposit**	Doris
Datum:	**558380, 33720**	**End Date:**	24-Apr-11	**Time:**	17:30	**Test Nº**	2
GS Elevation:	**22**	**Supervisor:**	JA			**DH Depth (m)**	135.0

Max Injection P (psi) 165

Depth to wedge 0 m



Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	15.8	m
Dp	Measured depth to packer	112.3	m
Dt	Measured depth to midpoint of test	123.7	m
ß	Inclination from horizontal (degrees)	79	º
Dw'	Vertical depth to static water level	1.0	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	110.2	m
Dt'	Vertical depth to midpoint of test	121.4	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	157	psi
Paquifer	Water column pressure in aquifer (unc.)	155	psi
Pdiff	Existing differential shear pressure	1	psi
Pshear	Shear pressure required at pump	499	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	22.7	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

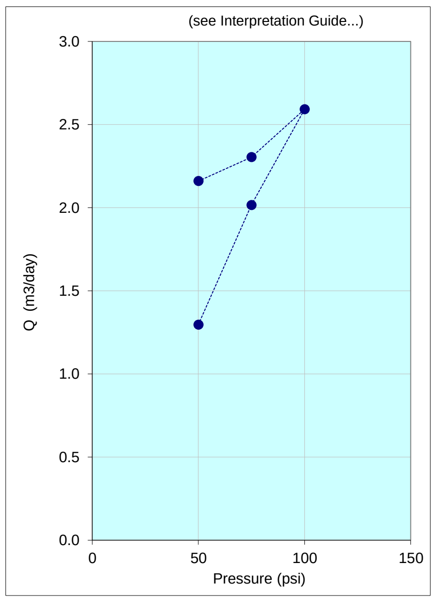
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65 \times 10^{-15} (Q^2 * Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q*Ln(R/r_b)) / 2*\pi*H_{nit}*L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁵ cm/sec

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min)**	***see flow calc. sheet**			
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	50	75	100	75	50
1	0.75	0.80	0.95	0.70	0.60
2	0.70	0.85	0.90	0.65	0.45
3	0.65	0.80	0.95	0.70	0.45
4	0.75	0.80	0.90	0.70	0.50
5	0.50		0.90		
Stable Q **(L/min)**	1.50	1.60	1.80	1.40	0.90
Leak Q (L/min)	0.00	0.00	0.00	0.00	0.00
Q (m^3/day)	2.2	2.3	2.6	2.0	1.3
Hf (m)	0.00	0.00	0.00	0.00	0.00
Hnit (m)	38.2	55.8	73.4	55.8	38.2
K (m/day)	2.1E-03	1.5E-03	1.3E-03	1.4E-03	1.3E-03
K (m/s)	**2.5E-08**	**1.8E-08**	**1.5E-08**	**1.6E-08**	**1.5E-08**
+/- (m/s)	1.5E-09	2.6E-09	3.6E-09	4.8E-09	1.1E-08
+/- order of mag.	0.03	0.06	0.09	0.12	0.25



Field Observations

zone geology: **Primarily quartz** (ore zone) w mafic volcanic pillow (112-118m)
zone fracture freq & quality (from core): < 2 FF/m
packer seal quality: good
flow meter system problems: none
measurement accuracy: 0.1L
other problems that may affect results: none

Test Interpretation

K values: **1.7E-8 m/s**

"type curve" interpretation: **type c**

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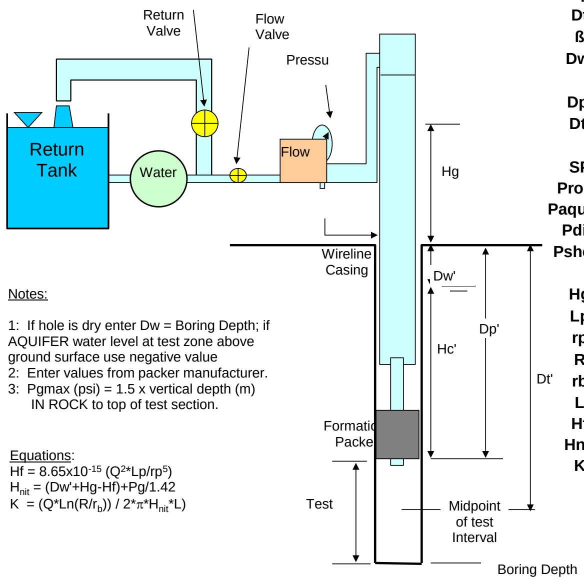
PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	118.3	to	162.0	**Drillhole Nº**	11TDD771
UTM (x,y)	**NAD 83, Zone 13**	**Start Date:**	26-Apr-11	Time:	9:45	**Deposit**	Doris
Datum:	**558380, 33720**	**End Date:**	26-Apr-11	Time:	11:15	**Test Nº**	3
GS Elevation:	**22**	**Supervisor:**	JA			**DH Depth (m)**	162.0

Max Injection P (psi): 174

Depth to wedge: 0 m

Symbol	Description	Value	Unit
Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	15.8	m
Dp	Measured depth to packer	118.3	m
Dt	Measured depth to midpoint of test	140.2	m
ß	Inclination from horizontal (degrees)	78	º
Dw'	Vertical depth to static water level	1.0	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	115.7	m
Dt'	Vertical depth to midpoint of test	137.1	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	164	psi
Paquifer	Water column pressure in aquifer (unc.)	163	psi
Pdiff	Existing differential shear pressure	1	psi
Pshear	Shear pressure required at pump	499	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	43.7	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		



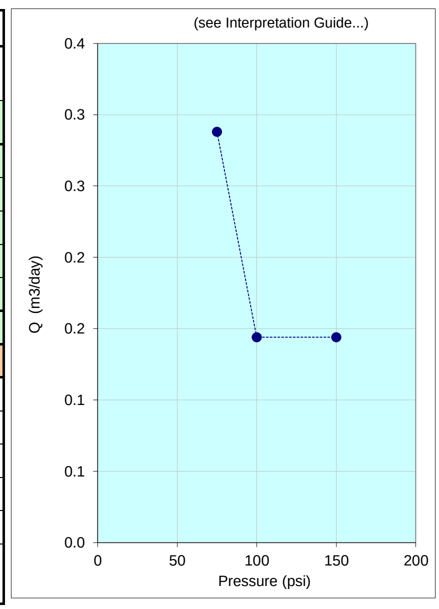
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65 \times 10^{-15}\ (Q^2 * L_p / r_p^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q * \ln(R/r_b)) / 2 * \pi * H_{nit} * L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁵ cm/sec

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	75	100	150	100	75
1	0.70	0.80	0.95	0.75	0.60
2	0.80	0.85	1.10	0.75	0.55
3	0.60	0.90	1.00	0.80	0.55
4	0.70	0.75	1.00		0.60
5					
Stable Q **(L/min)**	1.40	1.70	2.00	1.60	1.20
Leak Q (L/min)	1.20	1.60	1.90	1.60	1.20
Q (m³/day)	0.3	0.1	0.1	#N/A	#N/A
Hf (m)	0.00	0.00	0.00	#N/A	#N/A
Hnit (m)	55.8	73.4	108.6	#N/A	#N/A
K (m/day)	1.0E-04	3.8E-05	2.6E-05	#N/A	#N/A
K (m/s)	**1.2E-09**	**4.4E-10**	**3.0E-10**	**#N/A**	**#N/A**
+/- (m/s)	5.0E-10	2.9E-10	1.8E-10	#N/A	#N/A
+/- order of mag.	0.16	0.22	0.21	#N/A	#N/A



Field Observations

zone geology: **Primarily quartz** (discontinuous) w mafic volcanic pillow (153-162m). small structure at 150m
zone fracture freq & quality (from core): 0-10 FF/m, typ 2 FF/m
packer seal quality: good on initial seal, but seems to have high rod leak? Not typical for this hole
flow meter system problems: none
measurement accuracy: 0.05L but issues with leak
other problems that may affect results: leak seems to dominate flow, test shows similar signs to a nother rig - suspect something may not be working correctly with packer

Test Interpretation

K values: **5E-10 m/s**

"type curve" interpretation: **type c**

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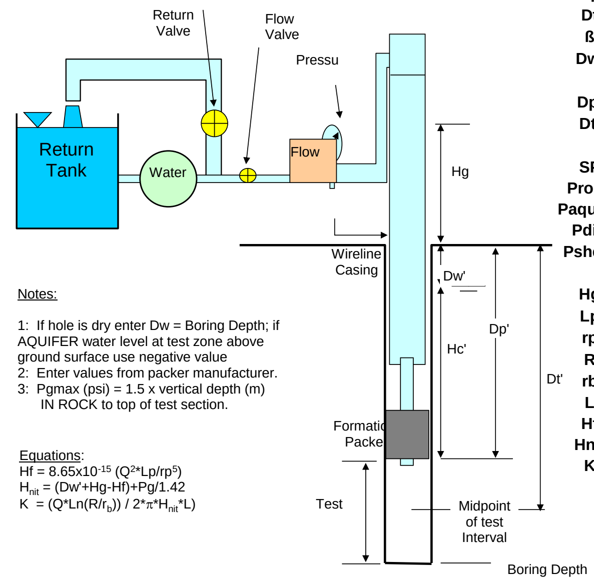
PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	**151.3**	**to**	**198.0**	**Drillhole Nº**	**11TDD771**
UTM (x,y)	**NAD 83, Zone 13**	**Start Date:**	**27-Apr-11**	**Time:**	**8:30**	**Deposit**	**Doris**
Datum:	**558380, 33720**	**End Date:**	**27-Apr-11**	**Time:**	**10:00**	**Test Nº**	**4**
GS Elevation:	**22**	**Supervisor:**	**JA**			**DH Depth (m)**	**198.0**

Max Injection P (psi) 222

Depth to wedge 0 m



Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	15.8	m
Dp	Measured depth to packer	**151.3**	m
Dt	Measured depth to midpoint of test	**174.7**	m
ß	Inclination from horizontal (degrees)	78	º
Dw'	Vertical depth to static water level	**1.0**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**148.0**	m
Dt'	Vertical depth to midpoint of test	**170.8**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**210**	psi
Paquifer	Water column pressure in aquifer (unc.)	**209**	psi
Pdiff	Existing differential shear pressure	**1**	psi
Pshear	Shear pressure required at pump	**499**	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	**46.7**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

Notes:

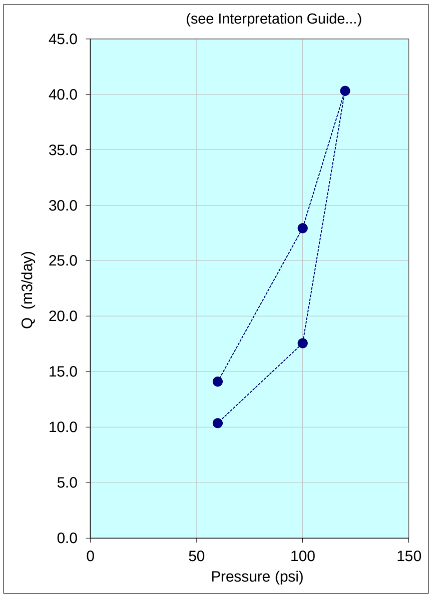
1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65\times10^{-15}\ (Q^2 {*} L_p/r_p^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q{*}Ln(R/r_b)) / 2{*}\pi{*}H_{nit}{*}L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm^2 = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^5 cm/sec

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	60	100	120	100	60
1	5.40	10.90	15.00	4.30	3.90
2	5.10	11.40	14.00	5.80	3.70
3	4.90	10.10	15.00	6.10	3.60
4	4.90	9.90	14.00	6.10	3.60
5	4.80	9.70	14.00	6.10	
Stable Q **(L/min)**	9.80	19.40	28.00	12.20	7.20
Leak Q (L/min)	0.00	0.00	0.00	0.00	0.00
Q (m^3/day)	14.1	27.9	40.3	17.6	10.4
Hf (m)	0.01	0.04	0.09	0.02	0.01
Hnit (m)	45.2	73.4	87.4	73.4	45.2
K (m/day)	5.7E-03	6.9E-03	8.4E-03	4.4E-03	4.2E-03
K (m/s)	**6.6E-08**	**8.0E-08**	**9.7E-08**	**5.0E-08**	**4.8E-08**
+/- (m/s)	5.3E-07	1.0E-06	2.9E-06	1.0E-06	5.5E-07
+/- order of mag.	0.96	1.13	1.49	1.33	1.09

(see Interpretation Guide...)



Field Observations

zone geology: basalt and quartz veining; structures at 185m (contact with ore zone); driller reported "water vein" from night shift, but unclear if that meant producing or lost water
zone fracture freq & quality (from core): 0-10 FF/m, typ 2 FF/m
packer seal quality: good
flow meter system problems: none
measurement accuracy: 1 L
other problems that may affect results: significant pressure variability - had difficulty with RST logger as program was not responding, hard to stabalize pressure on steps down

Test Interpretation

K values: **7E-8 m/s**

"type curve" interpretation: **type c**

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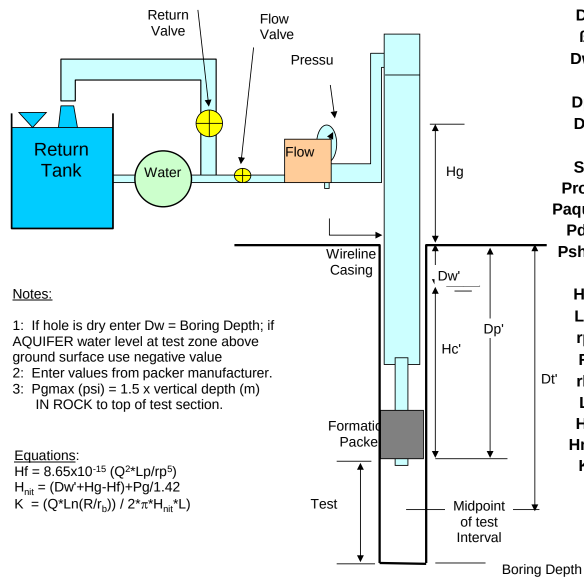
PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	**181.3**	**to**	**198.0**	**Drillhole Nº**	**11TDD771**
UTM (x,y)	**NAD 83, Zone 13**	**Start Date:**	**27-Apr-11**	**Time:**	**10:00**	**Deposit**	**Doris**
Datum:	**558380, 33720**	**End Date:**	**27-Apr-11**	**Time:**	**11:15**	**Test Nº**	**5**
GS Elevation:	**22**	**Supervisor:**	**JA**			**DH Depth (m)**	**198.0**

Max Injection P (psi)
266

Depth to wedge
0 m



Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	15.8	m
Dp	Measured depth to packer	**181.3**	m
Dt	Measured depth to midpoint of test	**189.7**	m
ß	Inclination from horizontal (degrees)	78	º
Dw'	Vertical depth to static water level	**1.0**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**177.3**	m
Dt'	Vertical depth to midpoint of test	**185.5**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**252**	psi
Paquifer	Water column pressure in aquifer (unc.)	**251**	psi
Pdiff	Existing differential shear pressure	**1**	psi
Pshear	Shear pressure required at pump	**499**	psi
Hg	Gauge height	2.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	**16.7**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

Notes:

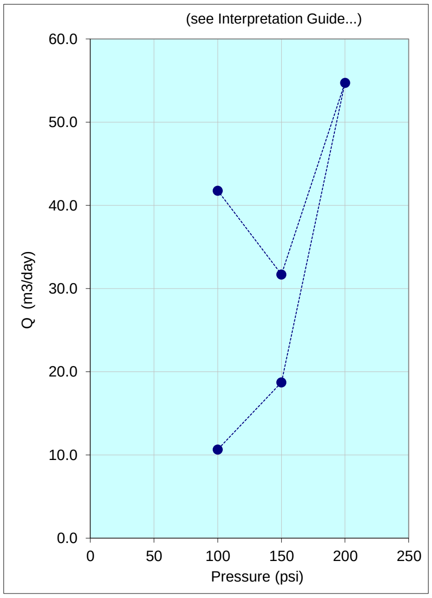
1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65\times10^{-15}\ (Q^2 \cdot L_p/r_p^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q \cdot \ln(R/r_b)) / 2 \cdot \pi \cdot H_{nit} \cdot L$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm^2 = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^5 cm/sec

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	100	150	200	150	100
1	18.00	11.00	18.50	6.00	3.70
2	16.50	9.50	19.00	6.00	3.60
3	14.50	11.50	19.50	7.00	3.70
4	15.50	10.50	19.00	7.00	3.90
5	14.50	11.50			
Stable Q **(L/min)**	29.00	22.00	38.00	13.00	7.40
Leak Q (L/min)	0.00	0.00	0.00	0.00	0.00
Q (m^3/day)	41.8	31.7	54.7	18.7	10.7
Hf (m)	0.09	0.05	0.16	0.02	0.01
Hnit (m)	73.3	108.6	143.7	108.6	73.4
K (m/day)	2.9E-02	1.5E-02	1.9E-02	8.8E-03	7.4E-03
K (m/s)	**3.4E-07**	**1.7E-07**	**2.2E-07**	**1.0E-07**	**8.6E-08**
+/- (m/s)	4.2E-06	2.4E-07	2.3E-07	3.1E-07	4.4E-06
+/- order of mag.	1.13	0.38	0.30	0.61	1.72

(see Interpretation Guide...)



Field Observations

zone geology: basalt with quartz veining; structure at 185m (break between quartz and basalt - broken core)
zone fracture freq & quality (from core): rubble zone near feature; otherwise <1 FF/m
packer seal quality: good
flow meter system problems: none
measurement accuracy: 1L
other problems that may affect results: pressure kept building during testing, hard to keep stable; during steps down, reverse flow would occur until it could equilibriate and then flow would continue

Test Interpretation

K values: **2E-7 m/s**

"type curve" interpretation: **type c**

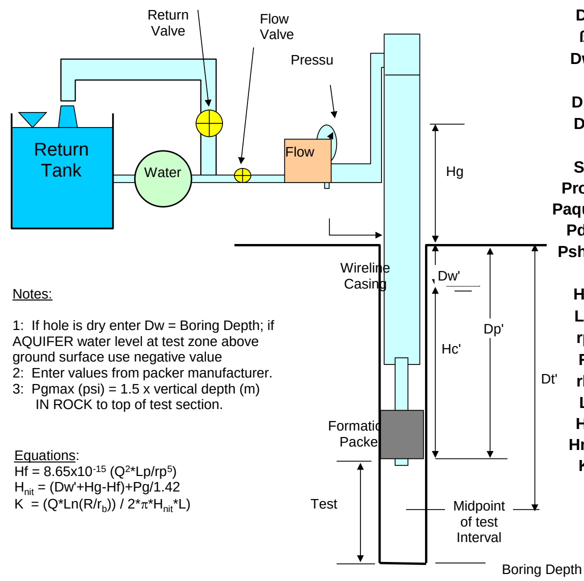
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	**232.1**	**to**	**294.0**	**Drillhole Nº**	**11TDD771**
UTM (x,y)	**NAD 83, Zone 13**	**Start Date:**	**1-May-11**	**Time:**	**10:00**	**Deposit**	**Doris**
Datum:	**558380, 33720**	**End Date:**	**1-May-11**	**Time:**	**11:30**	**Test Nº**	**6**
GS Elevation:	**22**	**Supervisor:**	**R Bowden**			**DH Depth (m)**	**294.0**

Max Injection P (psi) **339**

Depth to wedge 0 m



Symbol	Description	Value	Unit
Dw	Measured depth of static water level (1)	1.0	m
Dbr	Measured vertical depth to bedrock	15.8	m
Dp	Measured depth to packer	232.1	m
Dt	Measured depth to midpoint of test	263.1	m
ß	Inclination from horizontal (degrees)	77	º
Dw'	Vertical depth to static water level	1.0	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	226.2	m
Dt'	Vertical depth to midpoint of test	256.3	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	321	psi
Paquifer	Water column pressure in aquifer (unc.)	320	psi
Pdiff	Existing differential shear pressure	1	psi
Pshear	Shear pressure required at pump	499	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	61.9	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

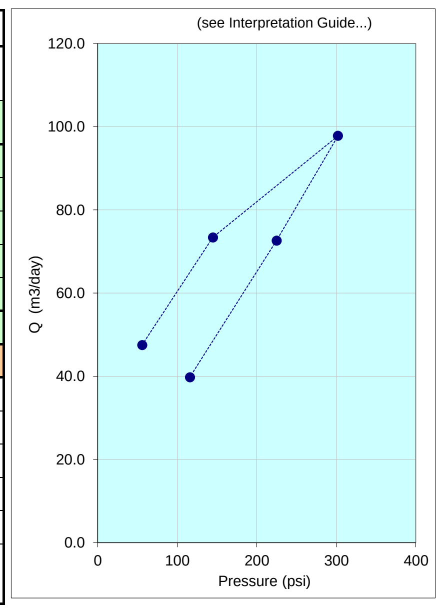
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65 \times 10^{-15} (Q^2 * Lp/rp^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q * \ln(R/r_b)) / 2 * \pi * H_{nit} * L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^5 cm/sec

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	56	145	302	225	116
1	33.00	51.00	70.00	51.00	28.50
2	33.60	51.00	68.00	51.00	28.00
3	32.20	51.00	67.00	50.50	28.00
4	32.70				27.50
5					
Stable Q **(L/min)**	33.00	51.00	68.00	50.50	28.00
Leak Q (L/min)	0.02	0.06	0.10	0.08	0.40
Q (m³/day)	47.5	73.4	97.8	72.6	39.7
Hf (m)	0.12	0.28	0.50	0.28	0.08
Hnit (m)	41.3	103.8	214.1	160.1	83.6
K (m/day)	1.6E-02	9.7E-03	6.3E-03	6.2E-03	6.5E-03
K (m/s)	**1.8E-07**	**1.1E-07**	**7.3E-08**	**7.2E-08**	**7.6E-08**
+/- (m/s)	-4.0E-08	-4.5E-10	3.5E-09	4.0E-08	6.8E-08
+/- order of mag.	-0.11	0.00	0.02	0.19	0.28



Field Observations

zone geology: **Mafic volcanic pillow** (foliated basalt) to 286, then diabase
zone fracture freq & quality (from core): 0-5 FF/m, typ <2 FF/m
packer seal quality: excellent
flow meter system problems: none
measurement accuracy: see below
other problems that may affect results: RST and Troll data.

Test Interpretation

K values: **2E-7 m/s**

"type curve" interpretation: **type c**

PACKER INJECTION TEST *(modified from HCI)*

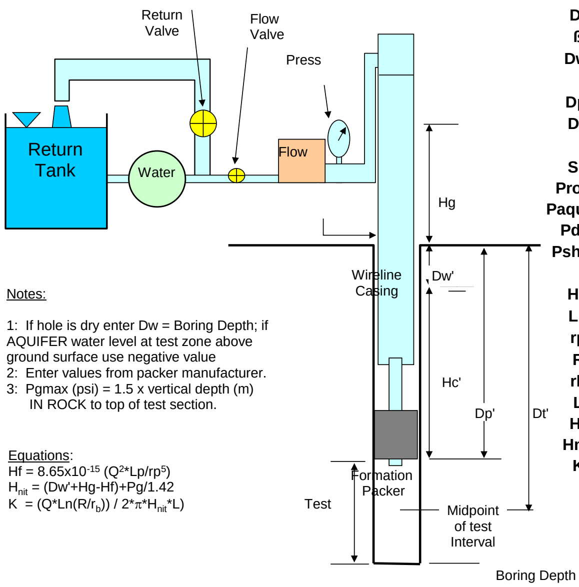
srk consulting

Project:	**Hope Bay**	**Test Interval (m):**	**55.3**	**to**	**87.2**	**Drillhole Nº**	**11TDD772**
UTM (x,y)	**557708, 33859**	**Start Date:**	**4-May-11**	**Time:**	**1:40 PM**	**Deposit**	**Doris**
Datum:	**Nad 83, Zone 13**	**End Date:**	**4-May-11**	**Time:**	**3:10 PM**	**Test Nº**	**1**
GS Elevation:	**5022**	**Supervisor:**	**R Bowden**			**DH Depth (m)**	**87.2**

Max Injection P (psi): 75

Depth to wedge: 0 m

Symbol	Description	Value	Unit
Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	32.8	m
Dp	Measured depth to packer	**55.3**	m
Dt	Measured depth to midpoint of test	**71.3**	m
ß	Inclination from horizontal (degrees)	65	º
Dw'	Vertical depth to static water level	**0.1**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**50.1**	m
Dt'	Vertical depth to midpoint of test	**64.6**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**71**	psi
Paquifer	Water column pressure in aquifer (unc.)	**71**	psi
Pdiff	Existing differential shear pressure	**0**	psi
Pshear	Shear pressure required at pump	**500**	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0270	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	**31.9**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		



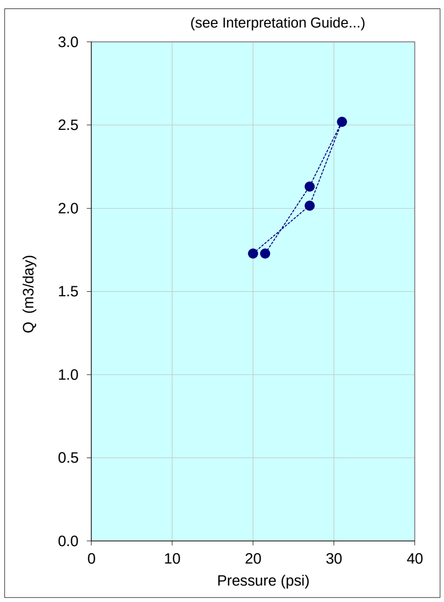
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65 \times 10^{-15} (Q^2 * L_p / r_p^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q * \ln(R/r_b)) / 2 * \pi * H_{nit} * L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁻⁵ cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	20	27	31	27	21.5
1	1.20	1.40	1.73	1.52	1.20
2	1.20	1.40	1.75	1.48	1.20
3	1.20	1.45	1.82	1.46	1.18
4					
5					
Stable Q **(L/min)**	1.20	1.40	1.75	1.48	1.20
Leak Q (L/min)	0.00	0.00	0.00	0.00	0.00
Q (m³/day)	1.7	2.0	2.5	2.1	1.7
Hf (m)	0.00	0.00	0.00	0.00	0.00
Hnit (m)	15.2	20.1	22.9	20.1	16.2
K (m/day)	3.0E-03	2.7E-03	2.9E-03	2.8E-03	2.8E-03
K (m/s)	**3.5E-08**	**3.1E-08**	**3.4E-08**	**3.3E-08**	**3.3E-08**
+/- (m/s)	3.7E-10	2.3E-09	2.4E-09	5.0E-10	2.7E-09
+/- order of mag.	0.00	0.03	0.03	0.01	0.03



Field Observations

zone geology: **Mafic volcanic pillow** w quartz (ore zone, 57-59m)
zone fracture freq & quality (from core): 0-12 FF/m, includes Fault C3PO @ 60.20 - 61.65m + Fault NW6 @ 83.90 - 84.10 m
packer seal quality: excellent
flow meter system problems: none
measurement accuracy: see data below
other problems that may affect results: none

Test Interpretation

K values: **3.3E-08 m/s**

"type curve" interpretation: **classic**

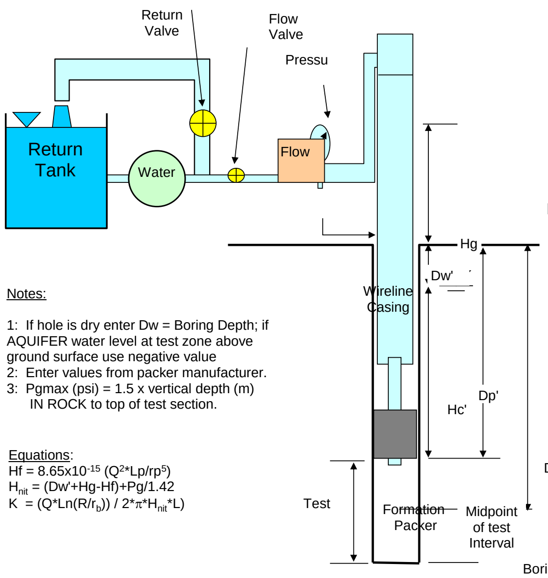
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	88.3	**to**	147.2	**Drillhole Nº**	11TDD772
UTM (x,y)	**557708, 33859**	**Start Date:**	6-May-11	**Time:**	11:00	**Deposit**	Doris
Datum:	**Nad 83, Zone 13**	**End Date:**	6-May-11	**Time:**	12:05	**Test Nº**	2
GS Elevation:	**5022**	**Supervisor:**	R Bowden			**DH Depth (m)**	147.2

Max Injection P (psi) 120

Depth to wedge 0 m



Notes:

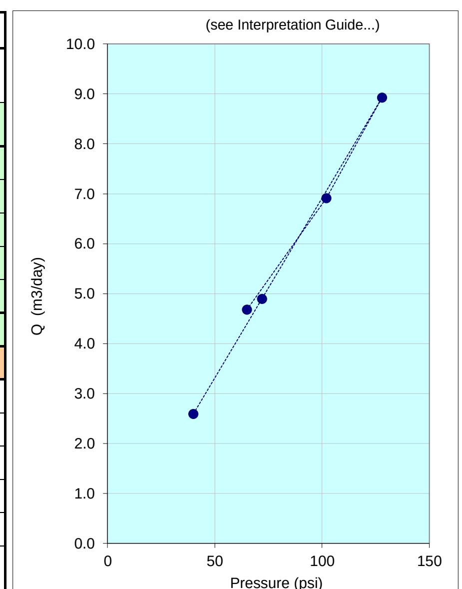
1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65\times10^{-15}\ (Q^2 \cdot Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q \cdot Ln(R/r_b))\ /\ 2 \cdot \pi \cdot H_{nit} \cdot L)$

