BC Geological Survey
Coal Assessment Report
1028

COAL ASSESSMENT REPORT TITLE PAGE AND SUMMARY

TITLE OF REPORT: Elkview Operations 2016 Exploration Report

TOTAL COST: $557,353.00

AUTHOR(S): Esaias E. (Bert) Schalekamp
SIGNATURE(S): Esaias E. (Bert) Schalekamp

NOTICE OF WORK PERMIT NUMBER(S)/DATE(S):
Mine Permit No.: C-2
Mine No.: 0600337201401
File: 14675-35-04

YEAR OF WORK 2016:

PROPERTY NAME: Elkview Operation, Teck Coal Limited

COAL LICENSE(S) AND/OR LEASES ON WHICH PHYSICAL WORK WAS DONE:
LOT 1 District LOT 4588 Kootenay
District PLAN 9330, Except parts included in PLAN 9591, 10218, RW PLAN 12980 and PLAN NEP89674

MINERAL INVENTORY MINFILE NUMBER(S), IF KNOWN: 0600337

MINING DIVISION: Fort Steele
NTS / BCGS: 082G10, 082G15 / 082G076
LATITUDE: ____49_____° __47_____' __10_____" N
LONGITUDE: __114_____° __49_____' ___39_____" W (at centre of work)
UTM Zone: 11 EASTING: 49.702 NORTHING: -114.818

OWNER(S): Teck Coal Limited

MAILING ADDRESS:
Teck Coal Limited
Elkview Operations
RR 1, Hwy 3
Sparwood, BC
V0B 2G1

OPERATOR(S) [who paid for the work]:
Teck Coal Limited

MAILING ADDRESS:
Same as above

REPORT KEYWORDS (lithology, age, stratigraphy, structure, alteration, mineralization, size and attitude. **Do not use abbreviations or codes**)

REFERENCES TO PREVIOUS ASSESSMENT WORK AND ASSESSMENT REPORT NUMBERS:

SUMMARY OF TYPES OF WORK IN THIS REPORT		EXTENT OF WORK (in metric units)	ON WHICH TENURES
GEOLOGICAL (scale, area)		NA	
	Ground, mapping	NA	
	Photo interpretation	NA	
GEOPHYSICAL (line-kilometres)		NA	
	Ground (Specify types)	NA	
	Airborne (Specify types)	NA	
	Borehole	29 Drillholes completed	LOT 1, District LOT 4588, Kootenay District Plan 9330
	Gamma, Resistivity,	5,960 Meters	A total of 19 RC drillholes (5,623m) were completed. 18 Drillholes were within active mining pits on the same property as above. One drillhole was outside the C2 boundary in the Baldy Ridge area. An additional 10 short underground core holes (337m) were completed.
	Resistivity	5,623 Meters	
	Caliper	5,623 Meters	
	Deviation	5,623 Meters	
	Dip	NA	
	Others (specify)		
	Core	337 Meters	Core drilling
	Non-core	5,623 Meters	RC drilling
SAMPLING AND ANALYSES			
Total # of Samples			
1975	Proximate		Currently estimates only, work still ongoing.
	Ultimate		
95	Petrographic		
95	Vitrinite reflectance		
	Coking		
	Wash tests		
PROSPECTING (scale/area)		NA	

PREPARATORY/PHYSICAL		
Line/grid (km)	NA	
Trench (number, metres)	NA	
Bulk sample(s)	NA	

Appendix C remains confidential under the terms of the Coal Act Regulation, and has been removed from the public version.

http://www.bclaws.ca/civix/document/id/complete/statreg/251_2004

Elkview Operations

Coal Assessment Report

2016 Exploration Program

Teck

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Statements of Author's Academic and Professional Qualifications

CERTIFICATE OF QUALIFIED PERSON

Name:

Esaias E. (Bert) Schalekamp,

P.Geo.

Company: Teck Coal Limited

Address: Elkview Operations
RR 1, Hwy 3
Sparwood, BC
V0B 2G1

I, Esaias E Schalekamp, P.Geo, am employed as a Senior Geologist Supervisor, at Elkview Operations. This certificate applies to the report titled "Elkview Operations, Summary Report, 2016 Exploration Program". I graduated from the University of Pretoria, South Africa with a Master of Science Degree specializing in Geology, 2007. I am a member of the Association of Professional Engineers and Geoscientists of British Columbia (# 40404). I started my career in South Africa in 1991 with Anglo American plc, Coal Division. From 2007 to 2011, I worked for Peace River Coal Inc. (Anglo American plc) on the Roman Mountain and Horizon projects and various greenfields and brownfields projects in Tumbler Ridge, BC. From 2011 to the present I have worked for Teck Coal Limited at the Fording River Operations (2011 to 2013) and from 2013 at the Elkview Operations. As a result of my experience and qualifications, I am a Qualified Person as defined in National Instrument 43-101 Standards of Disclosure for Mineral Projects (NI 43-101).

Esaias E Schalekamp, P.Geo.

Introduction

1. General Geography and History

The Elkview property is located approximately 3 km east of Sparwood. It is accessed by driving east on Highway 3, then turning on to the Elkview Mine access road as illustrated in Figure 1. The general coordinates of the property are Latitude: 49º 47' 10" N, Longitude: 114º 49' 39" W. The tenure associated with this site is LOT 1, DISTRICT LOT 4588, KOOTENAY DISTRICT PLAN 9330 as shown in Figure 2. Elkview Operations forms part of the larger TECK COAL LIMITED.

The Elkview mine site is situated within the front ranges of the southern Canadian Rocky Mountains. The coal measures are contained within the Mist Mountain Formation of the Kootenay Group.

Historical mining on the Elkview property began late in the 19th century and included underground mining of upper coal seams on both Baldy and Natal ridges. By 1969, Kaiser Resources Limited progressed to large scale open pit operations of the Balmer Mine. Reclamation permit (C-2 permit) was approved in 1970 authorizing the operation of the Balmer Mine under the BC Mines Act.

On August 31, 1992, Westar Mining Limited (successor to Kaiser Resources Limited) was petitioned into bankruptcy. On December 9, 1992, Teck Corporation acquired the assets of the Balmer property including all fixed infrastructure related to the Balmer Mine, mine equipment owned by Westar, and clear title to a portion of the original Kaiser Lands where coal mining rights had been acquired from Crowsnest Industries. Elkview Coal Corporation (ECC) was formed to operate the newly renamed Elkview Mine as a wholly owned subsidiary of Teck Corporation.

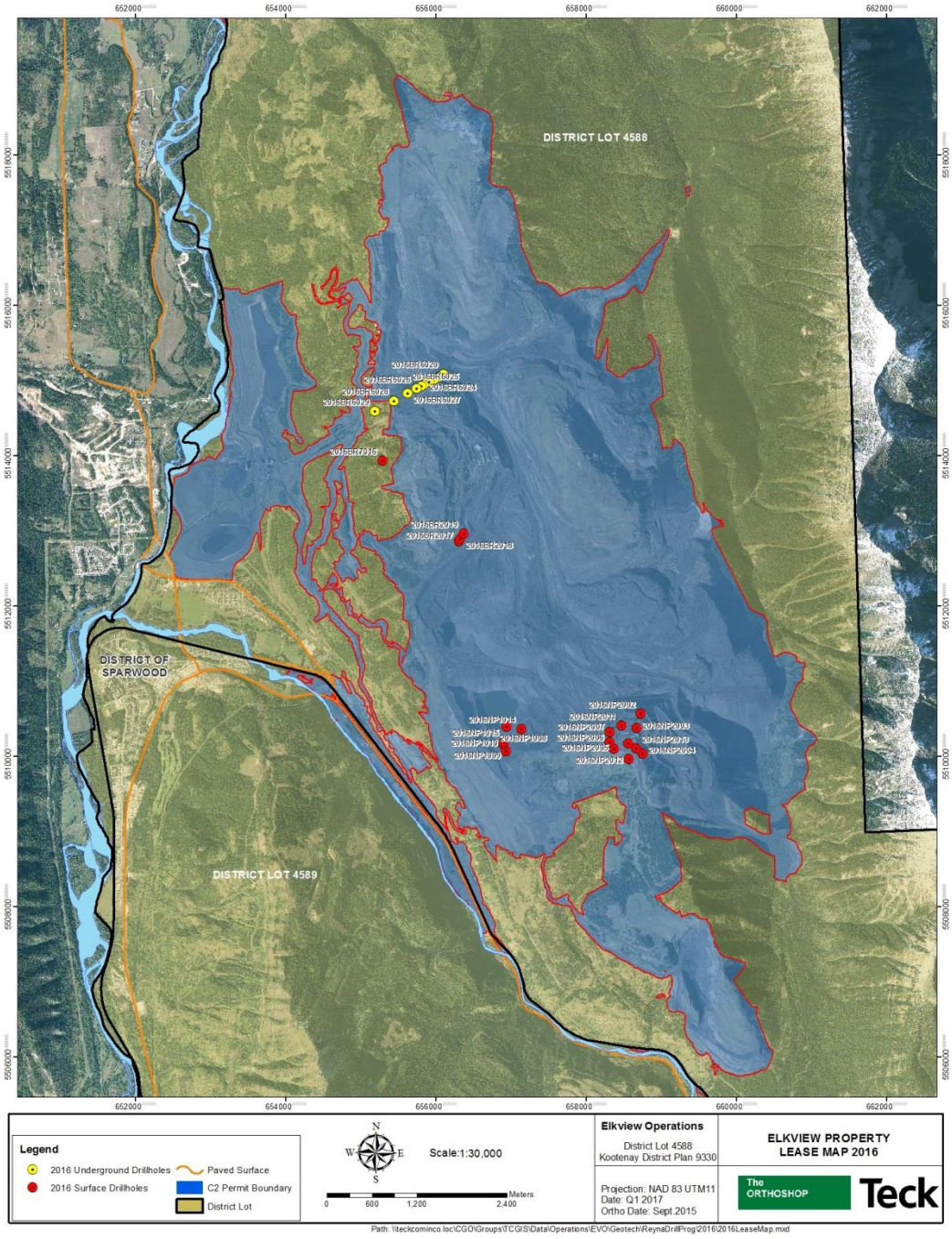
All approvals previously issued to Westar Mining - Balmer Operations were considered to be in good standing. Elkview made an application to resume operations under Section 10(1) of the Coal Act on April 26, 1993. An amended reclamation C-2 permit was issued on May 3, 1993. Mining and coal processing re-started shortly thereafter and continues today. There have been a number of amendments to the C-2 permit since 1993, as new operating areas and supporting infrastructure have been required. In 1996, an Environmental Assessment Certificate (EAC) was issued for the development of Bodie Spoil.

Since 1970, EVO has produced 202 M metric tonnes of steel-making coal for sale to various customers globally. As of 2013, total disturbance at EVO was 4,167 hectares (ha) with 2,902 ha of this area reclaimed.


British Columbia
Alberta
Ridley Terminal
Prince Rupert
Prince George
CNR
CNR
Edmonton
Pacific Ocean
Calgary
CPR
Westshore Terminal
Vancouver
Elk Valley
U.S.A.
N
FRO
Alberta
GHO
Elk River
Elkford
British Columbia
LCO
Sparwood
EVO
CPR
Crowsnest Pass
Cranbrook
Fernie
CPR
CMO
0
10
20
30 km

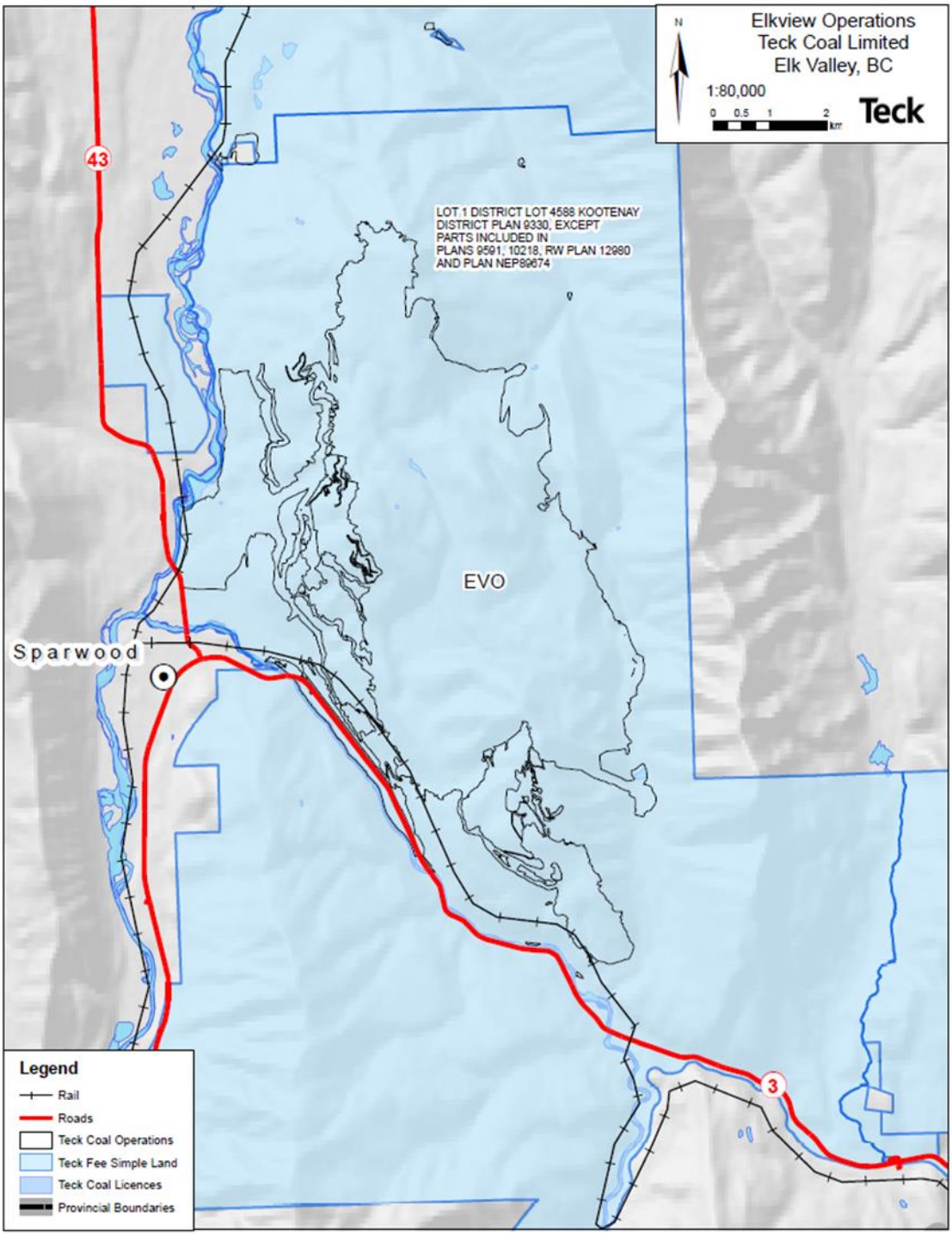
Reference:

i) Figure 1: Elkview Property Lease Map, 2016



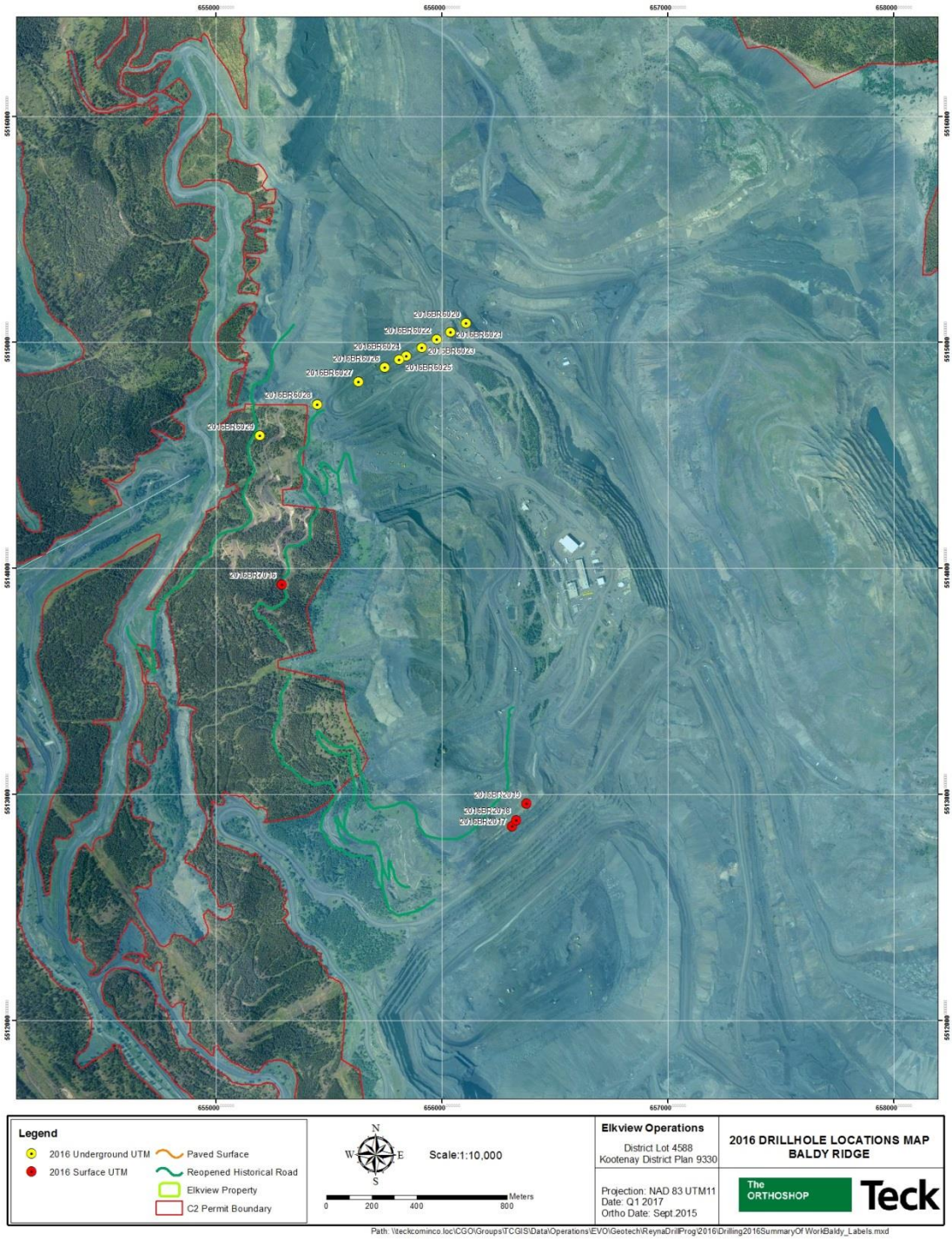
Reference:

ii) Figure 2: Elkview Property Tenure Map, 2016



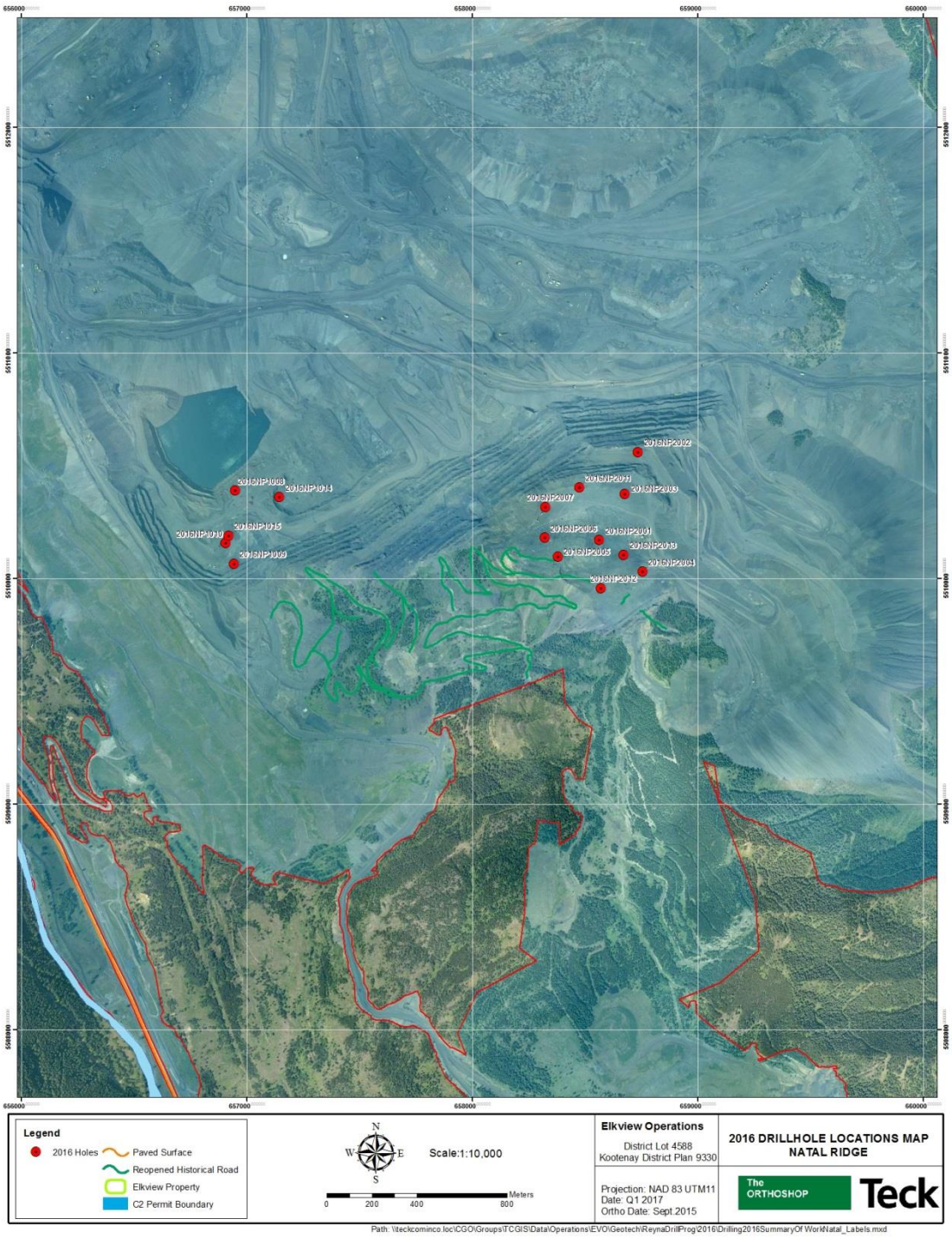
Reference:

iii) Figure 3: Elkview Drillhole Location Map, 2016 Baldy Ridge



Reference:

iv) Figure 4: Elkview Drillhole Location Map, 2016 Natal Ridge



2. Geology

i) Stratigraphy

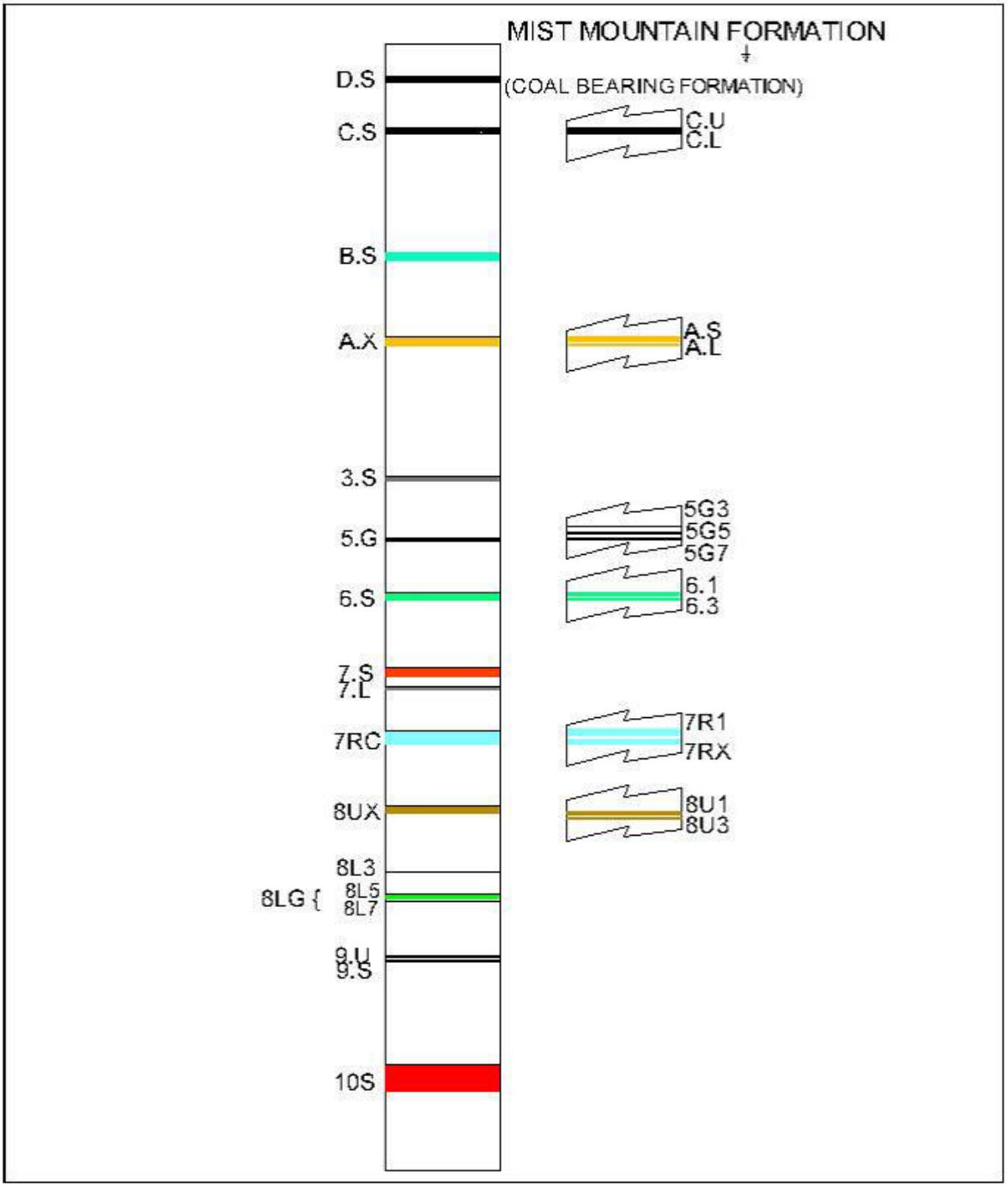
The general stratigraphy at Elkview Operations is summarized in Table 1 below.