Symbol	Description	Value	Unit
Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	32.8	m
Dp	Measured depth to packer	88.3	m
Dt	Measured depth to midpoint of test	117.8	m
ß	Inclination from horizontal (degrees)	65	º
Dw'	Vertical depth to static water level	0.1	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	80.0	m
Dt'	Vertical depth to midpoint of test	106.7	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	114	psi
Paquifer	Water column pressure in aquifer (unc.)	114	psi
Pdiff	Existing differential shear pressure	0	psi
Pshear	Shear pressure required at pump	500	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	58.9	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^5 cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	65	102	128	72	40
1	4.10	5.70	7.00	3.90	2.15
2	4.20	5.60	7.00	3.95	2.09
3	4.50	5.50		3.80	2.10
4	3.85	5.50			
5	3.60				
Stable Q **(L/min)**	3.65	5.50	7.00	3.90	2.10
Leak Q (L/min)	0.40	0.70	0.80	0.50	0.30
Q (m^3/day)	4.7	6.9	8.9	4.9	2.6
Hf (m)	0.00	0.00	0.00	0.00	0.00
Hnit (m)	46.9	72.9	91.2	51.8	29.3
K (m/day)	1.4E-03	1.4E-03	1.4E-03	1.4E-03	1.3E-03
K (m/s)	**1.7E-08**	**1.6E-08**	**1.6E-08**	**1.6E-08**	**1.5E-08**
+/- (m/s)	7.1E-10	1.9E-09	2.4E-09	2.0E-09	2.6E-09
+/- order of mag.	0.02	0.05	0.06	0.05	0.07



Field Observations

zone geology: **Mafic volcanic pillow** (foliated basalt)
zone fracture freq & quality (from core): 0-6 FF/m, 2 FF/m typical
packer seal quality: excellent
flow meter system problems: none
measurement accuracy: see below
other problems that may affect results: none

Test Interpretation

K values: **1.6E-08 m/s**

"type curve" interpretation: **ideal**

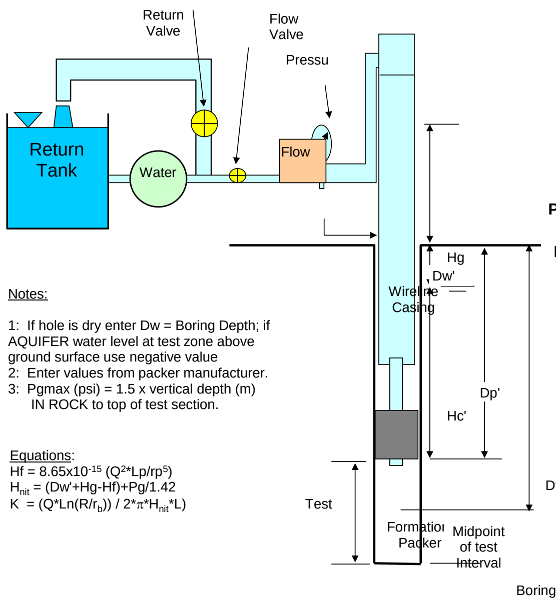
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	**145.3**	**to**	**228.2**	**Drillhole Nº**	**11TDD772**
UTM (x,y)	**557708, 33859**	**Start Date:**	**8-May-11**	**Time:**	**8:20**	**Deposit**	**Doris**
Datum:	**Nad 83, Zone 13**	**End Date:**	**8-May-11**	**Time:**	**9:20**	**Test Nº**	**3**
GS Elevation:	**5022**	**Supervisor:**	**R Bowden**			**DH Depth (m)**	**228.2**

Max Injection P (psi): **198**

Depth to wedge: 0 m



Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	32.8	m
Dp	Measured depth to packer	**145.3**	m
Dt	Measured depth to midpoint of test	**186.8**	m
ß	Inclination from horizontal (degrees)	65	º
Dw'	Vertical depth to static water level	**0.1**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**131.7**	m
Dt'	Vertical depth to midpoint of test	**169.3**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**187**	psi
Paquifer	Water column pressure in aquifer (unc.)	**187**	psi
Pdiff	Existing differential shear pressure	**0**	psi
Pshear	Shear pressure required at pump	**500**	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	**82.9**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

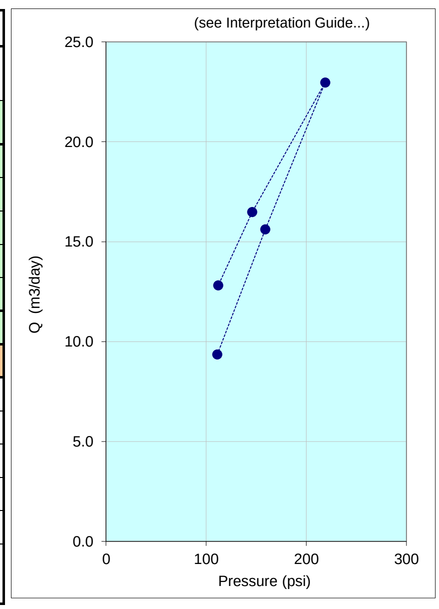
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65 \times 10^{-15} (Q^2 \cdot L_p/r_p^5)$
$H_{nit} = (Dw' + Hg - Hf) + Pg/1.42$
$K = (Q \cdot \ln(R/r_b)) / 2 \cdot \pi \cdot H_{nit} \cdot L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10⁵ cm/sec

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min)**	***see flow calc. sheet**			
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	111	**159**	**219**	**146**	**112**
1	**6.60**	**11.10**	**16.40**	**11.70**	**9.00**
2	**6.60**	**11.10**	**16.40**	**11.60**	**9.10**
3	**6.60**		**16.80**	**11.70**	**9.00**
4					
5					
Stable Q **(L/min)**	**6.60**	**11.10**	**16.40**	**11.70**	**9.00**
Leak Q (L/min)	**0.10**	**0.25**	**0.45**	**0.25**	**0.10**
Q (m^3/day)	9.4	15.6	23.0	16.5	12.8
Hf (m)	0.00	0.01	0.03	0.01	0.01
Hnit (m)	79.3	113.0	155.3	103.9	80.0
K (m/day)	1.2E-03	1.4E-03	1.5E-03	1.6E-03	1.6E-03
K (m/s)	**1.4E-08**	**1.6E-08**	**1.8E-08**	**1.9E-08**	**1.9E-08**
+/- (m/s)	4.1E-09	2.3E-09	9.6E-10	-1.5E-10	-9.5E-10
+/- order of mag.	0.11	0.06	0.02	0.00	-0.02



Field Observations

zone geology: **Mafic volcanic pillow** (foliated basalt) w felsic dyke (200-202m)
zone fracture freq & quality (from core): 0-2 FF/m, typ <1 FF/m
packer seal quality: ecellent
flow meter system problems: none
measurement accuracy: see below; very goo because RST datalogger used
other problems that may affect results: none

Test Interpretation

K values: **1.7E-08 m/s**

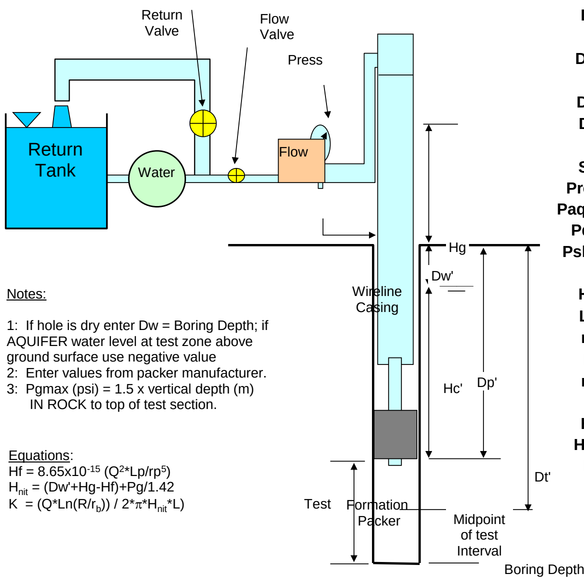
"type curve" interpretation: **near ideal**

PACKER INJECTION TEST *(modified from HCI)*

Project:	**Hope Bay**	**Test Interval (m):**	**283.3**	**to**	**321.2**	**Drillhole Nº**	**11TDD772**
UTM (x,y)	**557708, 33859**	**Start Date:**	**11-May-11**	**Time:**	**1:20**	**Deposit**	**Doris**
Datum:	**Nad 83, Zone 13**	**End Date:**	**11-May-11**	**Time:**	**2:05**	**Test Nº**	**4**
GS Elevation:	**5022**	**Supervisor:**	**R Bowden**			**DH Depth (m)**	**321.2**

Max Injection P (psi) **385**

Depth to wedge 0 m



Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	32.8	m
Dp	Measured depth to packer	**283.3**	m
Dt	Measured depth to midpoint of test	**302.3**	m
ß	Inclination from horizontal (degrees)	65	º
Dw'	Vertical depth to static water level	**0.1**	m
	Rod stickup above ground	**0.0**	m
Dp'	Vertical depth to packer	**256.8**	m
Dt'	Vertical depth to midpoint of test	**273.9**	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	**365**	psi
Paquifer	Water column pressure in aquifer (unc.)	**365**	psi
Pdiff	Existing differential shear pressure	**0**	psi
Pshear	Shear pressure required at pump	**500**	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	**37.9**	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

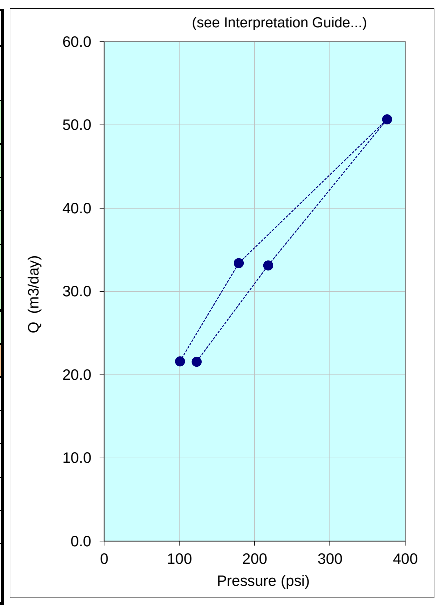
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$H_f = 8.65\times10^{-15} (Q^2 \cdot L_p/r_p^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q \cdot Ln(R/r_b)) / 2 \cdot \pi \cdot H_{nit} \cdot L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4 x 10^5 cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	**Q (Liters / min) *see flow calc. sheet**				
	P_g (psi) Step 1	**P_g (psi) Step 2**	**P_g (psi) Step 3**	**P_g (psi) Step 4**	**P_g (psi) Step 5**
	101	**179**	**376**	**218**	**123**
1	**15.60**	**24.00**	**37.00**	**24.00**	**15.60**
2	**15.40**	**24.00**	**37.00**	**24.40**	**15.40**
3				**23.20**	**15.60**
4					
5					
Stable Q **(L/min)**	**15.50**	**24.00**	**37.00**	**24.00**	**15.60**
Leak Q (L/min)	**0.50**	**0.80**	**1.80**	**1.00**	**0.63**
Q (m³/day)	21.6	33.4	50.7	33.1	21.6
Hf (m)	0.02	0.06	0.13	0.06	0.02
Hnit (m)	72.2	127.1	265.7	154.6	87.7
K (m/day)	6.7E-03	5.9E-03	4.3E-03	4.8E-03	5.5E-03
K (m/s)	**7.8E-08**	**6.8E-08**	**4.9E-08**	**5.6E-08**	**6.4E-08**
+/- (m/s)	-3.6E-09	-3.0E-09	2.0E-09	9.6E-09	1.0E-08
+/- order of mag.	-0.02	-0.02	0.02	0.07	0.06



Field Observations

zone geology: **Mafic volcanic pillow** (foliated basalt) w quartz (ore zone) + fault Force 1 (broken rubble zone)
zone fracture freq & quality (from core): 0-8 FF/m, typ <2 FF/m. Includes fault Force 1 @ 286.30 - 286.71m
packer seal quality: excellent once broken rod was replaced
flow meter system problems: none
measurement accuracy: good - see below, and also see RST data. Stable P and Q.
other problems that may affect results: none

Test Interpretation

K values: **6.8E-08 m/s**

"type curve" interpretation: **ideal**

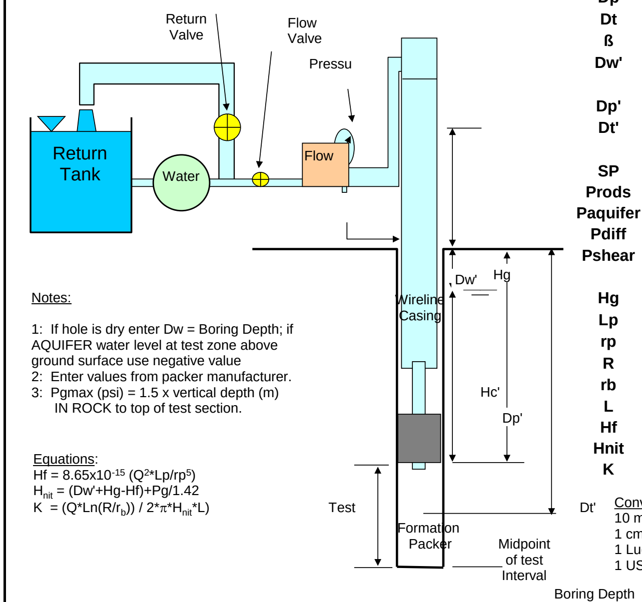
srk consulting

PACKER INJECTION TEST *(modified from HCI)*

Project:	Hope Bay	**Test Interval (m):**	289.3	to	321.2	**Drillhole Nº**	11TDD772
UTM (x,y)	557708, 33859	**Start Date:**	11-May-11	**Time:**	2:10 AM	**Deposit**	Doris
Datum:	Nad 83, Zone 13	**End Date:**	11-May-11	**Time:**	3:10 AM	**Test Nº**	5
GS Elevation:	5022	**Supervisor:**	R Bowden			**DH Depth (m)**	321.2

Max Injection P (psi) 393

Depth to wedge 0 m



Dw	Measured depth of static water level (1)	0.1	m
Dbr	Measured vertical depth to bedrock	32.8	m
Dp	Measured depth to packer	289.3	m
Dt	Measured depth to midpoint of test	305.3	m
ß	Inclination from horizontal (degrees)	65	º
Dw'	Vertical depth to static water level	0.1	m
	Rod stickup above ground	0.0	m
Dp'	Vertical depth to packer	262.2	m
Dt'	Vertical depth to midpoint of test	276.7	m
SP	Shear Pin Rating (psi)	500	psi
Prods	Water column pressure in drill rods	372	psi
Paquifer	Water column pressure in aquifer (unc.)	373	psi
Pdiff	Existing differential shear pressure	0	psi
Pshear	Shear pressure required at pump	500	psi
Hg	Gauge height	1.0	m
Lp	Length of discharge pipe	2.00	m
rp	Radius of discharge pipe (1"=0.0127m)	0.0127	m
R	Radius of influence (10 m is standard value)	10	m
rb	Borehole radius (HQ=0.048m, NQ=0.038m)	0.048	m
L	Length of test section	31.9	m
Hf	Friction Loss		
Hnit	Net injection head at midpoint of test		
K	Hydraulic conductivity		

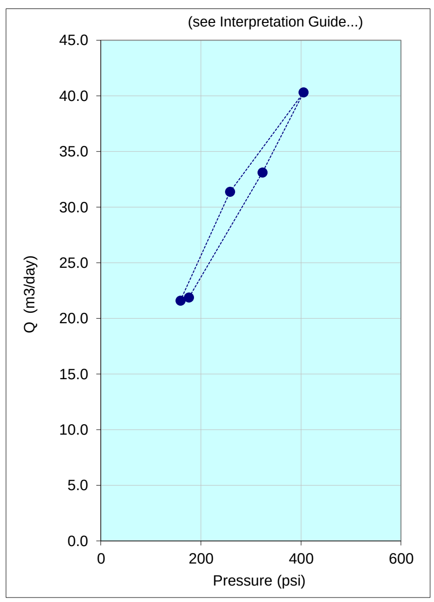
Notes:

1: If hole is dry enter Dw = Boring Depth; if AQUIFER water level at test zone above ground surface use negative value
2: Enter values from packer manufacturer.
3: Pgmax (psi) = 1.5 x vertical depth (m) IN ROCK to top of test section.

Equations:
$Hf = 8.65 \times 10^{-15} (Q^2 * Lp/rp^5)$
$H_{nit} = (Dw'+Hg-Hf)+Pg/1.42$
$K = (Q*Ln(R/r_b)) / 2*\pi*H_{nit}*L)$

Conversion Factors:
10 m of water = 0.9807 bar = 1kg/cm² = 14.2 psi
1 cm/sec = 864 m/day
1 Lugeon = 1 lit/min per meter at 10 bar, which is approx. 1.4×10^{5} cm/sec
1 US gpm = 3.785 lit/min = 5.45 m³/day

Measurement (show last 3 to 5 flow meter readings)	Q (Liters / min) *see flow calc. sheet				
	P_g (psi) Step 1	P_g (psi) Step 2	P_g (psi) Step 3	P_g (psi) Step 4	P_g (psi) Step 5
	159	258	405	323	176
1	14.60	21.80	28.80	23.40	15.30
2	15.10	21.80	28.00	23.00	15.20
3	15.10		28.00	23.00	
4					
5					
Stable Q **(L/min)**	15.00	21.80	28.00	23.00	15.20
Leak Q (L/min)					
Q (m³/day)	21.6	31.4	40.3	33.1	21.9
Hf (m)	0.02	0.05	0.09	0.06	0.03
Hnit (m)	113.0	182.7	286.2	228.5	125.0
K (m/day)	5.1E-03	4.6E-03	3.8E-03	3.9E-03	4.7E-03
K (m/s)	**5.9E-08**	**5.3E-08**	**4.3E-08**	**4.5E-08**	**5.4E-08**
+/- (m/s)	-1.2E-09	-2.8E-09	1.7E-09	5.5E-09	3.7E-09
+/- order of mag.	-0.01	-0.02	0.02	0.05	0.03



Field Observations

zone geology: **Mafic volcanic pillow** (foliated basalt) w quartz (ore zone)
zone fracture freq & quality (from core): 0-8 FF/m, typ <2 FF/m.
packer seal quality: excellent
flow meter system problems: none
measurement accuracy: good - see below, and also reference RST data. Stable P and Q
other problems that may affect results: none

Test Interpretation

K values: **4.9E-08 m/s**

"type curve" interpretation: **ideal**

Appendix E - Diagnostic Plots

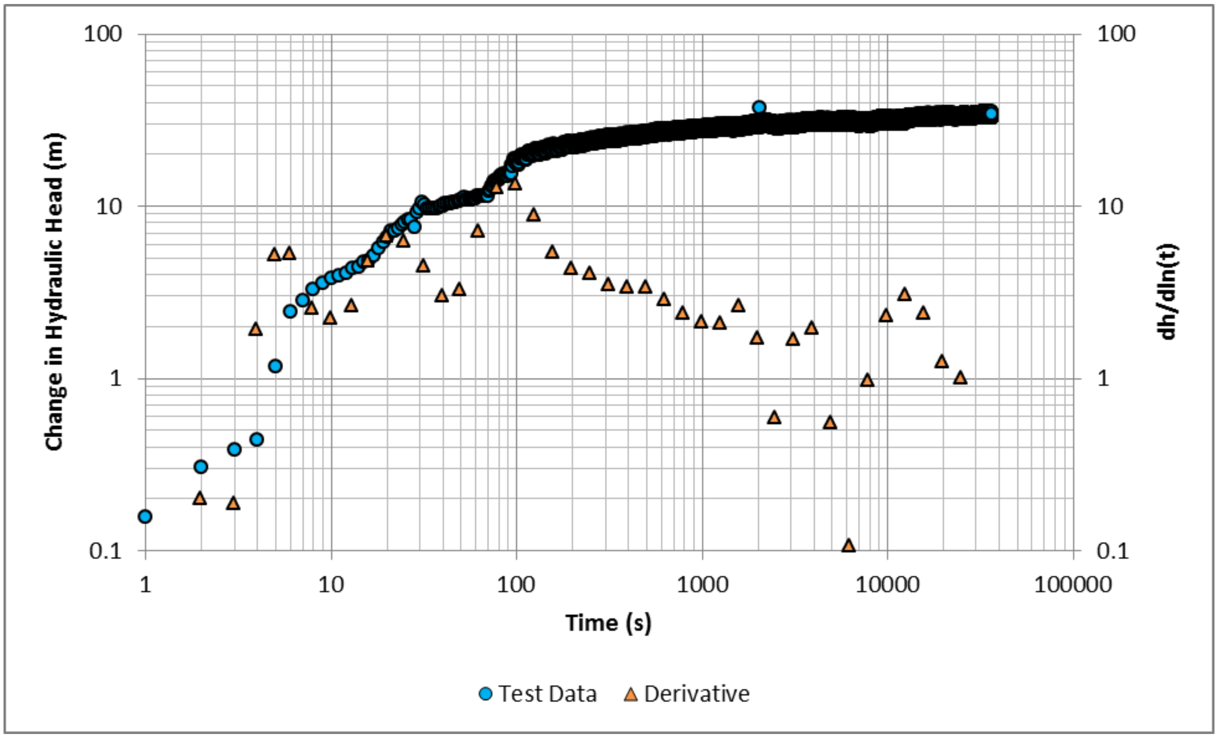


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Figure 1: Log-log diagnostic plot for injection well data during long-term injection test.

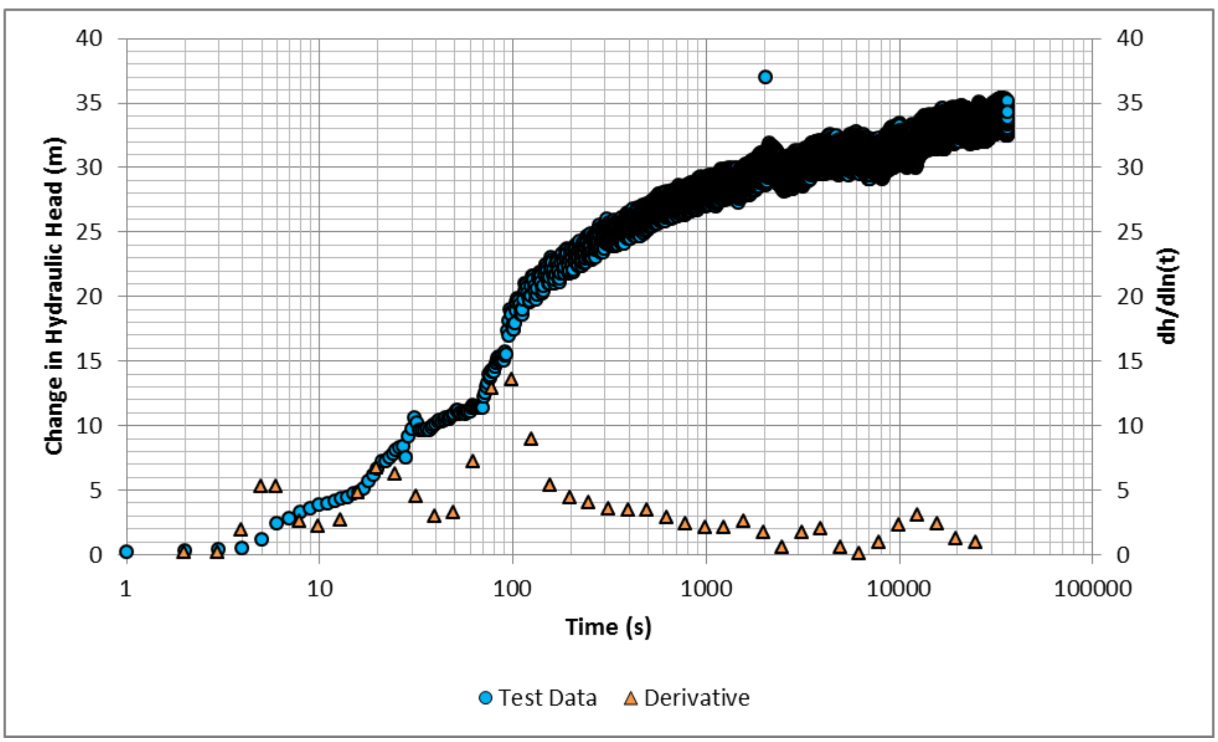

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Figure 2: Semi-log diagnostic plot for injection well data during long-term injection test.

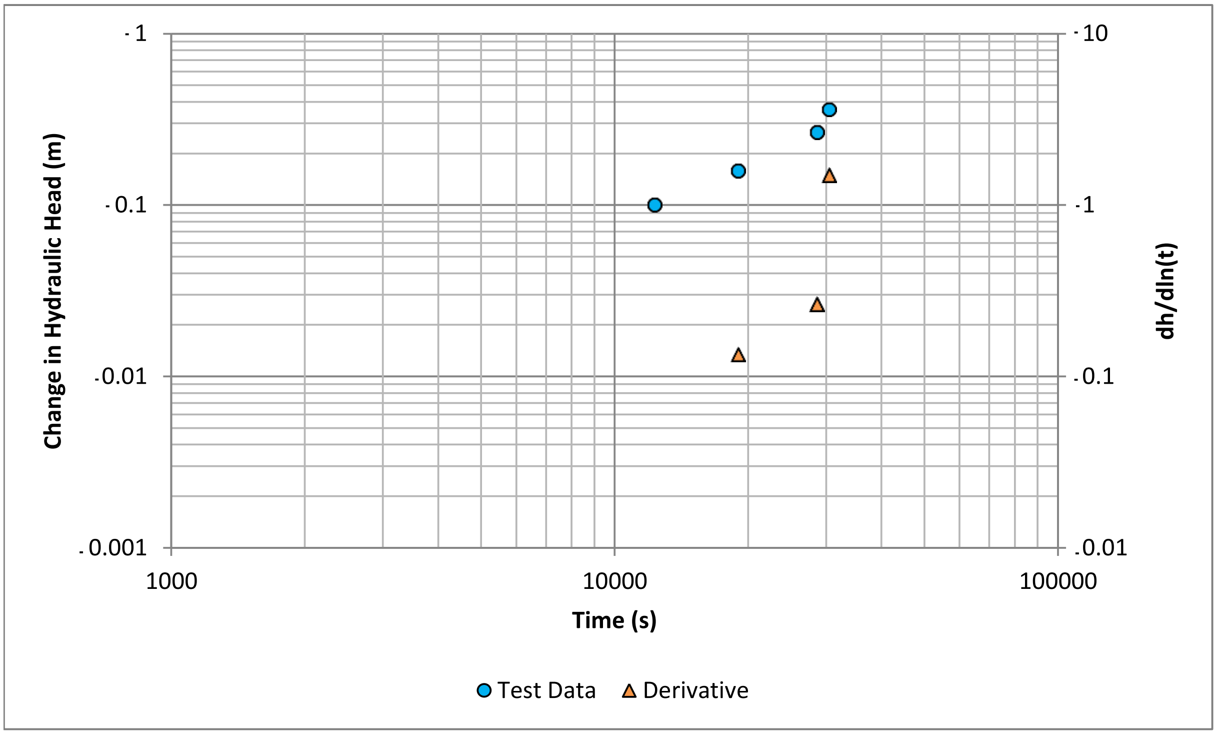

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Figure 3: Log-log diagnostic plot for 10WBW001 Zone 3 data during long-term injection test.

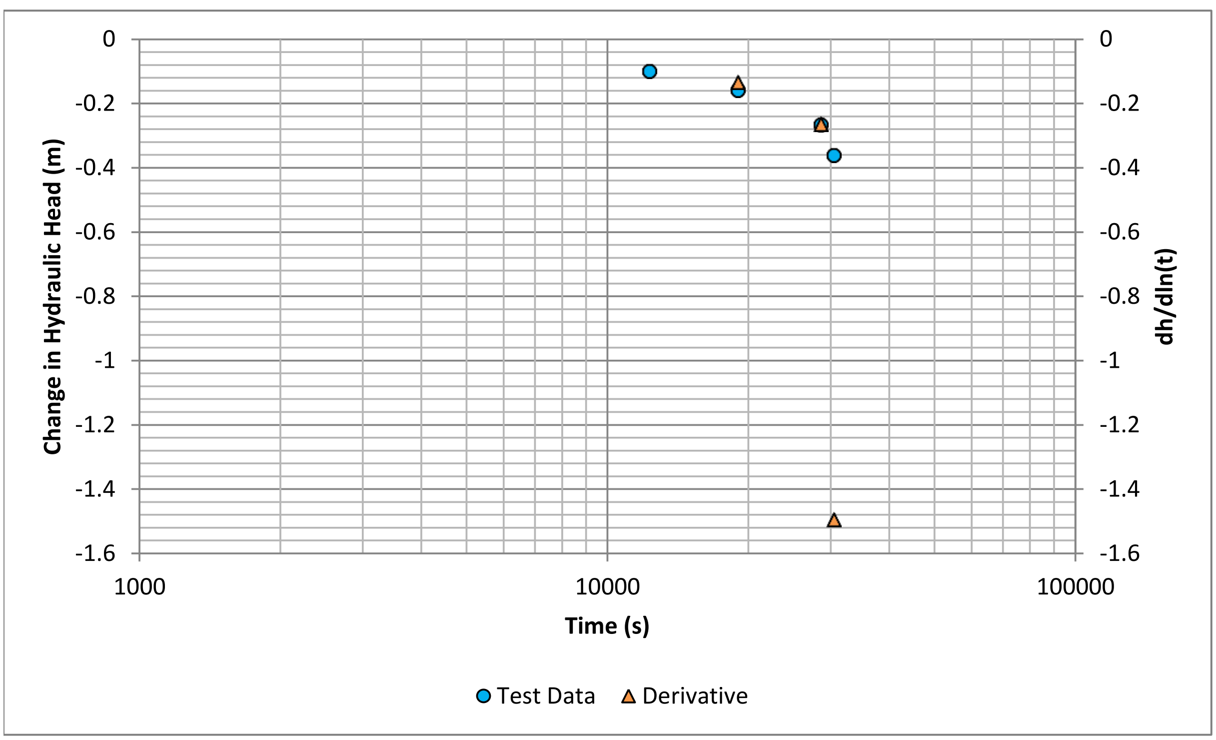

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Figure 4: Semi-log diagnostic plot for 10WBW001 Zone 3 data during long-term injection test.

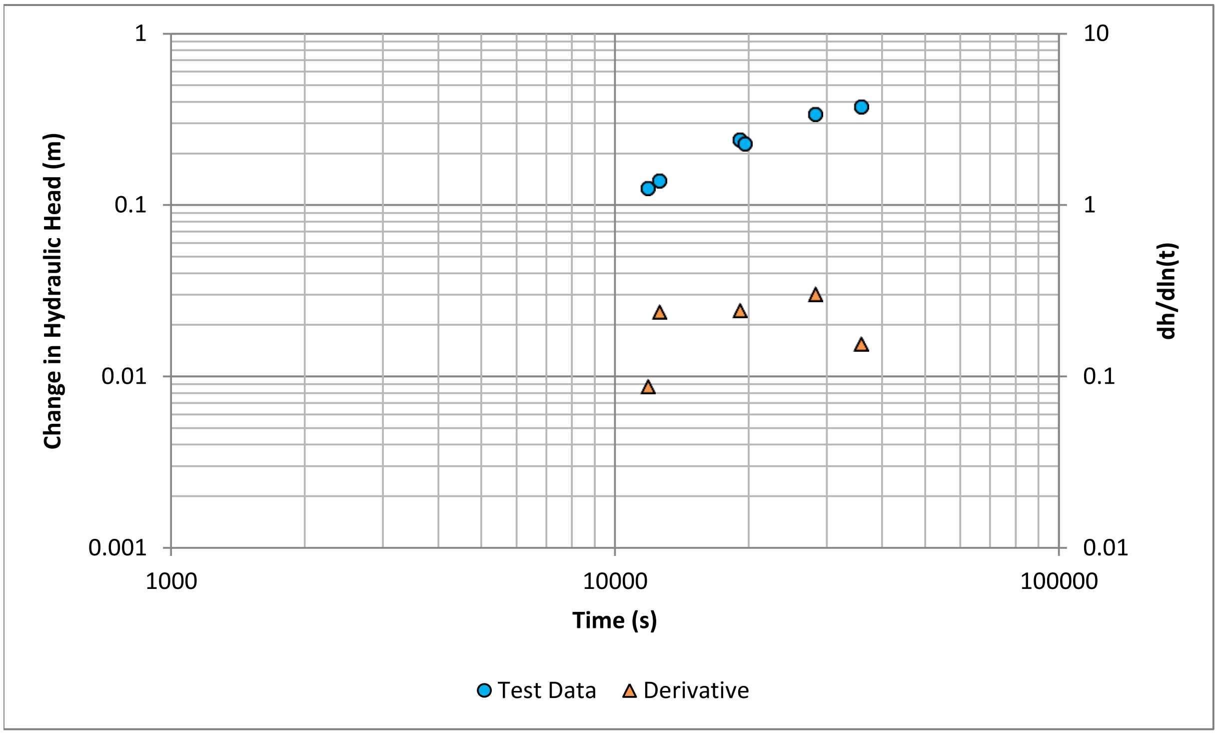

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Figure 5: Log-log diagnostic plot for 10WBW001 Zone 4 data during long-term injection test.

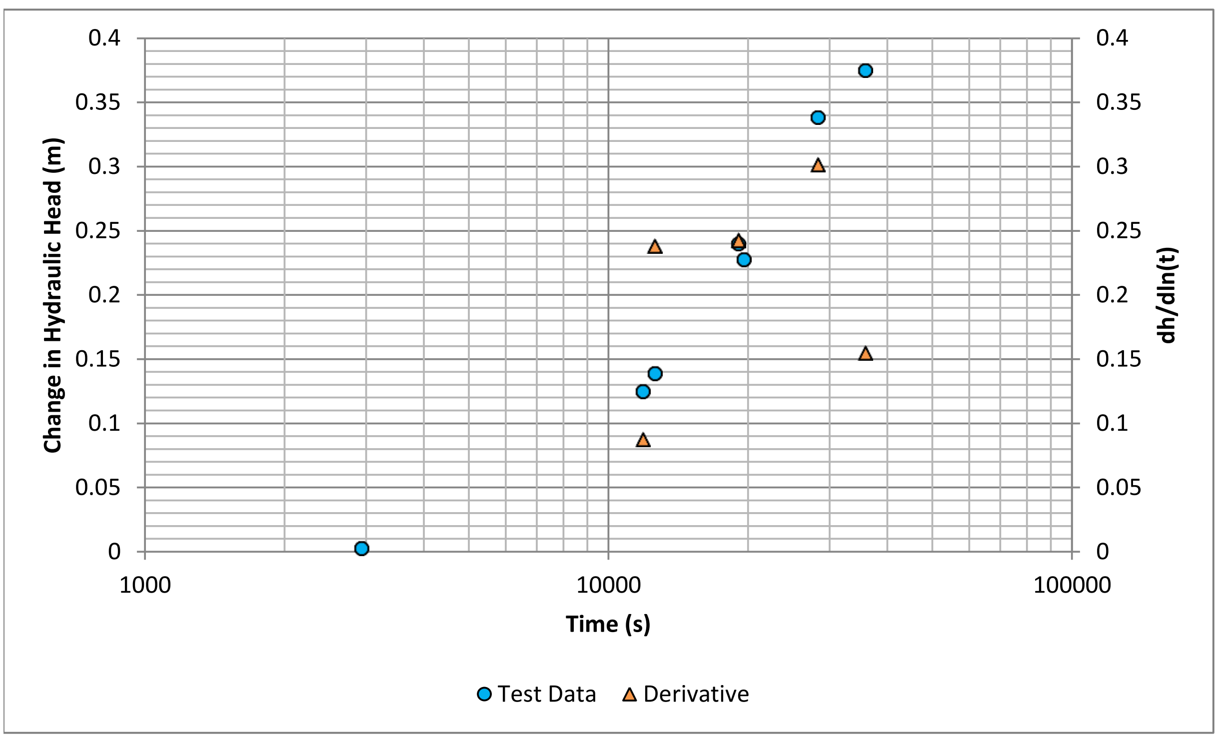

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Figure 6: Semi-log diagnostic plot for 10WBW001 Zone 4 data during long-term injection test.

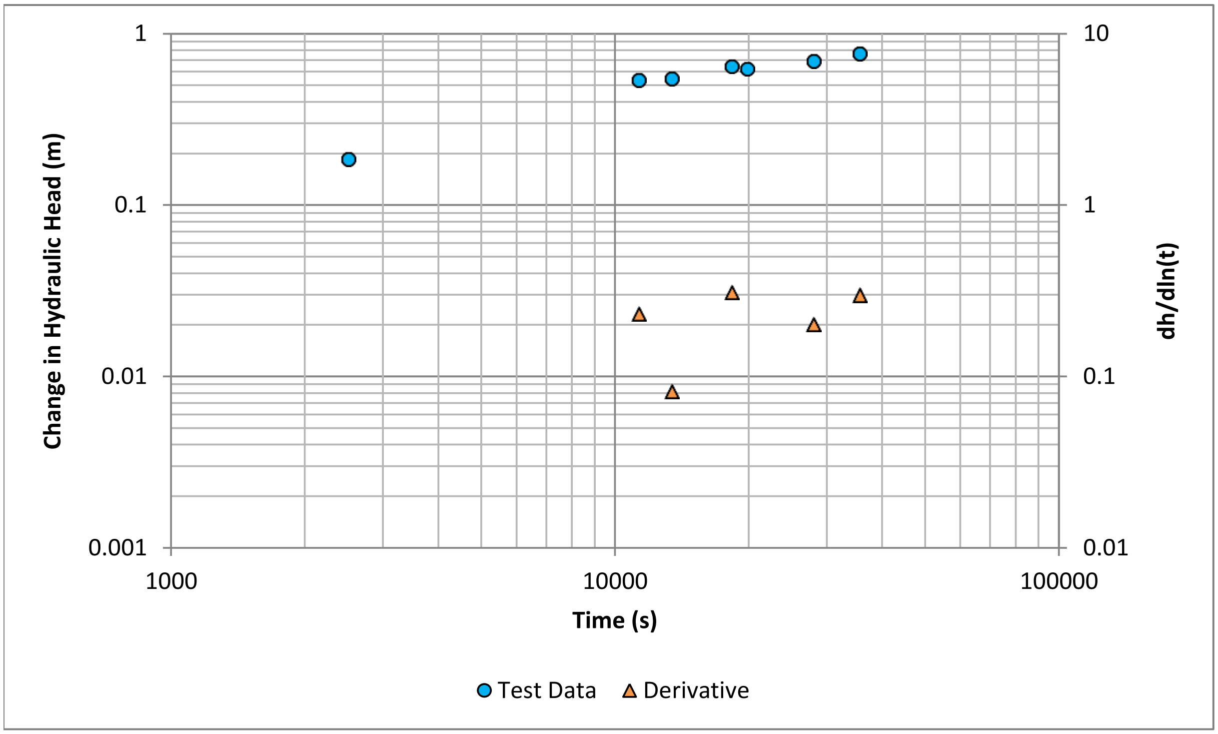

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Figure 7: Log-log diagnostic plot for 10WBW001 Zone 5 data during long-term injection test.

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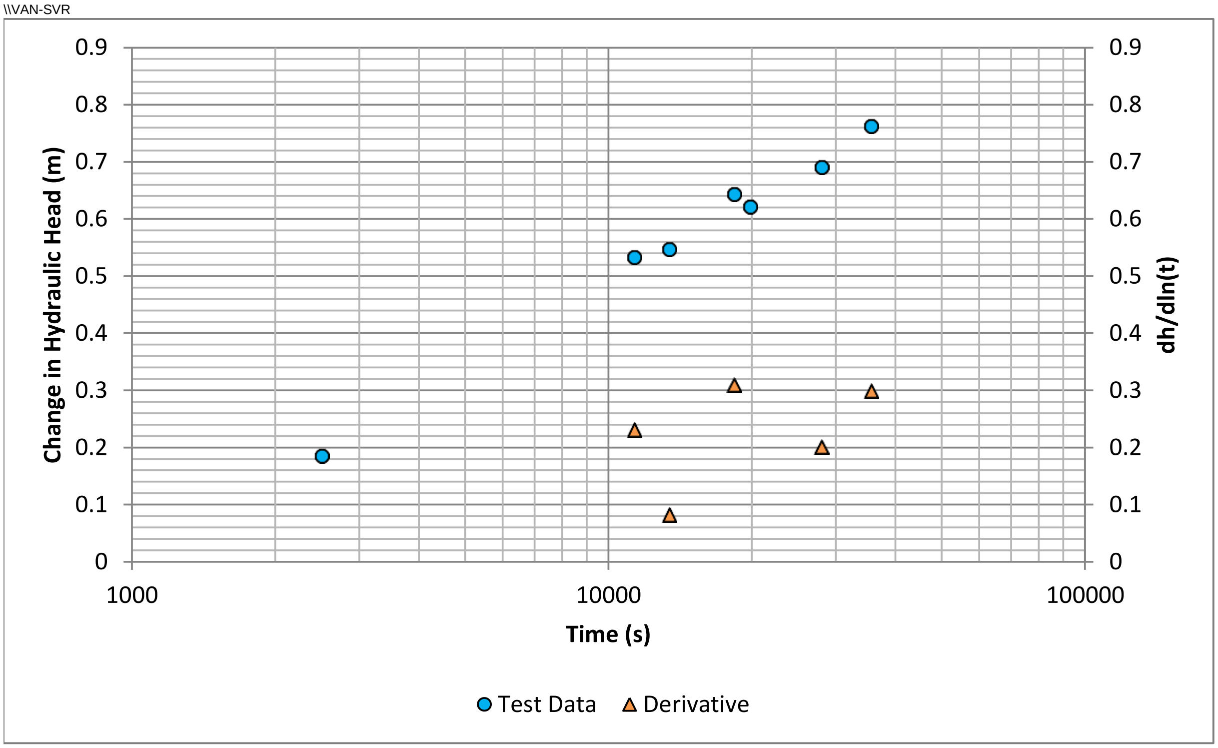

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Figure 8: Semi-log diagnostic plot for 10WBW001 Zone 5 data during long-term injection test.

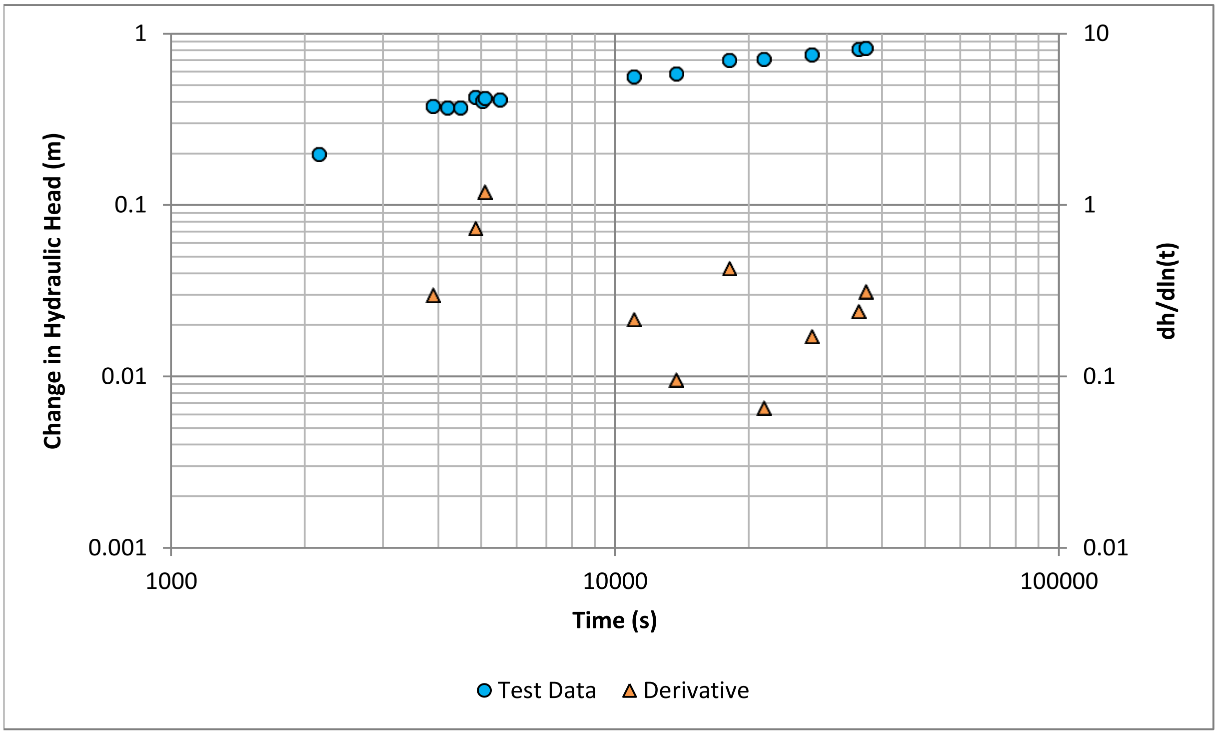

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Figure 9: Log-log diagnostic plot for 10WBW001 Zone 6 data during long-term injection test.

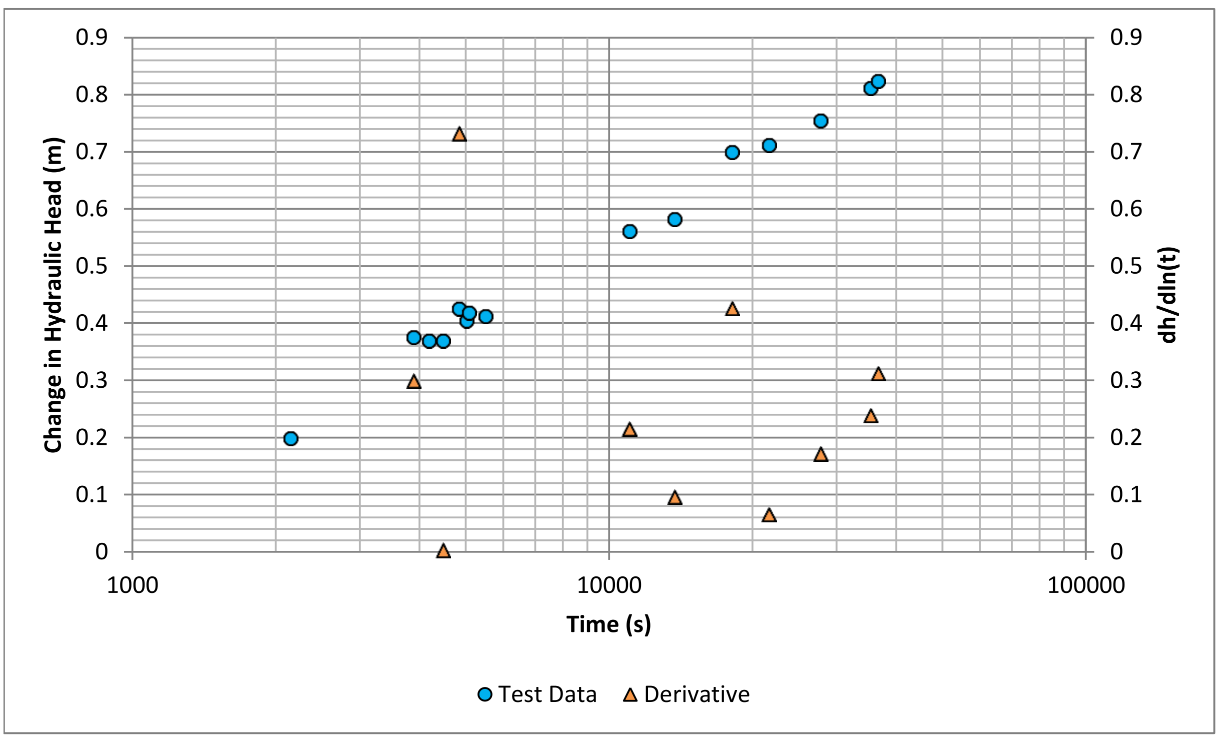

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Figure 10: Semi-log diagnostic plot for 10WBW001 Zone 6 data during long-term injection test.

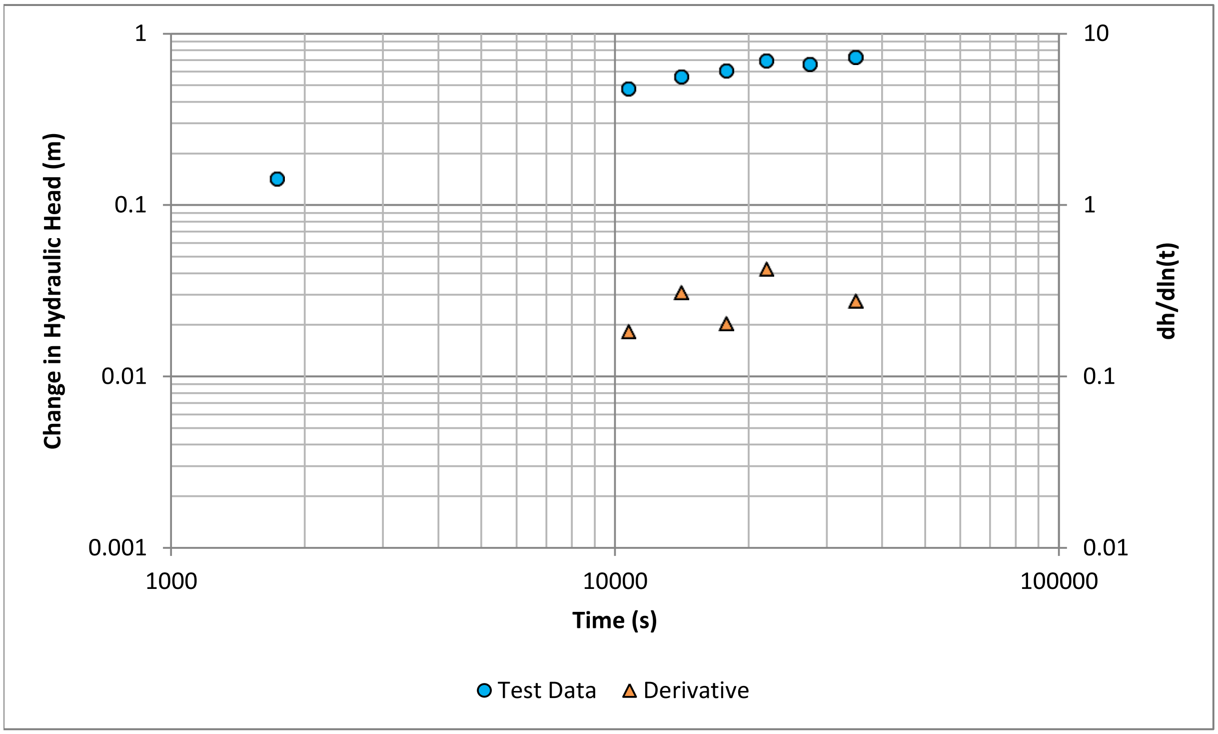

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Figure 11: Log-log diagnostic plot for 10WBW001 Zone 7 data during long-term injection test.

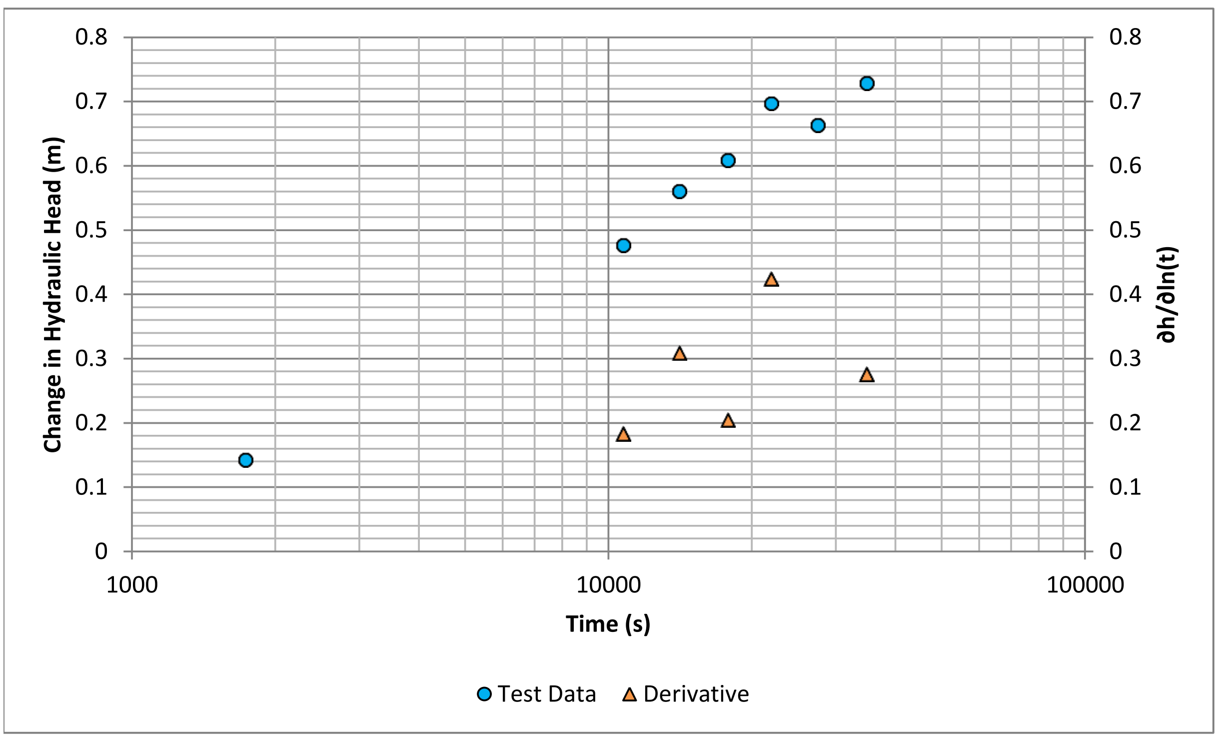

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Figure 12: Semi-log diagnostic plot for 10WBW001 Zone 7 data during long-term injection test.

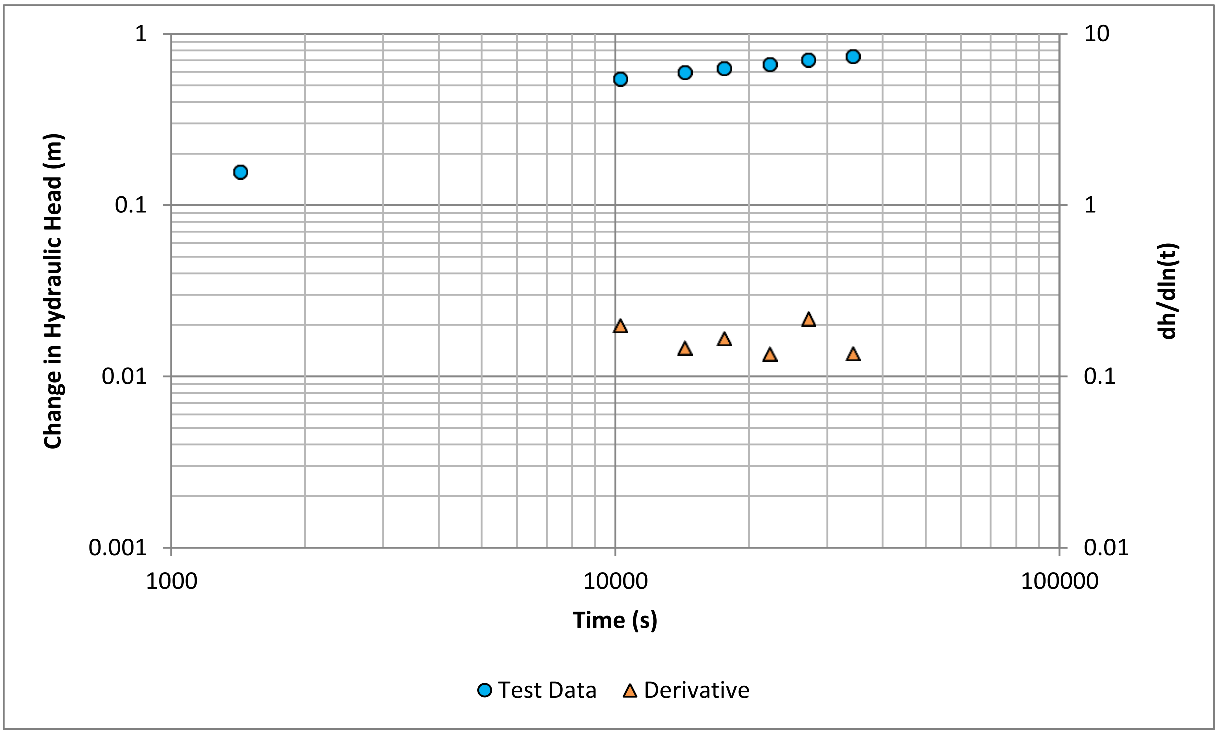

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Figure 13: Log-log diagnostic plot for 10WBW001 Zone 8 data during long-term injection test.

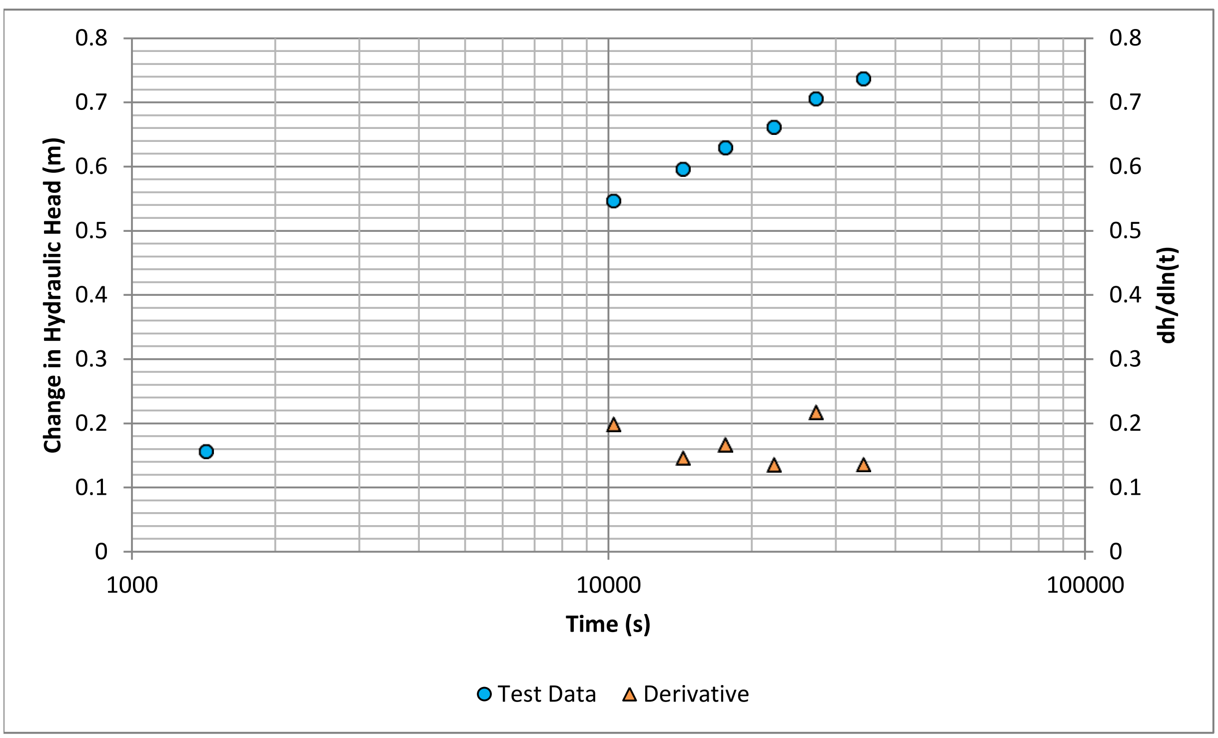

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Figure 14: Semi-log diagnostic plot for 10WBW001 Zone 8 data during long-term injection test.