Table 1 - Regional Stratigraphy

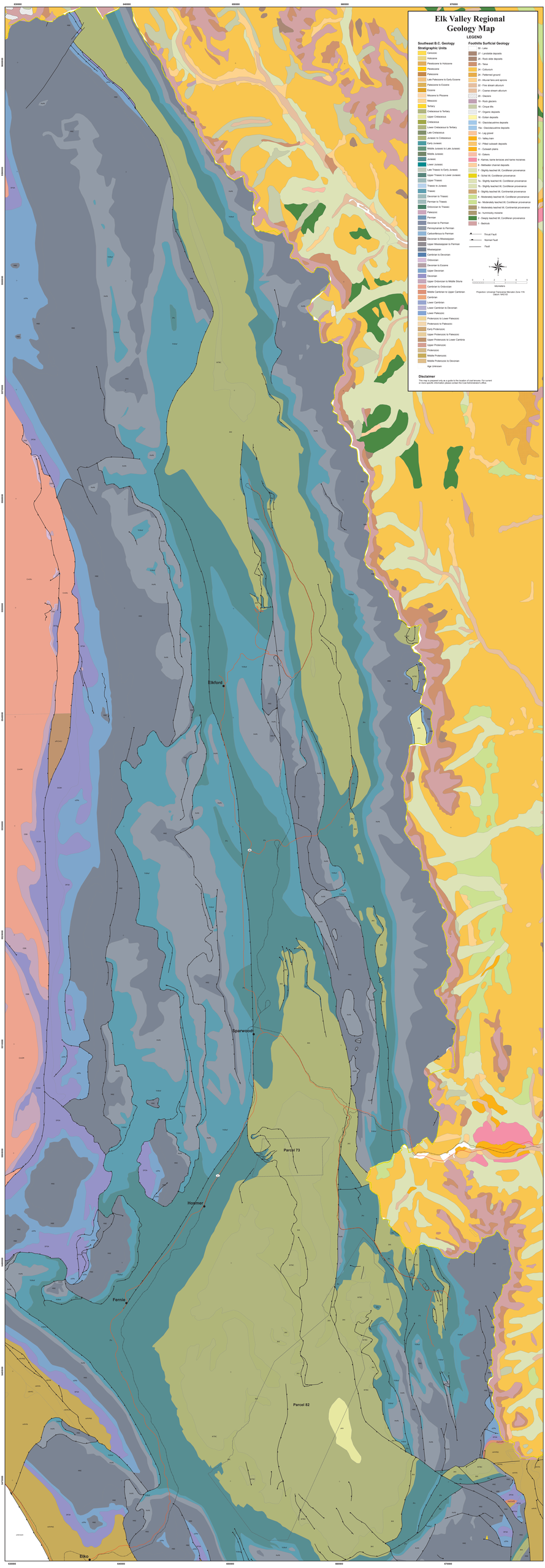
Period	Litho-Stratigraphic Units			Principle Rock Types
Recent				Colluvium
Quaternary				Clay, silt, sand, gravel, cobbles
Lower Cretaceous	Blairmore Group			Massive bedded sandstones and conglomerates
Lower Cretaceous to Upper Jurassic	KOOTENAY GROUP	Elk Formation		Sandstone, siltstone, shale, mudstones, chert pebble conglomerate, minor coal
		Mist Mountain Formation		Sandstone, siltstone, shale, mudstones, thick coal seams
		MORRISSEY FORMATION	Moose Mountain Member	Medium to coarse-grained quartz-chert sandstone
			Weary Ridge Member	Fine to coarse-grained, slight ferruginous quartz-chert sandstone
Jurassic	Fernie Formation			Shale, siltstone, fine-grained sandstone
Triassic	Spray River Formation			Sandy shale, shale quartzite
	Rocky Mountain Formation			Quartzite
Mississippian	Rundle Group			Limestone

Economic coal occurs in the Mist Mountain Formation of the Jurassic-Cretaceous Kootenay Group as shown in Table 1. The formation abruptly and conformably overlies the Morrissey Formation. It averages 500 to 600 meters in thickness and contains from 4 to 30 plus seams. There is approximately 60m of cumulative mineable coal thickness within the Mist Mountain Formation as illustrated in Table 2. Seams range in rank from high to low-volatile bituminous coal. The Elk Formation overlies the Mist Mountain Formation at the top of the Kootenay Group. Its characteristics are similar to those of the Mist Mountain, but lack coal seams of potential economic thickness, and contain sapropelic coals in addition to humic coals. The data confirms a general fining-upward sequence typical of fluvial-alluvial depositional systems.

Table 2 – Mist Mountain Formation Coal Seam Stratigraphy



The coal-forming environment is believed to have been relatively isolated from sources of clastic material. Three coalfields lie within the Mist Mountain Formation in southeastern BC: Elk Valley Coalfield, Flathead Coalfield and the Crowsnest Coalfield. The Elkview mine is situated at the northern end of the Crowsnest Coalfield. It produces low to medium-


Elk Valley Regional Geology Map
LEGEND
Southeast B.C. Geology Stratigraphic Units
Quaternary
Holocene
Pleistocene to Holocene
Pleistocene
Pliocene
Late Paleocene to Early Eocene
Paleocene to Eocene
Eocene
Miocene to Pliocene
Mesozoic
Tertiary
Cretaceous to Tertiary
Upper Cretaceous
Cretaceous
Lower Cretaceous to Tertiary
Late Cretaceous
Jurassic to Cretaceous
Early Jurassic
Middle Jurassic to Late Jurassic
Middle Jurassic
Jurassic
Lower Jurassic
Late Triassic to Early Jurassic
Upper Triassic to Lower Jurassic
Upper Triassic
Triassic to Jurassic
Triassic
Devonian to Triassic
Permian to Triassic
Ordovician to Triassic
Paleozoic
Permian
Devonian to Permian
Pennsylvanian to Permian
Carboniferous to Permian
Devonian to Mississippian
Upper Mississippian to Permian
Mississippian
Cambrian to Devonian
Ordovician
Devonian to Eocene
Upper Devonian
Devonian
Upper Ordovician to Middle Silurian
Cambrian to Ordovician
Middle Cambrian to Upper Cambrian
Cambrian
Lower Cambrian
Lower Cambrian to Devonian
Lower Paleozoic
Proterozoic to Lower Paleozoic
Proterozoic to Paleozoic
Early Proterozoic
Upper Proterozoic to Paleozoic
Upper Proterozoic to Lower Cambria
Upper Proterozoic
Proterozoic
Middle Proterozoic
Middle Proterozoic to Devonian
Age Unknown
Foothills Surficial Geology
30 - Lake
27 - Landslide deposits
26 - Rock slide deposits
25 - Talus
24 - Colluvium
24 - Patterned ground
23 - Alluvial fans and aprons
22 - Fine stream alluvium
21 - Coarse stream alluvium
20 - Glaciers
19 - Rock glaciers
18 - Cirque tills
17 - Organic deposits
16 - Eolian deposits
15 - Glaciolacustrine deposits
15a - Glaciolacustrine deposits
14 - Leg gravel
13 - Valley train
12 - Pitted outwash deposits
11 - Outwash plains
10 - Eskers
9 - Kames, kame terraces and kame moraines
8 - Meltwater channel deposits
7 - Slightly leached III, Cordilleran provenance
6 - Schist III, Cordilleran provenance
5a - Slightly leached III, Cordilleran provenance
5b - Slightly leached III, Cordilleran provenance
5 - Slightly leached III, Continental provenance
4 - Moderately leached III, Cordilleran provenance
4a - Moderately leached III, Cordilleran provenance
3 - Moderately leached III, Continental provenance
3a - Hummocky moraine
2 - Deeply leached III, Cordilleran provenance
1 - Bedrock
Thrust Fault
Normal Fault
Fault
N
0 1 2 3 4 5
0 0.5 1 2 3 4 5
Kilometers
Projection: Universal Transverse Mercator Zone 11N
Datum: NAD 83
Disclaimer
This map is prepared only as a guide to the location of coal tenures. For current or more accurate information please contact the Coal Administrator's office.
Elkford
Sparwood
Hosmer
Fernie
Elko
Parcel 73
Parcel 82

volatile hard coking coal and lesser amounts of thermal coal from a large number of seams through a thick Mist Mountain Formation section.

ii) Structure

The East Kootenay coalfields are underlain by the Lewis Thrust plate and form part of the Front Ranges of the Rocky Mountains. This area is characterized by initial compressional forces resulting in folding and thrust faulting followed by extensional structures such as normal faulting. The Crowsnest Coalfield is bounded by the west-dipping Erickson normal fault on the east and the Bourgeau thrust fault on the west.

The geology within the Elkview property dips towards the west at approximately twenty degrees and plunges gradually to the south at about four to eight degrees. Multiple thrust faults and normal faults occur throughout the property mostly striking in a north west to south east orientation. This has resulted in coal seam repeats and structural deformation and complexity along the thrust fault boundaries.

The geology at the Elkview Operations is classified as moderate and complex as per the Geological Survey of Canada Paper 88-21 *"A Standardized Coal Resource/Reserve Reporting System for Canada"*. There are numerous normal faults and thrust faults at the Elkview Operations that vary in the amount of displacement. Some of these faulted areas are associated with folds, over turned coal seams and other structural deformations.

3. Exploration Program 2016

i) Goals/ Objectives

The 2016 Exploration program was reduced to only include critical drilling requirements to reduce capital spending. The project was focused on drilling required to maintain a two to three year window of high geological confidence ahead of the active mine plan.

The objective of the 2016 exploration program was to increase the geotechnical data for mine design and high wall placement purposes of the planned Baldy Ridge 6 (BR6) pit. This drilling program was planned to collect additional structural and coal quality data within the complex faulted areas in Natal Phase 2 (NP2), Natal Phase 1 (NP1) and Baldy Ridge 2 (BR2) mining pits.

ii) Summary of Work Done

A total of nineteen reverse circulation boreholes were completed in the Baldy Ridge and Natal Ridge areas at Elkview Operations for a total of 5,623m of drilling and 0.6ha disturbed. Existing exploration trails were reactivated to access an existing drill pad which

was deactivated at the end of the program. The drilling locations are illustrated in both Figures 3 and 4.

A total of ten boreholes were drilled in NP2 pit for a total of 3,648m in 2016. The majority of these boreholes were placed within the complex fault zone to provide additional geological confidence for the model and production forecast. Drilling within the NP2 pit area provided new information and resulted in an updated fault and structural interpretation.

In-pit drilling was also completed within the NP1 pit and consisted of five reverse circulation boreholes for a total of 980m. Drilling within this pit was focused on the deeper western limit to confirm the 10 seam structure and volumes.

Three holes for a total of 848m were completed in the Baldy Ridge 2 (BR2) pit to intersect the complex thrust faulted 10 seam area. Due to the complexity and variability of this faulted zone we have historically seen large volume changes within the 10 seam.

One hole of 174m was drilled in Baldy Ridge 7 (BR7) for geotechnical, mine design and wall placement purposes. This was the only surface hole outside of the C2 boundary, all other holes were in-pit.

Elkview also completed underground drilling into the hanging wall of the main coal conveyance tunnel as part of the Baldy Ridge Expansion project. These holes were designed and placed to supply geotechnical information on the hanging wall lithology types and material strength and competencies. A total of ten short holes; 337m were completed. These holes are also illustrated on the drilling map in Figure 3.

Reverse circulation rotary drilling was performed by Foraco Drilling with one drill rig with the capability to drill to 650 meter depths. The geophysical logging was performed by Datalog Services. Gamma, neutron, open-hole density, slim-line density and borehole deviation were logged through the drill pipe on all boreholes. In addition, dipmeter analysis was performed on select boreholes.

All the drill holes were logged with slim tool equipment consisting of gamma density, gamma-neutron and downhole deviation. A total of 1,975 coal sample increments were collected and an estimated 95 seam composites will be analyzed to confirm coal quality, petrography, mineral ash analysis and sulphur.

Coal seams intersected in reverse circulation boreholes were sampled at half meter intervals (plys) and sent to the Elkview Central Lab. Raw ash, FSI, Residual Moisture and Light Transmittance analysis (as required) were performed on ply samples. Ply samples were grouped together to create composite samples to most accurately reflect seam quality

data. Current mining practices, geophysical log signatures and ply sample analysis were the main pieces of information used to generate composite samples from plys and determine core sample intervals. Lab analysis determined Ash, VM, RM, Sulfur, Phosphorous, FSI, LT and FC for composite samples and core samples at specific gravities ranging from 1.40 to 1.70 S.G. Raw and clean proximate analysis and rheological analysis was performed by the Elkview Central Lab. All mineral ash analysis work was send to the Green Hills Operations lab. Select composites and core samples were selected for petrographic analysis. David E. Pearson and Associates (Victoria, BC) performed all petrographic analysis.

The following table shows borehole locations with respect to Coal Lease and District Lot boundaries:

Table 3 – Elkview Operations 2016 Borehole locations

Mine pit / area	Boreholes
Baldy Ridge 2 (BR2)	2016BR2017, 2016BR2018, 2016BR2019
Baldy Ridge 6 (BR6)	2016BR6020, 2016BR6021, 2016BR6022, 2016BR6023, 2016BR6024, 2016BR6025, 2016BR6026, 2016BR6027, 2016BR6028, 2016BR6029
Baldy Ridge 7 (BR7)	2016BR7016
Natal Ridge 1 (NP1)	2016NP1008, 2016NP1009, 2016NP1010, 2016NP1014, 2016NP1015
Natal Ridge 2 (NP2)	2016NP2001, 2016NP2002, 2016NP2003, 2016NP2004, 2016NP2005, 2016NP2006, 2016NP2007, 2016NP2011, 2016NP2012, 2016NP2013

Elkview Operations
Drillhole Locations 2016

HOLEID	EAST	NORTH	Elevation (m)	Total Depth (m)	Azimuth	Dip	Borehole Type	Date Surveyed
2016BR2017	656312.6913	5512857.798	1788.56	274	0	-90	RC	2016-07-03
2016BR2018	656331.1576	5512885.009	1788.94	284	0	-90	RC	2016-07-04
2016BR2019	656377.3617	5512956.848	1789.8	290	0	-90	RC	2016-07-06
2016BR6020	656109.5767	5515082.59	1701.6	21	0	-90	CORE	2016-08-14
2016BR6021	656039.8379	5515044.201	1689.6	33.5	0	-90	CORE	2016-08-17
2016BR6022	655978.6564	5515011.354	1678.8	21.6	0	-90	CORE	2016-08-21
2016BR6023	655914.4939	5514975.175	1668.1	22	0	-90	CORE	2016-08-29
2016BR6024	655844.9479	5514939.014	1656.5	27.5	0	-90	CORE	2016-08-28
2016BR6025	655813.8924	5514922.406	1651.7	34.8	0	-90	CORE	2016-08-29
2016BR6026	655750.2911	5514887.525	1640.4	48	0	-90	CORE	2016-09-01
2016BR6027	655631.6457	5514823.304	1620.2	78.5	0	-90	CORE	2016-09-07
2016BR6028	655450.3285	5514724.571	1589.2	10.5	0	-90	CORE	2016-09-10
2016BR6029	655195.9234	5514585.047	1545.7	39.5	0	-90	CORE	2016-09-13
2016BR7016	655294.6059	5513926.932	1753.48	174	0	-90	RC	2016-06-30
2016NP1008	656948.7046	5510388.407	1423.89	207	0	-90	RC	2016-05-29
2016NP1009	656943.3116	5510063.446	1440.15	260	0	-90	RC	2016-05-31
2016NP1010	656906.9164	5510155.622	1440.08	201	0	-90	RC	2016-06-09
2016NP1014	657146.4169	5510358.819	1443.03	139	0	-90	RC	2016-06-17
2016NP1015	656919.4228	5510188.213	1440.32	173.5	0	-90	RC	2016-06-20
2016NP2001	658564.0014	5510167.824	1861.99	379.8	0	-90	RC	2016-05-08
2016NP2002	658736.8989	5510558.569	1859.65	300	0	-90	RC	2016-05-10
2016NP2003	658678.8132	5510371.661	1859.92	328	0	-90	RC	2016-05-12
2016NP2004	658756.338	5510028.573	1845.3	403	0	-90	RC	2016-05-19
2016NP2005	658380.6904	5510094.36	1862.3	390	0	-90	RC	2016-05-22
2016NP2006	658322.7193	5510179.546	1860.32	372	0	-90	RC	2016-05-25
2016NP2007	658325.1333	5510315.575	1859.86	350	0	-90	RC	2016-05-27
2016NP2011	658476.7198	5510401.664	1859.8	310	0	-90	RC	2016-06-12
2016NP2012	658572.1884	5509955.895	1844.34	424	0	-90	RC	2016-06-13
2016NP2013	658673.6056	5510103.356	1844.53	392	0	-90	RC	2016-06-15

iii) Results

The additional data from the 2016 exploration program was incorporated into the existing geological model.

Lab analyses of clean coal will be added to the seam's qualities in the Elkview acQuire™ database. Seam qualities increase the knowledge of the coal's marketability and assist long term mine planning in the region.

Reference:

ii) Appendix B – Sample Analysis

The 2016 coal samples are in the process of being analyzed. Available results will be included into next year's geological block model.

iv) Statement of Costs

The 2016 exploration program total cost was $557,353 and the cost breakdown is as follows.

Drilling cost, $ 453,653 (Foraco Drilling)

Geophysical logging, $ 103,700 (Datalog Services)

The analytical work is being completed by the Teck Coal Laboratory.

The Petrographic work will be completed by Pearsons.

4. Conclusion

Drillhole data from the 2016 exploration program was entered and interpreted as the program progressed. This enabled EVO to incorporate the newly updated geological structure and volumetric data into the 2016 End of Year (EOY) reserve and resources (R&R) model. The coal quality samples are still being analyzed and will be incorporated into Mid-Year (MY) and EOY models for 2017.

The 2016 exploration program has successfully increased borehole density in all the mentioned mining pits/areas. Televiewer data and geotechnical logging information have improved current pit shell design and are essential to ongoing mine design and planning of the Elkview Operations.

Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6020

Sheet 1 of 5

Date(s) Drilled	**08/13/2016**	Logged By	**Ken Y. & Nicholas B.**	Checked By	**Marty McCabe**
Drilling Method	**Rotary Diamond Drilling**	Drill Bit Size/Type	**HQ3 - 61 mm**	Total Depth Drilled (meters)	**21.0**
Drill Rig Type	**Boart LM 55**	Drilling Contractor	**Boart Longyear**	Approximate Surface Elevation	
Groundwater Level		Borehole Backfill	**Cap & Valve with Pressure Gauge**	Inclination from Horizontal/Bearing	**Vertical**
Location	**EVO - Chainage ~179.6 m, 4.48 m to Tunnel Floor from Collar, Top Roller No. 65**			Hammer Data	**N/A**

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	0				1				SHOTCRETE grey, fine grained fresh (I), medium strong (R3)													
					1				COAL black, fine grained fresh (I), weak (R1), fractured	SH	50		PL	R	Ca	T1	A0	1.5	0	3	25	
					NI					FR	70	-	PL	SM	-	-	A0	1	0	3	25	
		R1	57	20		R1-3	I			FR	60	-	PL	R	-	-	A0	1.5	0	3	30	
					NR				SHALE - silty dark grey, very fine grained, laminated fresh (I), moderately weak rock (R2) from 0.7 to 0.82 m	FR	85	-	ST	R	-	-	A0	3	0	3	30	
	1				3				COAL/SHALE interbedding, black, fine grained, fresh (I)													Field Axial PLT Test: **qu:4.3Mpa**, Type 6 Failure
					5					FR		-	-	-	Gr	-	A5	-	-	-	-	
									SHALE/COAL interbed, dark grey-black, fine grained, fresh (I), very weak to moderately weak rock (R1-R2) from 1.4m to 1.77m	JN	90	-	PL	SM	-	-	A0	1	0	4	25	
					3					SH	75	-	PL	SM	-	-	A0	1	0	4	25	
										JN	85	-	PL	R	-	-	A0	1.5	0	4	25	
										FR	86	-	ST	R	-	-	A0	3	0	4	25	
					4				SILTSTONE - interbedded with coal dark grey-black, fine grained fresh (I), very weak to moderately weak (R1-R2)	JN	55	-	PL	SM	Gr	T3	A1	1	0	4	25	
										JN	43	-	PL	R	Gr	T3	A1	1	0	4	25	
	2									JN	50	-	PL	R	Gr	T5	A5	1.5	8	4	20	
					NI					JN	56	-	C	R	-	-	A0	3	0	4	30	
		R2	70	0		R1-2	I			FR	85	-	I	R	Gr	T1	A2	3	0	4	25	
										JN	30	-	PL	R	Cm	T1	A1	1.5	0	4	25	
					NI					FR	85	-	PL	R	Gr	T4	A4	1.5	6	4	30	
					NR																	
					NR					FR	-	-	-	-	-	-	-	-	-	-	-	
	3								SHALE - silty dark grey, very fine grained, laminated fresh (I), very weak (R1) to moderately strong (R3)													
					1					JN	85	-	PL	SM	-	-	A0	1	0	2	25	
					0					JN	85	-	I	SM	-	-						Field Axial PLT Test: **qu:21.4Mpa**, Type 6 Failure
										JN	85	-	PL	SM	-	-	A0	1	0	2	25	
					0																	
		R3	100	88		R1-3	I			JN	80	-	PL	R	-	-	A1	1.5	0	2	25	
					0																	
	4				1					JN	85	-	PL	SM	-	-	A0	1	0	2	25	
					1																	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6020

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
				1					JN	72	-	PL	SM	-	-	A1	2	0	2	25	
				0					SH	80	-	PL	K	-	-	A1	1.5	0	2	25	
5								SILTSTONE - shaley light grey, fine grained, laminated fresh (I), moderately strong (R3)	JN	74	-	PL	SM	-	-	A1	2	0	2	20	
				0																	
	R4	100	100		R3	I															Field Axial PLT Test: **qu:92.1Mpa**, Type 2 Failure
				0					JN	75	-	I	R	-	-	A1	3	0	2	20	Field Diametral PLT Test: **qu:57.2Mpa**, Type 1 Failure
									JN	69	-	PL	SM	-	-	A1	1.5	0	2	25	
				2					JN	70	-	ST	SM	-	-	A2	1.5	0	2	25	
									JN	69	-	PL	R	-	-	A1	1.5	0	2	25	
				0																	
6																					
				0																	
				0																	
				0																	
	R5	73	57		R3	I			JN	79	-	PL	R	-	-	A1	1.5	0	4	25	
				4				fracture zone / suspected shear zone from 6.85 to 7.15 m	FR	-	-	-	R	-	-	A5	-	0	-		
7									SH	30	-	PL	SM	-	-	A2	2	0	4	10	
				NI					SH	40	-	PL	SM	-	-	A2	2	0	4	10	
				NR																	
									CO	85	-	PL	SM	Gr	T4	A2	1	0	0.5	10	
				3				COAL SEAM, dark grey, very weak (R1), from 7.5 m to 7.55 m.													
				0																	
8																					
				0																	
	R6	88	83		R1-4	I															
				0																	
				0																	
									JN	69	-	C	SM	-	-	A0	2	0	0.5	25	Field Diametral PLT Test: **qu:44.9Mpa**, Type 7 Failure
				1																	
9																					
				0				SILTSTONE/SHALE interbedding below 9m laminated, grey - very dark grey, fine grained, fresh, very weak to moderately strong (R1-R3)													
				0																	
	R7	97	53	3	R3	I			JN	60	-	C	SM	-	-	A0	3	1	3	25	
									SH	44	-	PL	SM	-	-	A0	1.5	1	3	20	
									SH	40	-	C	SM	-	-	A0	3	1	3	25	
									FR	75	-	PL	R	-	-	A0	3	1	3	25	
				5					FR	80	-	PL	SM	-	-	A3	1	2	3	25	
									SH	85	-	PL	P	Gr	T1	A1	1	3	3	25	
10									BD	85	-	PL	R	Ca	T1	A1	3	4	3	25	
				3					BD	83	-	PL	R	Gr	T1	A1	3	3	3	25	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6020

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R7	97	53	2	R3	I			BD	85	-	PL	SM	-	-	A0	2	-	3	20	
										BD	72	-	PL	SM	Ca	T1	A1	3	4	3	25	
										BD	71	-	PL	SM	-	-	A0	2	-	3	20	
										JN	42	-	PL	SM	Ca	T1	A1	1.5	3	4	25	
										JN	52	-	PL	SM	Ca	T1	A1	1.5	3	4	25	
					3					BD	85	-	PL	SM	Ca	T1	A4	1.5	3	4	20	
										BD	80	-	PL	SM	Ca	T1	A1	2	3	4	20	
										BD	78	-	PL	SM	Ca	T1	A1	2	3	4	20	Field Axial PLT Test: **qu:58Mpa**, Type 2 Failure
										BD	67	-	PL	SM	Ca	T1	A1	2	3	4	20	
					6					BD	81	-	PL	SM	-	-	A0	2	-	4	20	
	11									BD	84	-	PL	R	-	-	A0	2	-	4	20	
					3																	
		R8	94	55		R1-3	I															
					1					JN	72	-	PL	SM	-	-	A0	2	-	4	30	
					0																	
										M	66	-	PL	R	-	-	A0	1.5	-	4	30	
					2																	
	12								SILTSTONE - interbedded with SANDSTONE grey - dark grey, fine grained, laminated fresh (I), moderately strong (R3)														
					0																	
										BD	78	-	PL	R	-	-	A0	1.5	-	3	25	
					1																	
										BD	60	-	PL	SM	Cm	T1	A0	1	1	3	25	
					1																	
		R9	104	101		R3	I			BD	68	-	PL	SM	Cm	T1	A0	1	1	3	25	
					1																	
	13																					
					0																	
					1																	
										M	55	-	PL	R	-	-	A0	1.5	-	3	25	
					1					JN	70	-	PL	SM	Gr	T1	A0	2	1	3	25	
										BD	70	-	PL	R	Gr	T3	A3	1	10	3	25	
					1																	
										JN	56	-	C	SM	-	-	A0	2	-	4	25	
	14																					
					2																	
										BD	57	-	PL	SM	Ca	T1	A0	2	1	4	30	
		R10	100	83		R3	I			JN	62	-	PL	SM	-	-	A0	1	-	4	25	
					2					SH	61	-	PL	SM	-	-	A0	1	-	4	25	
										JN	45	-	PL	SM	-	-	A0	1	-	4	25	
					2					BD	75	-	PL	SM	Gr	T1	A0	2	1	4	25	
					0																	
	15								SANDSTONE - silty grey - dark grey, fine grained fresh (I), moderately strong (R3)														
					1					BD	80	-	PL	SM	-	-	A0	2	-	2	20	
		R11	98	98	1	R3	I			BD	85	-	PL	SM	Gr	T1	A1	1.5	1	2	20	
					0																	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6020

Elevation, meters	Depth, meters	Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					1					BD	61	-	PL	SM	Ca	T1	A1	1.5	1	2	20	
	16	R11	98	98	0	R3	I															
					0																	
					0					BD	71	-	PL	SM	Ca	T1	A1	1.5	1	2	20	
					1																	
	17				0																	
		R12	103	88		R3	I			FR	-	-	I	VR	-	-	A4	3	-	2	30	
					1																	
					0																	
					1					JN	10	-	C	R	-	-	A0	2	-	2	25	
	18				1				SILTSTONE grey, fine grained fresh (I), moderately strong (R3)	JN	74	-	PL	R	Cl	T1	A1	1.5	3	3	25	
										FR	74	-	-	-	-	-	-	-	-	-	-	
					1				COAL seam from 18.36m to 18.48m.	JN	60	-	PL	SM	-	-	A0	2	-	3	25	
					2				shaley becoming SHALE below, dark grey, moderately to very weak rock (R1-R3)	SH	40	-	C	K	Gr	T1	A1	1.5	1	3	25	
		R13	74	40		R1-3	I															
					2					JN	42	-	C	R	Gr	T1	A1	2	1	3	30	
										JN	65	-	PL	SM	Cl	T1	A1	2	2	3	25	
	19									FR	50	-	-	-	-	-	-	-	-	-	-	
					3				COAL infill													
					NR					FR	80	-	-	-	-	-	-	-	-	-	-	
					2				COAL seam from 19.50 to 19.63 m													
										BD	80	-	PL	R	Gr	T3	A3	3	4	3	30	
										SH	35	-	PL	SM	-	-	A0	2	-	3	20	
										JN	75	-	PL	SM	-	-	A0	2	-	3	20	
					3					JN	30	-	PL	R	Cl	T1	A1	1.5	2	3	25	
	20																					
					0					FR	43	-	PL	R	Cl	T1	A1	1.5	4	3	30	
		R14	100	54		R1-3	I			JN	40	-	PL	SM	Cl	T1	A1	1.5	4	3	25	
					3					JN	56	-	PL	SM	Ca	T1	A1	2	3	3	20	
										JN	18	-	PL	R	Cl	T1	A1	1.5	3	3	25	
										BD	74	-	I	R	Cl	T1	A1	1.5	3	3	25	
					2				SANDSTONE grey, fine grained fresh (I), moderately strong rock (R3)	BD	62	-	PL	R	Cl	T1	A1	1.5	3	3	20	
					2					FR	-	-	I	R	-	-	-	-	-	-	-	
	21								**END OF BOREHOLE AT 21.0 m ABOVE TUNNEL ROOF IN SANDSTONE.** Notes: 1. Borehole termination at 21.0 m in SANDSTONE. 2. Seepage observed from borehole after completion.															

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6020

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
								3. Borehole closed with cap and valve with tubing and presure gauge. 4. Pressure gauge monitoring: - September 09, 2016 - 150 kPa. - September 10, 2016 - 150 kPa. - September 11, 2016 - 125 kPa. - September 12, 2016 - 125 kPa. - September 16, 2016 - 185 kPa.													
22																					
23																					
24																					
25																					
26																					
27																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech **Project Location: Sparwood, BC** **Project Number: 60444413**	**Log of BH-2016BR6021** Sheet 1 of 7

Date(s) Drilled	**08/17/2016**	Logged By	**Ken Y. & Nicholas B.**	Checked By	**Marty McCabe**
Drilling Method	**Rotary Diamond Drilling**	Drill Bit Size/Type	**HQ3 - 61 mm**	Total Depth Drilled (meters)	**33.5**
Drill Rig Type	**Boart LM 55**	Drilling Contractor	**Boart Longyear**	Approximate Surface Elevation	
Groundwater Level		Borehole Backfill	**MPBX**	Inclination from Horizontal/Bearing	**Vertical**
Location	**EVO - Chainage ~264.2 m, 4.06 m to Tunnel Floor from Collar, Top Roller No. 127**			Hammer Data	**N/A**

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	0				NI				SHOTCRETE grey, fine grained	FR	60	-	I	VR	-	T0	A5	4	0	2	30	
										FR	-	-	I	VR	-	T0	A5	4	0	2	30	
		R1	96	20		R3	I		SILTSTONE light grey to dark grey, very fine to fine grained, laminated fresh (I), moderately strong (R3) fractured to 0.28m	JN	10	-	PL	VR	-	T0	A3	3	0	2	25	
					4					FR	40	-	I	VR	-	T0	A4	4	0	3	30	
										JN	75	-	PL	SM	Gr	T2	A2	2	0	3	25	
					1					JN	75	-	PL	SM	Gr	T2	A3	2	0	3	25	
										JN	75	-	PL	SM	Gr	T2	A2	2	0	3	25	
					5					JN	5	-	PL	R	-	T0	A1	1.5	0	3	25	
										SH	75	-	PL	K	Gr	T2	A3	2	0	3	10	
	1									SH	89	-	PL	K	Gr	T2	A3	1.5	1	3	10	
					NI				SHALE dark grey to black, interbedded with COAL fresh (I), weak (R1) 35cm rebar inclusion	SH	85	-	I	R	-	T0	A4	3	1	3	30	
		R2	78	35		R1-3	I			FR	-	-	I	SM	Gr	T5	A5	3	1	3	30	
					NI					BD	87	-	PL	SM	Gr	T5	A5	1	1	3	25	
									SANDSTONE - silty with laminated medium interbedded SILTSTONE light grey to dark grey, very fine to fine grained fresh (I), moderately strong rock (R3)	BD	35	-	PL	SM	Gr	T3	A3	2	1	3	20	
					2																	
					NR																	
	2																					
					1				light grey calcerous/limey SANDSTONE below 2.05 m	JN	15	-	PL	R	Ca	T1	A0	1.5	1	2	30	
										VN	15	-	PL	SM	Ca	T1	A0	-	-	2	30	
					0																	
		R3	104	82		R4	I															
					0																	
					0																	Field Diametral PLT Test: **qu:121.3Mpa**, Type 8 Failure
	3																					
					1				SHALE - silty dark grey, fine grained fresh (I), moderately strong (R3)	BD	68	-	PL	SM	Cm	T1	A0	1	1	2	25	
		R4	98	98		R3	I															
					1					BD	72	-	PL	SM	Cm	T1	A0	1	1	2	25	
					1				SANDSTONE - silty grey, fine grained fresh (I), moderately strong rock (R3)	BD	75	-	PL	SM	Cm	T1	A0	1	1	2	25	
					NI				SHALE dark grey, fine grained fresh (I), very weak (R1) to moderately weak (R3)	BD	70	-	PL	R	Ca	T1	A1	1	1	2	25	
	4	R5	90	40		R3	I			SH	75	-	PL	SM	-	T0	A0	1	1	2	25	
					2																	
					1					JN	10	-	PL	R	Ca	T1	A1	1.5	1	2	25	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6021

Elevation, meters	Depth, meters	Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R5	90	40	3	R3	I			BD	75	-	PL	SM	Ca	T1	A1	1	1	2	25	
										BD	58	-	PL	SM	-	T0	A0	1	1	2	25	
										JN		-		SM	Ca	T1	A1	1	1	2	25	
					1																	
	5				NI																	
										BD	50	-	PL	R	Gr	T2	A2	1.5	2	2	20	
					1				SILTSTONE - sandy grey to dark grey, fine grained fresh (I), moderately strong (R3) to strong (R4)												
					0																	
		R6	93	72		R3-4	I			BD	65	-	PL	SM	Cm	T0	A1	1	2	2	20	
					1																	
	6				0																	Field Axial PLT Test: **qu:71.7Mpa**, Type 6 Failure
					NR																	
									SANDSTONE - silty dark grey to grey, fine grained fresh (I), moderately strong rock (R3)												
					0					BD	48	-	PL	SM	Ca	T0	A1	1	3	3	20	
										JN	25	-	PL	R	Cm	T1	A1	1.5	1	3	25	
					2																	
	7									JN	36	-	PL	SM	Cm	T1	A1	1	1	3	25	
					1																	
										JN	8	-	PL	R	-	T0	A0	1.5	2	3	25	
		R7	103			R3	I			JN	10	-	C	SM	Cm	T0	A1	1.5	3	3	20	
					2																	
										BD	55	-	C	SM	-	T0	A0	3	2	3	25	
					2																	
										JN	42	-	PL	SM	Gr	T2	A2	1	2	3	30	
										JN	35	-	PL	R	Gr	T2	A2	1.5	2	3	30	
										JN	68	-	I	R	Gr	T2	A2	3	2	3	30	
					2																	
	8				0																	
										BD	75	-	PL	R	Gr	T1	A1	1.5	1	3	25	
					1					BD	73	-	PL	R	-	T0	A0	1.5	2	3	30	
										BD	75	-	PL	R	-	T0	A0	1.5	2	3	30	
					2					BD	75	-	PL	SM	-	T0	A0	1	1	3	25	
		R8	100	69		R3	I			JN	5	-	PL	SM	-	T0	A0	1	1	3	25	
										BD	78	-	PL	SM	-	T0	A0	1	1	3	25	
					2																	
										BD	75	-	PL	SM	Ca	T0	A1	1	3	3	25	
	9																					
					2					JN	78	-	U	R	Cm	T1	A1	2	1	3	25	
										BD	80	-	PL	SM	-	T0	A0	1	2	3	30	
					1																	
									strong (R4) below 9.5m													
					0																	
		R9	103	103	0	R4	I															
	10				0																	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6021

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					0																	
		R9	103	103	0	R4	I															
					1					BD	61	-	PL	R	Qz	T1	A1	1.5	1	3	25	
	11				0																	
					1					BD	52	-	C	R	Qz	T1	A1	3	1	3	25	
					1					BD	54	-	PL	SM	-	T0	A0	1	1	3	25	
		R10	100	85	0	R4	I															
	12				1					JN	8	-	PL	R	Ca	T1	A1	1.5	1	3	25	
					1					JN	62	-	PL	R	Qz	T1	A1	1.5	1	3	25	
					1				SILTSTONE grey, fine grained fresh (I), strong (R4)	SH	87	-	PL	P	-	T0	A3	0.5	1	6	25	
										FR	85	-	PL	R	Gr	T1	A4	1.5	1	6	10	
					NI				SHALE dark grey, fine grained fresh (I), very weak (R1)	JN	25	-	PL	SM	-	T0	A1	1	1	6	25	
	13				1					JN	85	-	ST	SM	-	T0	A1	2	1	6	25	
									SILTSTONE grey to dark grey, fine grained fresh (I), moderately strong (R3)	JN	25	-	PL	SM	-	T0	A1	1	1	6	25	
		R11	87	41		R1-4	I			JN	50	-	PL	R	-	T0	A2	1.5	1	6	30	
					7					JN	50	-	PL	R	-	T0	A2	1.5	1	6	30	
										JN	50	-	PL	R	-	T0	A2	1.5	1	6	30	
										JN	50	-	PL	R	-	T0	A2	1.5	1	6	30	
					4				COAL black, very fine slightly to moderately weathered (II-III), very weak (R1) increased joint density below	JN	50	-	PL	R	-	T0	A2	1.5	1	6	30	
										BD	86	-	PL	SM	-	T0	A1	1	1	6	30	
										SH	50	-	PL	SM	-	T0	A1	1	1	6	25	
					NR					SH	45	-	PL	SM	-	T0	A1	1	1	6	25	
	14									SH	60	-	PL	SM	Gr	T1	A2	1	1	3	25	
					10					SH	60	-	PL	SM	Gr	T1	A2	1	1	3	25	
										CO	90	-	PL	SM	Gr	T3	A3	1	1	3	25	
									SILTSTONE - shaley dark grey, fine grained, laminated fresh (I), moderately strong (R3)	FR	70	-	I	R	Gr	T3	A3	3	1	3	25	
					16					SH	60	-	C	K	-	T0	A3	2	1	3	25	
										FR	80	-	I	R	-	T0	A2	3	1	3	30	
					2																	Field Diametral PLT Test: **qu:46.2Mpa**, Type 1 Failure
		R12	100			R2-3	I			JN	70	-	PL	R	Gr	T2	A2	1.5	1	3	25	
					1					FR	86	-	PL	SM	Gr	T2	A3	1	1	3	25	
	15				1					JN	25	-	PL	SM	-	T0	A1	1	1	3	25	
										JN	70	-	ST	SM	-	T0	A1	1.5	1	3	25	
					3					JN	70	-	PL	R	-	T0	A1	1.5	1	3	25	
		R13	68	53	1	R1-3	I			JN	15	-	PL	R	-	T0	A1	1.5	1	3	25	

AECOM

Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6021

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
16				3					JN	15	-	PL	R	-	T0	A1	1.5	1	3	25	
				0					JN	20	-	PL	SM	-	T0	A1	1	1	3	25	
	R13	68	53	2	R1-3	I			CO	90	-	PL	VR	-	T0	A2	1.5	1	3	-	
				NI				COAL black slightly to moderately weathered (II-III), extremely weak (R0) to moderately weak (R2)													
				NR																	
17				NI																	
				NI																	
				NR																	
	R14	20	0		R2	I															
				NR																	
18				NR																	
				NR																	
				NI																	
				NI																	
19				NR																	
	R15	30	0		R2-0	I															
				NR																	
				NR																	
				NR																	
20				NI				fine, extremely weak below 20 m													
				NI																	
				NI																	
	R16	46	0		R0	I															
				NR																	
21				NR																	
				NR																	

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AECOM

Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6021

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R16	46	0		R0	I															
					NI																	
					NI																	
	22				NR																	
		R17	30	0		R0	I															
					NR																	
					NR																	
					NR																	
	23								fresh below 23 m													
					NI																	
					NI																	
					NI																	Field Axial PLT Test: **qu:1.6Mpa**, Type 2 Failure
		R18	75	0		R1	I															
					NI																	
	24				NR																	
					NR																	
					NI																	
					NI																	
	25				NI																	
		R19	73	0		R1	I															
					NI																	
					NR																	
					NR																	
	26				NI																	
					NI																	
		R20	59	0		R0	I															
					NI																	
					NR																	
	27																					

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AECOM

Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6021

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	27	R20	59	0	NR NR	R0	I															
	28	R21	75	0	NI NI NI NI NR NR	R0	I		coarse from 27.75 m to 28.62 m													
	29	R22	60	0	NI NI NI NI NR NR	R0	I			JN	43	-	PL	SM	-	T0	A1	1	1	3	25	
	30									JN	43	-	PL	SM	Gr	T2	A2	1	1	3	30	
										JN	76	-	PL	R	Gr	T2	A2	1.5	1	3	25	
										JN	78	-	PL	R	Gr	T2	A2	1.5	1	3	30	
										JN	77	-	PL	R	Gr	T2	A1	1.5	1	3	25	
										JN	52	-	PL	SM	Gr	T1	A1	1	1	3	25	
										FR	85	-	-	-	-	T0	-	-	-	-	-	
										FR	83	-	-	-	-	T0	-	-	-	-	-	
	31	R23	96	0	NI NI 4 4 3 2	R0-1	I			SH	20	-	PL	SM	Gr	T2	A1	1.5	1	3	25	
										JN	75	-	PL	R	Gr	T1	A1	1.5	1	3	25	
																						Field Axial PLT Test: **qu:4Mpa**, Type 2 Failure
	32	R24	85	32	NR 20 6	R3-2	I		becoming grey/black, very fine, increased fractures fresh below 32 m	FR	90	-	PL	SM	-	-	A1	1	1	12	20	
										FR	88	-	PL	SM	-	-	A1	1	1	12	20	
										JN	40	-	PL	SM	-	-	A1	1	1	12	20	
										JN	75	-	PL	SM	-	-	A1	1	1	12	20	
										JN	75	-	PL	SM	-	-	A1	1	1	12	20	
										FR	-	-	PL	SM	-	-	A1	1	1	-	20	
									SHALE - silty	SH	70	-	PL	K	Gr	T2	A3	1.5	1	12	10	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6021

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
									light grey to dark grey, fine grained, laminated fresh (I), moderately strong (R3)	SH	70	-	PL	K	Gr	T2	A3	1.5	1	12	10	
										BD	65	-	C	SM	Gr	T3	A3	1	1	12	20	
										SH	70	-	PL	K	Gr	T1	A2	1.5	1	12	10	
					3					FR	88	-	PL	VR	-	T0	A0	1.5	1	12	30	Field Axial PLT Test: **qu:39.5Mpa**, Type 2 Failure
										FR	88	-	PL	VR	Gr	T1	A0	1.5	1	12	30	
	33									SH	70	-	C	K	Gr	T3	A3	2	1	12	10	
		R24	85	32	10	R3-2	I			SH	60	-	C	K	Gr	T1	A3	2	1	12	10	
										SH	30	-	C	K	Gr	T1	A3	2	1	12	10	
										FR	30	-	I	K	Gr	T1	A2	2	1	12	10	
										FR	25	-	PL	VR	-	-	A1	1.5	1	12	30	
					3					CO	70	-	PL	-	-	-	-	-	-	-	-	
									COAL seam, grey/black	FR	88	-	PL	R	-	-	A1	2	1	12	25	
									slightly to moderately weathered (II-III), very weak to weak (R0-R2)	SH	20	-	PL	K	-	-	A1	1.5	1	12	10	

END OF BOREHOLE AT 33.5 m ABOVE TUNNEL ROOF IN SHALE.

Notes:
1. Borehole termination at 33.5 m in SHALE.
2. Seepage observed from borehole after completion.
3. Borehole instrumented with multi point bore hole extensometere (MPBX), MPBX anchor set at approximately 20m (Anchor 1), 12m (Anchor 2), 8m (Anchor 3) and 4m (Anchor 4) above tunnel roof.
4. Anchor 4 not confirmed inplaced after install.
5. MPBX monitoring:
   - September 10 (10.1°C)
     Anchor 1: 2451.6; Anchor 2: 2118.1;
     Anchor 3: 2511.7 & Anchor 4: 2632.9.

   - September 20 (9.8°C)
     Anchor 1: 2451.5; Anchor 2: 2117.9;
     Anchor 3: 2511.2 & Anchor 4: 2631.4.
6. Measured water flow upon drilling completion:
   - August 21, 2016: ~0.002 litres/second.
   - September 21, 2016: ~0.002 litres/second.

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6022

Date(s) Drilled	**08/21/2016**	Logged By	**Dave F. & Nicholas B.**	Checked By	**Marty McCabe**
Drilling Method	**Rotary Diamond Drilling**	Drill Bit Size/Type	**HQ3 - 61 mm**	Total Depth Drilled (meters)	**21.6**
Drill Rig Type	**Boart LM 55**	Drilling Contractor	**Boart Longyear**	Approximate Surface Elevation	
Groundwater Level		Borehole Backfill	**Collar Cap & Valve with Pressure Gauge**	Inclination from Horizontal/Bearing	**Vertical**
Location	**EVO - Chainage ~336.35 m, 4.09 m to Tunnel Floor from Collar, Top Roller No. 177**			Hammer Data	**N/A**

ROCK CORE

Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index
R1	75	17	NI, 7, 6	R4	II
R2	93	45	3, 1, 2, 7, 8, 0	R3-4	II
R3	100	83	0, 0, 3, 2	R1-3	I
R4	100	100	3, 4	R3	II
R5	100	21	3, 0, 0	R3	I-II

MATERIAL DESCRIPTION

SHOTCRETE
grey, fine grained

SILTSTONE
light grey to dark grey, very fine to medium grained, laminated
slightly weathered (II), strong (R4)
interbedded with SANDSTONE, bedding offset along fracture, calcite stringers

SHALE
dark grey, very fine grained
fresh (I), moderately strong (R3)
local SANDSTONE interbed, laminated with pyrite

SILTSTONE - sandy
grey to dark grey, coarse siltstone to very fine sand, thinly laminated
fresh (I), moderately strong (R3)

SANDSTONE - silty
light grey, coarse silt / fine sandtone grains
fresh to slightly weathered (I-II), moderately strong rock (R3)
local MUDSTONE interbeds and carbonaceous partings

Discountinuity Description

Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon
FR	40	-	I	VR	-	-	A1	4	2	2	30
FR	-	-	I	VR	-	-	A1	3	2	2	-
SH	30	-	PL	K	-	-	A2	2	2	2	25
FR	70	-	C	R	-	-	A4	3	2	2	25
SH	40	-	PL	R	-	-	A1	1.5	2	2	25
JN	85	-	PL	SM	-	-	A3	2	2	2	25
FR	20	-	C	VR	-	-	A3	2	2	2	25
JN	85	-	PL	R	-	-	A3	2	2	2	25
JN	30	-	PL	SM	-	-	A1	1	2	2	25
JN	30	-	PL	SM	-	-	A1	1.5	2	6	25
JN	30	-	PL	SM	-	-	A1	1.5	2	6	25
SH	50	-	PL	SM	Gr	T2	A1	1.5	1	6	25
JN	30	-	PL	SM	-	T1	A1	1.5	2	6	25
JN	70	-	PL	R	Gr	-	A1	1.5	1	6	25
SH	30	-	PL	K	-		A2	2	2	6	25
JN	40	-	PL	R	-	-	A1	2	2	6	25
JN	80	-	PL	SM	-	-	A2	1.5	2	6	25
SH	85	-	PL	K	Gr	T1	A2	1.5	1	6	25
FR	70	-	PL	R	-	-	A0	2	1	6	25
JN	85	-	PL	R	-	-	A1	1.5	0	6	25
FR	85	-	PL	SM	-	-	A4	2	1	6	-
FR	75	-	C	SM	-	-	A1	2	0	6	25
SH	76	-	C	SM	Gr	T1	A1	1.5	0	3	25
JN	2	-	PL	R	-	-	A0	1	0	3	25
M	85	-	-	-	-	-	-	-	-	4	-
JN	35	-	PL	R	-	-	A0	2	2	4	25
JN	10	-	PL	R	-	-	A0	1.5	2	4	25
BD	85	-	PL	R	Gr	T1	A1	1.5	1	4	25
FR	85	-	PL	R	-	-	A0	1.5	2	4	25
JN	10	-	PL	R	-	-	A1	1.5	2	4	25
JN	85	-	PL	R	-	-	A1	1.5	2	4	25
JN	10	-	PL	R	-	-	A1	1.5	2	4	25
JN	85	-	PL	R	-	-	A1	1.5	1	4	25
FR	-	-	I	R	-	-	-	1.5	2	4	25
JN	10	-	PL	R	-	-	A1	1.5	2	4	25

REMARKS AND OTHER TESTS

Field Axial PLT Test: **qu:15.3Mpa**, Type 2 Failure

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AECOM

Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6022

Elevation, meters	Depth, meters	Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					1					FR	10	-	PL	R	-	-	A2	1.5	0	4	25	
										M	85	-	PL	R	-	-	A2	1.5	0	4	25	
		R5	100	21	0	R3	I-II															
	5				3					FR	80	-	I	VR	-	T0	A0	4	0	6	30	Field Axial PLT Test: **qu:48.4Mpa**, Type 6 Failure
										JN	10	-	PL	R	-	T0	A1	1.5	2	6	30	
					2																	
										JN	10	-	PL	R	-	T0	A1	1.5	2	6	30	
					4					M	85	-	I	R	-	T0	-	-	-	-	-	
										SH	30	-	PL	K	Gr	T1	A2	1.5	0	6	10	
		R6	100	80	1	R1-3	I-II			M	85	-	I	R	-	T0	-	-	-	-	-	
										FR	30	-	PL	VR	Gr	T1	A1	1.5	0	6	25	
	6								SHALE - silty grey, very fine grained, thinly bedded slightly weathered (II), weak (R2)	SH	80	-	C	K	Gr	T1	A3	1.5	0	6	10	Field Axial PLT Test: **qu:20.6Mpa**, Type 6 Failure
					18					SH	80	-	PL	K	Gr	T1	A2	1.5	0	6	10	
										SH	40	-	I	SM	Gr	T1	A3	1.5	0	6	10	
										FR	-	-	I	R	-	T0	-	-	-	-	-	
										JN	80	-	PL	SM	-	T0	A1	1.5	0	6	25	
					11																	
										SH	60	-	PL	SM	Gr	T1	A1	1.5	0	6	25	
					15					SH	50	-	C	K	Gr	T1	A2	1.5	0	6	10	
									moderately strong (R3) below 6.6 m	FR	-	-	I	R	-	T0	-	-	-	-	-	
										FR	75	-	I	VR	-	T0	A2	3	0	6	25	
					NR				COAL seam, dark grey to black, very weak (R1) from 6.84 m to 7.20 m													
	7				2																	Field Axial PLT Test: **qu:15.2Mpa**, Type 2 Failure
		R7	76	28	3	R1-3	I															
					3																	
					3																	
	8																					
					2				interbedding with laminated SANDSTONE, medium bed spacing, loacalized thin coal beds from 8.1m to 8.67m	BD	75	-	PL	R	Gr	T2	A2	1.5	0	3	25	
										VN	70	-	PL	SM	Ca	T2	-	-	0	-	-	
					0					BD	70	-	PL	R	Gr	T2	A3	1.5	0	3	25	
										JN	12	-	PL	R	-	T0	A1	1.5	0	3	25	
					1					CO	80	-	PL	-	-	T0	-	-	-	-	-	
										FR	85	-	I	VR	-	T0	A1	4	0		30	
									SHALE becoming dark grey, massive and moderately strong (R3) below 8.1m													
		R8	81	53	0	R3-4	I															
	9								Joint	FR	87	-	PL	R	Gr	T1	A1	1.5	0	3	25	
					6					JN	20	-	U	R	-	T0	A1	2	0	3	25	
										CO	80	-	I	-	-	T0	-	-	-	-	-	
					NR				COAL black, very fine fresh (I), moderately weak (R1) highly fractured													
					NI																	
		R9	9	0	NR	R0-1	I															
	10																					
					NR																	

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AECOM

Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6022

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					NR																	
		R9	9	0	NR	R0-1	I															
					NR																	
	11				NI																	
					NI																	
					NR																	
		R10	9	0	NR	R2	I															
	12				NR																	
					NR																	
					NI				coal fragments becoming finer, slickenslides observed on recovered coal fragments below 12.6 m													
					NI																	
	13				NR																	
		R11	29	0	NR	R0-2	I															
					NR																	
					NR																	
	14				NI																	
					NR																	
					NR																	
		R12	27	0	NR	R0-2	I															
	15				NR																	
					NR																	
					NI																	
		R13	20	0		R1	I		increased fragment piece size, weak (R1)													

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6022

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	16				NI																	
					NI																	
					NR																	
		R13	20	0		R1	I															
					NR																	
					NR																	
	17				NI				slickenslides observed on recovered coal fragments from 17.1 m to 21.6 m	FR SH	90 0	- -	I PL	VR K	- -	T0 T0	A5 A1	4 1	0 0	- 3	- 10	
					NI																	
					NI					FR SH	87 20	- -	I PL	R K	- Gr	T0 T1	A5 A1	4 1	0 0	- 3	- 10	
		R14	50	0	NR	R1	I															
	18				NR																	
					NR																	
					NI																	
					NI																	
	19				NI																	
		R15	48	0	NI	R1	I															
					NI																	
					NR																	
	20				NI																	
					NI																	
					NI																	
		R16	81	0		R1	I															
					NI																	
	21				NI																	
					NR																	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
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Log of BH-2016BR6022

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R16	81	0		R1	I															

END OF BOREHOLE AT 21.6 m ABOVE TUNNEL ROOF IN COAL.

Notes:
1. Borehole termination at 21.6 m in COAL.
2. Seepage observed from borehole after completion.
3. Borehole closed with cap and valve with tubing presure gauge.
4. Pressure gauge monitoring:
   - September 09, 2016 - <10 kPa.
   - September 10, 2016 - <10 kPa.
   - September 11, 2016 - <10 kPa.
   - September 12, 2016 - <10 kPa.
   - September 16, 2016 - 85 kPa.

Depth: 22, 23, 24, 25, 26, 27

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6023

Date(s) Drilled	**08/24/2016**	Logged By	**Alex H. & Sam O.**	Checked By	**Marty McCabe**
Drilling Method	**Rotary Diamond Drilling**	Drill Bit Size/Type	**HQ3 - 61 mm**	Total Depth Drilled (meters)	**21.6**
Drill Rig Type	**Boart LM 55**	Drilling Contractor	**Boart Longyear**	Approximate Surface Elevation	
Groundwater Level		Borehole Backfill	**MPBX**	Inclination from Horizontal/Bearing	**Vertical**
Location	**EVO - Chainage ~398.0 m, 4.19 m to Tunnel Floor from Collar, Top Roller No. 240**			Hammer Data	**N/A**

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	0				NI				SHOTCRETE grey, medium grained													
					NI				SILTSTONE light grey to grey, very fine to fine grained, laminated fresh (I), moderately strong (R3)													
					2					FR	85	-	PL	SM	-	T0	A1	2		2	25	
										FR	75	-	PL	P	-	T0	A2	1.5		2	25	
		R1	92	11		R3	I															
					NI					FR	78	-	PL	SM	-	T0	A2	2		2	25	
										FR	89	-	PL	SM	-	T0	A2	2		2	25	
	1								SHALE - silty grey to dark grey, very fine to fine grained fresh (I), moderately strong (R3)	FR	84	-	PL	SM	-	T0	A2	2		2	25	
					NI					FR	85	-	PL	P	-	T0	A2	1.5		2	25	
					NI																	
					4					FR	80	-	PL	SM	-	T0	A2	2		2	25	
										BD	75	-	U	SM	-	T0	A2	1.5		2	25	
					NI				interbedding with COAL, very weak (R1) from 1.74 m to 1.83 m													
	2									BD	74	-	U	R	-	T0	A2	3		2	25	
					1					SH	80	-	I	R	-	T0	A1	2		2	25	
		R2	67	35		R3-1	I			JN	30	-	I	R	-	T0	A1	2		2	25	
					4																	
					NR																	
					NR																	
	3				NI				trace platy grains, polished lusture on recovered core below 3.0 m													
		R3	7	0	4	R4	I-II															
					NI				~ 50° to core axis evidence of shear exposed along mechanical fracture at 3.55 m very thinly to thinly bedded below 3.6 m	JN	57	-	PL	P	-	T0	A2	1.5	0	3	25	
					5					JN	59	-	PL	P	-	T0	A1	1	0	3	25	
										JN	68	-	PL	SM	-	T0	A1	1	0	3	25	
										BD	76	-	U	R	-	T0	A2	3	0	3	25	Field Axial PLT Test:
	4									JN	69	-	PL	SM	-	T0	A2	1	0	3	25	**qu:46.9Mpa**, Type 2
		R4	100	43	6	R2-3	I-II			JN	61	-	PL	SM	-	T0	A1	1	0	3	25	Failure
										JN	72	-	PL	R	-	T0	A2	1.5	0	3	25	
									SILTSTONE/SHALE interbedding below 4.13 m fracture along fossil plane at 4.15 m	FR	73	-	PL	R	-	T0	A1	1.5	0	3	25	
										JN	70	-	PL	P	-	T0	A1	1	0	3	25	
					2				thinly bedded below 4.3 m	FR	71	-	PL	R	-	T0	A1	1	0	3	25	
									fracture along fossil plane at 4.19 m	FR	51	-	U	R	-	T0	A1	3	0	3	30	

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Log of BH-2016BR6023

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	R4	100	43	2 1 NI	R2-3	I-II		SILTSTONE grey, fine grained slightly weathered (II), moderately strong (R3)	SH	70	-	PL	K	-	T0	A1	0.5	0	3	25	
5								polished and COAL coated fragments of SILTSTONE recovered at 5.1m													
	R5	10	0	NI NI NI NI NI NI	R0	II		COAL black, fine slightly to moderately weathered (II-III), extremely weak (R0), fragmented/breciated recovery													
6																					
7	R6	27	0	NI NI NI NI NI NI	R0	II-III															
8								fragmented and lustrous recovery below 8.1 m													
9	R7	33	0	NI NI NI NI NI NI	R0	II-III															
10	R8	89	0	NI NI	R0-1	II-III															Field Axial PLT Test: **qu:2.9Mpa**, Type 2 Failure

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
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Log of BH-2016BR6023

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					NI																	Field Axial PLT Test: **qu:32.9Mpa**, Type 6 Failure
		R8	89	0	NI	R0-1	II-III															
					NI																	
	11				NI																	
					NI																	
					NI																	
		R9	80	0	NI	R0-1	II-III															
	12				NI																	
					NI																	
					NI				coarse, angular below 12.6 m													
	13				NI																	
		R10	56	0	NI	R0	I-II															
					NI																	
	14				NI																	
					2																	
					3				SHALE - silty grey to dark grey, very fine to fine grained fresh (I), moderately strong (R3), very thinly bedded	FR	75	-	I	R	-	T0	A1	3	0	9	25
										BD	65	-	U	R	-	T0	A1	3	0	9	25	
										JN	30	-	ST	R	-	T0	A2	3	0	9	25	
		R11	80	47	2	R3	I			BD	45	-	I	R	-	T0	A1	3	0	9	25	
										FR	32	-	U	R	-	T0	A2	3	0	9	25	
	15									BD	33	-	I	R	-	T0	A1	3	0	9	25	
					2					FR	40	-	ST	R	-	T0	A1	3	0	9	25	
										SH	60	-	I	R	-	T0	A2	3	0	9	25	
					2																	
										CO	20	-	U	R	-	T0	A1	3	0	9	25	
					NI																	
		R12	91	33		R3-4	I															

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Log of BH-2016BR6023

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					NI																	
	16				2					FR	75	-	PL	R	-	T0	A3	1.5	0	3	25	
										BD	70	-	PL	R	-	T0	A2	1.5	0	3	25	
					3					FR	78	-	PL	R	-	T0	A2	1.5	0	3	25	
		R12	91	33		R3-4	I			BD	60	-	PL	R	-	T0	A2	1.5	0	3	25	
										BD	85	-	PL	R	-	T0	A2	1.5	0	3	25	
					2				interbedding with siltstone and sandstone, laminated with thin coal beds below 16.6 m													
					0				thinly bedded, moderately strong (R3) to strong (R4) below 16.6 to 18.6 m	BD	64	-	PL	R	-	T0	A2	1.5	0	3	25	
										BD	62	-	PL	R	-	T0	A2	1.5	0	3	25	
	17				2																	
					2					FR	85	-	U	P	-	T0	A2	1.5	0	2	25	
										BD	50	-	PL	SM	-	T0	A2	1.5	0	2	25	
										SH	70	-	I	SM	-	T0	A3	1.5	0	2	25	
					0					FR	76	-	U	SM	-	T0	A2	1.5	0	2	25	
		R13	93	87	3	R3-4	I			BD	70	-	U	P	-	T0	A2	1.5	0	2	25	
										BD	66	-	I	SM	-	T0	A2	1.5	0	2	25	
	18				2																	
					1					FR	80	-	I	R	-	T0	A1	1.5	0	2	25	
					0																	
					1					JN	40	-	ST	P	-	T0	A2	1.5	0	3	10	
	19				1					JN	45	-	ST	P	-	T0	A2	1.5	0	3	10	
										JN	60	-	U	R	-	T0	A1	3	0	3	25	
		R14	100	94	1	R3	I															
					0																	
					2					BD	82	-	ST	R	-	T0	A1	3	0	3	25	
	20									JN	15	-	PL	SM	-	T0	A0	1	0	3	25	
					1																	
					0				very weak (R1) below 20.2 m	JN	64	-	PL	K	-	T0	A2	1.5	0	6	25	
					2																	Field Axial PLT Test: **qu:21.9Mpa**, Type 6 Failure
		R15	93	80		R3-1	I			FR	48	-	PL	K	-	T0	A2	1.5	0	6	25	
										FR	46	-	PL	K	-	T0	A2	1.5	0	6	25	
					2					JN	49	-	PL	SM	Ca	T1	A0	1	2	6	25	
	21																					
					1					JN	36	-	PL	K	-	T0	A1	1.5	0	6	25	
					0					FR	72	-	U	R	-	T0	A1	1.5	0	6	25	

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Log of BH-2016BR6023

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R15	93	80		R3-1	I															

END OF BOREHOLE AT 21.6 m ABOVE TUNNEL ROOF IN SHALE .

Notes:
1. Borehole termination at 21.6 m in SHALE.
2. Seepage observed from borehole after drilliing completion.
3. Geophysical survey (Optical, Gamma and Orientation) of borehole was completed.
4. Borehole instrumented with multi point bore hole extensometere (MPBX), MPBX anchor set at approximately 20m (Anchor 1), 12m (Anchor 2), 8m (Anchor 3) and 4m (Anchor 4) above tunnel roof.
5. Anchor 2 not confirmed inplaced after install.
6. MPBX monitoring:
   - September 10 (3.7°C)
     Anchor 1: 4362.5; Anchor 2: 4283.7;
     Anchor 3: 2561.3 & Anchor 4: 2841.1.
   - September 20 (3.7°C)
     Anchor 1: 4361.8; Anchor 2: 4280.7;
     Anchor 3: 2561.3 & Anchor 4: 2841.2.
7. Measured water flow:
   - September 11, 2016: 0.59 litres/second.

Depth, meters: 22, 23, 24, 25, 26, 27

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech **Project Location: Sparwood, BC** **Project Number: 60444413**	**Log of BH-2016BR6024** Sheet 1 of 6

Date(s) Drilled	**08/26/2016**	Logged By	**Alex H. & Sam O.**	Checked By	**Marty McCabe**
Drilling Method	**Rotary Diamond Drilling**	Drill Bit Size/Type	**HQ3 - 61 mm**	Total Depth Drilled (meters)	**27.5**
Drill Rig Type	**Boart LM 55**	Drilling Contractor	**Boart Longyear**	Approximate Surface Elevation	
Groundwater Level		Borehole Backfill	**Cap & Valve with Pressure Gauge**	Inclination from Horizontal/Bearing	**Vertical**
Location	**EVO - Chainage ~418.2 m, 4.20 m to Tunnel Floor from Collar, Top Roller No. 252**			Hammer Data	**N/A**

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	0				1				SHOTCRETE grey, medium grained	JN	50	-	I	SM	-	T0	A1	2	0	1	25	
		R1	92	68	0	R2	I		SHALE - silty grey, very fine grained, very thinly laminated fresh (I) to highly weathered (IV), moderately strong (R3)													
					1				becoming more silty, SILTSTONE/SHALE interbedding below 0.5 m	FR	-	-	I	R	-	T0	A0	4	0	2	30	
										BD	75	-	PL	SM	-	T0	A1	1	0	2	25	
					3				highly weathered, non intact, calcite infill 27 degrees to CA, oxidation stains from 0.9 to 1.4 m													
	1				NI																	
		R2	101	71	4	R2-3	I-IV			BD	77	-	U	R	-	T0	A2	3	0	2	25	
										BD	77	-	U	SM	-	T0	A2	2	0	2	25	
					0																	
					0																	
	2				1				SILTSTONE - shaley light grey, medium grained, very thinly laminated fresh (I), moderately strong (R3) interbedding with SHALE, medium spaced interbedding induced fractures occur along SHALE interbed planes healed fractures parallel to core axis exposed by drill action,												
					0				oxidation staining and calcite infill coating (< 1mm) from 2.0m	BD	74	-	PL	SM	Gr	T1	A1	1	6	3	25	
					2				to 2.13m becoming sandy SILTSTONE, medium grained	BD	75	-	PL	SM	Gr	T1	A1	1	6	3	25	
		R3	100	57		R3-4	I-IV			FR	40	-	U	R	-	T0	A0	3	1	3	25	
					1																	
	3				NI				two fractures running 10° - 20° to core axis, oxidation staining and calcite infill coating (< 1 mm) from 3.0 to 3.4 m												
					NI																	
									SHALE - silty grey to dark grey, very fine grained to medium platy grains													
					1				fresh (I), very weak (R1)	FR	69	-	U	VR	-	T0	A0	3	0	9	30	
										FR	78	-	U	VR	-	T0	A0	3	0	9	30	
									healed fractures parallel to core axis exposed by drill action	FR	24	-	U	VR	-	T0	A0	3	0	9	30	
					4				from 3.7 to 3.8 m	CO	80	-	I	R	Gr	T3	A2	3	13	9	25	Field Axial PLT Test:
	4	R4	95	59		R1	I		COAL seam, black, extremely weak (R0) from 3.9 to 3.97 m	CO	71	-	PL	SM	Gr	T2	A2	1	6	9	25	**qu:11.0 MPa**, Type 2 Failure
					0																	
										SH	21	-	PL	K	-	T1	A1	0.5	0	9	10	
					3					JN	89	-	PL	SM	-	T0	A1	1	0	9	25	
										JN	37	-	PL	SM	-	T0	A0	1	0	9	25	

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Project Number: 60444413

Log of BH-2016BR6024

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
				2					CO	89	-	I	R	-	T2	A2	3	0	9	20	
	R4	95	59	NI	R1	I		COAL seam, fine, moist, black, very weak (R1) from 4.7 to 5.0 m													
5				NI				thinly bedded, moderately strong (R3) to strong (R4) below 5 m													
									FR	64	-	U	R	-	T0	A1	3	0	4	25	
				NI																	
				3					BD	84	-	PL	R	-	T0	A1	1.5	0	4	25	
	R5	97	65		R3-4	I			SH	75	-	U	K	-	T0	A3	3	0	4	30	
				1					SH	70	-	PL	K	-	T0	A3	0.5	0	4	30	
6									FR	82	-	PL	R	-	T0	A1	1.5	0	4	25	
				3																	
									BD	85	-	PL	SM	-	T0	A1	1	0	4	25	
				3					BD	83	-	I	R	-	T0	A1	3	0	4	25	
									FR	79	-	PL	R	-	T0	A1	1.5	0	3	20	
				1																	
									FR	76	-	U	R	-	T0	A1	3	0	3	20	
				1																	
7									JN	14	-	U	K	-	T0	A0	1.5	0	3	10	
				NI																	
	R6	100	33		R3-4	I															
				NI					BD	80	-	PL	R	-	T0	A1	1.5	0	3	25	
									BD	77	-	U	R	-	T0	A1	1.5	0	3	25	
				NI																	
									BD	85	-	U	R	-	T0	A1	3	0	3	25	
									BD	81	-	PL	R	-	T0	A1	1.5	0	3	25	
				NI																	
																					Field Diametral PLT Test: **qu:117.7 MPa**, Type 7 Failure
8				2					CO	85	-	PL	SM	-	T0	A1	1	0	2	25	
								COAL black, very fine grained highly weathered (IV), extremely weak (R0), fragmented													
				NI																	
				NI																	
	R7	93	10		R1-3	IV															
				NI																	
9																					
				NI																	
				NI																	
				NI																	
	R8	87	0	NI	R1	I															
10								lustrous black below 10 m													
				NI																	