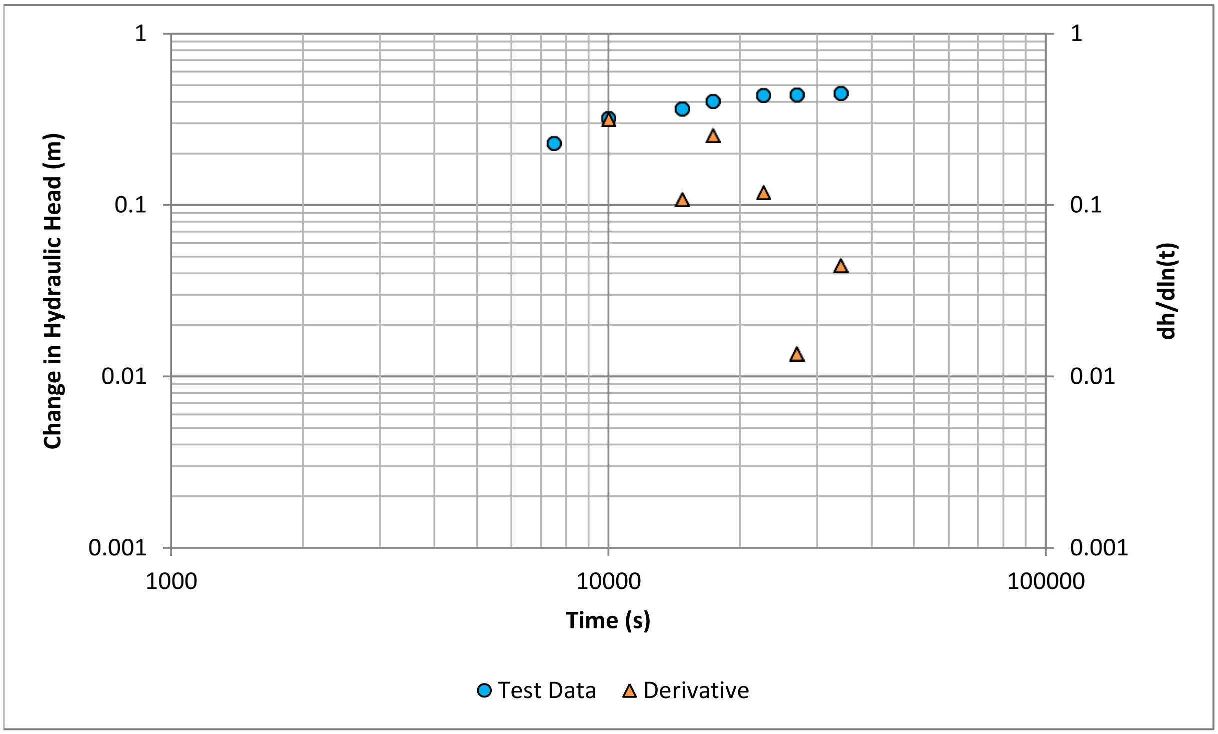

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Figure 15: Log-log diagnostic plot for 10WBW001 Zone 9 data during long-term injection test.

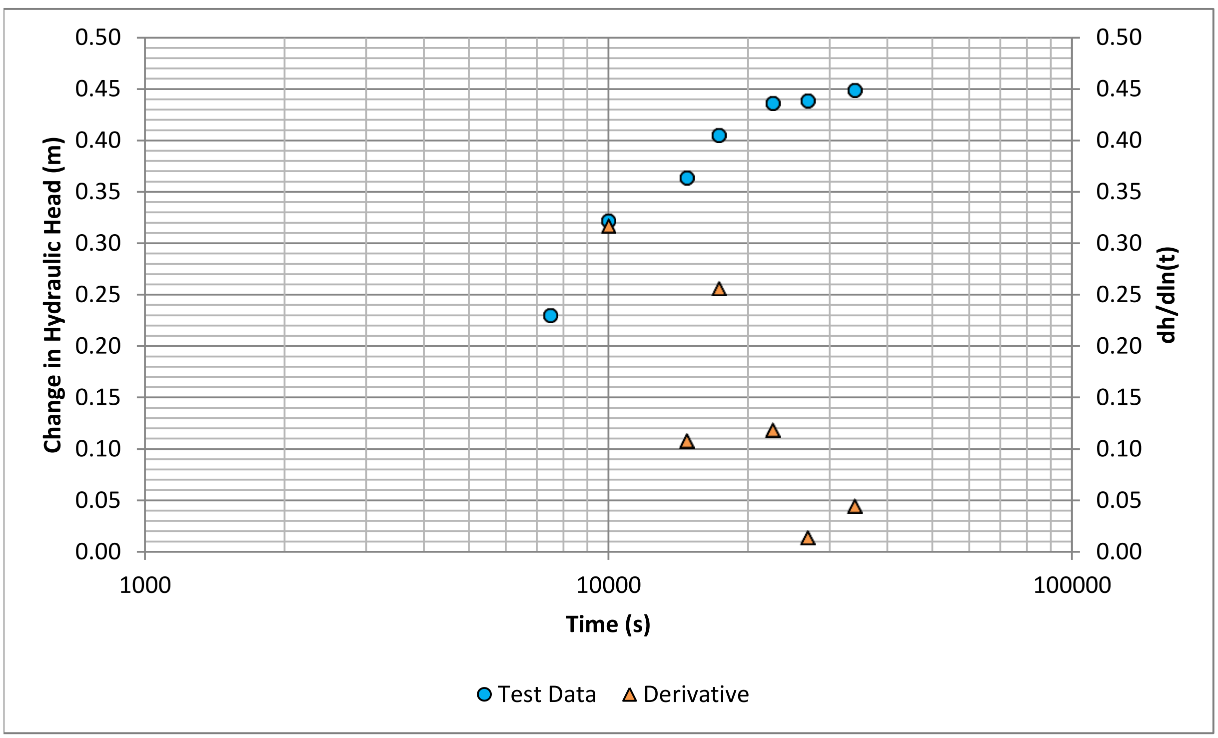

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Figure 16: Semi-log diagnostic plot for 10WBW001 Zone 9 data during long-term injection test.

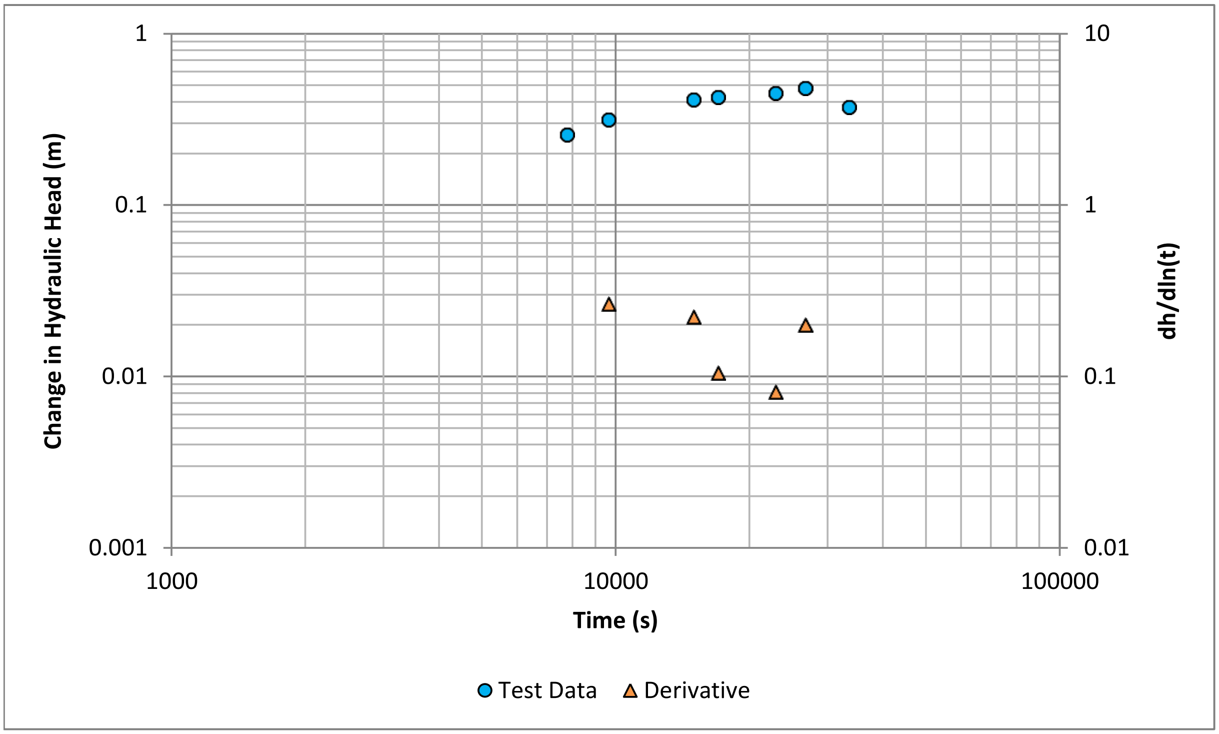

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Figure 17: Log-log diagnostic plot for 10WBW001 Zone 10 data during long-term injection test.

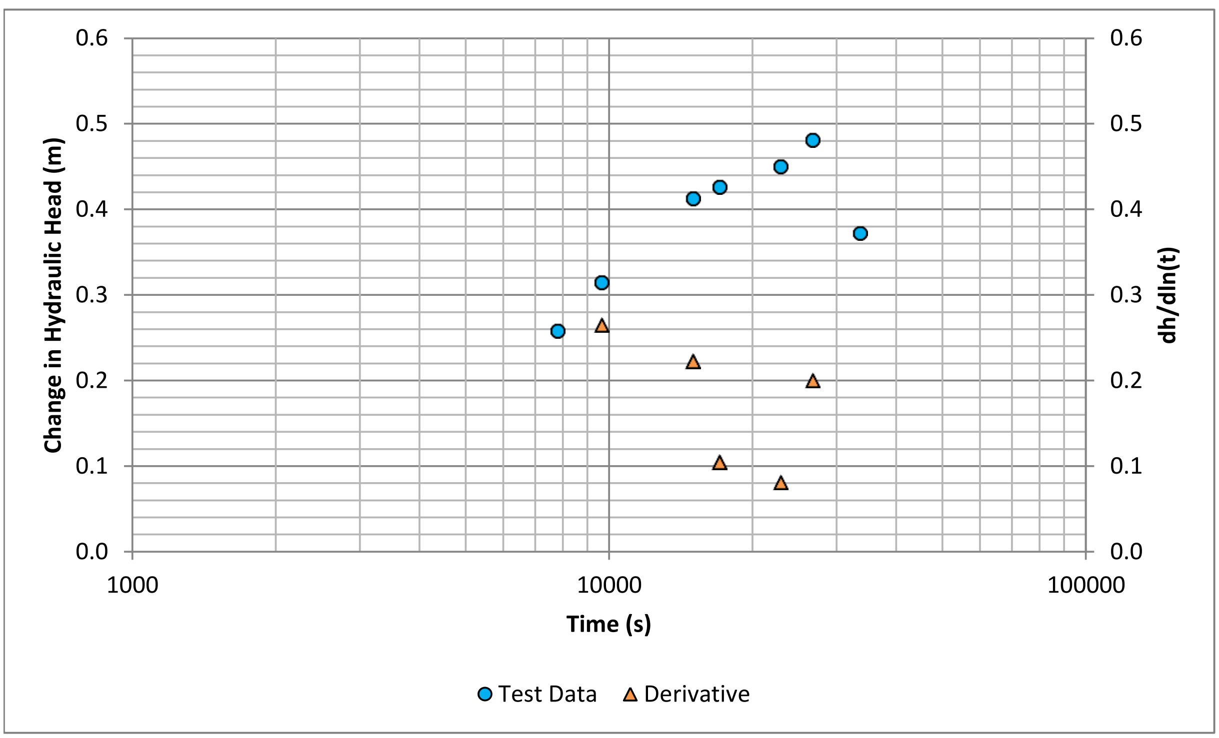

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Figure 18: Semi-log diagnostic plot for 10WBW001 Zone 10 data during long-term injection test.

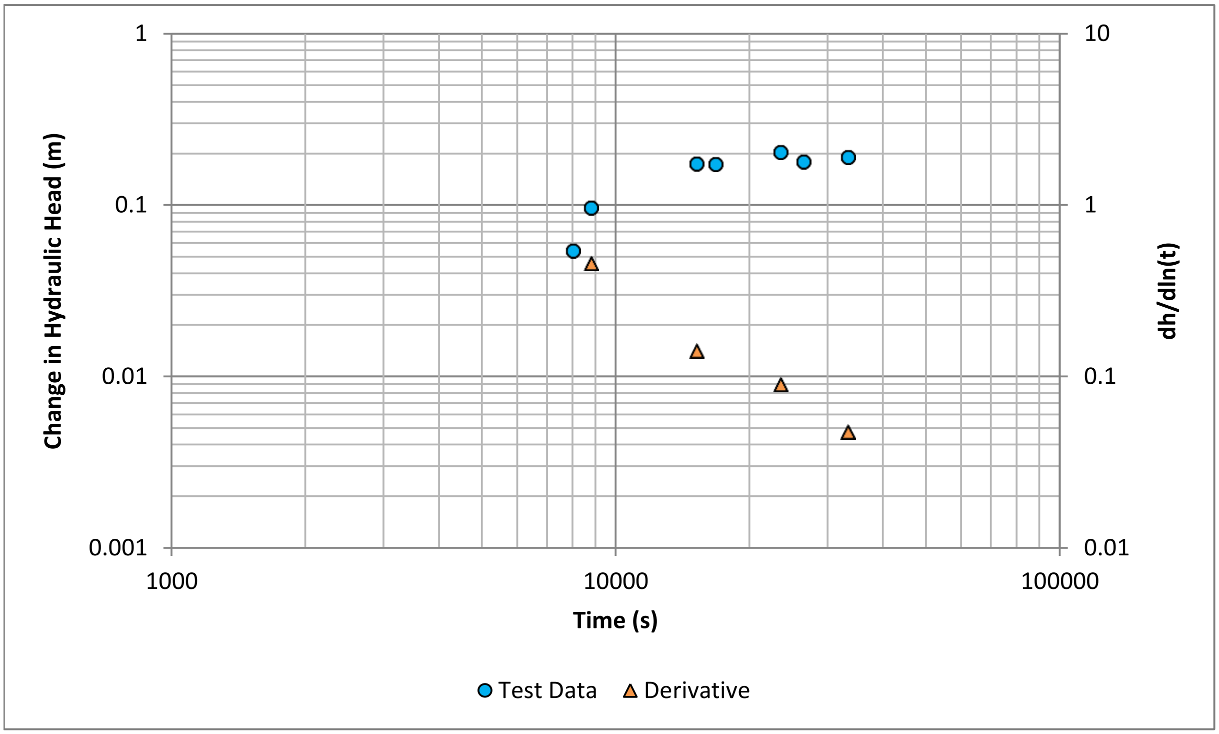

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Figure 19: Log-log diagnostic plot for 10WBW001 Zone 11 data during long-term injection test.

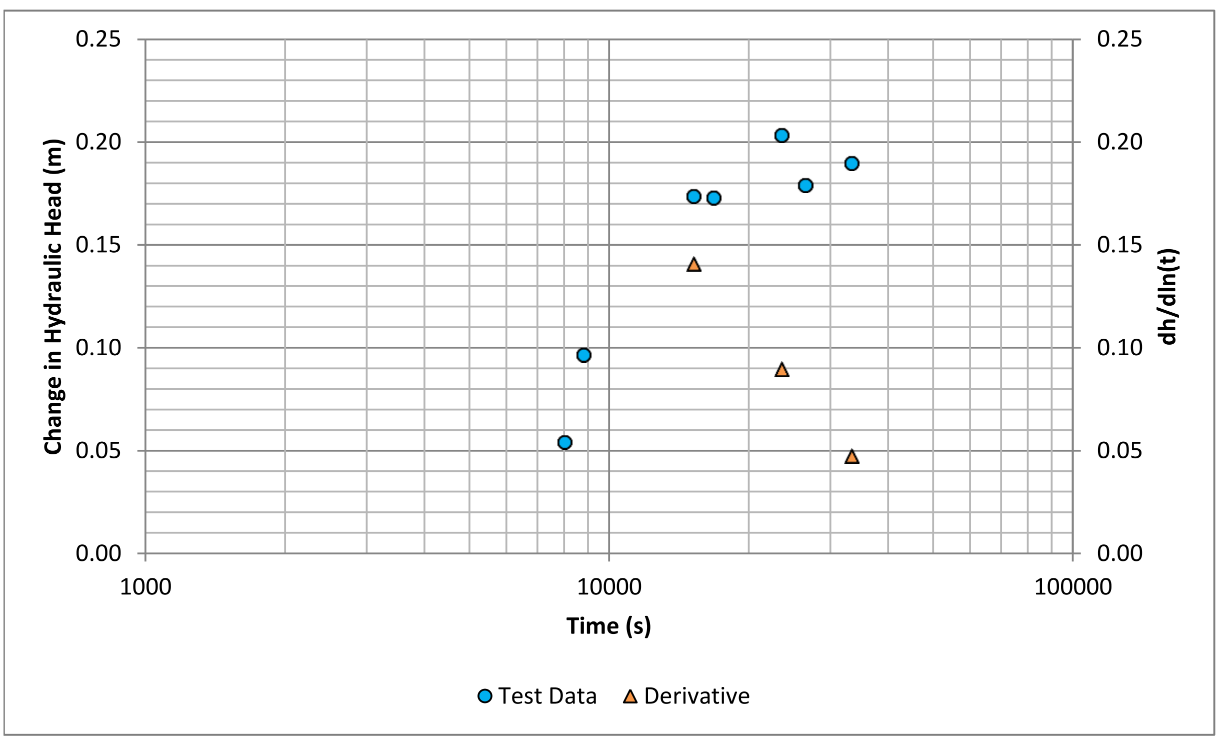

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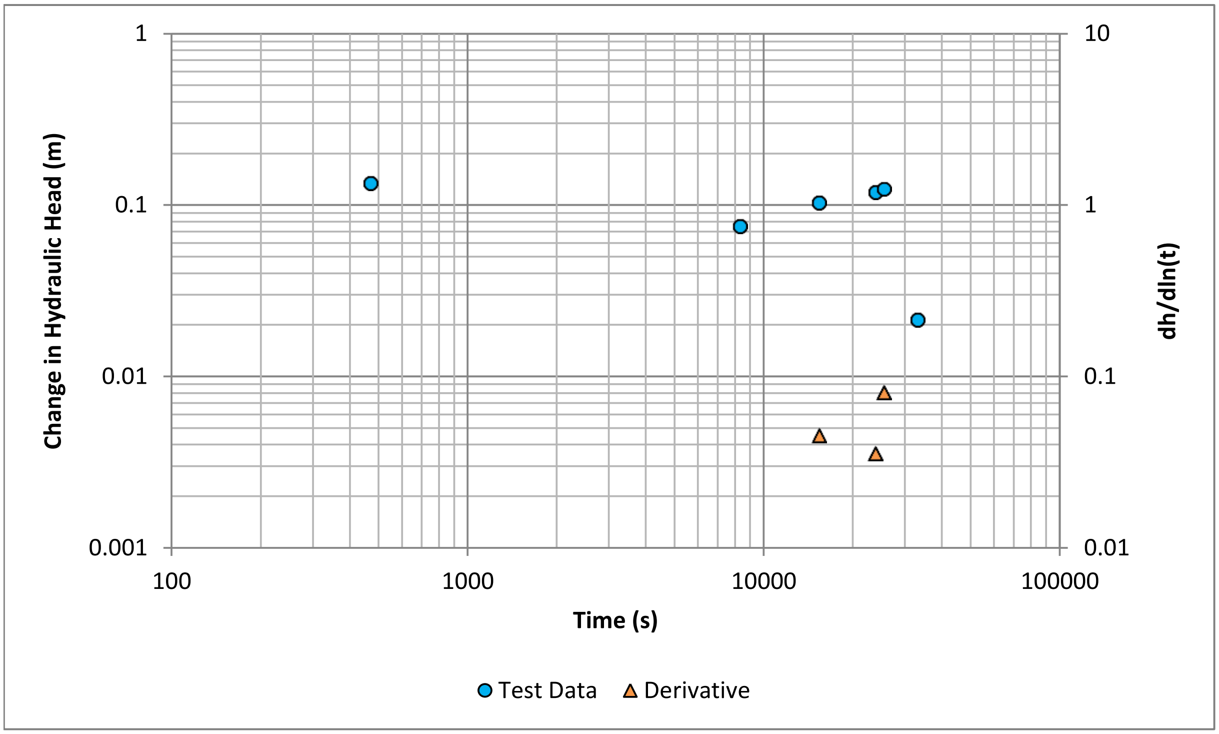
Figure 20: Semi-log diagnostic plot for 10WBW001 Zone 11 data during long-term injection test.



\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\Long term injection test\Diagnostic_Plots-12hr_Injection_Test-092711-jm-rev01.xlsx

Figure 21: Log-log diagnostic plot for 10WBW001 Zone 12 data during long-term injection test.

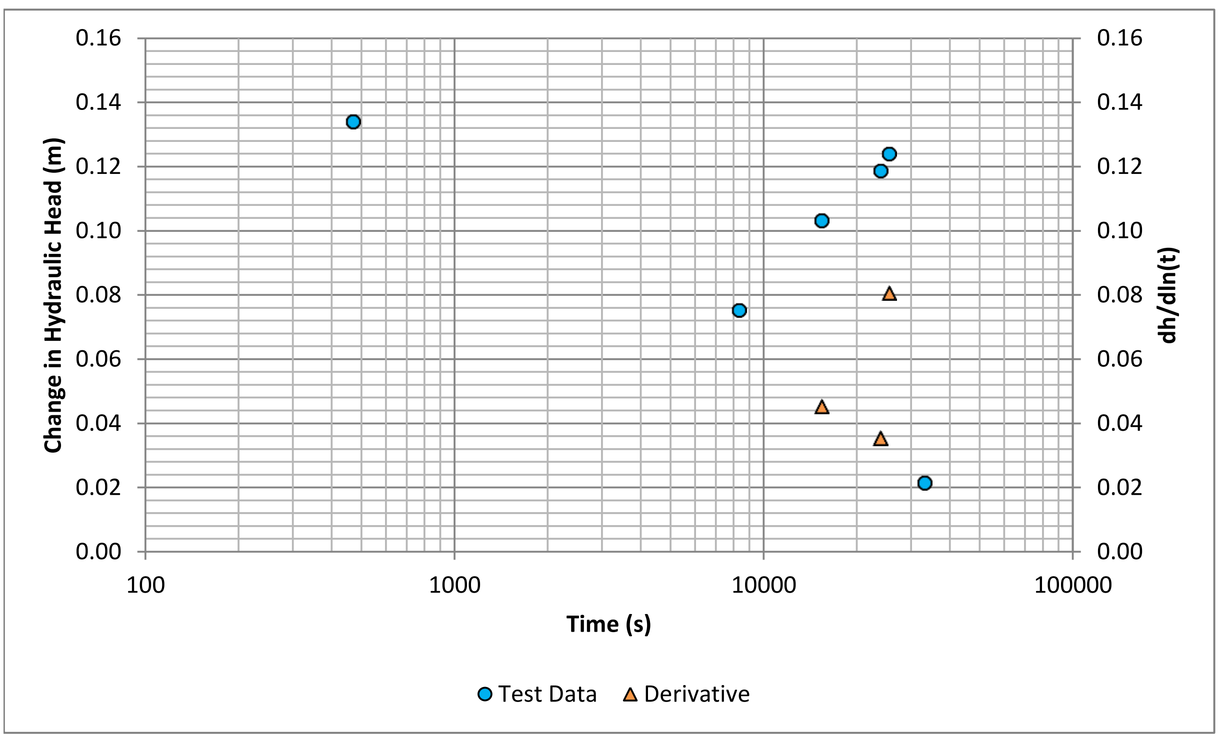


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Figure 22: Semi-log diagnostic plot for 10WBW001 Zone 12 data during long-term injection test.

Appendix F - Hydraulic Conductivity Assessment

Table 1: All Doris Central and Connector Packer Test Results.

Test Information						Test Interval - Depth along hole (m)			Test Interval - Vertical depth (m)			Hydraulic Conductivity (m/s)	Test Description																	
Newmont Drillhole ID	SRK Drillhole ID	Area	Sub-Area	Test Number	Date	Top	Bottom	Interval length	Top	Bottom	Interval length		Test Zone Lithology	Talik/ Frozen	Shallow basalt (<100m)	Deep Basalt (100m+)	Basalt (altered or not)	Alteration near mineralized zone	Joints near quartz veins	Main Diabase	Main diabase contact	Vugs near diabase contact	Other dykes	Other dyke contacts	Felsic Volcanics	Sedimentary Rocks	Modelled fault	Unmodelled fault	Ore Zone	Structure
08TDD628	08DHGT13	Doris	Central	1	5/27/08	52.2	141	88.8	46.2	124.8	78.6	2.0E-08	Deformation zone with basalts and foliation	Talik	Y	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
08TDD630	08DHGT14	Doris	Central	1	5/29/08	32.2	62	29.8	29.1	56.2	27.0	1.2E-07	Basalt	Talik	Y	N	Y	Y	N	N	N	N	N	N	N	N	Y	N	N	N
08TDD630	08DHGT14	Doris	Central	2	5/30/08	99.2	134	34.8	89.9	121.4	31.5	2.4E-07	Foliated Basalt	Talik	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
08TDD630	08DHGT14	Doris	Central	3	5/31/08	138.2	164	25.8	125.3	148.6	23.4	1.3E-08	Foliated Basalt	Talik	N	Y	Y	Y	Y	N	N	N	Y	Y	N	N	N	N	N	N
08TDD630	08DHGT14	Doris	Central	4	6/1/08	166.2	195	28.8	150.6	176.7	26.1	2.2E-08	Basalt and diabase contact	Talik	N	Y	Y	Y	N	N	N	N	Y	Y	N	N	N	N	N	N
08TDD630	08DHGT14	Doris	Central	5	6/3/08	201.2	263	61.8	182.3	238.4	56.0	6.6E-08	Basalt-diabase-gabbro; quartz veining	Talik	N	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N	N	N
08TDD631	08DHGT12a	Doris	Central	1	6/1/08	39.2	65	25.8	38.6	64.0	25.4	3.5E-08	Foliated Basalt w calcite and dolomite veining	Talik	Y	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
08TDD631	08DHGT12a	Doris	Central	2	6/3/08	96.2	122	25.8	94.7	120.1	25.4	3.5E-09	Basalt	Talik	Y	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
08TDD633	08DHGT15	Doris	Central	1	6/8/08	15.2	50	34.8	12.5	41.0	28.5	3.6E-10	Foliated Basalt	Frozen	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N
08TDD633	08DHGT15	Doris	Central	2	6/11/08	156.2	218	61.8	128.0	178.6	50.6	6.3E-11	Foliated Basalt	Frozen	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
08TDD633	08DHGT15	Doris	Central	3	6/13/08	279.2	341	61.8	228.7	279.3	50.6	3.4E-09	Foliated Basalt	Partially frozen	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N
08TDD633	08DHGT15	Doris	Central	4	6/15/08	357.2	401	43.8	292.6	328.5	35.9	4.8E-11	Diabase/foliated basalt contact - mostly in diabase; RZ at 357m along upper contact	Talik	N	Y	Y	Y	N	Y	Y	N	N	N	N	N	N	N	N	Y
10WBW001	10WBW001	Doris	Central	1	4/17/10	25	63	38	22.1	55.8	33.6	1.4E-06	Fractured basalt. Loss of circulation during drilling in this zone.	Talik	Y	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N
10WBW001	10WBW001	Doris	Central	2	4/18/10	64	102	38	56.7	90.3	33.6	4.7E-07	Fractured basalt with foliation. Jointed diabase in test zone, contact also jointed.	Talik	Y	N	Y	Y	N	N	N	N	Y	Y	N	N	N	N	N	N
10WBW001	10WBW001	Doris	Central	4	4/19/10	103	144.5	41.5	91.2	128.0	36.7	2.8E-07	[packer bybass ignore results]	Talik	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
10WBW001	10WBW001	Doris	Central	3	4/19/10	121.5	144.5	23	107.6	128.0	20.4	3.8E-07	[packer bybass ignore results]	Talik	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
10WBW001	10WBW001	Doris	Central	6	4/20/10	103	154	51	91.2	136.4	45.2	5.2E-08	Same as test 6a and 5.	Talik	N	Y	Y	Y	N	N	N	N	N	N	N	N	Maybe	Maybe	N	N
10WBW001	10WBW001	Doris	Central	6a	4/20/10	103	204.8	101.8	91.2	181.3	90.1	2.7E-08	Competent basalt, small shears possible including alpha fault?, foliation. Test result determined by subtracting result from test 6a from test 5.	Talik	N	Y	Y	Y	N	N	N	N	N	N	N	N	Maybe	Maybe	N	Y
10WBW001	10WBW001	Doris	Central	5	4/20/10	154	204.8	50.8	136.4	181.3	45.0	2.6E-09	Altered and foliated basalt, some heavy foliation but low joint frequency.	Talik	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N
10WBW001	10WBW001	Doris	Central	7	4/21/10	203	252	49	179.7	223.1	43.4	9.4E-08	Basalt with quartz veins and two small dykes. Higher FF/m around dykes. Slow artesian flow from rods before test, shut in pressure low, artesian head ~ 3m above Doris Lk level estimate. Formation could be pressurized from other drills.	Talik	N	Y	Y	Y	Y	N	N	N	Y	Y	N	N	N	N	N	N
10WBW001	10WBW001	Doris	Central	8	4/22/10	252	279	27	223.1	247.0	23.9	1.5E-06	Basalt, quartz and dolomite veins (2m) with fractures (no recovery). Main ore body. Loss of pressue during drilling, artesian flow source, and also reach limit of injection rate.	Talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	Maybe	Maybe	N	Y
10WBW001	10WBW001	Doris	Central	8a	4/22/10	252	297	45	223.1	263.0	39.8	9.2E-07	Same as test 8 and 9.	Talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	Maybe	Maybe	N	Y
10WBW001	10WBW001	Doris	Central	9	4/22/10	279	297	18	247.0	263.0	15.9	9.6E-09	Basalt, a few rubble zones or small faults between the altered baslat zones.	Talik	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	Y
10WBW001	10WBW001	Doris	Central	10	4/23/10	297	345	48	263.0	305.5	42.5	7.2E-09	Altered foliated basalt, intermediate dyke with broken contact, unaltered basalt.	Talik	N	Y	Y	Y	N	N	N	N	Y	Y	N	N	N	N	N	Y
10WBW001	10WBW001	Doris	Central	11	4/24/10	345	387	42	305.5	342.6	37.2	2.7E-08	Basalt. Major diabase upper contact with only minor jointing.	Talik	N	Y	Y	N	N	Y	Y	N	N	N	N	N	N	Maybe	N	N