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Log of BH-2016BR6024

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R8	87	0	NI, NI, NI	R1	I															
	11	R9	100	0	NI, NI, NI, NI, NI, NI	R1	I															
	12	R10	84	0	NI, NI, NI, NI, NI, NI	R1	I															
	13	R11	68	0	4, NI, NI, NI, NI, NI	R2	I		thinly laminated below 14 m													Field Diametral PLT Test: **qu:4.6 MPa**, Type 4 Failure
	14	R12	50	0	NI	R0	II															
	15																					

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Log of BH-2016BR6024

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	16	R12	50	0	NI, NI, NI, NI, NI, NI	R0	II															
	17	R13	87	0	NI, NI, NI, NI, NI, NI	R0	II															
	18																					
	19	R14	97	0	NI, NI, NI, NI, NI, NI	R0	II															
	20	R15	83	0	NI, NI, NI, NI, NI, NI	R0	II															
	21								slightly weathered below 21 m													

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Log of BH-2016BR6024

Elevation, meters	Depth, meters	Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R15	83	0		R0	II															
					NI					CO	88	-	I	VR	-	T0	A0	3	0	6		Field Diametral PLT Test: **qu:3.1 MPa**, Type 7 Failure
										BD	86	-	PL	R	-	T0	A1	1.5	0	6		
					4				SHALE - silty grey to dark grey, very fine grained, very thinly bedded fresh (I), moderately strong (R3) to strong (R4)	BD	83	-	PL	R	-	T0	A1	1.5	0	6		Field Axial PLT Test: **qu:33.5 MPa**, Type 2 Failure
										VN	50	-	U	R	Ca	T2	A0	3	0	6		
	22									FR	87	-	PL	R	-	T0	A2	1.5	0	6		Field Axial PLT Test: **qu:51.4 MPa**, Type 2 Failure
					3					JN	19	-	U	R	-	T0	A1	3	0	6		
		R16	80	29		R0-3	II-I			SH	77	-	U	R	-	T0	A2	3	0	6		
					3					SH	68	-	I	R	-	T0	A2	3	0	6		
										FR	85	-	C	SM	-	T0	A1	2	0	6		
					5					JN	66	-	PL	SM	-	T0	A1	1	0	6		
										JN	70	-	I	-	-	T0	A1	1.5	0	6		
					NR																	
	23																					
					0																	
					3					FR	83	-	U	R	-	T0	A1	3	0	3		
										JN	80	-	ST	K	-	T0	A1	3	0	3		
					NI																	
		R17	90	23		R4	I															
					NI																	
	24																					
					NI																	
					NI																	
					0																	
										FR	85	-	PL	R	-	T0	A1	1	0	3	25	
					1																	
	25									JN	66	-	ST	K	-	T0	A2	3	0	3	25	
					1																	
		R18	100	100		R4	I															
					1					JN	69	-	ST	K	-	T0	A2	3	0	3	25	
					1					BD	81	-	PL	R	-	T0	A1	1	0	3	25	
										BD	78	-	U	R	-	T0	A1	3	0	3	25	
					1																	
	26																					
					0																	
										SH	62	-	U	R	-	T3	A3	3	0	6	10	
					1																	
		R19	100	0		R4	I			SH	70	-	U	K	-	T3	A3	1.5	0	6	10	
					1					JN	72	-	I	K	-	T0	A1	1.5	0	6	25	
					NI					FR	80	-	PL	R	-	T0	A2	1.5	0	6	25	
										FR	81	-	PL	R	-	T0	A2	1.5	0	6	25	
	27																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6024

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	27	R19	100	0	3 NI	R4	I			FR FR FR	77 84 88	- - -	I I PL	R R R	- - -	T0 T0 T0	A2 A1 A1	1.5 1.5 1.5	0 0 0	6 6 6	25 25 25	
	28								**END OF BOREHOLE AT 27.5 m ABOVE TUNNEL ROOF IN SHALE .** Notes: 1. Borehole termination at 27.5 m in SHALE. 2. Seepage observed from borehole after drilliing completion (to be confirmed). 3. Geophysical survey (Optical, Gamma and Orientation) of borehole was completed. 4. Borehole closed with cap and valve with tubing and presure gauge. 5. Pressure gauge monitoring: - September 09, 2016 - 310 kPa. - September 10, 2016 - 350 kPa. - September 11, 2016 - 350 kPa. - September 12, 2016 - 300 kPa. - September 19, 2016 - 290 kPa. 6. Estimated water outflow: - August 21, 2016: ~0.15 litres/second.															
	29																					
	30																					
	31																					
	32																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6025

Date(s) Drilled	**08/28/2016**	Logged By	**Alex H. & Sam O.**	Checked By	**Marty McCabe**
Drilling Method	**Rotary Diamond Drilling**	Drill Bit Size/Type	**HQ3 - 61 mm**	Total Depth Drilled (meters)	**34.8**
Drill Rig Type	**Boart LM 55**	Drilling Contractor	**Boart Longyear**	Approximate Surface Elevation	
Groundwater Level		Borehole Backfill	**Cap & Valve with Pressure Gauge**	Inclination from Horizontal/Bearing	**Vertical**
Location	**EVO - Chainage ~456.2 m, 4.32 m to Tunnel Floor from Collar, Top Roller No. 276**			Hammer Data	**N/A**

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	0	R1	97	0	0	R3	III		SHOTCRETE grey, medium to coarse grained light grey matrix	CO FR FR FR	68 1 90 1	- - - -	U I I I	R VR VR VR	Ca Ca - Ca	T1 T1 T0 T1	A1 A0 A1 A0	3 3 3 3	0.75 0.75 0 0.75	4 4 4 4	25 30 30 30	
		R2	100	27	4 NI NI NI 3 1	R3	III		SILTSTONE - shaley grey, fine grained, heavily fractured moderately weathered (III), moderately strong (R3) fractures running parallel to core axis from 0.1 to 0.3 m calcite coating withing fracture planes, becoming very fine grained below 0.29 m fractures running parallel to core axis from 0.4 to 0.5 m multiple fractures: running parallel to core axis, 90 degrees to core axis and 20 degrees to core axis; calcite staining, polished surfaces for fractures parallel to core axis from 0.78 to 1.0 m	JN JN JN JN SH JN SH FR JN	90 - 90 90 74 90 15 83 88	- - - - - - - - -	I C PL PL PL U PL PL U	R SM SM P K R P SM R	- - - - Ca - - - Ca	T0 T0 T0 T0 T1 T0 T0 T0 T1	A1 A0 A0 A1 A1 A1 A0 A0 A1	3 4 4 1 0.5 3 1 1 3	0 0 0 0 0.75 0 0 0 0.75	9 9 9 9 9 9 9 9 9	30 30 30 10 10 25 25 25 25	Field Axial PLT Test: **qu:50.2Mpa**, Type 2 Failure
	1																					
	2	R3	101	90	1 0 0 1 1 0	R3	I		fine to medium grained, very thinly laminated, light grey below 1.8 m fractures from 1.8 to 3.3 m are healed fractures exposed by suspected dril action	FR FR JN	88 - 85	- - -	PL I ST	R R R	- - -	T0 T0 T2	A0 A0 A2	4 3 3	0 0 0	3 3 3	30 30 25	
	3																					
		R4	93	77	0 0 0 1 1	R3	I		becoming corse grained sandy siltstone below 3.3 m healed fracture parallel to core axis from 3.8 to 4.0 m	JN	77	-	U	R	St	T3	A3	3	13	3	0	
	4								SHALE grey to dark grey, very fine grained to platy grains fresh (I), moderately strong (R3)	JN JN	78 70	- -	U PL	R SM	- -	T1 T1	A1 A1	3 1	0 0	3 3	25 20	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6025

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	R4	93	77	2	R3	I		COAL seam, coarse, moist, black, very weak (R1), ~70% coal	CO	89	-	PL	P	-	T1	A1	1	0	3	10	
				NI				suspected joint, ~90 degrees to CA, irregular plane surface, discontinuity parallel to core axis on non intact recovery from 4.8 to 4.93 m	SH	40	-	C	K	-	T0	A2	0.5	0	6	10	
5									JN	61	-	U	SM	-	T0	A1	2	0	6	25	
				6					JN	75	-	U	R	-	T0	A1	3	0	6	25	Field Axial PLT Test: **qu:35.6Mpa**, Type 2 Failure
				2					JN	60	-	U	VR	-	T0	A3	3	0	6	20	
	R5	84	49	2	R3	II		COAL seam, black from 5.54 to 5.77 m	SH	60	-	U	K	-	T0	A3	0.5	0	6	10	
				NR				COAL/SHALE interbedding, shear observed on contact planes from 5.77 to 6.05 m													
6				NI					JN	-	-	U	R	-	T0	A2	3	0	6	25	
				1				fractures running parallel to core axis exposed by drill action from 6.3 to 6.35 m	SH	85	-	PL	K	-	T0	A1	0.5	0	2	10	
				2				gradational contact, shale becoming siiltstone, healed contact													
				0																	
7	R6	104	67	0	R3	I-II			JN	81	-	PL	SM	-	T0	A1	1	0	2	20	
									CO	89	-	-	-	-	T0	-	-	-	-	-	
				2				SANDSTONE grey - light grey, corse grained fresh to slightly weathered (I-II), moderately strong (R3) fractures running parallel to core axis exposed by drill action from 7.1 to 7.2 m healed contact, ~ 85 degress to core axis silty SANDSTONE becoming sandy SILTSONE below 7.4 m	JN	-	-	I	R	-	T0	A2	3	0	2	25	
				1																	
				NI				SANDSTONE/SILTSONE interbedding, predominantly SANDSTONE, fine to medium grained SANDSTONE is randomly fractured with irregular fractured faces some fractures exposed by drill action, fracture planes exhibit lusturous coal polished characteristics to 8.35 m													
8				2																	
				NI					FR	37	-	U	R	-	T0	A1	3	0	3	25	
	R7	82	33	1	R4-0	II			FR	82	-	U	R	-	T0	A1	3	0	3	25	
									CO	89	-	PL	SM	-	T0	A1	1.5	0	3	25	
				NI				COAL black, fine slightly weathered (II), very weak to weak (R0 - R1), soft													
9				NR																	
				NI																	
				NI																	
	R8	55	0		R1	II															
				NI																	
10				NI																	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6025

Elevation, meters	Depth, meters	Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R8	55	0	NR NR	R1	II															
	11	R9	75	0	NR NI NI NI NI NR	R0-1	I-II		proximity of suspected fault plane intersect from 11.8 to 12.3 m													Field Axial PLT Test: **qu:17.7Mpa**, Type 2 Failure
	12	R10	51	0	NR NI NI NR NR NI	R2	I-II		coarse, moderately weak (R2) below 12.3 m													
	13	R11	69	0	NR NI NI NI NI NR	R2	I-II															
	14	R12	63	0	NR NI	R1	I		lusturous, fragmented below 15.3 m													
	15																					

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AECOM

Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6025

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	16	R12	63	0	NI, NI, NI, NR	R1	I															
	17	R13	80	0	NR, NI, NI, NI, NI, NI	R1	II-III		very weak (R1) below 16.8 m													
	19	R14	87	0	NR, NI, NI, NI, NI, NI	R1	II-III															
	20	R15	77	0	NR, NI, NI, NI, NI, NI	R1	II-III															
	21	R16	87	0	NR	R1	II-III															

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AECOM

Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6025

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					NI																	
					NI				fine below 21.75 m													
	22	R16	87	0	NI	R1	II-III															
					NI																	
					NI																	
					NR				extremely weak (R0) to very weak (R1) below 22.8 m													
	23				NI				localized shale laminations below 23.0 to 27.3 m													
					NI																	
		R17	100	0	NI	R0-1	II-III															
					NI																	
	24				NI																	
					NI																	
					NI																	
					NI																	
	25	R18	57	0	NI	R0-1	II-III															
					NR																	
					NR																	
					NR																	
	26				NI																	
		R19	70	0	NI	R0-1	II-III															
					NI																	
	27																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6025

Elevation, meters	Depth, meters	Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	27	R19	70	0	NR	R0-1	II-III															
					NR																	
					NI																	
					NI																	
	28	R20	97	0	NI	R0-1	II-III															
					NI																	
					NI																	
					NI				coal within silty sand matrix from 28.8 to 29.05 m													
	29				NI																	
					NI																	
					NI																	
		R21	100	0	NI	R0-3	I-IV			CO	-	-	-	-	-	-	-	-	2	-		
					NI				SHALE dark grey, very fine grained fresh (I), very weak (R1) to strong (R4) shale laminations from 29.9 to 30.12 m													
	30				NI					FR	77	-	PL	K	-	T0	A2	1.5	0	2	10	
					3				dark grey to grey banding, very fine to fine grained, thinly bedded below 30.3 m	FR	82	-	PL	R	-	T0	A2	3	0	6	25	Field Diametral PLT Test: **qu:23.7Mpa**, Type 7 Failure Field Axial PLT Test: **qu:24.4Mpa**, Type 2 Failure
					1					JN	38	-	ST	R	-	T3	A2	3	0	6	25	
										JN	41	-	ST	R	-	T0	A2	3	0	6	25	
					0					BD	83	-	PL	R	-	T0	A2	3	0	6	25	
	31	R22	100	83	4	R4	I			BD	85	-	U	R	-	T0	A3	3	0	6	10	
										JN	50	-	U	R	-	T3	A3	3	0	3	10	
					1					JN	46	-	ST	R	-	T0	A2	3	0	6	25	
										FR	80	-	U	R	-	T0	A2	3	0	3	25	
					2					M	84	-	PL	R	-	T0	A2	3	0	6	25	
					3																	
	32				0					BD	81	-	PL	R	-	T0	A1	1.5	0	3	25	
		R23	100	100		R4	I															
					1																	
					1					VN	84	-	U	-	Ca	T1	A0	4	0.75	3	30	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6025

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	33	R23	100	100	0 1	R4	I			FR	67	-	U	R	-	T0	A1	3	0	3	25	
					0					JN	56	-	U	R	-	T0	A1	3	0	6	25	
					0					BD	84	-	U	R	-	T0	A1	3	0	6	25	
					1					FR	76	-	PL	R	-	T0	A1	3	0	6	25	
	34	R24	100	97	2	R3-4	I			FR	77	-	ST	R	-	T3	A3	3	0	6	10	
					1				fracture zone from 34.24 to 34.27 m	FR	64	-	U	R	-	T0	A1	3	0	6	25	
					2 1					BD	63	-	U	R	-	T0	A1	3	0	6	25	
	35								**END OF BOREHOLE AT 34.8 m ABOVE TUNNEL ROOF IN SHALE.** Notes: 1. Borehole termination at 34.8 m in SHALE. 2. Seepage observed from borehole after drilliing completion. 3. Geophysical survey (Optical, Gamma and Orientation) of borehole was completed. 4. Borehole closed with cap and valve with tubing and presure gauge. 5. Pressure gauge monitoring: - September 09, 2016 - 0 kPa. - September 10, 2016 - 0 kPa. - September 11, 2016 - <10 kPa. - September 12, 2016 - <10 kPa. - September 19, 2016 - 60 kPa.													
	36																					
	37																					
	38																					

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AECOM

Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6026

Date(s) Drilled	**08/30/2016**	Logged By	**Alex H. & Sam O.**	Checked By	**Marty McCabe**
Drilling Method	**Rotary Diamond Drilling**	Drill Bit Size/Type	**HQ3 - 61 mm**	Total Depth Drilled (meters)	**48.8**
Drill Rig Type	**Boart LM 55**	Drilling Contractor	**Boart Longyear**	Approximate Surface Elevation	
Groundwater Level		Borehole Backfill	**MPBX**	Inclination from Horizontal/Bearing	**Vertical**
Location	**EVO - Chainage ~528.8 m, 4.12 m to Tunnel Floor from Collar, Top Roller No. 369**			Hammer Data	**N/A**

ROCK CORE

Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index
R1	100	47	NI, NI, NI	R3-4	I
R2	101	39	1, 2, 2, NI, 2, NI	R3-4	II
R3	63	14	NI, NR, 3	R1	II
R4	34	13	NR, NR, NR	R2-3	III-IV
R5	100	72	0, 1, 1	R1-3	I

MATERIAL DESCRIPTION

SHOTCRETE
grey, fine to medium grained matrix

SANDSTONE
grey, fine to medium grained
fresh to slightly weathered (I-II), moderately strong to strong (R3-R4)
multiple healed hairline fractures exposed by suspected drill action from 0.05 m to 0.6 m
trace oxidation from 0.6 to 0.8 m

fracture 0-4 degrees to CA running from 0.85 to 1.0 m

non intact rock, oxidized core with intermediate plasticity
brown clay and polished coal infill
slickenslides observed on infill coal surfaces
COAL ~90 percent / SHALE ~10 percent below 1.93 m
contact with COAL seam
COAL seam, black, coarse, moist
slightly weathered (II), extremely weak (R0) to very weak (R1)

interbedded with laminated mudstone

SHALE - silty
dark grey to light grey, very fine to medium grained, thinly laminated
fresh (I), moderately strong to strong (R3-R4)

intermittent fracture zone from 4.13 to 4.90 m, fracture predominantly running parallel to core axis with trace oxidation staining

Discountinuity Description

Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
FR	10	-	PL	R	-	T0	A0	1.5	0	6	30	
FR	80	-	I	R	Gr	T3	A3	3	1	6	20	
JN	46	-	U	R	Gr	T2	A2	3	8	6	25	Field Diametral PLT Test: **qu:78.5Mpa**, Type 7 Failure
FR	17	-	PL	R	Qz	T1	A1	1.5	0.75	6	25	
JN	85	-	U	R	Gr	T1	A1	3	0.75	6	25	
CO	89	-	I	R	Gr	T4	A4	3	6	6	20	
JN	82	-	U	R	-	T0	A1	3	0	1	25	Field Diametral PLT Test: **qu:1.7Mpa**, Type 1 Failure
JN	80	-	PL	SM	-	T0	A1	1	0	1	25	
VN	-	-	PL	-	Ca	T2	A0	1	0.75	6	10	
VN	-	-	PL	-	Ca	T2	A0	1	0.75	6	10	
VN	-	-	PL	-	Ca	T2	A0	1	0.75	6	10	
FR	-	-	PL	P	G	T3	A2	1.5	4	6	10	
JN	-	-	ST	R	-	T0	A0	1.5	-	6	30	
FR	-	-	ST	R	G	T3	A2	1.5	4	6	10	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6026

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					0																	Field Axial PLT Test: **qu:9.9Mpa**, Type 6 Failure
										BD	-	-	PL	SM	-	T0	A0	1	-	6	30	
					NI					FR	-	-	PL	SM	G	T3	A2	1	4	6	10	
		R5	100	72		R1-3	I															
	5				2					FR	-	-	C	R	-	T0	A0	1	-	6	15	
										FR	-	-	U	R	-	T0	A0	2	-	6	30	
										JN	-	-	-	-	-	-	-	-	-	-	-	
					0				fine to very fine grained below 5.3 m													
					NI					JN	-	-	-	-	-	-	-	-	-	-	-	
					1																	
	6	R6	100	65	0	R2	I															
										FR	-	-	-	-	-	-	-	-	-	-	-	
					NI																	
					2					BD	-	-	-	-	-	-	-	-	-	-	-	Field Diametral PLT Test: **qu:35.6Mpa**, Type 8 Failure
										BD	-	-	-	-	-	-	-	-	-	-	-	
										JN	-	-	-	-	-	-	-	-	-	-	-	
					0				becoming less silty below 6.8 m													
	7				0																	
					3																	
		R7	100	90	1	R3	I			FR	-	-	-	-	-	-	-	-	-	-	-	
					2					BD	-	-	-	-	-	-	-	-	-	-	-	
										FR	-	-	-	-	-	-	-	-	-	-	-	
	8				2					SH	-	-	-	-	-	-	-	-	-	-	-	
					4					BD	60	-	PL	R	-	T0	A0	1.5	-	4	25	
										FR	86	-	PL	R	-	T0	A0	1.5	-	4	25	
										BD	84	-	PL	SM	-	T0	A1	1.5	-	4	25	
					NI					FR	78	-	PL	P	G	T4	A4	1.5	-	4	10	
									fractured zone from 8.7 to 9.0 m, planar, rough and infilled with shale pieces													
					0																	
	9	R8	67	43	2	R3-4	I			JN	43	-	C	K	-	T1	A1	1.5	-	4	25	
										JN	45	-	C	K	-	T1	A1	1.5	-	4	25	
					NR																	
					NR																	
					0																	
	10	R9	100	65		R3-4	I															
					0																	

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AECOM

Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6026

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					1					SH	36	-	ST	R	-	T0	A0	1.5	-	2	25	
					1					FR	38	-	ST	R	-	T0	A0	1.5	-	2	-	
		R9	100	65		R3-4	I		fractured zone from 10.7 to 10.75 m, planar, smooth to rough and infilled with brocken rock pieces	JN	14	-	C	R	-	T0	A0	1.5	-	2	-	
					NI																	
	11				NI																	
										FR	52	-	PL	SM	-	-	-	-	-	6	-	
										FR	55	-	PL	P	-	-	-	-	-	6	-	
					3																	
					2					FR	73	-	PL	SM	-	-	-	-	-	6	-	
										JN	55	-	ST	R	-	-	-	-	-		-	
					1					BD	77	-	PL	R	-	-	-	-	-	6	-	
	12	R10	90	63	2	R3-4	I			JN	60	-	C	R	-	-	-	-	-	6	-	
										FR	67	-	C	K	-	-	-	-	-	6	-	Field Diametral PLT Test: **qu:77.8Mpa**, Type 8 Failure
					3					JN	70	-	I	K	-	-	-	-	-	6	-	
										JN	51	-	I	K	-	-	-	-	-	6	-	
					0																	
					0																	
	13									FR	65	-	PL	R	-	T0	A1	1.5	-	4	25	
					2					BD	79	-	I	R	-	T0	A1	1.5	-	4	25	
					2					BD	75	-	U	K	-	T0	A1	1.5	-	4	10	
										JN	67	-	C	P	-	T0	A1	2	-	4	25	
										JN	80	-	I	P	Gr	T4	A2	2	-	4	25	
		R11	98	84	3	R3-4	I			JN	82	-	I	R	Gr	T4	A2	2	-	4	10	
										JN	76	-	U	SM	-	T0	A1	1	-	4	10	
									coal laminations between 13.6 and 13.7 m	JN	72	-	PL	SM	-	T0	A1	1	-	4	25	
					1					BD	82	-	U	P	-	T0	A1	2	-	4	25	
	14									FR	68	-	I	R	-	T0	A1	2	-	4	25	
					2				fractured zone from 14.08 to 14.14 m, planar, rough and infilled with brocken rock pieces	SH	40	-	C	K	-	T0	A2	0.5	0	12	10	
					0					SH	65	-	U	K	-	T0	A1	1.5	0	12	10	
					NI					FR	77	-	U	R	Gr	T2	A2	3	4	12	10	
					2					FR	83	-	U	R	-	T1	A1	3	4	12	25	Field Axial PLT Test: **qu:60.8Mpa**, Type 6 Failure
	15	R12	87		2	R3-4	I-III			FR	84	-	I	VR	-	T0	A1	3	0	12	25	Field Diametral PLT Test: **qu:23.6Mpa**, Type 4 Failure
										BD	78	-	U	R	-	T0	A1	3	0	12	25	
										JN	89	-	PL	SM	-	T0	A1	1	0	12	25	
										BD	68	-	PL	SM	-	T0	A1	1	0	12	25	
					4					FR	64	-	U	R	-	T0	A0	3	0	12	25	
					NR					JN	85	-	U	R	Gr	T1	A1	3	4	12	25	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6026

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
										JN	85	-	PL	R	Cm	T2	A2	1.5	8	12	25	
					4				very thinly laminated to 16.8 m	FR	82	-	U	R	-	T0	A1	3	0	6	25	
										FR	83	-	U	R	-	T0	A2	3	0	6	25	
	16									JN	87	-	PL	SM	-	T0	A1	1	0	6	25	
					4					M	87	-	I	R	-	T0	A0	4	0	6	30	
										BD	79	-	PL	SM	-	T0	A2	1	0	6	20	
										BD	84	-	PL	SM	-	T0	A1	1.5	0	6	25	
										FR	84	-	PL	R	-	T0	A1	1.5	0	6	25	Field Axial PLT Test: **qu:86.8Mpa**, Type 6 Failure
					5					SH	83	-	U	K	-	T0	A2	1.5	0	6	10	
										M	84	-	PL	SM	-	T0	A0	1	0	6	30	Field Axial PLT Test: **qu:92Mpa**, Type 6 Failure
										M	84	-	U	R	-	T0	A0	3	0	6	25	
		R13	97	63	1	R3-4	I			BD	85	-	PL	SM	-	T0	A0	1	0	6	30	
										BD	82	-	U	SM	-	T0	A0	2	0	6	30	
										M	80	-	U	R	-	T0	A0	4	0	6	30	
										JN	87	-	U	P	Gr	T1	A2	1	6	6	10	
					2				thinly to medium laminations below 16.8 m	FR	18	-	PL	R	-	T0	A0	1.5	0	6	30	
									SILTSTONE													
	17								grey, fine grained													
					0				fresh (I), moderately strong (R3) to strong (R4)													
									sandy SILTSTONE below 17.1 m													
					0																	
																						Field Axial PLT Test: **qu:72.2Mpa**, Type 2 Failure
					0					M	89	-	U	VR	-	T0	A0	4	0	6	30	
					3				becoming shaley, very fine grained below 17.8 m													
										FR	72	-	I	VR	-	T0	A0	3	0	4	30	
	18									FR	88	-	U	R	-	T0	A1	3	0	4	25	
		R14	103	70	0	R3-4	I															
					NI					JN	87	-	PL	SM	-	T0	A0	1	0	4	25	
										SH	66	-	PL	K	-	T0	A2	0.5	0	4	10	
									highly fractured, multiple core pieces with slickenslide below 18.48 to 18.8 m													
					NI																	
									trace gouge at 18.7 m													
					1					FR	-	-	I	VR	-	T0	A0	4	0	12	30	
	19																					
					2																	
										FR	61	-	U	R	-	T0	A0	3	0	12	30	
										SH	70	-	U	K	-	T0	A1	1.5	0	12	10	
										SH	66	-	U	K	Ca	T1	A1	1.5	0.75	12	10	
					3					FR	85	-	U	R	-	T0	A0	3	0	12	25	
										FR	57	-	U	R	-	T0	A0	3	0	12	25	
										JN	84	-	PL	SM	-	T0	A1	1	0	12	25	
		R15	105	93	2	R4	I		fragmented recovery, randomly oriented hairline calcite vein from 19.5 to 19.58 m	SH	67	-	U	K	Ca	T1	A1	1.5	0	12	10	
										FR	79	-	U	R	-	T0	A1	3	0	12	25	
					1																	
	20																					
					1																	
										SH	74	-	PL	K	Ca	T1	A0	1.5	0.75	4	10	
					3				becoming light grey, very thinly laminated below 20.3 m													
									fractured along calcite vein parallel to core axis from 20.3 to 20.4 m, healed calcite vein below 20.4 m	FR	78	-	PL	SM	Ca	T1	A0	1	0.75	4	25	
										SH	80	-	U	K	Ca	T1	A1	1.5	0.75	4	10	
					6					JN	89	-	PL	SM	Ca	T1	A1	1	0.75	4	25	
										JN	88	-	PL	P	Gr	T1	A2	1.5	0.75	4	25	
										JN	86	-	PL	P	Gr	T1	A1	1	0.75	4	25	
										FR	89	-	PL	SM	-	T0	A0	1	0	4	25	
		R16	103	76	1	R3	I			FR	87	-	U	R	-	T0	A0	4	0	4	30	
	21																					
					1																	
					0																	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6026

Elevation, meters	Depth, meters	Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R16	103	76	0	R3	I			JN	88	-	PL	SM	-	T0	A2	1	0	4	25	
					NI				multiple fractures exposed by drill action along healed fractures/weak planes													
	22				NI				discontinuity primarily along lamination/very thin bedding													
					1					JN	79	-	PL	SM	-	T0	A1	1	0	3	25	
		R17	100	57	1	R3	I			FR	85	-	PL	R	-	T0	A0	1.5	0	3	30	
					2					FR	77	-	PL	R	-	T0	A0	1.5	0	3	30	
	23				NI					FR	78	-	PL	SM	-	T0	A1	1	0	3	25	
					1					FR	16	-	PL	SM	-	T0	A0	1	0	12	30	
					3					M	-	-	ST	R	-	T0	A0	4	0	12	30	
										FR	34	-	U	P	-	T1	A1	2	0.75	12	25	
										FR	31	-	U	R	-	T0	A1	3	0	12	25	
					NI					CO	85	-	U	VR	-	T0	A2	3	0	12	25	
									COAL seam, black, coarse, moist, fragmented from 23.89 to 24.0 m	CO	75	-	PL	R	-	T1	A2	1.5	0	12	25	
	24	R18	91	57	2	R3	I-II		slightly weathered (II), very weak (R1) to moderately weak (R2)	SH	71	-	U	P	-	T0	A2	1.5	0	12	10	
										SH	42	-	C	K	-	T0	A2	1.5	0	12	10	
					1					JN	87	-	PL	SM	-	T0	A1	1	0	12	25	
					NR				suspected shear zone, polished and slickenslided core pieces from 24.55 to 24.8 m													
					NI																	
	25								COAL seam blended with siltstone, black, coarse, moist, from 24.9 to 26.15 m													
					NI					JN	84	-	PL	SM	-	T0	A1	1	0	0.5	25	
					0																	
		R19	85	55	0	R3-4	I															
					0																	
	26				NR																	
					0				siltstone becoming fine to medium grained below 26.3 m													
		R20	91	79	0	R4	I															
					0																	
	27																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6026

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	27	R20	91	79	0 1 NI	R4	I		contact with coal at 27.56 m COAL black, fine, lustrous slightly weathered (II), extremely weak (R0) to very weak (R1)	FR	78	-	I	VR	Gr	T1	A1	3	0.75	0.5	30	
	28	R21	42	0	NI NI NI NR NR NR	R1	III															
	29	R22	47	0	NI NI NI NR NR NR	R1	III		interbedded with thinly laminated siltstone from 29.3 to 30.8 m													
	30	R23	85	0	NI NI NI NI NI NI	R1	II															
	31	R24	67	0	NI NI	R1	II															
	32																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
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Log of BH-2016BR6026

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	33	R24	67	0	NI NI NR NR	R1	II		siltstone laminated partitions between 32.67 and 32.74 m													
	34	R25	93	0	NI NI NI NI NI NI	R1	II															
	35																					
	36	R26	86	0	NI NI NI NI 7 NR	R1	I-II															Field Axial PLT Test: **qu:5.4Mpa**, Type 2 Failure
	37	R27	100	0	NI NI NI NI NI NI	R1	II															
	38																					

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Log of BH-2016BR6026

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					NI																	
					NI																	
					NI																	
	39	R28	83	0	NI	R1	II															
					NI																	
					NR																	
					NI																	
	40				NI																	
					NI																	
		R29	97	0	NI	R1	II															
					NI																	
	41				NI																	
					NI																	
					NI																	
	42	R30	89	0	NI	R3-4	I															
					NI																	
					NR				highly weathered (IV) from 42.55 to 42.65 m													
					NI																	
	43				NI																	
		R31	63	7	NI	R1-2	I			CO	85	-	PL	R	-	T0	A0	1.5	0	3	25	
					4				SHALE - silty dark grey to light grey, very fine to fine grained, laminated fresh (I), very weak (R1) to moderately strong (R3)	SH FR	84 80	- -	U U	R R	G -	T2 T0	A1 A1	3 3	0 0	3 3	10 25	
					NR																	

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Log of BH-2016BR6026

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	44	R31	63	7	NR	R1-2	I															
					3					SH	83	-	U	R	-	T4	A1	3	0	6	-	Field Diametral PLT Test: **qu:25.1Mpa**, Type 2 Failure
										SH	83	-	I	R	G	T4	A2	1.5	0	6	-	
									joint parallel to CA from 44.46 to 44.67 m	JN	72	-	C	R	-	T0	A2	1.5	0	6	-	Field Axial PLT Test: **qu:43.5Mpa**, Type 2 Failure
										SH	80	-	I	P	G	T0	A4	1.5	0	6	-	
					3					SH	86	-	U	K	-	T0	A4	1.5	0	6	-	
										FR	85	-	PL	SM	-	T0	A1	1	0	6	-	
					2					BD	81	-	I	R	-	T0	A1	3	0	6	-	
	45	R32	100	53	0	R1-2	I			JN	84	-	I	R	-	T0	A1	3	0	6	-	
					1																	
					4					FR	77	-	C	R	-	T0	A1	3	0	6	-	
										JN	82	-	C	R	-	T0	A1	3	0	6	-	
										BD	81	-	PL	R	-	T0	A1	1.5	0	6	-	
					0																	
	46									JN	89	-	PL	R	St	T1	A1	1.5	6	6	25	
					1																	
										FR	87	-	PL	SM	-	T0	A1	1	6	6	25	
					2																	
										FR	84	-	U	R	-	T0	A1	3	6	6	25	
		R33	100	100	1	R3-4	I			JN	86	-	C	R	St	T1	A1	3	6	6	25	
					1					JN	70	-	C	P	-	T0	A1	3	6	6	25	
	47																					
					1					BD	83	-	I	SM	-	T0	A1	1	6	6	25	
					0				platy grains, dark grey with brownish hue, fine to medium grained, significant increase in silt content below 47.3 m													
					0																	
					1					BD	86	-	PL	SM	-	T0	A0	1	0.5	2	30	
	48	R34	102	102	0	R3-4	I															
					0																	
					0																	
	49								**END OF BOREHOLE AT 48.8 m ABOVE TUNNEL ROOF IN SHALE.**													

Notes:
1. Borehole termination at 48.8 m in silty SHALE.
2. Seepage observed from borehole after drilling completion (to be confirmed).
3. Geophysical survey (Optical, Gamma and Orientation) of borehole was completed.
4. Borehole instrumented with multi point bore hole

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
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Log of BH-2016BR6026

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
								extensometer (MPBX), MPBX anchor set at approximately 20m (Anchor 1), 12m (Anchor 2), 8m (Anchor 3) and 4m (Anchor 4) above tunnel roof. 5. MPBX monitoring: - September 10 (6.5°C) Anchor 1: 2429.0; Anchor 2: 2297.7; Anchor 3: 4264.2 & Anchor 4: 2937.8. - September 20 (6.4°C) Anchor 1: 2419.2; Anchor 2: 2298.0; Anchor 3: 4258.7 & Anchor 4: 2936.3. 6. Measured water flow: - September 19, 2016: 0.02 litres/second.													
50																					
51																					
52																					
53																					
54																					
55																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
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Log of BH-2016BR6027

Date(s) Drilled	**09/03/2016**	Logged By	**Alex, Sam & Nicholas**	Checked By	**Marty McCabe**
Drilling Method	**Rotary Diamond Drilling**	Drill Bit Size/Type	**HQ3 - 61 mm**	Total Depth Drilled (meters)	**78.5**
Drill Rig Type	**Boart LM 55**	Drilling Contractor	**Boart Longyear**	Approximate Surface Elevation	
Groundwater Level		Borehole Backfill	**Cap & Valve with Pressure Gauge**	Inclination from Horizontal/Bearing	**Vertical**
Location	**EVO - Chainage ~658.8 m, 4.31 m to Tunnel Floor from Collar, Top Roller No. 412**			Hammer Data	**N/A**

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	0	R1	100	0	NI	R3	III		SHOTCRETE grey, medium grained aggregates, well graded light grey sandy matrix contact with SANDSTONE is parallel to core axis from 0.04m to 0.10m and 90 degrees to core axis at 0.10m above collar													
		R2	100	46	NI NI NI 1 0 0	R3	III-I		SANDSTONE - silty grey to light grey, fine to medium grained fresh to moderately weathered (I-III), moderately strong to strong (R3-R4) randomly oriented fractured with calcite infill, some healed fractures running parallel to CA trace oxidation below 0.3 m clay and sandy infill at 1.15 m, healed hairline fracture from 1.15 to 1.8 m	JN	76	-	U	R	Cm	T3	A3	3	8	6	25
	1									CO	84	-	PL	SM	Gr	T2	A2	1	6	2	25	
										JN	86	-	PL	SM	Gr	T3	A3	1	6	2	25	
		R3	94	66	3 0 1 1	R3	I		SILTSTONE - shaley grey, fine grained fresh (I), moderately strong (R3)	JN	87	-	PL	SM	Gr	T1	A1	1	6	2	25	
	2																					
		R4	100	100	0 0 0	R4	I		SHALE - silty grey, fine grained fresh (I), moderately strong to strong (R3-R4)													
	3																					
		R5	100	83	0 1 1 0	R4	I		SANDSTONE - silty grey to light grey, fine to medium grained fresh (I), strong (R4)	BD	88	-	PL	R	Ox	T1	A1	1.5	1	2	25	
	4									M	83	-	PL	VR	-	T0	A0	1.5	0	2	30	
										M	79	-	PL	VR	-	T0	A0	1.5	0	2	30	
										M	87	-	PL	VR	-	T0	A0	1.5	0	2	30	
										M	88	-	PL	VR	-	T0	A0	1.5	0	2	30	

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Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R5	100	83	0, 0	R4	I			M	83	-	PL	VR	-	T0	A0	1.5	0	2	30	
	5	R6	100	100	0, 0, 0, 0, 0, 0	R4/5	I															
	6	R7	100	100	0, 0, 0, 0, 0, 0	R4/5	I															
	7	R8	100	100	0, 0, 0, 0, 0, 0	R4/5	I		strong (R4) to very strong (R5) below 8 m													
	8	R9	97	63	0, 0, 0	R4/5	I															
	9																					
	10																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6027

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
									JN	20	-	C	R	Sa	T1	A1	1.5	2	6	25	
				2					FR	75	-	I	R	Sa	T1	A1	1.5	2	6	25	
	R9	97	63	3	R4/5	I			JN	10	-	U	R	Sa	T1	A1	1.5	2	6	25	Field Diametral PLT Test: **qu:96.9Mpa**, Type 6 Failure
									BD	58	-	PL	R	Sa	T1	A1	1.5	2	6	25	
				3					JN	23	-	I	R	Sa	T1	A1	1.5	2	6	25	
11								moderately strong (R3) to strong (R4), fresh to moderately weathered (I-III), randomly oriented healed fractures below 11 m													
				NI					JN	22	-	C	R	Sa	T1	A1	1.5	2	12	25	
				NI																	
				4					JN	76	-	C	R	Sa	T1	A1	1.5	2	12	25	
	R10	100	13		R3/4	I-III			JN	27	-	PL	R	Sa	T1	A1	1.5	2	12	25	
				2					JN	50	-	I	R	St	T1	A1	3	4	12	25	
									JN	33	-	I	R	St	T1	A1	3	4	12	25	
12									BD	88	-	U	R	St	T1	A1	3	4	12	25	
									JN	57	-	PL	R	St	T1	A1	1.5	4	12	25	
				NI					BD	81	-	PL	R	Sa	T1	A1	1.5	3	12	25	
				NR																	
				NI																	
				NI																	
13																					
				NI																	
	R11	100	0		R3/4	I-III															
				NI					JN	17	-	I	R	Sa	T1	A1	3	4	12	25	
									BD	88	-	PL	R	Sa	T1	A1	1.5	4	12	25	
									FR	89	-	C	R	Sa	T1	A1	1.5	4	12	25	
				4					JN	57	-	U	R	Sa	T1	A1	1.5	4	12	25	
									JN	65	-	ST	R	Sa	T1	A1	1.5	4	12	25	
				3					FR	70	-	C	R	Sa	T1	A1	1.5	4	12	25	
14								highly fractured from 14 to 15 m fractures exposed by suspected drill action, fractures predominantly parallel to CA, no infills, mostly planar surfaces, smooth to rough surfaces													
				NI																	
				NI																	
				NI																	
	R12	100	51		R4	I-III															
				0																	
15																					
				0																	
				0																	
	R13	95	87	0	R4	I															

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					0					FR	20	-	U	R	-	T0	A1	3	0	1	30	
	16				2				fracture 16.0 to 16.25 m massive from 16.35 to 21.5 m	M	89	-	PL	R	-	T0	A0	4	0	1	30	
		R13	95	87	0	R4	I															
					0																	
					0																	
	17								very wide bedding spacing below 17 m													
					0																	
					0																	
					0																	
		R14	107	107		R4	I															
					0																	
	18				0																	
					0					M	89	-	PL	SM	-	T0	A0	4	0	0.5	30	Field Diametral PLT Test: **qu:189.8Mpa**, Type 2 Failure Field Axial PLT Test: **qu:140.2Mpa**, Type 2 Failure Field Diametral PLT Test: **qu:189.8Mpa**, Type 2 Failure
					0																	
					0																	
	19				0																	
		R15	100	100		R4	I															
					0					M	86	-	PL	R	-	T0	A0	4	0	0.5	30	
					0					JN	84	-	PL	SM	-	T0	A0	4	0	0.5	30	
					0																	
	20				0																	
					0					M	89	-	PL	SM	-	T0	A0	4	0	0.5	30	
									healed hairline fracture parallel to CA fracture along bedding plane													
					0																	
		R16	100	100		R4	I		healed bedding plane, 89 degrees to CA, medium to coarse grained below 20.66 m													
					0																	
	21																					
					0					M	85	-	U	SM	-	T0	A0	4	0	0.5	30	
					0																	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
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Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R16	100	100		R4	I															
					0				medium bedding spacing below 21.5 to 22.7 m													
										FR	86	-	PL	SM	-	T0	A0	4	0	0.5	30	
					2					FR	83	-	U	SM	-	T0	A0	4	0	0.5	30	
	22									FR	86	-	U	R	-	T0	A0	4	0	0.5	30	
					1																	
		R17	96	96		R4	I															
					0					FR	88	-	PL	R	-	T0	A0	4	0	0.5	30	
					1																	
					0				very thinly bedded, induced fractures occur along bedding plane below 22.7 m													
	23																					
					0																	
					2					JN	77	-	PL	SM	Gr	T1	A1	1.5	0.75	2	30	
										JN	71	-	PL	P	Gr	T2	A2	1	6	2	30	
					0																	
		R18	103	99		R4/5	I															
					0																	
	24																					
					0				healed bedding plane at 24.12 m medium bedding spacing below 24.12 m													
					0																	
					0																	
					0																	
	25																					
		R19	102	100		R4/5	I		thinly laminated from 25.2 to 25.7 m													
					0																	
					1					FR	67	-	U	R	-	T0	A1	3	0	2	25	
					0																	
	26																					
					0																	
					0																	
		R20	96	96		R4/5	I															
					0																	
					0																	
	27																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
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Log of BH-2016BR6027

Elevation, meters	Depth, meters	Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	27	R20	96	96	0	R4/5	I															
					0																	
					0				coarse grained below 27.5 m													
					0																	
	28				0																	
		R21	93	73		R3	I-II															
					1					JN	81	-	PL	R	Gr	T2	A2	3	8	6	20	
										JN	44	-	U	VR	Gr	T2	A2	3	6	6	20	
										JN	62	-	PL	P	Gr	T1	A2	3	6	6	20	
					3				COAL rich SANDSTONE from 28.58 to 28.85	JN	76	-	U	P	Gr	T1	A2	3	6	6	20	
										JN	85	-	U	VR	Sa	T1	A1	3	3	6	25	
										JN	86	-	U	R	Gr	T1	A1	3	3	6	25	
					3				COAL seam, lustrous black, coarse multiple discontinuity on coal along bedding plane, typically 86 degrees to CA, undulating rough to very rough, un altered, no infill, A4 to A5 openness													
	29				NI																	
					NR																	
					5																	
		R22	86	0		R1/3	II-III															
					7																	
	30				NI				SHALE grey to dark grey, very fine grained slightly to moderately weathered (II-III), very weak (R1) to moderately strong (R3)													
					NI				suspected shear (slickeslides and polished faces) zone from 30 to 30.5 m	JN	86	-	PL	SM	-	T1	A1	1	0	3	20	
									localized sandy SHALE	SH	87	-	U	R	G	T4	A3	1	-	6	10	
					NI					FR	79	-	PL	SM	-	T3	A3	1	-	6	10	
										FR	81	-	C	SM	Cm	T1	A1	1	4	6	25	
										SH	69	-	I	SM	Cm	T1	A1	1	4	6	25	
					4					SH	82	-	PL	SM	Cm	T1	A1	1	4	6	25	
										JN	75	-	PL	SM	Cm	T1	A1	1	4	6	25	
	31									JN	76	-	PL	SM	Cm	T1	A1	1	4	6	25	
					5					BD	85	-	PL	SM	Cm	T1	A1	1	4	6	25	
										FR	80	-	PL	SM	Cm	T1	A1	1	4	6	25	
										SH	72	-	PL	SM	Cm	T1	A1	1	4	6	25	
		R23	100	29		R3	I-III			JN	82	-	PL	SM	Cm	T1	A1	1	4	6	25	
					5					FR	80	-	I	SM	Cm	T1	A1	1	4	6	25	
										FR	83	-	I	SM	Cm	T1	A1	1	4	6	25	
										BD	89	-	PL	SM	Cm	T1	A1	1	4	6	25	
					5					SH	52	-	I	R	Cm	T1	A1	1	4	6	25	
					4																	
	32									SH	72	-	I	R	G	T3	A3	3	0	9	10	
					4					JN	39	-	U	P	-	T2	A2	3	0	9	10	
										JN	56	-	I	P	-	T1	A1	1.5	3	9	10	
										JN	33	-	PL	P	St	T1	A1	1.5	3	9	20	
		R24	95	66	3	R3	I-II			BD	80	-	U	SM	St	T1	A1	2	3	9	20	
					1					BD	84	-	PL	SM	St	T1	A1	2	3	9	20	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6027