10WBW001	10WBW001	Doris	Central	12	4/25/10	387	422.5	35.5	342.6	374.1	31.4	1.4E-11	Diabase, very low FF/m.	Talik	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N
10WBW001	10WBW001	Doris	Central	13	4/26/10	423	471	48	374.5	417.0	42.5	1.4E-11	Diabase, very low FF/m.	Talik	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N
10WBW001	10WBW001	Doris	Central	14	4/28/10	471	564	93	417.0	499.4	82.3	5.1E-09	Major diabase lower contact, then fractured foliated vuggy basalt below. 83% of test zone is low FF/m diabase.	Talik	N	Y	Y	N	N	Y	Y	Y	N	N	N	N	N	N	N	N
10WBW001	10WBW001	Doris	Central	14 a	4/28/10	547.95	564	16.05	485.2	499.4	14.2	2.9E-08	The result from test 14 if flow only came from the vuggy basalt below the diabase.	Talik	N	Y	Y	N	N	Y	Y	Y	N	N	N	N	N	N	N	N
11TDD763	DUC-10	Doris	Central	1	3/11/11	52.3	207	154.7	43.86	173.6	129.7	7.3E-08	Mafic volcanic flow w 5m ore zone and 5m dyke	unknow n	Y	Y	Y	Y	N	N	N	N	Y	Y	N	N	N	N	Y	N
11TDD764	DUC-20	Doris	Central	1	3/14/11	41.4	131.1	89.7	35.5	112.4	76.9	2.0E-07	Mafic volcanic pillow w Gabbro intrusion (95-114m), occasional mafic dyke	Talik	Y	Y	Y	N	N	N	N	N	Y	Y	N	N	N	N	N	N
11TDD764	DUC-20	Doris	Und Con	2	3/19/11	264.3	341.1	76.8	211.1	272.4	61.3	4.2E-09	Mafic volcanic pillow w ore zones (275-276m, 293-296m).	Talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	N
11TDD766	DCGT-05	Doris	Central	1	3/22/11	28.75	51.15	22.4	24.9	44.2	19.4	1.8E-06	Mafic volcanic flow w felsic dyke (28-34m)	Talik	Y	N	Y	N	N	N	N	N	Y	Y	Y	N	N	N	N	N
11TDD766	DCGT-05	Doris	Central	2	3/23/11	101.75	130.45	28.7	88.1	113.0	24.9	8.9E-10	Mafic volcanic pillow	Talik	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N
11TDD766	DCGT-05	Doris	Central	3	3/25/11	198.85	240.25	41.4	172.2	208.1	35.9	4.2E-08	Mafic volcanic flow	talik	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N
11TDD768	DCGT-07	Doris	Central	1	3/30/11	69.4	104.2	34.8	60.7	91.1	30.4	1.3E-07	Mafic volcanic pillow foliated basalt w volcanic flow feldspar (82-86m)	talik	Y	N	Y	N	N	N	N	N	Y	Y	Y	N	N	N	N	N
11TDD768	DCGT-07	Doris	Central	2	3/31/11	111.4	152.2	40.8	97.4	133.1	35.7	3.5E-09	Mafic volcanic pillow (foliated basalt) w ore zone (122-131m)	talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	Y	Y	N
11TDD768	DCGT-07	Doris	Central	5	4/3/11	234.4	269.2	34.8	196.6	225.8	29.2	1.7E-08	Mafic volcanic pillow (foliated basalt) w ore zone (231-247m)	talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	N
11TDD768	DCGT-07	Doris	Central	4	4/3/11	225.4	269.2	43.8	191.2	228.3	37.1	1.8E-08	Mafic volcanic pillow (foliated basalt) w ore zone (231-247m)	talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	N
11TDD768	DCGT-07	Doris	Central	6	4/4/11	267.43	299.2	31.77	224.3	250.9	26.6	5.9E-07	Mafic volcanic pillow (foliated basalt)	talik	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N
11TDD769	DCGT-22a	Doris	Central	1	4/7/11	30.4	38.2	7.8	28.0	35.2	7.2	5.9E-07	Mafic volcanic pillow (foliated basalt); major structure (20cm) shear zone	talik	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y
11TDD769	DCGT-22a	Doris	Central	2	4/9/11	129.4	143.2	13.8	117.3	129.8	12.5	2.9E-06	Mafic volcanic pillow (foliated basalt); major joints with gouge present	talik	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y
11TDD769	DCGT-22a	Doris	Central	3	4/10/11	189.4	200.2	10.8	170.2	179.9	9.7	7.5E-07	Mafic volcanic pillow (foliated basalt); natural rubble zone present	talik	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y
11TDD769	DCGT-22a	Doris	Central	1s s	4/12/11	129.1	290	160.9	117.9	264.9	147.0	3.2E-08	Primarily Mafic volcanic pillow, w 3m gabbro and 5m diabase intrusion, + ore zone.	Talik	N	Y	Y	Y	Y	N	N	N	Y	Y	N	N	N	N	Y	N
11TDD769	DCGT-22a	Doris	Central	2s s	4/12/11	153.1	290	136.9	139.9	264.9	125.1	1.0E-07	Primarily Mafic volcanic pillow, w 3m gabbro and 5m diabase intrusion, + ore zone.	Talik	N	Y	Y	Y	Y	N	N	N	Y	Y	N	N	N	N	Y	N
11TDD771	DCGT-14	Doris	Central	1	4/21/11	48.6	74.25	25.65	47.9	73.1	25.3	3.4E-08	Mafic volcanic pillow (foliated basalt)	Talik	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N
11TDD771	DCGT-14	Doris	Central	2	4/24/11	112.3	135	22.7	110.2	132.5	22.3	1.7E-08	Primarily quartz (ore zone) w mafic volcanic pillow (112-118m)	Talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	N
11TDD771	DCGT-14	Doris	Central	3	4/26/11	118.3	162	43.7	115.7	158.5	42.7	5.4E-10	Primarily quartz (discontinuous) w mafic volcanic pillow (153-162m); small structure	Talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	Y
11TDD771	DCGT-14	Doris	Central	4	4/27/11	151.3	198	46.7	148.0	193.7	45.7	7.1E-08	Primarily volcanic pillow w quartz (ore zone, 166-171m); structure at ore zone contact	Talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	Y
11TDD771	DCGT-14	Doris	Central	5	4/27/11	181.3	198	16.7	177.3	193.7	16.3	1.9E-07	Primarily quartz (discontinuous) w mafic volcanic pillow (181-186m); structure at contact with ore	Talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	Y	Y
11TDD771	DCGT-14	Doris	Central	6	5/1/11	232.1	294	61.9	226.2	286.5	60.3	9.5E-08	Mafic volcanic pillow (foliated basalt) to 286, above diabase; contact	Talik	N	Y	Y	N	N	Y	Y	N	N	N	N	N	N	N	N	N
11TDD772	11DCH04	Doris	Central	1	5/4/11	55.3	87.2	31.9	50.1	79.0	28.9	3.3E-08	Mafic volcanic pillow w quartz (ore zone, 57-59m); fault C3PO, NW6	Talik	Y	N	Y	Y	Y	N	N	N	N	N	N	N	Y	N	Y	Y
11TDD772	11DCH04	Doris	Central	2	5/6/11	88.3	147.2	58.9	80.0	133.4	53.4	1.6E-08	Mafic volcanic pillow (foliated basalt)	Talik	N	Y	Y	Y	N	N	N	N	N	N	N	N	Y	N	N	N
11TDD772	11DCH04	Doris	Central	3	5/8/11	145.3	228.2	82.9	131.7	206.8	75.1	1.7E-08	Mafic volcanic pillow (foliated basalt) w felsic dyke (200-202m)	Talik	N	Y	Y	Y	N	N	N	N	Y	Y	Y	N	N	N	N	N
11TDD772	11DCH04	Doris	Central	4	5/11/11	283.3	321.2	37.9	256.8	291.1	34.3	6.0E-08	Mafic volcanic pillow (foliated basalt) w quartz (ore zone); fault Force 1	Talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	Y	N	Y	Y
11TDD772	11DCH04	Doris	Central	5	5/11/11	289.3	321.2	31.9	262.2	291.1	28.9	4.9E-08	Mafic volcanic pillow (foliated basalt) w quartz (ore zone)	Talik	N	Y	Y	Y	Y	N	N	N	N	N	N	N	Y	N	Y	N

Table 2: Tests in shallow volcanics (<100m):

Newmont Drillhole ID	Test Number	Hydraulic Conductivity (m/s)
11TDD769	1	5.9E-07
11TDD766	1	1.8E-06
08TDD631	1	3.5E-08
08TDD630	1	1.2E-07
11TDD772	1	3.3E-08
11TDD771	1	3.4E-08
10WBW001	1	1.4E-06
11TDD768	1	1.3E-07
08TDD631	2	3.5E-09
10WBW001	2	4.7E-07
08TDD630	2	2.4E-07
11TDD764	1	2.0E-07
08TDD628	1	2.0E-08
11TDD763	1	7.3E-08
		Geometric Mean (m/s): 1.2E-07
		Minimum (m/s): 3.5E-09
		Maximum (m/s): 1.8E-06

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Table 3: Tests in shallow volcanics (<100m; excludes tests in alteration or diabase):

Newmont Drillhole ID	Test Number	Hydraulic Conductivity (m/s)
11TDD769	1	5.9E-07
11TDD766	1	1.8E-06
11TDD771	1	3.4E-08
11TDD768	1	1.3E-07
11TDD764	1	2.0E-07
		Geometric Mean (m/s): 2.5E-07
		Minimum (m/s): 3.4E-08
		Maximum (m/s): 1.8E-06

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Table 4: Tests in deep volcanics (>100m):

Newmont Drillhole ID	Test Number	Hydraulic Conductivity (m/s)
11TDD766	2	8.9E-10
11TDD772	2	1.6E-08
11TDD768	2	3.4E-09
11TDD771	2	1.7E-08
11TDD769	2	2.9E-06
10WBW001	4	2.8E-07
10WBW001	3	3.8E-07
08TDD630	3	1.3E-08
10WBW001	6	5.2E-08
11TDD771	3	5.3E-10
08TDD630	4	2.2E-08
11TDD769	3	7.5E-07
11TDD772	3	1.7E-08
11TDD771	4	7.1E-08
11TDD771	5	1.9E-07
10WBW001	6a	2.7E-08
10WBW001	5	2.6E-09
11TDD766	3	4.2E-08
11TDD768	5	1.7E-08
11TDD768	4	1.8E-08
08TDD630	5	6.6E-08
10WBW001	7	9.4E-08
11TDD768	6	5.9E-07
10WBW001	8	1.5E-06
11TDD769	1ss	3.2E-08
11TDD769	2ss	1.0E-07
10WBW001	8a	9.2E-07
10WBW001	9	9.6E-09
11TDD772	4	6.0E-08
11TDD772	5	4.9E-08
11TDD764	2	4.2E-09
11TDD771	6	9.5E-08
10WBW001	10	7.2E-09
08TDD633	4	4.8E-11
10WBW001	11	2.7E-08
		Geometric Mean (m/s): 3.4E-08 Minimum (m/s): 4.8E-11 Maximum (m/s): 2.9E-06

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Table 5: Tests in deep volcanics (>100m; excludes tests in alteration or diabase):

Newmont Drillhole ID	Test Number	Hydraulic Conductivity (m/s)
11TDD766	2	8.9E-10
11TDD769	2	2.9E-06
11TDD769	3	7.5E-07
11TDD766	3	4.2E-08
11TDD768	6	5.9E-07
		Geometric Mean (m/s): 1.7E-07
		Minimum (m/s): 8.9E-10
		Maximum (m/s): 2.9E-06

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Table 6: Tests in diabase – volcanics contact:

Newmont Drillhole ID	Test Number	Hydraulic Conductivity (m/s)
08TDD630	5	6.6E-08
11TDD771	6	9.5E-08
08TDD633	4	4.8E-11
10WBW001	11	2.7E-08
10WBW001	14	5.1E-09
10WBW001	14a	2.9E-08
		Geometric Mean (m/s): 1.0E-08
		Minimum (m/s): 4.8E-11
		Maximum (m/s): 9.5E-08

\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\HB Doris Central K probability distributions.jm.xlsx

Table 7: Tests in diabase:

Newmont Drillhole ID	Test Number	Hydraulic Conductivity (m/s)
10WBW001	12	1.4E-11
10WBW001	13	1.4E-11
		Geometric Mean (m/s): 1.4E-11
		Minimum (m/s): 1.4E-11
		Maximum (m/s): 1.4E-11

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Table 8: Tests in alteration near the mineralized zone:

Newmont Drillhole ID	Test Number	Hydraulic Conductivity (m/s)
11TDD772	2	1.6E-08
11TDD768	2	3.4E-09
11TDD771	2	1.7E-08
10WBW001	4	2.8E-07
10WBW001	3	3.8E-07
08TDD630	3	1.3E-08
10WBW001	6	5.2E-08
11TDD771	3	5.3E-10
08TDD630	4	2.2E-08
11TDD772	3	1.7E-08
11TDD771	4	7.1E-08
11TDD771	5	1.9E-07
10WBW001	6a	2.7E-08
10WBW001	5	2.6E-09
11TDD768	5	1.7E-08
11TDD768	4	1.8E-08
10WBW001	7	9.4E-08
10WBW001	8	1.5E-06
11TDD769	1ss	3.2E-08
11TDD769	2ss	1.0E-07
10WBW001	8a	9.2E-07
10WBW001	9	9.6E-09
11TDD772	4	6.0E-08
11TDD772	5	4.9E-08
11TDD764	2	4.2E-09
10WBW001	10	7.2E-09
08TDD633	4	4.8E-11
08TDD631	1	3.5E-08
08TDD630	1	1.2E-07
11TDD772	1	3.3E-08
10WBW001	1	1.4E-06
10WBW001	2	4.7E-07
08TDD631	2	3.5E-09
08TDD630	2	2.4E-07
08TDD628	1	2.0E-08
11TDD763	1	7.3E-08
		Geometric Mean (m/s): 3.3E-08 Minimum (m/s): 4.8E-11 Maximum (m/s): 1.5E-06

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Table 9: Tests in shallow alteration near the mineralized zone (<100m):

Newmont Drillhole ID	Test Number	Hydraulic Conductivity (m/s)
08TDD630	1	1.2E-07
08TDD631	1	3.5E-08
10WBW001	1	1.4E-06
11TDD772	1	3.3E-08
11TDD763	1	7.3E-08
08TDD628	1	2.0E-08
11TDD772	2	1.6E-08
10WBW001	2	4.7E-07
08TDD631	2	3.5E-09
08TDD630	2	2.4E-07
11TDD768	2	3.4E-09
10WBW001	4	2.8E-07
10WBW001	6	5.2E-08
10WBW001	6a	2.7E-08
11TDD771	2	1.7E-08
		Geometric Mean (m/s): 5.1E-08
		Minimum (m/s): 3.4E-09
		Maximum (m/s): 1.4E-06

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Table 10: Tests in deep alteration near the mineralized zone (>100m):

Newmont Drillhole ID	Test Number	Hydraulic Conductivity (m/s)
08TDD630	2	2.4E-07
11TDD772	2	1.6E-08
08TDD628	1	2.0E-08
11TDD768	2	3.4E-09
11TDD771	2	1.7E-08
10WBW001	4	2.8E-07
10WBW001	3	3.8E-07
08TDD630	3	1.3E-08
10WBW001	6	5.2E-08
11TDD771	3	5.3E-10
11TDD763	1	7.3E-08
08TDD630	4	2.2E-08
11TDD772	3	1.7E-08
11TDD771	4	7.1E-08
11TDD771	5	1.9E-07
10WBW001	6a	2.7E-08
10WBW001	5	2.6E-09
11TDD768	5	1.7E-08
11TDD768	4	1.8E-08
10WBW001	7	9.4E-08
10WBW001	8	1.5E-06
11TDD769	1ss	3.2E-08
11TDD769	2ss	1.0E-07
10WBW001	8a	9.2E-07
10WBW001	9	9.6E-09
11TDD772	4	6.0E-08
11TDD772	5	4.9E-08
11TDD764	2	4.2E-09
10WBW001	10	7.2E-09
08TDD633	4	4.8E-11
		Geometric Mean (m/s): 2.8E-08
		Minimum (m/s): 4.8E-11
		Maximum (m/s): 1.5E-06

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Table 11: Tests in Shallow Alteration near the Mineralized Zone (<100m):

Hole ID	Test #	K3
11TDD771	3	5.3E-10
11TDD768	2	3.4E-09
11TDD764	2	4.2E-09
08TDD630	3	1.3E-08
11TDD768	5	1.7E-08
11TDD771	2	1.7E-08
11TDD768	4	1.8E-08
11TDD769	1ss	3.2E-08
11TDD772	1	3.3E-08
11TDD772	5	4.9E-08
11TDD772	4	6.0E-08
11TDD771	4	7.1E-08
10WBW001	7	9.4E-08
11TDD769	2ss	1.0E-07
11TDD771	5	1.9E-07
10WBW001	8a	9.2E-07
10WBW001	1	1.4E-06
10WBW001	8	1.5E-06
		Geometric Mean (m/s): 4.4E-08 Minimum (m/s): 5.3E-10 Maximum (m/s): 1.5E-06

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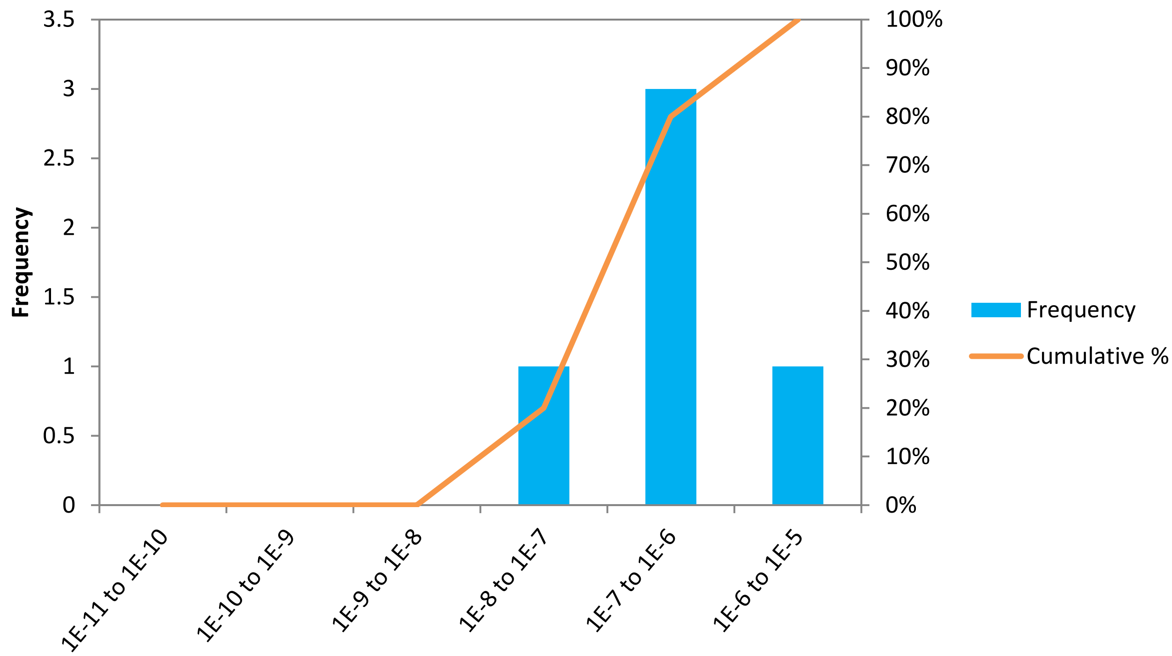
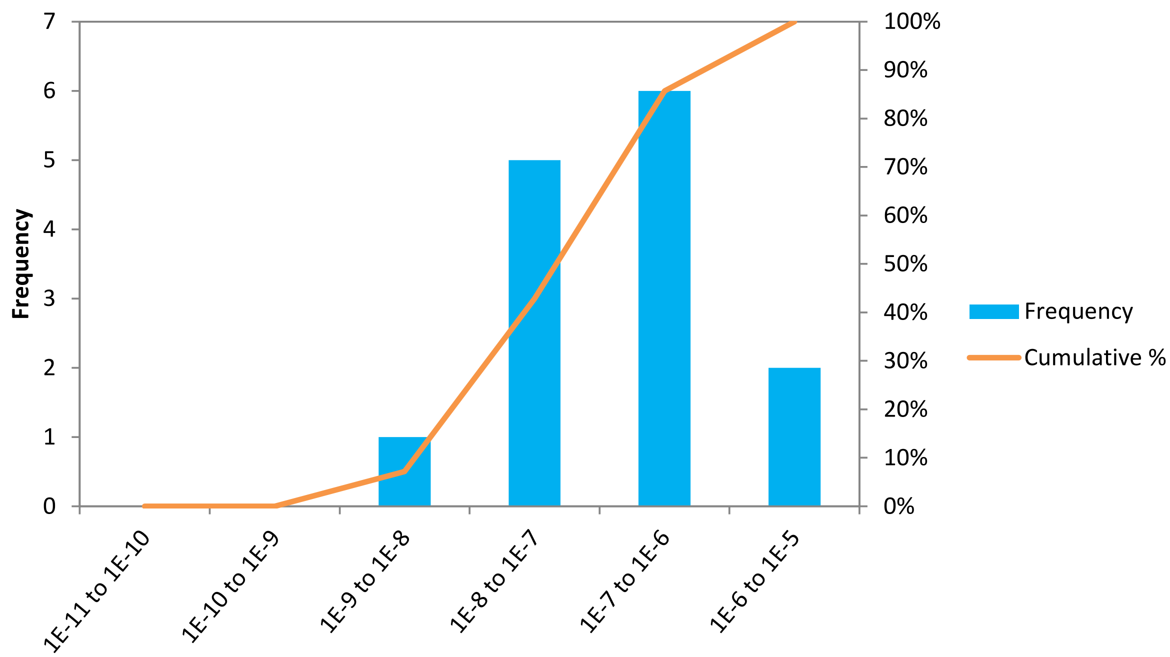


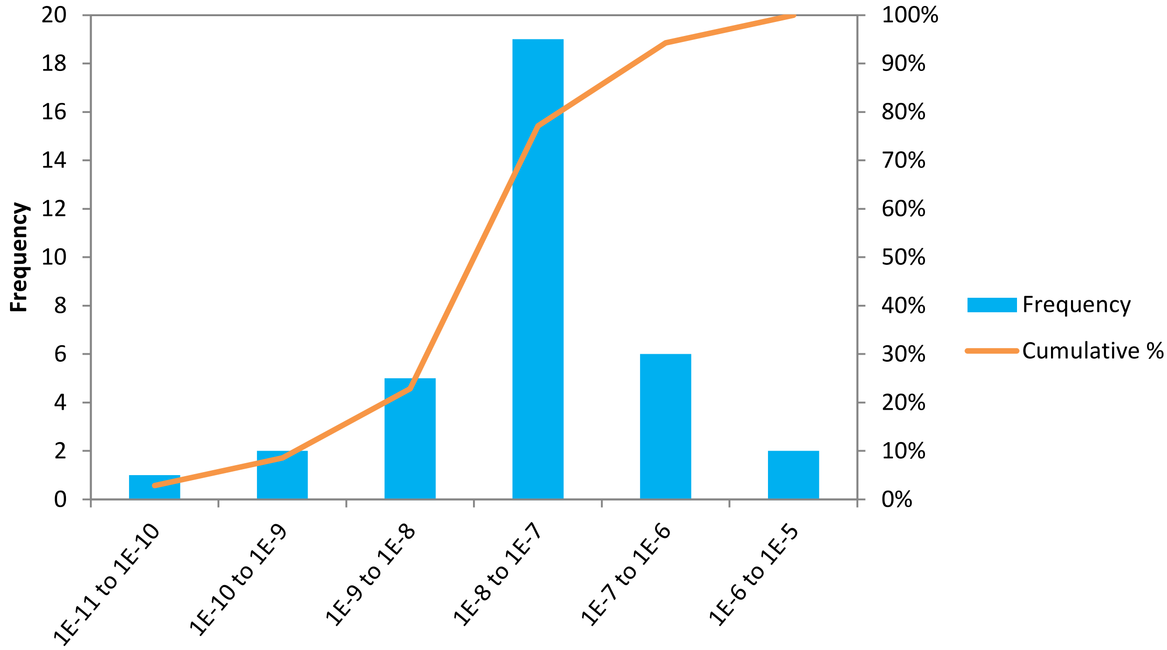
\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\HB Doris Central K probability distributions.jm.xlsx

Figure 1: Hydraulic conductivity distribution for packer tests conducted in shallow volcanics (<100m).



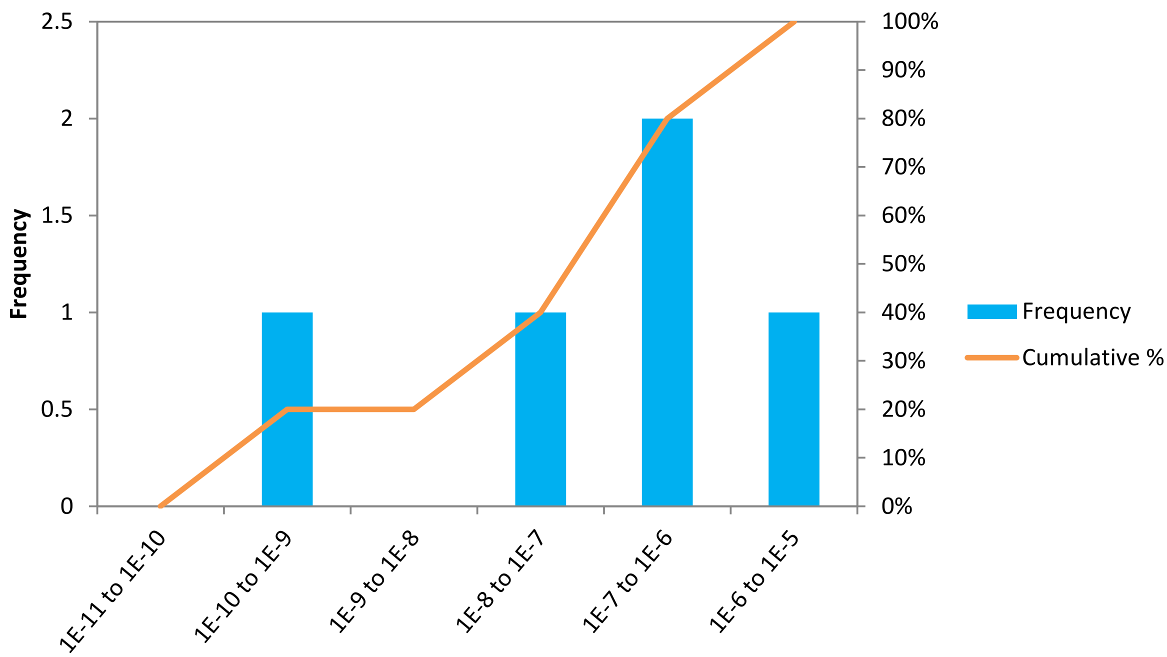
\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\HB Doris Central K probability distributions.jm.xlsx

Figure 2: Hydraulic conductivity distribution for packer tests conducted in shallow volcanics (<100m; excludes tests in alteration or diabase).



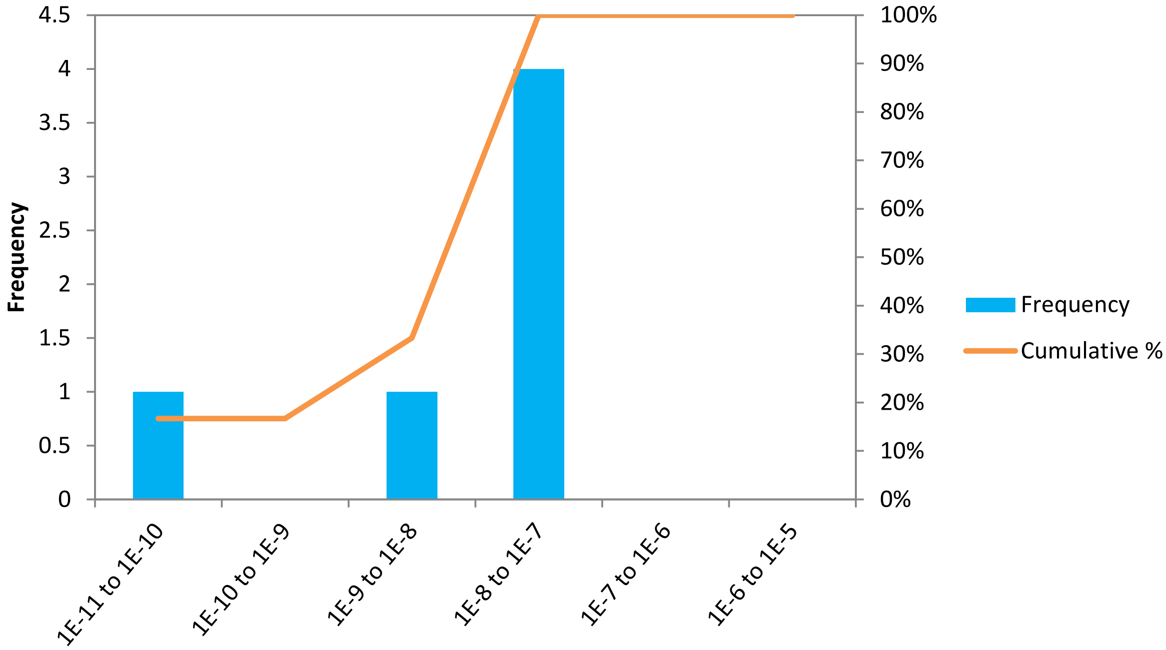
\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\HB Doris Central K probability distributions.jm.xlsx

Figure 3: Hydraulic conductivity distribution for packer tests conducted in deep volcanics (>100m).



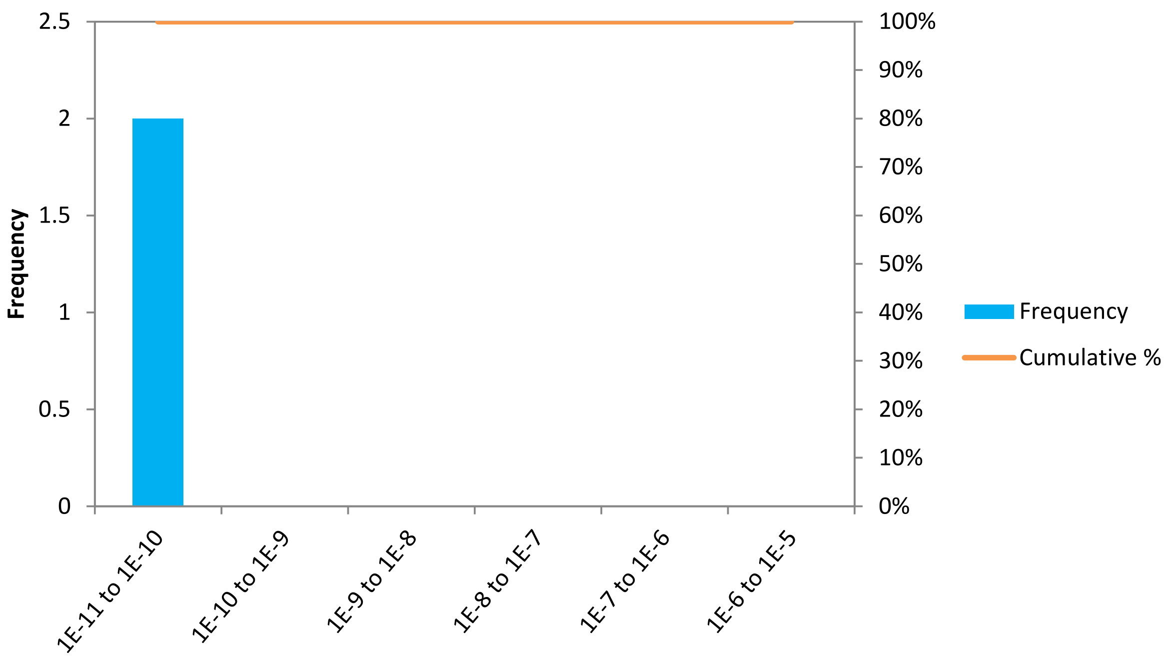
\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\HB Doris Central K probability distributions.jm.xlsx

Figure 4: Hydraulic conductivity distribution for packer tests conducted in deep volcanics (>100m; excludes tests in alteration or diabase).



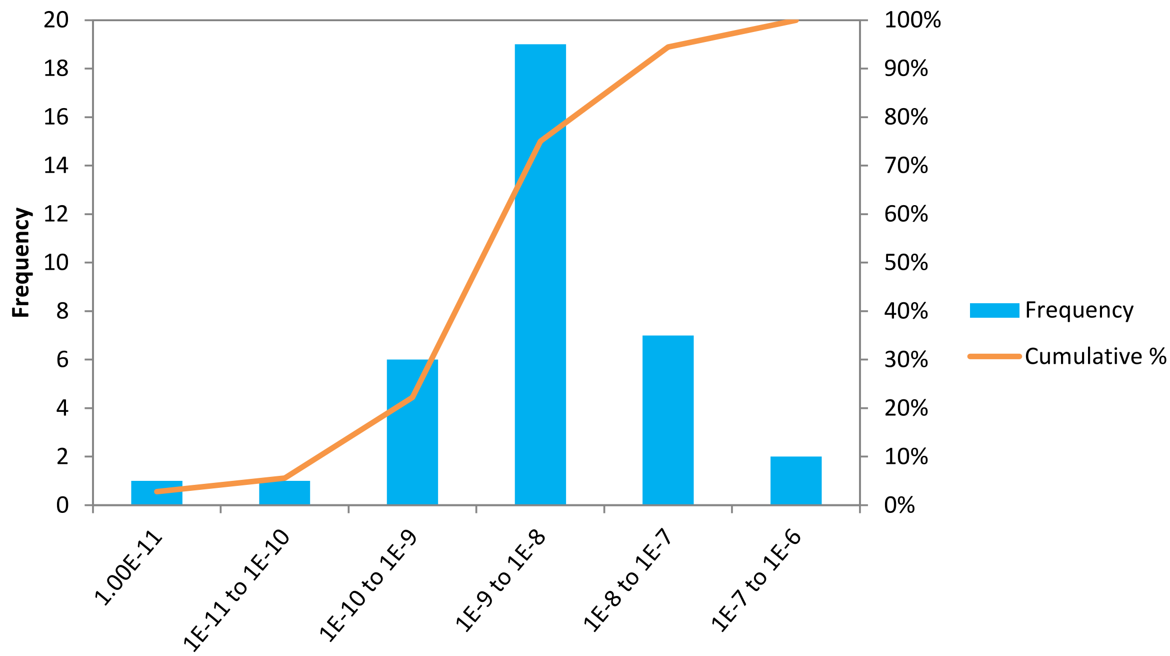
\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\HB Doris Central K probability distributions.jm.xlsx

Figure 5: Hydraulic conductivity distribution for packer tests conducted along the diabase – volcanics contact.



\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\HB Doris Central K probability distributions.jm.xlsx

Figure 6: Hydraulic conductivity distribution for packer tests conducted within the diabase dykes.



\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\HB Doris Central K probability distributions.jm.xlsx

Figure 7: Hydraulic conductivity distribution for packer tests conducted in alteration near the mineralized zone.

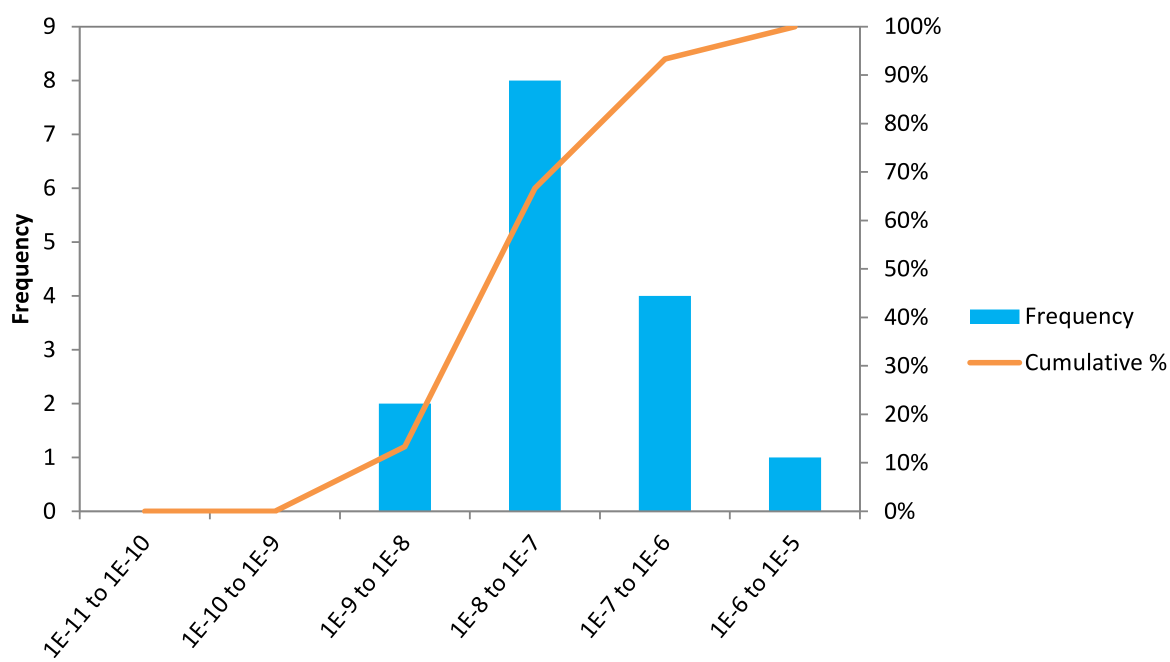


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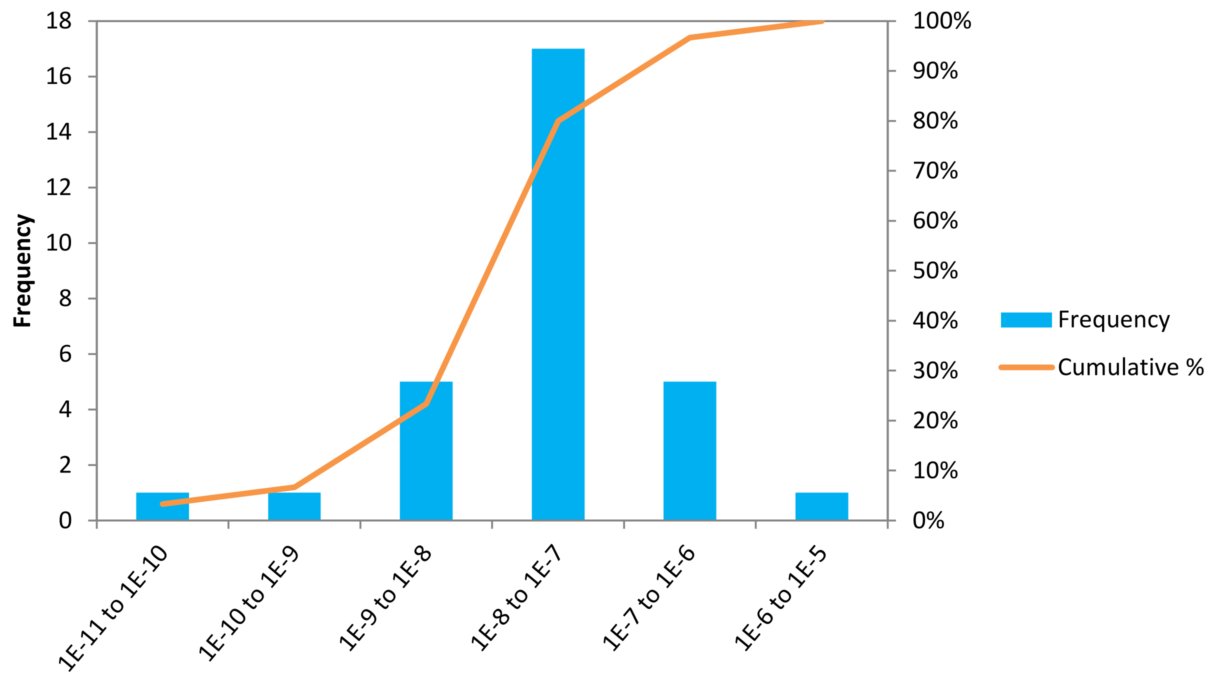
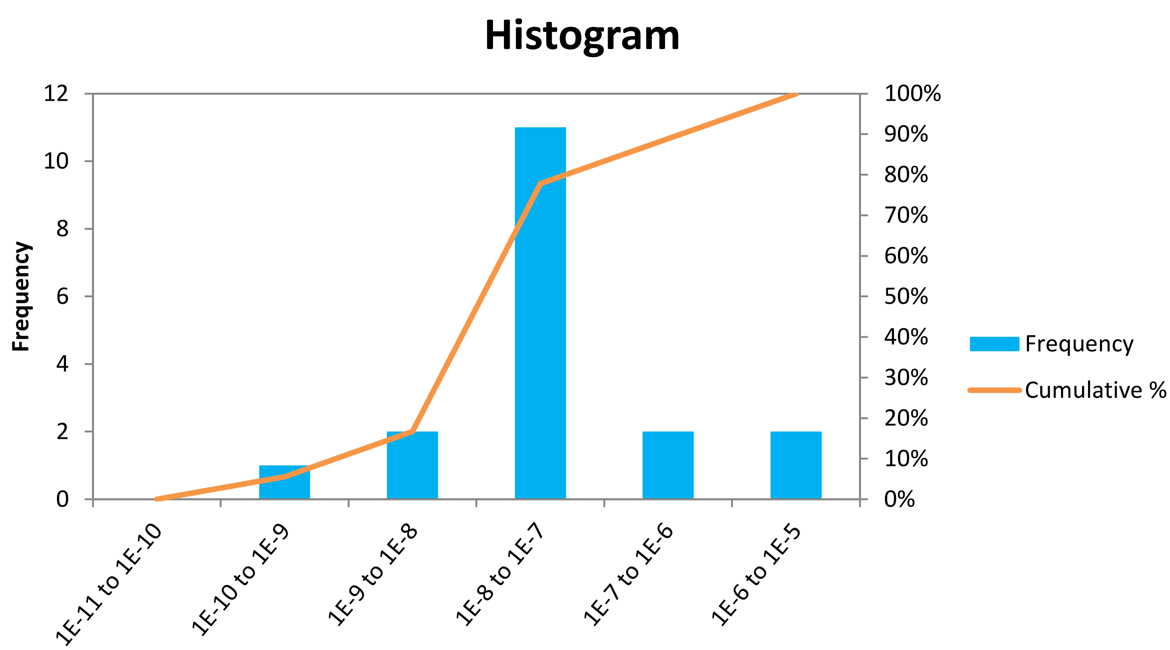
Figure 8: Hydraulic conductivity distribution for packer tests conducted in shallow alteration near the mineralized zone (<100m).



\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\HB Doris Central K probability distributions.jm.xlsx

Figure 9: Hydraulic conductivity distribution for packer tests conducted in deep alteration near the mineralized zone (>100m).



\\VAN-SVR0\Projects\01_SITES\Hope.Bay\1CH008.054_2011 Stage 2 Geotech-Hydro\020_Project_Data\SRK\!Hydraulic Conductivity\!REVIEWED\Summary Spreadsheets\HB Doris Central K probability distributions.jm.xlsx

Figure 10: Hydraulic conductivity distribution for packer tests conducted near quartz veins with nearby joints (>100m).

Appendix G - Groundwater Chemistry

		Sample Details						Field Measurements		
Field Sample ID / Unique ID	**Sample Zone**	**Sample From**	**Sample Purging Status**	**Location of port in zone**	**Zone port drillhole depth**	**Zone port vertical depth**	**Sample Comments**	**Total Litres Purged**	**Zone volumes purged**	**Field pH**
Units						**m**				
10WBW001-01a	n/a	Lake	Other	n/a	n/a	n/a	Lake water from hole in ice near intake.	n/a	n/a	n/a
10WBW001-07	n/a	Lake	Other	n/a	n/a	n/a	Grab of lake water	n/a	n/a	n/a
10WBW002-01	1	Westbay Port	Initial sample	Top	594.4	575.06	n/a	0	0	n/a
10WBW002-02	1	Westbay Port	Purging sample	Top	594.4	575.06	n/a	26	0.70	n/a
10WBW002-109a	1	Westbay Port	Purging sample	Top	594.4	575.06	Total metals sampled twice - one was clear, one was rusty with sediment (unsure which is which)	27	0.73	6.02
10WBW002-109b	1	Westbay Port	Purging sample	Top	594.4	575.06	Total metals sampled twice - one was clear, one was rusty with sediment (unsure which is which)	27	0.73	6.02
10WBW002-121	1	Westbay Port	Purging sample	Top	594.4	575.06	At end of Nov purging process	52	1.40	6.13
10WBW002-122	n/a	Other	Other	n/a	n/a	n/a	A mix from glycol & lake water from site ST-7, created to compare with what is inside the westbay (S122)	n/a	n/a	n/a
10WBW002-120	n/a	Other	Other	n/a	594.4	575.06	Sample of water INSIDE westbay using regular WB sampler probe near zone 1 depth	n/a	n/a	6.15
10WBW002-Z1-305	1	Westbay Port	Purging sample	Meas Port Upper	594.4	575.06	First 1L after being left untouched for 5 months	55		-
10WBW002-Z1-306	1	Westbay Port	Purging sample	Meas Port Upper	594.4	575.06	Second 1L after being left untouched for 5 months	56		8.85
10WBW002-Z1-307	1	Westbay Port	Purging sample	Meas Port Upper	594.4	575.06	4th to 6th 1L after being left untouched for 5 months	59		8.21 to 8.66
10WBW002-Z3-308	3	Westbay Port	Initial sample	Meas Port Upper	498.4	481.78	No purging done, for comparison with zone 1.	0	0	8.43
10WBW002-Z2-309	2	Westbay Port	Other	Meas Port Upper	506	489.16	Looks like the glycol from inside MP that was lost out through zone 2 MP.	0	0	7.46
10WBW002-Z1-400	1		Westbay Port	Meas Port Upper	594.4	575.06		62		8.41
10WBW002-Z1-401	1		Westbay Port	Meas Port Upper	594.4	575.06	Sample was bright orange in the final run, vs. no- to minimal colour in first two runs	63		9.17
10WBW002-Z3-402	3		Westbay Port	Meas Port Upper	498.4	481.78		3		6.87

		Field Measurements								Lab Details
Field Sample ID / Unique ID	**Sample Zone**	**Field Electrical Conductivity**	**Field Turbidity**	**Field DO**	**Field Temperature**	**Field Salinity**	**Field TDS**	**Field ORP**	**Sample Description**	**ALS File No.**
Units		**mS/cm**	**NTU**	**mg/L**	**°C**	**%**				
10WBW001-01a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	L880950
10WBW001-07	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	L909782
10WBW002-01	1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	L909782
10WBW002-02	1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	L909782
10WBW002-109a	1	> 99.9	409	12.35	0.69	> 4.0	> 99	146	Turbid, orange/red	L956881
10WBW002-109b	1	> 99.9	409	12.35	0.69	> 4.0	> 99	146	Turbid, orange/red	L956881
10WBW002-121	1	99.9	-5	14.15	4.33	4	99	106	n/a	L956881
10WBW002-122	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	L956881
10WBW002-120	n/a	48.4	319	15.73	2.47	0.9	29	74	Pink	L956881
10WBW002-Z1-305	1	-	-	-	-	-	-	-	Strong musty smell. Very aerated, foamed. CLEAR. H2SO4 precipitated in nutrients bottle. 400mL routine bottle	L996991
10WBW002-Z1-306	1	>99.9	515	15.73	4.85	>4	>99	272	Strong musty smell. BRIGHT ORANGE. Total metals and isotopes filled	L996991
10WBW002-Z1-307	1	>99.9	443 to 395	10.08 to 8.64	4.6 to 1.51	>4	>99	288 to 201	Strong musty smell. Slightly turbid. ORANGE. H2SO4 precipitated in nutrients bottle. All bottles filled.	L996991
10WBW002-Z3-308	3	>99.9	31	13.12	1.25	>4	>99	138	Params read on run 3. H2S04 precipated in nutrients bottle. Stings hands, looks like drill fluid? Same smell as samples 306	L996991
10WBW002-Z2-309	2	43	94.4	12.44	0.92	2.5	26	73	Looks like glycol - pink, smells like glycol, turbid, feels like glycol. This water is being sucked out of meas port when we sample from zone 1. 750mL	L996991
10WBW002-Z1-400	1	>99.9	262	19.38	-2.25	>4.0%	>99	230	Milky	
10WBW002-Z1-401	1	>99.9	112	19.69	-1.49	>4.0%	>99	181	Milky to Clear for first two runs, final run showed an orange appearance	
10WBW002-Z3-402	3	>99.9	164	17.15	-2.13	>4.0%	>99	301	Clear	

		Lab Details			Physical Tests						Dissolved Anions					
Field Sample ID / Unique ID	**Sample Zone**	**ALS SRK Sample ID**	**ALS Date Sampled**	**ALS Sample ID**	**Conductivity (EC)**	**Density**	**Hardness (as CaCO3)**	**pH**	**Salinity (EC)**	**Total Dissolved Solids**	**Alkalinity, Bicarbonate (as CaCO3)**	**Alkalinity, Carbonate (as CaCO3)**	**Alkalinity, Hydroxide (as CaCO3)**	**Alkalinity, Total (as CaCO3)**	**Ammonia as N**	**Bromide (Br)**
Units					**uS/cm**		**mg/L**	**pH**	**g/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
10WBW001-01a	n/a	10WBW001-01	26-APR-10	L880950-1	324		53.6	7.1		192				34.4		
10WBW001-07	n/a	10WBW001-07	15-JUL-10	L909782-7	304	0.998	48.8	8.52		188				31.8		
10WBW002-01	1	10WBW002-01	03-JUL-10	L909782-5	160000	1.13	180000			250000				56		
10WBW002-02	1	10WBW002-02	04-JUL-10	L909782-6	182000	1.14	200000			225000				59.5		
10WBW002-109a	1	10WBW002-109	07-NOV-10	L956881-1			187000								4.55	
10WBW002-109b	1	10WBW002-109	08-NOV-10	L956881-2			189000									
10WBW002-121	1	10WBW002-121	13-NOV-10	L956881-4	182000	1.17	183000	8.51		223000	57.4	1.6	-1	59	4.58	-250
10WBW002-122	n/a	10WBW002-122	14-NOV-10	L956881-5	152	1.02	45.7	7.56		187	46.1	-1	-1	46.1	0.04	-5
10WBW002-120	n/a	10WBW002-120	12-NOV-10	L956881-3	19200	1.08	73600	6.63		116000	42.8	-1	-1	42.8	1.91	-50
10WBW002-Z1-305	1	10WBW002-Z1-305	16-APR-11	L996991-1	182000	1.16	-	7.22		207000	220	-1	-1	220	-	10.6
10WBW002-Z1-306	1	10WBW002-Z1-306	16-APR-11	L996991-2		-	172000	-			-	-	-	-	-	-
10WBW002-Z1-307	1	10WBW002-Z1-307	17-APR-11	L996991-3	183000	1.16	178000	8.1		202000	160	-1	-1	160	6.4	58.9
10WBW002-Z3-308	3	10WBW002-Z1-308	17-APR-11	L996991-4	176000	1.15	164000	7.95		205000	145	-1	-1	145	6.3	-5
10WBW002-Z2-309	2	10WBW002-Z1-309	18-APR-11	L996991-5	39400	1.07	57600	7.5		97600	97.7	-2	-2	97.7	-	-5
10WBW002-Z1-400	1	10WBW002-Z1-400	20-JUN-11	L1021760-1	181000	1.16	208000	7.57								
10WBW002-Z1-401	1	10WBW002-Z1-401	20-JUN-11	L1021760-2	182000	1.16	187000	8.12		193000	49.8	-1	-1	49.8	8.3	
10WBW002-Z3-402	3	10WBW002-Z3-403	21-JUN-11	L1021760-4	159000	-	158000	7.03		169000						

		Dissolved Anions							Nutrients					Calculated	Total Metals
Field Sample ID / Unique ID	Sample Zone	Chloride (Cl)	Fluoride (F)	Silicate (as SIO2)	Sulfate (SO4)	Bicarbonate (HCO3)	Carbonate (CO3)	Hydroxide (OH)	Nitrate (as N)	Nitrite (as N)	Nitrate and Nitrite as N	Ortho Phosphate as P	Total Phosphate as P	TDS	Aluminum (Al)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW001-01a	n/a	76.6	0.069		3.44	41.9	-5	-5	0.053	-0.05	-0.071			158	-0.01
10WBW001-07	n/a	60.3	-0.05		2.42	27.2	5.7	-5	-0.05	-0.05	-0.071			129	0.048
10WBW002-01	1	114000	16		-100	68.3	-5	-5	-10	-10	-14			187000	30.5
10WBW002-02	1	123000	20		-100	11.9	29.9	-5	-10	-10	-14			203000	9.7
10WBW002-109a	1														0.161
10WBW002-109b	1														9.4
10WBW002-121	1	133000	-100	-100	-2500				-25	-5		-0.1	1.01		9.94
10WBW002-122	n/a	53	-2	-20	-50				-0.5	-0.1		12.1	10.3		0.0795
10WBW002-120	n/a	46800	-20	-100	-500				-5	-1		0.45	10.3		1.4
10WBW002-Z1-305	1	138000	-30	-	-50				-0.5	-0.1		0.53	0.62		-
10WBW002-Z1-306	1		-	-	-				-	-		-	-		6.24
10WBW002-Z1-307	1	138000	-30	-100	70				-0.5	-0.1		0.41	0.81		7.04
10WBW002-Z3-308	3	129000	-30	-100	78				-0.5	-0.1		0.57	0.57		0.254
10WBW002-Z2-309	2	43600	-30	-	-50				-0.5	-0.1		-	-		0.256
10WBW002-Z1-400	1														
10WBW002-Z1-401	1	128000			51								0.58		
10WBW002-Z3-402	3	104000			146										0.172

		Total Metals													
Field Sample ID / Unique ID	Sample Zone	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Cesium (Cs)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Gallium (Ga)	Iron (Fe)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW001-01a	n/a	-0.0004	0.00074	0.0036	-0.001		-0.05	-0.00005	8.47		-0.005	-0.002	0.0023		0.017
10WBW001-07	n/a	-0.0004	0.00055	0.0034	-0.001		-0.05	-0.00005	9.47		-0.005	-0.002	0.0019		0.108
10WBW002-01	1	-0.08	0.218	0.719	-0.2		0.95	-0.01	78500		0.63	0.094	-0.2		133
10WBW002-02	1	-0.08	0.507	0.736	-0.2		0.99	-0.01	96200		0.48	0.088	-0.2		34.4
10WBW002-109a	1	0.0104	-0.02	0.86	-0.005	-0.005	-1	-0.0005	77400	0.0057	0.0062	-0.0005	0.0242	-0.005	0.51
10WBW002-109b	1	0.0107	-0.02	0.827	-0.005	-0.005	-1	-0.0005	75500	0.0061	0.107	0.00841	0.0467	-0.005	38.6
10WBW002-121	1	0.0117	-0.02	0.832	-0.005	-0.005	-1	-0.0005	78800	0.0063	0.12	0.00949	0.0585	-0.005	54.6
10WBW002-122	n/a	-0.0005	0.0111	0.0026	-0.0005	-0.0005	-0.1	-0.00005	8.53	-0.0005	0.0016	-0.00005	0.00234	-0.0005	0.078
10WBW002-120	n/a	0.0081	0.027	0.28	-0.0025	-0.0025	-0.5	-0.001	25200	-0.0025	0.0243	0.002	0.0217	-0.0025	5.5
10WBW002-Z1-305	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-306	1	0.011	-0.02	0.808	-0.005	-0.005	1	-0.0005	68800	0.0064	0.0707	0.0061	0.0409	-0.005	27
10WBW002-Z1-307	1	0.0109	-0.02	0.845	-0.005	-0.005	-1	-0.0006	70800	0.0066	0.0783	0.00725	0.0406	-0.005	28.4
10WBW002-Z3-308	3	0.0085	-0.02	0.964	-0.005	-0.005	-1	-0.0005	65900	-0.005	0.0178	-0.0005	0.0127	-0.005	0.94
10WBW002-Z2-309	2	0.0065	0.038	0.276	-0.0025	-0.0025	-0.5	0.00115	22600	-0.0025	0.00534	0.00071	0.0174	-0.0025	1.3
10WBW002-Z1-400	1														
10WBW002-Z1-401	1														
10WBW002-Z3-402	3	0.0068	-0.02	0.715	-0.0025	-0.0025	0.91	-0.0005	57600	0.0045	-0.009	0.00063	0.0231	-0.0025	0.734

		Total Metals													
Field Sample ID / Unique ID	Sample Zone	Lead (Pb)	Lithium (Li)	Magnesium (Mg)	Manganese (Mn)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Rhenium (Re)	Rubidium (Rb)	Selenium (Se)	Silicon (Si)	Silver (Ag)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW001-01a	n/a	0.00089	-0.01	6.73	0.0035	-0.0001	-0.005	-0.002		2.3			0.00056		-0.0005
10WBW001-07	n/a	-0.0001	-0.01	5.87	0.0154	-0.0001	-0.005	-0.002		2.13			-0.002		-0.0001
10WBW002-01	1	0.113	-1.2	132	2.68	-0.0001	0.222	1.4		36			-0.4		-0.02
10WBW002-02	1	0.03	-1.2	114	0.47	-0.0001	0.223	1.82		35			-0.4		-0.02
10WBW002-109a	1	0.0039	-0.2	113	0.0233	-0.00001	0.178	0.0076	-10	-200	-0.005	0.051	-0.02	-5	-0.001
10WBW002-109b	1	0.0438	0.44	129	1.05	-0.00001	0.178	0.0359	-10	-200	-0.005	0.053	-0.02	25.4	0.0018
10WBW002-121	1	0.0663	-0.2	135	1.15	0.00001	0.193	0.0402	-10	-200	-0.005	-0.05	-0.02	27.8	0.0022
10WBW002-122	n/a	-0.0003	-0.02	5.3	0.00476	-0.00005	-0.002	0.00064	9.8	28	-0.0005	-0.005	-0.02	1.23	-0.0001
10WBW002-120	n/a	0.0116	-0.1	56	0.786	-0.00005	0.058	0.0174	6.5	-200	-0.0025	-0.025	-0.07	-5	-0.0005
10WBW002-Z1-305	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-306	1	0.0403	1.01	101	0.642	-	0.166	0.0321	-10	-200	-0.005	0.07	-0.02	9.8	0.0016
10WBW002-Z1-307	1	0.0336	0.51	110	0.759	-0.00001	0.165	0.0299	-10	-200	-0.005	0.06	-0.02	11.2	0.0016
10WBW002-Z3-308	3	-0.003	0.21	103	0.046	-0.00001	0.221	0.022	-10	-200	-0.005	0.054	-0.02	-5	-0.001
10WBW002-Z2-309	2	0.0154	-0.1	41.8	0.15	-	0.049	0.0145	-5	-100	-0.0025	-0.025	-0.1	-2.5	-0.0005
10WBW002-Z1-400	1														
10WBW002-Z1-401	1														
10WBW002-Z3-402	3	0.0041	0.33	102	0.181	-0.00005	0.19	0.0231	-5	-200	-0.0025	0.05	-0.03	-5	0.0018