Elevation, meters	Depth, meters	Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					0																	
	33	R24	95	66	1	R3	I-II			BD	87	-	PL	SM	-	T1	A1	2	3	9	20	
					2					BD	85	-	PL	SM	-	T1	A1	1	3	9	20	
					1				thinly laminated, moderately strong (R3), fresh (I) below 33.5 m	FR	84	-	U	SM	St	T1	A1	3	3	3	25	
					0																	
	34									BD	88	-	PL	SM	St	T1	A1	3	3	3	25	
					0					BD	86	-	PL	P	St	T1	A1	1	0	3	25	
		R25	71	45		R3	I-II			JN	66	-	I	R	-	T0	A3	1.5	-	3	25	
					2																	
					NI																	
					NR																	
	35				0																	
					0																	
					1					FR	87	-	PL	R	St	T1	A2	1.5	3	4	25	
		R26	100	95		R3	I-II			BD	85	-	PL	SM	St	T1	A2	1.5	3	4	25	
					1																	
	36				1					JN	11	-	C	R	St	T1	A1	1.5	3	4	25	
					1																	
					NI				randomly oriented healed calcite veins (<2 mm) from 36.5 to 38 m													
					2					JN	78	-	U	SM	St	T1	A1	2	4	3	25	
	37				2					FR	72	-	U	R	G	T4	A4	3	-	3	0	
		R27	100	56		R3	I-II			FR	88	-	PL	R	-	T4	A2	3	-	3	0	
					NI																	
					0																	
					0																	
	38																					
		R28	99	75	0	R3	I-III			FR	85	-	I	R	St	T1	A2	3	3	3	25	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
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Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					0																	
					1					FR	81	-	PL	R	-	T0	A2	3	3	3	25	
		R28	99	75	1	R3	I-III															
	39									JN	44	-	C	SM	St	T1	A2	1	3	3	25	
					2					JN	60	-	I		St	T1	A2	2	3	3	25	
										SH	81	-	I		St	T1	A3	2	3	3	10	
					3				COAL infill, suspected shear zone from 39.28 to 39.36 m	BD	85	-	PL	SM	St	T1	A2	1	3	3	25	
					0				SILTSTONE - shaley light to dark grey, very fine grained, laminated, pyrite bearing fresh (I), moderately weak (R2) to moderately strong (R3) interbedded with laminated to thinly bedded SANDSTONE	JN	85	-	PL	VR	-	-	A2	3	1	3	25	
					3					FR	20	-	PL	VR	-	-	A2	3	1	3	30	
	40									SH	90	-	PL	K	Gr	T1	A1	1.5	1	3	10	Field Axial PLT Test:
					4					SH	90	-	PL	K	Gr	T1	A2	1.5	1	3	10	**qu:49Mpa**, Type 6 Failure
										FR	90	-	PL	R	Gr	T1	A2	2	1	3	10	Field Axial PLT Test:
		R29	87	61		R2-3	I			SH	4	-	PL	K	Gr	T1	A1	0.5	1	3	10	**qu:49.7Mpa**, Type 2 Failure
					4																	
					0																	
					NR																	
	41								randomly oriented quartz and calcite stringers below 41.0 m													
					0					BD	90	-	PL	R	-	-	A2	1.5	1	3	25	
										BD	90	-	PL	R	-	-	A2	1.5	1	3	25	
					2																	
					2					BD	90	-	PL	R	-	-	A1	2	1	3	25	
										SH	87	-	PL	K	Gr	T1	A1	1	1	3	10	
		R30	100	79		R4	I															
					4					SH	45	-	PL	K	Gr	T1	A2	1	1	3	10	
	42									FR	10	-	PL	VR	Ca	T1	A1	3	1	3	30	
					1																	
					1					JN	85	-	PL	VR	-	-	A1	3	1	3	25	
					0																	
					0					CO	85	-	-	-	-	-	-	-	-	-	-	
	43									SH	85	-	C	P	Gr	T2	A2	1	1	3	10	
									sharp contact at 42.97 m													
					2				SHALE	SH	90	-	PL	K	Gr	T2	A2	1	1	3	10	
		R31	97	73		R5	I		dark grey, very fine grained	SH	90	-	PL	K	Gr	T2	A2	1	1	3	10	
									fresh (I), very strong (R5)	SH	90	-	PL	K	Gr	T2	A2	1	1	3	10	
					4				massive with local SILTSTONE/SANDSTONE interbeds,	SH	85	-	PL	K	Gr	T2	A2	1	1	3	10	
									below 42.97 m	JN	45	-	PL			T0	A1	1.5	1	3	20	
										JN	50	-	PL	P	Gr	T0	A1	1.5	1	3	20	
					5					SH	90	-	PL	P	Gr	T2	A2	1	1	3	10	
										SH	90	-	PL			T2	A2	1	1	3	10	
					0																	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	44	R31	97	73		R5	I		gradational contact over 0.05 m below 44.1 m	CO	90	-	-	-	Ca	-	-	-	-	-	-	
					0				SILTSTONE - shaley light to dark grey, very fine grained, laminated fresh (I), moderately strong (R3) interbedded with laminated SANDSTONE calcite stringers, fractures exposed by suspected drill action	VN	0	-	PL	-	St	T1	A0	-	-	-	-	
					0																	
					0																	
		R32	100	100		R4/5	I															
					1					JN	90	-	PL	R	-	T2	A2	1.5	1	2	20	
	45									FR	90	-	PL	R	-	-	A0	1.5	1	2	25	
					2					M	45	-	I	R	-	-	A0	1.5	1	2	30	
					0																	Field Axial PLT Test: **qu:197.8Mpa**, Type 2 Failure
					0																	
					1					FR	10	-	PL	VR	Qz	T1	A0	3	3	1	25	
										JN	86	-	ST	R	-	T0	A0	1.5	3	1	20	
	46				0																	
										JN	83	-	PL	SM	-	T0	A1	1	3	1	20	
		R33	100	61		R3	I			JN	87	-	PL	SM	-	T0	A0	1	3	1	20	
					2																	
					4				healed contact 87 degrees to CA SANDSTONE light grey with dark grey interbeds, medium grained, laminated fresh (I), strong (R4)	FR	-	-	I	R	-	T0	-	1.5	3	1	30	
					ni																	
	47								SHALE dark grey, very fine grained fresh (I), moderately strong (R3)	FR	-	-	I	R	-	T0	-	1.5	3	1	30	
					1					FR	87	-	PL	R	-	T0	-	1.5	3	1	20	
					0					SH	85	-	PL	K	Gr	T1	A1	1.5	1	6	10	
									COAL infill at 47.5 m	FR	85	-	-	-	-	-	-	3	1	6	-	
					8																	
		R34	81	50		R3	I			SH	65	-	PL	K	-	-	A1	0.5	1	6	10	
										SH	45	-	U	K	Gr	T2	A2	0.5	1	6	10	
					5				slickenslides shear zone from 47.81 to 47.99 m	SH	65	-	U	K	Gr	T2	A2	0.5	1	6	10	
										SH	45	-	U	K	Gr	T2	A3	0.5	1	6	10	
	48																					
					1																	
										JN	30	-	PL	R	-	-	A1	1.5	1	6	25	
					1																	
					NR				suspected COAL seam													
										FR	80	-	PL	R	-	-	-	1.5	1	-	25	
					NI																	
									SILTSTONE/SANDSTONE interbed from 48.88 to 50.0 m													
	49	R35	85	63		R3	I			SH	90	-	PL	K	Gr	T2	A1	1	1	3	10	
					9																	
					1					FR	80	-	PL	R	-	-	A2	1.5	1	-	25	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
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Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R35	85	63	0 0	R3	I															
	50				0 0 3				becoming silty SHALE, fine to platy grains, COAL inclusions across core diameter	JN SH CO	59 88 82	- - -	U U U	R K VR	Gr Gr Gr	T1 T1 T3	A1 A1 A3	3 1.5 3	0.75 0.75 6	4 4 4	25 10 10	
		R36	60	31	NR NR NR	R2/4	I		COAL black, fine, lustrous, moist slightly weathered (II), very weak to moderately weak (R1 - R2) fragmented													
	51																					
	52	R37	17	0	NI NR NR NR NR NR	R0	II-III															
	53	R38	19	0	NI NR NR NR NR NR	R0	II-III		wet, gougey texture below 53.20 m													
	54																					
		R39	26	0	NI NR NR	R1/0	I-II		fragmented to crushed recovery from 54.5 to 56.47 m													
	55																					

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Project Number: 60444413

Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					NR																	
		R39	26	0	NR	R1/0	I-II															
					NR																	
	56								fine, moist from 56.0 to 56.47 m													
					NI																	
					NI																	
										CO	76	-	I	VR	-	T0	A3	3	0	3	25	
										FR	82	-	I	VR	-	T0	A2	3	0	3	25	
									coarse, COAL/SILTSTONE, moderately strong (R3), grey, fresh from 56.47 to 56.6 m	JN	89	-	PL	R	-	T0	A2	1.5	0	3	25	Field Axial PLT Test: **qu:15.4Mpa**, Type 6 Failure
					NI				lustrous black, fragmented moist, fine COAL below 56.60 m													
		R40	47	0		R1	II															
					NR																	
	57																					
					NR																	
					NR																	Field Axial PLT Test: **qu:16Mpa**, Type 5 Failure
					NI																	
					NR																	
	58																					
					NR																	
		R41	24	0		R0	II															
					NR																	
					NR																	
					NR																	
	59																					
					NI																	
										JN	69	-	U	R	-	T0	A2	3	0	3	25	
					NI					JN	89	-	U	VR	-	T0	A2	3	0	3	25	Field Axial PLT Test:
									coarse below 59.34 m	JN	80	-	I	R	-	T0	A3	3	0	3	25	**qu:4Mpa**, Type 2 Failure
										JN	82	-	PL	VR	-	T0	A3	3	0	3	25	
					NR																	
		R42	31	0		R1/2	II															
					NR																	
	60																					
					NR																	
					NR																	
									fine, moist to wet below 60.5 m													
		R43	19	0	NI	R1/0	II-III															

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					NR																	
	61				NR																	
		R43	19	0	NR	R1/0	II-III															
					NR																	
					NR																	
	62				NI																	
					NR																	
					NR																	
		R44	24	0		R1	I															
					NR																	
	63				NR																	
					NR																	
					NI				low recovery of fragmented COAL/SHALE interbeds, fresh (I), extremely weak (R0) to moderately strong (R3) below 63.5 m													
					NR																	
	64				NR																	
		R45	53	10		R1	I															
					11					SH	72	-	PL	K	Gr	T1	-	0.5	1	3	10	
										SH	90	-	PL	K	Gr	T2	A3	0.5	1	3	10	
										FR	87	-	I	R	-	-	-	1.5	1	3	20	
					8					FR	86	-	I	R	-	-	-	1.5	1	3	20	
										SH	72	-	PL	K	Gr	T1	A3	0.5	1	3	10	Field Axial PLT Test:
										SH	75	-	PL	K	Gr	T1	A3	0.5	1	3	10	**qu:14.3Mpa**, Type 2
										FR	87	-	PL	R	-	-	A4	1.5	1	3	20	Failure
					5					SH	65	-	PL	K	Gr	T1	A3	0.5	1	3	10	
										JN	68	-	I	R	-	-	A2	1	1	3	20	
										CO	90	-	PL	R	Gr	T0	-	-	1	-	25	
	65								slickenslides observed at 65.0 to 65.13 m	FR	0	-	PL	R	-	-	A3	1.5	1	0.5	25	
					5					SH	68	-	U	K	Gr	T2	A3	3	2	3	10	
									sheared COAL/SHALE contact at 65.13 m	JN	78	-	PL	R	Gr	T1	A1	1.5	1	3	25	
									SHALE - silty dark grey, very fine grained fresh (I), moderately strong (R3)	SH	75	-	PL	K	Gr	T1	A1	1.5	1	3	10	
					4					SH	68	-	I	K	Gr	T1	A1	1.5	1	3	20	
										FR	80	-	PL	VR	-	-	A1	3	1	3	25	
					3					FR	80	-	PL	VR	-	-	A0	3	1	3	25	
		R46	97	56		R1/4	I-II			BD	68	-	PL	SM	Gr	T2	A1	1	1	3	20	
										SH	80	-	PL	K	Gr	T2	A1	1	1	3	10	
					4					SH	52	-	PL	K	Gr	T1	A3	1.5	2	3	10	
										JN	5	-	PL	R	-	-	-	1.5	2	3	20	
	66									FR	80	-	PL	R	-	-	A1	1.5	1	3	25	
					5					JN	10	-	PL	R	-	-	A1	1.5	2	3	20	
										FR	80	-	PL	R	-	-	A2	1.5	1	3	20	
										SH	60	-	PL	K	Gr	T3	A3	0.5	3	3	10	
					5					SH	55	-	PL	K	Gr	T3	A3	0.5	3	3	10	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R46	97	56		R1/4	I-II			BD	80	-	PL	R	Gr	T1	A2	1.5	2	3	25	
										FR	80	-	PL	R	-	-	A1	1	1	3	20	
					1					FR	87	-	PL	R	Gr	T1	A0	1.5	1	3	20	
										VN	87	-	PL	-	Qz	T1	A0	-	-	-	-	
										FR	90	-	PL	R	Gr	T1	A0	1.5	1	3	20	
					2					SH	65	-	PL	K	Gr	T1	A0	1.5	1	3	20	
	67								contact with SANDSTONE/SILTSTONE/SHALE crossbeds 70 degrees to CA from 66.95 to 67.70 m															
					0				SANDSTONE is light to dark grey, very fine to medium grained, moderately strong (R3)	JN	75	-	PL	R	-	-	A1	1.5	2	3	25	
		R47	93	88		R3	I															
					1					SH	89	-	PL	K	Gr	T2	A3	0.5	2	3	10	
					2					FR	90	-	I	VR	-	-	A0	3	1	-	30	
									contact, 65 degrees to CA, irregular at 67.70 m													
					0																	
	68								localized pyrite inclusion													
					0					SH	87	-	PL	K	St	T3	A3	0.5	2	3	10	
					2					SH	70	-	C	K	Gr	T2	A3	0.5	2	3	10	
										FR	85	-	PL	VR	-	-	A0	3	1	3	25	
										SH	85	-	PL	K	Ox	T1	A2	1	2	3	10	
					3					SH	65	-	PL	K	Gr	T2	A3	0.5	2	3	10	Field Axial PLT Test: **qu:7.2Mpa**, Type 2 Failure
		R48	98	82		R3	I-II			JN	85	-	PL	R	-	-	A3	1.5	1	3	20	
					2					JN	72	-	C	SM	Ch	T2	A1	1	1	3	20	
	69																					
					1					JN	84	-	I	R	St	T2	A1	1	1	3	20	
										SH	37	-	PL	K	Gr	T1	-	0.5	1	3	10	
										FR	87	-	PL	R	-	-	A0	1.5	1	3	25	
					2																	
					0				becoming very silty, SILTSTONE/SHALE interbedding below 69.5 m													
										M	89	-	I	VR	-	T0	A0	4	0	0.5	30	
					0					FR	0	-	PL	R	-	T0	A0	4	0	0.5	30	
	70								drill exposed fracture parallel to CA from 69.9 to 70.2 m													
					0																	
		R49	101	100		R4/5	I															
					0																	
					0																	
					0				healed stepped contact of SILTSTONE/SHALE interbed 90 degrees to CA at 70.74 m													
	71																					
					0																	
					0																	
		R50	105	91		R4	I-II															
					0																	
					2				platy shale grains below 71.77 m	SH	68	-	U	K	Gr	T3	A2	0.5	6	4	10	
										SH	89	-	PL	K	Gr	T2	A1	0.5	6	4	10	
	72																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	72				2				observed shear is perpendicular to joint plane at 72.0 m	JN	72	-	PL	P	Gr	T2	A1	0.5	6	4	10	
									vein (coal infill) healed, approximately 1 mm thick, 88 degrees to CA at 72.09 m	SH	78	-	U	K	Gr	T3	A2	0.5	6	4	10	
										VN	88	-	-	-	Gr	T1	A0	4	0.75	4	30	
		R50	105	91		R4	I-II			FR	84	-	U	R	-	T0	A0	4	0	4	30	
					0																	
										FR	88	-	U	R	Gr	T2	A2	3	6	9	25	
					5				trace clay, trace oxidation below 72.5 m	JN	77	-	U	P	Gr	T2	A2	1.5	6	9	20	
										SH	86	-	U	K	Gr	T2	A2	1.5	6	9	10	
										JN	89	-	I	VR	Gr	T4	A3	1	10	9	20	
										JN	89	-	PL	R	Gr	T1	A2	1.5	0.75	9	25	
					3					JN	69	-	PL	R	Gr	T4	A3	1	13	9	20	Field Axial PLT Test:
									observed shear orientation is approximately perpendicular to joint at 72.89 m	JN	74	-	U	SM	Gr	T1	A1	1	6	9	20	**qu:110.4Mpa**, Type 2
	73									FR	82	-	PL	R	-	T0	A1	3	0	9	25	Failure
					2					FR	85	-	U	R	-	T0	A1	3	0	9	25	
										FR	89	-	U	R	-	T0	A0	4	0	9	30	
		R51	101	56		R4	II-III			FR	81	-	U	R	-	T0	A1	3	1	9	25	
					1				fracture along undulating shear plane, trace oxidation on surface at 73.27 m													
										M	84	-	U	R	-	T0	A0	4	0	9	30	
					2					FR	89	-	PL	R	-	T0	A1	3	0	9	25	
										SH	80	-	PL	P	-	T4	A4	0.5	13	9	10	
										JN	85	-	PL	R	-	T0	A2	1.5	0	9	25	
					6					JN	88	-	PL	P	Gr	T3	A2	1	6	9	20	
										JN	64	-	U	P	Gr	T3	A2	1	6	9	20	
	74								healed fracture running parallel to CA, thinly laminated below 73.93 m	JN	70	-	U	SM	Gr	T2	A2	1.5	6	9	25	
					3					JN	87	-	PL	SM	-	T0	A2	1	0	9	10	
									becoming shaley SILTSTONE, gradational transition, very fine grained, grey, oxidized along weathered planes thinly laminated below 74.0 m	JN	79	-	PL	P	Gr	T1	A2	1	2	9	20	
										FR	85	-	PL	R	Gr	T1	A1	1.5	2	9	25	
										FR	74	-	I	VR	Gr	T4	A4	3	10	9	20	
					5				<1 mm micro vein 90 degrees to CA between 74.1 and 74.25 m	JN	65	-	U	R	Gr	T5	A3	3	10	9	20	
										VN	66	-	-	-	Gr	T1	A0	4	0.75	9	30	
									fractures below 74.1 m are along existing weak planes/bedding planes with coal infill	FR	67	-	U	VR	Gr	T4	A3	3	10	9	25	
					2					SH	68	-	C	K	Gr	T3	A3	1.5	6	9	10	
									randomly oriented veins (COAL infill) predominantly 90 degrees to core axis below 74.47 m	SH	73	-	U	VR	Gr	T3	A2	1.5	6	9	10	
										JN	90	-	PL	R	Gr	T2	A2	1.5	6	9	25	
		R52	100	77		R4/5	II			JN	90	-	PL	SM	Gr	T1	A1	1	2	9	20	
					2					JN	79	-	PL	SM	Ox	T0	A1	1	1	9	20	
										JN	80	-	U	SM	Ox	T0	A1	2	1	9	20	
	75																					
					0																	
					0																	
									SILTSTONE - shaley grey, fine grained, trace oxidation fresh (I), moderately strong (R3)													
					0																	
					0																	
	76																					
					1																	
										FR	34	-	U	R	-	T0	A1	3	0	2	25	
		R53	100	71		R4/5	II															
					2					SH	42	-	U	P	Ox	T0	A1	2	1	2	10	
										SH	37	-	U	K	Gr	T1	A1	1.5	6	2	10	
									suspected shear zone, slickenslides, mineralization and polished surface from 76.43 to 76.72 m													
					NI																	
										SH	60	-	U	K	Gr	T1	A1	1.5	6	2	10	
										SH	40	-	U	P	Gr	T1	A1	1.5	6	2	10	
					3					SH	42	-	PL	R	Gr	T2	A5	1.5	6	2	10	
	77																					
										SH	40	-	PL	K	Gr	T2	A2	0.5	3	2	10	
					1																	
										SH	45	-	PL	K	Gr	T1	A3	0.5	3	2	10	
		R54	97	88		R3/4	II															
					2					SH	40	-	PL	K	Gr	T2	A2	0.5	3	2	10	
					0				contact at 55 degrees to CA at 77.53 m													

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6027

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	78	R54	97	88	0 1 0	R3/4	II		transitions to slightly weathered (II), interbedded, laminated SANDSTONE/SILTSTONE/SHALE (limey) from 77.53 to 78.20 m transition back into muddy SILTSONE, dark grey, very fine to fine grained, moderately strong (R3), fresh, coal laminations below 78.20 m	FR	75	-	PL	R	-	T0	A0	1.5	0	3	25	
	79								**END OF BOREHOLE AT 78.5 m ABOVE TUNNEL ROOF IN SILTSTONE.** Notes: 1. Borehole termination at 78.5 m in SILTSTONE. 2. Seepage observed from borehole after drilliing completion. 3. Installed Bradley Plug at approximately 4 m above tunnel roof. 4. Geophysical survey (Optical, Gamma and Orientation) of borehole was completed. 5. Borehole closed with cap and valve with tubing and presure gauge. 5. Pressure gauge monitoring: - September 09, 2016 - 0 kPa. - September 10, 2016 - 0 kPa. - September 11, 2016 - <10 kPa. - September 12, 2016 - <10 kPa. - September 19, 2016 - 70 kPa.															
	80																					
	81																					
	82																					
	83																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6028

Date(s) Drilled	**09/11/2016**	Logged By	**Dave F. & Nicholas B.**	Checked By	**Marty McCabe**
Drilling Method	**Rotary Diamond Drilling**	Drill Bit Size/Type	**HQ3 - 61 mm**	Total Depth Drilled (meters)	**10.5**
Drill Rig Type	**Boart LM 55**	Drilling Contractor	**Boart Longyear**	Approximate Surface Elevation	
Groundwater Level		Borehole Backfill	**Cap & Valve with Pressure Gauge**	Inclination from Horizontal/Bearing	**Vertical**
Location	**EVO - Chainage ~874.4 m, 4.35 m to Tunnel Floor from Collar, Top Roller No. 551**			Hammer Data	**N/A**

ROCK CORE

Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index
R1	70	9	10, 15, 5, NI	R2/3	III
R2	100	0	20	R1/3	II
R3	41	0	11, 13, 20, NI, NR, NR	R0/3	II
R4	43	0	NI, 20, NI, NR, NR, NR	R0/3	II

MATERIAL DESCRIPTION

SHOTCRETE

fracture zone from 0.17 to 0.29 m

SILTSTONE
grey, very fine to fine grained, laminated
moderately weathered (III), weak (R2) to moderately strong (R3)
trace oxidation, moderate to highly fractured core
silt and clay mineral infill within fracture, dominant fractures are 65 and 30 degrees to CA
fracture zone from 0.41 to 0.47 m
fracture zone from 0.77 to 1.20 m

suspected fault zone from 1.30 to 1.43 m

fracture zone with joints from 1.5 to 2.0 m

suspected fault zone, notable gouge from 2.01 to 2.12 m

fracture zone from 3.2 to 3.43 m

suspected fault zone from 3.44 to 3.53 m
suspected fault zone with gouge and fractured core from 3.49 to 3.53 m

Discountinuity Description

Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
FR	-	-	I	R	Ox	T2	-	1.5	4	-	20	
JN	50	-	PL	R	-	-	A4	1.5	4	6	25	
JN	30	-	PL	R	-	-	A4	1.5	3	6	25	Field Diametral PLT Test: **qu:94.8Mpa**, Type 5 or 6 Failure
FR	30	-	I	R	Ox	T3	-	1.5	3	6	25	
JN	64	-	PL	VR	-	-	A2	1.5	2	6	25	
FR	72	-	I	VR	-	-	A4	3	2	6	25	
JN	40	-	PL	R	St	T1	A3	1.5	2	6	20	
JN	42	-	PL	R	St	T1	A3	1.5	2	6	20	
FR	65	-	I	R	Cm	T2	A3	1.5	3	6	20	
FR	30	-	PL	R	Cm	T2	A1	1.5	3	6	20	
JN	72	-	I	VR	Cm	T1	A2	3	2	6	20	
FR	30	-	I	VR	Cm	T0	A3	4	2	6	20	
FT	45	-	PL	SM	Cm	T5	A3	1	2	6	0	
JN	45	-	PL	R	Cm	T1	A3	1.5	2	6	0	
JN	40	-	PL	R	Cm	T1	A3	1.5	2	6	0	
JN	35	-	PL	R	Cm	T2	A3	1.5	2	6	0	
JN	45	-	PL	VR	-	-	A2	3	1	6	20	
JN	85	-	I	VR	-	-	A2	3	1	6	20	
JN	35	-	PL	R	Ox	T0	A2	1.5	2	6	20	
JN	35	-	PL	R	-	-	A1	1.5	1	6	20	
FR	-	-	I	SM	-	-	A5	1	2	6	20	
FT	30	-	PL	SM	Cm	T5	A1	0	1	6	0	
JN	65	-	I	VR	-	-	A4	3	2	6	25	Field Diametral PLT Test: **qu:9.4Mpa**, Type 4 Failure
JN	45	-	ST	VR	-	-	A2	3	2	6	25	
FR	0/90	-	I	VR	Cm	T2	A2	4	2	6	20	
FT	40	-	PL	R	Cm	T5	A2	0	1	6	20	
JN	45	-	PL	R	Cm	T3	A3	3	1	6	30	
FR	-	-	I	R	-	-	-	1.5	2	6	25	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6028

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
				10				fracture zone from 4.5 to 4.62 m													
				0																	
									JN	80	-	C	R	Ox	T0	A1	1.5	2	6	25	
5									JN	42	-	PL	R	Ox	T0	A1	1	2	6	20	
				NI					FT	54	-	PL	R	Cm	T5	A4	3	2	6	10	
								suspected fault zone, gougy and fractured recovery, oxidized from 5.07 to 5.71 m													
	R5	47	25		R0/2	III															
				NR																	
				NR					FT	54	-	I	VR	Cm	T5	A4	4	2	6	-	
				NR																	Field Axial PLT Test: **qu:82.7Mpa**, Type 5 Failure (Reamed < 6m)
6									FT	40	-	PL	R	Cm	T5	A4	1.5	2	6	0	
				NI				becoming sandy SILTSTONE, light to dark grey, thinly laminated below 6.0 m bedding changing from 50 degrees to 10 degrees to CA due to suspected fault-related block rotation	JN	26	-	PL	R	Cm	T2	A1	1.5	2	6	0	
				15																	
									FR	-	-	I	R	Cm	T2	A4	1.5	2	6	-	Field Axial PLT Test: **qu:115.1Mpa**, Type 6 Failure
				15					JN	45	-	PL	R	Ox	T1	A2	1.5	2	6	25	Field Axial PLT Test: **qu:86.7Mpa**, Type 2 Failure
	R6	65	23		R0/4	II-III			JN	60	-	PL	R	St	T1	A2	1.5	2	6	25	
				NI					JN	60	-	PL	R	St	T1	A2	1.5	2	6	25	
									JN	60	-	PL	R	St	T1	A2	1.5	2	6	25	
7									JN	60	-	PL	R	Ox	T1	A2	1.5	2	6	25	
				2																	
				NR																	
									FR	40	-	PL	R	-	-	A5	4	2	3	30	
									JN	50	-	PL	R	-	-	A3	1.5	1	3	20	
				5				fine to medium grained, thinly bedded SANDSTONE from 7.55 to 9.0 m fracture zone from 7.75 to 8.0 m, includes re-drilled rock fragments due to borehole caving contact at 7.55 m, 50 degrees to CA	JN	38	-	C	R	-	-	A3	1.5	2	3	20	
									FR	-	-	I	R	-	-	A5	1.5	1	3	-	
				NI					JN	50	-	PL	R	-	-	-	1.5	2	3	20	
8																					
				NR																	
	R7	33	9		R2/4	II															
				NR																	
				NR																	
				NR																	
9																					
				NI				dark grey, very fine grained, weak rock (R2) below 9.0 m													
				NI																	
	R8	100	0	NI	R1/2	I-II		SHALE dark grey, very fine grained to platy fresh to moderately weathered (I-II), extremely weak (R0) to moderately weak (R2)													
				NI																	
10																					
				NI																	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6028

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
		R8	100	0	NI	R1/2	I-II															

END OF BOREHOLE AT 10.5 m ABOVE TUNNEL ROOF IN SHALE.

Notes:
1. Borehole termination at 10.5 m in SHALE due to poor/unstable ground conditions and potential safety issues with caving and equipment damage.
2. Seepage observed from borehole after drilliing completion.
3. Borehole closed with cap and valve with tubing and presure gauge (To be confirmed).
4. Pressure gauge monitoring:
   - September 09, 2016 - 0 kPa.
   - September 10, 2016 - 0 kPa.
   - September 11, 2016 - <10 kPa.
   - September 12, 2016 - <10 kPa.
   - September 19, 2016 - 65 kPa.

Depth, meters: 11, 12, 13, 14, 15

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6029

Date(s) Drilled	**09/14/2016**	Logged By	**Dave F. & Nicholas B.**	Checked By	**Marty McCabe**
Drilling Method	**Rotary Diamond Drilling**	Drill Bit Size/Type	**HQ3 - 61 mm**	Total Depth Drilled (meters)	**39.6**
Drill Rig Type	**Boart LM 55**	Drilling Contractor	**Boart Longyear**	Approximate Surface Elevation	
Groundwater Level		Borehole Backfill	**MPBX**	Inclination from Horizontal/Bearing	**Vertical**
Location	**EVO - Chainage ~1195.2 m, 4.24 m to Tunnel Floor from Collar, Top Roller No. 772**			Hammer Data	**N/A**

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	0								SHOTCRETE	FR	90	-	PL	SM	-	-	A1	1.5	1	3	25	
					3				SILTSTONE - shaley	FR	90	-	PL	R	-	-	A2	1.5	1	3	25	
									dark grey, very fine grained	FR	74	-	PL	R	-	-	A1	1.5	1	3	25	
		R1	85	78	1	R3	I		fresh (I), moderately strong (R3), gritty fracture surfaces													
					0																	
									light to dark grey, laminated, moderately strong (R3) to strong (R4) below 0.6 m													
					1					SH	74	-	PL	K	Gr	T2	A2	0.5	4	3	10	
	1				0																	Field Axial PLT Test: **qu:71.8Mpa**, Type 6 Failure
		R2	98	97	1	R3-4	I															
					0					FR	88	-	PL	VR	-	-	A1	1.5	0	3	25	
					0																	
	2				0																	
					2					JN	72	-	C	R	-	-	A2	3	0	3	25	
										FR	55	-	PL	VR	-	-	A0	1.5	0	3	30	
					2																	
										SH	76	-	PL	K	-	-	A1	0.5	4	3	10	
										SH	34	-	PL	K	Gr	T3	A2	0.5	10	3	10	
		R3	87	64	5	R4	I			SH	87	-	PL	K	Gr	T1	A1	0.5	4	3	10	
										SH	72	-	PL	K	Gr	T2	A2	0.5	10	3	10	
	3									SH	65	-	C	K	Gr	T2	A3	0.5	10	3	10	
					2					VN	76	-	PL	-	Ca	T1	A0	-	0.75	3	-	
										SH	90	-	PL	K	Gr	T1	A2	0.5	4	3	10	
										SH	89	-	PL	K	Gr	T1	A2	0.5	4	3	10	Field Axial PLT Test: **qu:48.3Mpa**, Type 6 Failure
					2					SH	88	-	PL	K	Gr	T1	A1	0.5	4	3	10	
										FR	90	-	I	R	-	-	A1	1.5	0	3	30	
					6				fracture zone 90 to 25 degrees to CA from 3.6 to 4.4 m													
									thinly laminated to moderately spaced bedding below 3.6 m													
					8																	
	4	R4	93	33	NI	R2-4	I															
					NI					BD	89	-	PL	SM	-	-	A1	1	0	3	-	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6029

Elevation, meters	Depth, meters	Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					1					JN	89	-	PL	SM	-	-	A1	1.5	0	3	25	
		R4	93	33	1	R2-4	I			FR	82	-	PL	R	-	-	A0	1.5	0	3	30	
	5				4				carbonate stringers, localized limey SANDSTONE beds < 0.20 m thick below 5.1 m	SH	55	-	PL	K	Gr	T1	A1	0.5	2	3	10	
					3					SH	60	-	PL	R	Gr	T3	A2	0.5	10	3	10	
					1																	
										JN	75	-	PL	R	-	-	A1	1.5	0	3	25	
		R5	89	75	1	R3-4	I															
	6									JN	60	-	C	K	-	-	A1	1.5	0	3	25	
					2					JN	87	-	PL	R	Ca	-	A2	1.5	0	3	25	
					1					JN	82	-	PL	SM	-	T1	A1	1	3	3	10	
					0																	Field Axial PLT Test: **qu:83.4Mpa**, Type 2 Failure Field Diametral PLT Test: **qu:61.6Mpa**, Type 7 Failure Field Axial PLT Test: **qu:114.5Mpa**, Type 2 Failure
					1																	
	7				0					JN	81	-	ST	SM	-	-	A1	1	0	3	25	
		R6	93	93	0	R3-4	I															
					1					JN	85	-	PL	SM	-	-	A1	1	0	3	25	
					0																	
	8				0																	
					0				SANDSTONE - silty, shaley grey , fine to medium grained fresh (I), strong (R4), interbedded with SILTSTONE													
					1					FR	-	-	PL	R	-	-	A1	1.5	0	4	20	
		R7	105	105	0	R4	I															
	9				2					FR	10	-	PL	R	-	-	A1	1.5	0	4	25	
										FR	-	-	PL	R	-	-	A1	1.5	0	4	20	
										JN	-	-	U	R	-	-	A1	1.5	0	4	20	
					0																	
										FR	35	-	ST	R	-	-	A2	1.5	0	4	25	
					2					JN	-	-	U	-	-	-	A2	1.5	0	4	10	
		R8	95	95	0	R4	I															
	10				-					FR	70	-	PL	-	-	-	A1	1.5	0	2	25	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
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Log of BH-2016BR6029

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
										FR	85	-	PL	R	-	-	A1	1.5	0	2	25	
										FR	89	-	PL	R	-	-	A1	1.5	0	2	25	
					-					FR	-	-	ST	R	-	-	A2	1.5	0	2	20	
		R8	95	95	-	R4	I			FR	-	-	PL	R	-	-	A2	1.5	0	2	25	
					-																	
	11									JN	20	-	ST	SM	Ox	T1	A1	1	0.75	3	20	
									randomly distributed carbonate/calcite stringer below 11.1 m	FR	90	-	PL	SM	-	-	A1	1.5	0	3	25	
					-					-	90	-	C	SM	Cm	T1	A1	1.5	4	3	25	
					-																	
										JN	90	-	PL	R	-	-	A1	3	0	3	25	
		R9	94	84	-	R4	I															
	12									FR	85	-	C	R	-	-	A1	3	0	3	25	
					-					FR	90	-	U	R	Ca	T1	A1	3	0.75	3	20	
										JN	10	-	PL	SM	Ca	T2	A2	1.5	0.75	3	20	
					-					JN	15	-	PL	SM	Cm	T2	A2	1.5	4	3	20	
					-																	
					-																	
	13																					
					-																	
		R10	103	87	-	R4	I															
										FR	90	-	C	SM	Cm	T2	A2	1.5	4	3	25	
										FR	95	-	ST	R	Cm	T1	A1	3	4	3	25	
					-					JN	75	-	ST	R	Ca	T2	A2	3	0.75	3	20	
					-																	
										FR	0	-	C	SM	Ca	T1	A1	1.5	0.75	3	20	
	14									FR	90	-	PL	SM	Cm	T1	A1	1.5	4	3	25	
					0																	
					0																	
					0																	
										FR	-	-	ST	R	-	-	A2	3	0	3	25	
		R11	103	73	4	R4	I															
										FR	70	-	U	R	-	-	A1	3	0	3	25	
	15									FR	-	-	PL	R	Gr	T2	A2	3	1	3	25	
					8					FR	-	-	PL	SM	-	-	A2	2	1	3	10	
					11					FR	85	-	U	R	Cm	T1	A2	3	1	3	25	
										FR	-	-	U	R	Cm	T1	A2	3	1	3	25	
										JN	-	-	ST	R	Ca	T2	A2	3	0.75	3	20	
					3					FR	20	-	I	R	Cm	T1	A2	1.5	4	3	25	
		R12	105	87		R4	I			FR	-	-	PL	R	Cm	T1	A2	1.5	4	3	25	

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Log of BH-2016BR6029

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
				0				grey shaley SILTSTONE interbed from 15.7 to 15.9 m	FR	-	-	PL	R	Cm	T1	A2	1.5	4	3	25	
16								siltstone interbed with silty SANDSTONE below 15.9 m													
				4					FR	45	-	PL	SM	-	-	A1	1.5	0	3	25	
									FR	10	-	U	R	-	-	A1	3	0	3	25	
									FR	90	-	PL	SM	Cm	T1	A2	1.5	4	3	10	
				2					FR	-	-	PL	SM	Cm	T1	A2	1.5	4	3	10	
	R12	105	87		R4	I															
									FR	-	-	PL	R	-	-	A1	1.5	0	3	25	
				4					FR	-	-	I	R	-	-	A1	3	0	3	25	
				0																	
17																					
				8				fracture zone, slickensided core, multi angled core from 17.1 to 18.6 m													
				8																	
				8																	
	R13	83	10	8	R4	I															
									JN	90	-	PL	R	-	-	A1	1.5	0	3	25	
18									FR	90	-	PL	R	-	-	A1	1.5	0	3	25	
				3																	
									JN	-	-	PL	R	-	-	A2	1.5	0	3	20	
				4					FR	90	-	U	R	-	-	A1	3	0	3	25	
									FR	-	-	I	R	-	-	A1	3	0	3	30	
									FR	-	-	PL	SM	-	-	A1	2	0	3	25	
				1					FR	85	-	PL	SM	-	-	A1	3	0	3	25	
									JN	-	-	PL	R	Ca	-	A2	3	1	3	20	
				1																	
19																					
				1																	
									FR	85	-	U	SM	-	-	A2	2	0	3	25	
									FR	90	-	C	SM	-	-	A2	1.5	0	3	25	
	R14	97	91	1	R4	I															
				0																	
									BD	85	-	PL	SM	Cm	T2	A2	1.5	4	3	25	
				1				localized grey shaley SILTSTONE interbed from 19.8 to 20.1 m													
20									FR	-	-	I	SM	Cm	T2	A2	1.5	4	3	25	
				1					FR	90	-	PL	R	-	-	A1	3	0	3	25	
				1					FR	90	-	PL	R	-	-	A1	3	0	3	25	
				1					FR	-	-	PL	R	-	-	A1	3	0	3	25	
	R15	103	91		R4	I															
				0																	
21																					
				1					FR	90	-	PL	R	-	-	A1	3	0	3	25	
				14					FR	-	-	PL	SM	Su	T2	A2	3	0.75	3	25	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
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Log of BH-2016BR6029

Elevation, meters / Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	R15	103	91		R4	I		localized grey shaley SILTSTONE interbed from 21.4 to 21.7 m	BD	90	-	PL	R	Ch	T2	A2	3	3	3	25	
									FR	90	-	-	-	-	-	-	-	-	-	-	
				1																	
									FR	-	-	PL	SM	-	-	A1	3	0	3	25	
				0																	
22																					
				1					FR	-	-	PL	R	Gr	T2	A2	3	3	3	25	
	R16	102	102	0	R4	I															
				0																	
				0																	
23																					
				2					FR	90	-	I	R	-	-	A1	3	0	3	25	
								very thin coal partings below 23.1 m	FR	90	-	I	R	-	-	A2	3	0	3	30	
				1					FR	-	-	PL	SM	Ca	T1	A1	1.5	0.75	3	25	
				0																	
	R17	101	80	0	R4	I															
24																					
				1					FR	-	-	-	-	-	-	-	-	-	-	-	
				0					JN	-	-	PL	SM	-	-	A2	1.5	0	3	25	
				1																	
									FR	-	-	PL	SM	Gr	T2	A2	1.5	3	3	25	
				0																	
25																					
				0																	
	R18	103	100	0	R4	I															
				1																	
				0																	
26																					
				1					FR	89	-	PL	SM	-	-	A0	1	0	0.5	25	
				1																	Field Axial PLT Test: **qu:39.2Mpa**, Type 2 Failure
	R19	103	100		R3	I			FR	87	-	PL	SM	Gr	-	A0	1	0	0.5	25	
				1																	
				0					FR	87	-	PL	SM	Gr	T3	A1	1	0	0.5	25	
27																					

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
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Log of BH-2016BR6029

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
	27				1																	
		R19	103	100	0	R3	I			FR	80	-	PL	R	-	-	A0	1	0	0.5	25	
					0				light to dark grey, very fine to medium grained, moderately strong (R3), 1 - 10 cm thick silty SANDSTONE and SILTSTONE beds, fractures occur along silty bedding planes below 27.6 m	FR	81	-	PL	SM	-	-	A1	1	0	0.5	25	
					1																	
	28				0																	
										BD	87	-	U	SM	-	-	A1	1	0	0.5	25	
		R20	98	95	3	R3	I			FR	87	-	PL	SM	St	T1	A1	1	0	0.5	25	
										FR	87	-	PL	SM	-	-	A0	1	0	0.5	25	
					0																	
										FR	85	-	PL	SM	-	-	A1	1	0	0.5	25	
					1																	
	29				1																	
										FR	88	-	PL	SM	-		A0	1	0	0.5	25	Field Axial PLT Test: **qu:91.4Mpa**, Type 2 Failure
					0																	
					2																	
										JN	85	-	PL	SM	St	T2	A2	1	3	0.5	25	
										FR	85	-	PL	SM	-	-	A1	1	0	0.5	25	
										VN	15	-	PL	-	Ca	T2	-	-	0.75	-	-	
		R21	99	99	1	R3	I															
										CO	87	-	C	R	-	-	A0	1.5	0	0.5	25	
	30				1				transition to SANDSTONE from silty SANDSTONE contact at 30.05 m light grey , fine to medium grained fresh (I), moderately strong (R3), interbedded with SILTSTONE with thicker SANDSTONE beds														
					0																	
					0				increasing SANDSTONE bed thickness below 30.6 m													
										FR	85	-	PL	SM	-	-	A1	1	0	0.5	25	
					2					FR	87	-	PL	SM	Ca	T1	A2	1	0.75	0.5	25	
	31																					
					0																	
		R22	99	97	0	R3	I															
					1																	
										FR	85	-	PL	SM	-	-	A1	1	0	0.5	25	
					0					VN	25	-	PL	-	Ca	T1	-	-	0.75	0.5	-	
	32																					
					0																	
		R23	99	81	1	R3	I			FR	89	-	PL	SM	-	-	A0	1	0	0.5	25	
					3					FR	2	-	I	VR	-	-	A1	3	0	0.5	25	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
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Log of BH-2016BR6029

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
										FR	40	-	I	VR	Ca	T1	A2	3	0.75	0.5	25	
										FR	85	-	PL	SM	-	-	A1	1	0	0.5	25	
					2					FR	17	-	PL	VR	-	-	A0	1.5	0	0.5	25	
										FR	80	-	PL	SM	-	-	A0	1	0	0.5	25	
	33								limey SANDSTONE CONTACT, transitions into thicker beds 85 degrees to CA below 32.93 m	FR	85	-	PL	R	-	-	A1	1	0	0.5	25	
		R23	99	81	1	R3	I															
										FR	10	-	PL	VR	Ca	T1	A0	1.5	0.75	0.5	30	
					1				sheeted carbonate stringers 10 degrees to CA from 33.3 to 33.5 m	FR	8	-	PL	VR	Ca	T1	A0	1.5	0.75	0.5	30	
					0																	
					0																	
	34																					
					1																	
										JN	87	-	PL	SM	Cm	T2	A2	1	3	2	20	
		R24	98	95	1	R3	I		COAL infill between discontinuity from 34.3 to 35.1 m	JN	85	-	PL	VR	Cm	T2	A2	1.5	3	2	20	
										VN	15	-	-	-	Ca	T1	-	-	0.75	2	-	
					3																	
										JN	85	-	PL	SM	Cm	T1	A1	1	3	2	20	
										JN	87	-	PL	SM	Cm	T1	A1	1	3	2	20	
					0					BD	88	-	PL	SM	Cm	T3	A0	1	8	2	0	
	35																					
					0				shaley SILTSTONE interbeds < 6 cm, oxide infill within discontinuity below 34.3 m													
					0																	
					3					SH	80	-	C	K	Gr	T1	A1	0.5	3	2	10	
										FT	89	-	PL	SM	Cm	T3	A0	1	8	2	0	
		R25	100	98	0	R3	I			JN	10	-	PL	R	Ca	T1	A1	1.5	0.75	2	25	
	36																					
					1																	
										FR	84	-	PL	SM	-	-	A1	1	0	2	25	
					1					JN	15	-	PL	R	Ca	T1	A1	1.5	1	2	25	
										JN	5	-	PL	R	Ca	T1	A0	-	1	2	-	
					3																	
									SILTSTONE laminations, increased oxidation staining on healed fractures, fractures mostly parallel to bedding planes below 35.1 m	FR	90	-	PL	SM	-	T0	A2	1	0	4	25	
					12																	
	37									FR	20	-	I	VR	Ox	T0	A1	3	1	4	25	
					10					FR	90	-	PL	SM	Ox	T1	A1	1	0	4	25	
		R26	91	51	2	R3	II-III			JN	20	-	PL	R	Ox	T0	A1	1.5	1	4	20	
										BD	88	-	PL	SM	Cm	T1	A1	1	3	4	25	
					1																	
										FR	88	-	PL	VR	Ox	T0	A0	1.5	1	4	25	
					0					VN	30	-	PL	-	Ca	T1	A0	-	1	4	25	
										VN	30	-	PL	-	Ca	T1	A0	-	1	4	25	
	38																					
					12					JN	-	-	PL	SM	Ox	T1	A0	-	1	4	25	
										FR	90	-	PL	R	Ox	T1	A1	1.5	1	3	25	
		R27	95	53		R3	II-III		calcite stringers < 1mm thick 38 degrees to bedding plane	JN	-	-	U	R	Ox	T1	A1	1.5	1	3	25	

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Project: Teck BRE Tunnel Rehab. FS - U/G Geotech
Project Location: Sparwood, BC
Project Number: 60444413

Log of BH-2016BR6029

Elevation, meters	Depth, meters	ROCK CORE: Run No.	Recovery, %	RQD, %	Fractures/0.25m	Strength Index	Weathering Index	Lithology	MATERIAL DESCRIPTION	Discontinuity Description: Type	Alpha, °	Beta, °	Surface Shape	Surface Roughness	Infill Type	Thickness Rating	Openess Rating	Jr	Ja	Jn	Jcon	REMARKS AND OTHER TESTS
					13					FR	-	-	I	R	Ox	T1	A1	1.5	1	3	25	
										FR	80	-	C	SM	Ox	T1	A1	1.5	1	3	25	
										JN	-	-	PL	SM	Ox	T1	A1	1.5	1	3	25	
										FR	80	-	PL	SM	Ox	T1	A1	1.5	1	3	25	
					2					FR	5	-	PL	SM	Ox	T0	A0	1.5	1	3	25	
										FR	40	-	PL	SM	Ox	T1	A1	1.5	1	3	25	
										FR	85	-	I	R	Ox	T0	A0	3	1	3	25	
					1					FR	35	-	ST	SM	Ox	T1	A1	2	1	3	25	
		R27	95	53		R3	II-III			FR	-	-	U	R	Ox	T2	A2	3	1	3	25	
	39				1					FR	35	-	PL	SM	Ox	T1	A1	1.5	1	3	25	
					0																	
	40								**END OF BOREHOLE AT 39.6 m ABOVE TUNNEL ROOF IN SANDSTONE.** Notes: 1. Borehole termination at 48.8 m in silty SANDSTONE. 2. Seepage observed from borehole after drilliing completion (to be confirmed). 3. Borehole instrumented with multi point bore hole extensometere (MPBX), MPBX anchor set at approximately 20m (Anchor 1), 12m (Anchor 2), 8m (Anchor 3) and 4m (Anchor 4) above tunnel roof. 4. MPBX monitoring: - September 16 (6.5°C) Anchor 1: 4080.8; Anchor 2: 2781.5; Anchor 3: 2741.1 & Anchor 4: 2489.4. - September 20 (6.4°C) Anchor 1: 4071.6; Anchor 2: 2763.3; Anchor 3: 2744.6 & Anchor 4: 2492.4. 5. Measured water flow: - September 19, 2016: ~0.38 litres/second.												
	41																					
	42																					
	43																					

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