Field Sample ID / Unique ID	Sample Zone	Total Metals: Sodium (Na)	Strontium (Sr)	Tellurium (Te)	Thallium (Tl)	Thorium (Th)	Tin (Sn)	Titanium (Ti)	Tungsten (W)	Uranium (U)	Vanadium (V)	Yttrium (Y)	Zinc (Zn)	Zirconium (Zr)	Dissolved Metals: Aluminum (Al)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW001-01a	n/a	34.2			-0.0001		-0.05	-0.001		-0.0001	-0.001		0.009		-0.01
10WBW001-07	n/a	29.2			-0.0001		-0.05	0.0013		-0.0001	-0.001		-0.004		-0.01
10WBW002-01	1	580			-0.02		-0.08	2.97		-0.02	0.98		-0.8		-1
10WBW002-02	1	240			-0.02		-0.08	0.81		-0.02	1.34		-0.8		-1
10WBW002-109a	1	280	33.1	-0.005	0.00054	-0.005	-0.01	-0.05	0.028	-0.0005	-0.005	-0.005	0.595	-0.005	-0.05
10WBW002-109b	1	1770	59	-0.005	0.00052	-0.005	-0.01	0.366	0.028	-0.0005	0.0279	-0.005	0.373	-0.005	
10WBW002-121	1	450	37.3	-0.005	-0.0005	-0.005	-0.01	0.378	0.03	-0.0005	0.0282	-0.005	0.557	-0.005	-0.05
10WBW002-122	n/a	26	0.036	-0.0005	-0.00005	-0.0005	-0.001	0.0051	-0.001	0.000151	0.00166	-0.0005	0.015	-0.0005	-0.005
10WBW002-120	n/a	-200	9.71	-0.0025	-0.00025	-0.0025	-0.005	0.083	-0.005	-0.00025	0.0049	-0.0025	3.12	-0.0025	-0.025
10WBW002-Z1-305	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10WBW002-Z1-306	1	4070	94.3	-0.005	0.00056	-0.005	-0.01	0.315	0.03	-0.0005	0.0223	-0.005	2.51	-0.005	-
10WBW002-Z1-307	1	1930	60.3	-0.005	0.00057	-0.005	-0.01	0.386	0.028	-0.0005	0.0243	-0.005	1.91	-0.005	-0.05
10WBW002-Z3-308	3	880	33.7	-0.005	-0.0005	-0.005	-0.01	-0.05	0.018	-0.0005	-0.005	-0.005	0.703	-0.005	0.052
10WBW002-Z2-309	2	-100	9.76	-0.0025	-0.00025	-0.0025	-0.005	-0.025	-0.005	-0.00025	-0.0025	-0.0025	76.7	-0.0025	-0.025
10WBW002-Z1-400	1														0.04
10WBW002-Z1-401	1														0.042
10WBW002-Z3-402	3	1530	31.9	-0.0025	-0.00025	-0.0025	0.0052	-0.025	0.0121	-0.00025	-0.0025	-0.0025	1.71	-0.0025	-0.025

Field Sample ID / Unique ID	Sample Zone	Dissolved Metals: Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Cesium (Cs)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Gallium (Ga)	Iron (Fe)	Lead (Pb)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW001-01a	n/a	-0.0004	0.00057	0.0037	-0.001		-0.05	-0.00005	9.3		-0.005	-0.002	0.0022		-0.03	0.0007
10WBW001-07	n/a	-0.0004	0.00068	0.0036	-0.001		-0.05	-0.00005	9.7		-0.005	-0.002	0.0016		0.035	-0.0001
10WBW002-01	1	-0.08	0.266	0.683	-0.1		0.86	-0.01	72100		0.371	0.061	-0.12		-1.5	-0.02
10WBW002-02	1	-0.08	0.421	0.77	-0.1		0.99	-0.01	79800		0.328	0.074	-0.12		-1.5	-0.02
10WBW002-109a	1	0.0093	-0.02	0.833	-0.005	-0.005	-1	-0.0005	74700	0.0063	0.0079	-0.0005	0.0129	-0.005	0.12	0.003
10WBW002-109b	1															
10WBW002-121	1	0.0094	-0.02	0.817	-0.005	-0.005	-1	-0.0005	73100	0.0062	-0.001	-0.0005	0.0158	-0.005	-0.1	-0.003
10WBW002-122	n/a	-0.0005	0.0103	0.0034	-0.0005	-0.0005	-0.1	-0.00005	8.55	-0.0005	-0.0005	-0.0001	0.0018	-0.0005	-0.01	-0.003
10WBW002-120	n/a	0.0076	0.027	0.308	-0.0025	-0.0025	-0.5	-0.0012	29400	-0.0025	-0.0025	0.00052	0.0101	-0.0025	-0.05	-0.015
10WBW002-Z1-305	1	-	-			-	-	-		-	-	-	-	-	-	-
10WBW002-Z1-306	1	-	-			-	-	-		-	-	-	-	-	-	-
10WBW002-Z1-307	1	0.0087	-0.02	0.815	0.005	0.005	-1	0.0005	71100	0.0065	-0.002	0.0005	0.0123	0.005	-0.1	0.003
10WBW002-Z3-308	3	0.0082	-0.02	0.986	-0.005	-0.005	-1	-0.0005	65300	0.0052	-0.001	-0.0005	0.0115	-0.005	-0.1	-0.003
10WBW002-Z2-309	2	0.0044	0.029	0.265	-0.0025	-0.0025	-0.5	0.00094	23000	-0.0025	-0.0005	0.00038	0.0094	-0.0025	-0.05	0.0024
10WBW002-Z1-400	1	0.0087	-0.02	0.829	0.0025	0.0025	1.48	0.0005	83000	0.0057	-0.002	0.00025	0.0155	0.0025	-0.05	0.0015
10WBW002-Z1-401	1	0.0085	0.01	0.818	0.0025	0.0025	1.03	0.0005	74600	0.0061	0.0005	0.00025	0.0134	0.0025	0.058	0.0015
10WBW002-Z3-402	3	0.0075	-0.02	0.795	-0.0025	-0.0025	0.9	-0.0005	63100	0.005	-0.0005	0.00039	0.0186	-0.0025	-0.05	-0.0015

Field Sample ID / Unique ID	Sample Zone	Dissolved Metals: Lithium (Li)	Magnesium (Mg)	Manganese (Mn)	Mercury (Hg)	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Rhenium (Re)	Rubidium (Rb)	Selenium (Se)	Silicon (Si)	Silver (Ag)	Sodium (Na)
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10WBW001-01a	n/a	0.0032	7.37	-0.005	-0.0001	-0.005	-0.002		2.31			0.00058		-0.0001	38
10WBW001-07	n/a	0.004	5.96	0.006	-0.0001	-0.005	-0.002		2.11			-0.002		-0.0001	29.6
10WBW002-01	1	-0.6	113	-0.25	-0.0001	0.222	1.43		39			-0.4		-0.02	655
10WBW002-02	1	-0.6	124	-0.25	-0.0001	0.18	1.68		52			-0.4		-0.02	300
10WBW002-109a	1	0.44	110	0.0196	-0.00001	0.163	-0.005	-10	-200	-0.005	0.053	-0.02	-5	-0.001	1680
10WBW002-109b	1														
10WBW002-121	1	-0.2	113	0.0141	-0.00001	0.175	0.0072	-10	-200	-0.005	-0.05	-0.02	-5	-0.001	490
10WBW002-122	n/a	-0.02	5.9	0.00109	-0.00005	-0.002	-0.0005	11.4	31	-0.0005	-0.005	-0.02	1.32	-0.0001	30
10WBW002-120	n/a	-0.1	65	0.741	-0.00005	0.063	0.0096	-5	-200	-0.0025	-0.025	-0.07	-5	-0.0005	-200
10WBW002-Z1-305	1	-		-		-	-	-	-	-	-	-	-	-	
10WBW002-Z1-306	1	-		-		-	-	-	-	-	-	-	-	-	
10WBW002-Z1-307	1	0.5	102	0.0182		0.157	0.0059	10	200	0.005	0.059	0.02	5	-0.001	1830
10WBW002-Z3-308	3	0.22	102	0.0372		0.22	0.0098	-10	-200	-0.005	0.057	-0.02	-5	-0.001	900
10WBW002-Z2-309	2	-0.1	42.4	0.12		0.047	0.0103	-5	-100	-0.0025	-0.025	-0.1	-2.5	-0.0005	-100
10WBW002-Z1-400	1	0.1	125	0.0088	-	0.189	0.0113	5	200	0.0025	0.056	0.01	5	0.00086	470
10WBW002-Z1-401	1	0.29	111	0.0151	0.00005	0.195	0.008	5	200	0.0025	0.056	0.01	5	0.00109	1160
10WBW002-Z3-402	3	0.37	111	0.185	-0.00005	0.199	0.0177	-5	-200	-0.0025	0.054	-0.05	-5	0.00179	1680

		Dissolved Metals												Isotope Chemistry	
Field Sample ID / Unique ID	Sample Zone	Strontium (Sr)	Tellurium (Te)	Thallium (Tl)	Thorium (Th)	Tin (Sn)	Titanium (Ti)	Tungsten (W)	Uranium (U)	Vanadium (V)	Yttrium (Y)	Zinc (Zn)	Zirconium (Zr)	Delta 2H x 1000	Delta 18O x 1000
Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		
10WBW001-01a	n/a			-0.0001		-0.05	-0.001		-0.0001	-0.001		0.0061		-156.3	-19.44
10WBW001-07	n/a			-0.0001		-0.05	-0.001		-0.0001	0.0011		-0.002		-146.79	-18.5
10WBW002-01	1			-0.01		-0.05	-0.06		-0.02	0.863		-0.2		-147.68	-20.52
10WBW002-02	1			-0.01		-0.05	-0.06		-0.02	1.08		-0.2		-149.12	-20.83
10WBW002-109a	1	57.6	-0.005	0.00053	-0.005	-0.01	-0.05	0.026	-0.0005	-0.005	-0.005	-0.03	-0.005		
10WBW002-109b	1														
10WBW002-121	1	35.8	-0.005	-0.0005	-0.005	-0.01	-0.05	0.024	-0.0005	-0.005	-0.005	0.044	-0.005		
10WBW002-122	n/a	0.038	-0.0005	-0.00005	-0.0005	-0.001	-0.005	-0.001	0.000155	0.00166	-0.0005	0.0069	-0.0005		
10WBW002-120	n/a	11	-0.0025	-0.00025	-0.0025	-0.005	-0.025	-0.005	-0.00025	-0.0025	-0.0025	1.99	-0.0025		
10WBW002-Z1-305	1	-	-	-	-	-	-	-	-	-	-	-	-		
10WBW002-Z1-306	1	-	-	-	-	-	-	-	-	-	-	-	-		
10WBW002-Z1-307	1	58.6	0.005	0.00054	0.005	-0.01	0.05	0.024	0.0005	0.005	0.005	0.294	0.005		
10WBW002-Z3-308	3	33.2	-0.005	-0.0005	-0.005	-0.01	-0.05	0.019	-0.0005	-0.005	-0.005	0.18	-0.005		
10WBW002-Z2-309	2	9.98	-0.0025	-0.00025	-0.0025	-0.005	-0.025	-0.005	-0.00025	-0.0025	-0.0025	35.2	-0.0025		
10WBW002-Z1-400	1	37.5	0.0025	-0.00025	0.0025	-0.005	0.025	0.0233	0.00025	0.0025	0.0025	0.052	0.0025		
10WBW002-Z1-401	1	46	0.0025	0.00025	0.0025	0.0068	0.025	0.0229	0.00025	0.0025	0.0025	0.06	0.0025		
10WBW002-Z3-402	3	35.1	-0.0025	-0.00025	-0.0025	-0.005	-0.025	0.0131	-0.00025	-0.0025	-0.0025	0.828	-0.0025		

Field Sample ID / Unique ID
Units
10WBW001-01a
10WBW001-07
10WBW002-01
10WBW002-02
10WBW002-109a
10WBW002-109b
10WBW002-121
10WBW002-122
10WBW002-120
10WBW002-Z1-305
10WBW002-Z1-306
10WBW002-Z1-307
10WBW002-Z3-308
10WBW002-Z2-309
10WBW002-Z1-400
10WBW002-Z1-401
10WBW002-Z3-402

Field Sample ID / Unique ID
Units
10WBW001-01a
10WBW001-07
10WBW002-01
10WBW002-02
10WBW002-109a
10WBW002-109b
10WBW002-121
10WBW002-122
10WBW002-120
10WBW002-Z1-305
10WBW002-Z1-306
10WBW002-Z1-307
10WBW002-Z3-308
10WBW002-Z2-309
10WBW002-Z1-400
10WBW002-Z1-401
10WBW002-Z3-402

Appendix H - Point Load and Laboratory Test Results

Golder Associates

Golder Associates Ltd. - Burnaby Laboratory
4280 Still Creek Drive
Burnaby, B.C. Canada V5C 6C8

Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000
Project:	Hope Bay
Client:	SRK Consulting
Location:	Nunavut
Lab ID	79

Failure Mode

(1) Diagonal shear plane(s)
(2) Vertical fracture(s)
(3) Vertical splitting
(4) Shear along foliation / discontinuity
(5) Conical
(6) Spalling
(7) Other
Note: (deg) measured from core axis

									Wet		Dry	Maximum	Stress			
No.	**Hole ID**	**Sample**	**Depth**	**Dia**	**Ht**	**A**	**V**	**Mass**	**Density**	**W**	**Density**	**Load**	**σ**	**SRK Litho**	**Failure Mode**	
	#	#	(m)	(mm)	(mm)	(cm^2)	(cm^3)	(g)	(Kg/M^3)	(%)	(Kg/M^3)	(kN)	(MPa)		Type	(deg)
1	11TDD766	7	241.57 - 241.87	60.76	127.18	29.00	368.76	990.00	2685	0.59	2669	206.50	71.2	MV	4	8
2	11TDD768	1	60.64 - 60.94	60.55	126.43	28.80	364.06	1072.80	2947	0.02	2946	141.90	49.3	MV	4/2	54
3	11TDD768	3	139.79 - 140.05	60.22	117.58	28.48	334.89	970.80	2899	0.02	2898	200.50	70.4	MV	4/2	43
4	11TDD768	4	159.47 - 159.79	60.36	127.04	28.61	363.52	1069.20	2941	0.03	2940	550.90	192.5	MV	2	N/A
5	11TDD768	5	181.40 - 181.71	60.27	126.78	28.53	361.70	1013.10	2801	0.02	2800	264.10	92.6	MV	1	~15
6	11TDD769	4	130.98 - 131.28	60.50	126.16	28.75	362.68	1034.40	2852	0.02	2852	273.60	95.2	MV	4	15
7	11TDD769	5	158.20 - 158.52	60.45	126.62	28.70	363.40	1032.10	2840	0.03	2839	273.40	95.3	MV	4	14
8	11TDD769	6	187.10 - 187.34	60.43	124.86	28.68	358.11	1021.30	2852	0.03	2851	317.40	110.7	MV	4	8
9	11TDD769	7	219.38 - 219.68	60.56	125.89	28.80	362.62	1025.60	2828	0.03	2827	345.00	119.8	MV	4	4
10	11TDD769	9	294.11 - 294.44	61.10	125.61	29.32	368.30	1013.90	2753	1.55	2711	179.80	61.3	MV	4/1	8/16
11	11PSD284	1	34.42 - 34.74	60.94	127.63	29.17	372.26	1087.60	2922	0.04	2921	251.70	86.3	Not Provided	4/2	N/A
12	11PSD284	2	47.84 - 48.16	60.86	126.62	29.09	368.35	1067.10	2897	0.08	2895	203.50	70.0	Not Provided	4/2	N/A
13	11PSD279	5	201.58 - 201.88	60.81	126.33	29.04	366.90	1018.30	2775	0.05	2774	33.40	11.5	IFV	4	28
14	11PSD279	7	258.24 - 258.82	60.80	115.81	29.03	336.24	935.10	2781	0.05	2780	62.40	21.5	IFV	4	28
15	11PSD279	9	317.43 - 317.72	60.73	126.44	28.97	366.25	1015.80	2773	0.04	2772	25.80	8.9	IFV	4	28
16	11TDD771	1	31.60 - 31.90	60.85	126.04	29.08	366.54	1049.60	2864	0.01	2863	258.80	89.0	MV	4	21
17	11TDD771	8	252.93 - 253.21	60.86	125.86	29.09	366.14	989.60	2703	0.73	2683	55.30	19.0	MV	4	28
18	11PSD276A	2	71.13 - 71.45	60.46	124.65	28.71	357.86	1042.50	2913	0.04	2912	62.70	21.8	MV	4	19

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

Golder Associates Ltd. - Burnaby Laboratory
4280 Still Creek Drive
Burnaby, B.C. Canada V5C 6C8

Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.: 11-1415-0030 / 3000
Project: Hope Bay
Client: SRK Consulting
Location: Nunavut
Lab ID 79

Failure Mode
(1) Diagonal shear plane(s)
(2) Vertical fracture(s)
(3) Vertical splitting
(4) Shear along foliation / discontinuity
(5) Conical
(6) Spalling
(7) Other
Note: (deg) measured from core axis

No.	Hole ID	Sample	Depth	Dia	Ht	A	V	Mass	Wet Density	W	Dry Density	Maximum Load	Stress σ	SRK Litho	Failure Mode Type	Failure Mode (deg)
	#	#	(m)	(mm)	(mm)	(cm^2)	(cm^3)	(g)	(Kg/M^3)	(%)	(Kg/M^3)	(kN)	(MPa)		Type	(deg)
19	11PSD276A	12	370.80 - 371.16	Sample Broke During Preparation - Not Testable												
20	11PSD279	1	78.73 - 79.02	60.54	126.08	28.79	362.93	1071.00	2951	0.04	2950	69.10	24.0	MV	4	23
21	11PSD279	3	136.58 - 136.92	60.76	124.79	29.00	361.83	1049.80	2901	0.03	2901	79.80	27.5	MV	4	30
22	11PSD279	13	435.24 - 435.47	60.82	126.67	29.05	368.01	1037.20	2818	0.01	2818	230.60	79.4	EMMI	1/4	17
23	11PSD276A	5	152.68 - 152.99	60.45	126.97	28.70	364.40	1072.70	2944	0.07	2942	59.00	20.6	MV	4	28
24	11PSD276A	7	222.40 - 222.78	60.70	125.89	28.94	364.30	1005.10	2759	0.04	2758	94.50	32.7	IFV	4	23
25	11TDD769	2	69.27 - 69.63	59.64	124.69	27.94	348.33	998.20	2866	0.02	2865	154.60	55.3	MV	4	18
26	11TDD772	1	47.20 - 47.45	60.40	125.52	28.65	359.65	1071.00	2978	0.06	2976	340.70	118.9	MV	4	7
27	11TDD772	2	103.95 - 104.27	60.25	127.08	28.51	362.31	1092.00	3014	0.01	3014	198.90	69.8	MV	4	8

G. Patton	July 14, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

Golder Associates Ltd. - Burnaby Lab
4280 Still Creek Drive
Burnaby, B.C. Canada V5C 6C6

Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD766**
Project:	Hope Bay	**Sample Number:**	7
Location:	Nunavut	**Depth (m):**	241.57 - 241.87
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**206.50**	Diameter (mm)	60.76
		Height (mm)	127.18
Stress σ (MPa)	**71.2**	Area (cm^2)	29.00
		Volume (cm^3)	368.76
Pace Rate (kN/s)	0.50	Mass (g)	990.00
		Moisture Content (%)	0.59
SRK Litho	MV	Wet Density (Kg/m^3)	2684.67
		Dry Density (Kg/m^3)	2668.93

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**8**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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BEFORE TEST

AFTER TEST

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

Golder Associates Ltd. - Burnaby Lab
4280 Still Creek Drive
Burnaby, B.C. Canada V5C 6C6

Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD768**
Project:	Hope Bay	**Sample Number:**	1
Location:	Nunavut	**Depth (m):**	60.64 - 60.94
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**141.90**	Diameter (mm)	60.55
		Height (mm)	126.43
Stress σ (MPa)	**49.3**	Area (cm^2)	28.80
		Volume (cm^3)	364.06
Pace Rate (kN/s)	0.50	Mass (g)	1072.80
		Moisture Content (%)	0.02
SRK Litho	MV	Wet Density (Kg/m^3)	2946.80
		Dry Density (Kg/m^3)	2946.25

Failure Mode		Notes
		- Water content as received
Type:	**4/2**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**54**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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BEFORE TEST

AFTER TEST

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

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4280 Still Creek Drive
Burnaby, B.C. Canada V5C 6C6

Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD768**
Project:	Hope Bay	**Sample Number:**	3
Location:	Nunavut	**Depth (m):**	139.79 - 140.05
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**200.50**	Diameter (mm)	60.22
		Height (mm)	117.58
Stress σ (MPa)	**70.4**	Area (cm^2)	28.48
		Volume (cm^3)	334.89
Pace Rate (kN/s)	0.50	Mass (g)	970.80
		Moisture Content (%)	0.02
SRK Litho	MV	Wet Density (Kg/m^3)	2898.84
		Dry Density (Kg/m^3)	2898.25

Failure Mode		Notes
		- Water content as received
Type:	**4/2**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**43**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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BEFORE TEST

AFTER TEST

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

Golder Associates Ltd. - Burnaby Lab
4280 Still Creek Drive
Burnaby, B.C. Canada V5C 6C6

Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD768**
Project:	Hope Bay	**Sample Number:**	4
Location:	Nunavut	**Depth (m):**	159.47 - 159.79
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**550.90**	Diameter (mm)	60.36
		Height (mm)	127.04
Stress σ (MPa)	**192.5**	Area (cm^2)	28.61
		Volume (cm^3)	363.52
Pace Rate (kN/s)	0.50	Mass (g)	1069.20
		Moisture Content (%)	0.03
SRK Litho	MV	Wet Density (Kg/m^3)	2941.24
		Dry Density (Kg/m^3)	2940.40

Failure Mode		Notes
		- Water content as received
Type:	**2**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**N/A**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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BEFORE TEST

AFTER TEST

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

Golder Associates Ltd. - Burnaby Lab
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Burnaby, B.C. Canada V5C 6C6

Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD768**
Project:	Hope Bay	**Sample Number:**	5
Location:	Nunavut	**Depth (m):**	181.40 - 181.71
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**264.10**	Diameter (mm)	60.27
		Height (mm)	126.78
Stress σ (MPa)	**92.6**	Area (cm^2)	28.53
		Volume (cm^3)	361.70
Pace Rate (kN/s)	0.50	Mass (g)	1013.10
		Moisture Content (%)	0.02
SRK Litho	MV	Wet Density (Kg/m^3)	2800.98
		Dry Density (Kg/m^3)	2800.42

Failure Mode		Notes
		- Water content as received
Type:	**1**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**~15**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

BEFORE TEST

AFTER TEST

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G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD769**
Project:	Hope Bay	**Sample Number:**	4
Location:	Nunavut	**Depth (m):**	130.98 - 131.28
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**273.60**	Diameter (mm)	60.50
		Height (mm)	126.16
Stress σ (MPa)	**95.2**	Area (cm^2)	28.75
		Volume (cm^3)	362.68
Pace Rate (kN/s)	0.50	Mass (g)	1034.40
		Moisture Content (%)	0.02
SRK Litho	MV	Wet Density (Kg/m^3)	2852.11
		Dry Density (Kg/m^3)	2851.56

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**15**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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BEFORE TEST

AFTER TEST

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD769**
Project:	Hope Bay	**Sample Number:**	5
Location:	Nunavut	**Depth (m):**	158.20 - 158.52
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**273.40**	Diameter (mm)	60.45
		Height (mm)	126.62
Stress σ (MPa)	**95.3**	Area (cm^2)	28.70
		Volume (cm^3)	363.40
Pace Rate (kN/s)	0.50	Mass (g)	1032.10
		Moisture Content (%)	0.03
SRK Litho	MV	Wet Density (Kg/m^3)	2840.12
		Dry Density (Kg/m^3)	2839.30

Failure Mode	Notes
	- Water content as received
Type: **4**	**Mode:**
	(1) Diagonal shear plane(s)
Degrees:* **14**	(2) Vertical fracture(s)
	(3) Vertical splitting
	(4) Shear along foliation /discontinuity
	(5) Conical
* Degrees measured with respect to core axis.	(6) Spalling
	(7) Other

Comments

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BEFORE TEST

AFTER TEST

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD769**
Project:	Hope Bay	**Sample Number:**	6
Location:	Nunavut	**Depth (m):**	187.10 - 187.34
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**317.40**	Diameter (mm)	60.43
		Height (mm)	124.86
Stress σ (MPa)	**110.7**	Area (cm^2)	28.68
		Volume (cm^3)	358.11
Pace Rate (kN/s)	0.50	Mass (g)	1021.30
		Moisture Content (%)	0.03
SRK Litho	MV	Wet Density (Kg/m^3)	2851.90
		Dry Density (Kg/m^3)	2851.06

Failure Mode	Notes
	- Water content as received
Type: **4**	**Mode:**
	(1) Diagonal shear plane(s)
Degrees:* **8**	(2) Vertical fracture(s)
	(3) Vertical splitting
	(4) Shear along foliation /discontinuity
	(5) Conical
* Degrees measured with respect to core axis.	(6) Spalling
	(7) Other

Comments

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BEFORE TEST

AFTER TEST

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

Golder Associates Ltd. - Burnaby Lab
4280 Still Creek Drive
Burnaby, B.C. Canada V5C 6C6

Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD769**
Project:	Hope Bay	**Sample Number:**	7
Location:	Nunavut	**Depth (m):**	219.38 - 219.68
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**345.00**	Diameter (mm)	60.56
		Height (mm)	125.89
Stress σ (MPa)	**119.8**	Area (cm^2)	28.80
		Volume (cm^3)	362.62
Pace Rate (kN/s)	0.50	Mass (g)	1025.60
		Moisture Content (%)	0.03
SRK Litho	MV	Wet Density (Kg/m^3)	2828.30
		Dry Density (Kg/m^3)	2827.47

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**4**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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BEFORE TEST

AFTER TEST

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

Golder Associates Ltd. - Burnaby Lab
4280 Still Creek Drive
Burnaby, B.C. Canada V5C 6C6

Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD769**
Project:	Hope Bay	**Sample Number:**	9
Location:	Nunavut	**Depth (m):**	294.11 - 294.44
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**179.80**	Diameter (mm)	61.10
		Height (mm)	125.61
Stress σ (MPa)	**61.3**	Area (cm^2)	29.32
		Volume (cm^3)	368.30
Pace Rate (kN/s)	0.50	Mass (g)	1013.90
		Moisture Content (%)	1.55
SRK Litho	MV	Wet Density (Kg/m^3)	2752.95
		Dry Density (Kg/m^3)	2710.85

Failure Mode		Notes
		- Water content as received
Type:	**4/1**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**8/16**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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BEFORE TEST

AFTER TEST

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Golder Associates

Golder Associates Ltd. - Burnaby Lab
4280 Still Creek Drive
Burnaby, B.C. Canada V5C 6C6

Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD284**
Project:	Hope Bay	**Sample Number:**	1
Location:	Nunavut	**Depth (m):**	34.42 - 34.74
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**251.70**	Diameter (mm)	60.94
		Height (mm)	127.63
Stress σ (MPa)	**86.3**	Area (cm^2)	29.17
		Volume (cm^3)	372.26
Pace Rate (kN/s)	0.50	Mass (g)	1087.60
		Moisture Content (%)	0.04
SRK Litho	Not Provided	Wet Density (Kg/m^3)	2921.61
		Dry Density (Kg/m^3)	2920.53

BEFORE TEST

Failure Mode		Notes
		- Water content as received
Type:	**4/2**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**N/A**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

AFTER TEST

Comments

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G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD284**
Project:	Hope Bay	**Sample Number:**	2
Location:	Nunavut	**Depth (m):**	47.84 - 48.16
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**203.50**	Diameter (mm)	60.86
		Height (mm)	126.62
Stress σ (MPa)	**70.0**	Area (cm^2)	29.09
		Volume (cm^3)	368.35
Pace Rate (kN/s)	0.50	Mass (g)	1067.10
		Moisture Content (%)	0.08
SRK Litho	Not Provided	Wet Density (Kg/m^3)	2897.00
		Dry Density (Kg/m^3)	2894.56

Failure Mode		Notes
		- Water content as received
Type:	**4/2**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**N/A**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference: ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD279**
Project:	Hope Bay	**Sample Number:**	5
Location:	Nunavut	**Depth (m):**	201.58 - 201.88
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**33.40**	Diameter (mm)	60.81
		Height (mm)	126.33
Stress σ (MPa)	**11.5**	Area (cm^2)	29.04
		Volume (cm^3)	366.90
Pace Rate (kN/s)	0.50	Mass (g)	1018.30
		Moisture Content (%)	0.05
SRK Litho	IFV	Wet Density (Kg/m^3)	2775.42
		Dry Density (Kg/m^3)	2774.06

Failure Mode	Notes
	- Water content as received
Type: **4**	**Mode:**
	(1) Diagonal shear plane(s)
Degrees:* **28**	(2) Vertical fracture(s)
	(3) Vertical splitting
	(4) Shear along foliation /discontinuity
	(5) Conical
* Degrees measured with respect to core axis.	(6) Spalling
	(7) Other

Comments

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD279**
Project:	Hope Bay	**Sample Number:**	7
Location:	Nunavut	**Depth (m):**	258.24 - 258.82
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**62.40**	Diameter (mm)	60.80
		Height (mm)	115.81
Stress σ (MPa)	**21.5**	Area (cm^2)	29.03
		Volume (cm^3)	336.24
Pace Rate (kN/s)	0.50	Mass (g)	935.10
		Moisture Content (%)	0.05
SRK Litho	IFV	Wet Density (Kg/m^3)	2781.09
		Dry Density (Kg/m^3)	2779.60

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**28**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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BEFORE TEST

AFTER TEST

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD279**
Project:	Hope Bay	**Sample Number:**	9
Location:	Nunavut	**Depth (m):**	317.43 - 317.72
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**25.80**	Diameter (mm)	60.73
		Height (mm)	126.44
Stress σ (MPa)	**8.9**	Area (cm^2)	28.97
		Volume (cm^3)	366.25
Pace Rate (kN/s)	0.50	Mass (g)	1015.80
		Moisture Content (%)	0.04
SRK Litho	IFV	Wet Density (Kg/m^3)	2773.49
		Dry Density (Kg/m^3)	2772.40

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**28**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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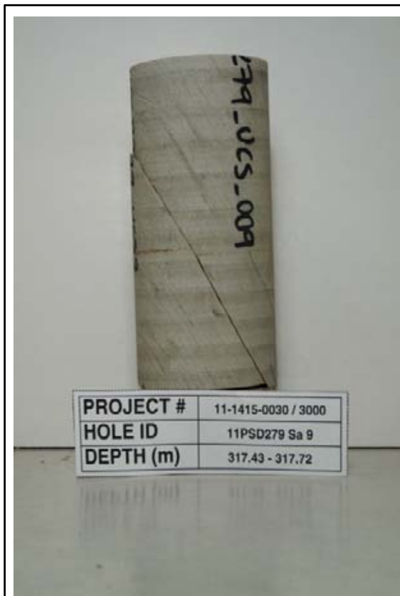
BEFORE TEST



AFTER TEST

G. Patton	July 13, 2011	E. Kostyukov	July 21, 2011
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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD771**
Project:	Hope Bay	**Sample Number:**	1
Location:	Nunavut	**Depth (m):**	31.60 - 31.90
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**258.80**	Diameter (mm)	60.85
		Height (mm)	126.04
Stress σ (MPa)	**89.0**	Area (cm^2)	29.08
		Volume (cm^3)	366.54
Pace Rate (kN/s)	0.50	Mass (g)	1049.60
		Moisture Content (%)	0.01
SRK Litho	MV	Wet Density (Kg/m^3)	2863.55
		Dry Density (Kg/m^3)	2863.27

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**21**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD771**
Project:	Hope Bay	**Sample Number:**	8
Location:	Nunavut	**Depth (m):**	252.93 - 253.21
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**55.30**	Diameter (mm)	60.86
		Height (mm)	125.86
Stress σ (MPa)	**19.0**	Area (cm^2)	29.09
		Volume (cm^3)	366.14
Pace Rate (kN/s)	0.50	Mass (g)	989.60
		Moisture Content (%)	0.73
SRK Litho	MV	Wet Density (Kg/m^3)	2702.83
		Dry Density (Kg/m^3)	2683.11

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**28**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD276A**
Project:	Hope Bay	**Sample Number:**	2
Location:	Nunavut	**Depth (m):**	71.13 - 71.45
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**62.70**	Diameter (mm)	60.46
		Height (mm)	124.65
Stress σ (MPa)	**21.8**	Area (cm^2)	28.71
		Volume (cm^3)	357.86
Pace Rate (kN/s)	0.50	Mass (g)	1042.50
		Moisture Content (%)	0.04
SRK Litho	MV	Wet Density (Kg/m^3)	2913.11
		Dry Density (Kg/m^3)	2912.00

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**19**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD279**
Project:	Hope Bay	**Sample Number:**	1
Location:	Nunavut	**Depth (m):**	78.73 - 79.02
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**69.10**	Diameter (mm)	60.54
		Height (mm)	126.08
Stress σ (MPa)	**24.0**	Area (cm^2)	28.79
		Volume (cm^3)	362.93
Pace Rate (kN/s)	0.50	Mass (g)	1071.00
		Moisture Content (%)	0.04
SRK Litho	MV	Wet Density (Kg/m^3)	2951.00
		Dry Density (Kg/m^3)	2949.89

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**23**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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BEFORE TEST

AFTER TEST

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD279**
Project:	Hope Bay	**Sample Number:**	3
Location:	Nunavut	**Depth (m):**	136.58 - 136.92
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**79.80**	Diameter (mm)	60.76
		Height (mm)	124.79
Stress σ (MPa)	**27.5**	Area (cm^2)	29.00
		Volume (cm^3)	361.83
Pace Rate (kN/s)	0.50	Mass (g)	1049.80
		Moisture Content (%)	0.03
SRK Litho	MV	Wet Density (Kg/m^3)	2901.36
		Dry Density (Kg/m^3)	2900.53

BEFORE TEST

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**30**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

AFTER TEST

Comments

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD279**
Project:	Hope Bay	**Sample Number:**	13
Location:	Nunavut	**Depth (m):**	435.24 - 435.47
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**230.60**	Diameter (mm)	60.82
		Height (mm)	126.67
Stress σ (MPa)	**79.4**	Area (cm^2)	29.05
		Volume (cm^3)	368.01
Pace Rate (kN/s)	0.50	Mass (g)	1037.20
		Moisture Content (%)	0.01
SRK Litho	EMMI	Wet Density (Kg/m^3)	2818.42
		Dry Density (Kg/m^3)	2818.15

Failure Mode		Notes
		- Water content as received
Type:	**1/4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**17**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD276A**
Project:	Hope Bay	**Sample Number:**	5
Location:	Nunavut	**Depth (m):**	152.68 - 152.99
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**59.00**	Diameter (mm)	60.45
		Height (mm)	126.97
Stress σ (MPa)	**20.6**	Area (cm^2)	28.70
		Volume (cm^3)	364.40
Pace Rate (kN/s)	0.50	Mass (g)	1072.70
		Moisture Content (%)	0.07
SRK Litho	MV	Wet Density (Kg/m^3)	2943.71
		Dry Density (Kg/m^3)	2941.51

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**28**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference: ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11PSD276A**
Project:	Hope Bay	**Sample Number:**	7
Location:	Nunavut	**Depth (m):**	222.40 - 222.78
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**94.50**	Diameter (mm)	60.70
		Height (mm)	125.89
Stress σ (MPa)	**32.7**	Area (cm^2)	28.94
		Volume (cm^3)	364.30
Pace Rate (kN/s)	0.50	Mass (g)	1005.10
		Moisture Content (%)	0.04
SRK Litho	IFV	Wet Density (Kg/m^3)	2758.99
		Dry Density (Kg/m^3)	2757.90

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**23**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

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BEFORE TEST

AFTER TEST

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference: ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD769**
Project:	Hope Bay	**Sample Number:**	2
Location:	Nunavut	**Depth (m):**	69.27 - 69.63
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**154.60**	Diameter (mm)	59.64
		Height (mm)	124.69
Stress σ (MPa)	**55.3**	Area (cm^2)	27.94
		Volume (cm^3)	348.33
Pace Rate (kN/s)	0.50	Mass (g)	998.20
		Moisture Content (%)	0.02
SRK Litho	MV	Wet Density (Kg/m^3)	2865.63
		Dry Density (Kg/m^3)	2865.06

Failure Mode	Notes
	- Water content as received
Type: **4**	**Mode:**
	(1) Diagonal shear plane(s)
Degrees:* **18**	(2) Vertical fracture(s)
	(3) Vertical splitting
	(4) Shear along foliation /discontinuity
	(5) Conical
* Degrees measured with respect to core axis.	(6) Spalling
	(7) Other

Comments

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BEFORE TEST

AFTER TEST

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference	ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD772**
Project:	Hope Bay	**Sample Number:**	1
Location:	Nunavut	**Depth (m):**	47.20 - 47.45
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**340.70**	Diameter (mm)	60.40
		Height (mm)	125.52
Stress σ (MPa)	**118.9**	Area (cm^2)	28.65
		Volume (cm^3)	359.65
Pace Rate (kN/s)	0.50	Mass (g)	1071.00
		Moisture Content (%)	0.06
SRK Litho	MV	Wet Density (Kg/m^3)	2977.92
		Dry Density (Kg/m^3)	2976.25

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**7**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

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Unconfined Compressive Strength of Intact Rock Core Specimens

Reference
ASTM D7012-07 Method C

Project No.:	11-1415-0030 / 3000	**Hole ID:**	**11TDD772**
Project:	Hope Bay	**Sample Number:**	2
Location:	Nunavut	**Depth (m):**	103.95 - 104.27
Client:	SRK Consulting	**Lab ID No:**	79

Testing Results		Sample Measurements	
Max Load (kN)	**198.90**	Diameter (mm)	60.25
		Height (mm)	127.08
Stress σ (MPa)	**69.8**	Area (cm^2)	28.51
		Volume (cm^3)	362.31
Pace Rate (kN/s)	0.50	Mass (g)	1092.00
		Moisture Content (%)	0.01
SRK Litho	MV	Wet Density (Kg/m^3)	3013.99
		Dry Density (Kg/m^3)	3013.71

Failure Mode		Notes
		- Water content as received
Type:	**4**	**Mode:**
		(1) Diagonal shear plane(s)
Degrees:*	**8**	(2) Vertical fracture(s)
		(3) Vertical splitting
		(4) Shear along foliation /discontinuity
		(5) Conical
* Degrees measured with respect to core axis.		(6) Spalling
		(7) Other

Comments

** The test data given herein pertain to the sample provided only. This report constitutes a testing service only. Interpretation of the data given here may be provided upon request.*

BEFORE TEST

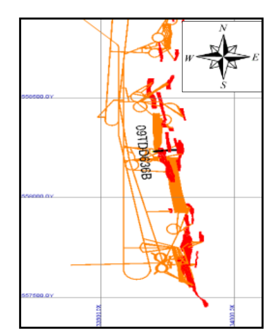
AFTER TEST

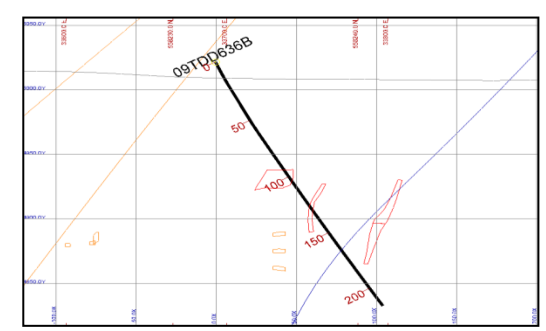
G. Patton	July 14, 2011	E. Kostyukov	July 21, 2011
TESTED BY	DATE	CHECKED BY	DATE

Appendix I - Detailed Core Photo Review

Graph Legend

- FF/m
- IRS
- Ore body





Photograph Legend

- Ore body

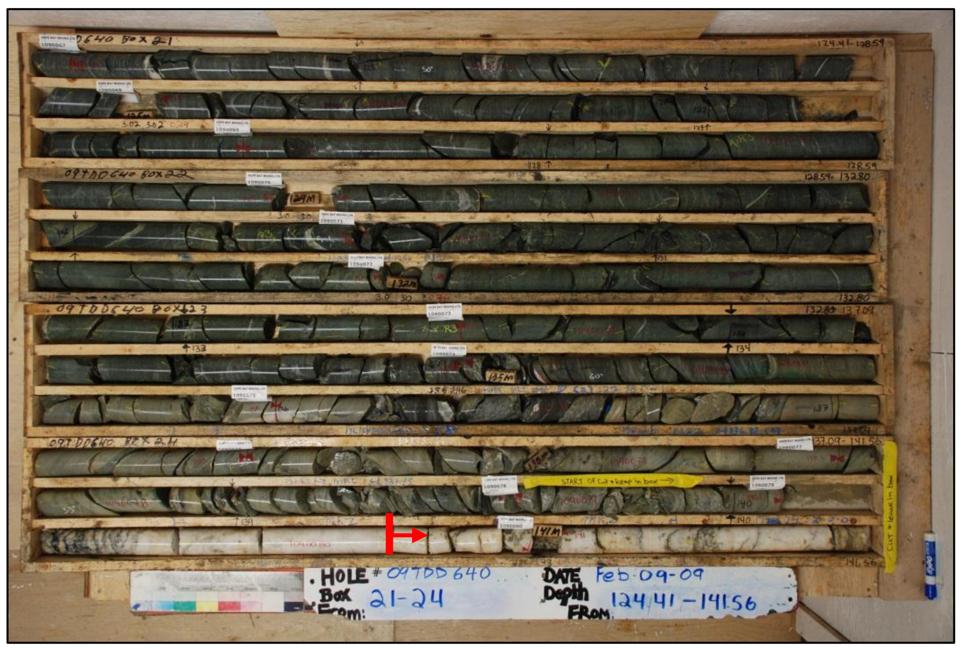
srk consulting

NEWMONT NORTH AMERICA

Rock Mass Assessment
Doris Central and Connector

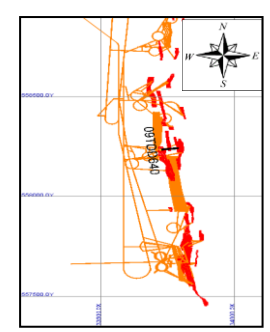
Doris Underground Core Photo Review: 09TDD636B

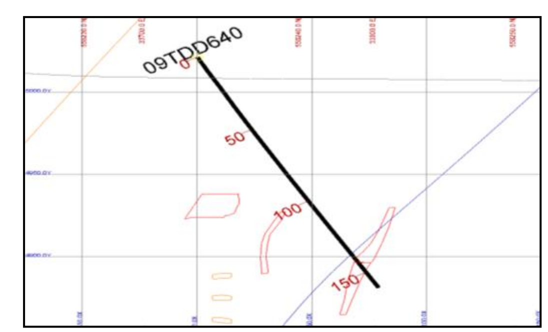
Job No: 1CH008.054	Hope Bay Gold Project	Date: 20111107	Approved: RG	Figure: I.1
Filename: Appendix I.pptx				



Graph Legend

- FF/m
- IRS
- Ore body





Photograph Legend

- Ore body

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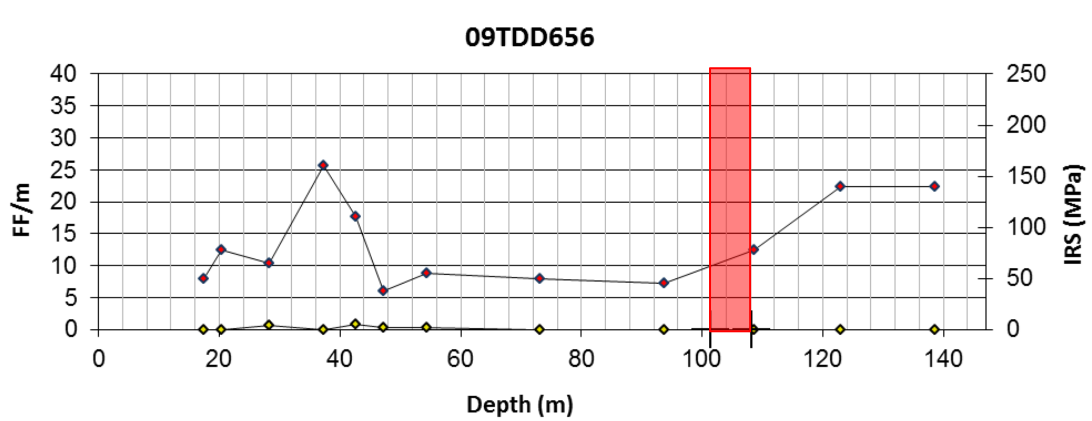
NEWMONT NORTH AMERICA

Rock Mass Assessment
Doris Central and Connector

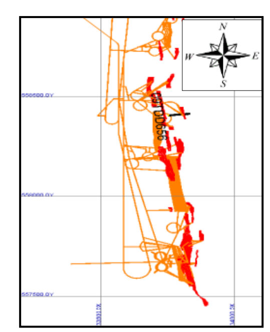
Doris Underground Core Photo Review: 09TDD640

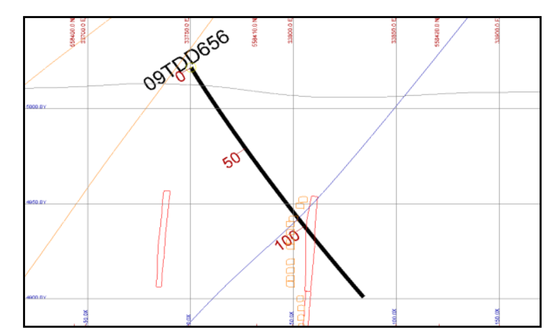
Job No: 1CH008.054	Hope Bay Gold Project	Date: 20111107	Approved: RG
Filename: Appendix I.pptx		Figure:	I.2



Graph Legend

- FF/m
- IRS
- Ore body





Photograph Legend

- Ore body

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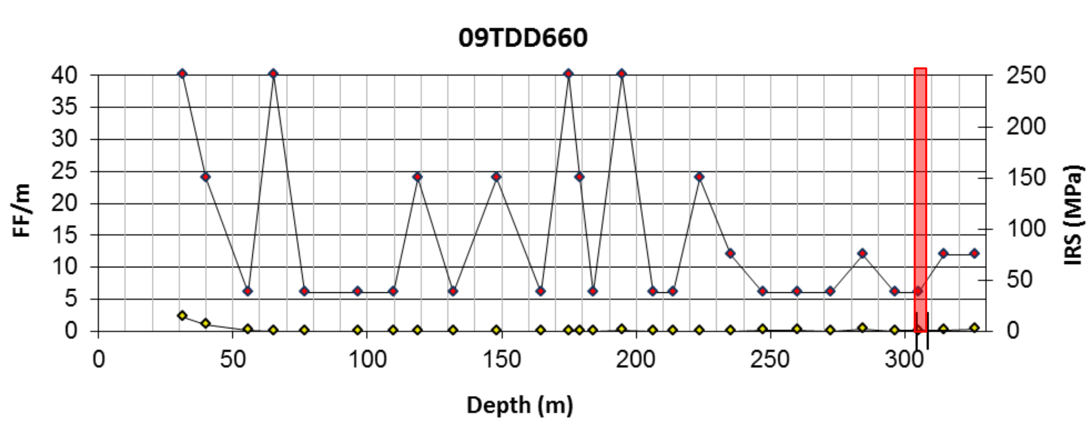
Job No: 1CH008.054
Filename: Appendix I.pptx

Hope Bay Gold Project

Rock Mass Assessment
Doris Central and Connector

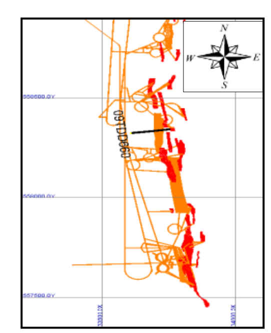
Doris Underground Core Photo Review: 09TDD656

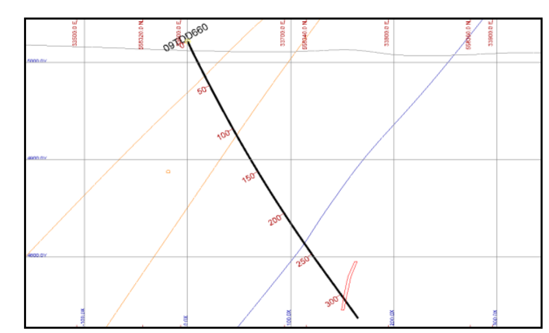
Date:	Approved:	Figure:
20111107	RG	I.3



Graph Legend

- FF/m
- IRS
- Ore body





Photograph Legend

- Ore body

srk consulting

NEWMONT NORTH AMERICA

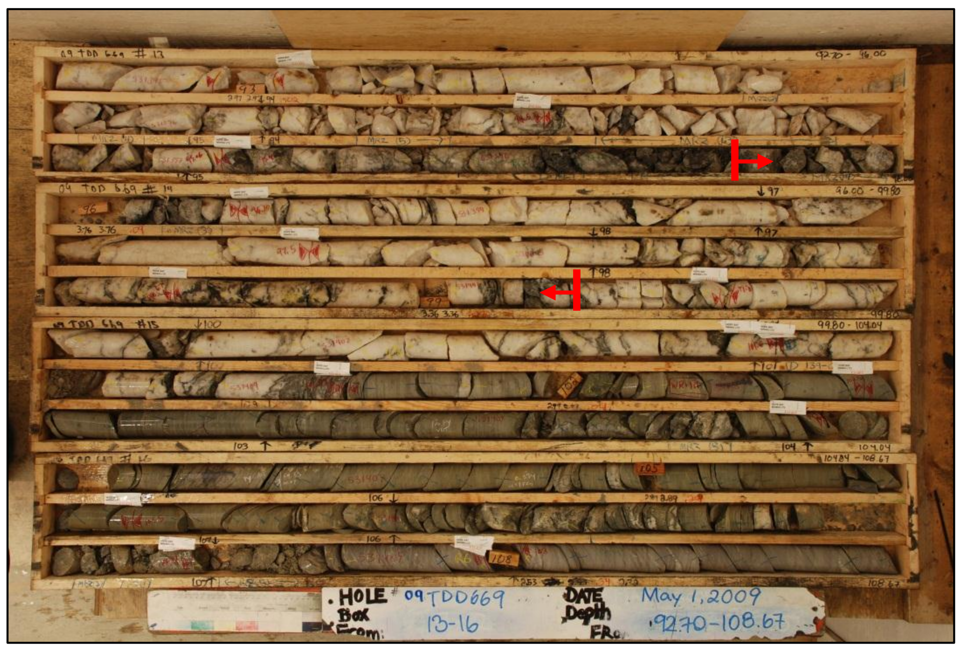
Rock Mass Assessment
Doris Central and Connector

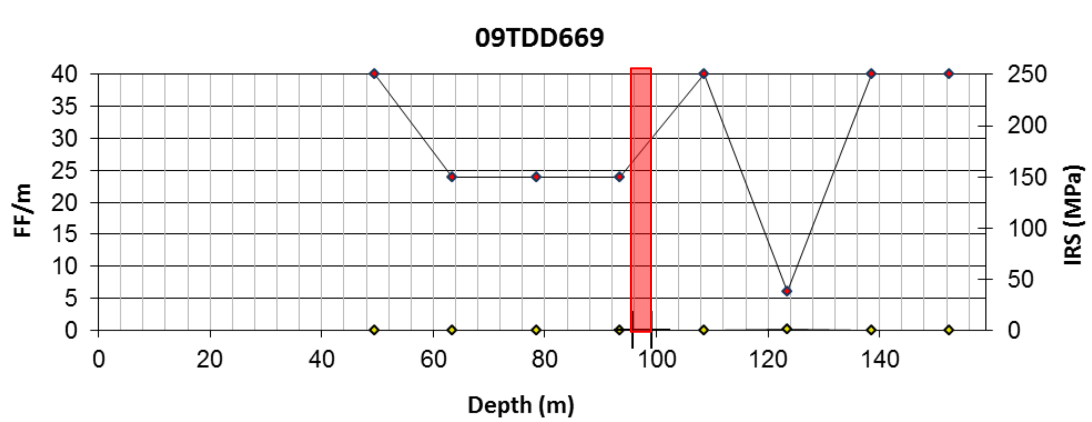
Doris Underground Core Photo Review: 09TDD660

Job No: 1CH008.054
Filename: Appendix I.pptx

Hope Bay Gold Project

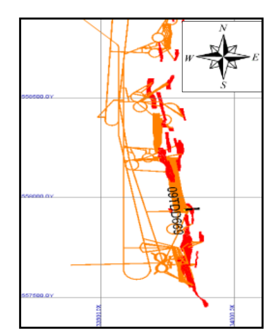
Date: 20111107 | Approved: RG | Figure: I.4

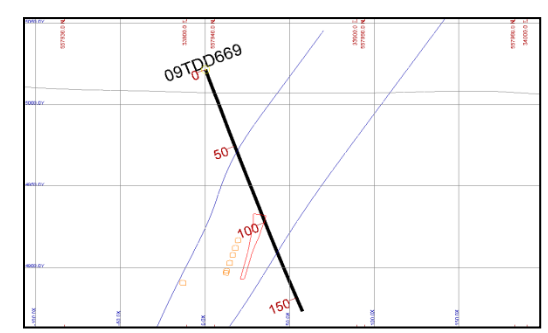




Graph Legend

- FF/m
- IRS
- Ore body





Photograph Legend

- Ore body

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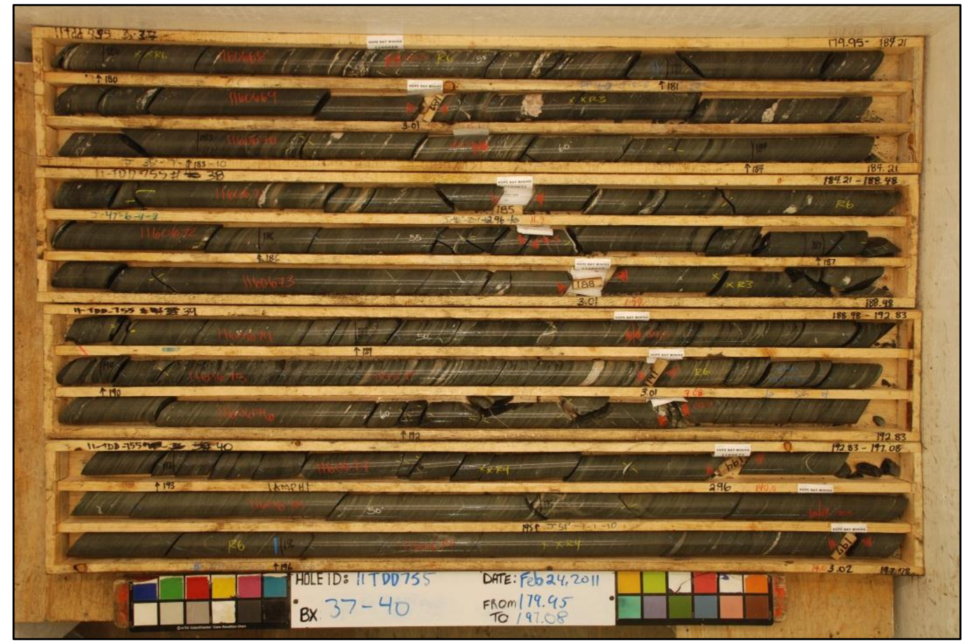
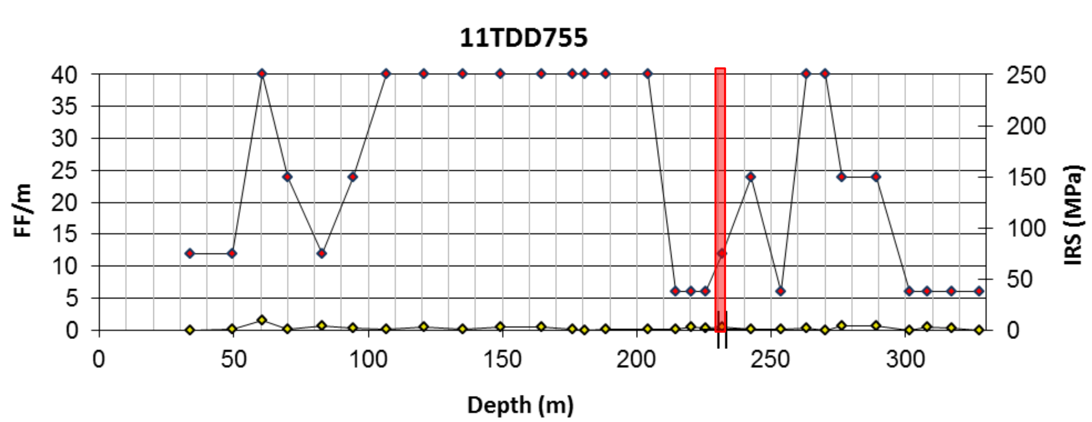
NEWMONT NORTH AMERICA

Rock Mass Assessment
Doris Central and Connector

Doris Underground Core Photo Review: 09TDD669

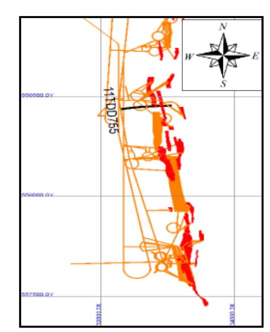
Job No: 1CH008.054 Filename: Appendix I.pptx	Hope Bay Gold Project	Date: 20111107	Approved: RG	Figure: I.5

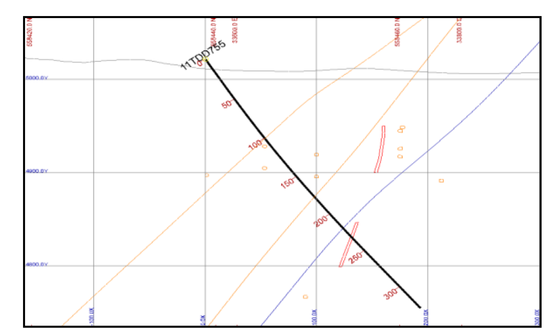




Graph Legend

- FF/m
- IRS
- Ore body





Photograph Legend

- Ore body

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NEWMONT NORTH AMERICA

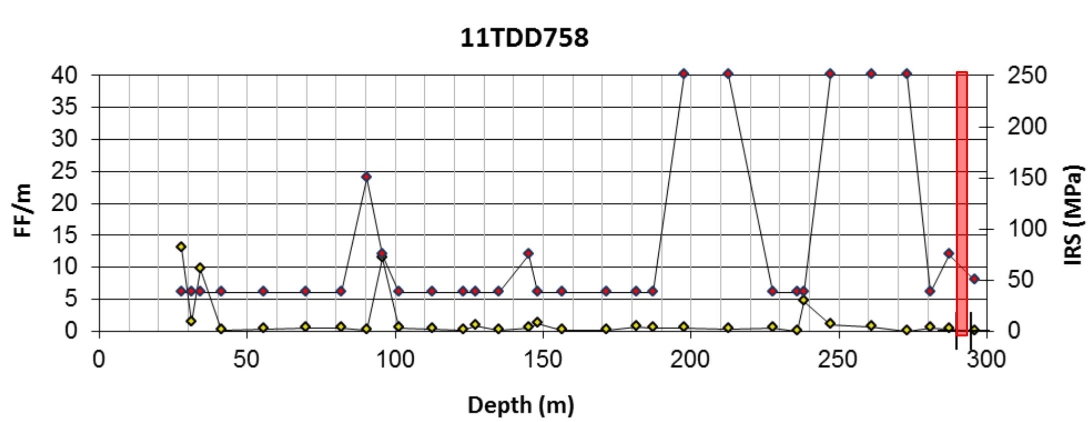
Rock Mass Assessment
Doris Central and Connector

Doris Underground Core Photo Review: 11TDD755

Job No: 1CH008.054
Filename: Appendix I.pptx

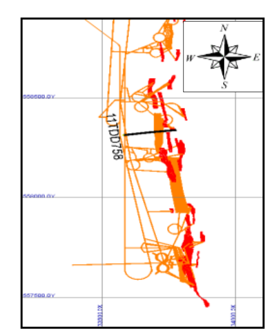
Hope Bay Gold Project

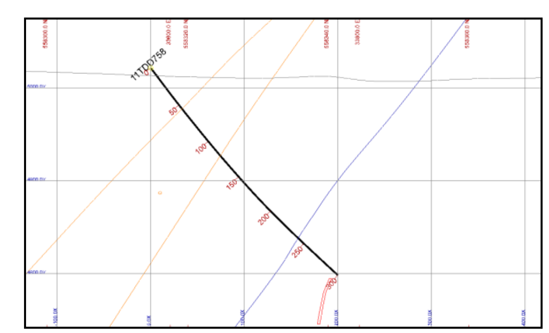
Date:	Approved:	Figure:
20111107	RG	I.6



Graph Legend

- FF/m
- IRS
- Ore body





Photograph Legend

- Ore body

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NEWMONT NORTH AMERICA

Rock Mass Assessment
Doris Central and Connector

Doris Underground Core Photo Review: 11TDD758

Job No: 1CH008.054
Filename: Appendix I.pptx

Hope Bay Gold Project

Date:	Approved:	Figure:
20111107	RG	I.7